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Green finance and green growth nexus: evaluating the role of globalization and human capital

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ABSTRACT

Green finance is one of the emerging research areas, particularly in academia and industries. However, its contribution to green growth remains relatively unexplored. Unlike previous studies, the current research contributes to the existing literature by using green finance as a policy tool for achieving green growth. The method of moment quantile regression is used to investigate the link between green finance and other control variables on green growth in the 19 selected OECD economies from 1990 and 2021. The main findings of the study support the idea that green finance accelerates green growth in the selected countries. Similarly, the results for human capital show a significantly positive relationship with green growth. Additionally, increase in globalization and GDP decrease green growth. To promote green growth and achieve the sustainable environmental goals set by OECD economies, policymakers and regulators must prioritize green finance.

ARTICLE HISTORY

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KEYWORDS

Green finance; green growth; OECD economies; MMQR approach

1. Introduction

Many financial activities around the globe experienced a slowdown and in some cases production even came to a halt due to the COVID-19 pandemic that began at the end of 2019 (Xu et al., 2023). Scholars and environmentalists worldwide (Feng et al., 2022; Z. Khan et al., 2023; Werikhe, 2022; Xu et al., 2023) argue that as firms and ventures resume their financial operations, they should prioritize environmental concerns. This concept is often referred to as the green recovery of the global economy and there is an urgent need for nations to work towards achieving their sustainable development goals (Xu et al., 2023; Yu et al., 2023). Furthermore, the green economic recovery can lead to an environmentally friendly society, innovations, worldwide integration, create employment, a carbon-neutral economy, and a reduction in severe environmental issues. Conversely pushing economies to embrace the idea of green economic recovery will undoubtedly promote the transition to clean energy and reduce the world's dependence on fossil fules. Considering non-renewable energy sources primarily petroleum as the root cause of economic crises such as oil shocks, political tensions, and even armed

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conflict among nations (Johnstone & McLeish, 2020; G. Li et al., 2020; Xu et al., 2023) a green economic recovery that reduces reliance on fossils fuels can lead to a positive outcomes such as peace and stability.

Although all the benefits of green economic restoration, the most difficult challenge is the absence of sufficient capital to sustain green tasks. Financiers in the economic sector are reluctant to sustain green projects given that they frequently have late returns and also pay low profits in the future. The lack of funding for varied green project development is reviewed as a critical concern since federal governments, particularly in developing nations, need more cash to progress all environment-friendly efforts and various other financial projects. This issue became more serious during the COVID-19 pandemic. The government's concentration became more serious on saving the lives of the people, and there was little importance given to such projects (Martawardaya et al., 2022). As a result, developed and developing economies must find a suitable solution to counteract these flaws. One of the most viable and inventive approaches to address this serious problem is to use green finance systematically and economically. Green financing is expected to effectively stimulate exogenous green growth through increased investment in green initiatives. Furthermore implementing environmentally sustainable initiatives will enhance overall welfare, establish eco-conscious economic structures, mitigate mortality rate caused by air pollution, and generate employment opportunities. The development of renewable resources enables the revival of the economy, leading to sustainable growth and eco-friendly economic advancement. Huang et al., (2022) believed that green finance can facilitate the advancement of green technologies in advanced nations. The objective of green development is to modernize countries, reduce their energy consumption, and promote the use of innovative green technologies. Similarly, Zhang et al. (2022) asserted that the implementation of environmentally friendly initiatives can boost the effectiveness of green finance as a driver for sustainable development in impoverished countries.

It is critically important to investigate the relationship between green finance and green growth, particularly in the post-COVID-19 pandemic, when economies are attempting to revive economic development based on environmental factors. For this purpose, numerous studies took place and they have examined different indicators for green growth and environmental issues. These indicators such as industrialization (Mealy & Teytelboym, 2022), renewable energy consumption (T. Jiang et al., 2022; Sarwar, 2022), financial development (Xuan et al., 2023), globalization (Chen et al., 2023), fiscal decentralization (Tufail et al., 2021), agriculture (Y. Lin & Li, 2023) and tourism (Shang et al., 2023). However, the existing body of previous studies has ignored the relationship between green finance and green growth, particularly in OECD economies. Furthermore, to additionally explain the green finance in selected OECD countries Figure 1 presents the variation in diverse environmentally related government R&D budgets in these economies. We calculated the averages of each year for all 19 selected economies and presented the result in Figure 1.

The graph illustrates the consistent gradual increase in green finance across OECD economies. However, Figure 1 additionally shows that green finance decreased during the global economic crisis of (2007–08) which went through a large adverse adjustment in 2010, which is an indication of the European financial obligation situation. After 2008 these economies gradually moved towards a better green finance system. Unfortunately,



Figure 1. Green finance in OECD economies 1990–2021. Source: Authors visualization based on 19 (OECD) economies panel data from OECD statistics.

again at the end of 2019 when the pandemic started, these economies decreased their finances, particularly for environmentally friendly projects. The decline in green finance in OECD economies during the specified years may be attributed to changes in government administrations, the global financial crisis, and the COVID-19 pandemic. However, several barriers to green finance exist, including a lack of comprehension among financiers. Moreover, investors often face challenges in decision-making due to insufficient information and stringent quality requirements. As green finance aligns with conventional finance and contributes to the economic growth of countries, the concept is still emerging and there remains an urgent need for in-depth research.

Based on the above discussion it is important to study whether the ongoing development of green finance in the selected OECD economies can contribute to the advancement of green growth. This is particularly valuable for analyzing and assessing the ongoing development of green finance in OECD economies. Moreover, it is evident from the preceding discussion that additional studies are necessary to establish the link between green finance and green growth. Therefore, our current research aims to address this gap by examining the effect of green finance on green growth in the selected

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Figure 2. Methodological Design. Source: Authors Visualization

economies. Additionally, we have incorporated essential control variables such as human capital, globalization, and economic development to conduct a more comprehensive analysis of their influence on green growth. The selection of these variables is based on the high literacy rates, well-globalized market, and pursuit of high economic growth in OECD economies. We employed the MMQR regression method because it provides a flexible and robust framework for modeling the conditional distribution of the dependent variable, accounting for heterogeneity, outliers, and nonlinear relationships. This research assesses the current state of green development in OECD economies and explores its potential impact on future green growth. The findings of this research have the potential to aid policymakers and environmentalists in recognizing green finance as a pivotal indicator for fostering green growth and contributing to the protection of the ecosystem for both present and future generations. We selected the OECD economies for this study because these economies collectively represent a substantial share of the global economy. The OECD member states include some of the world's advanced economies such as the USA, Australia, Denmark, and others. These nations play a significant role in globalization, international trade, and investment. Furthermore, they possess robust institutional frameworks and regulatory environments that can facilitate the



Figure 3. Visualization of MMQR results. Source: Authors Visualization based on MMQREG technique applied in STATA.

implementation of green finance initiatives including well-established financial systems, effective governance structures, and a mature legal framework. Therefore, studying the experiences and knowledge of these economies is essential for a comprehensive understanding of the subject matter.

Based on the article's aims and contribution to previous literature the study structure can be designed in the following way. Section 2 deeply elaborates on the recent literature review relevant to the study and formulates the literature gap. Section 3 discusses the theoretical mechanism and methodology of the study. The section 4 discusses the results as well as discussions. Section 5 elaborates conclusion and appropriate policy recommendations.

2. Literature review

2.1. Green finance and green growth

Although there is no globally approved definition of green finance as a brand-new financial model the literature offers three basic summaries. The first is environmental finance, which provides financial solutions to address practical issues such as environmental management, pollution monitoring, resource preservation, and other eco-friendly initiatives (Latif et al., 2022). According to the 2nd perspective, financial development employs various financial techniques and products to mitigate environmental risks (Bhattacharyya, 2022). The third and most recent perspective posits that green finance constitutes a financial framework that promotes environmentally friendly investments and contributes to the development of an environmentally conscious society with a focus on carbon finance (Zhao et al., 2023). Generally, prior research in the field of

green finance can be categorized into two distinct study groups. The first group concentrated on the efficiency aspect of green finance solutions examining how this strategy could be implemented using sustainable growth strategies in various countries both theoretically and experimentally. Conversely, several studies have demonstrated the ineffectiveness of financial strategies due to various reasons including the lack of transparency in policymaking and government intervention.

In the first group of studies, various findings highlighted the effectiveness of green finance tools in advancing green growth and energy transformation goals. For instance, M. A. Khan et al. (2022) studied Asian economies and found that green finance helps reduce carbon footprint. Similarly, Peng & Xiong (2022) conducted research in China and concluded that it promoted Chinese green projects. Furthermore, Al Mamun et al. (2022) examined the global impact of green finance showing significant positive effects worldwide. The second group focused on the relationship between green finance tools and other financial sector indicators. For instance, R. Wang et al. (2022) investigated the effectiveness of green finance advertisements on green growth but found limited impact on development targets. M. Liu (2022) discovered the inefficiency of the green bond market due to its poor resilience to volatility. Adekoya et al. (2021) found a similar inefficiency in the U.S. green bond market due to high volatility. In the case of Hong Kong, Ng (2018) concluded that practical plans and market-based approaches are necessary for the green finance system to be more effective. Similarly, in the case of Colombia, Ruiz et al. (2016) advocated for government intervention to stimulate private involvement in the green financing system.

The second group of studies investigated the complex relationship between green finance tools and various key factors. The literature in this domain probed the intersections of green finance with resource efficiency and its impact on green growth as exemplified by the work of Sun et al. (2022). Desalegn & Tangl (2022) conducted a comprehensive review of prior studies culminating in the discernment that green finance indeed exerts a positive influence on overall green economic growth. Huang et al. (2022) contended that substantial green growth can be realized through the judicious application of green finance driven by the catalytic spillover effect of green technology. This argument received empirical validation in the research conducted by Mngumi et al. (2022), who meticulously analyzed spanning the BRICS economies from 2005 to 2019 using a panel quantile regression methodology. Furthermore, H. Zhou & Xu (2022) illustrated the outcomes derived from the advancement of fintech technology with this progress moderated by green finance, ultimately leading to a discernible upsurge in green economic growth. X. Wang & Wang (2021) underscored the pivotal role played by green finance in the revitalization of the commercial framework thereby contributing positively to green growth (X. Zhou et al., 2020). in their study focused on various provinces in China unearthed that green finance serves as a potent driver not only for economic expansion but also for environmental enhancement.

2.2. Globalization and green growth

Social Scientists and policymakers have engaged in robust debates concerning the impact of globalization on economic growth. Some argue that globalization fosters sustainable development (Jahanger, Chishti, et al., 2022; Zeraibi et al., 2023). Ulucak et al. (2020) identified three channels through which globalization affects eco-friendly development. The "scale impact" posits that economic globalization may raise nonrenewable fuel consumption, potentially harming environmental quality. The "technological effect" effect contends that it can promote more efficient and environmentally friendly green development. The structure effect suggested a nuanced link with both positive and negative implications for eco-friendly growth (Chen et al., 2023). The impact of financial globalization varies across studies. C. Jiang & Chang (2022) found a positive influence on the ecofriendly development of the host economy while Song et al. (2015) indicated potential efficiency reduction in heavily polluting industries. X. L. Wang et al. (2021) highlighted negative spillover effects on eco-friendly productivity in the industrial sector. However, W. Li et al. (2019) argued that financial globalization leads to technological advancement that expedites eco-friendly transformation in the host economies' industrial sectors promoting eco-friendly development. B. Lin & Zhu (2019) observed a positive effect in Taiwan, Macao, and Hong Kong while Chen et al. (2023) suggested a beneficial impact on domestic consumers further stimulating eco-friendly growth. These findings underscore the ongoing debate surroundings the influence of economic globalization on green growth

2.3. Human capital and green growth

The endogenous growth theory underscores the pivotal role of human capital in the production process and economic growth (Jahanger, Hossain, et al., 2023; Zafar et al., 2019). Human capital is intricately connected with the natural system and exerts a substantial influence on environmental issues. For instance, it facilitates the adaptation of the economic system, spurs industrial growth, enhances public awareness of environmental concerns, and encourages the development of green technologies through research and development investment (Ganda, 2022). Recent research substantiated the positive impact of human capital on carbon emissions reduction in BRICS economies for the period of 1990 to 2017 (Ganda, 2022). This underscored the importance of ongoing environmental education to promote comprehension of zero emissions policies and foster sustainable environmental prosperity. Further research revealed that South Asia displays a higher propensity to embrace green technologies and promote the sustainable use of natural resources when equipped with advanced knowledge and education (Sarkodie et al., 2020). Similar findings are evident in the context of Latin America and the Caribbean (Nathaniel et al., 2021) where the development of human capital and increased environmental awareness and conducive to sustainable economic growth. A study conducted in Pakistan between 1971 and 2014 demonstrated that a higher level of human development led to a reduction in carbon emissions without impeding economic expansion (Bano et al., 2018). In the case of the United States, Zafar et al. (2019) used the ARDL model and found that human capital has a positive impact on environmental quality and efficient utilization of natural resources.

2.4. Economic growth and green growth

The available literature has not directly explored the specific relationship between economic growth and green growth though a limited body of literature has explored 8 🖌 M. TUFAIL ET AL.

the interconnection between economic growth and green innovation which can ultimately contribute to the realization of green growth (Samad & Manzoor, 2011). examined the critical role of economic growth in nurturing green development. They posited that economic growth facilitates green innovation by creating a broader market for technological advancement and by enabling increased investment in green technologies. D. Liu et al. (2020) explored into the repercussions of government-set economic growth targets concerning resource allocation and their implications for development. In a similar vein. Meirun et al. (2021) conducted a study in Singapore employing the BARDL model revealing a positive relationship between economic growth and the development of green technology in both the short and long run. Conversely, Shen et al. (2021) and L. Wang et al. (2021) asserted that an elevation in economic growth targets can impede the progress of green technology. Their argument centers on the prioritization of quantity over the quality of development, potentially stifling green innovations.

2.5. Literature gap

It is evident from the literature review provided above that the selected 19 OECD economies in particular lack satisfactory explanations of the four primary variables of concern mentioned earlier. However, to formulate interactive strategies aimed at collectively achieving high green growth in these countries, it is imperative to assess these potential variables and their impact on green growth to inform relevant policymaking objectives. Furthermore, trade, globalization, and massive energy projects serve as common bonds among OECD countries. Moreover, previous research on the contribution of green finance, globalization, and human capital to long-term sustainability has often neglected the potential cross-sectional dependence and slope heterogeneity in the panel data, which can lead to biased findings. Consequently, this study employs an appropriate econometric methods that address issues such as non-stationarity, heterogeneity, endogeneity, and cross-section dependence.

3. Theoretical mechanism and methodology

3.1. Theoretical mechanism and model building

This section explored the theoretical linkages between green finance (GREF), globalization (GLOB), economic growth (GDP), and human capital (HUMC) exploring their influence on green growth (GREG). In recent times there has been a growing global awareness of the urgent need to address environmental issues and promote sustainable development. In parallel the concept of "Green Growth" has gained significant prominence as a response to the increasingly conspicuous challenges posed by climate change and the over-exploitation of natural resources. Green growth constitutes an economic development paradigm that strives to achieve prosperity while concurrently mitigating ecosystem degradation. At the heart of the pursuit of green growth lies the concept of green finance which include the application of financial mechanisms to support environmentally sustainable projects.

The Environmental Kuznets Curve (EKC) theory posits an inverted U-shaped relationship between environmental deterioration and income per capita (Jahanger, Ozturk, et al., 2023; Kuznets, 1955; Mahmood, 2023; Mahmood, Hassan, et al., 2023; Mahmood, Saqib, et al., 2023; Yang et al., 2023). In the initial stages of economic development, as a nation's wealth increases, environmental degradation tends to exacerbate due to heightened industrialization and resource consumption. As societies amass greater affluence there is typically an inclination to prioritize environmental protection, resulting in a decrease in environmental deterioration once a particular income threshold is surpassed. At this stage, green finance may play a pivotal role by channeling funds toward sustainable practices, renewable energy, and eco-friendly technologies. This include investments in sustainable transportation, energy-efficient infrastructure, and renewable energy projects. As economies progress and income levels ascend the deleterious impact on the environment may intensify but simultaneously awareness of environmental issues heightens. Green finance encourages businesses to adopt more environmentally friendly technologies and procedures facilitating the transition toward sustainable development. Initiatives such as green bonds are instrumental in raising funds for environmentally sound enterprises. According to the EKC theory, there is a turning point at which environmental degradation declines as income levels continue to rise. At this juncture, societies can invest in cleaner technologies and practices. By taking into consideration the long-term benefits of integrating environmental factors into financial decisions, green finance may motivate industries to formulate enduring environmentally conscious strategies. In this framework, the majority of the selected OECD economies have traversed these development stages. Consequently, we anticipate that the swift introduction and execution of green finance initiatives may support green growth in these economies, such as $\delta_1 = \frac{\text{GRE}\tilde{G}_{\text{it}}}{\text{GREE}_{*}} > 0$.

In the filed of environmental economics, Chichilnisky (1994) and Copeland & Taylor (1994) have made notable contributions to the discourse on the Pollution Heaven Hypothesis. This concept can be significantly influenced by the forces of globalization, characterized by increased trade and investment flows between nations. In this context, businesses may opt to relocate their production operations to countries with less stringent environmental regulations to curtail expenses and boost their profitability inadvertently leading to the phenomenon of "exporting pollution". The environment and green growth in OECD nations may suffer as a result of this issue. Therefore we anticipate that globalization reduce green growth in these countries such as $\delta_2 = \frac{\text{GREG}_{it}}{\text{GLOB}_{it}} < 0$. On the other hand, the human capital theory introduced by (Becker, 1964) emphasizes the significance of education, training, and skills as a form of capital in which individuals can invest. According to this theory enhancing people's abilities to foster environmentally friendly economic activities can be achieved within the framework of green growth through investment in education and training associated with sustainable practices, renewable technology, and environmental management. Those who have specialized knowledge in areas such as renewable energy, sustainable agriculture, resource efficiency, and circular economy concepts may make significant contributions to the development of green growth. Countries may make the switch to greener economic models by investing in human capital in these fields. That's why we are expecting that human capital may promote green growth in OECD economies such as $\delta_3 = \frac{\text{GREG}_{it}}{\text{HUMC}_{it}} > 0$. In case of rapid economic growth countries' enhanced reliance on conventional fossil fuels might trigger the industrial sector to expand, which would certainly better urge boosted per capita income and also the distribution of revenue. Nonetheless, the raised per capita income also leads to greater financial savings and the level of financial investment in the industry, which even increases the energy demand. Subsequently, much more nonrenewable fuel source is shed, as demonstrated by the situations of some OECD economies that import a huge amount of energy. This high level of energy consumption increases economic growth but adversely affects the environment. That's why we predict that rapid economic growth decreases green growth in OECD economies s $\delta_4 = \frac{\text{GREG}_{it}}{\text{GDPP}_{it}} > 0$.

Therefore, based on the above theoretical framework and extensively elaborated literature this article intends to investigate the green finance (GREF) and green growth (GREG) nexus along with other mandatory variables such as globalization (GLOB), human capital (HUMC), and economic growth (GDP) in the targeted 19 OECD economies during 1990 to 2021. It is generally agreed upon that panel data allows for a more adaptable and comprehensive method of investigating problems and their components (Tufail, Song, Ali, et al., 2022). Following the study of Jiakui et al. (2023) and Xu et al. (2023), this study designs the following model for conducting empirical research.

$$GREG_{it} = f(GREF_{it}, GLOB_{it}, HUMC_{it}, GDP_{it})$$
(1)

For more clarification and easily understandable the above model can be converted into the regression model in the following way.

$$GREG_{it} = \gamma_0 + \delta_1 GREF_{it} + \delta_2 GLOB_{it} + \delta_3 HUMC_{it} + \delta_4 GDP_{it} + e_{it}$$
(2)

Where γ_0 absorbs the model intercept, the slope of variables is denoted by δ' . The random error of the model is e_{it} , while i represents the cross section (comprising 19 OECD countries in this specific context) and t indicates the time period which is 1990 to 2021. The selected 19 OECD economies are presented in Table A1 in the Appendix A. The choice of this specific time period is underpinned by several considerations. The emergence of the concept of green finance and sustainable development was particularly notable in the year 1990. Additionally, the selected time frame encapsulates various significant environmental events such as the Kyoto Protocol and Paris Agreement which contributed to an increased global focus on climate change and sustainable development. It is noteworthy that this period also cover unfavorable events including the global financial crisis of 2007–2008 and the COVID-19 pandemic at the end of 2019.

The Data for these variables are retrieved from reputable and widely recognized sources such as the World Development Indicator, OECD Statistics, KOF Swiss Economic Institute, and Penn World Table. A comprehensive overview of the variables including notations, measurements, and the respective sources of data is provided in details Table 1. There are, nevertheless, several developed and growing economies. While Most of the OECD countries consist a diverse group of member countries, the majority of these nations are characterized by their advanced economic status and exhibit varying degrees of commitment to environmental sustainability. In response to environmental challenges, these nations have undertaken various policy measures and regulatory initiatives aimed at promoting green finance with the dual objectives of mitigating environmental

Variable Title	Abbreviation	Measurement	Source
Green Growth	GREG	Environmentally adjusted multifactor productivity growth.	OECD Statistics
Green Finance	GREF	Environmentally related government R&D budget, percentage total government R&D.	OECD Statistics
Globalization	GLOB	KOF globalization index.	KOF Swiss Economic Institute
Human Capital	HUMC	Human capital index.	Penn World Table
Economic Growth	GDP	Constant 2015 US dollars	World Bank

Table 1. Variables description and sources.

degradation and fostering green growth. Therefore, examining these economies assumes paramount significance. Given their economic capabilities and commitment to sustainability, these OECD countries possess the potential to play an important role in increasing green growth, thereby serving as an example for the global community.

3.2. Econometric methodology

To comprehensively examine panel data, this study conducts a detailed statistical analysis of the selected variables. This analysis includes key statistical indicators such as mean, median, range, minimum, and maximum values, which provide fundamental insights into the dataset. Additionally, the standard deviation is calculated to assess the degree of variation from the mean indicating the data volatility over time. Moreover, the distributional properties of the data are investigated using normality metrics, specifically skewness and kurtosis. These metrics help evaluate whether the variable's distribution confirms normality requirements. While Skewness and Kurtosis offer precise insights into the data dispersion this study, explore deeper into the assessment of normality. It employs (Jarque & Bera, 1987) which examines excess Kurtosis and Skewness assuming that they have ideally zero values to support the assumption of normal distribution within the dataset. Below is the Jarque-Bera mathematical expression.

$$JB = N \cdot \frac{1}{6} \left(S^2 + \frac{(K-3)^2}{4} \right)$$
(3)

This study primarily focuses on panel data analysis necessitating the use of appropriate econometric tools tailored for panel data. The initial concern is to address the presence of cross-sectional dependency and slope heterogeneity among the panel data. While the economies under consideration may share some similarities these commonalities could lead to inaccurate findings in econometric research, particularly in panel estimates. Therefore, it is crucial to assess the 19 OECD economies for the presence of parallel or distinct characteristics. To achieve this, the suitable coefficient heterogeneity test introduced by M. H. Pesaran & Yamagata (2008) is applied. The equation for this test is as follows.

$$\hat{\Delta}_{SCH} = (N)^{1/2} (2k)^{-1/2} \left(\frac{1}{N} \dot{S} - K \right)$$
(4)

$$\hat{\Delta}_{ASCH} = (N)^{1/2} \left(\frac{2K(T - K - 1)}{T + 1} \right)^{-1/2} \left(\frac{1}{N} S - 2K \right)$$
(5)

In the above equation Δ_{SCH} indicates the slope coefficient homogeneity. The Δ_{ASCH} stands for the homogeneity of the slope coefficient following modification or correction.

In today's globalized economic market, several factors can render a nation highly interconnected with the rest of the world, such that a change in one parameter in a given area may affect another region or country. Neglecting cross-sectional dependence can lead to inaccurate or biased results. To address this, we employ the cross-section dependence test introduced by H. Pesaran (2004) to assess interdependence among the 19 OECD economies. This test which utilizes independent cross-sections as the null hypothesis, is mathematically represented as follows:

$$CD_{Test} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{k=1+i}^{N} T_{ik}$$
(6)

This study employs a suitable unit root estimation method to address common challenges in the panel data analysis such as cross-section dependence and slope coefficient heterogeneity. The research relies on the M. H. Pesaran (2007) cross-sectional IPS (i.e., CIPS) test known for its reliability compared to Levin, Lin, Chu, Dickey-Fuller, and augmented Dickey-Fuller. In the beginning, M. H. Pesaran (2006) introduced a factor model to investigate unexplained cross-sectional means associated with cross-sectional dependence. The ordinary and first differenced cross-section lags are combined into the Increased Dickey-Fuller linear expression (M. H. Pesaran, 2007) utilizing the same techniques regardless of whether the panel is unbalanced (T > NorN > T), this approach allowed for cross-sectional dependence. The CIPS statistics are calculated using the following equation:

$$CIPS = N^{-1} \sum_{i=1}^{N} CADF_i$$
(7)

In some cases, the M. H. Pesaran (2007) test assumes that a panel time series' unit root would be constant.

This approach enables the identification of the long-term equilibrium relationship between the study variables as all variables become stationary. Diagnostic test results confirm cross-sectional dependence and indicate variability in the slope coefficients. To address these challenges this research employs a robust empirical method. Specifically, the cointegration test developed by Westerlund (2007) is used for error correction. In this test, the null hypothesis assumes that the error adjustment term will have a value of zero. This method is very important because it covers both the group statistics i.e., $G_{\tau} = \frac{1}{N} \sum_{i=1}^{N} \frac{\hat{\alpha}_i}{S.E\hat{\alpha}_i}$, and $G_a = \frac{1}{N} \sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}$, as well as the panel statistics i.e., $P_{\tau} = \frac{\hat{\alpha}}{S.E(\alpha)}$, and $P_a = T.\hat{\alpha}$ in the analysis.

The considered variables exhibited stationarity, a prerequisite for calculating long-run elasticities, and also encompassed elements of long-run cointegration,

enabling the computation of long-run elasticities. However, the subsequent analysis encountered non-symmetric data distribution, necessitating the utilization of an advanced method of moment quantile regression (MMQR) approach. While techniques such as FMOLS, DOLS, GMM, and others can be employed to obtain the long-term coefficients, they have limitations in addressing nonlinearity potentially leading to inconsistent results.

As suggested by Koenker & Bassett (1978) conditional difference can be employed to address issues related to nonlinearity while the quantile regression technique is suitable for examining mean dependency. Machado & Silva (2019) presented the method of moment quantile regression approach for assessing the variability in quantile estimations concerning the latter method. The advanced expression for the conditional location-scale variance is denoted by $Q_y(\tau | R)$ and is defined as follows.

$$Y_{it} = \alpha_i + \beta R_{it} + (\gamma_i + \rho \dot{Z}_{it}) \mu_{it}$$
(8)

In the preceding expression the probability representation $p(\gamma_i + \rho Z_{it})$ equal to one, while the values of α, β, γ , and ρ are determined by this study's chosen anticipation. The subscript i designates the fixed effect constrained to the values i = 1, 2, ..., n characterized by the parameters α_i and γ_i . The k-vector, represented as Z in this context, denotes the defining characteristic of R, and vector "i" signifies unpredictability.

$$Z_I = Z_1(R), i = 1, 2, \dots, k$$
 (9)

R_{it}is distributed identically and independently across all fixed i and time points (t), and it is orthogonal to both t and i, as explained in the equation (Machado & Silva, 2019). Consequently, both reserves and external components remain constant. In light of this clarification, the previously described model can be modified as follows:

$$Q_{y}(\tau \mid R_{it}) = (\alpha_{i} + \gamma_{i}q(\tau)) + \beta R_{it} + \rho \dot{Z}_{it}q(\tau)$$
(10)

The list of independent variables in the specialized research framework has been increased R_{it} to include GREF, GLOB, GDP, and HUMC. Each of these variables is transformed into a natural logarithm, removing units and allowing the presentation of estimated results as a percentage. Additionally, as mentioned by Y_{it}, R_{it} indicates the quantile dispersion of the predictor variables, and in this investigation, R_{it} is assumed to be GREG, which also relies on the quantile location. Additionally, the equation $-\alpha_i(\tau) \equiv \alpha_i + \gamma_i q(\tau)$ reflects the scalar component that causes the fixed effect of τ quantiles. The intercept is unaffected by these quantiles, though. Due to the specifications' structural independence, several additional results are changeable. Finally, $q(\tau)$ represents the τ – thquantile sample, which in this study are Q^{0.25}, Q^{0.50}, Q^{0.75}, and Q⁹⁰. That's why the following formula for the quantile is used.

$$\min_{\mathbf{q}} \sum_{\mathbf{i}} \sum_{\mathbf{t}} \theta_{\tau} \big(\mathbf{R}_{\mathbf{it}} - \big(\gamma_{\mathbf{i}} + \rho \dot{\mathbf{Z}}_{\mathbf{it}} \big) \mathbf{q} \big) \tag{11}$$

where $\theta_{\tau}(A) = (\tau - 1)AI\{A \le 0\} + TAI\{A \ge 0\}$ represents testing features.

Besides the MMQR which is used for the long-run estimator, this research applied the (Dumitrescu & Hurlin, 2012) causality test as a robustness test. The linear model which was introduced by Dumitrescu & Hurlin (2012) is represented in the following way.

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$$y_{it} = a_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{it}$$
(12)

In the above equation $a_i and \beta_i$ the slope coefficients and individual intercept, while the symbol "i" and t represents cross-section and time period respectively. Moreover $\gamma_i^{(k)}$ and $\beta_i^{(k)}$ are the autoregressive parameters and the regression coefficient estimates respectively. In the temporal dimension, the parameters a_i and β_i are constant, but the parameters $\gamma_i^{(k)}$ and $\beta_i^{(k)}$ are expected to vary between nations. The (Dumitrescu & Hurlin, 2012) panel causality approach contrasts a causal relationship as the alternative to the null hypothesis of no causal relationship. Following are the average test statistic and standardized test statistic for the (Dumitrescu & Hurlin, 2012) test:

$$W_{N,T}^{HNC} = N^{-1} \sum_{i=1}^{N} W_{i,T}$$
 (13)

$$Z_{N,T}^{HNC} = \sqrt{\frac{N}{2M}} \left(W_{N,T}^{HNC} - M \right) \to N(0,1)$$
⁽¹⁴⁾

The $W_{i,T}$ shows the individual Wald statistics, while the $W_{N,T}^{HNC}$ and $Z_{N,T}^{HNC}$ represents the average and standardized test statistics. The methodological structure of the current study is outlined in Figure 2 respectively.

4. Results and discussion

This section presents the empirical findings of the study and discusses the assessment outlines in section 3. Table 2 provides the descriptive statistics for the targeted variables. The statistics reveal variations in the range values of the variables indicating an irregular monitoring pattern. To validate the volatility of the GREG, GLOB, GDP, HUMC, and GREF over the selected period, standard deviation values are assessed. The study also analyzes the non-normal distribution of the variables including Kurtosis and Skewness. Since the normality analysis as per (Jarque & Bera, 1987) is applied, this research considers data normality and significance concern. The results confirm that the observed statistics exceed the critical value at the 1%, 5%, and 10% significance level. Consequently, the null hypothesis is rejected for each of these variables, implying the presence of non-linearity in all of them.

Table 3 presents the results of slope heterogeneity and cross-sectional dependence. The outcomes of the test introduced by (M. H. Pesaran & Yamagata, 2008) for the

	1				
	GREG	GREF	GLOB	HUMC	GDP
Mean	2.127	3.959	76.64	3.116	8.33E+11
Median	1.885	2.740	79.47	3.135	2.51E+11
Maximum	10.33	20.78	90.32	3.721	4.58E+12
Minimum	-4.110	0.000	43.88	1.920	9.14E+09
Std. Dev.	2.119	4.171	10.23	0.384	1.14E+12
Skewness	0.923	2.133	-1.056	-0.568	1.679
Kurtosis	6.838	6.915	3.501	2.877	4.861
Jarque-Bera	459.7	849.5	119.5	33.10	373.4
Probability	0.000	0.000	0.000	0.000	0.000

Table 2. Descriptive statistics.

targeted model indicate a substantial and significant delta and adjusted delta values providing strong evidence to reject the null hypothesis of heterogeneous slope and support the alternative of heterogeneous slope at the 1% level of significance. The various financial frameworks and interdependencies among the targeted OECD countries offer a plausible explanation for this heterogeneity. When an economic phenomenon or event occurs in one country, it generates shockwaves in other nations. Furthermore, the results of the test (H. Pesaran, 2004) also support the acceptance of the alternative hypothesis of cross-section dependency for all variables found at the 1% and 5% significance levels. This indicates the presence of cross-sectional dependency among the cross-sectional units of the data. The integration of regional trade and economic activities amongst OECD countries is among the factors contributing to this cross-sectional dependency. These findings align with recent research specifically focused on green growth (Chen et al., 2023; Sharif et al., 2023).

The presence of cross-sectional dependency and slope heterogeneity in the panel data can result in biased and less informative results. To address this issue the study employs the most updated and robust panel unit root test introduced by (M. H. Pesaran, 2007). The outcomes of this test are presented in Table 4. The results confirm that globalization (GLOB) and green finance become stationary at the level. Conversely, when considered in the first differences the green growth (GREG), economic growth (GDP), and human capital become stationary at a 1 percent significance level.

The long-run connections between the variables are tested using two different cointegration tests namely (Pedroni, 1999) and the Johansen-Fisher panel test (Maddala & Wu, 1999). The results from these tests are presented in Table 5. The Pedroni cointegration test results reveal that six out of the eleven statistics (Panel PP, Panel ADF, Weighted Panel pp, Weighted Panel ADF, Group pp, and also Group ADF) are statistically

Table 3. Slope heterogeneity and cross-section dependence results.					
Homogenous/Heterogeneous Slope Coefficient Testing					
$\widetilde{\Delta}^{Ajusted}$					
27.277***					
ection Dependence Test					
GDP HUMC					
63.649*** 67.862***					

1% 5% and 10% significance is denoted by *** ** and *

170, 3 70, anu	10% signi	incance is	uenoteu	bу	'	, anu	

	At Level At Fi	rst Difference	
Variable(s)	I(0)	I(1)	Order of Integration
GREG	-2.217	-4.932***	I(1)
GLOB	-3.112***	-	I(0)
GDP	-1.962	-4.636***	I(1)
HUMC	0.219	-3.564***	I(1)
GREF	-3.316***	-	I(0)

Table 4. Panel unit root results.

1%, 5%, and 10% significance is denoted by ***, **, and *.

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H0: No cointegration	Statistics	Probability
Pedroni cointegration test	t	
Panel v	-0.0386	0.5154
Panel rho	0.4978	0.6907
Panel pp	-2.2651**	0.0118
Panel ADF	-2.4163***	0.0078
Weighted Panel v	-0.5307	0.7022
Weighted Panel rho	-0.3848	0.3502
Weighted Panel pp	-5.0208***	0.0000
Weighted Panel ADF	-5.6811***	0.0000
Group rho	1.5458	0.9389
Group pp	-4.0674***	0.0000
Group ADF	-3.3687***	0.0004
No. of CE(s)	Fisher stats* (trace test)	Fisher stats* (max-Eigen test)
Johansen Fisher Cointegra	ation test	
None	277.9***	181.0***
At most 1	135.4***	64.57***
At most 2	95.80***	51.38**
At most 3	76.89***	52.44**
At most 4	89.59***	89.59***

Table 5.	Panel	cointegration	test	results
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1%, 5%, and 10% significance is denoted by ***, **, and *.

significant at the 1% and 5% significance levels. Furthermore, the outcomes indicate the presence of a cointegrated connection between the targeted variables at the 1 percent significance level according to Fisher's cointegration test (trace test statistics or Max-Eigen test statistics, regardless). Therefore it can be concluded that the variables of interest which include green growth, green finance, globalization, human capital, and GDP tend to move together in the long run.

After establishing the cointegration among the targeted variables, we proceeded to conduct regression analysis to assess the long-run impact of the core explanatory variables notably green finance along with other control variables including globalization, human capital, and economic growth on green growth in the case of 19 OECD economies. To support this investigation, we employed the method of moment quantile regressions. The results of the MMQR analysis are presented in Table 6. Our findings reveal that green finance exerts a significant and positive influence on green growth across all quantiles. A one percent increase in green finance corresponds to a 0.015%,0.017%,0.20%, and 0.024% increase in green growth progressing from the lower (25th percentile) to the higher (90th percentile) quantiles. This emphasize the critical role played by Green finance in fostering green growth in OECD countries. In these nations, green finance enables the redirection of capital towards environmentally responsible and sustainable enterprises. Instruments such as green bonds, green loans,

			<u> </u>	-		
	Location	Scale		Quantiles		
Variables			Q _{0.25}	Q _{0.50}	Q _{0.75}	Q _{0.90}
GREF	0.0176	0.0033	0.0151***	0.0173***	0.0201***	0.0243***
GLOB	-0.0395	-0.0147	-0.0282**	-0.0380***	-0.0504***	-0.0689***
HUMC	1.4156	0.4556	1.0667***	1.3696***	1.7537***	2.3265***
GDP	-0.1856	-0.4073	-0.1263*	-0.1445*	-0.4878***	-1.0000***

Table 6. Method of moment quantile regression (MMQR).

1%, 5%, and 10% significance is denoted by ***, **, and *.

and sustainable mutual funds incentivized investors to channel their capital into projects with a favorable environmental impact. These projects includes areas such as energyefficient buildings, sustainable transportation systems, and renewable energy infrastructure. The promotion of green finance ultimately contributes to the expansion of the ecofriendly market. Furthermore, green finance catalyzes innovation by offering financial incentives for the development and promotion of green technology and sustainable practices. As financial institutions evaluate the environmental risk associated with their investments they recognize the potential for advancement in industries that contribute to environmental solutions. This in turn can drive the growth of green technologies including solar energy, wind energy, and electric vehicles, thereby revolutionizing markets and creating new avenues for green economic growth. The incentives provided by green finance systems play a crucial role in accelerating the adoption of these technologies, thereby supporting overall green growth in OECD countries. Our findings align with the conclusion drawn in recent studies by Gu et al. (2023), Xu et al. (2023), and G. Zhou et al. (2022).

The results of the MMQR analysis indicate that globalization has a negative and significant impact on green growth across all quantiles. Specifically, the findings suggest that a one percent increase in globalization is associated with a 0.028%,0.038%,0.050%, and 0.068% reduction in green growth ranging from the lower to high (25th percentile) to the higher (90th percentile) quantiles. This phenomenon can be attributed to the fact that the expansion of international trade and production has increased existing environmental issues such as deforestation, air pollution, and carbon emissions with many products traversing complex supply chains that span international borders, it becomes increasingly challenging to pinpoint the ultimate responsibility for a product's carbon footprint. Additionally, environmental regulations have often been relaxed in favor of growing economy, creating a delicate tradeoff between short-term progress and long-term environmental sustainability. The effect of globalization on green growth can be further influenced by variations in environmental regulation among OECD countries. The competition of foreign investment can lead nations to lower their environmental standards, resulting in a "race to the bottom" where environmental concerns are compromised for economic gains. Such regulatory disparities can create imbalances in green growth initiatives among OECD nations. These findings are consistent with previous studies by Ahmad & Wu (2022) and Xuan et al. (2023), while the results differ from the outcomes of Chen et al. (2023).

Table 6 reveals noteworthy observations: the results consistently affirm that human capital has a significant and positive influence on green growth across all quantiles. According to the outcomes in ceteris paribus a one percent increase in human capital is associated with a substantial 1.066%,1.369%,1.753%, and 2.326% increase in green growth from low to high (25th to 90th) quantiles. Human capital in this context plays a pivotal role as a catalyst for progress and a crucial driver of green growth. This positive relationship between human capital and green growth can be attributed to several factors. Knowledgeable and experienced individuals are better equipped to identify sustainable solutions, develop innovative green technologies, and implement resource-efficient practices. Investments in education and training contribute to building a workforce that is well-prepared to tackle environmental challenges creatively and devise novel approaches to more environmentally

H _o	Wald – Stats	\overline{Z} – Stats	p - value(s)
GLOB≠GREG	6.7199***	5.0033	0.000
GREG≠GLOB	8.5600***	4.7096	0.000
GDP≠GREG	6.3474***	7.6696	0.000
$GREG \neq GDP$	7.5330***	5.1776	0.000
HUMC≠GREG	9.7369***	6.8030	0.000
GREG≠HUMC	3.5462**	2.5219	0.011
GREF≠GREG	8.6413***	5.8590	0.000
$GREG \neq GREF$	3.2342*	1.9485	0.051

Table 7. Causality test (dumitrescu-hurlin).

1%, 5%, and 10% significance is denoted by ***, **, and *.

friendly methods. Furthermore, the influence of human capital extends to consumer behavior as it promotes a heightened awareness of the environmental consequences associated with consumption choices. Informed individuals are more likely to make choices that support sustainable products and services thereby encouraging businesses to adopt greener practices to this demand. In the context of OECD economies where there is a high literacy rate the role of human capital in driving green growth becomes especially pronounced. These findings align with prior research in existing literature underscoring the positive relationship between human capital and green growth as evidenced in studies by Nathaniel et al. (2021) and H. Wang et al. (2023).

Table 6 further affirms that economic growth has a negative and statistically significant impact on green growth across all quantiles in the case of selected 19 OECD economies. The results indicate that in ceteris paribus a 1 percent surge in economic growth is associated with a reduction of 0.126%,0.144%,0.487%, and 1.00% in green growth from low to high (25th to 90th) quantiles. High rates of economic growth are often linked to increased resource consumption including heightened demand for energy, water, and raw materials. If these resources are not managed sustainably, it can lead to environmental degradation and a decline in green growth. Additionally, it's worth noting that economic growth is typically measured on a quarterly or annual basis which can incentivize short-term decision-making. This emphasis on short-term gains may result in the neglect of long-term environmental considerations in favor of immediate financial benefits. This phenomenon has been observed in prior studies as demonstrated by Ngo et al. (2022); and Tufail, Song, Umut, et al. (2022). The results of the MMQR model are outlined in Figure 3.

It is crucial to check the robustness of the model to compare the results with the primary model of the study. Therefore this study employs the causality test proposed by Dumitrescu & Hurlin (2012) for conducting a robustness test. The results are detailed in Table 7, indicating the existence of bi-directional causality among all the selected variables. The variables GLOB \neq GREG, GREG \neq GLOB, GDP \neq GREG, GREG \neq GDP, HUMC \neq GREG, GREG \neq HUMC, GREF \neq GREG, and GREG \neq GREF show bidirectional causality with each other at significance levels with 1%, 5 %, and 10%. These results signify that globalization and green growth, economic growth and green growth, human capital and green growth, and green finance and green growth cause each other as statistically presented in Table 7. Furthermore, an overview of the abbreviations can be found in Table 8.

5. Conclusion, policy recommendations, and limitations

The concept of green finance, which combines economic resources with environmental progress, has garnered significant attention in contemporary financial and environmental literature. However, there remains a somewhat limited understanding of the relationship between green finance and green growth, specifically in the case of OECD economies. This study contributes novel insight to the existing body of research by scrutinizing the impact of green finance on green growth in the presence of human capital, globalization, and economic growth for panel of 19 selected OECD economies over the period 1990 to 2021. Employing rigorous econometric methods this study produces reliable and solid findings. It is noteworthy that the model suffers from slope heterogeneity and the cross-sections are dependent. All variables in the analysis exhibit mixed order integration, with some existing at a level while others require first differencing. Moreover, long-run cointegration is evident among all under investigation in this study. The findings emphasize the significance of green finance, human capital, globalization, and economic growth in the context of green growth. Notably an increase in green finance and enhanced human capital contribute positively to green growth in the sample OECD economies. In contrast, Globalization and GDP show a negative association with green growth. Furthermore, the study shows compelling evidence of bidirectional causality among all the variables targeted in the analysis.

This study suggests specific policy implications based on the findings. First, it recommends that OECD countries foster green finance by instituting consistent and transparent regulations that support environmentally responsible investments. These measures include the establishment of explicit criteria delineating green investment, ensuring standardized reporting on environmental impacts, and introducing tax incentives aimed at incentivizing individuals and businesses to invest in sustainable sectors. Collectively these measures serve to promote green growth by attracting financial support for ecofriendly projects, enhancing transparency, and reducing financial barriers for those interested in championing environmentally beneficial initiatives. Second it is suggested that expanding the green bond market represents a strategic approach to facilitate the financing of environmentally responsible initiatives in the case of OECD economies. Green bonds are financial instruments purposefully designed to finance environmental projects. Furthermore, financial institutions can be encouraged to create and promote these bonds thereby fostering their growth. These bonds are structured following green investment criteria, rendering them appealing to socially and environmentally conscious investors. Additionally, governments can issue green bonds to raise funds for environmentally friendly programs and initiatives. In doing so, they not only demonstrate their commitment to sustainability but also attract investment from individuals and institutions interested in supporting environmental causes. This development of the green bond market increases the availability of capital for projects contributing to environmental wellbeing thereby consolidating actions to achieve environmental sustainability. Third it is suggested that collaboration with both OECD and non-OECD nations is critical for establishing standardized norms in green finance and fostering international investment in sustainable initiatives. This collaboration necessitates active engagement in international climate accords and initiatives designed to align national policies with

global sustainability objectives. Through participation in these international initiatives, countries can harmonize their approaches to green finance thereby establishing consistent standards and regulations that facilitate cross-border investments in environmentally responsible projects. This not only serves to channel more funding towards sustainable initiatives but also ensures that nations work collectively toward a shared goal of combating climate change and promoting green growth on a global scale.

The study is subject to certain limitations. First and foremost, it is essential to note that the study scope is constrained to the investigation of 19 OECD economies. Originally, we intended to encompass all 37 OECD economies. However, due to data limitations, the selection was reduced from 37 to 19 economies. Additionally, despite our initial objective to cover data up to the year 2023 limitations in the available data constrained us to restrict our empirical analysis to date up to 2021. Furthermore, it would be of significant interest for future research to consider the impact of recent global crises like the Israel-Palestinian conflict the Russia- Ukraine conflict, and the economic consequences of COVID-19. These crises have significantly disturbed the global economic landscape, and an investigation into their effects could yield valuable insights. Morover this study focuses on OECD economies as a case study, future research studies could explore other economic groups such as BRICS, G7, and G8 potentially leading to informative and innovative findings. Additionally, there is potential for further research to examine the relationship between green finance and various other factors including social, governance, and environmental dimensions. Analyzing these multidimensional relationships could may provide a more comprehensive understanding of the dynamics at play in green finance initiatives.

Abbreviations

OECD	Organization for Economic Cooperation and Development
MMQR	Method of Moment Quantile Regressions
ARDL	Auto Regressive Distributive Lag
EKC	Environmental Kuznets Curve
GREG	Green Growth
GREF	Green Finance
GLOB	Globalization
GDP	Gross Domestic Product
HUMC	Human Capital
R&D	Research and Development

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References

- Adekoya, O. B., Oliyide, J. A., Asl, M. G., & Jalalifar, S. (2021). Financing the green projects: Market efficiency and volatility persistence of green versus conventional bonds, and the comparative effects of health and financial crises. *International Review of Financial Analysis*, 78, 101954. https://doi.org/10.1016/j.irfa.2021.101954
- Ahmad, M., & Wu, Y. (2022). Combined role of green productivity growth, economic globalization, and eco-innovation in achieving ecological sustainability for OECD economies. *Journal of Environmental Management*, 302, 113980. https://doi.org/10.1016/j.jenvman.2021.113980
- Al Mamun, M., Boubaker, S., & Nguyen, D. K. (2022). Green finance and decarbonization: Evidence from around the world. *Finance Research Letters*, 46, 102807. https://doi.org/10. 1016/j.frl.2022.102807
- Bano, S., Zhao, Y., Ahmad, A., Wang, S., & Liu, Y. (2018). Identifying the impacts of human capital on carbon emissions in Pakistan. *Journal of Cleaner Production*, 183, 1082–1092. https://doi.org/10.1016/j.jclepro.2018.02.008
- Becker, G. (1964). *Human capital*. (Press for the National Bureau of Economic Research. In: 1993, 3rd ed., Human Capital: A theoretical and empirical Analysis, with). Columbia University.
- Bhattacharyya, R. (2022). Green finance for energy transition, climate action and sustainable development: Overview of concepts, applications, implementation and challenges. *Green Finance*, 4(1), 1–35. https://doi.org/10.3934/GF.2022001
- Chen, R., Ramzan, M., Hafeez, M., & Ullah, S. (2023). Green innovation-green growth nexus in BRICS: Does financial globalization matter? *Journal of Innovation & Knowledge*, 8(1), 100286. https://doi.org/10.1016/j.jik.2022.100286

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- Chichilnisky, G. (1994). Property rights and the dynamics of renewable resources in north-south trade. In *Trade, innovation, environment* (Vol. 2, pp. 15–54). Springer. https://doi.org/10.1007/978-94-011-0948-2_2
- Copeland, B., & Taylor, M. S. (1994). Taylor MS. North-South trade and the environment. *The Quarterly Journal of Economics*, 109(3), 755–787. https://doi.org/10.2307/2118421
- Desalegn, G., & Tangl, A. (2022). Enhancing green finance for inclusive green growth: A systematic approach. *Sustainability*, *14*(12), 7416. https://doi.org/10.3390/su14127416
- Dumitrescu, E.-I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), 1450–1460. https://doi.org/10.1016/j.econmod.2012.02.014
- Feng, H., Liu, Z., Wu, J., Iqbal, W., Ahmad, W., & Marie, M. (2022). Nexus between government spending's and green economic performance: Role of green finance and structure effect. *Environmental Technology & Innovation*, 27, 102461. https://doi.org/10.1016/j.eti.2022.102461
- Ganda, F. (2022). The environmental impacts of human capital in the BRICS economies. *Journal of the Knowledge Economy*, 13(1), 611–634. https://doi.org/10.1007/s13132-021-00737-6
- Gu, X., Shen, X., Zhong, X., Wu, T., & Rahim, S. (2023). Natural resources and undesired productions of environmental outputs as green growth: EKC in the perspective of green finance and green growth in the G7 region. *Resources Policy*, *82*, 103552. https://doi.org/10.1016/j. resourpol.2023.103552
- Huang, Y., Chen, C., Lei, L., & Zhang, Y. (2022). Impacts of green finance on green innovation: A spatial and nonlinear perspective. *Journal of Cleaner Production*, 365, 132548. https://doi.org/ 10.1016/j.jclepro.2022.132548
- Jahanger, A., Chishti, M. Z., Onwe, J. C., & Awan, A. (2022). How far renewable energy and globalization are useful to mitigate the environment in Mexico? Application of QARDL and spectral causality analysis. *Renewable Energy*, 201, 514–525. https://doi.org/10.1016/j.renene. 2022.10.081
- Jahanger, A., Hossain, M. R., Onwe, J. C., Ogwu, S. O., Awan, A., & Balsalobre-Lorente, D. (2023). Analyzing the N-shaped EKC among top nuclear energy generating nations: A novel dynamic common correlated effects approach. *Gondwana Research*, 116, 73–88. https://doi.org/10.1016/ j.gr.2022.12.012
- Jahanger, A., Ozturk, I., Onwe, J. C., Joseph, T. E., & Hossain, M. R. (2023). Do technology and renewable energy contribute to energy efficiency and carbon neutrality? Evidence from top ten manufacturing countries. Sustainable Energy Technologies and Assessments, 56, 103084. https:// doi.org/10.1016/j.seta.2023.103084
- Jarque, C. M., & Bera, A. K. (1987). A test for normality of observations and regression residuals. *International Statistical Review/Revue Internationale de Statistique*, 55(2), 163–172. https://doi. org/10.2307/1403192
- Jiakui, C., Abbas, J., Najam, H., Liu, J., & Abbas, J. (2023). Green technological innovation, green finance, and financial development and their role in green total factor productivity: Empirical insights from China. *Journal of Cleaner Production*, 382, 135131. https://doi.org/10.1016/j. jclepro.2022.135131
- Jiang, C., & Chang, Y. (2022). Clean energy projects in Asian economies: Does FDI and stock market matter for sustainable development? *Economic Research-Ekonomska Istraživanja*, 35(1), 5843–5857. https://doi.org/10.1080/1331677X.2022.2038650
- Jiang, T., Yu, Y., Jahanger, A., & Balsalobre-Lorente, D. (2022). Structural emissions reduction of China's power and heating industry under the goal of "double carbon": A perspective from input-output analysis. Sustainable Production and Consumption, 31, 346–356. https://doi.org/ 10.1016/j.spc.2022.03.003
- Johnstone, P., & McLeish, C. (2020). World wars and the age of oil: Exploring directionality in deep energy transitions. *Energy Research & Social Science*, 69, 101732. https://doi.org/10.1016/j. erss.2020.101732
- Khan, Z., Hossain, M. R., Badeeb, R. A., & Zhang, C. (2023). Aggregate and disaggregate impact of natural resources on economic performance: Role of green growth and human capital. *Resources Policy*, 80, 103103. https://doi.org/10.1016/j.resourpol.2022.103103

- Khan, M. A., Riaz, H., Ahmed, M., & Saeed, A. (2022). Does green finance really deliver what is expected? An empirical perspective. *Borsa Istanbul Review*, 22(3), 586–593. https://doi.org/10. 1016/j.bir.2021.07.006
- Koenker, R., & Bassett, G., Jr. (1978). Regression quantiles. Econometrica: Journal of the Econometric Society, 46(1), 33-50. https://doi.org/10.2307/1913643
- Kuznets, S. (1955). Economic growth and income inequality. *The American Economic Review*, 45 (1), 1–28.
- Latif, B., Ong, T. S., Meero, A., Abdul Rahman, A. A., & Ali, M. (2022). Employee-perceived corporate social responsibility (CSR) and employee pro-environmental behavior (PEB): The moderating role of CSR skepticism and CSR authenticity. *Sustainability*, *14*(3), 1380. https://doi. org/10.3390/su14031380
- Lin, Y., & Li, C. (2023). Towards sustainable development: Research on the green growth effect of digital agriculture in China. *Environmental Science and Pollution Research*, 1–14. https://doi.org/10.1007/s11356-023-28367-2
- Lin, B., & Zhu, J. (2019). Determinants of renewable energy technological innovation in China under CO2 emissions constraint. *Journal of Environmental Management*, 247, 662–671. https:// doi.org/10.1016/j.jenvman.2019.06.121
- Liu, M. (2022). The driving forces of green bond market volatility and the response of the market to the COVID-19 pandemic. *Economic Analysis and Policy*, 75, 288–309. https://doi.org/10. 1016/j.eap.2022.05.012
- Liu, D., Xu, C., Yu, Y., Rong, K., & Zhang, J. (2020). Economic growth target, distortion of public expenditure and business cycle in China. *China Economic Review*, 63, 101373. https://doi.org/ 10.1016/j.chieco.2019.101373
- Li, W., Wang, J., Chen, R., Xi, Y., Liu, S. Q., Wu, F., Masoud, M., & Wu, X. (2019). Innovationdriven industrial green development: The moderating role of regional factors. *Journal of Cleaner Production*, 222, 344–354. https://doi.org/10.1016/j.jclepro.2019.03.027
- Li, G., Zakari, A., & Tawiah, V. (2020). Energy resource melioration and CO2 emissions in China and Nigeria: Efficiency and trade perspectives. *Resources Policy*, 68, 101769. https://doi.org/10. 1016/j.resourpol.2020.101769
- Machado, J. A., & Silva, J. S. (2019). Quantiles via moments. *Journal of Econometrics*, 213(1), 145–173. https://doi.org/10.1016/j.jeconom.2019.04.009
- Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. Oxford Bulletin of Economics and Statistics, 61(S1), 631–652. https://doi.org/10. 1111/1468-0084.0610s1631
- Mahmood, H. (2023). Trade, FDI, and CO2 emissions nexus in Latin America: The spatial analysis in testing the pollution haven and the EKC hypotheses. *Environmental Science and Pollution Research*, 30(6), 14439–14454. https://doi.org/10.1007/s11356-022-23154-x
- Mahmood, H., Hassan, M. S., Rej, S., & Furqan, M. (2023). The environmental kuznets curve and renewable energy consumption: A review. *International Journal of Energy Economics & Policy*, 13(3), 279. https://doi.org/10.32479/ijeep.14270
- Mahmood, H., Saqib, N., Adow, A. H., & Abbas, M. (2023). FDI, exports, imports, and consumption-based CO2 emissions in the MENA region: Spatial analysis. *Environmental Science and Pollution Research*, 30(25), 67634–67646. https://doi.org/10.1007/s11356-023-27245-1
- Martawardaya, B., Rakatama, A., Junifta, D. Y., & Maharani, D. A. (2022). Green economy post COVID-19: Insights from Indonesia. *Development in Practice*, 32(1), 98–106. https://doi.org/10. 1080/09614524.2021.2002817
- Mealy, P., & Teytelboym, A. (2022). Economic complexity and the green economy. *Research Policy*, 51(8), 103948. https://doi.org/10.1016/j.respol.2020.103948
- Meirun, T., Mihardjo, L. W., Haseeb, M., Khan, S. A. R., & Jermsittiparsert, K. (2021). The dynamics effect of green technology innovation on economic growth and CO 2 emission in Singapore: New evidence from bootstrap ARDL approach. *Environmental Science and Pollution Research*, 28(4), 4184–4194. https://doi.org/10.1007/s11356-020-10760-w

- Mngumi, F., Shaorong, S., Shair, F., & Waqas, M. (2022). Does green finance mitigate the effects of climate variability: Role of renewable energy investment and infrastructure. *Environmental Science and Pollution Research*, 29(39), 59287–59299. https://doi.org/10.1007/s11356-022-19839-y
- Nathaniel, S. P., Nwulu, N., & Bekun, F. (2021). Natural resource, globalization, urbanization, human capital, and environmental degradation in Latin American and Caribbean countries. *Environmental Science and Pollution Research*, 28(5), 6207–6221. https://doi.org/10.1007/ s11356-020-10850-9
- Ng, A. W. (2018). From sustainability accounting to a green financing system: Institutional legitimacy and market heterogeneity in a global financial centre. *Journal of Cleaner Production*, 195, 585–592. https://doi.org/10.1016/j.jclepro.2018.05.250
- Ngo, T., Trinh, H. H., Haouas, I., & Ullah, S. (2022). Examining the bidirectional nexus between financial development and green growth: International evidence through the roles of human capital and education expenditure. *Resources Policy*, *79*, 102964. https://doi.org/10.1016/j.resour pol.2022.102964
- Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61(S1), 653–670. https://doi.org/10.1111/1468-0084.61.s1.14
- Peng, W., & Xiong, L. (2022). Managing financing costs and fostering green transition: The role of green financial policy in China. *Economic Analysis and Policy*, 76, 820–836. https://doi.org/10. 1016/j.eap.2022.09.014
- Pesaran, H. (2004). General diagnostic tests for cross-sectional dependence in panels. *Cambridge Working Papers in Economics*, University of Cambridge, 435.
- Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967–1012. https://doi.org/10.1111/j.1468-0262.2006. 00692.x
- Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312. https://doi.org/10.1002/jae.951
- Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. Journal of Econometrics, 142(1), 50–93. https://doi.org/10.1016/j.jeconom.2007.05.010
- Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, 142(1), 50–93. https://doi.org/10.1016/j.jeconom.2007.05.010
- Ruiz, J. G., Arboleda, C., & Botero, S. (2016). A proposal for green financing as a mechanism to increase private participation in sustainable water infrastructure systems: The Colombian case. *Procedia Engineering*, 145, 180–187. https://doi.org/10.1016/j.proeng.2016.04.058
- Samad, G., & Manzoor, R. (2011). Green growth: An environmental technology approach. *Pakistan Development Review*, 50(4II), 471–490. https://doi.org/10.30541/v50i4IIpp.471-490
- Sarkodie, S. A., Adams, S., Owusu, P. A., Leirvik, T., & Ozturk, I. (2020). Mitigating degradation and emissions in China: The role of environmental sustainability, human capital and renewable energy. *Science of the Total Environment*, 719, 137530. https://doi.org/10.1016/j.scitotenv.2020. 137530
- Sarwar, S. (2022). Impact of energy intensity, green economy and blue economy to achieve sustainable economic growth in GCC countries: Does Saudi vision 2030 matters to GCC countries. *Renewable Energy*, 191, 30–46. https://doi.org/10.1016/j.renene.2022.03.122
- Shang, Y., Lian, Y., Chen, H., & Qian, F. (2023). The impacts of energy resource and tourism on green growth: Evidence from Asian economies. *Resources Policy*, 81, 103359. https://doi.org/10. 1016/j.resourpol.2023.103359
- Sharif, A., Kocak, S., Khan, H. H. A., Uzuner, G., & Tiwari, S. (2023). Demystifying the links between green technology innovation, economic growth, and environmental tax in ASEAN-6 countries: The dynamic role of green energy and green investment. *Gondwana Research*, 115, 98–106. https://doi.org/10.1016/j.gr.2022.11.010
- Shen, F., Liu, B., Luo, F., Wu, C., Chen, H., & Wei, W. (2021). The effect of economic growth target constraints on green technology innovation. *Journal of Environmental Management*, 292, 112765. https://doi.org/10.1016/j.jenvman.2021.112765

- Song, M., Tao, J., & Wang, S. (2015). FDI, technology spillovers and green innovation in China: Analysis based on data envelopment analysis. *Annals of Operations Research*, 228(1), 47–64. https://doi.org/10.1007/s10479-013-1442-0
- Sun, Y., Guan, W., Cao, Y., & Bao, Q. (2022). Role of green finance policy in renewable energy deployment for carbon neutrality: Evidence from China. *Renewable Energy*, 197, 643–653. https://doi.org/10.1016/j.renene.2022.07.164
- Tufail, M., Song, L., Adebayo, T. S., Kirikkaleli, D., & Khan, S. (2021). Do fiscal decentralization and natural resources rent curb carbon emissions? Evidence from developed countries. *Environmental Science and Pollution Research*, 49179–49190. https://doi.org/10.1007/s11356-021-13865-y
- Tufail, M., Song, L., Ali, S., Wahab, S., & Hassan, T. (2022). Does more immigration lead to more violent and property crimes? A case study of 30 selected OECD countries. *Economic Research-Ekonomska Istraživanja*, 1–19. https://doi.org/10.1080/1331677X.2022.2094437
- Tufail, M., Song, L., Umut, A., Ismailova, N., & Kuldasheva, Z. (2022). Does financial inclusion promote a green economic system? Evaluating the role of energy efficiency. *Economic Research-Ekonomska Istraživanja*, 1–21. https://doi.org/10.1080/1331677X.2022.2053363
- Ulucak, Z. Ş., İlkay, S. Ç., Özcan, B., & Gedikli, A. (2020). Financial globalization and environmental degradation nexus: Evidence from emerging economies. *Resources Policy*, 67, 101698. https://doi.org/10.1016/j.resourpol.2020.101698
- Wang, H., Peng, G., Luo, Y., & Du, H. (2023). Asymmetric influence of renewable energy, ecological governance, and human development on green growth of BRICS countries. *Renewable Energy*, 206, 1007–1019. https://doi.org/10.1016/j.renene.2022.12.125
- Wang, X., & Wang, Q. (2021). Research on the impact of green finance on the upgrading of China's regional industrial structure from the perspective of sustainable development. *Resources Policy*, 74, 102436. https://doi.org/10.1016/j.resourpol.2021.102436
- Wang, L., Wang, H., Dong, Z., Wang, S., & Cao, Z. (2021). The air pollution effect of government economic growth expectations: Evidence from China's cities based on green technology. *Environmental Science and Pollution Research*, 28(22), 27639–27654. https://doi.org/10.1007/ s11356-021-12536-2
- Wang, R., Zhao, X., & Zhang, L. (2022). Research on the impact of green finance and abundance of natural resources on China's regional eco-efficiency. *Resources Policy*, 76, 102579. https://doi. org/10.1016/j.resourpol.2022.102579
- Werikhe, A. (2022). Towards a green and sustainable recovery from COVID-19. Current Research in Environmental Sustainability, 4, 100124. https://doi.org/10.1016/j.crsust.2022.100124
- Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics*, 69(6), 709–748. https://doi.org/10.1111/j.1468-0084.2007.00477.x
- Xuan, D., Jiang, X., & Fang, Y. (2023). Can globalization and the green economy hedge natural resources? Functions of population growth and financial development in BRICS countries. *Resources Policy*, 82, 103414. https://doi.org/10.1016/j.resourpol.2023.103414
- Xu, J., She, S., Gao, P., & Sun, Y. (2023). Role of green finance in resource efficiency and green economic growth. *Resources Policy*, 81, 103349. https://doi.org/10.1016/j.resourpol.2023.103349
- Yang, S., Jahanger, A., & Hossain, M. R. (2023). How effective has the low-carbon city pilot policy been as an environmental intervention in curbing pollution? Evidence from Chinese industrial enterprises. *Energy Economics*, 118, 106523. https://doi.org/10.1016/j.eneco.2023.106523
- Yu, Y., Nie, J., & Jahanger, A. (2023). An evaluation of the energy-related carbon dioxide emissions from China's light sector to achieve sustainable development goals. *Evaluation Review*, 48(1), 7–31. https://doi.org/10.1177/0193841X231164880
- Zafar, M. W., Zaidi, S. A. H., Khan, N. R., Mirza, F. M., Hou, F., & Kirmani, S. A. A. (2019). The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: The case of the United States. *Resources Policy*, 63, 101428. https://doi.org/10.1016/j. resourpol.2019.101428

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- Zeraibi, A., Jahanger, A., Adebayo, T. S., Ramzan, M., & Yu, Y. (2023). Greenfield investments, economic complexity, and financial inclusion-environmental quality nexus in BRICS countries: Does renewable energy transition matter? *Gondwana Research*, *117*, 139–154. https://doi.org/ 10.1016/j.gr.2022.12.020
- Zhang, H., Geng, C., & Wei, J. (2022). Coordinated development between green finance and environmental performance in China: The spatial-temporal difference and driving factors. *Journal of Cleaner Production*, 346, 131150. https://doi.org/10.1016/j.jclepro.2022.131150
- Zhao, L., Gu, J., Abbas, J., Kirikkaleli, D., & Yue, X.-G. (2023). Does quality management system help organizations in achieving environmental innovation and sustainability goals? A structural analysis. *Economic Research-Ekonomska Istraživanja*, 36(1), 2484–2507. https://doi.org/10. 1080/1331677X.2022.2100436
- Zhou, X., Tang, X., & Zhang, R. (2020). Impact of green finance on economic development and environmental quality: A study based on provincial panel data from China. *Environmental Science* and Pollution Research, 27(16), 19915–19932. https://doi.org/10.1007/s11356-020-08383-2
- Zhou, H., & Xu, G. (2022). Research on the impact of green finance on China's regional ecological development based on system GMM model. *Resources Policy*, 75, 102454. https://doi.org/10. 1016/j.resourpol.2021.102454
- Zhou, G., Zhu, J., & Luo, S. (2022). The impact of fintech innovation on green growth in China: Mediating effect of green finance. *Ecological Economics*, 193, 107308. https://doi.org/10.1016/j. ecolecon.2021.107308

Appendix A

Australia	Finland
Austria	France
Belgium	Germany
Canada	Greece
Chile	Hungary
Colombia	Iceland
Costa Rica	Ireland
Czech Republic	Italy
Denmark	Japan
Estonia	

 Table A1. List of 19 OECD countries examined in this article.