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Green Growth Drivers: A Bibliometric Analysis of Green Innovation, Renewable Energy, Industrialization, and Institutional Quality

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ABSTRACT

This study explores the academic landscape of green growth using a bibliometric analysis approach based on Scopus data, comprising a sample of 226 articles. Through keyword co-occurrence analysis and data visualization techniques, the study elucidates the development trends and knowledge structure of the field. The results indicate a significant increase in the number of publications, particularly after 2022, reflecting growing scholarly interest in sustainable development. Green growth is identified as an interdisciplinary field, primarily situated within environmental science, energy, and economics. Keyword analysis reveals four major thematic clusters related to green innovation, renewable energy, industrialization, and institutional quality, which are closely interconnected within the research structure. Notably, institutional quality plays a pivotal role in moderating the relationships among these factors. The study provides a systematic overview and offers implications for future research directions and policy formulation aimed at promoting green growth.

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1. INTRODUCTION

In recent years, green growth has emerged as a key strategic orientation for achieving sustainable development, aiming to balance economic growth with environmental protection. In the face of global challenges such as climate change, environmental degradation, and resource depletion, many countries have promoted development strategies that emphasize low emissions and efficient resource use (Nations, 2015; OECD, 2011).

Building on this context, a growing body of literature has examined the key determinants of green growth, with particular emphasis on green innovation, renewable energy, industrialization, and institutional quality. Green innovation is widely recognized as a critical driver of sustainable growth through improving resource-use efficiency (Ghisetti & Quatraro, 2017). Renewable energy plays a pivotal role in mitigating greenhouse gas emissions (Danish & Ulucak, 2020), while industrialization can exert both positive and negative environmental effects (Wang et al., 2018). Furthermore, institutional quality is considered a foundational factor in shaping and effectively implementing environmental policies (Acemoglu & Robinson, 2008).

Despite the growing body of literature on green growth, existing studies remain fragmented and lack a systematic synthesis. Much of the prior research tends to focus on individual determinants, without adequately capturing the interrelationships among these factors within a broader analytical framework. Moreover, the rapid expansion of scientific publications has created an increasing need for comprehensive review studies to identify research trends, map the knowledge structure, and uncover emerging research directions.

To address these limitations, the study employs a bibliometric analysis approach to systematically review and comprehensively evaluate the literature on green growth. This method enables the exploration of the intellectual structure and research trends through the analysis of scientific publication data (Aria & Cuccurullo, 2017; Donthu et al., 2021). Data are collected from the Scopus database and analyzed using visualization techniques to identify thematic clusters and the developmental trajectory of the field.

This research contributes to the existing literature in several respects. First, it provides a comprehensive overview of the evolution of green growth research over time. Second, it identifies the main research themes and their interconnections. Third, it highlights research gaps and proposes directions for future studies.

2. LITERATURE REVIEW

2.1. Green Growth

Green growth refers to a process of economic expansion that is accompanied by the mitigation of environmental degradation, improved resource-use efficiency, and the reduction of greenhouse gas emissions. According to the OECD (2011), green growth aims to ensure that economic progress does not come at the expense of the natural resources essential for long-term well-being.

In empirical studies, green growth is commonly measured using composite indicators such as carbon productivity, green total factor productivity, and environmentally adjusted GDP (Chen et al., 2023; Danish & Ulucak, 2020). These indicators capture the extent to which economic growth can be achieved while simultaneously minimizing negative environmental impacts.

2.2. Determinants of Green Growth

Green growth is influenced by a range of economic, technological, and institutional factors. Recent studies have highlighted the roles of green innovation, renewable energy, industrialization, and institutional quality as core drivers facilitating the transition toward a sustainable growth model (Chen et al., 2023; Danish & Ulucak, 2020).

Green Innovation

Green innovation refers to technological innovation activities aimed at reducing environmental impacts and improving resource-use efficiency (Ghisetti & Quatraro, 2017). In prior empirical studies, this variable is commonly proxied by the number of green patents (Zhang et al., 2019).

Renewable Energy

Renewable energy encompasses naturally replenished energy sources such as solar, wind, and hydropower. The increased adoption of renewable energy is considered a key solution for reducing emissions and promoting sustainable growth (Mahjabeen et al., 2020).

Industrialization

Industrialization refers to the structural transformation of an economy toward the industrial sector. While it plays a vital role in driving economic growth, it may also exert pressure on the environment (Opoku & Yan, 2019). This variable is typically measured by the share of industrial value added in GDP.

Institutional Quality

Institutional quality reflects the effectiveness of governance and the capacity of governments to design and implement policies. It is commonly measured using composite indices such as the Worldwide Governance Indicators (WGI) (Kaufmann et al., 2011).

2.3. Mechanisms of the Effects of Determinants on Green Growth

2.3.1. The Impact of Green Innovation on Green Growth

Green innovation is widely regarded as a core driver of green growth, primarily through enhancing resource-use efficiency and reducing pollutant emissions. From the perspective of endogenous growth theory, technological innovation improves productivity and facilitates the development of environmentally friendly production solutions (Ghisetti & Quatraro, 2017; Romer, 1990). Empirical evidence suggests that green innovation can reduce carbon intensity while promoting sustainable economic growth (Chen et al., 2023; Zhang et al., 2019).

However, the effects of green innovation are not always uniform. Some studies highlight the existence of a rebound effect, whereby technological improvements lower the cost of energy use, potentially leading to increased consumption and offsetting environmental gains (Brockway et al., 2021; Zhang et al., 2018). Therefore, the impact of green innovation on green growth is contingent upon the institutional context and the level of technological development across countries.

2.3.2. Impact of Renewable Energy on Green Growth

Renewable energy plays a crucial role in the transition toward a low-carbon economy, thereby promoting green growth. According to the energy transition theory, replacing fossil fuels with clean energy sources helps reduce greenhouse gas emissions and improve environmental quality (Apergis & Payne, 2010; Sadorsky, 2009). Numerous empirical studies have confirmed that renewable energy consumption has a positive impact on green growth by reducing emission intensity and enhancing energy efficiency (Danish & Ulucak, 2020; Meng et al., 2022).

However, in the short term, high initial investment costs and technological limitations may reduce the economic efficiency of renewable energy (Venkatraja, 2020). In addition, the intermittency of certain renewable energy sources poses challenges for energy systems. Therefore, the impact of renewable energy on green growth may be bidirectional, particularly in developing economies.

2.3.3. Impact of Industrialization on Green Growth

Industrialization affects green growth through both positive and negative channels. In the early stages of development, industrialization is often associated with increased use of fossil fuels and higher pollution emissions, which degrade environmental quality (Grossman & Krueger, 1995; Shahab et al., 2013). However, as the economy reaches a certain level of income, technological progress and stricter environmental regulations can help reduce emissions and improve production efficiency.

This relationship is commonly explained by the Environmental Kuznets Curve hypothesis, which suggests that environmental pollution initially increases with economic growth but eventually declines once income surpasses a certain threshold (Dinda, 2004; Wang et al., 2018). Therefore, the impact of industrialization on green growth is nonlinear and depends on the stage of economic development.

2.3.4. Impact of Institutional Quality on Green Growth

Institutional quality plays a fundamental role in promoting green growth by establishing and effectively enforcing environmental policies. According to institutional theory, strong institutions help reduce transaction costs, enhance transparency, and create incentives for green investment activities (Acemoglu & Robinson, 2008; North, 1990). Empirical studies also indicate that institutional quality has a positive impact on reducing emissions and fostering sustainable growth (Murshed, 2024; Tawiah et al., 2021).

Moreover, effective institutions help guide the market through policy instruments such as carbon taxes, renewable energy subsidies, and environmental regulations, thereby promoting green innovation and energy transition. In contrast, weak institutions may undermine policy implementation and limit positive environmental outcomes.

2.3.5. Interaction Effects Among Factors

In addition to their direct impacts, the factors in the model also interact with one another. In particular, institutional quality can play a moderating role in the relationship between green innovation, renewable energy, and green growth.

High-quality institutions enhance the effectiveness of green innovation by protecting intellectual property rights and encouraging investment in research and development (Qiu et al., 2022). At the same time, institutions support the energy transition process by establishing policies that promote renewable energy development and reduce risks for investors (Murshed, 2024).

Therefore, the impact of these factors on green growth is not only independent but also contingent upon the institutional quality of the economy.

3. METHODOLOGY

This study employs bibliometric analysis to examine the knowledge structure and development trends in the field of green growth. This is a quantitative method based on scientific publication data, enabling the exploration of relationships among studies through citation analysis, keyword co-occurrence, and academic collaboration networks. As such, it provides a comprehensive and systematic overview of the research domain (Aria & Cuccurullo, 2017; Donthu et al., 2021). In the context of this study, the method is particularly useful for clarifying key themes such as green innovation, renewable energy, industrialization, and institutional quality.

The data are collected from the Scopus database, focusing on English-language articles in the fields of economics, finance, management, and environmental science. The search query is constructed using the TITLE-ABS-KEY field, combining keyword groups related to green growth and its determinants, including: (“green growth” OR “sustainable growth” OR “environmentally sustainable growth”) AND (“green innovation” OR “eco-innovation” OR “environmental innovation”) AND (“renewable energy” OR “clean energy” OR “green energy”) AND (“industrialization” OR “industrial development”) AND (“institutional quality” OR “governance quality” OR “institutions”) AND (“Vietnam” OR “developing countries” OR “emerging economies”).

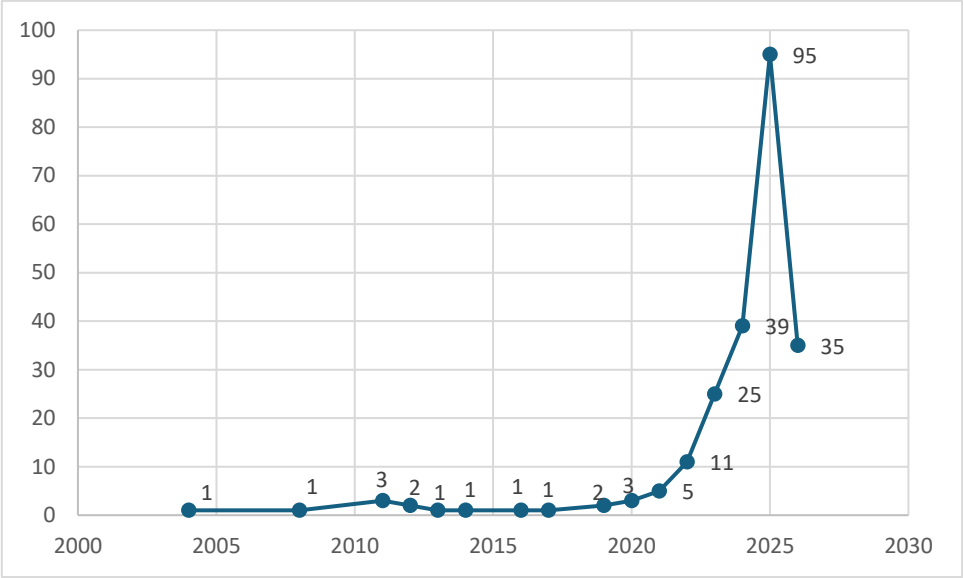
The initial search yielded a total of 642 articles. The data were then screened based on predefined criteria to exclude irrelevant documents, non-article publications, and duplicates. After this process, the final dataset consisted of 226 articles, ensuring both relevance and reliability for the analysis.

The processed data were exported in CSV format and analyzed using VOSviewer software. The analytical techniques include: (i) trend analysis of publications over time to assess the development of the field; (ii) co-authorship network analysis to identify leading countries and influential authors; and (iii) keyword co-occurrence analysis to detect major research themes and their interrelationships. Through keyword clustering techniques, the study clarifies the intellectual structure of the green growth field and provides a foundation for identifying research gaps in subsequent sections.

4. RESULTS

4.1. Publication Trends

The analysis of publication trends over time shows that research on green growth has increased significantly in recent years. During the period 2004 – 2016, the number of publications remained very limited, ranging from only 1 to 3 articles per year, reflecting the early stage when this topic had not yet attracted much attention.



Source: Author's data processing results

Figure 1: Number of publications over the years

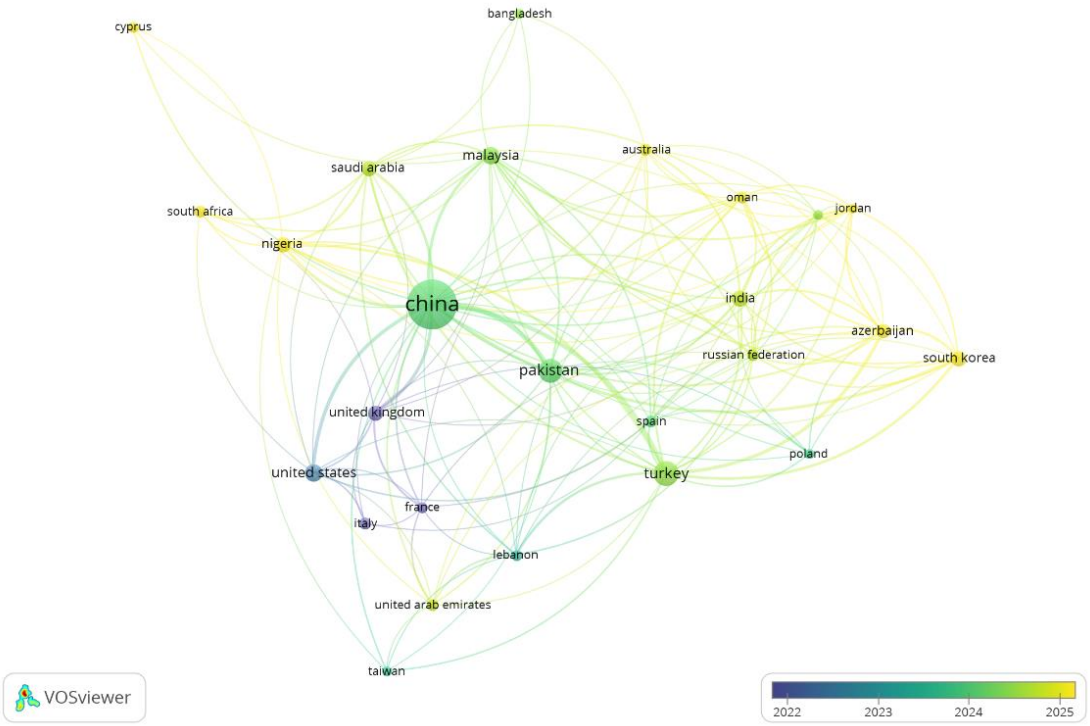
During the period 2017 – 2021, a modest increase in the number of studies was observed, indicating the gradual expansion of the field in the context of growing attention to sustainable development and environmental issues.

Notably, from 2022 onwards, the number of publications has risen sharply and entered an explosive growth phase, with a rapid increase in the number of articles each year, reaching its peak in 2025. This trend reflects the increasing interest of the academic community in green growth, particularly in the context of global commitments to sustainable development and carbon neutrality.

Overall, the development of this field can be divided into three phases: the initial stage, the growth stage, and the rapid expansion stage. This progression indicates that green growth is becoming a central research topic worldwide.

4.2. Countries of Publication

The country-level analysis reveals an uneven distribution of contributions to green growth research, with several emerging economies standing out. China leads significantly in terms of the number of publications, reflecting its central role in both research and practical green transformation.



Source: Author's data processing results

Figure 2: Country collaboration network

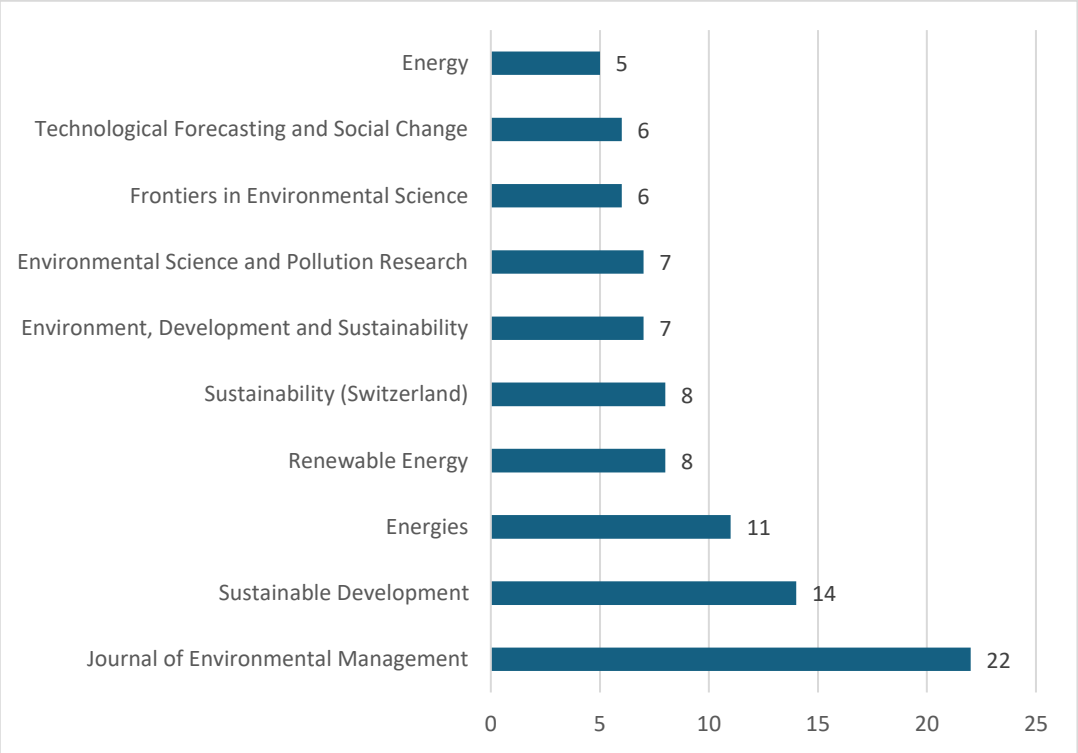
Other countries such as Turkey, Pakistan, and India also make notable contributions, while Malaysia, Nigeria, and the United States demonstrate the broad participation of both developed and developing economies. This suggests that green growth is not only a concern for developed countries but also a priority for transitioning and emerging economies.

In addition, the international collaboration network shows increasing connectivity among countries, with China, the United States, and European nations playing central roles. However, the level of collaboration remains uneven, indicating significant potential for expanding research partnerships in the future, particularly among developing countries.

4.3. Authors and Sources of Publication

The author-level analysis indicates that the field of green growth research is highly fragmented and dispersed, with contributions coming from numerous research groups rather than being concentrated among a few prominent scholars. Most authors appear with low publication frequency, reflecting the interdisciplinary and expanding nature of the field.

Some authors, such as Danish, Hassan S.T., and Khan I., have made notable contributions; however, no single author dominates in terms of publication output. This suggests that academic influence in this field depends not only on the number of publications but also on citation impact and roles within academic collaboration networks.



Source: Author's data processing results

Figure 3: Top 10 journals by number of publications

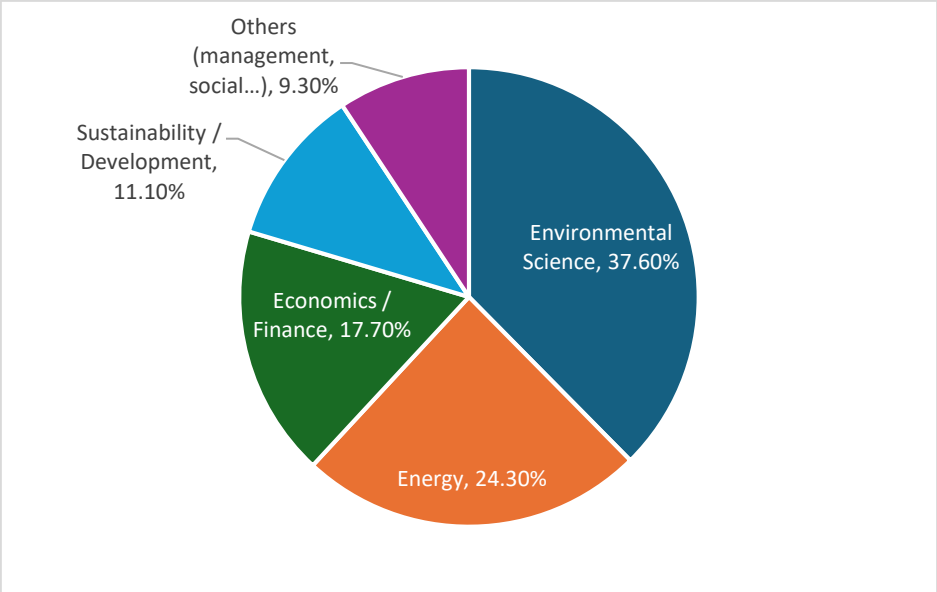
Figure 3 illustrates that studies on green growth are primarily published in journals related to environmental economics, energy, and sustainable development. Among these, the Journal of Environmental Management has the highest number of publications, followed by Sustainable Development and Energies. Other journals such as Sustainability, Renewable Energy, Environment, Development and Sustainability, and Environmental Science and Pollution Research are also among the leading publication outlets.

Overall, the concentration of publications in specialized journals on environment and energy highlights the interdisciplinary nature of green growth research and indicates that this field is attracting broad attention from the global academic community.

4.4. Subject Areas of Publication

Studies on green growth are distributed across various disciplines, with environmental science, energy, and economics being the most prominent fields.

Specifically, Environmental Science accounts for the largest share at 37.6%, indicating that research primarily focuses on issues such as climate change, emissions, and environmental protection. This is followed by the Energy field at 24.3%, reflecting the crucial role of energy transition and renewable energy development in promoting green growth.



Source: Author's data processing results

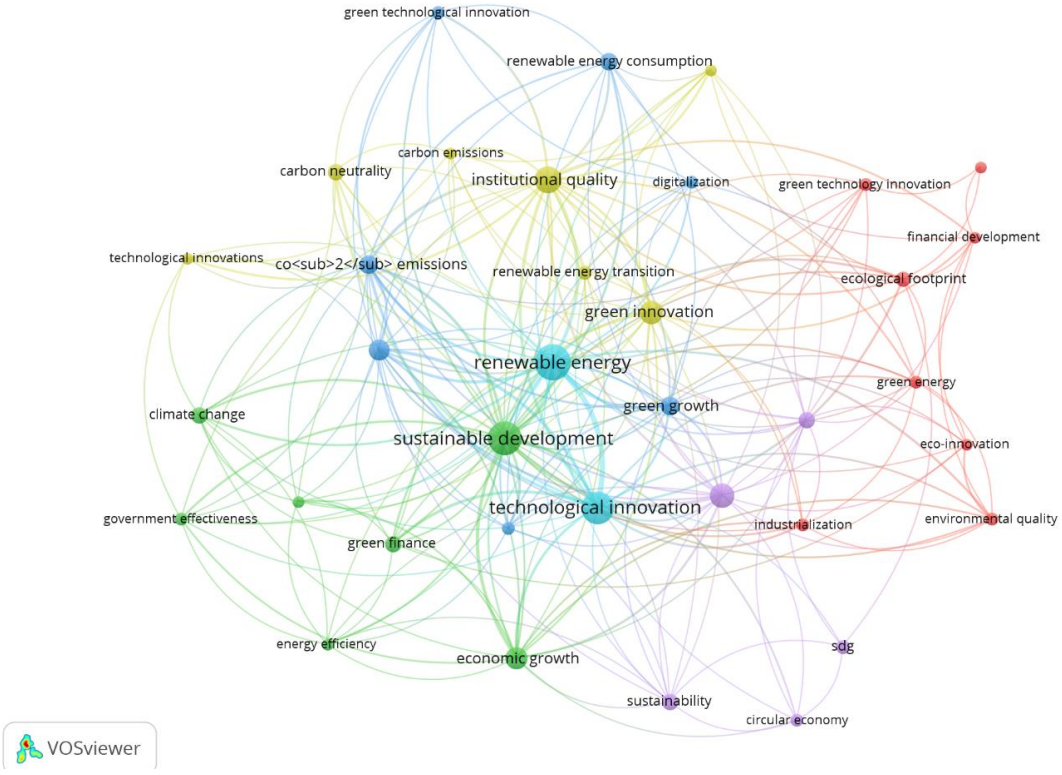
Figure 4: Subject areas of publication

The field of Economics and Finance accounts for 17.7%, focusing on the relationship between economic growth and the environment, as well as the role of policies and financial instruments. In addition, studies in Sustainability and Development represent 11.1%, emphasizing the long-term aspects of socio-economic development associated with environmental protection. Moreover, other fields such as management, social sciences, and related disciplines account for approximately 9.3%, indicating the expansion of green growth research into institutional and governance dimensions.

Overall, this distribution confirms that green growth is a highly interdisciplinary field, requiring the integration of environmental, energy, and economic perspectives to achieve sustainable development.

4.5. Keyword Co-occurrence

The results of the keyword co-occurrence analysis, visualized using VOSviewer, reveal that the research structure of green growth is formed through clearly defined thematic clusters. These clusters reflect the main research directions and the interconnections among them.



Source: Author's data processing results

Figure 5: Keyword co-occurrence network

Based on the network map, the keywords are grouped into four main thematic clusters as follows:

Cluster 1: Green Innovation and Technological Innovation (Blue)

This cluster revolves around central keywords such as technological innovation, green technological innovation, and renewable energy consumption. It reflects the role of technological innovation in driving green growth.

The strong linkages between technological innovation, renewable energy, and CO_2 emissions indicate that studies in this cluster focus on assessing the impact of technological progress on environmental performance and emission reduction. This confirms that technological innovation is one of the core drivers of green growth.

Cluster 2: Renewable Energy and Sustainable Development (Green)

This cluster includes prominent keywords such as renewable energy, sustainable development, economic growth, energy efficiency, and green finance. It is a large and highly interconnected cluster, highlighting the central role of renewable energy in green growth research.

The strong connection between renewable energy and sustainable development reflects an integrated research trend that combines economic development with environmental protection. Additionally, the presence of green finance and government effectiveness suggests the growing importance of green finance and governance in supporting the energy transition.

Cluster 3: Industrialization, Emissions, and Environmental Impact (Red)

This cluster includes keywords such as industrialization, ecological footprint, environmental quality, and green energy. Studies in this cluster focus on the environmental impacts of economic activities and industrialization.

The linkage between industrialization and ecological footprint suggests that research is assessing the environmental costs of economic growth while seeking solutions to mitigate negative impacts. This cluster most clearly reflects the "trade-off" relationship between economic growth and environmental sustainability.

Cluster 4: Institutional Quality and Governance (Yellow)

This cluster centers on keywords such as institutional quality, carbon emissions, carbon neutrality, and digitalization. It highlights the role of institutions and policies in promoting green growth.

The connections between institutional quality and factors such as carbon emissions and green innovation indicate that institutions play a crucial mediating role in coordinating economic and environmental activities. Moreover, the emergence of digitalization suggests a new research trend integrating digital transformation with green growth.

Overall, the keyword map shows that green growth research is structured around four main pillars: technological innovation – energy – industrialization – institutions. Among these, central keywords such as renewable energy, technological innovation, and sustainable development act as key hubs linking different thematic clusters.

Notably, the dense interconnections among clusters indicate an increasingly interdisciplinary trend in green growth research. However, some clusters remain relatively disconnected, particularly between the industrialization and institutional clusters, suggesting the existence of research gaps in integrating these factors within a unified analytical framework.

5. CONCLUSION

The study employs bibliometric analysis to systematically review research on green growth over the period 2010–2025. The results indicate that this field has experienced rapid development, particularly since 2022, reflecting the growing interest of the academic community in environmental issues and sustainable development.

The analysis of the intellectual structure reveals that green growth is a highly interdisciplinary field, primarily concentrated in environmental science, energy, and economics. At the same time, four key factors—green innovation, renewable energy, industrialization, and institutional quality—play central roles in the research network. These factors are closely interconnected, with institutional quality acting as a moderating force within the overall structure.

The findings also highlight the diversity in research approaches and results related to green growth, suggesting that outcomes depend heavily on development contexts and institutional conditions. This implies that countries should adopt flexible policy approaches, combining the promotion of green innovation, the development of renewable energy, and the improvement of institutional quality to achieve sustainable growth.

This study contributes by providing a comprehensive overview of the structure and trends in green growth research. However, due to the reliance on a single database and bibliometric methods, the study does not examine causal relationships among variables. Future research may expand the dataset and apply quantitative methods to test these relationships more rigorously.

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CONFLICTS OF INTEREST

The author declare that there are no conflicts of interest related to the publication of this research.

AUTHOR CONTRIBUTIONS

The author solely contributed to this research. Nguyen Thi Hao conceptualized the study, developed the research framework, conducted data collection and bibliometric analysis, and interpreted the results. The author also carried out the literature review and prepared, revised, and approved the final manuscript for submission.

TRANSPARENCY

The author confirms that this manuscript is an honest, accurate, and transparent account of the study. No essential aspects of the research have been omitted, and any deviations from the initial research plan have been clearly explained. The study was conducted in accordance with ethical standards in academic research and writing.

ETHICAL STATEMENTS

This study utilizes secondary data obtained from the Scopus database for bibliometric analysis. It does not involve human participants, personal data, or confidential information; therefore, ethical approval was not required. The research adheres to ethical standards in academic publishing.

FEATURED APPLICATION

This study provides a comprehensive overview of the intellectual structure and development trends in green growth research. The findings offer practical implications for researchers and policymakers in identifying key drivers, such as green innovation, renewable energy, industrialization, and institutional quality, to design effective strategies and policies that promote sustainable and environmentally friendly economic growth.

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