

“The interplay between renewable energy, green finance, and economic development: A bibliometric review”

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THE INTERPLAY BETWEEN RENEWABLE ENERGY, GREEN FINANCE, AND ECONOMIC DEVELOPMENT: A BIBLIOMETRIC REVIEW

Abstract

Research on the relationships among green finance, renewable energy, and economic development has expanded rapidly in recent years; however, the intellectual structure, collaboration patterns, and thematic evolution of this interdisciplinary field remain insufficiently understood. This study addresses this gap by conducting a comprehensive bibliometric analysis of publications indexed in the Web of Science Core Collection using VOSviewer and Biblioshiny, the web interface of the bibliometrix R package. The analytical framework integrates performance analysis with science mapping techniques, including keyword co-occurrence, citation, co-citation, bibliographic coupling, thematic mapping, and thematic evolution analyses. The findings reveal substantial growth in scientific production and increasing international collaboration, while identifying an intellectual foundation primarily shaped by studies on econometric methodologies, the relationships between economic growth and environmental sustainability, and the integration of green finance with energy economics. Four major research streams emerge: green financial instruments and markets; the finance, growth, and emissions nexus; renewable energy transition and policy; and advanced quantitative modeling approaches. Thematic evolution further indicates that, although green finance, renewable energy, and sustainable development remain the core research themes, emerging topics such as digital finance and the digital economy are receiving increasing scholarly attention. By providing a comprehensive knowledge map of the field, this study contributes to a better understanding of its intellectual foundations, conceptual development, and future research directions, while offering valuable insights for researchers and policymakers seeking to promote sustainable finance, renewable energy transition, and long-term economic development.

Keywords

green finance, renewable energy, economic growth, sustainability, bibliometric analysis

JEL Classification

Q01, Q42, G20, O44

INTRODUCTION

Green finance plays a significant role in promoting renewable energy development and supporting sustainable economic growth (Lee et al., 2023; Sinha et al., 2025). In the context of increasing environmental degradation and climate change, achieving both economic sustainability and environmental protection has become a critical concern for policymakers and scholars (Kumar et al., 2024). As economies move closer to green and climate-resilient development trajectories, the relationship between green finance, renewable energy, and economic development has become important for achieving the sustainability targets articulated in the United Nations Sustainable Development Goals (SDGs). Green finance facilitates the allocation of capital to environmentally sustainable investments and supports renewable energy transitions, thereby contributing to environmental protection and

long-term economic development (Du et al., 2023; Xing et al., 2024; Zournatzidou, 2025). Policymakers are increasingly encouraged to integrate green financial instruments with renewable energy strategies to reduce CO₂ emissions and achieve sustainable development outcomes (Yadav et al., 2024), reinforcing its role in the transition toward a low-carbon economy (Kaur & Negi, 2025).

Despite the growing body of literature, existing studies largely focus on bilateral relationships, such as the link between green finance and renewable energy or between renewable energy and economic growth. This fragmented approach limits a comprehensive understanding of the complex interactions among these domains (Tao & Chao, 2023). In response, bibliometric analysis has emerged as an effective method for systematically mapping scientific knowledge and identifying research trends (Duman et al., 2024). Although prior studies highlight the rapid growth of research in green finance and sustainability (Jaishree & Dogga, 2025), comprehensive analyses examining the interplay among green finance, renewable energy, and economic development remain limited.

1. LITERATURE REVIEW

Green finance has become a critical policy instrument for promoting environmental sustainability by directing financial resources toward low-carbon investments, renewable energy development, and green technological innovation. Previous studies have shown that green finance contributes to improving environmental quality, enhancing energy efficiency, and facilitating the transition to sustainable economic development through green investment and financial market mechanisms (Du et al., 2023; Lee & Lee, 2022; Rasoulinezhad & Taghizadeh-Hesary, 2022). At the same time, renewable energy has been widely recognized as a key driver of economic growth and carbon emission reduction, reinforcing the role of integrating financial development with clean energy policies.

The growing academic interest in this area has led to the emergence of several review studies employing bibliometric methods. Existing bibliometric analyses have examined research trends in green finance, sustainable development, renewable energy, and environmental sustainability, highlighting influential publications, collaboration networks, and emerging research themes (Donthu et al., 2021; Jaishree & Dogga, 2025; Kaur & Negi, 2025; Kumar et al., 2024; Tao & Chao, 2023). These studies have demonstrated the rapid expansion of green finance research and identified its increasing connections with environmental governance, technological innovation, and sustainable development.

However, previous bibliometric studies have generally focused on individual topics such as green fi-

nance, sustainable development, or renewable energy, rather than examining the integrated research landscape linking green finance, renewable energy, and economic development. Consequently, the intellectual structure, collaboration patterns, thematic evolution, and emerging research directions across these interconnected domains remain insufficiently explored. To address this gap, the present study conducts a comprehensive bibliometric analysis using the Web of Science Core Collection and VOSviewer and Biblioshiny to provide a systematic knowledge map of the field, identify its major research streams, and suggest future research directions.

Accordingly, this study aims to (1) map publication trends and collaboration patterns in research connecting green finance, renewable energy, and economic development; (2) identify the field's intellectual structure and major research themes; and (3) highlight emerging topics and directions for future research. Figure 1 presents the conceptual framework used to organize the review of the relationships among green finance, renewable energy, and economic development. It provides a conceptual basis for interpreting the bibliometric findings rather than a model for empirical hypothesis testing.

2. METHOD

2.1. Data collection

The Web of Science Core Collection (WoSCC) was used as the sole data source for this study. WoSCC was selected because its high-quality indexing, standardized bibliographic metadata, and com-

Source: Adapted from Mol and Spaargaren (2000),
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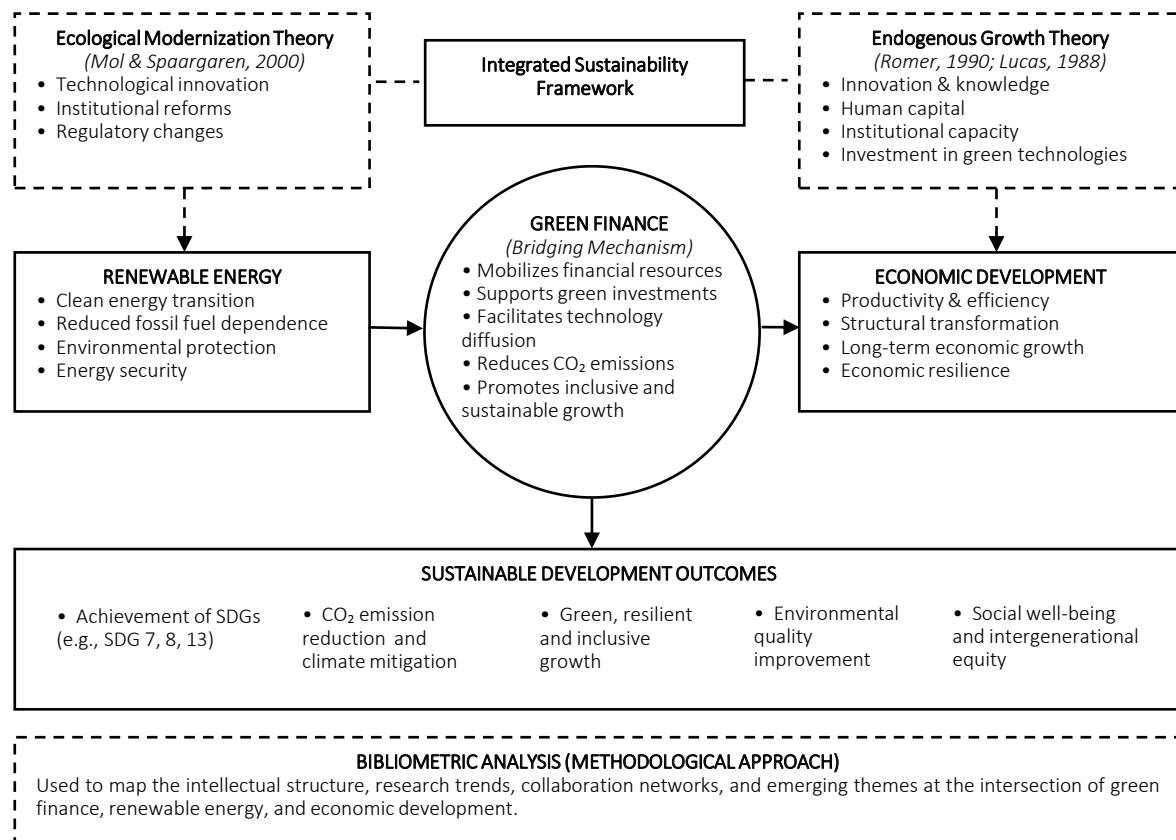


Figure 1. Conceptual framework of the interplay between green finance, renewable energy, and economic development

prehensive cited-reference records provide a reliable foundation for citation-based bibliometric analysis. Furthermore, it is widely recognized as one of the most authoritative and frequently used databases in bibliometric research on sustainability, environmental economics, and energy studies (Donthu et al., 2021; Tao & Chao, 2023). Using a single database also minimizes inconsistencies in document indexing and citation matching that may arise when integrating records from multiple bibliographic sources (Ramos & Rita, 2024).

The search strategy was designed to capture studies at the intersection of green finance, renewable energy, and economic development. A topic search, covering article titles, abstracts, author keywords, and keywords plus, was conducted on July 7, 2026, using the following query:

TS = (("green finance" OR "sustainable finance" OR "climate finance" OR "low-carbon finance" OR "green bond" OR "green investment") AND ("renew-

able energy" OR "clean energy" OR "energy transition") AND ("economic development" OR "economic growth" OR "sustainable development" OR "green growth"))).

The initial search retrieved 1.178 records. The dataset was subsequently limited to English-language, peer-reviewed journal articles, resulting in a final sample of 1.091 publications published between 2007 and 2026. No time restriction was applied to capture the field's complete development. Figure 2 presents the study selection process. Full records and cited references were exported in plain-text format for bibliometric analysis using VOSviewer.

2.2. Bibliometric analysis

The bibliometric analysis combined performance analysis and science mapping to provide a comprehensive overview of the research field (Donthu et al., 2021). VOSviewer was used to construct and visualize keyword co-occurrence, citation, co-ci-

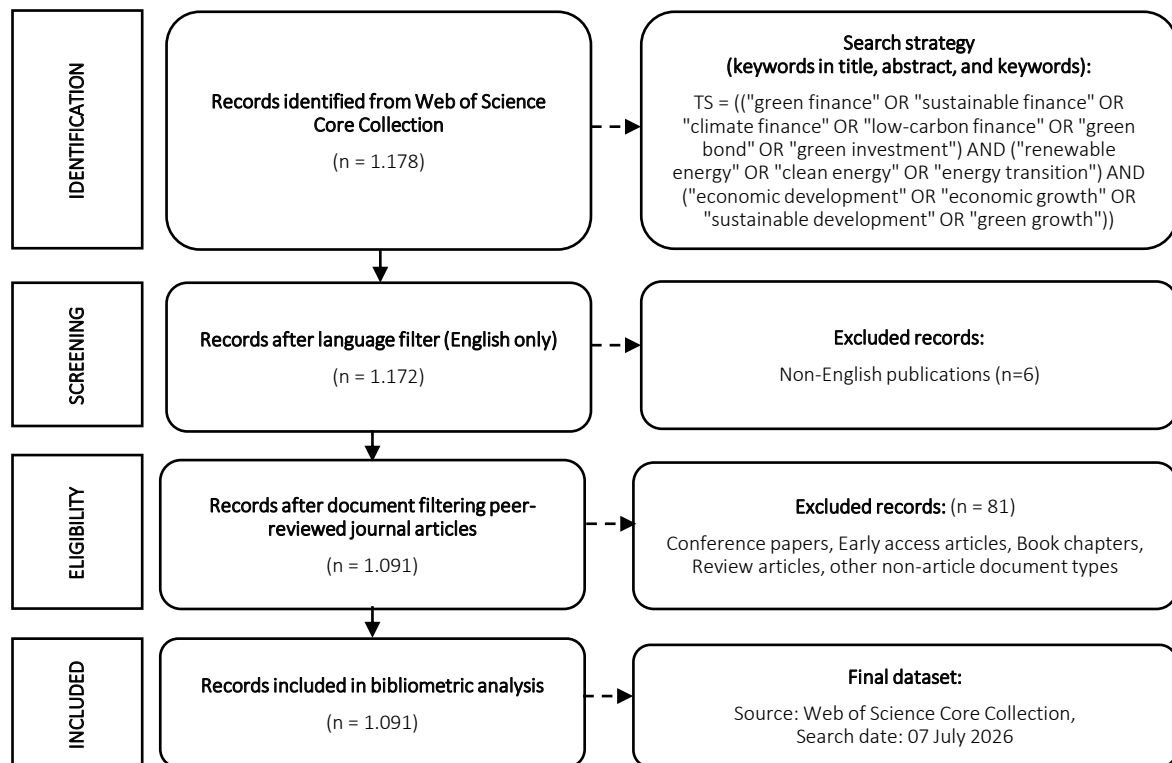


Figure 2. PRISMA flow diagram

tation, and bibliographic coupling networks (van Eck & Waltman, 2010). Biblioshiny, the web interface of the bibliometrix R package, was used for descriptive performance analysis and to generate the three-field plot, thematic map, thematic evolution, and trend-topic analyses (Aria & Cuccurullo, 2017). These complementary tools supported the examination of the field's conceptual structure, intellectual foundations, influential publications, and emerging research themes.

Specifically, keyword co-occurrence analysis was used to identify the conceptual structure of the research domain, while citation analysis identified influential publications through direct citation relationships. Co-citation analysis was conducted to reveal the intellectual foundations of the field by identifying references that are frequently cited together, whereas bibliographic coupling analysis captured emerging research fronts by linking documents sharing common references. Prior to network construction, keyword normalization was performed using the VOSviewer thesaurus function to merge synonymous terms, standardize spelling variations, and minimize network fragmentation.

The keyword co-occurrence network was generated using a minimum occurrence threshold of 10, resulting in 118 keywords. Co-citation analysis retained 191 cited references, while bibliographic coupling included 333 connected documents. Collectively, these complementary analyses provide a comprehensive understanding of the evolution of the research field by identifying its conceptual structure, intellectual foundations, influential studies, and emerging research directions.

3. RESULTS

3.1. Publication trends

Figure 3 illustrates the annual publication trends in research on the relationships among green finance, renewable energy, and economic development during the study period. The results indicate an overall upward trend in scientific publications, reflecting the growing academic interest in this interdisciplinary field. Although the number of publications remained relatively limited during the early years, research output began to accelerate after 2020 and experienced particularly rapid

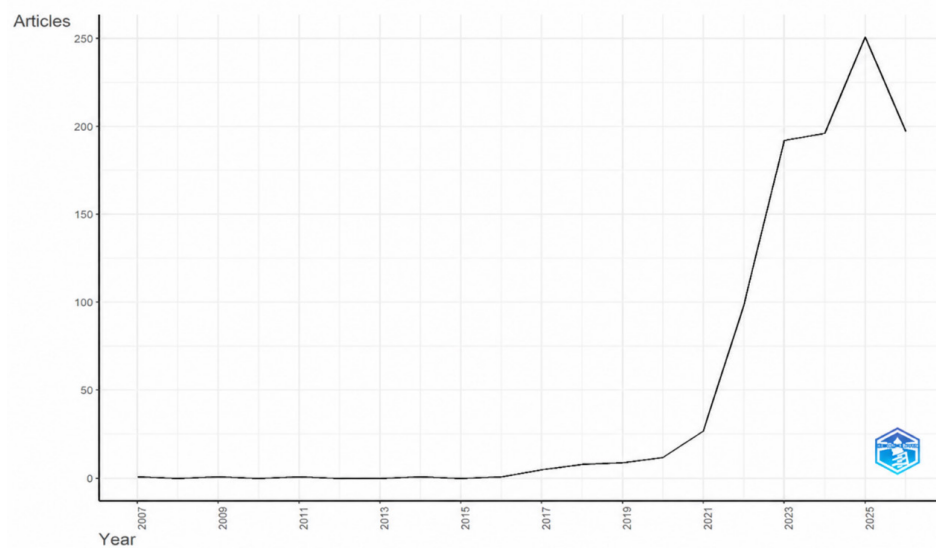


Figure 3. Annual scientific production

growth from 2022 onward. This upward trend suggests that the integration of green finance, renewable energy, and sustainable economic development has become an increasingly important research agenda in response to global concerns regarding climate change, energy transition, and sustainable development.

The observed growth in publication output also reflects the expanding recognition of green finance as a critical mechanism for supporting renewable energy investment and facilitating sustainable economic transformation. The increasing volume of publications demonstrates that the field has evolved from an emerging research topic into a well-established area of interdisciplinary inquiry, attracting contributions from economics, finance, energy, environmental science, and public policy. Overall, the publication trend confirms the rapid development of this research domain and provides a foundation for subsequent analyses of col-

laboration networks, influential publications, and thematic evolution.

3.2. Leading countries

Table 1 presents the top 15 countries in terms of scientific production, measured by author-country frequencies. China ranked first with 1,170 author appearances, far exceeding Türkiye (188), which ranked second. India and Pakistan shared third place with 144 appearances each, followed by Saudi Arabia (96), Malaysia (83), and Vietnam (81). The United Kingdom (67) and the United States (45) were the only high-income Western countries among the top ten contributors, while Poland (47), South Korea (44), Azerbaijan (42), Australia (41), Italy (38), and Tunisia (38) also demonstrated active participation in this research field.

The geographical distribution of scientific production indicates that research on green finance, re-

Table 1. Top 15 countries by scientific production

Rank	Country	Frequency	Rank	Country	Frequency
1	China	1,170	9	Poland	47
2	Türkiye	188	10	USA	45
3	India	144	11	South Korea	44
4	Pakistan	144	12	Azerbaijan	42
5	Saudi Arabia	96	13	Australia	41
6	Malaysia	83	14	Italy	38
7	Vietnam	81	15	Tunisia	38
8	UK	67			

newable energy, and economic development has attracted broad international interest, with Asian countries accounting for the largest share of publications. The leading positions of China, Türkiye, India, Pakistan, Malaysia, and Vietnam suggest that these countries have become important contributors to the literature, reflecting increasing academic attention to sustainable finance, renewable energy development, and economic transition. At the same time, the presence of countries from Europe, North America, and Oceania among the leading contributors demonstrates that this research field has developed into a globally relevant area of interdisciplinary inquiry.

3.3. Leading authors

Figure 4 presents the ten most productive authors in the field of green finance, renewable energy, and economic development. Chien-Chiang Lee ranked first with 16 publications, followed by Arshian Sharif (13) and Farhad Taghizadeh-Hesary (10). Abraham Deka contributed 9 publications, while Kangyin Dong, Huseyin Ozdeser, and Tetyana Pimonenko each published 7 articles. The remaining positions were occupied by Sahar Afshan, Daniel Balsalobre-Lorente, and Muhammad Irfan, with 6 publications each, indicating the presence of a relatively active group of scholars contributing to this research area.

The distribution of author productivity suggests that scientific output is concentrated among a limited number of researchers who have made substantial contributions to the development of the field. In addition to being the most productive author, Chien-Chiang Lee also produced the most influential publication in the dataset, with “How does green finance affect green total factor productivity? Evidence from China” receiving 1,022 global citations (Lee & Lee, 2022). Similarly, Farhad Taghizadeh-Hesary is among the leading contributors in terms of publication output and co-authored one of the most highly cited studies on the role of green finance in improving energy efficiency and renewable energy development (Rasoulnezhad & Taghizadeh-Hesary, 2022). These findings indicate that a relatively small group of authors has played a prominent role in shaping the development of research on green finance, renewable energy, and economic development.

To further explore the relationships among influential references, productive authors, and major research themes, a three-field plot was constructed (Figure 5). The results reveal strong linkages between highly cited references, leading authors, and frequently occurring keywords, particularly those related to green finance, renewable energy, and economic growth. These connections demonstrate a well-integrated intellectual structure in



Figure 4. Most relevant authors

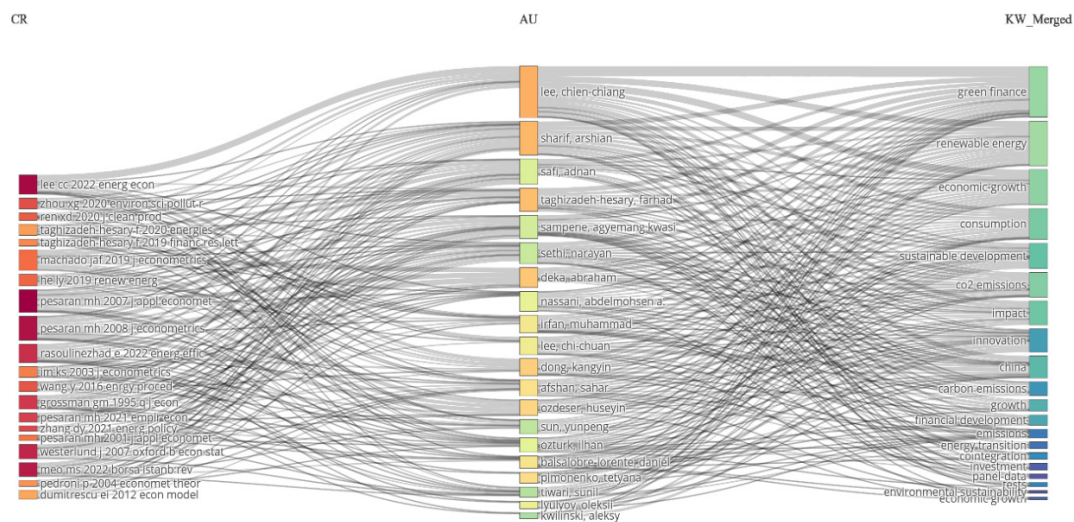


Figure 5. Three-field plot linking co-cited references (CR), authors (AU), and keywords (KW)

which influential scholars have contributed to the development of the core research themes within the field.

3.4. Leading journals

Figure 6 presents the ten most productive journals in green finance, renewable energy, and economic development. Collectively, these journals published 429 articles, representing approximately 39% of the total dataset. Renewable Energy ranked first with 72 publications, followed by Environmental

Science and Pollution Research (63), Sustainable Development (56), Sustainability (55), and Resources Policy (47). The other leading journals were Journal of Environmental Management (31), Energy Economics (30), Energies (27), Frontiers in Environmental Science (27), and Journal of Cleaner Production (21).

The distribution of publications across these journals reflects the interdisciplinary nature of research on green finance, renewable energy, and economic development. The prominence of jour-

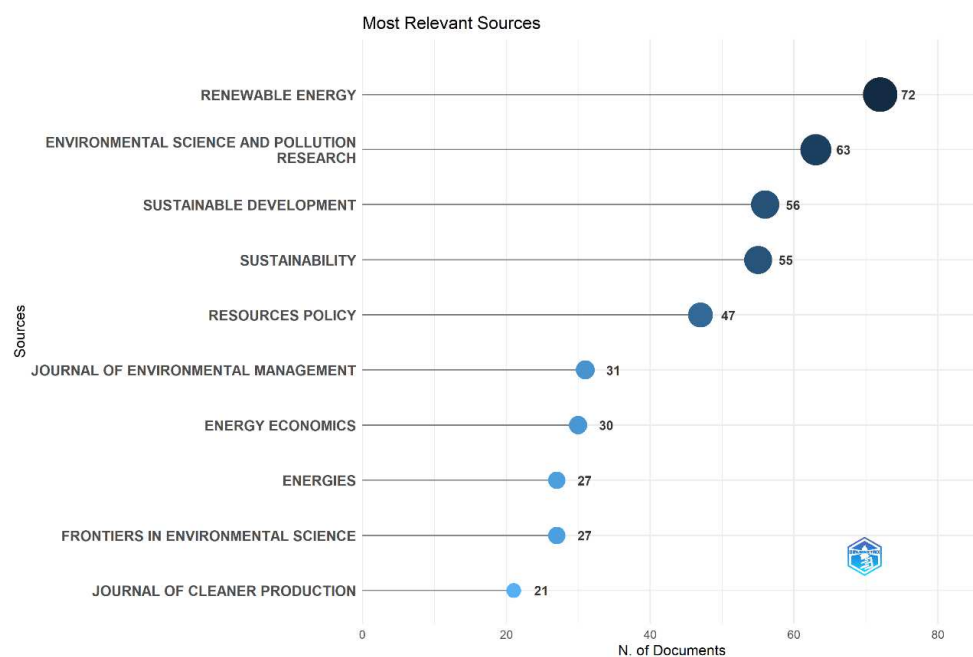


Figure 6. Most relevant sources

nals specializing in renewable energy, environmental science, sustainability, and environmental economics indicates that the field integrates perspectives from multiple disciplines. Although Renewable Energy published the largest number of articles, scientific output remains distributed across several high-impact journals, suggesting that this research area continues to evolve through contributions from diverse academic disciplines and publication outlets.

3.5. Highly cited documents

Table 2 presents the ten most globally cited publications in the field. Lee and Lee (2022), published in *Energy Economics*, ranked first with 1,022 global citations, followed by Irfan et al. (2022) with 684 citations. Zhou et al. (2020), Jiakui et al. (2023), Rasoulinezhad and Taghizadeh-Hesary (2022), and Li and Umair (2023) also recorded exceptionally high citation counts, each receiving more than 490 citations. While earlier publications generally accumulated higher total citation counts, several recent studies published in 2022–2023 achieved outstanding citations per year and normalized citation scores, indicating their rapid academic influence.

The most highly cited publications primarily examine the relationships among green finance, renewable energy, environmental quality, and economic development using advanced econometric methods. Many of these studies focus on China or multi-country panel datasets, reflecting the growing emphasis on empirical evidence in understanding sustainable development pathways. Their high citation impact suggests that these publications have provided important theoretical and empirical foundations for subsequent research in this field.

Figure 7 illustrates the document citation network among the retrieved publications. Several highly cited studies, particularly Lee and Lee (2022), Rasoulinezhad and Taghizadeh-Hesary (2022), Zhou et al. (2020), and Jiakui et al. (2023), occupy central positions within the network, indicating their important roles in knowledge diffusion and the development of major research themes. The network also reveals several interconnected citation clusters, suggesting that the literature has evolved around multiple, closely related research streams.

Table 2. Ten most globally cited documents

Document	Article title	Total citations	Citations per year	Normalized citations
Lee and Lee (2022), <i>Energy Economics</i>	How does green finance affect green total factor productivity? Evidence from China	1,022	204.4	11.40
Irfan et al. (2022), <i>Technological Forecasting and Social Change</i>	Influence mechanism between green finance and green innovation: Exploring regional policy intervention effects in China	684	136.8	7.63
Zhou et al. (2020), <i>Environmental Science and Pollution Research</i>	Impact of green finance on economic development and environmental quality: a study based on provincial panel data from China	540	77.1	3.54
Jiakui et al. (2023), <i>Journal of Cleaner Production</i>	Green technological innovation, green finance, and financial development and their role in green total factor productivity: Empirical insights from China	533	133.2	10.14
Rasoulinezhad and Taghizadeh-Hesary (2022), <i>Energy Efficiency</i>	Role of green finance in improving energy efficiency and renewable energy development	498	99.6	5.56
Li and Umair (2023), <i>Renewable Energy</i>	Does green finance development goals affects renewable energy in China	495	123.8	9.42
Ren et al. (2020), <i>Journal of Cleaner Production</i>	Nexus between green finance, non-fossil energy use, and carbon intensity: Empirical evidence from China based on a vector error correction model	404	57.7	2.65
Liao and Shi (2018), <i>Energy Policy</i>	Public appeal, environmental regulation and green investment: Evidence from China	376	41.8	4.09
Yang et al. (2021), <i>Resources Policy</i>	Nexus between green finance, fintech, and high-quality economic development: Empirical evidence from China	367	61.2	4.34
Madaleno et al. (2022), <i>Energy Economics</i>	A step forward on sustainability: The nexus of environmental responsibility, green technology, clean energy and green finance	325	65.0	3.63

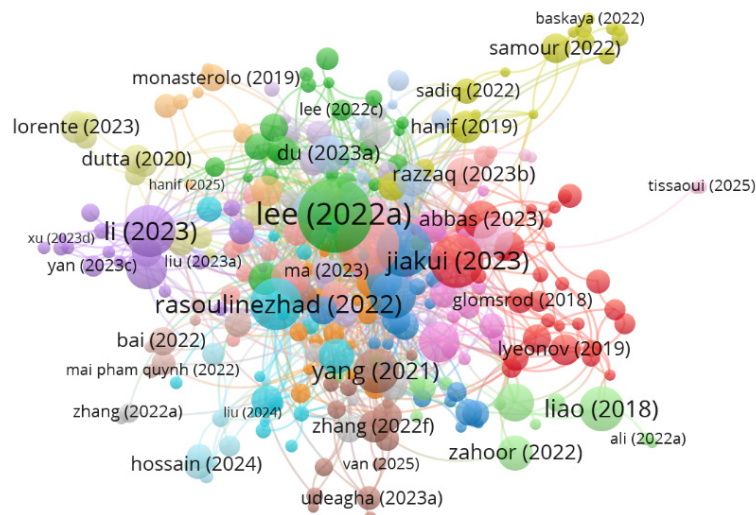


Figure 7. Document citation network

3.6. Keyword co-occurrence analysis

Figure 8 illustrates the keyword co-occurrence network generated from 118 keywords with a minimum occurrence threshold of 10. The results show that renewable energy (475 occurrences), green finance (421), and economic growth (350) form the conceptual core of the research field. Other frequently occurring keywords include carbon dioxide emissions (268), sustainable development (186), financial development (121), and carbon emissions (120), highlighting the central role of environmental sustainability in the existing literature.

The keyword network is organized into five thematic clusters, reflecting the major research directions within the field. The first cluster focuses on green financial instruments, climate finance, and financial markets. The second centers on green finance, renewable energy transition, sustainable development, and technological innovation. The third primarily addresses environmental quality, carbon emissions, and the environmental Kuznets curve. The remaining clusters include advanced econometric methods and contextual topics related to developing countries and energy systems. Collectively, these clusters demonstrate that

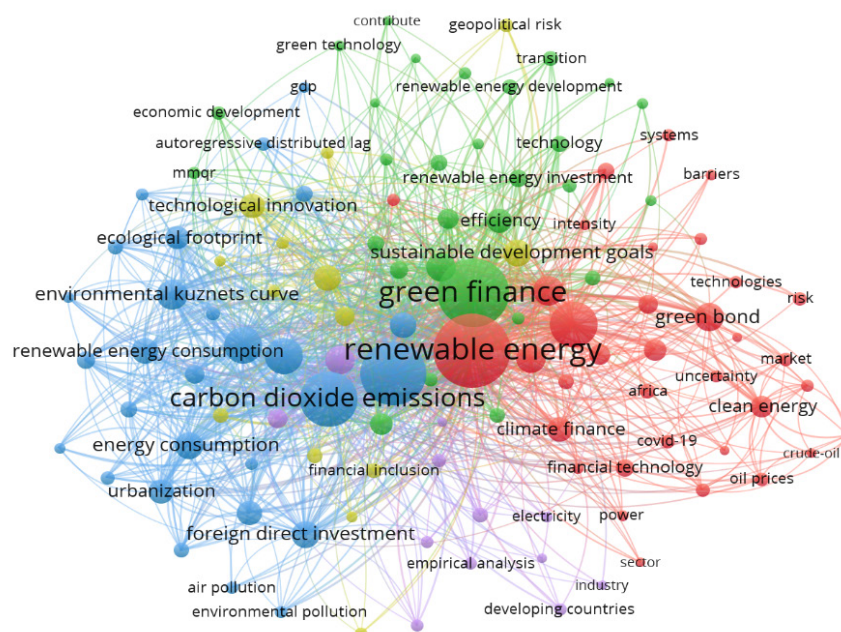


Figure 8. Keyword co-occurrence network

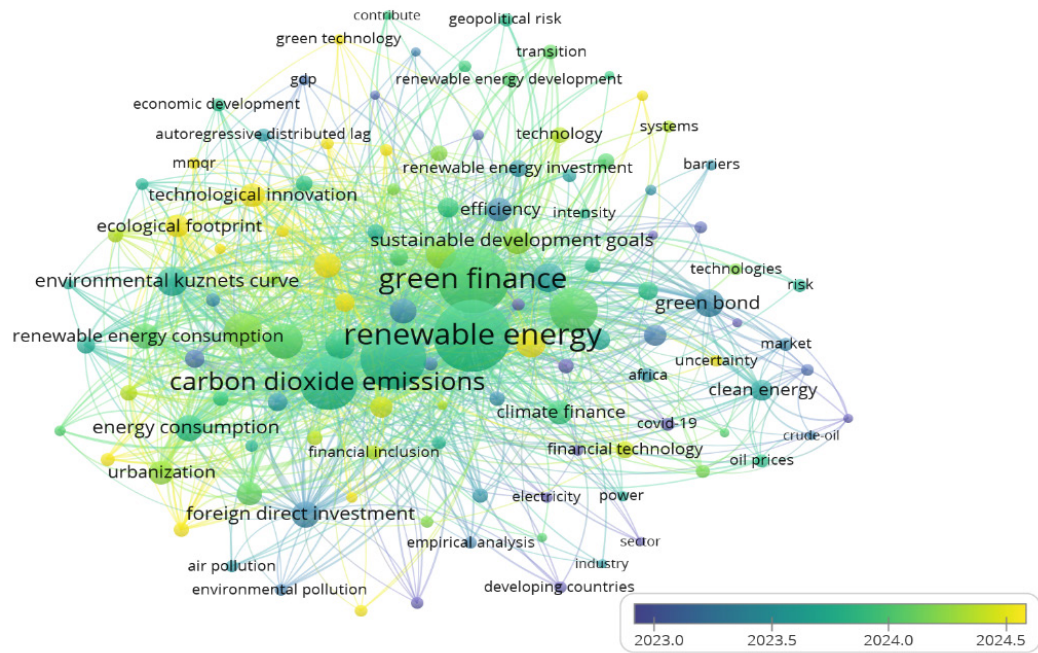


Figure 9. Keyword co-occurrence overlay by average publication year

research is structured around the interconnected themes of green finance, renewable energy, economic growth, and environmental sustainability.

Figure 9 presents the overlay visualization of the keyword co-occurrence network based on the average publication year. The visualization indicates that topics such as ecological footprint, foreign direct investment, financial technology, and advanced econometric methods have appeared more frequently in recent years, suggesting that the literature is increasingly incorporating digital finance, environmental performance, and more sophisticated analytical approaches.

3.7. Co-citation analysis

Figure 10 presents the co-citation network of the 191 cited references that met the minimum citation threshold. The network reveals four major clusters representing the intellectual foundations of the research field. The largest cluster is dominated by methodological studies on panel econometric techniques, including cross-sectional dependence, panel cointegration, and unit-root testing. A second cluster consists of influential studies examining the relationships among green finance, renewable energy, and environmental sustainability. The remaining clusters encompass research related to renewable energy finance, resource policy,

green bonds, and sustainable finance, reflecting the diversity of the field's intellectual foundations.

The co-citation structure demonstrates that research on green finance, renewable energy, and economic development is supported by both methodological and empirical contributions. The prominence of econometric references alongside highly cited empirical studies indicates that robust quantitative methods have played an important role in advancing this research area. Collectively, the four clusters provide the theoretical and methodological foundations upon which subsequent studies have been developed.

3.8. Bibliographic coupling analysis

Figure 11 presents the bibliographic coupling network of 333 connected documents, illustrating the current research fronts in the field. The analysis identifies five major clusters. The largest cluster focuses on the interactions among green finance, renewable energy, green innovation, and economic growth. The remaining clusters address topics related to environmental quality, climate finance, energy transition, resource management, and energy poverty, highlighting the breadth of contemporary research.

Compared with the co-citation network, bibliographic coupling reflects the intellectual connections among recent publications rather than the

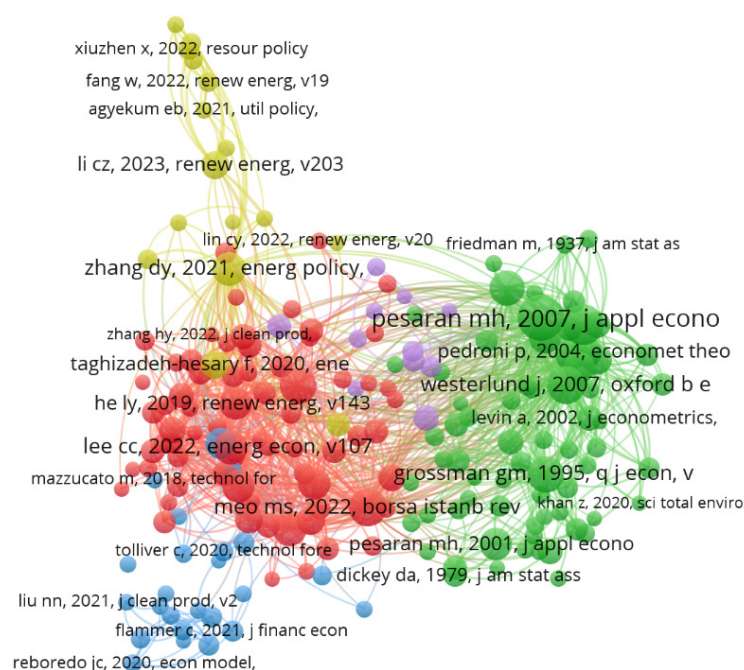


Figure 10. Co-citation network of cited references

foundational literature. The results indicate that current research has expanded beyond the traditional relationships among finance, economic growth, and environmental emissions to incorporate themes such as climate finance, natural resource management, and the socio-economic dimensions of sustainable development. This pattern suggests an increasingly diversified and interdisciplinary research landscape.

3.9. Thematic analysis

Figure 12 presents the thematic map based on the centrality–density framework, while Figure 13 illustrates the thematic evolution of the research field across three time periods. Together, these analyses provide an overview of the maturity and evolution of the major research themes.

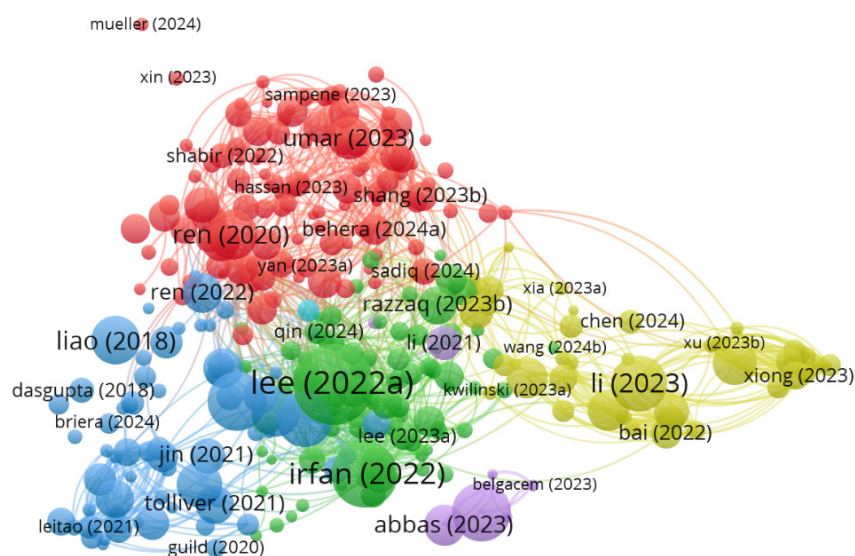


Figure 11. Bibliographic coupling network of documents

The thematic map identifies renewable energy transition, green economic growth, and advanced econometric methods as well-developed motor themes. The main basic themes include green finance, renewable energy, sustainable development, environmental sustainability, and technological innovation, confirming their central roles in the literature. In contrast, green bonds, climate change, and the Sustainable Development Goals (SDGs) appear as emerging or evolving themes.

The thematic evolution analysis shows that research has gradually expanded over time. During 2007–2023, studies mainly focused on economic growth, energy, renewable energy, and environmental quality. Between 2024 and 2025, research broadened to include clean energy, policy, and panel data. In the most recent period (2026), greater attention was given to renewable energy, carbon dioxide emissions, cointegration, countries, and sustainable development, reflecting the continued development of cross-country studies and advanced econometric applications.

3.10. Trend topics

Figure 14 presents the temporal evolution of research topics by identifying the periods in which author keywords reached their highest prominence. The results show that the research field has evolved from an initial focus on energy, economic growth, and environmental quality toward broader themes related to green finance, renewable energy, and sustainable development. More recently, the literature has expanded to include green investment, foreign direct investment, financial development, and environmental performance, reflecting the increasing integration of financial and environmental perspectives.

Recent trend topics highlight growing attention to energy transition, digital finance, financial technology (FinTech), ecological footprint, and advanced econometric techniques such as cross-sectional dependence and cointegration. These trends indicate the continued diversification of research themes and the increasing application of

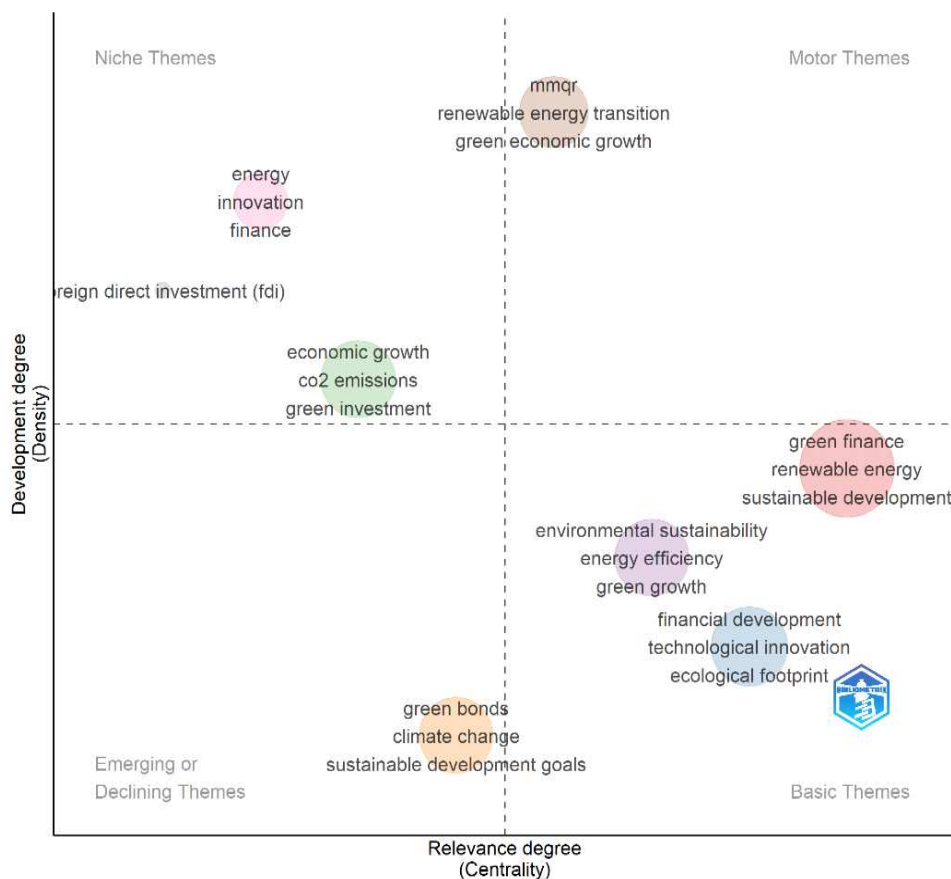


Figure 12. Thematic map

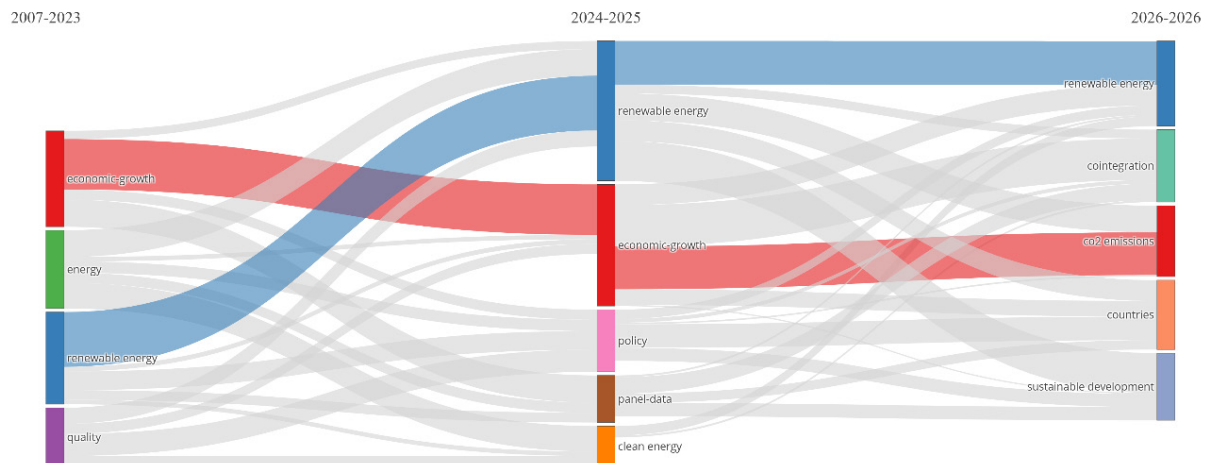


Figure 13. Thematic evolution across the periods 2007–2023, 2024–2025, and 2026

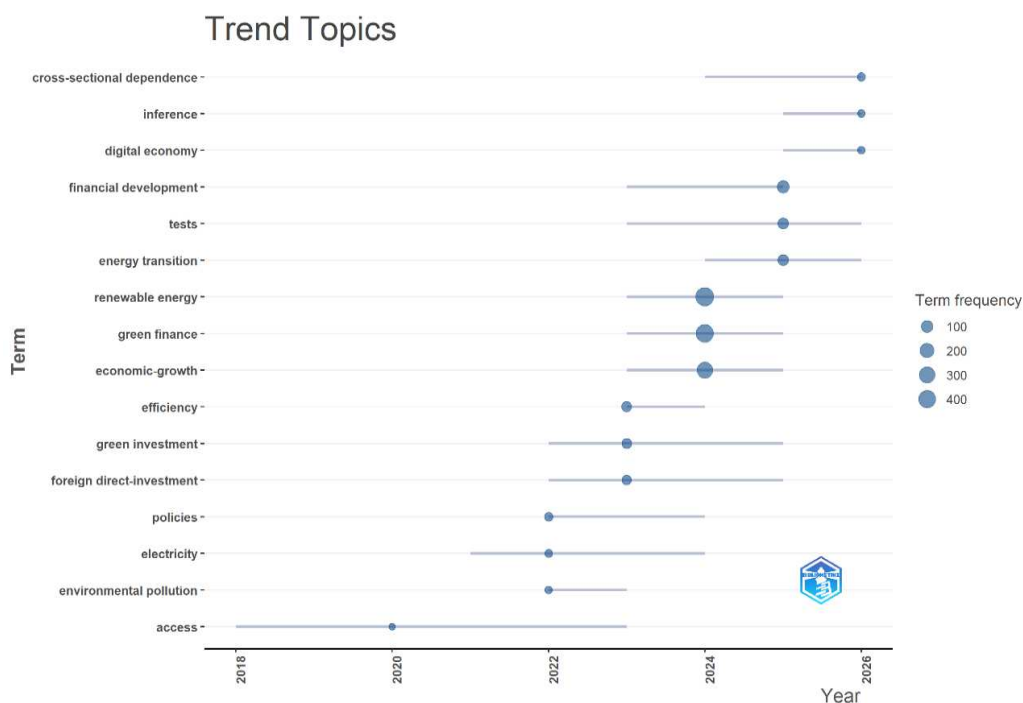


Figure 14. Trend topics

digital finance and advanced quantitative methods in studies of renewable energy and sustainable economic development.

4. DISCUSSION

4.1. Development and intellectual structure of the field

The bibliometric findings demonstrate that research on the nexus between green finance, renewable energy, and economic development has

developed rapidly into a well-established interdisciplinary research field. The remarkable growth in publications after 2022 reflects increasing academic and policy interest in understanding how financial mechanisms can facilitate energy transition and sustainable economic development. This expansion is consistent with Jaishree and Dogga (2025), who documented substantial growth in research on green finance and sustainable development during 2010–2024. While their review addressed the broader finance–sustainability relationship, the present study focuses specifically on the intersection of green finance, renewable

energy, and economic development. At the same time, the citation, co-citation, and bibliographic coupling analyses reveal a relatively stable intellectual structure built around a small group of highly influential studies. These seminal publications have established the empirical and methodological foundations of the field, with subsequent research largely extending their analytical frameworks to different countries, datasets, and policy contexts. The substantive focus of these influential studies helps explain the connections observed in the present analysis. Lee and Lee (2022) examined green finance and green total factor productivity, Zhou et al. (2020) investigated its relationships with economic development and environmental quality, and Rasoulinezhad and Taghizadeh-Hesary (2022) examined energy efficiency and renewable energy development. The present review complements these empirical contributions by mapping how their research themes are connected within the wider literature. Collectively, these findings suggest that the literature has evolved through cumulative knowledge development, with recent studies extending established theoretical and empirical foundations across different contexts.

Another notable characteristic of the field is its strong geographical concentration. China has emerged as the dominant contributor, followed by several rapidly developing economies, including Türkiye, India, Pakistan, Malaysia, and Vietnam. China's leading position is consistent with Jaishree and Dogga (2025), who also identified China as the largest contributor, followed by India and the United Kingdom. Differences in the prominence of other countries may reflect variations in research scope, database coverage, and publication periods between the two reviews. This pattern reflects the growing importance of green finance and renewable energy policies in countries undergoing rapid economic transformation and pursuing sustainable development objectives. By contrast, contributions from Africa and Latin America remain comparatively limited, indicating that the current knowledge base is still concentrated in a relatively small number of geographical contexts. However, publication counts based on author affiliations indicate the geographical distribution of scholarly participation and do not necessarily identify the countries investigated. The keyword, thematic,

and bibliographic coupling analyses further show that research has become increasingly integrated around the core themes of green finance, renewable energy, economic growth, and environmental sustainability, while gradually expanding toward digital finance, climate-related risks, and energy transition. This thematic structure is consistent with Tao and Chao (2023), who identified green finance, economic growth, renewable energy, and CO₂ emissions as prominent keywords in their review of green finance and energy. The overlap suggests continuity in the field's central concerns, while the present analysis provides an updated account of their connections and thematic development within the selected three-domain intersection. Together, these findings indicate an increasingly interconnected research field that continues to diversify through new research topics and interdisciplinary perspectives.

4.2. Emerging research themes and methodological development

The thematic analyses indicate that the research field has gradually expanded beyond the traditional relationship between green finance, renewable energy, and economic growth toward a broader sustainability perspective. While these three themes remain the conceptual core of the literature, recent studies increasingly integrate issues related to environmental quality, green innovation, energy transition, and sustainable development. This thematic overlap is consistent with Jaishree and Dogga (2025), who identified green finance, sustainable development, renewable energy, and climate finance as key research themes. Similarly, Kumar et al. (2024) examined the intersection between green finance and environmental sustainability through bibliometric and content analysis. Compared with these broader sustainability-oriented reviews, the present study examines how environmental themes connect specifically with renewable energy and economic development within a common research landscape. This evolution reflects a shift from examining the direct economic impacts of green finance to exploring its broader role in facilitating low-carbon development and achieving long-term sustainability objectives. The prominence of green innovation also corresponds with Irfan et

al. (2022), who identified industrial structure, economic growth, and research and development investment as transmission channels linking green finance with green innovation. Their empirical analysis provides a substantive explanation for the connections among finance, innovation, and development observed in the present keyword network, although keyword co-occurrence does not independently establish these mechanisms. The emergence of topics such as digital finance, financial technology, and ecological footprint further suggests that the field is responding to new technological and environmental challenges, highlighting the growing interaction between financial innovation and sustainable energy systems. This development reinforces the research agenda discussed by Kumar et al. (2024), who identified digital finance and artificial intelligence as areas requiring further investigation. The present findings suggest growing attention to related topics within the finance–energy–development intersection, rather than implying that these topics are entirely new to green finance scholarship.

The bibliometric evidence also reveals a clear methodological evolution. The co-citation network highlights the prominence of advanced panel econometric methods, while the thematic evolution and trend-topic analyses indicate increasing attention to cross-sectional dependence, cointegration, and other second-generation econometric techniques. This methodological orientation is consistent with the approaches adopted in influential empirical studies. Zhou et al. (2020) investigated green finance, economic development, and environmental quality using provincial panel data from China, whereas Rasoulinezhad and Taghizadeh-Hesary (2022) applied a STIRPAT framework to examine relationships among emissions, energy efficiency, green energy, and finance across selected economies. Ren et al. (2020), by comparison, used a vector error correction model to examine the dynamic relationships among green finance, non-fossil energy use, and carbon intensity in China. These studies illustrate the field's use of both panel and time-series approaches to investigate aggregate relationships. These findings suggest that methodological sophistication has become an important characteristic of the field, enabling researchers to examine increasingly complex relationships among finance, en-

ergy, and environmental variables. However, the strong reliance on macro-level panel data also points to an important research gap. Compared with the extensive use of country-level analyses, relatively limited attention has been given to firm-level, project-level, or household-level evidence. While the aggregate designs employed in these influential studies address relationships across regions or economies, they leave questions about financing access, project implementation, and household technology adoption unresolved. The present review therefore complements their contributions by identifying opportunities to connect aggregate findings with evidence on the decisions and processes through which green finance operates. Future research could therefore benefit from integrating micro-level data, quasi-experimental designs, and interdisciplinary approaches to provide a more comprehensive understanding of how green finance contributes to renewable energy development and sustainable economic growth.

4.3. Implications and future research directions

The findings of this bibliometric review provide several important theoretical implications. First, the study offers a comprehensive overview of the intellectual structure and knowledge evolution of research on the nexus among green finance, renewable energy, and economic development, demonstrating how the field has progressed from an emerging topic to a mature interdisciplinary research area. Unlike previous bibliometric studies that primarily examined bilateral relationships, this review integrates the three domains into a unified analytical framework, thereby providing a more comprehensive understanding of their conceptual relationships and research evolution. Second, the results reveal that although the literature has expanded rapidly, its theoretical foundation remains concentrated around macroeconomic and environmental perspectives. The growing prominence of themes such as digital finance, green innovation, and energy transition suggests opportunities to integrate broader theoretical perspectives, including institutional theory, innovation systems, and socio-technical transition frameworks (Geels, 2002), to explain how financial systems facilitate sustainable development under different economic and policy contexts.

Table 3. Summary of research gaps and future research directions

Bibliometric evidence	Gap	Future research direction
Governance and institutional quality remain peripheral themes in the keyword network	Limited understanding of governance mechanisms	Examine how regulatory quality, institutional capacity, and financial system design influence the effectiveness of green finance
Country-level panel studies dominate the literature, while behavioral and firm-level research remains scarce	Lack of micro-level evidence	Conduct firm-, project-, and household-level studies using surveys, experiments, and transaction-level data
Digital finance, FinTech, and ecological footprint have recently emerged as trend topics	Digitalization remains underexplored	Investigate fintech-enabled green finance, AI applications, digital inclusion, and digital energy systems
Scientific production is highly concentrated in China and several Asian countries	Limited geographical diversity	Expand empirical research in Africa, Latin America, and other underrepresented regions through comparative and cross-country studies
Co-citation analysis shows heavy reliance on advanced panel econometric methods	Limited methodological diversity	Employ causal identification strategies, quasi experimental designs, mixed methods, and qualitative approaches
Green bond research appears as an emerging or declining theme, while social dimensions remain limited	Narrow focus on financial instruments	Explore transition finance, biodiversity finance, carbon markets, just transition, and energy poverty
The literature remains largely grounded in EKC-based macroeconomic perspectives	Limited theoretical integration	Integrate institutional theory, innovation systems, and socio-technical transition theory to explain the finance, energy, and development nexus

From a practical perspective, the findings highlight the increasing importance of green finance as a policy instrument for promoting renewable energy development and sustainable economic growth. The concentration of influential studies on renewable energy deployment, environmental performance, and carbon emission reduction suggests that green financial policies have become an integral component of national sustainability strategies. At the same time, the geographical distribution of publications reveals that current evidence is heavily concentrated in China and several emerging Asian economies, while research from Africa and Latin America remains relatively limited. Expanding empirical evidence from underrepresented regions would improve the generalizability of existing findings and support the development of context-specific policy recommendations.

The bibliometric analysis also identifies several promising directions for future research. Future

studies should move beyond country-level panel analyses by incorporating firm-, project-, and household-level evidence to better understand the mechanisms through which green finance influences renewable energy investment and economic development. Greater attention should also be given to emerging topics such as digital finance, financial technology, climate-related financial risks, and energy transition, which have recently gained increasing research interest. Methodologically, future research could benefit from employing causal identification strategies, mixed-method approaches, and comparative cross-country analyses to strengthen empirical robustness and broaden the applicability of research findings. Furthermore, strengthening collaboration among researchers from developed and developing economies may contribute to a more geographically balanced and globally representative body of knowledge. Table 3 summarizes the research gaps identified from the bibliometric findings and outlines corresponding directions for future research.

CONCLUSION

This study aimed to map publication trends and collaboration patterns, identify the intellectual structure and major research themes, and highlight emerging topics and future research directions at the intersection of green finance, renewable energy, and economic development. Research on the nexus between green finance, renewable energy, and economic development has expanded rapidly and evolved into a well-established interdisciplinary field. The findings indicate that the literature is built around four core themes (green finance, renewable energy, economic growth, and environmental sustainability) supported by an increasingly stable intellectual foundation and continuously evolving research

fronts. Recent developments also reveal growing attention to digital finance, energy transition, climate-related issues, and more advanced econometric approaches, reflecting the field's increasing maturity and diversification.

This study contributes to the literature by providing the comprehensive bibliometric synthesis that integrates green finance, renewable energy, and economic development into a unified analytical framework. The findings also highlight important research gaps, including limited geographical representation, insufficient micro-level evidence, and the need for broader theoretical and methodological perspectives. Addressing these gaps will strengthen future research and provide more robust evidence to support sustainable finance policies and renewable energy development.

Although this review is limited to English-language publications indexed in the Web of Science Core Collection, it offers a systematic knowledge map that can serve as a useful reference for researchers, practitioners, and policymakers. Future studies should broaden database coverage, incorporate diverse methodological approaches, and examine underrepresented regional contexts to further advance understanding of the nexus among green finance, renewable energy, and economic development.

AUTHOR CONTRIBUTIONS

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REFERENCES

1. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959-975. <https://doi.org/10.1016/j.joi.2017.08.007>
2. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285-296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
3. Du, J., Shen, Z., Song, M., & Vardanyan, M. (2023). The role of green financing in facilitating renewable energy transition in China: Perspectives from energy governance, environmental regulation, and market reforms. *Energy Economics*, 120, Article 106595. <https://doi.org/10.1016/j.eneco.2023.106595>
4. Duman, B. D., Adak, M., & Güleş, A. (2024). VOSviewer analysis of studies on software selection in the logistics sector. *Logistics, Supply Chain, Sustainability and Global Challenges*, 15(s1), 29-37. <https://doi.org/10.2478/jlst-2024-0002>
5. Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, 31(8-9), 1257-1274. [https://doi.org/10.1016/S0048-7333\(02\)00062-8](https://doi.org/10.1016/S0048-7333(02)00062-8)
6. Irfan, M., Razaq, A., Sharif, A., & Yang, X. (2022). Influence mechanism between green finance and green innovation: Exploring regional policy intervention effects in China. *Technological Forecasting and Social Change*, 182, Article 121882. <https://doi.org/10.1016/j.techfore.2022.121882>
7. Jaishree, & Dogga, S. M. (2025). Unveiling research trends on the nexus between green finance and sustainable development: A systematic bibliometric review. *Discover Sustainability*, 6(1), Article 577. <https://doi.org/10.1007/s43621-025-01331-5>
8. 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, Article 135131. <https://doi.org/10.1016/j.jclepro.2022.135131>
9. Kaur, A., & Negi, P. S. (2025). A systematic literature review and bibliometric analysis on inclusive green finance with an emphasis on the digital economy and green growth. *Journal of Money and Business*, 5(1), 113-133. <https://doi.org/10.1108/JMB-09-2024-0053>
 10. Kumar, A., Ahuja, S., Soti, N., Saini, A. K., & Bharti. (2024). Navigating the green finance frontier: A bibliometric and content analysis of green finance and environmental sustainability. *Cogent Economics & Finance*, 12(1), Article 2398217. <https://doi.org/10.1080/23322039.2024.2398217>
 11. Lee, C.-C., Wang, F., & Chang, Y.-F. (2023). Does green finance promote renewable energy? Evidence from China. *Resources Policy*, 82, Article 103439. <https://doi.org/10.1016/j.resour-pol.2023.103439>
 12. Lee, C.-C., & Lee, C.-C. (2022). How does green finance affect green total factor productivity? Evidence from China. *Energy Economics*, 107, Article 105863. <https://doi.org/10.1016/j.eneco.2022.105863>
 13. Li, C., & Umair, M. (2023). Does green finance development goals affects renewable energy in China. *Renewable Energy*, 203, 898-905. <https://doi.org/10.1016/j.renene.2022.12.066>
 14. Liao, X., & Shi, X. (2018). Public appeal, environmental regulation and green investment: Evidence from China. *Energy Policy*, 119, 554-562. <https://doi.org/10.1016/j.enpol.2018.05.020>
 15. Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3-42. [https://doi.org/10.1016/0304-3932\(88\)90168-7](https://doi.org/10.1016/0304-3932(88)90168-7)
 16. Madaleno, M., Dogan, E., & Taskin, D. (2022). A step forward on sustainability: The nexus of environmental responsibility, green technology, clean energy and green finance. *Energy Economics*, 109, Article 105945. <https://doi.org/10.1016/j.eneco.2022.105945>
 17. Mol, A. P. J., & Spaargaren, G. (2000). Ecological modernisation theory in debate: A review. *Environmental Politics*, 9(1), 17-49. <https://doi.org/10.1080/09644010008414511>
 18. Ramos, R., & Rita, P. (2024). Structure of REDEE and EJMBE research: A bibliometric analysis. *European Journal of Management and Business Economics*, 33(1), 1-19. <https://doi.org/10.1108/EJMBE-04-2022-0109>
 19. Rasoulinezhad, E., & Taghizadeh-Hesary, F. (2022). Role of green finance in improving energy efficiency and renewable energy development. *Energy Efficiency*, 15(2), Article 14. <https://doi.org/10.1007/s12053-022-10021-4>
 20. Ren, X., Shao, Q., & Zhong, R. (2020). Nexus between green finance, non-fossil energy use, and carbon intensity: Empirical evidence from China based on a vector error correction model. *Journal of Cleaner Production*, 277, Article 122844. <https://doi.org/10.1016/j.jclepro.2020.122844>
 21. Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), S71-S102. <https://doi.org/10.1086/261725>
 22. Sinha, M., Mukhopadhyay, P., Das, O., & Kundu, A. (2025). Role of green finance in green growth in Global South. In R. C. Das (Ed.), *Green energy investments and economic development* (pp. 89-107). Palgrave Macmillan. https://doi.org/10.1007/978-981-96-6166-4_6
 23. Tao, Z., & Chao, J. (2023). A bibliometric and visualized analysis of research on green finance and energy in a global perspective. *Research in Globalization*, 7, Article 100156. <https://doi.org/10.1016/j.resglo.2023.100156>
 24. van Eck, N. J., & Waltman, L. (2010). Software survey: VOS-viewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523-538. <https://doi.org/10.1007/s11192-009-0146-3>
 25. Xing, C., Zhang, X., Zhang, Y., & Zhang, L. (2024). From green-washing to innovation-washing: Environmental information intangibility and corporate green innovation in China. *International Review of Economics & Finance*, 93, 204-226. <https://doi.org/10.1016/j.iref.2024.03.077>
 26. Yadav, A., Gyamfi, B. A., Asongu, S. A., & Behera, D. K. (2024). The role of green finance and governance effectiveness in the impact of renewable energy investment on CO₂ emissions in BRICS economies. *Journal of Environmental Management*, 358, Article 120906. <https://doi.org/10.1016/j.jenvman.2024.120906>
 27. Yang, Y., Su, X., & Yao, S. (2021). Nexus between green finance, fintech, and high-quality economic development: Empirical evidence from China. *Resources Policy*, 74, Article 102445. <https://doi.org/10.1016/j.resour-pol.2021.102445>
 28. 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>
 29. Zournatzidou, G. (2025). Green finance and sustainable development: Investigating the role of greentech business ecosystem through PRISMA-driven bibliometric analysis. *Administrative Sciences*, 15(4), Article 150. <https://doi.org/10.3390/admsci15040150>