Exploring the Role of Green Finance in Banking Towards Sustainable Development: Evidence from a Bibliometric Analysis

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Abstract

This study uses bibliometric analysis of Web of Science data from 2011 to 2025 to assess research trends in the context of green finance pertaining to financial institutions, specifically banks. Advanced tools like Biblioshiny and VOSviewer made it easier to use bibliometric analysis. Green finance has gained popularity since it is in line with sustainability objectives and global environmental issues. It has become an essential tool for solving environmental issues worldwide and advancing sustainable development. Numerous facets of green finance research are examined in the study, such as publishing trends by year, the most cited articles, contributing nations, journals, author co-citation analysis, and keyword co-occurrence analysis.

Key words: Green finance, sustainability, bibliometric analysis, financial institutions, sustainable development

Introduction

In the global movement to combat climate change and advance sustainable development, green financing has become a vital tool. The shift to a low-carbon, resilient economy is accelerated by green financing, which directs financial resources towards projects and activities that have a beneficial environmental impact, such as lowering greenhouse gas emissions, supporting renewable energy, and encouraging resource efficiency. Green finance principles have become more widely accepted in the banking industry, which reflects a larger commitment to coordinating financial flows with the Sustainable Development Goals (SDGs) of the UN, especially those pertaining to climate action (SDG 13), affordable and clean energy (SDG 7), and responsible consumption and production (SDG 12) (Raghu Raman, Suparna Ray, Dayana Das andPrema Nedungadi, 2025).

Research and innovation in sustainable and green finance have exploded over the last 20 years, with an emphasis on creating financial products like carbon-linked securities, green bonds, and climate bonds to support environmentally friendly initiatives (Endang Pitaloka,, Edi Purwanto,Yohanes Totok Suyoto,Agustine Dwianika, 2024). In addition to making it easier to raise funds for clean technology and sustainable infrastructure, these tools also aid in

reducing the risks and uncertainties that stand in the way of achieving the 2030 SDG targets. Green finance has the ability to significantly boost economic growth, lower carbon emissions, and spur technological innovation, according to empirical research. Notable effects have been seen in both industrialized and developing nations.

Despite these advancements, the landscape of green finance remains complex and fragmented, characterized by varying degrees of implementation, regulatory frameworks, and market maturity across regions (Yen Hai Hoang, 2023). Bibliometric analysis has become an invaluable tool for mapping the evolution of green finance research, identifying key thematic clusters—such as alternative energy, carbon emissions, and sustainable investment—and highlighting the contributions of leading institutions, authors, and journals in the field (Vardari et. al, 2024). Such analyses provide critical insights into research trends, gaps, and future directions, informing both academic inquiry and policy formulation.

This article aims to explore the role of green finance in banking as a driver of sustainable development, leveraging bibliometric analysis to synthesize existing research and illuminate emerging patterns and challenges (Loso Judijanto,Tirta Yoga,Indah Oktari Wijayanti, 2024). By systematically examining the scholarly landscape, this study seeks to contribute to a deeper understanding of how financial innovation within the banking sector can advance sustainability objectives and support the global transition toward a greener future.

Methodology

This research utilizes both descriptive and network analysis methodologies to conduct a thorough examination of the bibliometric landscape pertaining to green banking and its relationship with banking sustainability. A dataset comprising 375 researchers was extracted from the Web of Science in plaintext format and subsequently analysed using Biblioshiny and VOS viewer software. Various analytical procedures were performed in alignment with the specified research focus. The application of Biblioshiny and VOS viewer enabled a detailed exploration of the research landscape, elucidating connections and trends within the existing literature.

The authors aimed to ensure that the conclusions drawn from this bibliometric study were based on current and easily comprehensible scientific research. This goal was accomplished by using particular filters that were available in the Web of Science database. Before being published, publications are subjected to rigorous peer review procedures that are customised to meet the requirements of each publication. Open access restrictions also allow works

published in this format to be accessed for free, which promotes wider scholarly participation. With the intention of examining the content of articles published during the previous 15 years, the chosen publishing years covered the years 2011 through 2025. These filters were used to create a sample of 375 articles, which were further analysed using bibliometrics.

Design of the study

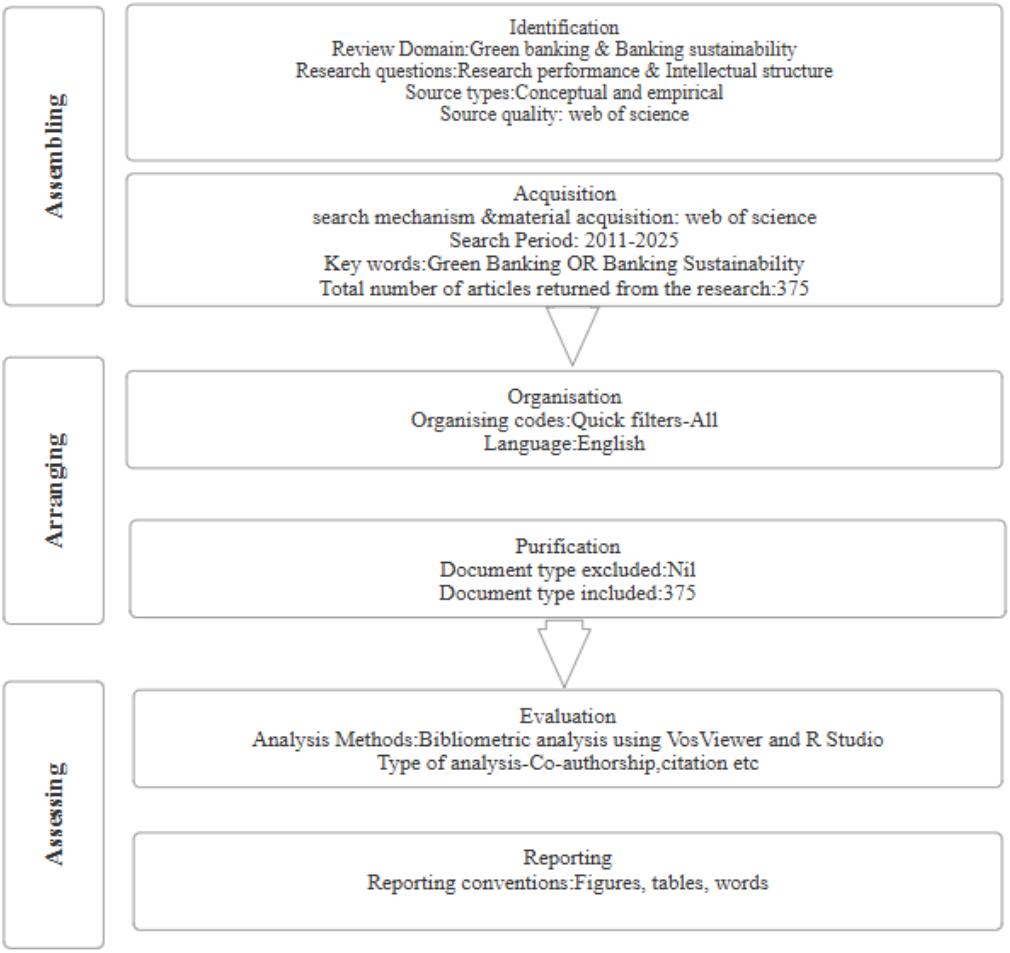

Figure 1: Authors' Elaboration

Main information about data

		AUTHORS	
Timespan	2011:2025	Authors	1224
Sources (Journals, Books, etc)	116	Authors of single-authored docs	14
Documents	375	AUTHORS COLLABORATION	
Annual Growth Rate %	29.91	Single-authored docs	14
Document Average Age	2.58	Co-Authors per Doc	3.86

Average citations per doc	23.1	International co-authorships %	50.93
References	21673	DOCUMENT TYPES	
DOCUMENT CONTENTS		article	347
Keywords Plus (ID)	743	article; early access	17
Author's Keywords (DE)	1239	article; retracted publication	4

Table 1: Authors' elaboration

The bibliometric data and citation trends for green finance in banking sustainability from 2011 to 2025 reveal a rapidly expanding research field, marked by a sharp increase in publications-peaking in 2024-and a high annual growth rate of nearly 30%. While the early years (notably 2013 and 2018) saw fewer publications, these works were highly influential, as reflected in their exceptionally high average citations per year, indicating the foundational nature of research during that period. In recent years, the volume of articles has surged, with a corresponding rise in international collaboration (over 50% co-authored internationally) and a robust average of 23.1 citations per document, though the average citations per year have naturally declined for the most recent publications due to their limited time to accumulate citations. Overall, the data demonstrates that green finance in banking has transitioned from a niche topic to a mainstream, dynamic research area, driven by global sustainability initiatives, regulatory developments, and the financial sector's increasing engagement with climate change and environmental issues.

Average citations per year

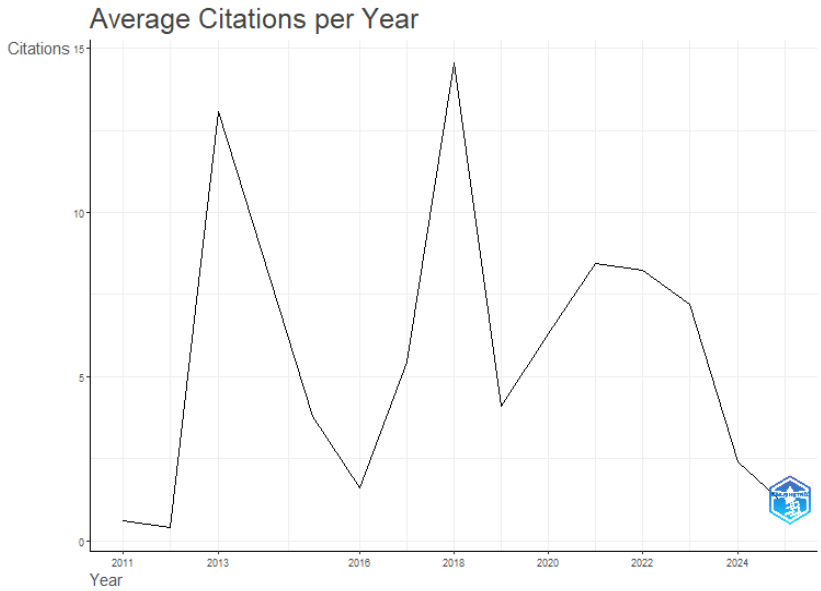

Figure 2: Authors' elaboration

The above image shows the trend of average citations per year for publications in green finance and banking sustainability from 2011 to 2025, highlighting several key patterns. Early years, such as 2013 and 2018, exhibit sharp peaks in average citations, indicating that a

small number of highly influential or foundational articles were published during those periods. As the field gained momentum, especially after 2018, the number of publications increased significantly, but the average citations per year became more moderate, reflecting both the influx of new research and the shorter time frame for recent articles to accumulate citations. The decline in average citations in the most recent years (2024–2025) is typical, as these articles have had limited exposure time. Overall, the graph illustrates the evolution of green finance in banking from a niche research area with sporadic high-impact studies to a rapidly growing field with broader scholarly engagement and sustained, though more distributed, citation impact.

Average scientific production

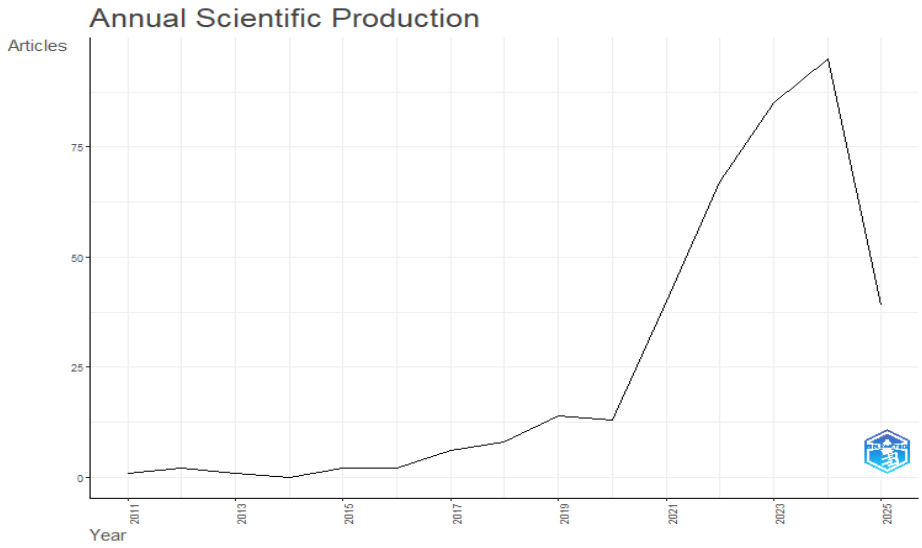

Figure 3: Authors' elaboration

The above figure illustrates the annual scientific production in the field of green finance and banking sustainability from 2011 to 2025, showing a clear trend of accelerating research activity. From 2011 to around 2018, the number of published articles remained quite low and relatively stable, indicating limited academic attention to the topic during this period. However, starting around 2019, there is a noticeable and rapid increase in the number of articles published each year, peaking sharply in 2024. This surge reflects a growing global interest and urgency in addressing sustainability issues within the banking sector, likely driven by heightened regulatory focus, climate change concerns, and international sustainability initiatives. The apparent drop in 2025 is likely due to incomplete data for the year, as it is still in progress. Overall, the graph highlights the transition of green finance in banking from a niche research area to a mainstream and rapidly expanding field in recent years.

Global country collaboration network

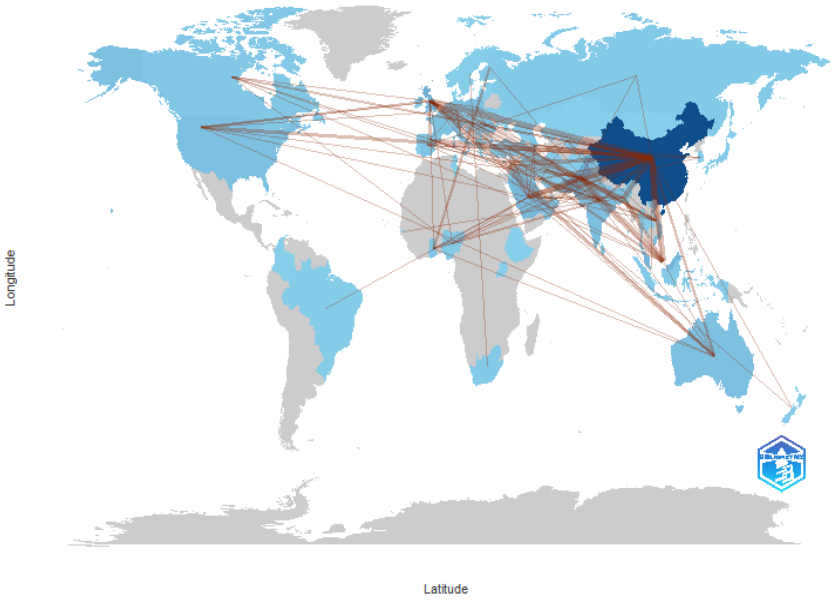

Figure 4: Authors' elaboration

The above image depicts a global country collaboration network in the field of green finance and banking sustainability, with lines representing co-authorship and research partnerships between countries. China, highlighted in dark blue, stands out as the central hub of international collaboration, engaging extensively with numerous countries across Asia, Europe, North America, and Oceania. The density and spread of connecting lines indicate that China has established strong research ties with both developed and developing nations, reflecting its leadership and growing influence in this area. Other countries are shown in lighter blue, suggesting varying but generally lower levels of collaboration compared to China. Overall, the map illustrates the increasingly international and interconnected nature of research in green finance, with China playing a pivotal role in driving global scholarly cooperation and knowledge exchange.

Most cited countries

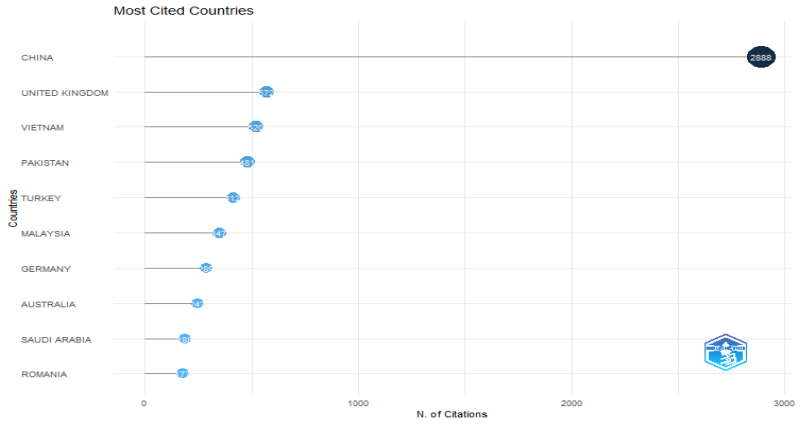

Figure 5: Authors' elaboration

The above image presents a horizontal bubble chart ranking the most cited countries in the field of green finance and banking sustainability based on the total number of citations. China stands out overwhelmingly as the global leader, with 2,888 citations-far surpassing all other countries on the list. The United Kingdom, Vietnam, Pakistan, Turkey, Malaysia, Germany, Australia, Saudi Arabia, and Romania follow, each with significantly fewer citations, ranging from 277 (United Kingdom) down to just 7 (Romania). This stark disparity highlights China's dominant influence and central role in shaping the research landscape of green finance and banking sustainability, while also indicating that, although other countries contribute to the field, their impact in terms of citation volume is comparatively limited.

Country co-occurrence network

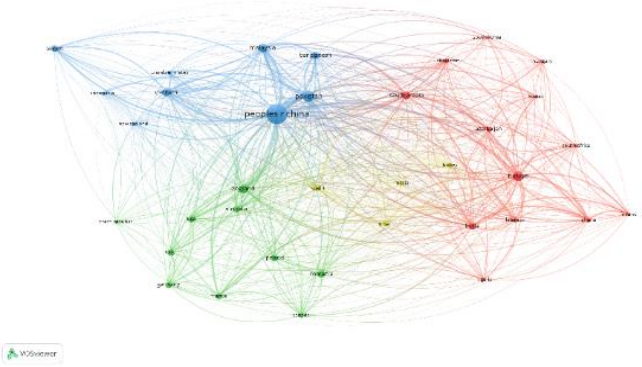

Figure 6: Authors' elaboration

This network visualizes the co-occurrence of countries mentioned in the research literature on green finance and related topics. Each node represents a country, and the size of the node likely indicates the frequency with which that country is mentioned or studied in the context of green finance. The lines connecting the countries signify that these countries are frequently discussed together within the same research publications, suggesting comparative studies, analyses of international collaborations, or the spread of green finance initiatives across borders. The clustering algorithm has grouped countries based on their co-occurrence patterns. For example, the blue cluster appears to include several Asian countries like "Peoples r China," "Pakistan," "Malaysia," and "Bangladesh," suggesting a significant body of research focuses on green finance developments and comparisons within this region. Similarly, the red cluster includes European and African countries, while the green and yellow clusters represent other geographical groupings with shared research attention. This network highlights the global distribution of research interest in green finance and identifies regions that are frequently studied in relation to one another.

Most global cited documents

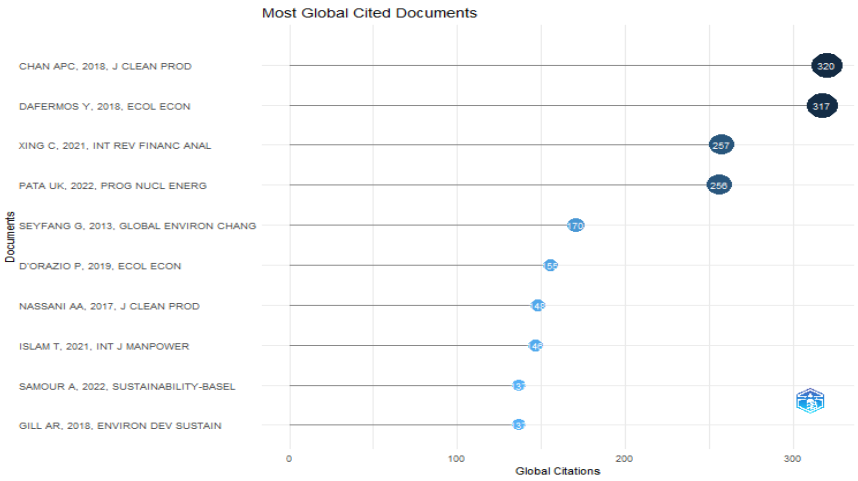

Figure 7: Authors' elaboration

The above image displays a bubble chart of the most globally cited documents in green finance and banking sustainability, ranking the top ten papers by total citations. The chart highlights that the articles by Chan (2018) and Dafermos (2018) are the most influential, with 320 and 317 citations respectively, significantly outpacing the others. Following these, papers by Xing (2021) and Pata (2022) also show high impact with over 250 citations each. The remaining documents, while still notable, have fewer citations, ranging from 33 to 170. This visualization underscores that a small number of key publications have had a disproportionately large influence on the field, serving as foundational or highly referenced works that shape ongoing research and discussions in green finance and banking sustainability.

Coupling network of documents using co-citation relationships

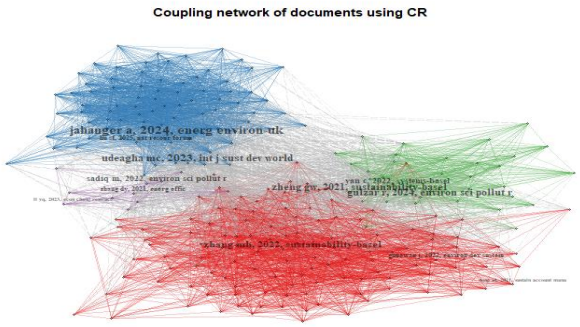

Figure 8: Authors' elaboration

The above image visualizes a coupling network of documents using co-citation relationships (CR) in the field of green finance and banking sustainability, where nodes represent individual research papers and lines indicate the strength of their bibliographic coupling. The

network is distinctly clustered into three major groups, colored blue, red, and green, each representing a thematic or topical cluster within the literature. The blue cluster, anchored by works such as Jahanger (2024), likely focuses on energy and environmental issues; the red cluster, centered on Zhang (2022), appears to emphasize sustainability and broader environmental policy; while the green cluster, with key documents like Van (2022) and Gulzar (2021), may address applied aspects of sustainability and pollution. The dense interconnections within each cluster suggest strong thematic coherence, while the links between clusters indicate interdisciplinary overlaps and shared references. Overall, this network highlights the structure and interconnectedness of research themes, revealing both the diversity and integration of scholarship in green finance and banking sustainability.

Green Finance & Banking Sustainability: Author Co-citation Network

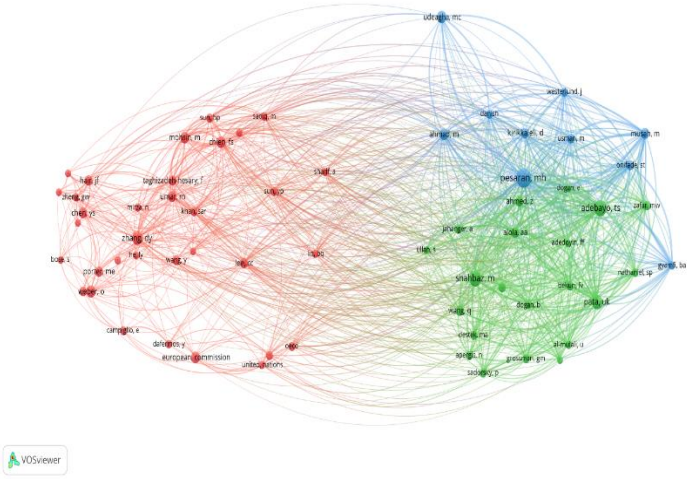

Figure 9: Authors' elaboration

The presence of distinct clusters suggests different schools of thought or specific areas of focus within this broader topic. For instance, the red cluster might represent foundational work on the theoretical linkages between environmental considerations and financial performance in banking, potentially including early studies on risk management and green lending practices. Authors within this cluster are likely to cite each other frequently, indicating a shared intellectual heritage.

The green cluster could signify a more contemporary focus, perhaps exploring the practical implementation of green finance initiatives within the banking sector, such as the development of green financial products, the impact of environmental regulations, or case studies of sustainable banking practices, possibly even with a regional focus relevant to Kerala or India. The authors in this cluster are likely engaging with more recent literature and potentially building upon the foundational work identified in the red cluster.

The blue cluster might represent a distinct yet related area, possibly focusing on the macroeconomic or policy dimensions of green finance and banking sustainability. This could include research on the role of central banks, government incentives for green finance, or the impact of international agreements on the banking sector's sustainability efforts. The connections between these clusters, indicated by the lines, suggest cross-pollination of ideas and the interconnectedness of these different facets of research. Highly cited authors, represented by larger nodes, act as central figures whose work has significantly influenced multiple areas within the field. Analysing the specific authors within each cluster and the strength of the connections between them would provide even richer insights into the evolution and key debates within this critical area of research.

Keyword Co-occurrence Network

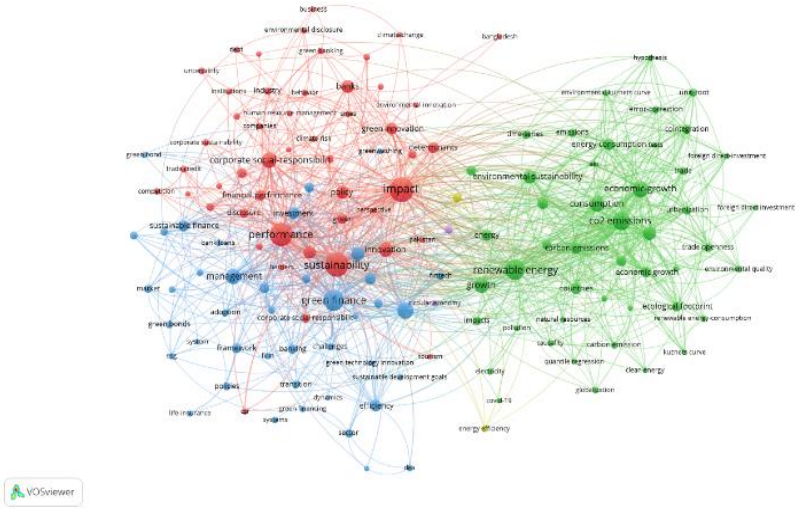

Figure 10: Authors' elaboration

This image displays a keyword co-occurrence network derived from research publications related to green finance and its impact on various aspects, likely including banking sustainability. The size of the nodes represents the frequency with which a particular keyword appears in the literature, while the lines connecting them indicate how often these keywords appear together within the same publications. The clustering algorithm has grouped related keywords into distinct color-coded clusters, suggesting different thematic areas within the broader research domain. For example, the blue cluster appears to center around the "performance" and "sustainability" of financial institutions, linking to concepts like "financial performance," "risk management," and potentially "corporate social responsibility." The green cluster seems to revolve around environmental aspects, with keywords such as "environmental sustainability," "renewable energy," "CO2 emissions," and "climate change." The red and yellow clusters likely represent other significant dimensions of the research, possibly focusing on policy frameworks ("policy," "regulation"), market mechanisms ("green bonds," "market"), or the broader "impact" of green finance on economic and environmental outcomes. Analyzing the central keywords and the connections between clusters can reveal the key research themes and their interrelationships in the study of green finance.

Publication Co-citation Network

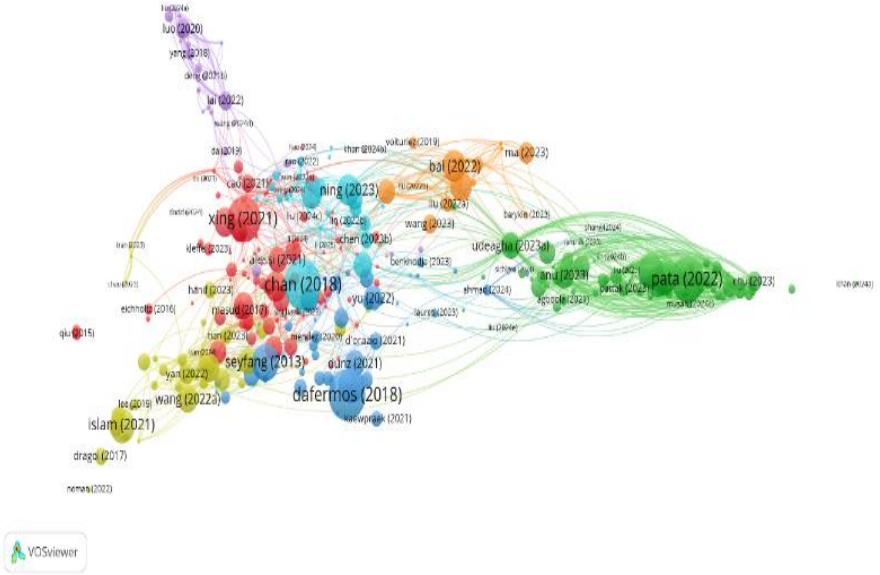

Figure11. Authors' elaboration

The bibliometric co-citation network visualization, generated using VOSviewer, illustrates the intellectual structure of research on green finance in banking for sustainable development. The map reveals several prominent thematic clusters. The red and blue clusters focus on foundational theories, policy frameworks, and macroeconomic implications, anchored by key publications such as Chan (2018) and Dafermos (2018). The green cluster, led by highly cited works like Pata (2022) and Anai (2023), emphasizes bibliometric reviews and empirical analyses. Meanwhile, the orange cluster reflects emerging market perspectives, with contributions from Bai (2022) and Ma (2023), while the purple and yellow clusters explore innovative financial instruments and environmental economics. The interconnections among clusters indicate a growing interdisciplinary convergence, with certain works bridging theoretical, empirical, and regional studies. This mapping highlights the evolving and multifaceted nature of green finance in the banking sector.

Discussions

The bibliometric analysis conducted for the period 2011 to 2025 indicates a significant transformation in the research landscape of green finance and banking sustainability. The field has experienced rapid expansion, with publication output peaking in 2024 and an annual growth rate nearing 30%. Although early years such as 2013 and 2018 produced fewer publications, these works demonstrated substantial scholarly impact, evidenced by their high average citations per year, underscoring their foundational role in shaping subsequent research. In recent years, the field has seen a marked increase not only in the volume of published studies but also in international collaboration, with more than half of the articles involving authors from multiple countries. This growing global engagement reflects the widespread recognition of green finance as a critical component of sustainable development.

While citation averages for recent publications remain lower due to their limited time in circulation, the overall average of 23.1 citations per document signals robust academic interest and influence. These trends collectively highlight the evolution of green finance from a niche topic to a mainstream research priority, driven by regulatory advancements, global sustainability imperatives, and the financial sector's increasing responsiveness to climate and environmental challenges.

The analysis of citation and publication trends in green finance and banking sustainability from 2011 to 2025 reveals a clear evolution of the field from a niche area to a dynamic and widely studied topic. Early years, particularly 2013 and 2018, saw the publication of a few highly influential articles that garnered significant citations, laying the groundwork for future research. From 2019 onward, there was a marked acceleration in publication output, peaking in 2024, driven by increasing global attention to sustainability, regulatory developments, and climate-related financial concerns. This surge in research activity has led to a broader and more diverse body of literature, resulting in a moderation of average citations per year due to the shorter time recent articles have had to accumulate impact. The slight decline observed in 2025 likely reflects incomplete data. Overall, these trends underscore the rapid mainstreaming of green finance in academic discourse and the growing engagement of the research community with sustainability challenges in the banking sector.

The analysis of global collaboration and citation metrics in green finance and banking sustainability research underscores the increasingly international nature of the field, with China emerging as a dominant force. China's central role is evident both in its extensive international co-authorship network and its position as the most cited country, with 2,888 citations—far surpassing all others. This prominence reflects not only China's leadership in fostering global research partnerships but also its influence in shaping scholarly discourse. The most cited documents, particularly those by Chan (2018) and Dafermos (2018), further highlight that a small number of foundational works continue to exert a substantial impact on the field. While other countries, including the United Kingdom, Vietnam, and Pakistan, contribute meaningfully, their citation impact remains significantly lower. Collectively, these findings reveal a concentrated pattern of scholarly influence, with China at the forefront, driving both research output and international collaboration in the rapidly growing domain of green finance and banking sustainability.

The co-citation and author co-citation network analyses offer valuable insights into the intellectual structure and thematic development of research in green finance and banking sustainability. Document co-citation patterns reveal three major thematic clusters: one centered on energy and environmental issues (blue), another focused on broader sustainability and policy frameworks (red), and a third addressing applied aspects such as pollution reduction and environmental management (green). These clusters highlight both thematic coherence and interdisciplinary overlap within the field. Similarly, the author co-citation network uncovers distinct schools of thought, with clusters representing foundational theoretical work, contemporary implementation studies, and macroeconomic or policy-oriented research. The interconnectedness among these clusters reflects the evolving and integrated nature of the field, while highly cited authors serve as intellectual anchors bridging

diverse research areas. Together, these network analyses underscore the multidimensional character of green finance scholarship and its progression from foundational theories to practical and policy-driven applications.

The keyword co-occurrence, country co-occurrence, and publication co-citation network analyses collectively offer a comprehensive view of the thematic structure, geographic focus, and intellectual foundations of green finance research. The keyword co-occurrence network reveals several thematic clusters, such as financial performance, environmental sustainability, climate change, and policy frameworks, highlighting the multidimensional nature of the field and its interrelated research areas. The country co-occurrence network further demonstrates the global scope of green finance scholarship, with regional clusters—such as Asian, European, and African countries—frequently studied together, reflecting both comparative analyses and international research collaborations. Meanwhile, the co-citation network of publications identifies key influential works and distinct intellectual clusters, pointing to foundational studies that have shaped the field's development. Together, these visualizations underscore the interdisciplinary, international, and evolving character of green finance research, offering valuable insights into the field's major themes, regional emphases, and scholarly impact.

Conclusion

Based on the bibliometric analysis from 2011 to 2025, it is evident that green finance and banking sustainability have rapidly evolved from a niche research area into a dynamic, mainstream field characterized by robust academic growth, increasing international collaboration, and significant scholarly influence. The surge in publication output—peaking in 2024—reflects mounting global attention to sustainability and regulatory imperatives, while the high citation impact of early foundational works underscores their enduring relevance. China's leadership in both research output and international partnerships highlights the concentrated yet globally interconnected nature of scholarly activity in this domain. Thematic and network analyses further reveal a multidimensional and interdisciplinary field, with research spanning energy, environmental management, policy frameworks, and practical applications. Collectively, these trends point to a vibrant, maturing research landscape that is well-positioned to inform policy, guide financial innovation, and support the banking sector's pivotal role in advancing sustainable development worldwide.

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