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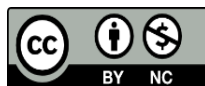
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Bibliometric Analysis of Green Finance Research Using Science Mapping Technique

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Abstract

The increasing importance of green finance in the global financial system has led to a surge in related research. However, a comprehensive bibliometric analysis of the green finance literature remains limited. This study aims to analyze the structure of green finance research using VOSviewer. The motivations behind this study include identifying the main themes and trends in green finance research, profiling the leading authors, institutions, and countries contributing to the field, and understanding the relationships between different research clusters within green finance.

A total of 617 publications from 2009 to 2024 were analyzed. The bibliometric analysis results reveal prominent themes and trends in the green finance literature. Additionally, examining the most cited authors, influential institutions, and geographical distribution helps identify key stakeholders in this field. The findings indicate that publications in "Green Finance" are limited, reflecting its status as an emerging area of research. However, as environmental issues escalate, academic interest in this field is expected to grow. This study provides a solid foundation for future green finance research.

Keywords

Green Finance,
Green Investment,
Green Economy

JEL Classification

G10, G15, Q56

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Yeşil Finans Araştırmalarının Bilim Haritalama Teknikleriyle Bibliyometrik Analizi

Öz

Küresel finansal sistemde yeşil finansın artan önemi, bu alandaki araştırmaların çoğalmasına yol açmıştır. Ancak, yeşil finans literatürünün kapsamlı bir bibliyometrik analizi henüz yeterince yapılmamıştır. Bu çalışma, yeşil finans araştırmalarının yapısını VOSviewer kullanarak incelemeyi amaçlamaktadır. Bu çalışmaya yön veren motivasyonlar arasında yeşil finans araştırmalarındaki ana temaların ve eğilimlerin belirlenmesi, bu alana katkıda bulunan önde gelen yazarların, kurumların ve ülkelerin profilinin çıkarılması ve yeşil finanstaki farklı araştırma kümeleri arasındaki ilişkilerin anlaşılması yer almaktadır.

2009'dan 2024'e kadar toplam 617 yayın incelenmiştir. Bibliyometrik analiz sonuçları, yeşil finans literatüründe belirli temaların ve trendlerin öne çıktığını göstermektedir. Ayrıca, en çok atıf alan yazarlar, etkili kurumlar ve coğrafi dağılımın incelenmesi, bu alandaki önemli paydaşların belirlenmesine yardımcı olmaktadır. Sonuçlar, "Yeşil Finans" alanında yapılan yayınların sınırlı sayıda olduğunu ve bu alanın yeni gelişmekte olduğunu göstermektedir. Ancak, çevresel sorunların artmasıyla bu alandaki akademik ilginin de artacağı öngörülmektedir. Bu çalışma, yeşil finans araştırmalarının derinlemesine anlaşılmasına ve gelecekteki araştırmalar için sağlam bir temel oluşturmaktadır.

Anahtar Kelimeler

Yeşil Finans,
Yeşil Yatırımlar,
Yeşil Ekonomi

JEL Kodu

G10, G15, Q56

1. Introduction

Green finance has gained substantial importance in recent years as the world faces increasing environmental challenges and the need for sustainable development. It represents a critical approach to channeling financial resources into projects and policies that contribute to environmental sustainability, such as renewable energy, energy efficiency, and climate change mitigation. As the field evolves, understanding the structure and dynamics of green finance research is essential for identifying current trends, key contributors, and emerging opportunities. This study uses bibliometric analysis from the Web of Science to map the green finance literature and provides a comprehensive overview of its thematic development, key authors, institutions, and geographical distribution. Through this analysis, the study aims to uncover insights that can guide future research and foster collaborations to promote sustainable financial practices globally.

Research Problem: The specific topic addressed by the study: In recent years, green finance has received significant attention due to its potential to address environmental challenges through sustainable financial practices. The research problem in this study is to examine the general structure of green finance research using bibliometric analysis, identifying key themes, trends, and the relationships between different research clusters.

Objectives: Goals and research questions: The main objectives of this study are to explore the primary themes and trends in green finance research, identify leading authors,

institutions, and countries in the field, and understand the relationships between various research clusters. Specifically, the research questions are:

What are the main themes and trends in green finance research?

Who are the leading authors contributing to this field, and what are the institutions and countries involved?

How are different clusters of research in green finance related?

Significance, Contribution to literature and practice: This study contributes to the literature by providing a comprehensive overview of the green finance research landscape. By identifying major themes and trends, it helps researchers and practitioners understand the current priorities in green finance and suggests potential areas for future research. The bibliometric analysis also identifies leading authors, institutions, and countries, thus fostering potential collaborations and joint research efforts. Moreover, by examining the relationships between research clusters, the study highlights the importance of multidisciplinary approaches in addressing green finance challenges, offering a more holistic understanding of the field.

Limitations, Scope and constraints: This study is limited to the literature available in the Web of Science database. The analysis was conducted on data obtained from Web of Science as of July 1, 2024, using VOSviewer for bibliometric visualization. Additionally, the analysis is restricted to research within the fields of Business, Management, Economics, and Business Finance, narrowing the scope to these specific areas. As such, the study may not represent the full breadth of research on green finance, and its findings should not be generalized beyond the included databases or fields.

In conclusion, this study provides a comprehensive and in-depth bibliometric analysis of green finance research based on data obtained from the Web of Science database. It makes significant contributions to the field by mapping the thematic development, key authors, institutions, and geographical distribution of green finance research. This study lays a solid foundation for future studies by highlighting emerging trends, key research clusters, and opportunities for collaboration.

2. Conceptual Framework

Green finance refers to financial practices that seek solutions to environmental problems such as environmental sustainability and climate change. In academic literature, the term “green finance” generally covers financial products, investments, policies, and strategies that aim to

reduce environmental impacts or promote positive environmental outcomes. Green finance includes tools and mechanisms that will help the financial system achieve environmental sustainability goals (Lee & Lee, 2022:3)

Key elements of green finance include integrating environmental risks and opportunities into financial decision-making processes, financing green projects and technologies, measuring and reporting environmental performance, and developing green financial products and services. Green bonds, green loans, investment funds in the context of sustainability and environmental risk assessment tools are prominent applications in this context. Low interest rates, low bank charges, donations to environmental organizations, etc. In these ways, customers are encouraged to use “green” financial products. Green financing is now seen as one of the important pillars of sustainable global development (He et al., 2019: 974)

Research in this field generally aims to understand the relationships between financial performance and environmental impact and contributes to financial institutions developing sustainability-oriented strategies. This study aims to better understand the current situation in the green finance literature and determine future research directions through a bibliometric analysis using VOSviewer software. In this context, answers were sought to the following questions:

- *Who are the most cited authors and studies in the field of green finance?*
- *Which institutions are the most effective in this field?*
- *What are the key themes and trends in the literature?*
- *What is the geographical distribution of green finance research?*

The importance of this study is to provide a comprehensive mapping of the green finance literature, helping researchers and policymakers better understand the knowledge gaps and future research opportunities in this field. In addition, this study contributes to making academic and applied studies in the field more focused and effective by revealing the evolution of research in the field of green finance over time and the building blocks of the existing literature.

In the literature summary below, summaries of the works of the top five most cited authors are presented in a comprehensive and detailed manner. Clear information about the subjects, methodologies and findings of the research is given, and the important points of each study are conveyed. An overview of the studies' context and how they contribute to relevant literature is also provided.

Table 1

Literature Review of the Most Cited Authors and Publications on Web of Science (Top 20)

Authors	Publication Year	Total Citations	Average per Year
Sharfman, M. P., & Fernando, C. S.	2008	792	46.59
Flammer, C.	2021	613	36.06
Zerbib, O.D	2019	524	87.33
Lee, C. C., & Lee, C. C.	2022	510	170
Yu, C. H., Wu, X., Zhang, D., Chen, S., & Zhao, J.	2021	491	122.75
Zhang, D., Mohsin, M., Rasheed, A. K., Chang, Y., & Taghizadeh-Hesary, F.	2021	451	112.75
Taghizadeh-Hesary, F., & Yoshino, N.	2019	379	63.17
Meo, M. S., & Abd Karim, M. Z.	2022	319	106.33
Irfan, M., Razzaq, A., Sharif, A., & Yang, X.	2022	316	105.33
Zhou, G., Zhu, J., & Luo, S.	2022	298	99.33
Nguyen, T. T. H., Naeem, M. A., Balli, F., Balli, H. O., & Vo, X. V.	2021	277	69.25
Lv, C., Bian, B., Lee, C. C., & He, Z.	2021	255	63.75
Tiwari, A. K., Abakah, E. J. A., Gabauer, D., & Dwumfour, R. A.	2022	243	81
Le, T. L., Abakah, E. J. A., & Tiwari, A. K.	2021	234	58.5
Lee, C. C., Lee, C. C., & Li, Y. Y.	2021	218	54.5
Banga, J.	2019	216	36
Madaleno, M., Dogan, E., & Taskin, D.	2022	221	70.33
Dikau, S., & Volz, U.	2021	201	50.25
Reboredo, J. C., Ugolini, A., & Aiube, F. A. L.	2020	194	38.8
Broadstock, D. C., & Cheng, L. T.	2019	191	31.83

Note. The table was created by the author on 01.07.2024 with information obtained from the Web of Science database.

Sharfman & Fernando (2008), in their study on 267 U.S. firms examining the financial impacts of environmental risk management, found that improved environmental risk management reduces the cost of capital. The study demonstrates that firms prefer debt financing over equity financing due to environmental risk management, which provides benefits such as lower capital costs and tax advantages. Furthermore, it highlights that environmental strategies directly influence firms' cost structures and financing decisions, offering a new perspective on the relationship between environmental and economic performance.

Flammer (2021) examined green bonds issued by companies to finance environmentally friendly projects. The study found that green bonds have become increasingly common, particularly in sectors where environmental considerations hold financial significance. Findings

reveal that green bond issuances are well-received by investors, with stronger effects observed for first-time issuers and third-party-certified bonds. Additionally, firms issuing green bonds demonstrated improved environmental performance, such as higher environmental scores and lower CO₂ emissions, alongside increased ownership by long-term, environmentally conscious investors. The results align with signaling theory, suggesting that green bonds effectively convey firms' credible environmental commitments.

Zerbib (2019) analyzed the impact of environmental preferences on bond prices through green bonds, focusing on the yield differential between green and conventional bonds from July 2013 to December 2017. Using a matching method and a two-step regression approach, the study found a small negative premium (-2 basis points) for green bonds, indicating slightly lower yields compared to conventional bonds. This negative premium was more pronounced in the financial sector and for lower-rated bonds. The findings suggest that while the effect of environmental preferences on bond pricing is modest, it does not deter the expansion of the green bond market.

Lee & Lee (2022), investigate the role of green finance in enhancing green total factor productivity (GTFP) in China. Their study addresses a gap in the literature by examining the interrelationship between economic, resource, and environmental developments within the green economy. To achieve this, they developed a comprehensive green finance development index and assessed GTFP by considering both energy and environmental constraints. Using a balanced panel dataset from 30 Chinese provinces spanning 2006 to 2018, they evaluated the relationship between green finance development and GTFP using the super-SBM model. The results revealed that advancements in green finance significantly contribute to higher levels of green productivity. Furthermore, the study found that regions with more favorable economic and social conditions and higher pollution levels saw a greater positive impact from green finance.

Yu et al. (2021), explore how financial constraints influence green innovation and the ways green finance policies help alleviate these constraints. The analysis, based on data from Chinese firms between 2001 and 2017, revealed that enterprises with greater financial limitations exhibited reduced capacities for green innovation. Privately-owned enterprises (POEs) were found to be more vulnerable than state-owned enterprises (SOEs) in this regard. The study suggests that although green finance policies help mitigate these challenges, green loans are less accessible to POEs. The authors recommend government support for POEs in green investments and improved information sharing between financial institutions and private-

sector enterprises. They also propose the development of a comprehensive green performance evaluation system by the China Banking Regulatory Commission.

Zhang et al. (2021), examine the effects of public expenditure on research and development (R&D), green economic growth, and energy efficiency in countries participating in the Belt and Road Initiative (BRI) from 2008 to 2018. Using panel data analysis and the GMM method, the authors demonstrate that public spending positively influences green economic growth and energy efficiency, with varying effects across countries. The study highlights that these positive effects are more pronounced in nations with higher GDP, and that investing public funds in human capital and green energy R&D is vital for fostering a sustainable green economy. Furthermore, a positive correlation was found between R&D expenditures, energy consumption, and carbon emissions.

Taghizadeh-Hesary & Yoshino (2019), contribute to the green finance literature by proposing two frameworks aimed at increasing private sector involvement in green finance and investment. The first framework focuses on minimizing the risk of green finance and enhancing the returns on green energy projects by utilizing green credit guarantee schemes (GCGSs) and returning tax revenue from the spillover effects of green energy supply to investors. The second framework integrates distributed ledger technologies (DLTs) into existing financial structures to encourage small-scale green project investments through increased transparency. The findings suggest that these frameworks can boost investor confidence and improve decision-making processes, especially by highlighting projects with a high likelihood of success and strong credit scores.

Meo & Abd Karim (2022) examined the impact of green finance on carbon dioxide (CO₂) emissions in the top ten economies supporting green finance (e.g., Canada, Denmark, Japan, the UK, and the US). Using Quantile-on-Quantile Regression (QQR), the study analyzed the dependency structure between green finance and CO₂ emissions across different quantiles. The findings confirmed a negative impact of green finance on CO₂ emissions, with variations across quantiles influenced by market conditions and country-specific factors. The study highlights green finance as an effective strategy for reducing CO₂ emissions.

Irfan et al. (2022) examine the mechanisms by which inclusive green finance contributes to green innovation in China, using regional data from 2010 to 2019. The study employed mediation effects and panel vector autoregression models to empirically test these relationships. The findings reveal that green finance significantly supports green innovation across various predictors. Policy intervention effects show that green financial innovation and reform pilot

regions more effectively promote green innovation and sustainable performance compared to other regions. Mediation analysis indicates that industrial structure, economic growth, and R&D investments are key channels through which green finance influences green innovation. The study underscores the importance of supporting green finance to foster green innovation and recommends that regional governments develop policies to enhance industrial structures and allocate R&D resources toward green products.

Zhou et al. (2022) investigated the impact of fintech innovations and green finance on green growth in China. Using provincial panel data from 2011 to 2018, the study assessed the effects of fintech development and green finance on green economic growth. The findings revealed that fintech and green finance significantly promote green economic growth, with a stronger impact observed in eastern China compared to central and western regions. The research further demonstrated that fintech innovation fosters green economic growth through green credit and investments. These results highlight the potential of enhancing green finance development to drive sustainable economic growth.

Nguyen et al. (2021) investigated the dynamic nature of the relationships between green bonds and other asset classes—such as stocks, commodities, clean energy, and conventional bonds—over time and at different frequency levels from 2008 to 2019. The study employed the rolling window wavelet correlation method to analyze the temporal and frequency-dependent variations in these correlations. The findings revealed that correlations peaked following the 2007–2009 Global Financial Crisis. While stocks, commodities, and clean energy exhibited high co-movement, green bonds demonstrated low or negative correlations with stocks and commodities, highlighting their diversification benefits.

Lv et al. (2021) examined the regional disparities in the development of green finance in China. Their analysis, based on data from 2010 to 2019, revealed that while the overall level of green finance development has increased, it remains relatively low. The study also found that regional differences have decreased, though these disparities were largely driven by intra-regional inequalities. The research highlighted a trend of polarization in green finance development between Eastern, Central, Western, and Northeastern China, with these differences showing signs of convergence over time.

Tiwari et al. (2022) examined the transformation relationships between green bonds, renewable energy stocks, and carbon prices during the COVID-19 pandemic. Using daily data from 2015 to 2020 and applying the TVP-VAR approach, the research investigated the dynamic interconnectedness between these assets. The study found that clean energy stocks transmitted

shocks, while green bonds and wind energy stocks absorbed these shocks. Furthermore, tests using various portfolio techniques revealed that diversified portfolios helped reduce risk, with the minimum connected portfolio achieving the highest Sharpe ratio. Similar interconnectedness structures were observed during the pandemic period as well.

Le et al. (2021) examined the volatility connectedness between fintech, green bonds, and cryptocurrencies. Using daily data from 2018 to 2020 and applying the methods of Diebold & Yilmaz (2012) and Baruník et al. (2017), the study found a high degree of interconnectedness between fintech and traditional assets. It identified that assets like Bitcoin transmitted shocks, while green bonds absorbed them. Additionally, the study revealed that short-term trading carried higher risk, while assets such as gold, oil, and green bonds provided effective hedging.

Lee et al. (2021) examined the relationships between oil prices, geopolitical risks, and the green bond index. Using a quantile analysis method based on the Granger causality test, the study found bidirectional effects of geopolitical risks on oil prices at extreme quantile levels, and of oil prices on the green bond index at lower quantile levels. Additionally, the impact of geopolitical risks on green bonds was more pronounced at lower quantile levels. These findings provide valuable insights for policymakers to implement effective measures.

Banga (2019) examined the potential of green bonds to finance climate change in developing countries. The study found that while this market has grown in developed countries, its full potential has not been realized in developing nations due to various barriers. These barriers include the lack of institutional regulations, high transaction costs, and minimum issuance sizes. The study suggests that to develop the green bond market in emerging economies, national development banks should act as intermediaries, and local governments should provide guarantees to cover transaction costs.

Madaleno et al. (2022) examined the causal relationships between green finance, clean energy, environmental responsibility, and green technology. Using a time-varying causality test, the analysis revealed that these relationships weakened during the COVID-19 period. It was found that clean energy influences green finance, but the reverse effect of green finance on clean energy is weaker. The study emphasizes the need to support environmental responsibility and green finance through investments in green technology.

Dikau & Volz (2021) examined the role of central banks in addressing climate-related risks and supporting sustainability policies. Their analysis of 135 central banks revealed that only 12% explicitly have sustainability mandates, while 40% have a responsibility to support

government sustainability goals. The study emphasizes that climate risks can directly affect the traditional functions of central banks and argues that all banks should integrate these risks into their policies.

Reboredo et al. (2020) investigated the network connections between green bonds and different asset classes. The study used wavelet coherence to analyze the dynamic correlations between green bond and asset class price changes and determined network connectivity based on the error variance decomposition of a multivariate vector autoregressive model. A strong connection was found between green bonds and government and corporate bonds, while green bonds showed weaker connections with high-yielding corporate bonds, stocks, and energy assets. The study provides important implications for portfolio design and hedging strategies for green bond investors.

Broadstock & Cheng (2019) examined the time-varying relationship between green and conventional bond markets and the macroeconomic factors influencing this relationship. In the first stage, the authors calculated dynamic conditional correlations (DCC), and in the second stage, they used dynamic model averaging (DMA) to identify the factors affecting the relationship. The study demonstrates that the relationship between green and conventional bonds is sensitive to factors such as financial market volatility, economic policy uncertainty, daily economic activity, oil prices, and news-based sentiment (positive/negative) related to green bonds.

The reviewed literature summary highlights the need for more detailed research, particularly on the global geographic distribution of green finance. Additionally, the lack of studies exploring the impacts of green finance across different sectors presents a significant opportunity to enhance research diversity in this field.

- **Contributions to the Literature and Gaps in the Literature of the Study**

The originality of this study lies in mapping the overall structure of the green finance literature using a bibliometric analysis approach and examining the connections between different themes, authors, institutions, and countries. Unlike other studies, it provides a detailed analysis of the thematic and global geographical distribution of green finance literature while also emphasizing the importance of multidisciplinary approaches. With these characteristics, it differentiates itself methodologically and in terms of scope from existing studies.

This study offers the following by addressing the literature from a broad perspective:

Global Perspective: Instead of limiting green finance research to specific countries, this study provides a comprehensive analysis of global authors, institutions, and themes.

Relationships between Research Themes: By mapping the multidisciplinary nature of the literature and the interactions between clusters, the study contributes to understanding the synergy and information flow within the field of green finance.

Guidance for Future Research: By identifying gaps in the literature and potential research opportunities, the study offers recommendations for addressing these gaps in future work.

Limitations of the Study: The limitations of this study include the examination of literature solely from the Web of Science database. The analysis was conducted on data obtained from the Web of Science database using Vosviewer, with the data extraction date being **July 1, 2024**. Additionally, the analysis was narrowed by applying restrictions to fields such as Business, Management, Economics, and Business Finance.

3. Method

Bibliometric Analysis is an analytical method used to understand the development and growth of a particular discipline or field. This method also reveals which themes emerge within the field and how these themes form a structure. By examining key features in the literature, it becomes possible to understand changes and trends in the field. Data such as the number of works, authors, journals, geographical distribution, types of works, and publication titles are analyzed, providing insights into the development of the field (Lee et al., 2020: 367). Co-word analysis, proposed by Callon et al. in 1983, allows for the identification of relationships and their strengths among words found in research over different periods. This type of analysis focuses on keyword groups in publications and visualizes word relationships to create a conceptual map of the examined literature (Callon et al., 1983: 191-235).

Bibliometrics was originally introduced by Pritchard and by Nalimov and Mulchenko in 1969. Pritchard described bibliometrics as a method that applies mathematics and statistics to books and other communication media. Nalimov and Mulchenko defined scientometrics as a qualitative method focused on the analysis of science as an information process. The subsequent development of bibliometrics has expanded into informatics, encompassing electronic media and utilizing statistical analysis of text or hypertext systems, as well as measuring information from electronic libraries. Today, there are several software tools available for conducting bibliometric studies. These analyses are carried out using various

databases such as Web of Science (WoS), Scopus, and Google Scholar, along with specialized software (Maliha, 2023:1). Web of Science (WoS), offered by Thomson Reuters, is a widely used citation indexing service and a part of the Web of Knowledge platform for scientific research (Hou et al., 2015).

Web of Science has a robust history as a citation database, providing comprehensive and reliable data for evaluating research impact and understanding scientific networks. It spans a wide range of disciplines, from social sciences to natural sciences and humanities, offering the advantage of in-depth data for multidisciplinary research (Ho & Wang, 2020:370). Additionally, it provides integrated tools and analytical capabilities that streamline data collection and analysis processes. **One of the reasons for preferring Web of Science is its provision of specialized databases and filtering options tailored to specific research areas, facilitating in-depth analysis in those fields.** High-quality standards, extensive coverage, strong citation analyses, and integrated tools make Web of Science more preferred compared to other databases like Google Scholar or Scopus.

Frequently used software in bibliometric analyses includes VOSviewer, BibExcel, CiteSpace, BiblioShiny (an extension of the bibliometrix R package), and HistCite. VOSviewer stands out as a powerful tool for visualizing bibliometric maps and performing cluster analyses (Maliha, 2023:1). In this study, the Web of Science database and VOSviewer bibliometric program were selected due to their extensive coverage, reliability, and analytical capabilities, making them effective solutions for bibliometric analyses.

The data used in this study were carefully selected from articles addressing the concept of "Green Finance". The documents were obtained from the Web of Science (WoS) database and mapped by the author using the VOSviewer visual mapping method.

- **Science Mapping Technique**

The term "bibliometrics" was first introduced by Alan Pritchard in his 1969 study titled *Statistical Bibliography or Bibliometrics*. This method aims to analyze scientific literature from thematic, social, and intellectual perspectives, providing a detailed examination of the structures and relationships within research fields. Within this framework, the science mapping technique involves computational methods developed to visualize, analyze, and model scientific and technological activities. Science mapping serves as a powerful tool to visually present the conceptual, social, and intellectual dynamics of a specific field, aiming to understand its evolution and development (Pritchard, 1969).

This study applies the science mapping technique to map the green finance literature. Using the VOSviewer software, bibliometric networks were created, visualizing key research themes and their interconnections. VOSviewer contributes to understanding the evolution of the field by examining the interactions among authors, institutions, and keywords within the literature. This analysis is instrumental in grasping the overall structure of the literature, identifying emerging themes in green finance, and uncovering relationships between different research groups. This method assists researchers in understanding how green finance has developed and provides insights into which themes require further exploration in the future.

4. Findings and Discussion

In this study, bibliometric analysis of publications in the field of "Green Finance" was carried out. Analysis date **July 1, 2024**. Analyzed with Vosviewer with data obtained from the Web of Science database. Before any restrictions were imposed, there were a total of 1,863 publications on the subject of "Green Finance" in the Web of Science database. The analysis was narrowed down by imposing restrictions in areas such as Business, Management, Economics and Business Finance, and a total of 617 publications were reached as of 01.07.2024. **There are 96 publications in the field of Business, 82 in the field of Management, 351 in the field of Economics and 232 in the field of Business Finance.**

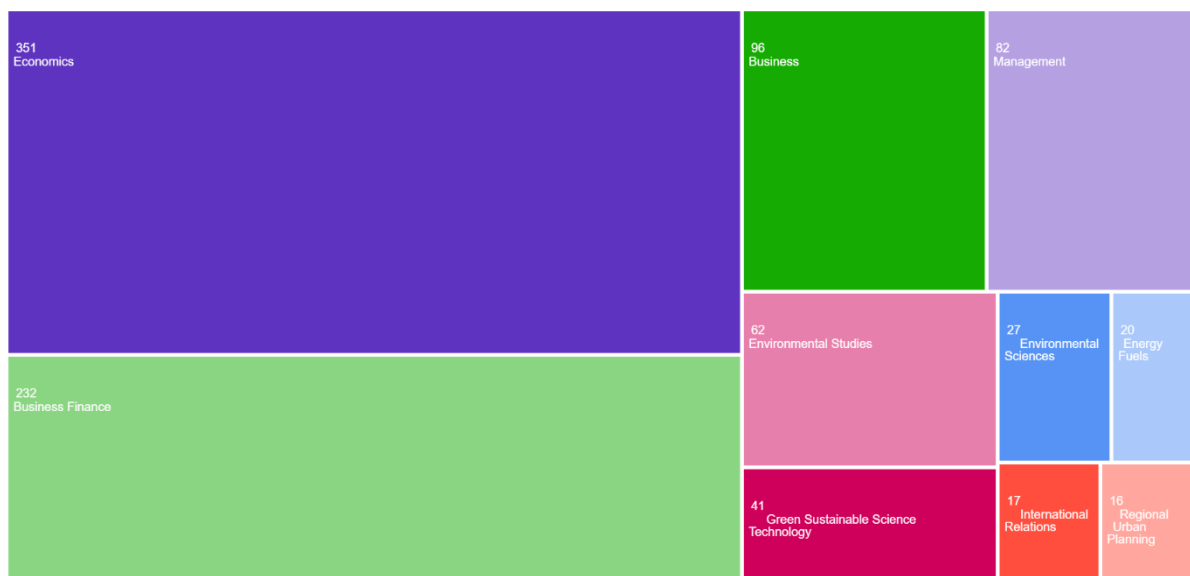
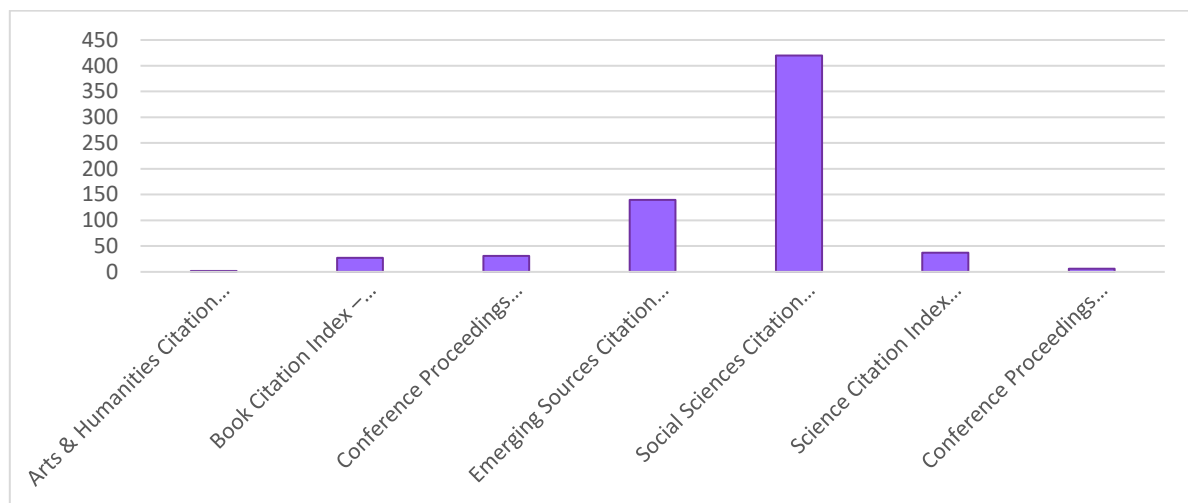


Figure 1. Treemap Chart (Field: Web of Science Categories)

According to Figure 1, Economics constitutes 351 publications, 56.888%, Business Finance 232 publications, 37.601%, Business 96 publications, 15.559%, Management 82 publications, 13.290%. There are also Article 546, Early Access 70, Proceeding Paper 31, Book

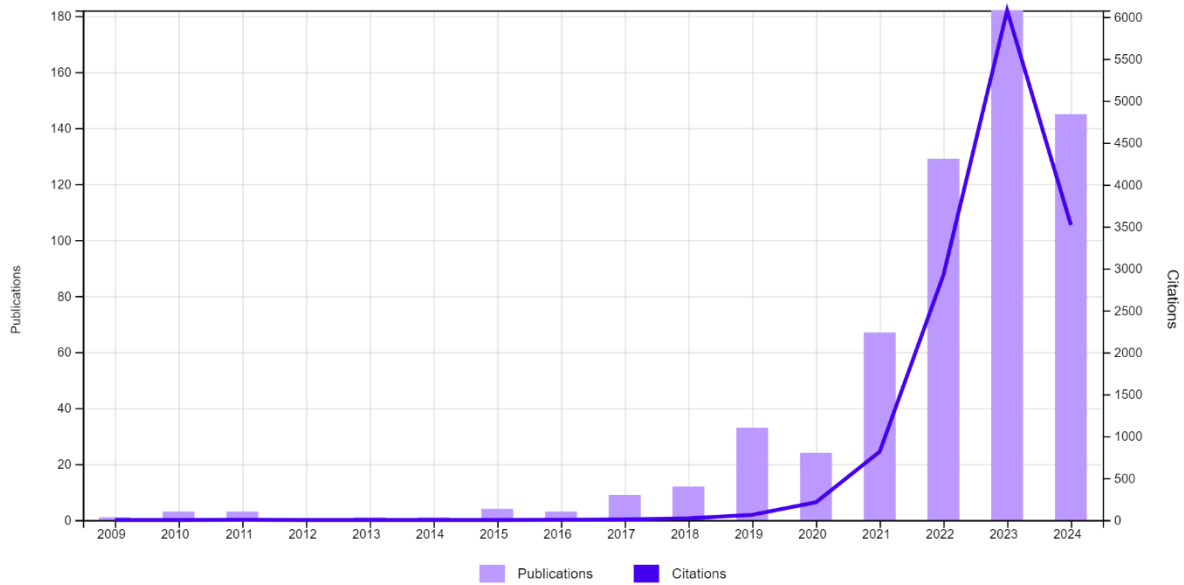
Chapters 24, Review Article 19, Editorial Material 15, Book 3, Book Review 2, Correction 1 and Retraction 1 in these areas. Among them, the most publications (27) belong to Taghizadeh-Hesary, Farhad. He is followed by Umar, Muhammad and Dong, Kangyin with 7 publications.



Graph 1. Distribution of the Number of Publications According to Web of Science Indexes

According to Graph 1, when the number of publications according to Web of Science indexes is examined, it is observed that there are great differences in different categories. The indexes with the least number of publications are A&HCI with 2 publications and CPCI-S with 6 publications. BKCI-SSH has 27 publications. CPCI-SSH has 31 publications. There are 37 publications in the SCI – EXPANDE and 140 publications in the ESCI index. SSCI stands out in this group with 420 publications. Also Citing Articles: Total 7,427 Analyze, 7,030 Analyze; Without self-citations. 59 H-Index.

Publications and citations obtained after the space restriction with the concept of "Green Finance" are given together.



Graph 2. Times Cited and Publications Dealing With "Green Finance" Over 2009-2024

According to Graph 2, there was 1 publication, and zero citation in 2009, 3 publications, and zero citation in 2010, and no publication or citation in 2012. There is 1 publication, zero citation in 2013, 1 publication, zero citation in 2014, 4 publications, zero citation in 2015, 3 publications, 3 citations in 2016, 9 publications, 8 citations in 2017, 12 publications, 21 citations in 2018.

In 2019, there was a leap in terms of publication citations and 33 publications and 62 citations were made.

Although the number of publications decreased to 24 in 2020, the number of citations increased to 212. It is thought that the decrease in the number of publications may be due to the global COVID-19 epidemic. In 2021, the number of publications increased to 67 and the number of citations increased to 815. In 2022, the number of publications increased to 129 and the number of citations reached 815. In 2023, the peak number of publications reached 182 and the number of citations increased to 2922. By July 1, 2024, the total number of publications has increased to 145 and the number of citations has increased to 3519.

Based on your bibliometric analysis, we see that there are a limited number of publications on the subject of "Green Finance" between 2009 and 2024. Especially considering that the number of publications in certain academic fields is relatively low, several possible evaluations can be made about the reasons and consequences of this situation:

- **A New and Developing Field:** "Green Finance" is a relatively new field of research. As environmental problems and sustainability issues have become more important in recent years, interest in these issues is also increasing.

- **Data and Resource Limitations:** Limited data and resources on the subject of "Green Finance" may make it difficult for researchers to enter this field. In particular, the lack of data necessary to measure the impacts and outcomes of green finance may have prevented further studies in this area.

- **Impact of Environmental Policies:** Countries' environmental policies and regulations can directly affect the interest in green finance. In countries where environmentally friendly policies and regulations are inadequate, interest and research on green finance may be limited. This can directly affect the number of studies and publications.

- **Traditional Finance and Economics:** Traditional finance and economics topics may still receive more attention in the academic world. Green finance is often viewed as an alternative method of financing and therefore may receive less attention than traditional financing methods and economic analysis.

4.1. Co-Author Analysis

Co-author analysis is used to understand collaboration networks between authors in a research field. This analysis is used to determine which authors have collaborated and the place of specific authors in the collaboration network. Below are the results of the co-author analysis using VOSviewer and the authors included in each cluster are listed. Authors in each cluster collaborated with each other, and those who were unconnected were ignored.

Figure 2 includes co-citations of the authors. When the minimum number of documents belonging to authors was selected as two and the minimum number of citations was selected as one, 1553 authors and 148 matches were found.

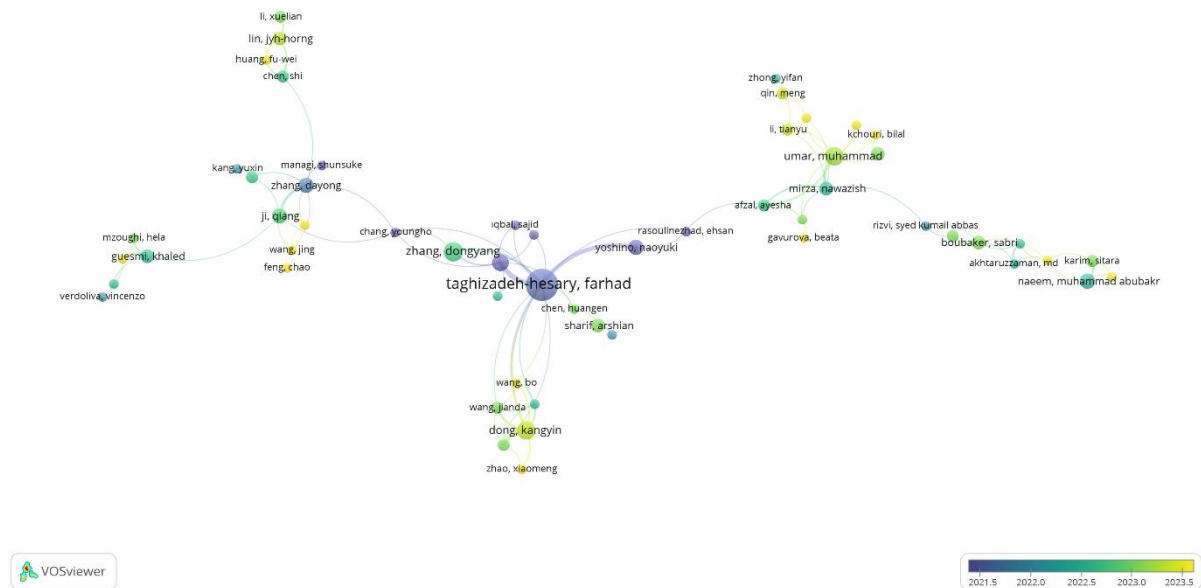


Figure 2. Co-Authors Analysis (co-authorship of authors)

- In the first cluster (9 items): Akhtaruzzaman, M.; AL Mamun, M.; Banerje, A.K.; Boubaker, S.; Karim, S.; Kumar, S.; Moussa, F.; Naeem, M.A.; Rizvi, S.K.A. are included.
- In the second cluster (8 items): Feng, C.; Guo, K.; Ji, Q.; Kang, Y.; Liu, C.; Managi, S.; Wang, J.; Zhang, D.
- In the third cluster (7 items): Chang, Y.; Iqbal, S.; Iqbal, W.; Liu, Z.; Mohsin, M.; Taghizadeh-Hesary, F.; Zhang, D.
- In the fourth cluster (6 items): Afzal, A.; Gavurova, B.; Mirza, N.; Rasoulimezad, E.; Skare, M.; Yoshino, N.
- In the fifth cluster (6 items): Dong, K.; Dong, X.; Wang, B.; Wang, J.; Zhao, J.; Zhao, X.
- In the sixth cluster (5 items): Benkraiem, R.; Guesmi, K.; Mzoughi, H.; Verdoliva, V.; Vigne, S.
- In the seventh cluster (4 items): Kchouri, B.; Safi, A.; Umar, M.; Wang, K-H.
- In the eighth cluster (4 items): Chen, S.; Huang, F-W.; Li, X.; Lin, J-H.
- In the ninth cluster (4 items): Li, T.; Qin, M.; Yue, X-G.; Zhong, Y.
- In the tenth cluster (3 items): Chen, H.; Razzaq, A.; Sharif, A.

These clusters from the shared author analysis depict collaborations and network structures among the authors. Each cluster of authors has contributed to scientific output through collaborative work. This analysis provides valuable insights into understanding collaborations in the research field.

4.2. Citation of Authors Analysis

Authors citation analysis is a type of bibliometric analysis that examines the citations that authors make to each other in a particular research field. This analysis reveals which authors have the most engagement in a given field, whose work is cited more, and which groups of authors work together or cite each other more frequently.

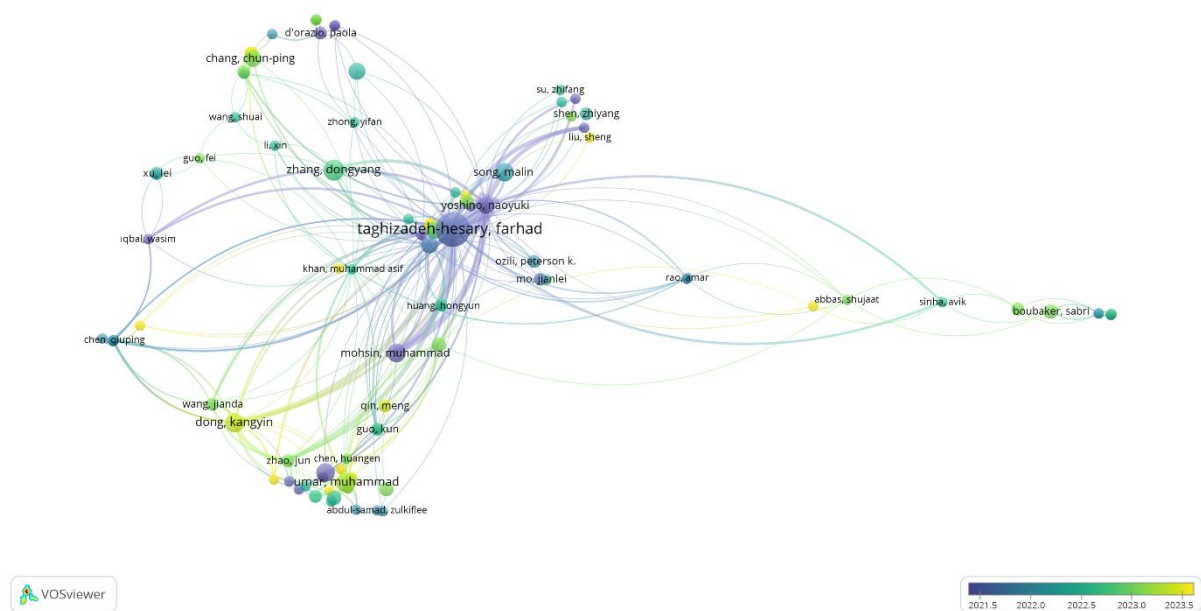


Figure 3. Citation of Authors Analysis

In Figure 3, when a minimum publication count of 2 and citation count of 1 for authors were selected, it resulted in 1553 authors and 148 matches identified.

The clusters represent groupings of analyzed authors based on their citation connections with each other. Each cluster indicates authors who frequently cite each other. Observations regarding co-citations among authors are made in Figure 3. The authors included in each cluster are as follows:

- In the first cluster (13 items): Abbas, S.; Akhtaruzzaman, Md.; Banerjee, A.K.; Boubaker, S.; Gavurova, B.; Moussa, F.; Rao, A.; Rizvi, S.K.A.; Sharma, G.D.; Sinha, A.; Verdoliva, V.; Vigne, S.

These authors in the first cluster form a cohesive group in the field of green finance, frequently citing each other's work which often supports common research themes.

- In the second cluster (13 items): Caldecott, B.; Chang, C.P.; Chen, D.; Dong, S.; Guo, F.; Hu, H.; Iqbal, W.; Li, X.; Wang, Q.J.; Wang, S.; Xu, L.; Zhang, D.; Zheng, M.

Authors in the second cluster also exhibit strong citation connections among themselves, contributing to the literature in green finance through collaborative or supportive research efforts.

- In the third cluster (12 items): Chang, Y.; Huang, H.; Ji, Q.; Kumar, S.; Liu, C.; Managi, S.; Mbanyele, W.; Wnag, F.; Wnag, J.; Wang, K-H.; Zhang, D.; Zhang, W.

Authors in the third cluster form another group frequently citing each other, particularly in the areas of green finance and sustainability.

- In the fourth cluster (11 items): Abdul-Samad, Z.; Cheok, M-Y.; Dong, X.; Iqbal, N.; Kchouri, B.; Sadiq, M.; Safi, A.; Sharif, A.; Umar, M.; Zhao, J.; Zhao, X.

There is also a strong collaboration and research network among these authors.

- In the fifth cluster (9 items): Afzal, A.; Guo, K.; Kang, Y.; Li, T.; Mirza, N.; Qin, M.; Rasoulinezhad, E.; Skare, M.; Yue, X-G.

- In the sixth cluster (9 items): Du, J.; Guo, Q.; Iqbal, S.; Li, R.; Liu, S.; Shen, Z.; Su, Z.; Taghizadeh-Hesary, F.; Yoshino, N.

- In the seventh cluster (8 items): Bethlendi, A.; Cheng, R.; D'Orazio, P.; Gupta, R.; Naeem, M.A.; Pora, A.; Rajan, R.S.; Zhong, Y.

- In the eighth cluster (8 items): Chen, Q.; Dong, K.; Fekete-Farkas, M.; Ning, B.; Pan, Y.; Wang, B.; Wang, J.; Xiamo, J.

- In the ninth cluster (5 items): Azhgaliyeva, D.; Chen, H.; Mohsin, M.; Volz, U.; Weber, O.

- In the tenth cluster (3 items): Khan, M.A.; Liu, Z.; Mansour, N.

- In the eleventh cluster (3 items): Liu, M.; Mo, J.; Ozili, P.K.

- In the twelfth cluster (1 item): Song, M.
- In the thirteenth cluster (1 item): Karim, S.
- In the fourteenth cluster (1 item): Hassa, M.K.

Authors in single-author clusters may have worked independently of other authors or appear more isolated within the citation network. Author citation analysis is valuable for understanding the scientific interactions and collaborations among authors in a specific field. These clusters highlight groups of authors with intense interactions and collaborations. This analysis demonstrates which authors are most influential in the field of green finance, who receives more citations, and which author groups collaborate together. Such analyses contribute to a better understanding of the direction of scientific research and relationships among researchers.

4.3. Country Citation Analysis

Country citation analysis is a type of bibliometric analysis that examines which countries are most cited in a particular research field and the citation links between these countries. This analysis is done to evaluate the contributions and scientific interactions of researchers in different countries. Tools such as VOSviewer visualize these analyses, revealing which countries interact more, which countries are more influential in certain areas, and how scientific collaborations are structured.

In Figure 6 below, when a minimum of five documents and one citation pertaining to a country were selected, 83 countries and 35 matches were found.

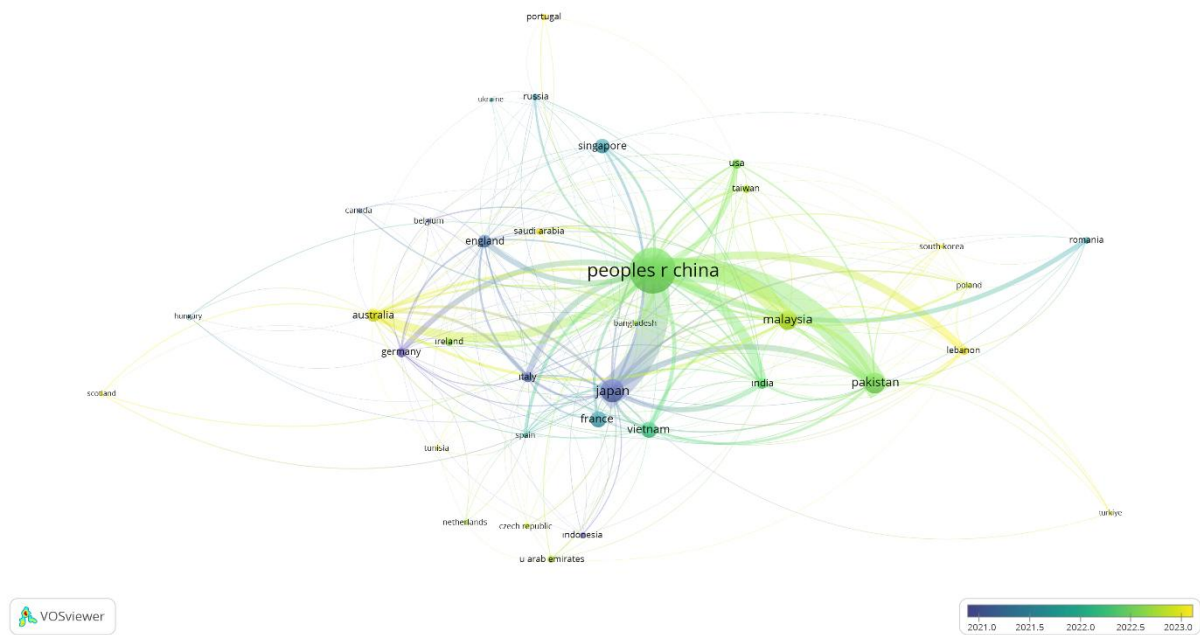


Figure 4. Country Citation Analysis (Scores Avg. Citations)

Clusters are grouped based on the citation connections among the analyzed countries. Each cluster indicates that the countries within it exchange citations more frequently with each other. Upon closely examining the clusters in Figure 6:

- First Cluster (9 items): Czech Republic, France, Germany, Indonesia, Italy, Japan, Netherlands, United Arab Emirates, Vietnam.

The countries in this cluster have a dense citation network in the field of green finance. The collaboration between European countries (France, Germany, Italy, Netherlands, Czech Republic) and Asian countries (Indonesia, Japan, Vietnam) demonstrates the intercontinental scientific interactions and collaborations. These countries significantly influence each other in green finance research.

- Second Cluster (6 items): Belgium, Canada, Ireland, Saudi Arabia, Spain, Tunisia.

The countries in the second cluster establish a connection between Europe (Belgium, Ireland, Spain) and North America (Canada) as well as the Middle East and North Africa (Saudi Arabia, Tunisia). This indicates widespread information exchange and research collaborations in green finance among these regions.

- Third Cluster (5 items): Lebanon, People's Republic of China, Poland, Romania, South Korea.

The third cluster connects Asian countries (China, South Korea) with European countries (Poland, Romania) and the Middle East (Lebanon), highlighting research collaborations and joint studies among these regions.

- Fourth Cluster (5 items): England, Portugal, Russia, Singapore, Ukraine.

The countries in the fourth cluster show connections between Europe (England, Portugal, Russia, Ukraine) and Asia (Singapore), emphasizing the importance of collaborations in green finance between these two continents.

- Fifth Cluster (4 items): India, Malaysia, Pakistan, Turkey.

The countries in the fifth cluster form connections between South Asia (India, Pakistan), Southeast Asia (Malaysia), and Turkey, indicating intensive collaborations and information exchange among these regions.

- Sixth Cluster (3 items): Australia, Hungary, Scotland.

The sixth cluster connects Australia with European countries (Hungary, Scotland), demonstrating the presence of research collaborations between these two regions.

- Seventh Cluster (3 items): Bangladesh, Taiwan, USA.

The seventh cluster represents connections between Asia (Bangladesh, Taiwan) and North America (USA), highlighting significant scientific collaborations between these two continents.

Country citation analysis is valuable for understanding the scientific interactions and collaborations among countries in a specific field. These clusters highlight groups of countries with intense interactions and collaborations. This analysis demonstrates which countries are most influential in the field of green finance, who receives more citations, and which country groups collaborate together.

In conclusion, the Country Citation Analysis is crucial for understanding the global distribution of scientific research in green finance and the collaborations between countries. Each cluster indicates strong citation links between specific geographical regions or countries, showing that these regions influence each other and produce scientific knowledge.

The country citation analysis highlights the prominence of Asian and European countries in the field of green finance. This indicates that countries in these regions make

significant contributions and that research intensity is high. The prominence of these regions in green finance research and literature can be attributed to several factors:

- Economic and Environmental Needs:

In Asia, particularly in large economies such as China, Japan, South Korea, and India, rapid industrialization and urbanization have increased environmental problems. These countries must take significant steps towards sustainable development and environmental protection, leading to a higher demand for green finance instruments and increased research in this area (Wen et al., 2022:1). The European Union promotes green finance to support sustainable development and environmental protection policies. The European Commission's green finance strategies and regulations have increased research and significant contributions in this field (Afzal, et al., 2022: 5150-5163).

- Political and Legal Regulations:

European countries implement various legal regulations and incentive policies to achieve sustainable development goals. These policies increase green finance practices among financial institutions and companies and encourage academic research. Similarly, Asian governments adopt green finance policies to meet environmental protection and sustainable development goals (Goglio & Catturani, 2019: 239-261). For example, China's "green finance reforms" and Japan's sustainable energy investments contribute to increased research in this area (Wen et al., 2022:1).

- Technological Innovation and Development:

Asian countries are making significant progress in green technologies and sustainable energy sources, encouraging the research and development of green finance instruments and applications. Europe is at the forefront of innovative green finance instruments and technologies. Research in areas such as green bonds, sustainable banking practices, and renewable energy projects reinforces Europe's leadership in this field (Dorfleitner & Braun, 2019: 207-237).

The Country Citation Analysis emphasizes the leadership of Asia and Europe in green finance and the importance of research in this area. Green finance is a critical tool for achieving sustainable development goals, and countries in these regions play a pioneering role.

The answer to the question "What is the geographical distribution of 'Green Finance' research?" have provided through the Country Citation Analysis.

4.4. Organization Citation Analysis

Organization Citation Analysis is a method used to evaluate the research impact of certain institutions in scientific research. This analysis shows how much a particular institution is cited by other researchers and institutions and helps determine the institution's place and influence in the research world.

When a minimum of five documents and one citation from an institution were selected, 48 matches were found among 837 institutions. (Weights: citations, Scores: Avg. pub. year was selected.)

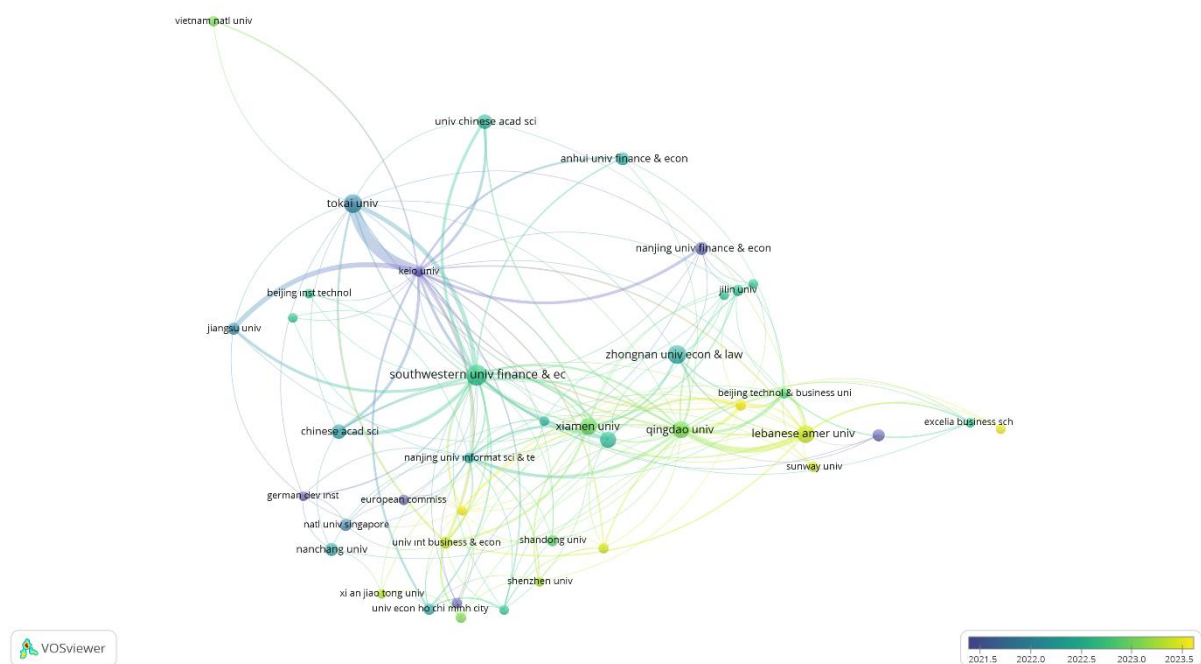


Figure 5. Organizations Citation Analysis

- In the first cluster (9 items): Beijing Institute of Technology, Central University of Finance & Economics, European Commission, German Development Institute, Nanjing University of Information Science and Technology, Nankai University, National University of Singapore, Southwestern University of Finance & Economics, University College Dublin.

The institutions in the first cluster span a wide geographical distribution, including leading universities and research institutes from both Asia and Europe. This highlights the importance of international collaboration and knowledge sharing in green finance research.

- In the second cluster (9 items): Chinese Academy of Sciences, City University of Macau, Nanchang University, Renmin University of China, Shenzhen University, University

of Economics Ho Chi Minh City, University of International Business & Economics, University of Oxford, Xi'an Jiaotong University.

The institutions in the second cluster include universities with strong research infrastructures, particularly from China and the United Kingdom. The emphasis China places on green finance research, combined with the contributions from prestigious institutions like the University of Oxford, underscores the diversity and strength of global research efforts in this field.

- In the third cluster (7 items): Beijing Technology & Business University, Excecia Business School, Lebanese American University, Liaoning University, Qingdao University, Sunway University, Wuhan University.

The third cluster includes various universities from China and other countries, illustrating that not only Asian universities but also educational institutions from other regions significantly contribute to green finance research.

- In the fourth cluster (7 items): Jilin University, Nanjing University of Finance & Economics, Peking University, Shanghai University of Finance & Economics, Xiamen University, Zhejiang Gongshang University, Zhongnan University of Economics and Law.

The institutions in the fourth cluster predominantly comprise leading universities in China, emphasizing China's pivotal role in academic research on green finance and its emergence as a significant hub for knowledge production in this field.

- In the fifth cluster (5 items): Jiangsu University, Keio University, Tokai University, University of Chinese Academy of Sciences, Vietnam National University.

The fifth cluster features prominent universities from Japan and Vietnam. Japan's advanced research in green finance and contributions from developing countries like Vietnam demonstrate the broad spectrum of green finance research in the Asia region.

- In the sixth cluster (3 items): Capital University of Economics & Business, Shandong University, Zhejiang University of Finance & Economics.

The institutions in the sixth cluster are predominantly based in China, indicating that various Chinese universities are making significant contributions to green finance research and enriching the knowledge base in this area.

- In the seventh cluster (1 item): Anhui University of Finance & Economics.

The organizations citation analysis reveals that institutions in Asia and Europe are particularly prominent. Chinese universities and research institutes, in particular, have made substantial contributions to green finance, highlighting China's leadership and its significant role in knowledge production in this area. Prestigious European universities and research institutes also play a vital role in green finance research. This analysis demonstrates the global geographical spread of green finance research and the significant contributions of international collaborations to knowledge production in this field.

This analysis have been answered the question: Which are the most influential institutions in the field of Green Finance?

4.5. Keyword Analysis

Keyword analysis helps us understand which topics are prominent in the green finance literature and which themes are receiving more attention. This analysis provides in-depth information on the different dimensions of green finance, allowing researchers to better evaluate the gaps and opportunities in these areas.

In Figure 6, when the minimum number of occurrences of a keyword is selected as 10, the figure containing 23 keywords is as follows.

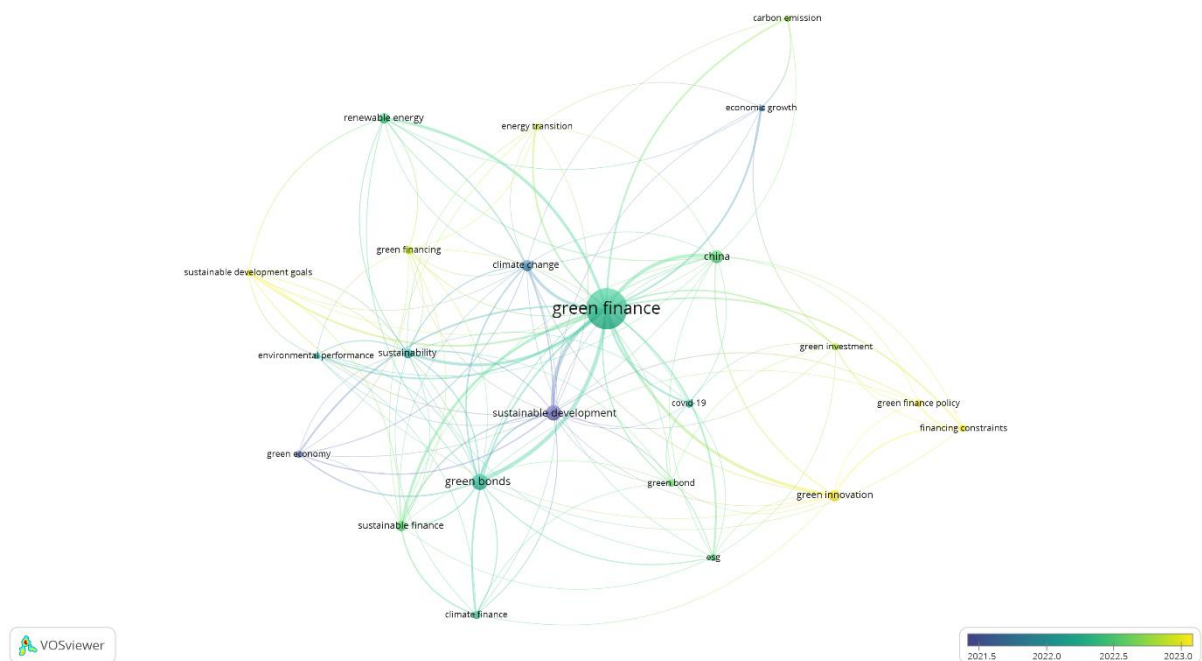


Figure 6. Keyword Analysis

In the keyword analysis, the keywords are divided into four clusters, each organized around specific themes:

- First Cluster (7 items): Covid-19, ESG, Financing Constraints, Green Bond, Green Finance Policy, Green Innovation, Green Investment.

In the first cluster, the impact of the Covid-19 pandemic, ESG factors, financing constraints, green bonds, and green finance policies are frequently discussed keywords. This highlights the prominence of topics such as the pandemic's impact on green finance and the increasing importance of ESG criteria.

- Second Cluster (6 items): Carbon Emission, China, Climate Change, Economic Growth, Energy Transition, Green Finance.

The second cluster focuses on China's role in the green finance market, the reduction of carbon emissions, and the relationships between economic growth and energy transition.

- Third Cluster (5 items): Climate Finance, Green Bonds, Green Economy, Sustainable Development, Sustainable Finance.

In the third cluster, topics such as climate finance, green economy, and sustainable development are prominent.

- Fourth Cluster (5 items): Environmental Performance, Green Financing, Renewable Energy, Sustainability, Sustainable Development Goals.

The fourth cluster concentrates on environmental performance, renewable energy, and sustainable development goals.

The keyword analysis has been provided an answer to the question: "What are the key themes and trends in the literature?"

5. Conclusions and Recommendations

The primary goal of this study is to provide a comprehensive mapping of the green finance literature, helping both researchers and policymakers better understand the knowledge gaps and identify future research opportunities in this field. Through bibliometric analysis, this study addresses several key research questions related to green finance. Specifically, the study explores the following research problem: What are the general themes, trends, and relationships between different research clusters in green finance? To answer this, the research questions are framed as: What are the main themes and trends in green finance research? Who are the leading

authors contributing to this field, and which institutions and countries are involved? How are the different clusters of research in green finance related? By addressing these questions, the study aims to contribute to both the theoretical and practical understanding of green finance.

General Statements: The bibliometric analysis reveals that research publications on "Green Finance" have been relatively limited between 2009 and 2024. Despite the low number of publications in this specific field, the findings show that green finance has become a growing area of interest, particularly as environmental issues and sustainability have gained increasing global attention. The study highlights that green finance, while a relatively new research domain, is poised for further expansion as environmental concerns and the need for sustainable financial practices become more urgent.

Generalizability of Results: The findings from this study are highly relevant to the broader academic community, offering insights into green finance and its interdisciplinary nature. Although the study focuses on literature indexed in the Web of Science database, the results can be generalized to reflect global research trends. However, the geographical distribution observed in the study suggests that regions with more advanced environmental policies and regulations tend to have a higher volume of research. This geographical bias should be considered when interpreting the results, as it may limit the global applicability of the findings. Additionally, since only publications in the Web of Science database were analyzed, other databases were excluded from the study. Therefore, when generalizing the results, this limitation should be kept in mind.

Critical Reflection on Assumptions: The study assumes that data gaps and limited resources are significant barriers to more extensive research in green finance. These assumptions appear valid, especially in developing economies where environmental data is often scarce. Additionally, the scope of the analysis, which is based on data from the Web of Science, might exclude other potentially valuable research not indexed in this database. These assumptions must be carefully considered when interpreting the findings, as they may limit the scope of the study's conclusions.

Practical Challenges: A significant practical challenge identified in this study is the lack of comprehensive data and resources available on green finance. The absence of necessary data for measuring the impacts and outcomes of green finance has hindered more in-depth research. Additionally, the implementation of green finance principles faces challenges, especially in countries with insufficient eco-friendly policies and regulations. These limitations directly influence the scope and applicability of green finance research and practice.

Stronger Future Research Directions: In light of the growing significance of environmental sustainability and climate change, future research in green finance should address several critical areas. First, more comprehensive and inclusive databases should be created to address the data gaps and resource limitations in green finance, which will allow researchers to conduct more detailed and extensive analyses. Furthermore, more research is needed to explore the impact of national environmental policies and regulations on the adoption and effectiveness of green finance. Studies in this area will be crucial for understanding how policy frameworks influence the growth and success of green finance. Additionally, comparative research that contrasts traditional financing methods with green finance models should be encouraged. Such studies could better highlight the advantages and disadvantages of green finance, informing both academic and practical decision-making.

Significance of the Study: This study contributes significantly to the literature by providing a comprehensive overview of the green finance research landscape. It identifies major themes and trends, helping researchers and practitioners better understand current priorities and emerging areas of interest in the field. Furthermore, by mapping key authors, institutions, and countries, the study fosters opportunities for collaboration and joint research efforts. The analysis also underscores the importance of a multidisciplinary approach in addressing green finance challenges, providing a more holistic understanding of the field and its potential. This work serves as a foundation for future studies, highlighting emerging trends, key research clusters, and opportunities for further investigation.

Limitations: While the study provides valuable insights, it is important to note certain limitations. The analysis is based exclusively on data from the Web of Science database as of July 1, 2024, and the VOSviewer tool for bibliometric visualization. The scope is further limited to research within specific fields, including Business, Management, Economics, and Business Finance. Consequently, the study may not fully represent the breadth of research on green finance, and the findings should not be generalized beyond the included fields or database. Moreover, only Web of Science publications were examined, and other databases were excluded from the study. This limitation should be considered when generalizing the results.

In conclusion, this study offers a comprehensive and in-depth bibliometric analysis of green finance research, contributing to the literature by mapping thematic development, identifying key authors, institutions, and geographical trends, and uncovering emerging research clusters. The study provides valuable insights for both scholars and practitioners and lays a solid foundation for future research in this vital and growing field.

Declaration of Research and Publication Ethics

This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement

Since the author is the sole author of the article, the contribution rate is 100%.

Declaration of Researcher's Conflict of Interest

There are no potential conflicts of interest in this study.

References

- Afzal, A., Rasoulinezhad, E., & Malik, Z. (2022). Green finance and sustainable development in Europe. *Economic research-Ekonomska istraživanja*, 35(1), 5150-5163.
- Banga, J. (2019). The green bond market: a potential source of climate finance for developing countries. *Journal of Sustainable Finance & Investment*, 9(1), 17-32.
- Broadstock, D. C., & Cheng, L. T. (2019). Time-varying relation between black and green bond price benchmarks: Macroeconomic determinants for the first decade. *Finance research letters*, 29, 17-22.
- Callon, M., Courtial, J. P., Turner, W. A., & Bauin, S. (1983). From translations to problematic networks: An introduction to co-word analysis. *Social science information*, 22(2), 191-235.
- Dikau, S., & Volz, U. (2021). Central bank mandates, sustainability objectives and the promotion of green finance. *Ecological Economics*, 184, 107022.
- Dorfleitner, G., & Braun, D. (2019). Fintech, digitalization and blockchain: possible applications for green finance. *The rise of green finance in Europe: opportunities and challenges for issuers, investors and marketplaces*, 207-237.
- Flammer, C. (2021). Corporate green bonds. *Journal of financial economics*, 142(2), 499-516.
- Goglio, S., & Catturani, I. (2019). Sustainable Finance: A Common Ground for the Future in Europe?. *The Rise of Green Finance in Europe: Opportunities and Challenges for Issuers, Investors and Marketplaces*, 239-261.
- He, L., Liu, R., Zhong, Z., Wang, D., & Xia, Y. (2019). Can green financial development promote renewable energy investment efficiency? A consideration of bank credit. *Renewable Energy*, 143, 974-984.
- Ho, Y. S., & Wang, M. H. (2020). A bibliometric analysis of artificial intelligence publications from 1991 to 2018. *COLLNET journal of scientometrics and information management*, 14(2), 369-392.
- Hou, Q., Mao, G., Zhao, L., Du, H., & Zuo, J. (2015). Mapping the scientific research on life cycle assessment: a bibliometric analysis. *The International Journal of Life Cycle Assessment*, 20, 541-555.
- Le, T. L., Abakah, E. J. A., & Tiwari, A. K. (2021). Time and frequency domain connectedness and spill-over among fintech, green bonds and cryptocurrencies in the age of the fourth industrial revolution. *Technological Forecasting and Social Change*, 162, 120382.
- Lee, I. S., Lee, H., Chen, Y. H., & Chae, Y. (2020). Bibliometric analysis of research assessing the use of acupuncture for pain treatment over the past 20 years. *Journal of Pain Research*, 367-376.
- Lee, C. C., Lee, C. C., & Li, Y. Y. (2021). Oil price shocks, geopolitical risks, and green bond market dynamics. *The North American Journal of Economics and Finance*, 55, 101309.

- Lee, C. C., & Lee, C. C. (2022). How does green finance affect green total factor productivity? Evidence from China. *Energy economics*, *107*, 105863.
- Lv, C., Bian, B., Lee, C. C., & He, Z. (2021). Regional gap and the trend of green finance development in China. *Energy Economics*, *102*, 105476.
- Maliha, H. (2023). A Review on Bibliometric Application Software. *Scientometrics Letters*, *1*(1).
- Meo, M. S., & Abd Karim, M. Z. (2022). The role of green finance in reducing CO2 emissions: An empirical analysis. *Borsa Istanbul Review*, *22*(1), 169-178.
- Nguyen, T. T. H., Naeem, M. A., Balli, F., Balli, H. O., & Vo, X. V. (2021). Time-frequency comovement among green bonds, stocks, commodities, clean energy, and conventional bonds. *Finance Research Letters*, *40*, 101739.
- Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of documentation*, *25*, 348-349.
- Razzaq, 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*, 121882.
- Reboredo, J. C., Ugolini, A., & Aiube, F. A. L. (2020). Network connectedness of green bonds and asset classes. *Energy Economics*, *86*, 104629.
- Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. *Strategic management journal*, *29*(6), 569-592.
- Taghizadeh-Hesary, F., & Yoshino, N. (2019). The way to induce private participation in green finance and investment. *Financ Res Lett* *31*: 98–103.
- Tiwari, A. K., Abakah, E. J. A., Gabauer, D., & Dwumfour, R. A. (2022). Dynamic spillover effects among green bond, renewable energy stocks and carbon markets during COVID-19 pandemic: Implications for hedging and investments strategies. *Global Finance Journal*, *51*, 100692.
- Wen, H., Lee, C. C., & Zhou, F. (2022). How does fiscal policy uncertainty affect corporate innovation investment? Evidence from China's new energy industry. *Energy Economics*, *105*, 105767.
- Yu, C. H., Wu, X., Zhang, D., Chen, S., & Zhao, J. (2021). Demand for green finance: Resolving financing constraints on green innovation in China. *Energy policy*, *153*, 112255.
- Zerbib, O. D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of banking & finance*, *98*, 39-60.
- Zhang, D., Mohsin, M., Rasheed, A. K., Chang, Y., & Taghizadeh-Hesary, F. (2021). Public spending and green economic growth in BRI region: mediating role of green finance. *Energy Policy*, *153*, 112256.

Zhou, G., Zhu, J., & Luo, S. (2022). The impact of fintech innovation on green growth in China: Mediating effect of green finance. *Ecological Economics*, 193, 107308.