Journal of Turkish

Operations Management

State-of-the-art literature review on green finance with tabular-graphical and network analyses

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Article Info

Article History:

Received: 18.09.2023
Revised: 01.12.2023
Accepted: 08.12.2023

Keywords:

Green Finance
Green Economy
Sustainable Development
Environmental Protection
Green Manufacturing
Risk Assessment

Abstract

Green finance is a method of financing that supports investments with a positive impact on the environment, such as the acquisition of eco-friendly goods and services as part of sustainable development or the building of eco-friendly infrastructure. Green finance has started to occupy a very important place in the literature in recent years due to the increasing sensitivity towards the environment. In this literature review, the relations of green finance with fields such as green economy, sustainable development, environmental protection, green manufacturing, and risk assessment have been examined in all aspects with the help of tables and figures. In addition, a bibliometric analysis of green finance studies' authors, publication sources, institutions, countries, subject areas, document types, and funding sponsors is presented with graphical analyses. The most widely publishing journals in the field of green finance, the most cited studies, conferences in this field, and books published on green finance are presented in tables. Instruments and components of green finance are also reviewed in detail by graphical illustrations. The literature review draws on data from Elsevier's Scopus, presenting a comprehensive analysis of publications, authors, keywords, countries, institutions, and funding sponsors in the field of green finance. Notably, China emerges as a focal point for both academic research and practical implementation of green finance initiatives. The study's outcomes not only contribute to a comprehensive understanding of existing green finance literature but also pave the way for future researchers by presenting trends, patterns, and potential areas for exploration within this critical domain.

1. Introduction

The increasing world population, decreasing water and underground resources, environmental and air pollution have caused the threats of global warming and climate change to become problems affecting the whole world. The uncontrolled use of fossil fuels is one of the main factors that make it difficult to implement sustainable living policies by disrupting the balance of nature. The threat of global warming, which affects the whole world, has led many countries and businesses to produce environmentally sensitive solutions. When it comes to the finance sector, we come across the concept of "green finance".

Today's unregulated and unconscious use of fossil fuels considerably raises the dangers of climate change and global warming. Therefore, it is crucial to give priority to the use of renewable energy in both business and daily life, such as solar and wind energy. Those who desire to lessen environmental pollution, carbon footprint, and hazardous gas emissions into the atmosphere can do so by using energy-saving devices. Nonetheless, it is important

to promote the use of efficient and renewable energy sources in projects, services, and goods. At this point, the concept of green financing starts to emerge.

Green finance is a concept that connects the finance and business sectors through environmentally friendly projects, products, and technologies. Green finance provides financial support for environmentally friendly projects. The primary goal of green financing projects is to create efficient, thorough, and market-driven solutions to environmental issues. It is thought that the development of environmental awareness in the world and the increase in energy need day by day will make the green finance trend a phenomenon in the long run. Because the only benefit of turning to renewable energy sources and environmentally friendly technologies in production is not the protection of nature. Studies in green finance also offer important advantages to investors that can positively affect socio-economic growth, improve their investments, and enable them to encounter new business opportunities.

In traditional methods, the only issue that affects the investment decision of the investor is the financial value of the investment, but today this approach loses its validity. In addition to economic and financial criteria, environmental and social impact, risks, and opportunities are also considered in business and investment decisions. Investors, who put sustainability and environmental protection among their priorities, now examine the companies and projects they will invest in from many different aspects. The shaping of investments within the framework of sustainability performance brings along sustainable finance practices. From the perspective of sustainability practices, investment is required to realize sustainable development, to provide smart technologies that support the environment, environmentally friendly energy systems, nature-friendly infrastructures, and information technology to support it. To long-term benefit society and the business sector, sustainable finance is a responsible financial system that includes all types of financial services that include environmental and social governance factors in company or investment decisions.

The principles, which were published in September 2019 with the participation of 130 banks, aiming to harmonize the banking sector with the United Nations Sustainable Development Goals and the Paris Climate Agreement, aiming to build a sustainable future are called “Responsible Banking Principles”. These principles also provide the industry with a comprehensive framework that oversees sustainability at all levels and in all fields of activity. The United Nations Environment Program Finance Initiative has adopted the Principles of Responsible Banking, which include compliance, impact and target setting, customers, stakeholders, governance and culture, transparency, and responsibility. With the goal of sustainable development and a better future, the Principles of Responsible Banking, which set the roadmap for the banking sector all over the world, also form the basic framework of the sustainable banking system of the future. The type of banking that aims to increase environmentally friendly practices and reduce carbon footprint, takes measures to prevent waste of natural resources and works at this point is defined as "green banking". "Green investments" refer to ethical investments made in businesses that promote environmentally friendly methods and products and carry out their operations accordingly.

It may only be partially applicable for insurers to provide green financing through government loan subsidies to borrow cleaner production for environmental sustainability (Li et al., 2023). An accurate understanding and grasp of green finance's role and effect process would aid in improving policy accuracy and renewable energy development (Tang and Zhou, 2023). As a result, more research on green finance is needed to ensure its efficient use and, as a result, to determine the necessary actions. Consequently, the primary objective of this study is to analyze previous studies to identify trends and patterns in the green finance literature and to provide a route map for future researchers working on this subject. With a similar objective, Wu (2022) conducted a literature survey on trade openness, green finance, and natural resources. Their findings suggested that the exploitation of natural resources is a prerequisite for both trade openness and green finance. Ozili (2022) presented a review of the literature on green finance research around the world. Their research showed that there are a variety of issues, such as a lack of understanding and inconsistent definitions of green finance, a lack of coordination between government policies for green financing, inconsistent laws, and a lack of profitable incentives for investors and financial institutions willing to make investments in the fight against climate change. The first mixed-methods systematic review of the state-of-the-art trends in green finance research was presented by Debrah et al. (2022), with both bibliometric and qualitative analysis. Gilchrist et al. (2021) evaluated the limits of green finance with a survey of literature in the context of green bonds and green loans. Fathihani et al. (2021) reviewed 30 peer-reviewed journal articles on green and sustainable finance and summarized them in two tables. Hacihasanoğlu (2020) reviewed the environmental Kuznets curve literature and the implications for green finance. Although there are some green finance literature studies, the goal of this study is to deal with all green finance studies statistically to show the relations between authors and keywords of green finance based on VOSviewer network graphs and to present a state-or-art literature review on green finance. Furthermore, whereas previous studies on green finance had a more limited scope of research areas, our study will cover all aspects of green finance.

This study aims to comprehensively explore the landscape of green finance by addressing specific research questions that delve into its intricate relationships with various sectors such as the green economy, sustainable development, environmental protection, green manufacturing, and risk assessment. The investigation further delves into the role of different financial instruments, including debt, equity, green bonds, and funds, in promoting environmental sustainability. The integration of Environmental, Social, and Governance (ESG) criteria into investment decisions, the potentials and challenges associated with green finance, and the implications of the lack of standardized definitions are scrutinized. The study also examines the role of green bonds as a typical green finance tool and how consistent definitions can guide market and risk analysis effectively. Additionally, the research explores how green finance contributes to Sustainable Development Goals, environmental development, and the support for environmentally friendly technologies. The investigation concludes with an examination of the current landscape of green finance literature, focusing on distribution, authors, keywords, countries, institutions, and funding sponsors, with a particular emphasis on China's leadership in both academic research and practical implementation of green finance on a global scale.

The remaining sections of the paper are given as follows. Section 2 provides insight into green finance with related subtitles. Section 3 includes a comprehensive literature review on green finance. Sections 4 and 5 present green finance instruments and the publication media on green finance, respectively. Section 6 concludes the paper with recommendations for future study.

2. Green finance

Green finance is a system that encourages transforming the traditional economy through sustainable and inclusive methods. The green finance model includes sustainable development projects and initiatives, and all financial instruments used for environmental products and policies. Reducing risk perceptions and internalizing environmental externalities are the two fundamental objectives of green finance. Green finance applied on a large and economically viable scale aids in ensuring that green investments take precedence over unsustainable growth models. Green financing ensures transparency and long-term benefits from investments in environmental goals. This model is compatible and intertwined with all sustainable development criteria determined by the United Nations Sustainable Development Goals.

Green finance includes a broad range of financial services including investment, banking, and insurance. The dominant financial instruments in this financing model are debt and equity. To meet the growing demand, new financial institutions such as green banks and green funds are being established, in addition to new financial instruments such as green bonds and carbon market instruments. The most popular and in-demand green finance activities are renewable energy investments, sustainable infrastructure financing, and green bonds.

Green finance refers to investments in all financial sectors and asset classes that incorporate environmental, social, and governance (ESG) criteria into investment decisions and integrate sustainability into risk management to promote the development of a more sustainable economy. ESG information is increasingly being incorporated into the reporting processes of various actors in the investment value chain. Investors are raising difficult questions about how ESG performance is evaluated, managed, and reported as ESG reporting moves from niche to mainstream and begins to have an impact on the balance sheet. ESG data have progressed to the point where it has been adopted by the finance sector as a critical tool for identifying companies poised to succeed and those poised to underperform or fail (Lee, 2020). Challenges and opportunities, sustainable development, environmental development, and environmental technologies for green finance are the main research areas in the recent literature.

2.1. Potentials and challenges of green finance

The financial gap needed to meet the Sustainable Development Goals is expected to be several trillion dollars annually, even in developing nations (Johansen and Vestvik, 2020). Significant investments are required to make the switch to a low-carbon economy, and they can only be made with substantial private sector involvement. Incorporating ESG factors in private investments is moving away from risk management and toward important development and chances that produce long-term value for organizations and society (Risi, 2020). Nonetheless, several microeconomic issues have restricted capital mobilization for green projects (Desalegn and Tangl, 2022). For instance, there are maturity mismatches between investors' typically short-term time perspectives and long-term green investments. Moreover, in the past, there has frequently been a lack of coordination between economic and environmental policy approaches (Gago and Labandeira, 2010; Matzdorf and Meyer, 2014). Governments can collaborate with various stakeholders to boost capital flows and create new financial strategies across various asset classes to expand and diversify the financing of the private sector, particularly through initiatives aimed at creating capacity.

The lack of a standard definition of "green" and an accurate classification of green activities to help investors and financial institutions allocate money effectively and make educated decisions is one of the most pressing problems with green finance. The definition of green funding needs to be clearer to prevent "greenwashing" (Berensmann and Lindenberg, 2016). For market and risk analysis, benchmarking, and directing capital flows to green and sustainable initiatives, consistent minimum requirements and definitions of green finance are necessary. The development of green financial assets will be aided by disclosure requirements and regulations. There should be regulatory incentives for green financing in addition to voluntary principles and norms that are adopted and followed for all asset types.

A typical green finance tool is a green bond. A green bond is what is specified under a code of conduct. To be eligible, a bond must meet the requirements for the use of proceeds, have a procedure for project appraisal and selection, guarantee that any proceeds are managed appropriately, and offer thorough reporting.

2.2. Sustainable development goals and green finance

The United Nations (UN) collaborates with countries, financial regulators, and the financial sector to align financial systems with the 2030 Agenda for sustainable development (Khan and Farooqui, 2021). It directs financial flows to help the Sustainable Development Goals to be met. Financial markets, where banks and investors allocate capital to various sectors, are at the center of today's globalized economy. Capital allocation shapes ecosystems as well as future production and consumption patterns. The three primary focuses of contemporary work on green finance include developing public-private partnerships through financing instruments like green bonds, helping the public sector create a conducive climate, and boosting the ability of community companies through microcredit.

It provides services to countries through the UN resource efficiency program to review their policies and regulatory environments for the financing system and to develop sustainable finance roadmaps. The UN intends to assist all stakeholders in local financial markets in shaping and supporting the path of multi-country policy initiatives at the sub-regional, regional, and global levels by assisting central banks in this process.

2.3. The role of green finance in terms of environmental development

As global energy demand rises, so will interest in clean, environmentally friendly energy sources. The International Energy Agency (IEA) predicts that demand for renewable energy will rise by about 30% by 2030 because of global environmental regulatory policies (Scott and Gössling, 2021). Governments that act in this direction also play an important role in encouraging businesses and institutions. Companies that use renewable energy, for instance, may be able to borrow at a lower cost. Some solar energy and electric vehicle projects in European countries receive financing assistance or a tariff guarantee (Jacobs et al., 2013). Financial institutions have a significant impact on the activities of trade and industry sectors. As a result, green financing assistance provided by financial institutions is regarded as one of the most important steps taken in terms of environmental development.

2.4. Environmentally friendly technologies

Environmentally friendly technology is a concept that defines economically valuable and applicable technologies that aim to consume as little water, raw materials, and energy as possible while producing as little waste as possible. Within the context of environmentally friendly technologies, "clean production" is required (Wang et al., 2017). Cleaner production also includes processes that are carried out within the framework of preventive and holistic environmental strategies to reduce environmental risks (Al-Yousfi, 2004). The following are some of the areas where environmentally friendly technologies are widely used today: sources of renewable energy, energy efficiency and savings, natural life conservation, recyclable ingredients and waste, limiting greenhouse gas emissions minimizing air and environmental pollution, utilization of plant-based products and materials, reducing raw material consumption.

2.5. Green financing support for environmental technologies

Financial institutions provide green financing support to companies that operate using environmentally friendly technologies and contribute to sustainable living (Sadiq, 2022). For example, some financial institutions offer the advantage of providing funds to companies that carry out projects on renewable energy such as wind farms, hydroelectric power plants, solar power plants, or biofuels (Hwang, 2010). It can also invest in stocks in such projects. The green financing support provided by financial institutions to companies working on environmental technologies is not limited to the advantages of providing funds. Some financial institutions can also act as guarantors for environmentally friendly products with risk-sharing (Liu and Faure, 2018). It can launch special investor product lines for products and services containing renewable and clean energy (Loock, 2012). Green public and investment funds created in the field of asset management also allow investors to support green technologies.

Green financing support provides important incentives for companies from different sectors to advance their work by sustainable living principles. Soon, it is thought that the competitiveness of companies will be determined by the sustainability performance of their activities. And yet, studies in the field of green finance are at the forefront of encouraging steps taken in this direction.

3. State-of-the-art literature review

To conduct a robust and systematic literature review on green finance, our research employed a multi-step methodology. The primary database utilized was Elsevier's Scopus, and a thorough search strategy involved key terms like "green finance," "sustainable development," "environmental protection," "green manufacturing," and "risk assessment" in study titles, keywords, or abstracts. Inclusion criteria necessitated a focus on green finance and its intersections with various sectors, financial instruments, Sustainable Development Goals, and environmentally friendly technologies. Studies published from 2005 onwards were considered, with an emphasis on English-language papers to ensure accessibility. Exclusion criteria were applied to filter out irrelevant or duplicated content. The selected studies were then grouped based on thematic similarities, covering categories such as green finance instruments, Sustainable Development Goals, challenges, and potentials. Data synthesis involved both quantitative analyses, like publication trends and country-wise distributions, and qualitative content analysis to extract key themes. Bibliometric analyses, including co-authorship networks and funding sponsors, were visualized using tools like VOSviewer. This comprehensive methodology enables a nuanced exploration of the current state of green finance literature, identifying trends, gaps, and suggesting avenues for future research.

Elsevier's Scopus was used as the main database in this literature study. A total of 932 studies were accessed that contain "green finance" in the study titles, keywords, or abstracts. The first of these studies was published in 2005 (Fusaro, 2005) and defined green finance as an emerging financial trend. Figure 1 presents the flow diagram of the systematic literature review.

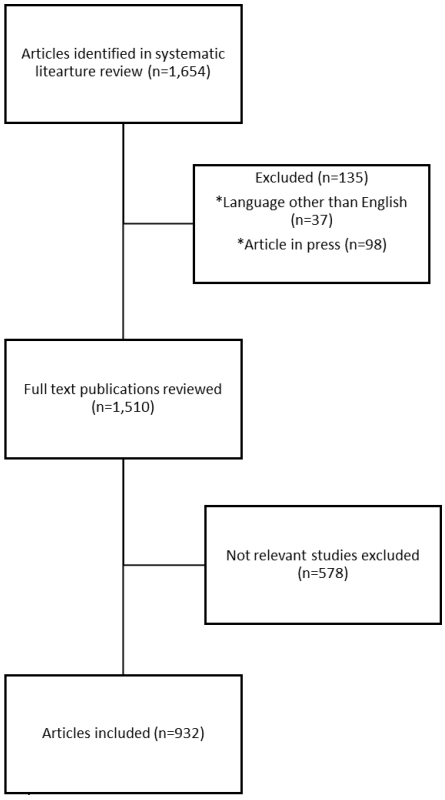

Figure 1. Flow diagram of the systematic literature review.

The distribution of publications on green finance by year is displayed in Figure 2. In 2022, 476 out of the 932 articles (51%) were published. As each year went by, it was evident that there were more publications. Examining the data reveals that there have been a significant number of studies in this area, especially after 2014. The number of studies in 2023 is much fewer because the data for the study were only collected in the first quarter of 2023.

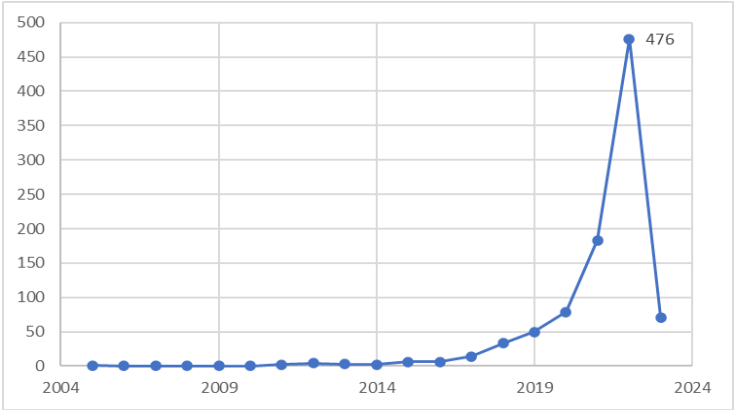

Figure 2. Green finance documents by year

Figure 3 shows the 25 countries with the highest number of publications on green finance. China has the most research and publications on green finance (n = 554). As can be seen, China has nearly half of the studies in this field which is followed by the United Kingdom (62 studies) and Pakistan (62 studies).

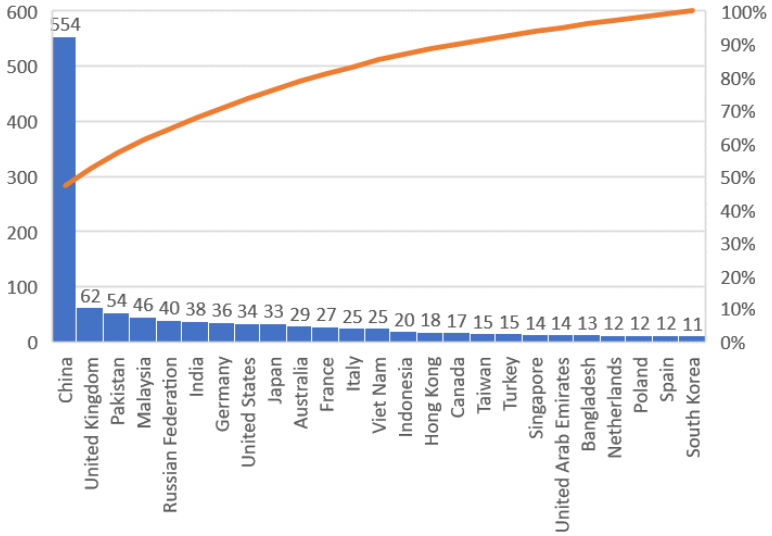

Figure 3. Documents by country

Figure 4 shows the density distribution of the countries on the world map where green finance studies have been carried out.

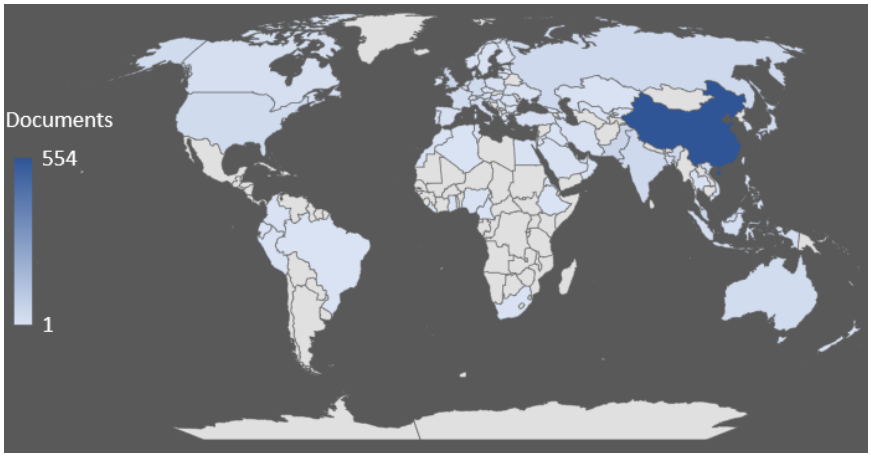

Figure 4. Density distribution of green finance studies by the countries

Figure 5 shows 16 institutions with more than 10 studies on green finance. Southwestern University of Finance and Economics has the most publications (n = 24). Following the Southwestern University of Finance and Economics are Jiangsu University and Tokai University with 21 studies.

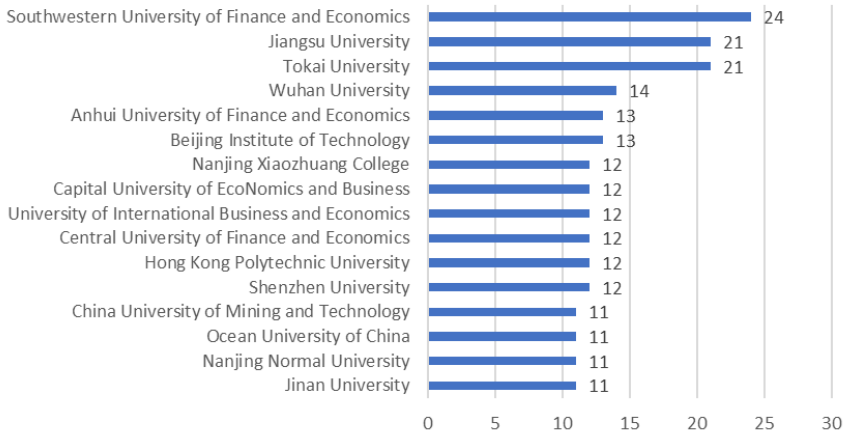

Figure 5. Documents by affiliation

A total of 3,000 keywords were found when the keywords used in green finance studies were examined. 87 keywords were categorized in this way using the criterion of a minimum of 15 repetitions of a word. As the number of repetitions rises, there are naturally fewer keywords that can be categorized. The common words found as a consequence of the research are shown in Figure 6. The terms "green finance" (847 times), "China" (232), "finance" (226 times), "sustainable development" (178 times), and "investments" (122 times) are the most often used keywords. Clusters with various color codes, such as green, yellow, red, and blue, are used to represent word groups. The frequency and quantity of repetitions in which words and colors are employed together determine their relationship.

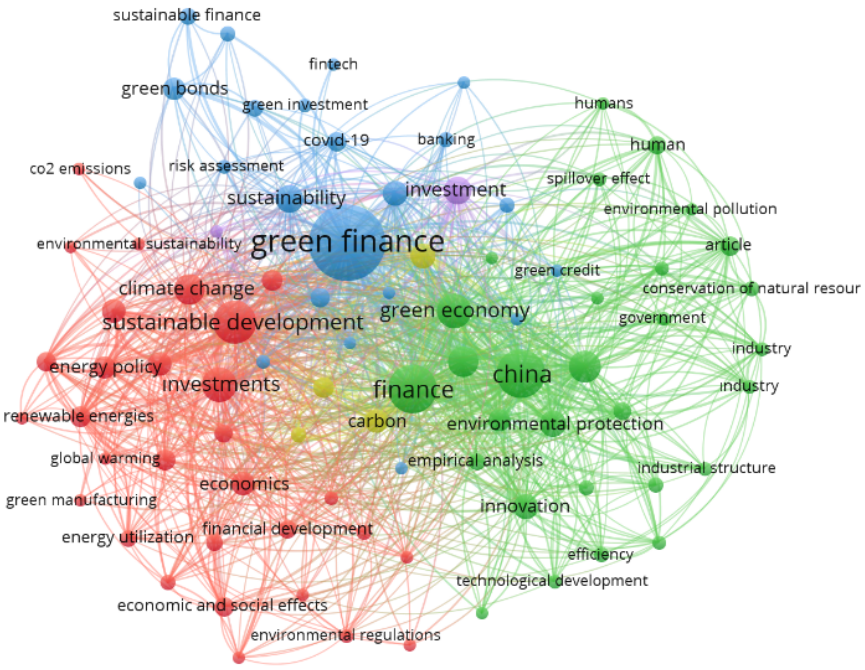

Figure 6. VOSviewer visual map of common keywords

As seen in Figure 6, three of the most common keywords used with green finance are China, sustainable development, and investment. Journal articles published in 2023, which include one of these three terms in their keywords and green finance in their titles are examined in detail in Table 1.

Table 1. Green finance studies with China, sustainable development, or investment keywords

Authors	Handled Problem	Considered Green Finance Issues	Analysis Technique
Tang and Zhou (2023)	Effects of green finance on the growth of renewable energy	Consistency	Spatial Panel Dobbin model
Wang et al. (2023)	Energy efficiency effects of green funding and renewable energy	Efficiency	Nonlinear autoregressive distributed lag, Two-stage least squares
Lee et al. (2023)	How green finance contributes to the economy's decarbonization	Economic decarbonization	Econometric models
Lu et al. (2023)	Security of water, electricity, and food within the limits of green finance	Sustainability	Quantitative analysis
Qin et al. (2023)	Investigating if green finance and the blockchain market can facilitate carbon neutrality	Carbon neutrality	Time-varying parameter-stochastic volatility-vector auto-regression model
Li and Umair (2023)	How sustainable growth is facilitated by green financing and renewable energy sources	Sustainable development	Cross-sectional dependency test
Gu et al. (2023)	Green finance's effects on changing energy use patterns	Green innovation	Benchmark regression model
Xu and Dong (2023)	Effects of green finance on high-quality economic growth	Economic development	Intermediary model, Regional heterogeneity analysis
Li et al. (2023)	Knowledge ecology and green finance policy governance	Cost of green development	Bibliometric and atlas analysis
Bei and Wang (2023)	Causality relationship between investments in renewable energy and green finance	Sustainability	Coherence wavelet technique
Gan and Voda (2023)	Reduction of carbon emission intensity with green finance	Low-carbon development	Panel ordinary least squares, Mediation effect, Threshold regression models
Ma (2023)	The contribution of green finance, human capital, and education to overall energy efficiency	Sustainable development	Slack-based measure method
Geng et al. (2023)	Effects of green finance and natural resource endowment	Green economic efficiency	Super-efficiency slacks-based measure model, Tobit model
Zhang et al. (2023)	Green finance, the use of renewable energy, and the extension of agricultural land	Low-carbon economy	Dynamic ordinary least squares method
Liu and Wang (2023)	Effect of green financing reform pilot zones on green innovation	Green transformation and innovation	Difference-in-difference method
Zhang et al. (2023)	Impact of innovation pilot zones and green finance reform on urban green development	Green total factor productivity	Difference-in-difference method

Huang and Khan (2023)	Government policy for early-stage green finance	Low-carbon emissions economy	Econometric model
Xia (2023)	Green finance's impact on carbon emissions	Green technology advancement	STIRPAT model
Ip et al. (2023)	Effects of urbanization and green finance on the tourism sector	Green economic development	Cross-sectional dependency ratio, Panel cointegration, and Dumitrescu-Hurlin panel causality tests
Jia (2023)	Effects of green finance on the degree of economic decarbonization	Green bond	Content analysis method
Wang (2023)	Green financing policy's effects on the manufacturing sector	Green innovation efficiency	Difference-in-difference model
Zhang et al. (2023)	Relationship between geopolitical risk and green finance	Environmental management	Time-varying causality testing
Chen et al. (2023)	Green finance and renewable energy's dynamic effects	Sustainable development	Stochastic volatile time-varying vector autoregressive model
Tiawon and Miar (2023)	The importance of generating renewable energy, energy efficiency, and green funding	Sustainable economic development	Autoregressive distributed lag model
Maria et al. (2023)	Bibliometric analysis of green finance evolution	Green transition	Structural topic modeling
Chen et al. (2023)	Options for using green technology under the cap-and-trade system	Insurer green finance	Simulation
Jiakui et al. (2023)	The contribution of green total factor productivity and green financing	Green technological innovation	Data envelopment analysis, Directional distance function
Wu (2023)	Investments in renewable energy and the impact of green financing on economic performance	Economic performance	Generalized methods of moment, Fixed-effect model
Xiang and Cao (2023)	Green finance and natural resources commodities prices	Green bond	QARDL estimation approach, Wald test, Granger causality test
Aloui et al. (2023)	Green finance and green quantitative easing effect on investors' behaviors	Green bond	Bayesian vector autoregression model

Figure 7 shows a network of collaboration among authors who have published more than five articles on green finance. 57 of the 1869 authors are divided into nine clusters, each represented by a different color. Each cluster represents a collaborative team, and the figure depicts the cluster's core authors. Most of the authors who worked closely together were from the same institution, and they mostly worked with local researchers rather than foreign researchers.

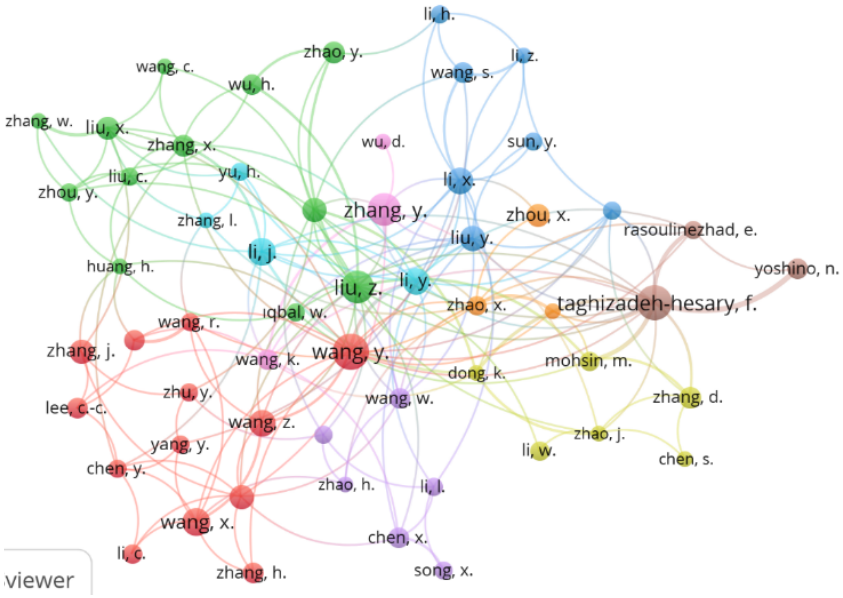

Figure 7. Co-authorship network diagram

When Figure 8, reflecting the subject areas of the studies in the field of green finance, is examined, it is seen that the most common studies are in the fields of Environmental Science (n = 437); Economics, Econometrics and Finance (n = 307); and Social Sciences (n = 247), respectively.

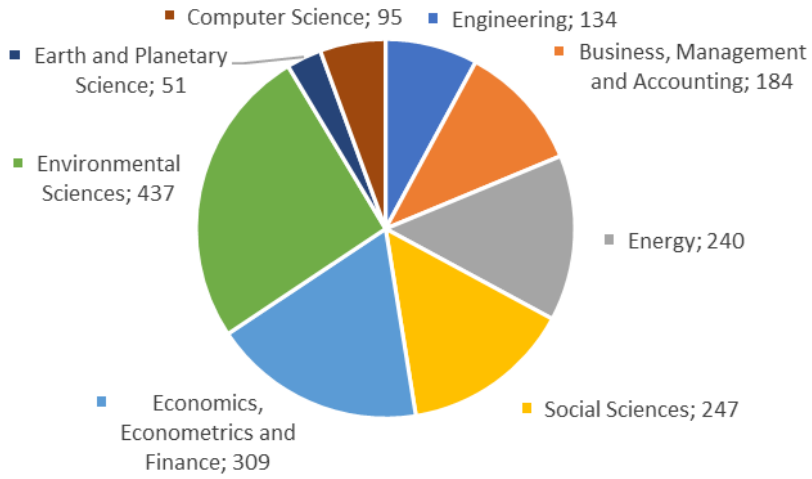

Figure 8. Documents by subject area

Figure 9 reveals that articles dominate green finance research (n = 745), followed by conference papers (n = 80), and book chapters (n= 55).

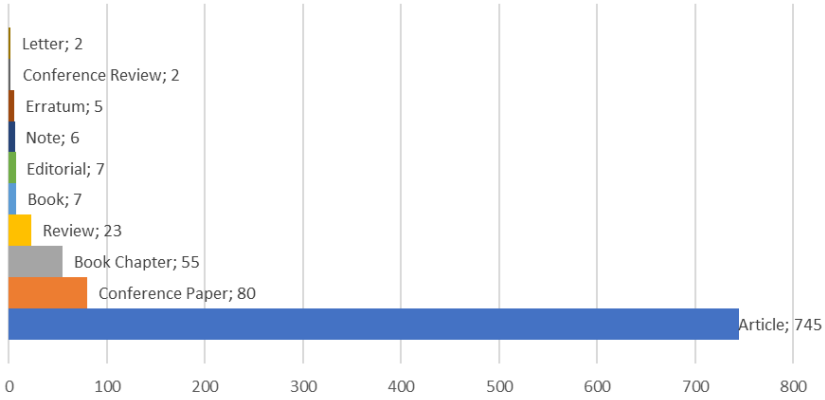

Figure 9. Documents by type

Figure 10 shows the 10 funding sponsors who provided the most financial support to the studies in the field of green finance.

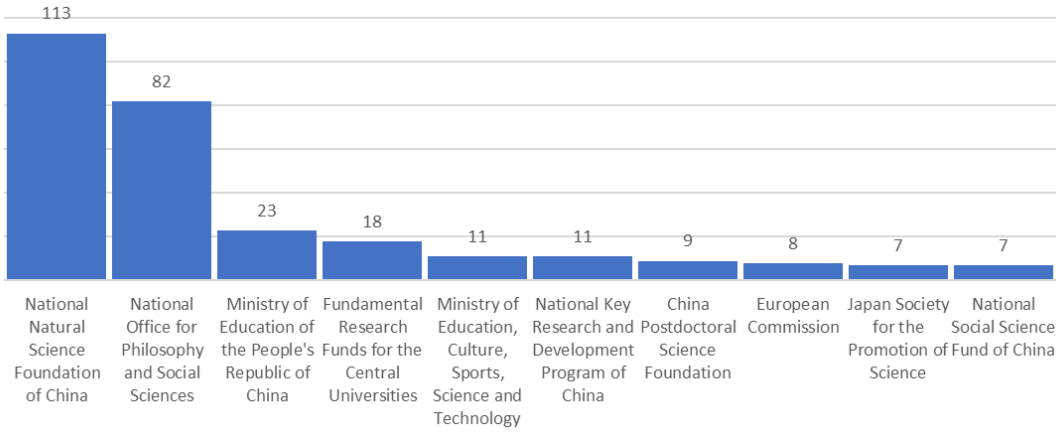

Figure 10. Documents by funding sponsor

Figures 3, 4, and 5 support the fact that the first three sponsors are of Chinese origin. In addition, the fact that one of the three most common keywords in Figure 6 is China shows that China is the leading country in the world in academic studies in the field of green finance.

4. Green finance instruments

Green finance instruments are products and services that provide a channel for financial capital to environmentally friendly projects or green industrial sectors whose activities aid in the transition to a low-carbon economy (Stojanovic and Ilic, 2018) such as green credit, green security, green insurance, green investment, carbon finance, green loan, green mortgage, green fund, green index, green asset, green bond, green microfinance, and green saving (Xu and Dong, 2023; Li et al., 2022; Weber and Oni, 2015). Figure 11 shows the frequency of the studies including green finance instruments in the Scopus database. Studies with more than one green finance instrument in the title, abstract, or keywords are repeated in the figure.

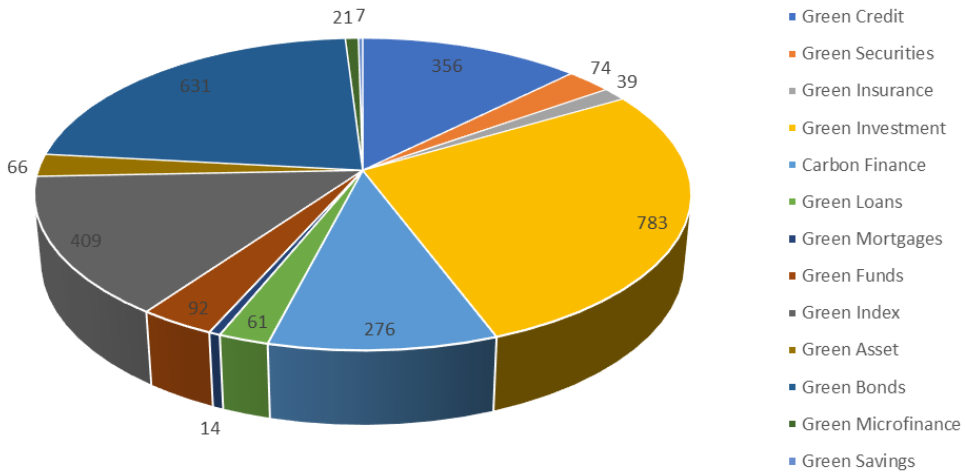

Figure 11. The frequency of the studies includes green finance instruments

When Figure 11 is examined, it is seen that the three green finance instruments that have been studied the least are green savings, green mortgage, and green microfinance, respectively and it is concluded that studies in this field can be increased and there is still a gap in the literature in these areas.

United Nations Environment Program (2017) clustered the categories of the green finance definition components into six as given in Figure 12. In the same figure, some areas of divergence and the number of studies on these areas in the Scopus database are given.

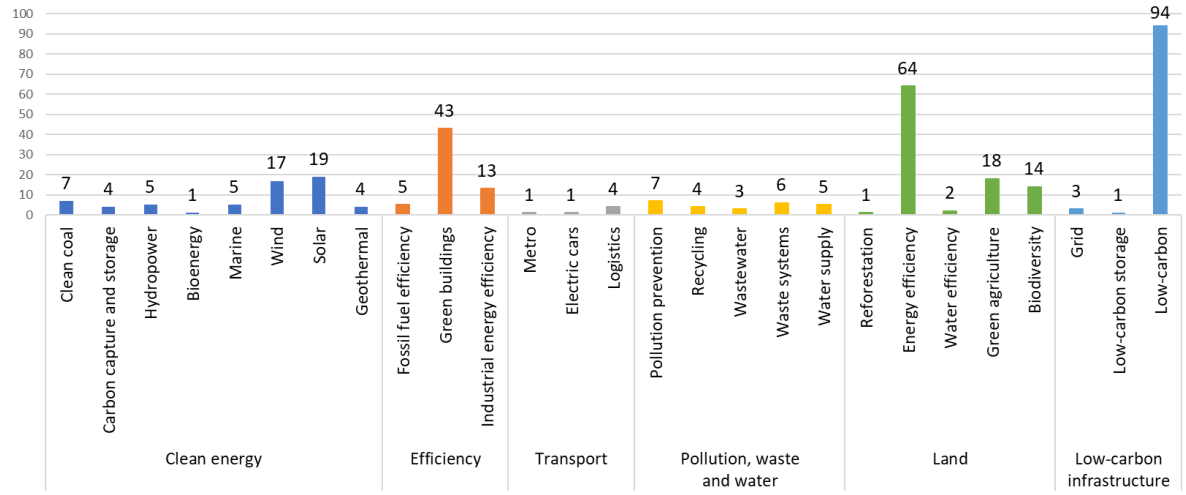

Figure 12. Components of green finance definitions

Figure 13 shows the leading countries in terms of the value of green bonds issued worldwide in 2018 (in billion U.S. dollars) (Weforum, 2019).

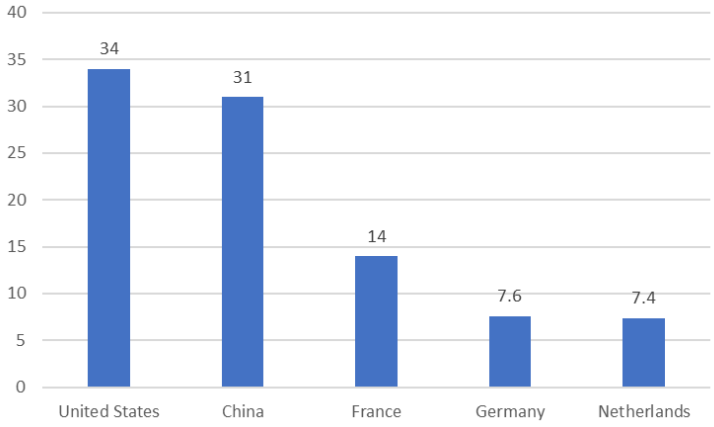

Figure 13. Value of green bond markets worldwide by major countries in 2018

The United States issued 34 billion dollars' worth of green bonds in 2018, while China came in second with 31 billion dollars' worth of green bonds. China is the leader in academic research on green finance, but it lags the United States in actual implementation.

5. Publication media on green finance

Table 2 shows the distribution of the studies by sources with more than 10 publications on green finance. In this context, 86 studies were published in the journal Environmental Science and Pollution Research. More than a total of 100 studies on green finance were published in the journals Sustainability Switzerland, Resources Policy, and Frontiers in Environmental Science. The journal with the highest rate of citations per article, based on the number of publications, is the Journal of Cleaner Production (21.1), which is ranked sixth overall. With 16.0 points, Energy Economics is in second place, followed by 15.51 points by Energies. In 14 journals, 7.9 citations per article on average were recorded. It is noteworthy that this average is lower than that of the top-ranked journal in terms of articles, Environmental Science and Pollution Research.

Table 2. Documents by source

Sources	Publications	Citations	Number of Citations per Article
Environmental Science and Pollution Research	86	633	7.4
Sustainability Switzerland	66	645	9.8
Resources Policy	33	251	7.6
Frontiers In Environmental Science	32	100	3.1
Renewable Energy	31	269	8.7
Journal of Cleaner Production	23	486	21.1
Energy Economics	22	351	16.0
International Journal of Environmental Research and Public Health	22	107	4.9
E3s Web of Conferences	18	34	1.9
Energies	14	211	15.1
Economic Research Ekonomska Istrazivanja	13	60	4.6
Economics Law and Institutions in Asia Pacific	13	6	0.5
Journal Of Sustainable Finance and Investment	13	116	8.9
Iop Conference Series Earth and Environmental Science	11	18	1.6

According to the number of citations, Table 3 lists the top 10 studies among the articles. The article with the most citations among those scanned in the context of the study has 266 citations and was released in Finance Research Letters. The second-placed article, which was printed in the Energy Policy journal, received 234 citations.

Table 3. Articles by citation

Article Content	Journal	Citation
How to encourage private investment and engagement in green financing (Taghizadeh-Hesary and Yoshino, 2019)	Finance Research Letters	266
In the BRI region, public spending and green economic growth mediated via green financing (Zhang et al., 2021)	Energy Policy	234
Impact of green financing on total green factor productivity with proof from China (Lee and Lee, 2022)	Energy Economics	173
Green finance bibliometric analysis: status, evolution, and potential directions (Zhang et al., 2019)	Finance Research Letters	170
Two features of market mechanisms and policies related to the function of green financing in environmental conservation (Wang and Zhi, 2016)	Energy Procedia	167
Demand for green finance: Overcoming China's financial barriers to green innovation (Yu et al., 2021)	Energy Policy	167
Sustainable methods for investing in renewable energy projects and using green funding (Taghizadeh-Hesary and Yoshino, 2020)	Energies	141
Can green financial development increase the effectiveness of investments in renewable energy by considering bank credit (He et al., 2019)	Renewable Energy	134

Based on Chinese provincial panel data, the effect of green finance on economic development and environmental quality (Zhou et al., 2020)	Environmental Science and Pollution Research	123
The relationship between green finance and reducing climate change in the N-11 and BRICS countries by using the difference-in-difference method (Nawaz et al., 2021)	Environmental Science and Pollution Research	114

The number of conferences and events in the field of green finance is increasing day by day. The most recent examples are the Forum on Green Finance and Investment (2022) by the OECD Center on Green Finance and Investment, the 7th Green Finance Research Advances (2022) co-organized by Banque de France and the Institut Louis Bachelier, and UK-Turkey Green Finance Conference (2022) organized by the UK Department for International Trade and the Republic of Turkey's Ministry of Treasury and Finance. In addition, events on green finance were also organized by some banks in 2022, such as The Global Green Finance Leadership Program (2022) by World Bank (Malaysia) and Green Finance Conference (2022) by The Central Bank of Hungary.

Table 4 shows the books including green finance in their titles together with their editors or authors, the year of publication, and the publishers. In this context, 11 books published between 2011 and 2023 are included in the table.

Table 4. Books on green finance

Editor/ Author	Book Title	Publisher
Samsul Alam, Sergey Sosnovskikh (2023)	Environmental Finance and Green Banking	Routledge
Maria Madi, Miriam Kennet (2021)	Green Investment, Green Economy and Green Finance	The Green Economics Institute
Karen Wendt (2021)	Green and Social Economy Finance	CRC Press
Simon Thompson (2021)	Green and Sustainable Finance: Principles and Practice in Banking, Investment and Insurance	Kogan Page
Aaron Ezroj (2020)	Carbon Risk and Green Finance	Routledge
Fanny M. Cheung, Hua Guo, Ying-yi Hong (2020)	Green Finance, Sustainable Development and the Belt and Road Initiative	Routledge
Jingyan Fu, Artie W. Ng (2020)	Sustainable Energy and Green Finance for a Low-carbon Economy	Springer Cham
Sang-Bing Tsai, Chung-Hua Shen, Hua Song (2019)	Green Finance for Sustainable Global Growth	IGI Global
Jeffrey D. Sachs, Wing Thye Woo, Naoyuki Yoshino, Farhad Taghizadeh-Hesary (2019)	Handbook of Green Finance	Springer Singapore
Marco Migliorelli, Philippe Dessertine (2019)	The Rise of Green Finance in Europe	Palgrave Macmillan Cham
Zongwei Luo (2011)	Green Finance and Sustainability: Environmentally- Aware Business Models and Technologies	IGI Global

6. Conclusion

Green finance has been one of the first areas of interest for leading countries in the field of finance. Some countries leading the way in green finance have reached billions of dollars in investments in this area. China draws attention as the leading country in the field of green finance studies. It has been observed that the publications in this field have increased exponentially since 2005. With green finance, the field of finance has expanded as a science by gaining many special terms such as green credit, green securities, green insurance, green investment, and carbon

finance. Difference-in-difference model and autoregression model are the two most widely used analytical techniques in green finance studies. United Nations Environment Program categorized the components of green finance definitions into six classes which are clean energy; efficiency; transport; pollution, waste, and water; land; and low-carbon infrastructure. Under these classes low-carbon, energy efficiency, green building, solar energy, green agriculture, wind energy, and biodiversity are the most studied areas in the literature.

The implications of the results for practice and policy in this study are substantial and hold relevance for both the financial sector and policymakers. The comprehensive review of green finance literature, encompassing topics such as sustainable development, environmental protection, and risk assessment, offers insights that can inform financial practices aligned with environmental responsibility. The identified gaps in understanding and inconsistent definitions of green finance underscore the need for standardized frameworks and definitions to prevent "greenwashing" and enhance the effectiveness of investments in the fight against climate change. The prominence of China in both academic research and financial investments in green finance suggests a global leadership role in shaping sustainable financial practices. For practitioners, the study emphasizes the importance of incorporating environmental, social, and governance (ESG) criteria into investment decisions, aligning with the United Nations Sustainable Development Goals. Policymakers can benefit from the findings by fostering regulatory incentives for green financing, ensuring transparency, and promoting consistency in defining and categorizing green activities. The study's insights provide a roadmap for practitioners and policymakers to navigate the evolving landscape of green finance, contributing to a more sustainable and environmentally conscious financial ecosystem.

Several limitations are inherent in the review processes of this study. First, the reliance on Elsevier's Scopus database may introduce a publication limitation, as it represents only one source of academic literature. The exclusion of other databases my cause missing some contributions in the field of green finance. Additionally, the study's cutoff date in the first quarter of 2023 may not capture the most recent developments in the rest of the year. The categorization of keywords and the identification of clusters using VOSviewer, while valuable for visualization, may oversimplify the complexity of green finance literature.

Future research in the field of green finance could build upon the foundations laid by this comprehensive literature review. First and foremost, there is a need for in-depth investigations into specific green finance instruments that have received relatively less attention, such as green savings, green mortgage, and green microfinance. Exploring these areas could provide nuanced insights into the financial mechanisms contributing to environmental sustainability. Additionally, researchers should delve into the practical implications of green finance policies and principles, evaluating their effectiveness in promoting sustainable practices across various sectors. As green finance gains momentum globally, comparative studies analyzing the implementation and impact of green finance initiatives in different countries would be invaluable. Furthermore, incorporating a more extensive range of databases and including gray literature in future reviews could offer a more comprehensive understanding of the evolving landscape of green finance research. Lastly, exploring the synergies between green finance and emerging technologies, such as blockchain and artificial intelligence, could uncover innovative approaches to address environmental challenges. These avenues for future research would contribute to a deeper understanding of green finance dynamics, fostering the development of more effective policies and practices for sustainable financial systems.

Contribution of Researchers

Both authors have contributed equally to the work.

Conflicts of Interest

The authors declared that there is no conflict of interest.

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