

# *International Green Finance Research Progress, Hotspot Analysis and Trend Outlook--Based on VOSviewer's Bibliometric Analysis*

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**Abstract:** The issue of "double carbon" target climate change has attracted widespread attention in the international arena. Based on the Web of Science database, this paper draws the knowledge map of international green finance research field by using the visualization and analysis software VOSviewer with a total of 1567 green finance-related literature from 2016 to 2022 as samples. The research keywords include sustainable development, environmental performance, carbon emission reduction, etc.; the clustering of research themes mainly includes four major directions: carbon emission reduction, green innovation, green policy and risk management; the combination of green finance with inclusive finance, digital finance and green consumption should become the future of international green finance research. The research on green finance combined with inclusive finance, digital finance and green consumption should become the key focus areas of international green finance research in the future.

## **1. Introduction**

With the outbreak of multiple shocks such as global warming, environmental pollution, resource depletion, energy crisis and new coronavirus pandemic, the concept of sustainable development and green development has been implemented and deepened, and major economies have taken the protection of ecological environment and adaptation to climate change as the main measures to improve the resilience of economic development[1-3]. In this context, the formation of green finance theory has emerged from the situation[4]. Green finance refers to the economic activities of financial institutions in the process of investment and financing decisions, paying attention to resources, environment and other factors, and actively guiding the flow of funds to promote the economy to sustainable and high-quality development[5-7]. Green finance can optimize the macroeconomy by generating green investment in the form of savings, thus promoting economic structure optimization and supply-side quality improvement, and stabilizing economic growth[8-9]; it can also promote microeconomics such as enterprises and markets by reducing transaction costs, supporting green innovation and operation, actively responding to risks, and guiding green consumption; at the same time, it can promote the overall green development of the economy, and complement a series of green policies such as carbon neutrality. At the same time, it can promote the overall green development of the economy and complement a series of green policies such as carbon neutral policies[10-12].

In view of this, based on the international literature data in the field of green finance collected in the Web of Science (WoS) database since 2016, this paper uses conventional statistical methods and the VOSviewer literature visualization tool to map the knowledge areas of international green finance research, sort out the changes of research hotspots in this field, dig into the current political and market information behind the changes of keywords[13], and at the same time We also summarize the future trends in order to provide some reference for the future theoretical and practical research on green finance[14].

## 2. Analysis of research dynamics in the international research literature on green finance

This paper uses the visual analysis software VOSviewer (Version1.6.18) as an analysis tool for the study. To better analyze the literature on the topic of green finance, this paper uses the Web of Science™ core collection as the database, limited to Social Sciences Citation Index (SSCI) and Science Citation Index Expanded (SCI-EXPANDED) for data collection. The data collection is limited to Social Sciences Citation Index (SSCI) and Science Citation Index Expanded (SCI-EXPANDED). The data were retrieved on October 7, 2022, and since 2016 is also known as the "first year of green finance development", the time span of the selected literature is 7 years from 2016 to 2022.

### 2.1 Analysis of posting time and posting volume

The annual number of publications in the literature can map the development level of the research field in a certain time period. The annual publication data of international green finance-related literature were imported into Excel to make a line graph of the number of core journal papers published. It can be seen that the overall trend of the number of publications in the international green finance theme literature from 2016 to 2022 is on the rise, with a larger increment from 2020 to 2022.

With the accelerated externalities of climate, environment and ecological problems in recent years, major global economies are vigorously promoting the development of green finance. At the G20 Summit in 2016, green finance was included in the meeting topic for the first time, and in February 2021, the G20 Finance Ministers and Central Bank Governors Meeting agreed to resume the establishment of the G20 Sustainable Finance Study Group, with China and the United States as co-chairs, to coordinate financial resources, jointly address potential financial risks arising from climate change, and promote the green transformation of the global economy. Especially in 2020-2022, as countries pay more and more attention to sustainable development, relevant international organizations and countries have issued many policy documents involving green finance, and the academic research and industry practice related to green finance are becoming more and more abundant and in-depth.

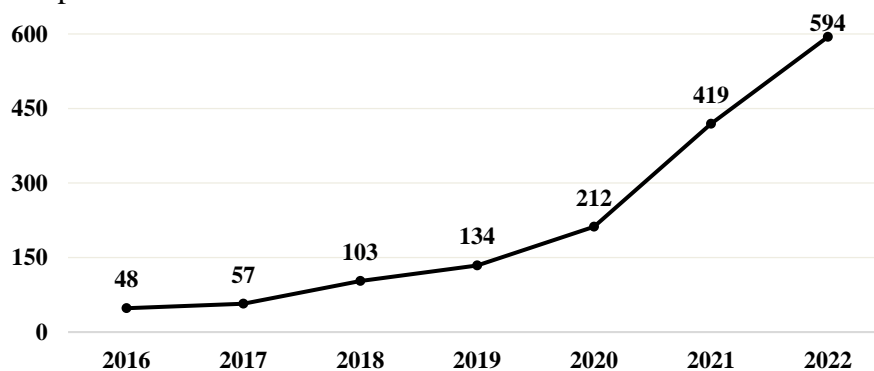


Figure 1: Trends in the number of international literature published in the field of green finance

In summary, the international policy, technology, and business environment have provided a superior development environment for green finance, and the attention of international scholars to green finance research has gradually increased, which has enriched the relevant theoretical foundation and provided reference for the further development of the green finance field, and also made the relevant research results in the international green finance field show a multiplication. The results are shown in the figure 1.

## 2.2 Analysis of international author

High-producing authors and their collaborative groups within a scientific field are the core drivers of that research area. The author co-occurrence knowledge map can be used to visualize the high-output authors and their collaborative relationships within the field. From the obtained sample of international green finance literature, 4372 authors in the field of blended learning research during 2016-2022 were extracted, and the condition of a minimum number of 3 publications per author was set, 152 core authors with certain influence were screened out, and the author contribution map was drawn using VOSviewer, and the top 3 authors with the largest number of publications The top 3 authors were Taghizadeh-hesary, Farhad (19 articles), Mohsin, Muhammad (9 articles), and Yoshino, Naoyuki (8 articles). The results are shown in the figure 2.

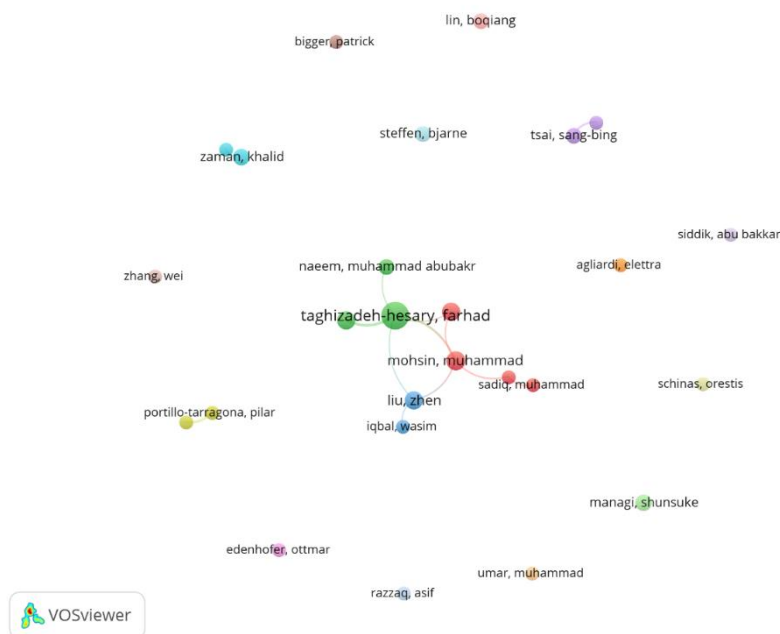


Figure 2: International Author Collaboration Network Mapping

The above mapping shows that at present, in the field of green finance, in terms of cooperation, most of the international high-output research is carried out independently, and a smaller number of high-output research authors have formed certain cooperative relationships, but in terms of the connection strength of the nodes, there are fewer academic links between scholars from different countries, and the degree of cooperative communication among scholars is generally weak. As countries are currently paying more and more attention to sustainable development, green finance has received great attention from the academic community, and promoting the development of green finance and improving the related system has been an international consensus, the core authors should further play a leading role and strengthen the cooperation and communication with cross-institutional and interdisciplinary researchers in order to promote the expansion and extension of research in the

field of green finance internationally.

### 2.3 Analysis by international research institutions

The number of publications by research institutions can represent the research capability of their fields. In this paper, VOSviewer was used to make a cooperative mapping of research institutions in the field of green finance research internationally, showing only the networks where there are linkages.

There are 1791 research institutions in 1567 foreign publications, and the minimum number of 10 publications per institution is set. 143 research institutions are eligible, and the top 3 institutions with the largest number of publications are Jiangsu University (27 publications), Wuhan University (27 publications) and Xiamen University (23 articles), all from China.

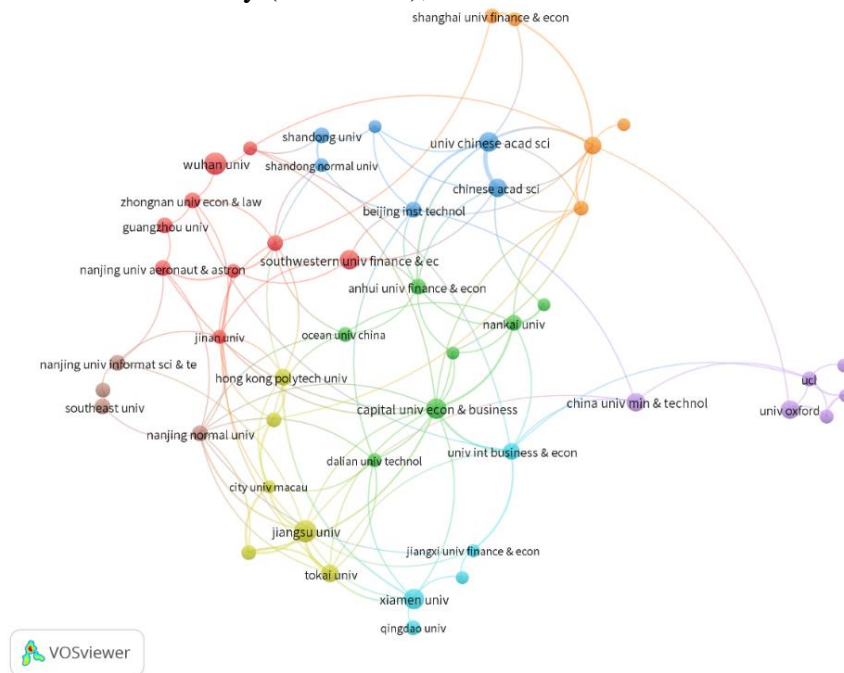


Figure 3: Mapping of international institutional cooperation network

The analysis of the cooperation network mapping of international institutions shows that there is cooperation among various high-production research institutions and the scale of cooperation is large, but there are more local cooperation and less cross-regional cooperation, and a more stable and mature cooperation network has been formed. The ranking of research institutions in terms of the number of articles published shows that the most prolific research institutions in the field of green finance mainly come from China, which indicates the high importance and continuous attention of Chinese scholars to green finance. As the field of green finance continues to develop, different research institutions in the international arena should also deepen their cooperation and exchange in the future to jointly promote the depth and enrichment of the green finance research field. The results are shown in the figure 3.

### 2.4 Analysis of country cooperation

In the field of green finance research, China has published 787 articles, which is much higher than other countries, and is the country with the most articles among international journals in the field of green finance, accounting for 50.22%, and is undoubtedly at the forefront of the leading position in the field of green finance internationally. In terms of the connectivity of the graph, the nodes are

densely and intricately connected to each other, indicating the existence of more collaborative relationships between different countries. In addition to China, where the UK, The United States and Germany have also published more articles in the field of green finance research, indicating that these countries are at the relative core of the international green finance research field and that the relevant research is more influential. The results are shown in the figure 4.

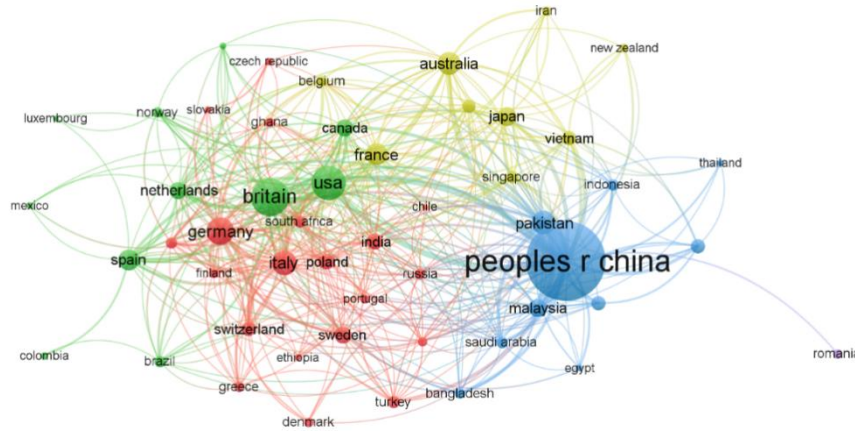


Figure 4: Country Cooperation Network Mapping

### 3. Analysis of hot areas of international research on green finance

Keywords are the core ideas of an article, and the research hotspots in a field can be quickly grasped through the study of keywords in that field. The accuracy and frequency of keywords are two important factors that affect the accuracy of the results of the co-occurrence method for identifying research hotspots in a field. In this study, keywords were visualized from the co-occurrence perspective using VOSviewer software. In order to make the analysis results more accurate, the keywords in the literature were first processed for data cleaning, which mainly included the unification of keywords in case and singular and plural, full names and abbreviations and synonyms.

Table 1: Top 20 keyword frequency in international green finance literature

Number	Keyword	Occurrences	Total Link Strength
1	green finance	512	2431
2	green innovation	304	1764
3	sustainability	269	1425
4	impact	257	1526
5	environmental performance	235	1403
6	carbon emission reduction	231	1425
7	policy	226	1174
8	economic growth	202	1231
9	green investment	185	1124
10	climate change	168	779
11	china	159	940
12	renewable energy	154	921
13	green credit	119	657
14	management	115	686
15	growth	107	631
16	green bond	98	410
17	constraint	96	593
18	risk management	95	520
19	energy	87	473
20	model	86	447

The keywords with frequencies higher than 10 times were set as high-frequency keywords, and some of the keywords with high frequencies but no analytical significance were canceled. 173

keywords were qualified, and the keyword frequency was ranked statistically, among which the top 20 ranked by word frequency were as follows. The results are shown in the table 1.

In the field of international green finance research, excluding "green finance", "green innovation" has the highest frequency with 304 occurrences, which is the most researched focus of international scholars. "sustainability" and "impact" ranked second and third, with 269 and 257 occurrences, respectively. In addition, "environmental performance", "carbon emission reduction", "policy" The keywords "environmental performance", "carbon emission reduction", "policy", etc. are also the hotspots that are relatively more concerned and researched.

Figure 5 shows the co-occurrence map after clustering of keywords, and the research hotspots in the field of international green finance can be summarized into four major directions according to the clustering results.

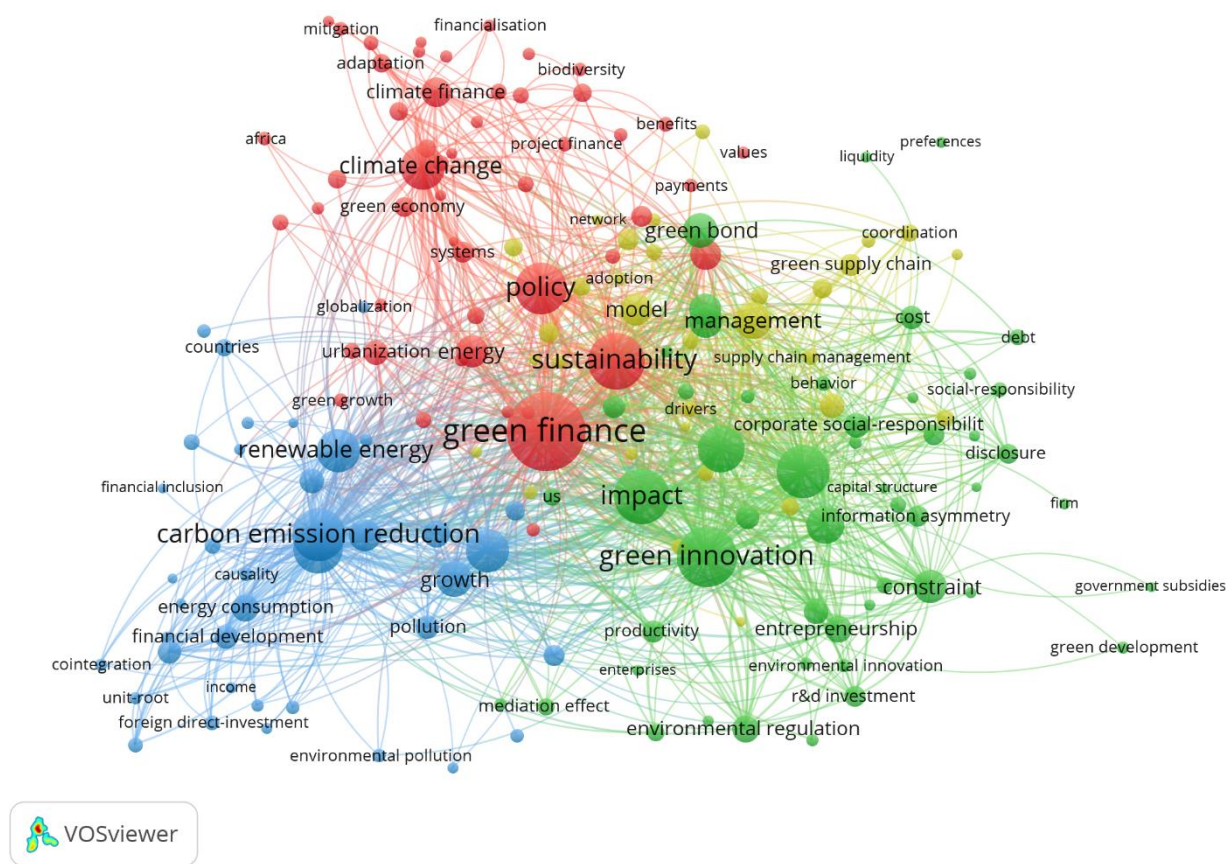


Figure 5: Clustering map of keywords related to the international green finance field

### 3.1 Green Finance and Carbon Emission Reduction

In the field of green finance, on the one hand, carbon finance is an important part of green finance; on the other hand, other financial activities that promote energy conservation, emission reduction and environmental protection often also have the effect of reducing carbon emissions. And in terms of quantitative relationship, global data show that the development of green finance is closely related to the reduction of carbon emissions. Therefore, the international research on the impact of green finance on carbon emission intensity is rich, and the impact of different green financial instruments on carbon emission intensity, the heterogeneity of green finance on carbon emission intensity, and the mechanisms and paths of green finance to curb carbon emission intensity in a multidimensional perspective have been explored in depth, such as green finance can optimize industrial structure,

adjust energy structure and promote green technological innovation to curb carbon emissions.

### 3.2 Green Finance and Green Innovation

Green innovation refers to all forms of innovation that minimizes damage to the environment and ensures that natural resources are used in the most efficient manner. It is a practice that can improve a company's competitiveness, economic and environmental performance. Energy use reduction, waste recycling, pollution control, resource sustainability and green product design are all factors to consider. Green innovation activities are often characterized by long return cycles, information asymmetry and high risk, making it difficult for related companies and projects to obtain long-term financial support under traditional financial models, facing severe maturity mismatch and investment constraints. Green finance is essentially a financial resource rationing based on environmental constraints, which can tilt the capital investment of green enterprises and green projects, improve the financing ability of green enterprises and financial resource support of green projects, and at the same time, green innovation can reduce the negative impact of enterprises on the environment and develop environmentally friendly technologies and products to reduce pollution. .

### 4. Conclusion

This paper mainly composes 1567 papers in the field of green finance from 2016-2022 in the WOS database through VOSviewer software, and visually reflects the various aspects of green finance research such as publication trends, research cooperation, research progress, and hot frontier through visualization mapping. From the chronological characteristics of the publications, the number of international green finance research publications grew rapidly and steadily from 2016 to 2022, becoming a research hotspot in recent years, which will lay a solid theoretical foundation for the further development of green finance; from the keyword word frequency statistics, the international research hotspots of green finance mainly focus on high word frequency such as sustainable development, green innovation, environmental performance, green investment, carbon emission reduction, etc. Key words. Future research should be based on the existing achievements, combined with new problems and challenges encountered in the development process of international society reality, and improve the research related to green finance with a multi-dimensional perspective, and continue to promote in the following directions: 1. research on the combination of green finance and inclusive finance; 2. research on the combination of green finance and digital finance; 3. research on green finance supporting green consumption.

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