

Mohanty, Sagarika et al.

**Article**

## Emerging research trends in green finance: A bibliometric overview

Journal of Risk and Financial Management

**Provided in Cooperation with:**

MDPI – Multidisciplinary Digital Publishing Institute, Basel

*Suggested Citation:* Mohanty, Sagarika et al. (2023) : Emerging research trends in green finance: A bibliometric overview, Journal of Risk and Financial Management, ISSN 1911-8074, MDPI, Basel, Vol. 16, Iss. 2, pp. 1-17, <https://doi.org/10.3390/jrfm16020108>

This Version is available at:

<https://hdl.handle.net/10419/275176>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by/4.0/>

Article

# Emerging Research Trends in Green Finance: A Bibliometric Overview

Sagarika Mohanty<sup>1</sup>, Sudhansu Sekhar Nanda<sup>2,\*</sup> , Tushar Soubhari<sup>3</sup> , Vishnu N S<sup>4</sup>, Sthitipragyan Biswal<sup>5</sup>   
and Shalini Patnaik<sup>6</sup>

- <sup>1</sup> KIIT School of Management, KIIT University, Bhubaneswar 751024, Odisha, India  
<sup>2</sup> Department of Finance, Kirloskar Institute of Management, Harihar 577601, Karnataka, India  
<sup>3</sup> Department of Commerce, N.S.S. College, University of Calicut, Manjeri 676122, Kerala, India  
<sup>4</sup> Department of Commerce and Professional Studies, Rajagiri College of Social Sciences (Autonomous), Cochin 683104, Kerala, India  
<sup>5</sup> Department of Management, ASTHA School of Management, Bhubaneswar 752101, Odisha, India  
<sup>6</sup> Department of Finance, Institute of Management and Information Science, Bhubaneswar 752101, Odisha, India  
\* Correspondence: nandasudhansusekhar.87@gmail.com

**Abstract:** Green finance is significant since it is the first organized effort by the financial industry to link financial performance with a positive environmental impact. Green finance products are being developed appropriately to achieve sustainability. The present study employs a fundamental bibliometric methodology to assess the current state and progress of academic research on green finance. 1748 papers are taken for this study. Data are extracted from a scholarly database i.e., SCOPUS and for network analysis, VOSviewer software is used. The present paper is focused on six research questions. Information is gathered to examine the above research questions and network maps are applied. We examined year-wise document publications, types of documents, subject areas, most influential articles, different journal sources, co-authorship of countries, and co-occurrence of keywords of green finance. We categorized keywords into clusters and discovered new trends in green finance. The paper also highlighted the recent issues and challenges. The study has also certain limitations and it is concluded by providing implications and suggestions for future studies. At last, this paper will give more insights to researchers, academicians, and others to discover the research gaps in this field of green finance.

**Keywords:** green finance; sustainable finance; bibliometric analysis; network analysis; VOSviewers; green initiatives; financial markets; green investment



**Citation:** Mohanty, Sagarika, Sudhansu Sekhar Nanda, Tushar Soubhari, Vishnu N S, Sthitipragyan Biswal, and Shalini Patnaik. 2023. Emerging Research Trends in Green Finance: A Bibliometric Overview. *Journal of Risk and Financial Management* 16: 108. <https://doi.org/10.3390/jrfm16020108>

Academic Editor: Shuke Fu

Received: 28 December 2022

Revised: 30 January 2023

Accepted: 2 February 2023

Published: 10 February 2023



**Copyright:** © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

The global financial crisis (2007) collapsed the backbone of the international financial system. The financial crisis highlighted the recent trends in conventional finance toward the exclusive concentration of earnings in a concrete sense. The result was a loss of faith on the part of the public institutions toward the lending financial institutions (Morano et al. 2020). To bridge the trust among the investors, the lending financial institutions started implementing new approaches. The public's interest in finance in green investment, socially responsible investment, and social impact investment are among these strategies that are progressively expanding (Morano et al. 2020; Rizzello et al. 2016; Sibanda 2013). The twofold exposure framework demonstrated that there was an interaction between the global financial crisis and other climatic change risks (Leichenko et al. 2009). Thus, global attention has been focused heavily on sustainability and climate change (Zhang et al. 2019). As a result, green finance is significant since it is the first organized effort by the financial industry to link financial performance with a positive environmental impact. It can also be considered as one of the clear indications that the economic system has begun to adapt to the challenge of the environment at large (Berrou et al. 2019).

Since the UN 2030 agenda was unveiled in 2015, member nations have designated Sustainable Development Goals (SDGs) as their top priority. A significant level of financial means is needed for initiatives to accomplish SDGs (Pizzi et al. 2021). The Sustainable Development Goals (SDGs) are implemented in 17 prime areas, where green finance plays a significant role. The purpose of green finance, according to Soundarrajan and Vivek (2016), is to strategically include the financial industry in the transformation to minimal carbon emission and wealth optimization economies as well as in the context of addressing climate change. Promoting inclusive green finance is an essential approach to reaching sustainable development goals since it concentrates on the three aspects of sustainable development (financial, ecological, and societal) (Naz et al. 2020).

Enhanced capital inflows from the public and non-public sectors are possible through the use of green finance, which aims to advance key sustainable development objectives (Ahmad et al. 2022). Green finance serves as a link between the financial and eco-friendly sectors (Ngo et al. 2021). It can also direct the flow of capital, thereby assisting in the optimization of industrial structures (Salazar 1998). Green financial products have been developed to achieve sustainability. These items refer to financial services such as undertaking venture investment, risk assessment, and greener project activities that preserve the environment, assist professional energy preservation, and enhance sustainable development (Ding et al. 2022). According to Chami et al. (2002), green finance aids in risk management and boosts the credibility of financial institutions in the market. Green debt products are a relatively new development in financial markets. The application of this instrument in financing renewable energy projects worldwide has been established (Narayan et al. 2022; Charfeddine and Kahia 2019). By introducing the purchase of liquid fixed-income assets with the additional feature of bringing investors with a social conscience who want to rely on green initiatives in the financial market, green bonds, also known as climate bonds or sustainable bonds, are expected to signify the start of a paradigm change (Bernabé Argandoña et al. 2022; Hadaś-Dyduch et al. 2022; Lee and Lee 2022). In the Chinese regulatory framework, “green financial bonds” are generally issued by retail banks to corporate investors (Zhang et al. 2022; Ehlers and Packer 2017). The entire net income from the issuance of green financial bonds shall be used to finance green initiatives, often through the issuance of green loans for the development of green infrastructure projects (Lin and Hong 2022). Narayan et al. (2022) provide evidence of the quest for quality, with investors shifting their investments from riskier assets such as conventional and Islamic stocks to safer ones such as Sukuk and Green Sukuk. Generally, financial institutions that care about environmental sustainability deal with green financial securities on the financial market (Talan and Sharma 2019). In addition, establishing a green financial system can enable the allocation of social capital for investments in green businesses, increase corporate social responsibility awareness, and accelerate the industry’s overall transition to a greener economy (Chen et al. 2022; Mehta et al. 2020; Shahbaz et al. 2013). During the COVID-19 pandemic, this evidence was very compelling. Environmental and natural resource externalities can be addressed with the aid of market mechanisms using green finance (Narayan et al. 2022; Ghosh et al. 2022). Green and sustainable financing offers advantages and opportunities (Meher et al. 2020). Consequently, many businesses are strongly emphasizing sustainability and implementing eco-friendly business practices that are good for the environment and encourage sustainability (Desalegn and Tangl 2022).

Zhang et al. (2017) research also examined the mechanisms of geographical spillover impact and diversity in China’s eastern, middle, and western provinces. They provide a framework for choosing green funding to support regional green development by extending the study viewpoint and subject matter of financial geography. Green economic development is facilitated by green finance, and this results in green GDP growth (Wang et al. 2020). Expanding the investment and finance channels of the green industry is a key step in the development of a green economy to support the government’s guidance and support for the sector (Li et al. 2022; Du et al. 2022). Consequently, green financing can be

used to accomplish comprehensive green growth as it assists in alleviating and assembling flexibility against the adverse consequences of environmental changes (Prajapati et al. 2021).

All the financial institutions were ordered to provide green products to support sustainable development. This investment strategy will help achieve the UN SDGs, especially SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), and SDG 13 (climate action) (Desalegn and Tangl 2022). From previous literature, it was found that green finance is termed sustainable finance (Salazar 1998; Liu et al. 2015; Lindenberg 2014; Ghosh et al. 2022; Alshater et al. 2021), and socially responsible investment by (Diener and Habisch 2022; Martí-Ballester 2015), ESG finance by (Gillan et al. 2021; Giese et al. 2019; Van Duuren et al. 2016). This study addresses the following research questions:

1. What are the current trends in research publications on green finance?
2. What publications and papers have the most impact on green finance research?
3. Which organizations, nations, and authors most frequently contribute to the field of green finance?
4. What are the primary subject areas and keywords for study in green finance?
5. What are the recent issues and challenges in green finance?
6. What areas of green finance research will be pursued in the future?

#### *Objectives of the Study*

The objective of the paper is to analyze the current trends in green finance along with details of publications, organizations, countries/nations, and the highest cited authors. The purpose is also analysis which area and keywords will be highlighted in the green finance field and address the issues and challenges.

The current paper's structure will showcase the many sections, which will be displayed as follows: The introduction to green finance is already presented in Section 1, which mentioned the background of the study and addressed the research questions and objectives. Section 2 will be covered the methodology part. The detailed analysis and discussion will be explained in Section 3, which will cover the year and no. of publications, different types of documents, subject area, most influential articles, different journal sources, co-authorship of countries, and co-occurrence of keywords of green finance. The findings will be shown in Section 4. The conclusion will be presented in Section 5 which includes the Limitations, Implications, and Recommendations of the study. The last section will wrap up this paper with the specified references.

## **2. Methodology**

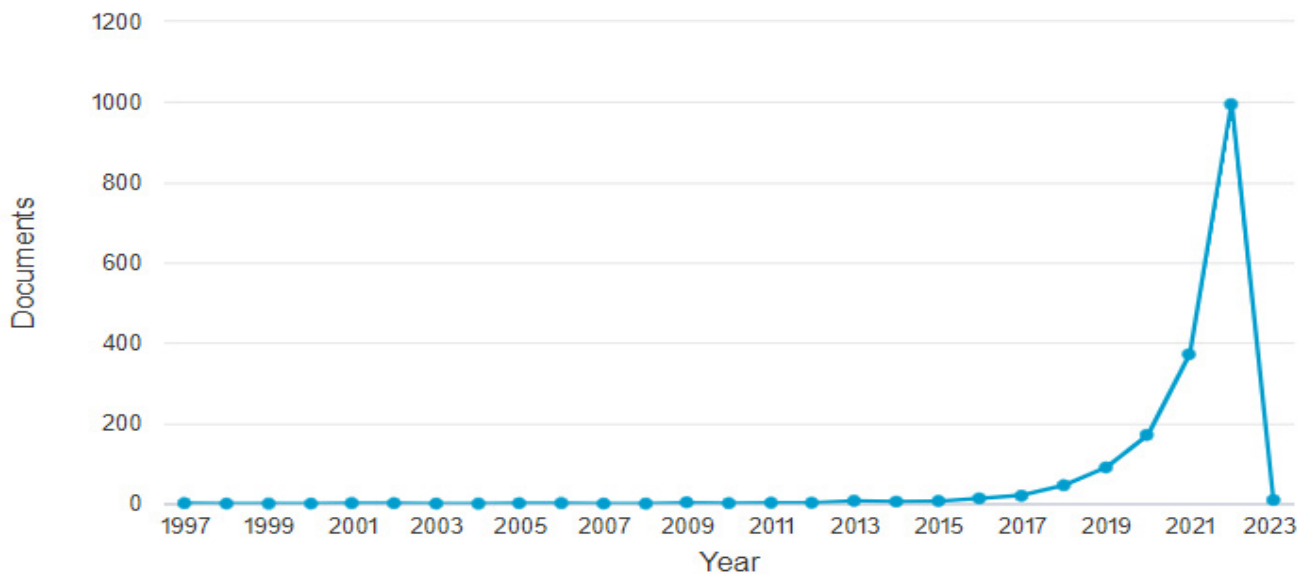
SCOPUS is one of the most popular and broadly involved academic databases that provides leading journal articles, references, and publication details for research and development. Thus, in the present study, SCOPUS was used for the literature survey and analysis. The retrieval strategies are as follows: Database = SCOPUS; Topic search = 'Green Finance'; Period of study = 1997 to 2023 (collected data from SCOPUS on 1 November 2022, only 9 papers of 2023 are registered). We got 1748 document results for our study. Publication outcomes were exported in text form, including citation information, bibliographic information, abstracts, and keywords.

This study breaks down the fundamental features of green finance publications predominantly from two perspectives: (1) the primary highlights, that is, the efficiency and impact of publications in light of certain bibliometric pointers such as the total no. publications (TP) and no. of citations (TC), the average citations per publication (AC), and h-index according to the viewpoint of sources, authors, countries/nations, and organizations/affiliations; (2) this paper utilize Vosviewer to introduce the visualization network, which is useful to notify the research areas of interest and improvement patterns (Wang et al. 2020; Chen and Liu 2020).

### 3. Analysis and Discussion

#### 3.1. Analysis Based on Documents

Figure 1 shows the number of publications based on the year of publication. Green Finance papers were published in 1997. As per the analysis of documents by year, it was observed that the highest number of publications was published in 2022, with 995 documents, followed by 2021 and 2020, with 373 and 171 documents, respectively. To date, it has been observed that by 2023, nine papers will be published in SCOPUS-based journals. As per the publication trend, the number of green finance papers has increased tremendously and will also grow in the near future.



**Figure 1.** Documents by year. (Extracted from SCOPUS).

As indicated by SCOPUS, we have obtained a wide range of green finance publications. Figure 2 illustrates the eight different types of documents. It demonstrates that the majority of publications are from articles with 1539, which accounts for 88.0% of all records, followed by 81 review paper publications, representing 4.6%; 64 and 52 of them are conference papers and book chapters, respectively. Of the total publications, four were books, four were notes, two were editorials, and two were short surveys, accounting for 0.2%, 0.2%, 0.1%, and 0.1%, respectively. Articles are popular choice for researchers in this field.

Figure 3 demonstrated the top 10 universities in which green finance-related papers are published.

According to the data, it was observed that the top universities published  $\geq 25 \leq 50$  papers. Jiangsu University got the 1st rank in green finance publications, accounting for 48 documents, followed by the Beijing Institute of Technology and the University of Economics Ho Chi Minh City, with 42 and 33 no. of publications. This was followed by Tokai University (32), City University of Macau (29), Nanchang University (28), Southwestern University of Finance and Economics (28), Xiamen University (27), China University of Mining and Technology (27), and Qingdao University (26).

Table 1 Lists the top 10 subject areas of green finance that involve “Environmental Science” (1048 publications which occupy 59.95% of total publications); “Energy” (632, 36.16%); “Social Science” (549, 31.40%); “Economics, Econometrics, and Finance” (487, 27.86%); “Business, Management and Accounting” (321, 18.36%); “Engineering” (281, 16.08%); “Computer Science” (134, 7.67%); “Earth and Planetary Sciences” (76, 4.35%); “Mathematical methods in social science” (69, 3.95%); “Arts and Humanities” (67, 3.83%).

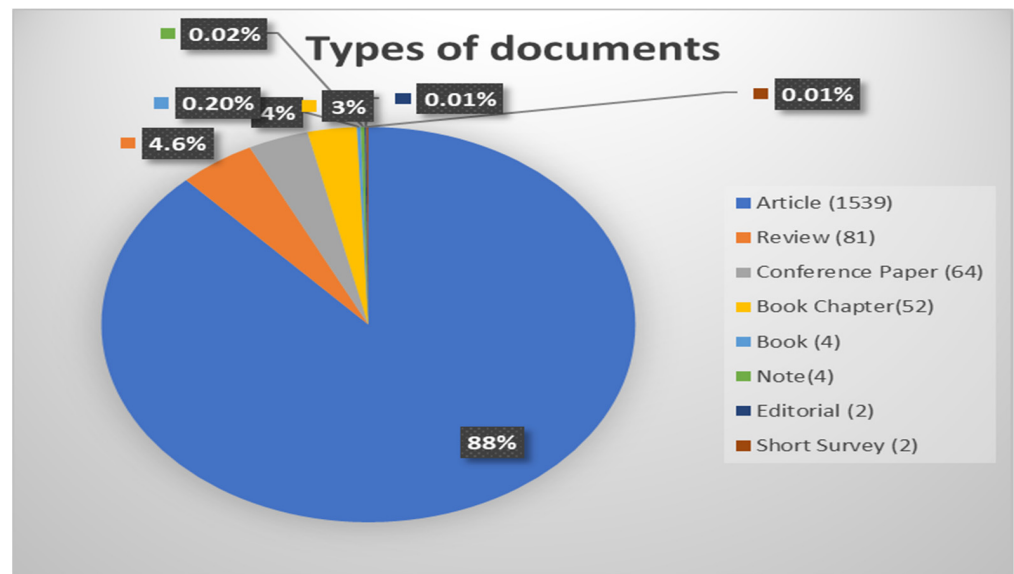


Figure 2. Types of documents published. (Extracted from SCOPUS).

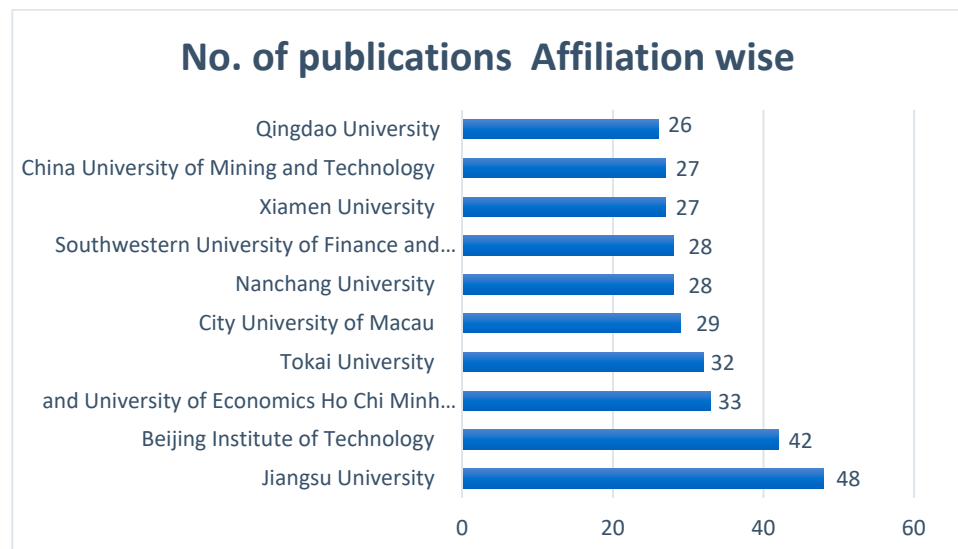


Figure 3. Paper publications based on affiliation. (Extracted from SCOPUS).

We can see that several topics, particularly “Environmental Science,” “Energy,” “Social Science,” “Economics, Econometrics and Finance,” and “Business, Management, and Accounting” are relevant to the research topic of green finance. Due to the fact that numerous scientific study outputs have examined green finance from multiple angles, it may be multidisciplinary.

The top ten influential articles have shown the details of authors, sources, countries, periods, citations, and keywords in Table 2.

Table 2 reveals that out of the top 10 papers, two papers were published in the Finance Research Letters in the year 2019, the Journal of Cleaner Production also 2 publications in 2019, and two papers were from the Journal of Environmental Management was published in 2011 and 2021, respectively. The title “The way to induce private participation in green finance and investment” is the highest cited article in the field of green finance research which has published in 2019 by Taghizadeh-Hesary and Yoshino and it’s citation 233. “Public spending and green economic growth in BRI region: Mediating role of green finance” is another highest cited paper, published by Zhang et al. in the year 2021 with 186 citations and so on. These ten papers were drawn from a highly diverse range of sources,



highlighting the subject’s interdisciplinary aspect once again. This information will benefit researchers in analyzing the highest-cited papers on green banking and keyword analysis, which will lead to meaningful research shortly.

**Table 1.** Information about subject areas in green finance: document basis.

Subject Areas	TP	TP%
Environmental Science	1048	59.95%
Energy	632	36.16%
Social Sciences	549	31.40%
Economics, Econometrics and Finance	487	27.86%
Business, Management and Accounting	321	18.36%
Engineering	281	16.08%
Computer Science	134	7.67%
Earth and Planetary Sciences	76	4.35%
Mathematical methods in social science	69	3.95%
Arts and Humanities	67	3.83%

(Extracted from SCOPUS). TP = total no. of publications and TP% = % of the total number of publications.

**Table 2.** Most influential articles on green finance.

Rank	Authors Name	Titles	Source Titles	Total Citation	Keywords	Methodology Applied
1	<a href="#">Taghizadeh-Hesary and Yoshino (2019)</a>	The way to induce private participation in green finance and investment	Finance Research Letters (Netherlands)	233	Distributed ledger technology; Energy finance; Green credit guarantee scheme; Green finance; Sustainable development goals (SDGs)	Spillover tax revenue model and Credit guarantee premium scheme
2	<a href="#">Zhang et al. (2021)</a>	Public spending and green economic growth in BRI region: Mediating role of green finance	Energy Policy (United Kingdom)	186	Belt and road initiative; Generalized method of moments; Green public finance; Radial direction distance function; Sustainable green finance	Generalized method of moments (GMM) method and data envelopment analysis (DEA)
3	<a href="#">Shen et al. (2021)</a>	Do green investment, financial development, and natural resources rent limit carbon emissions? A provincial panel analysis of China	Science of the Total Environment (United Kingdom)	160	China; CS-ARDL; Financial development; Green investment; Natural resources rent	Cross-sectionally augmented autoregressive distributed lags (CS-ARDL)
4	<a href="#">Zhang et al. (2019)</a>	A bibliometric analysis on green finance: Current status, development, and future directions	Finance Research Letters (Netherlands)	151	Bibliometric analysis; Climate change; Green finance	Bibliometric analysis
5	<a href="#">Zhang et al. (2011)</a>	Tracking the implementation of green credit policy in China: Top-down perspective and bottom-up reform	Journal of Environmental Management (United States)	150	Banking sector; Environmental responsibility; Environmental risk management; Green credit; Policy implementation	Theory of policy implementation

**Table 2.** *Cont.*

Rank	Authors Name	Titles	Source Titles	Total Citation	Keywords	Methodology Applied
6	Mohsin et al. (2021)	Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies	Journal of Environmental Management (United States)	147	Asian economies; Econometric model; Environment management; Greenhouse gasses; Renewable energy; Sustainability	Random Effect (RE) approach and Hausman Taylor Regression (HTR)
7	He et al. (2019)	Green credit, renewable energy investment, and green economy development: Empirical analysis based on 150 listed companies in China	Journal of Cleaner Production (United Kingdom)	145	Green credit; Green economy development index; Renewable energy investment; Threshold effect	Green economy development index
8	Wang and Zhi (2016)	The Role of Green Finance in Environmental Protection: Two Aspects of Market Mechanism and Policies	Energy Procedia (United Kingdom)	145	green finance; market mechanism; policies; renewable energy	Market mechanism approach
9	Taghizadeh-Hesary and Yoshino (2020)	Sustainable solutions for green financing and investment in renewable energy projects	Energies (Switzerland)	129	Community-based trust funds; Green credit guarantee scheme; Green finance; Green investment; Renewable energy	Spillover tax revenue model and Credit guarantee premium scheme
10	Gianfrate and Peri (2019)	The green advantage: Exploring the convenience of issuing green bonds	Journal of Cleaner Production (United Kingdom)	121	Climate change; Fixed income; Green bonds; Propensity score; Responsible investment; Sustainability	Propensity score matching approach

**3.2. Analysis Based on Sources**

Table 3 showcases the top-10 prolific journals on green finance with their few metrics such as TP total no. of publications (TP), % of total no. of publications (TP%), the total citation (TC), the average citation per publication (AC), h-index and total link strength. From the above Table, it found that according to country wise both the United Kingdom and the Netherlands have an equal source of publications i.e., 3 sources of each country out of 10 and followed by the United States with 2 productive journals. Sustainability (Switzerland) is published 218 papers which is found the highest paper-published journal on green finance and followed by the Environmental Science and Pollution Research and The Journal of Cleaner Production with 180 and 58 no. of documents. Out of the overall publications, these 3 journals scored 26.0,9% and the rest was done by the other journals. It is also found that Environmental Science and Pollution Research is the highest cited journal which has 1824 citations, followed by Sustainability (Switzerland) with 1670 and the Journal of Cleaner Production with 1448 citations. Based on average citations, the following 3 journals have got the highest rank. Such as the Finance Research Letters (AC = 36.95 and TP = 22), the Energy Policy (AC = 35.19 and TP = 32), and the Journal of Environmental Management (AC = 31.33 TP = 43). The Energy Policy has the highest no. of h-index i.e., 234 followed by the Journal of Cleaner Production (232) and the Ecological Economics

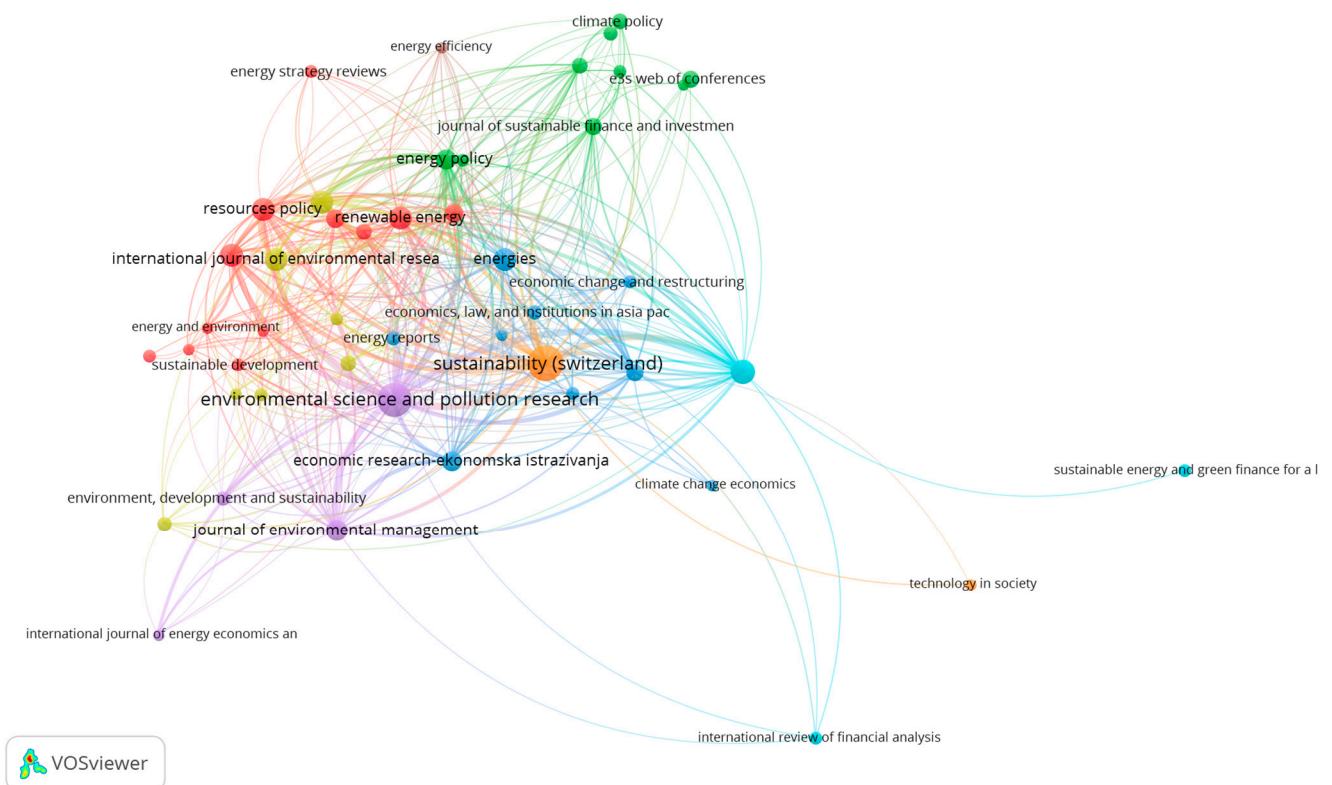


(220). As per the overall analysis, Environmental Science and Pollution Research have the most connected journal of green finance research with 810 total strength links. Figure 4 it is mentioned that economic modeling, climate change economics, and technology society have few no. of publications in this field.

**Table 3.** Top-10 Productive Journals on green finance research.

Rank	Source	Country	TP	TP%	TC	AC	h-Index	Total Link Strength
1	Sustainability (Switzerland)	Switzerland	218	12.47	1670	7.66	109	537
2	Environmental Science and Pollution Research	Germany	180	10.29	1824	10.33	132	810
3	Journal of Cleaner Production	United Kingdom	58	3.31	1448	24.97	232	384
4	Renewable Energy	United Kingdom	50	2.86	487	9.74	210	192
5	Energy Economics	Netherlands	47	2.69	781	16.62	168	254
6	Journal of Environmental Management	United States	43	2.46	1347	31.33	196	278
7	Energy Policy	United Kingdom	32	1.83	1126	35.19	234	264
8	Technological Forecasting and Social Change	United States	28	1.6	431	15.39	134	94
9	Finance Research Letters	Netherlands	22	1.26	813	36.95	62	223
10	Ecological Economics	Netherlands	16	0.92	390	24.38	220	76

TP = total no. of publications and TP% = % of the total number of publications. of publications; TC, total number of publications of citations; AC, average citations.



**Figure 4.** Citations wise sources.

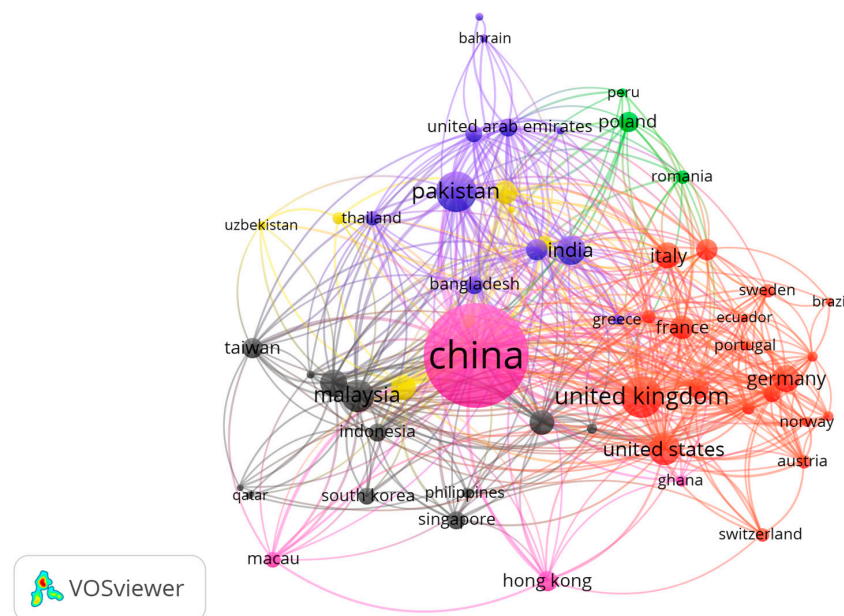
### 3.3. Analysis Based on Country

The geographic distribution of publications can be determined by examining the distribution of the nations that publish in this field. From Table 4, it is evident that China, with 957 articles, has produced the most scholarly papers on the subject of green finance, accounting for 54.57% of the total publications from 1997 to 2023. This was followed by the United Kingdom (155) and Pakistan (144), accounting for 8.87% and 8.24% of the total publications, respectively. Apart from TP, total citations (TC) are more frequent in China (10,519 times), followed by Pakistan (2541) and the United Kingdom (2105 times). AC was more prevalent in Japan (25.59) and Vietnam (20.28), followed by other countries. China published the most articles on the topic, had the strongest links, and amassed the most knowledge in the area, as shown in Figure 5.

**Table 4.** Co-authorship of country wise.

Country Name	TP	TP%	TC	AC	Total Link Strength
China	957	54.75	10,519	10.99	591
United Kingdom	155	8.87	2105	13.58	198
Pakistan	144	8.24	2541	17.65	300
Malaysia	98	5.61	1720	17.55	171
United States	91	5.21	1047	11.51	145
India	77	4.41	633	8.22	68
Germany	64	3.66	716	11.18	93
Viet Nam	64	3.66	1289	20.28	113
Italy	60	3.43	934	15.57	57
Japan	58	3.32	1484	25.59	82

TP = total no. of publications and TP% = % of the total number of publications. of publications; TC, total number of publications of citations; AC, average citations.



**Figure 5.** Co-authorship of country.

There are six clusters, and each cluster encompasses nations that undertake studies in a specific area or sub-area of green finance. In VOSviewer, the closer the two countries are to one another, the stronger is their relationship. A thicker line indicates a strong link and similarity between the two countries. In our study, China had a strong link and similarities to Pakistan, the United Kingdom, the United States, Taiwan, Macau, and Hong Kong. Countries such as China, Malaysia, Pakistan, Macau, and Turkey have recently joined a

group of nations that publishes green financing. From the VOSviewer result (Figure 5) shows that in cluster 4, China had connections with 54 countries and its total link strength was 575. However, there are a few counties such as Brunei Darussalam, Chile, Denmark, Iceland, North Macedonia, the Syrian Arab Republic, and Uganda, where green finance has less popular and very few studies have been done. Moreover, the countries such as China, Malaysia, Pakistan, Macau, Saudi Arabia, Bangladesh, and Turkey have recently joined a group of nations that publishes green financing.

It is vital to note that nations with no participation are automatically removed from the network. The co-authorship between nations is indicated by the lines linking the points visible on the network map, and the proximity among the clusters reflects the volume of publications and the strength of co-authorship between the nations. This provides a comprehensive picture of how well various nations collaborate on green finance-related matters.

### 3.4. Analysis Based on Keywords

Table 5 lists the 20 most popular keywords in this field of study. The top three themes in the literature were green finance, sustainable development, and sustainability. Green finance promotes the sustainable development of the economy, and it is obvious that this is a topic that pertains to sustainability. A visual representation of the co-occurrence of the authors' keywords and all keywords is shown in Figures 6 and 7, respectively. As per the analysis of the author's keywords from Figure 6, it is observed that the "green intellectual capital", "carbon emission efficiency", and "green bank" had fewer occurrences and the highest occurrences in "green finance", "sustainable development" and "sustainability". However, all keywords network analysis has also shown in Figure 7 where "green finance" and, "sustainable development" along with carbon emission, environmental economics, economic development, and ecological innovation was found highest occurrences and less in "sustainable investment", "low-carbon finance", "low-carbon investment". The study of keywords revealed significant data that can be utilized to explain the basic aspects of green finance. Green policy implications should govern green finance because it is linked to green investment, green growth, and climate variability. The focus areas revolve around financial development through sustainable finance, climate finance, investment in green bonds, and green innovation. Econometricians and financial economists must contribute to the field of green finance as well as to environmental economists and scientists to achieve sustainability.

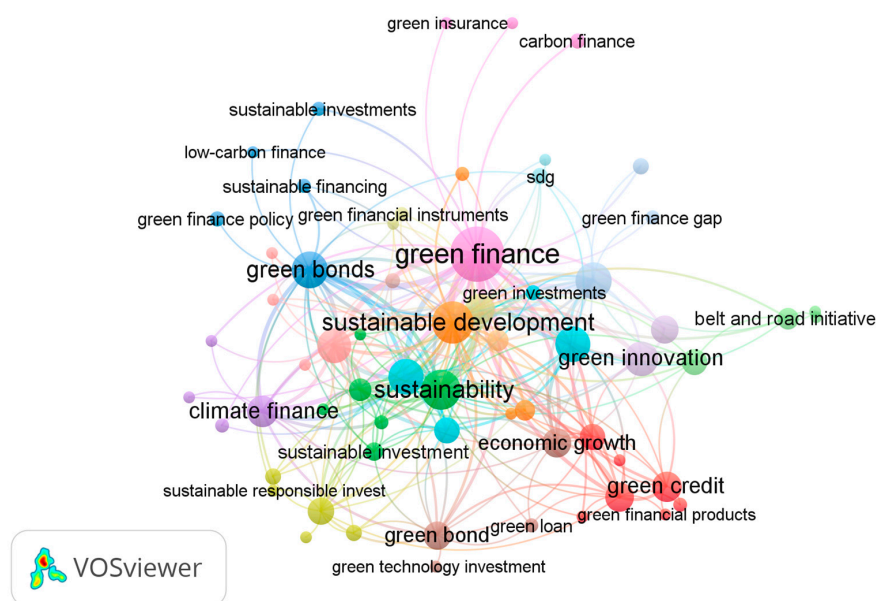


Figure 6. Co-occurrence of author's keywords.

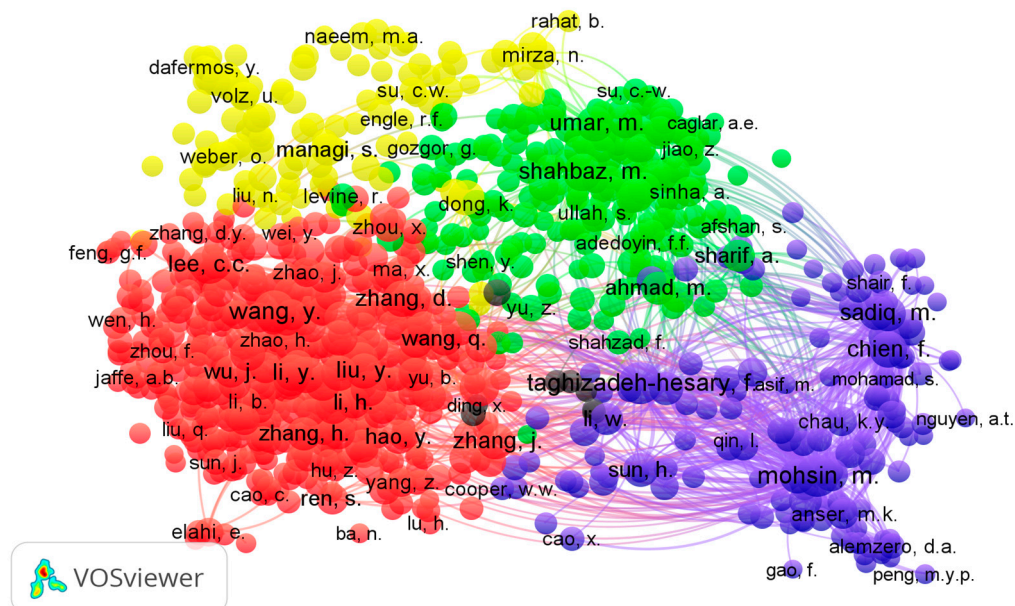




**Table 6.** Co-citations of authors’ analysis.

Author	Citations	Total Link Strength
Mohsin, M.	1168	171,638
Wang, y.	1167	107,954
Taghizadeh-hesary, F.	1161	117,596
Zhang, Y.	875	99,030
Lee, C.C.	768	74,726
Shahbaz, M.	677	79,450
Li, Y.	639	63,731
Zhang, J.	634	75,145
Chien, F.	632	103,087
Zhang, D.	618	55,358

When the authors of two publications receive a citation from the same author in a third document, it is known as a co-citation network of authors (Baber and Fanea-Ivanovici 2022). Consequently, co-citations jointly determine the number of documents cited. When conducting a co-citation analysis, the ‘cited authors’ unit of analysis can be used to determine the most significant (Galletta et al. 2022). Table 6 contains the supporting numerical information for this analysis. Based on our experience, five major clusters were identified, as shown in Figure 8. Cluster 1 (red) which consisted of 483 cited authors, cluster 2 (green) which consisted of 234 cited authors, cluster 3 (blue) consisted of 139 cited authors, cluster 4 (yellow) and cluster 5 (black) consisted of 131 cited authors and 13 cited authors, respectively. The outcomes of cited authors we got from VOSviewer while considering 1000 as the minimum no. of citations of an author. In addition, the top 2 cited authors of each cluster were listed below. The red cluster (Top authors: Lee, Zhang), green cluster (Top authors: Shahbaz, Charfeddine), blue cluster (Top authors: Taghizadeh-hesary, Mohsin), yellow cluster (Top authors: Yoshino, Managi), and black cluster (Top authors: Ding, Shahzad).



**Figure 8.** Co-citations of authors’ networks.

### 3.6. Analysis Based on Issues and Challenges in Green Finance

Apart from this, various issues and challenges regarding green finance have also been noticed in existing studies. Different countries have highlighted their critical issues and challenges in financing green projects. For example, mismatched interests of investors, high borrowing costs, and counterfeit assurances of environmental compliance are some

challenges faced by Indian investors while investing in green finance (Chhaochharia 2021). Green financing in China confronts four primary difficulties. Such as the absence of policy directives, a lack of capacity building, unsuitable financing terms for long-term projects, and the absence of a general definition for “green assets” (Lee 2020). From the perspective of Malaysian bankers, the feasibility of the project to be funded, a lack of a track record, and a lack of familiarity with green technology are the top three key obstacles to the success of green technology financing (Amran et al. 2018). The study findings of Zheng et al. (2021) also suggested that the substantial barriers to the growth of green finance in Bangladesh include a high default culture, operational self-sufficiency, lack of proper legal responsibilities, inaccurate evaluation of loan applications, and a lack of effective accountability and transparency and inadequate corporate governance. The following issues are also examined from the study of Fedorova (2020) as being specific to green finance: discrepancies in the interpretation of the terms “green finance” and “green economy sectors,” challenges in measuring and evaluating the external effects of green finance, institutional barriers to the growth of green finance, information asymmetry, and issues with the prediction of credit and market risks.

#### 4. Findings

According to the 1st research question, there is a noticeable increasing trend in the number of documents indicating that interest in the study of green finance performance is growing. The number of publications and citations has rapidly increased.

To assess the 2nd research question, the top ten authors and journals with their parameters are shown in Tables 2 and 3, respectively. “The way to induce private participation in green finance and investment” was found to be the most trending paper which has been published in the Journal of Finance Research Letter and Sustainability (Switzerland) and secured the top most published journal with 218 publications.

According to the 3rd research question, Jiangsu University (China) contributes the most to green finance. As shown in Table 4 and Figure 5, China has published the most publications, the strongest connections, and accumulated the most expertise in the green finance field. The author is a significant player in demonstrating the research potential and assessing the development of an academic issue (Baber and Fanea-Ivanovici 2022). The evaluation of the author’s collaboration demonstrated the subject’s potential for further studies related to green finance. Mohsin, M, Wang, Y, and Taghizadeh-Hesary, F are the most cited authors from the outcomes of authors’ co-citation network analysis in the green finance paper with citations of 1168, 1167, and 1161, respectively, as figured out in Table 6 and Figure 8. During the investigation, it was discovered that many authors prefer to collaborate with a small number of people, leading to many significant author groups from 1997 to 2023.

As per subject area studies, it is observed from Table 1 that Environmental Science (1048), energy (632), and Social Sciences (549) have the greatest impact on green finance research, contributing 59.95%, 36.16%, and 31.40%, respectively, from the total publications. It is also found that shortly “Economics, Econometrics, and Finance,” and “Business, Management, and Accounting” areas will play a prominent role in this field of research.

A network map of the authors’ keywords (Figure 6) and all keywords (Figure 7) will be beneficial to academics for a detailed analysis of the green finance field. As per the outcomes from VOSviewers, more studies have been conducted using the keywords sustainable finance and sustainability. “Green financial products,” “green innovation performance,” “green insurance,” “green finance gaps,” “green bank,” “green credit rating” and others are a few keywords that fewer studies have done. If researchers work in this area, they are likely to obtain meaningful outcomes shortly. It is also inferred from the prior literature that different countries experience some common issues and challenges while investing in green finance. Such as the definition of green finance, technical issues in green technology adoption, inaccurate assessment of loan applications, policy framework, and legal compliances of green finance (Chhaochharia 2021; Lee 2020; Zheng et al. 2021).



## 5. Conclusions

Green finance enables business in the market. The main driver of economic sustainability is the growth of the green industry. Power generation, ecological sustainability, cleaner production, and renewable energy companies have all grown as a result of green investment (Du et al. 2022). This study used a fundamental bibliometric methodology to evaluate the status and development of scholarly work on green finance. This analysis consisted of a total of 1748 publications. In order to conduct the network analysis, data were taken from the SCOPUS and entered into the VOSviewer program. This study focused on six research questions. Information was gathered to examine the research questions and network maps were applied. From the bibliometric analysis and findings, it is observed that green finance has broader aspects. It is also noticed that the trend of publication in this field has been increasing faster and China has placed a remarkable position for publication of the highest cited documents. This paper has also emphasized the issues and challenges. Moreover, the overall paper will give pertinent knowledge to other researchers to study in this field.

Few limitations in the study is faced which are outlined here. First, the SCOPUS data do not contain all relevant literature; therefore, the data in this study are not comprehensive. For doable research, other databases such as WoS, google scholar, and other methodologies such as SLR and other network analyses, such as the co-occurrence of index keywords, citations, co-citations of other parameters, and bibliometric coupling, can also be applied. Secondly, only articles and review papers were employed for the analysis; however, future research could concentrate on relevant books, book chapters and conference papers to widen the scope of the data.

The results provide some practical implications for financial companies, administrators, bankers, financiers, government officials, and investors to encourage green finance for the fulfillment of the country's sustainable development objectives (SDGs). Financial literacy in green finance is one of the keys to the inculcate public at a large. Thus, the government should take the initiative to provide information, coordinate efforts, encourage growth, and supervise green finance-related activities. To minimize the credit risk in green finance, the financial institutions should sanction loans to those investors which have good creditworthiness. Proper training should also be given to bankers, financiers, and practitioners about the operation of green technology and its applicability.

Risk and return are two major factors that affect the investor's financial decisions. Thus, further studies can be done on perceived financial risk and expected return on green finance instruments. Nowadays financial awareness plays a significant role. As per the current scenario, a demographical analysis of different countries of financial literacy on green finance could also be proven relevant studies in this field. Apart from these, further studies could be done on different countries' policies regarding green finance, and cross countries' green industries' financial performance. The above-mentioned studies can be done by applying different methodologies which will give meaningful results to researchers. Furthermore, the study may explore in green finance AI systems and blockchain analysis.

**Author Contributions:** Conceptualization, S.S.N.; methodology, S.M.; software, S.M.; validation, S.S.N. and S.M.; formal analysis, S.S.N. and S.M.; investigation, T.S.; resources, T.S.; data curation, V.N.S.; writing—original draft preparation, S.M.; writing—review and editing, V.N.S.; visualization, S.B.; supervision, S.B.; project administration, S.P. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

- Ahmad, Mahmood, Zahoor Ahmed, Yang Bai, Guitao Qiao, József Popp, and Judit Oláh. 2022. Financial inclusion, technological innovations, and environmental quality: Analyzing the role of green openness. *Frontiers in Environmental Science* 10: 80. [CrossRef]
- Alshater, Muneer M., Osama F. Atayah, and Allam Hamdan. 2021. Journal of Sustainable Finance and Investment: A bibliometric analysis. *Journal of Sustainable Finance & Investment* 1–22. [CrossRef]
- Amran, Azlan, Mehran Nejati, Say Keat Ooi, and Faizah Darus. 2018. Exploring Issues and Challenges of Green Financing in Malaysia: Perspectives of Financial Institutions. In *Sustainability and Social Responsibility of Accountability Reporting Systems*. Springer: Singapore, pp. 255–66.
- Baber, Hasnan, and Mina Fanea-Ivanovici. 2022. Fifteen years of crowdfunding—A bibliometric analysis. *Technology Analysis & Strategic Management* 1–15. [CrossRef]
- Bernabé Argandoña, Lorena Carolina, Salvador Cruz Rambaud, and Joaquín López Pascual. 2022. The Impact of Sustainable Bond Issuances in the Economic Growth of the Latin American and Caribbean Countries. *Sustainability* 14: 4693. [CrossRef]
- Berrou, Romain, Philippe Dessertine, and Marco Migliorelli. 2019. An overview of green finance. *The Rise of Green Finance in Europe* 3–29. [CrossRef]
- Chami, Ralph, Thomas F. Cosimano, and Connel Fullenkamp. 2002. Managing ethical risk: How investing in ethics adds value. *Journal of Banking & Finance* 26: 1697–718.
- Charfeddine, Lanouar, and Montassar Kahia. 2019. Impact of renewable energy consumption and financial development on CO<sub>2</sub> emissions and economic growth in the MENA region: A panel vector autoregressive (PVAR) analysis. *Renewable energy* 139: 198–213. [CrossRef]
- Chen, Qiuping, Bo Ning, Yue Pan, and Jinli Xiao. 2022. Green finance and outward foreign direct investment: Evidence from a quasi-natural experiment of green insurance in China. *Asia Pacific Journal of Management* 39: 899–924. [CrossRef]
- Chen, Xiaoyan, and Yisheng Liu. 2020. Visualization analysis of high-speed railway research based on CiteSpace. *Transport Policy* 85: 1–17. [CrossRef]
- Chhaochharia, Megha. 2021. Green Finance in India: Progress and Challenges. *Research Journal of Humanities and Social Sciences* 12: 223–26. [CrossRef]
- Desalegn, Goshu, and Anita Tangl. 2022. Enhancing Green Finance for Inclusive Green Growth: A Systematic Approach. *Sustainability* 14: 7416. [CrossRef]
- Diener, Joel, and André Habisch. 2022. Developing an Impact-Focused Typology of Socially Responsible Fund Providers. *Journal of Risk and Financial Management* 15: 298. [CrossRef]
- Ding, Xue, Wei Li, Dujuan Huang, and Xinghong Qin. 2022. Does Innovation Climate Help to Effectiveness of Green Finance Product R&D Team? The Mediating Role of Knowledge Sharing and Moderating Effect of Knowledge Heterogeneity. *Sustainability* 14: 3926.
- Du, Mo, Ruirui Zhang, Shanglei Chai, Qiang Li, Ruixuan Sun, and Wenjun Chu. 2022. Can Green Finance Policies Stimulate Technological Innovation and Financial Performance? Evidence from Chinese Listed Green Enterprises. *Sustainability* 14: 9287. [CrossRef]
- Ehlers, Torsten, and Frank Packer. 2017. Green Bond Finance and Certification. BIS Quarterly Review September. Available online: <https://ssrn.com/abstract=3042378> (accessed on 27 December 2022).
- Fedorova, Elena P. 2020. Role of the state in the resolution of green finance development issues. *Finansovyy zhurnal—Financial Journal* 4: 37–51. [CrossRef]
- Galletta, Simona, Sebastiano Mazzù, and Valeria Naciti. 2022. A bibliometric analysis of ESG performance in the banking industry: From the current status to future directions. *Research in International Business and Finance* 62: 101684. [CrossRef]
- Ghosh, Bikramaditya, Spyros Papanthasiou, Vandita Dar, and Dimitrios Kenourgios. 2022. Deconstruction of the Green Bubble during COVID-19 International Evidence. *Sustainability* 14: 3466. [CrossRef]
- Gianfrate, Gianfranco, and Mattia Peri. 2019. The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production* 219: 127–35. [CrossRef]
- Giese, Guido, Linda-Eling Lee, Dimitris Melas, Zoltán Nagy, and Laura Nishikawa. 2019. Foundations of ESG investing: How ESG affects equity valuation, risk, and performance. *The Journal of Portfolio Management* 45: 69–83. [CrossRef]
- Gillan, Stuart L., Andrew Koch, and Laura T. Starks. 2021. Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance* 66: 101889. [CrossRef]
- Hadaś-Dyduch, Monika, Blandyna Puszer, Maria Czech, and Janusz Cichy. 2022. Green Bonds as an Instrument for Financing Ecological Investments in the V4 Countries. *Sustainability* 14: 12188. [CrossRef]
- He, Lingyun, Lihong Zhang, Zhangqi Zhong, Deqing Wang, and Feng Wang. 2019. Green credit, renewable energy investment and green economy development: Empirical analysis based on 150 listed companies of China. *Journal of Cleaner Production* 208: 363–72. [CrossRef]
- Liu, Jingyu, Yan Xia, Shih-mo Lin, Jie Wu, and Ying Fan. 2015. Short-medium and long-term impact analysis of China's green credit policy based on financial CGE model. *Chinese Journal of Management Science* 23: 46–52.
- Lee, Chi-Chuan, and Chien-Chiang Lee. 2022. How does green finance affect green total factor productivity? Evidence from China. *Energy Economics* 107: 105863. [CrossRef]

- Lee, Jung Wan. 2020. Green finance and sustainable development goals: The case of China. *Journal of Asian Finance Economics and Business* 7: 577–86. [CrossRef]
- Leichenko, Robin, Karen O'Brien, and William Solecki. 2009. Climate change and the global financial crisis. *GECHS Synthesis Human Security in an Era of Global Change* 25: 25–52.
- Lindenberg, Nannette. 2014. Definition of Green Finance (15 April 2014). DIE Mimeo. Available online: <https://ssrn.com/abstract=2446496> (accessed on 27 December 2022).
- Lin, Lin, and Yanrong Hong. 2022. Developing a Green Bonds Market: Lessons from China. *European Business Organization Law Review* 23: 143–85. [CrossRef]
- Li, Yue, Ting Ding, and Wenzhong Zhu. 2022. Can Green Credit Contribute to Sustainable Economic Growth? An Empirical Study from China. *Sustainability* 14: 6661. [CrossRef]
- Martí-Ballester, Carmen Pilar. 2015. Investor reactions to socially responsible investment. *Management Decision* 53: 571–604. [CrossRef]
- Meher, Bharat Kumar, Iqbal Thonse Hawaldar, Latasha Mohapatra, Cristi Marcel Spulbar, and Felicia Ramona Birau. 2020. The effects of the environment, society and governance scores on investment returns and stock market volatility. *International Journal of Energy Economics and Policy* 10: 234–39. [CrossRef]
- Mehta, Pooja, Manjit Singh, and Manju Mittal. 2020. It is not an investment if it is destroying the planet: A literature review of socially responsible investments and proposed conceptual framework. *Management of Environmental Quality: An International Journal* 31: 307–29. [CrossRef]
- Mohsin, Muhammad, Hafiz Waqas Kamran, Muhammad Atif Nawaz, Muhammed Sajjad Hussain, and Abdul Samad Dahri. 2021. Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. *Journal of Environmental Management* 284: 111999. [CrossRef] [PubMed]
- Morano, Pierluigi, Francesco Tajani, and Debora Anelli. 2020. A decision support model for investment through the social impact bonds. The case of the city of Bari (Italy). *Valori e Valutazioni* 24: 163–78.
- Narayan, Paresh Kumar, Syed Aun R. Rizvi, and Ali Sakti. 2022. Did green debt instruments aid diversification during the COVID-19 pandemic? *Financial Innovation* 8: 1–15. [CrossRef]
- Naz, Farheen, Judit Oláh, Dinu Vasile, and Róbert Magda. 2020. Green purchase behavior of university students in Hungary: An empirical study. *Sustainability* 12: 10077. [CrossRef]
- Ngo, Quang-Thanh, Hoa Anh Tran, and Hai Thi Thanh Tran. 2021. The impact of green finance and COVID-19 on economic development: Capital formation and educational expenditure of ASEAN economies. *China Finance Review International* 12: 261–79. [CrossRef]
- Pizzi, Simone, Francesco Rosati, and Andrea Venturelli. 2021. The determinants of business contribution to the 2030 Agenda: Introducing the SDG Reporting Score. *Business Strategy and the Environment* 30: 404–21. [CrossRef]
- Prajapati, Dhaval, Dipen Paul, Sushant Malik, and Dharmesh K. Mishra. 2021. Understanding the preference of individual retail investors on green bond in India: An empirical study. *Investment Management and Financial Innovations* 18: 177–89. [CrossRef]
- Rizzello, Alessandro, Maria Cristina Migliazza, Rosella Carè, and Annarita Trotta. 2016. Social impact investing: A model and research agenda. In *Routledge Handbook of Social and Sustainable Finance*. London and New York: Routledge, pp. 102–24.
- Salazar, Jose. 1998. Environmental finance: Linking two world. Paper presented at A Workshop on Financial Innovations for Biodiversity Bratislava, Bratislava, Slovakia, May 1–3; vol. 1, pp. 2–18.
- Shahbaz, Muhammad, Qazi Muhammad Adnan Hye, Aviral Kumar Tiwari, and Nuno Carlos Leitão. 2013. Economic growth, energy consumption, financial development, international trade and CO<sub>2</sub> emissions in Indonesia. *Renewable and Sustainable Energy Reviews* 25: 109–21. [CrossRef]
- Shen, Yijuan, Zhi-Wei Su, Muhammad Yousaf Malik, Muhammad Umar, Zeeshan Khan, and Mohsin Khan. 2021. Does green investment, financial development and natural resources rent limit carbon emissions? A provincial panel analysis of China. *Science of the Total Environment* 755: 142538. [CrossRef] [PubMed]
- Sibanda, Mabutho. 2013. Financialization of Green Capital: A Panacea? *Mediterranean Journal of Social Sciences* 4: 371–71. [CrossRef]
- Soundarrajan, Parvadavardini, and Nagarajan Vivek. 2016. Green finance for sustainable green economic growth in India. *Agricultural Economics* 62: 35–44. [CrossRef]
- Taghizadeh-Hesary, Farhad, and Naoyuki Yoshino. 2019. The way to induce private participation in green finance and investment. *Finance Research Letters* 31: 98–103. [CrossRef]
- Taghizadeh-Hesary, Farhad, and Naoyuki Yoshino. 2020. Sustainable solutions for green financing and investment in renewable energy projects. *Energies* 13: 788. [CrossRef]
- Talan, Gaurav, and Gagan Deep Sharma. 2019. Doing well by doing good: A systematic review and research agenda for sustainable investment. *Sustainability* 11: 353. [CrossRef]
- Van Duuren, Emiel, Auke Plantinga, and Bert Scholtens. 2016. ESG integration and the investment management process: Fundamental investing reinvented. *Journal of Business Ethics* 138: 525–33. [CrossRef]
- Wang, Xinxin, Zeshui Xu, and Marinko Škare. 2020. A bibliometric analysis of Economic Research-Ekonomska Istra zivanja (2007–2019). *Economic research-Ekonomska istraživanja* 33: 865–86. [CrossRef]
- Wang, Yao, and Qiang Zhi. 2016. The role of green finance in environmental protection: Two aspects of market mechanism and policies. *Energy Procedia* 104: 311–16. [CrossRef]

- Zhang, Bing, Yan Yang, and Jun Bi. 2011. Tracking the implementation of green credit policy in China: Top-down perspective and bottom-up reform. *Journal of Environmental Management* 92: 1321–27. [[CrossRef](#)] [[PubMed](#)]
- Zhang, Dongyang, Muhammad Mohsin, Abdul Khaliq Rasheed, Youngho Chang, and Farhad Taghizadeh-Hesary. 2021. Public spending and green economic growth in BRI region: Mediating role of green finance. *Energy Policy* 153: 112256. [[CrossRef](#)]
- Zhang, Dayong, Zhiwei Zhang, and Shunsuke Managi. 2019. A bibliometric analysis on green finance: Current status, development, and future directions. *Finance Research Letters* 29: 425–30. [[CrossRef](#)]
- Zhang, Meihui, Chi Zhang, Fenghua Li, and Ziyu Liu. 2022. Green Finance as an Institutional Mechanism to Direct the Belt and Road Initiative towards Sustainability: The Case of China. *Sustainability* 14: 6164. [[CrossRef](#)]
- Zhang, Ning, Zhu Liu, Xuemei Zheng, and Jinjun Xue. 2017. The carbon footprint of China's belt and road. *Science* 357: 1107–7. [[CrossRef](#)] [[PubMed](#)]
- Zheng, Guang-Wen, Abu Bakkar Siddik, Mohammad Masukujjaman, Nazneen Fatema, and Syed Shah Alam. 2021. Green finance development in Bangladesh: The role of private commercial banks (PCBs). *Sustainability* 13: 795. [[CrossRef](#)]

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.