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# Green Bonds Research: A Structured Literature Review

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**ABSTRACT :** Using information from the Web of Science database and VOSviewer software, this study conducts a thorough bibliometric analysis to investigate the literature on green bonds. Amidst worldwide apprehensions over climate change and sustainability, green bonds have emerged as crucial financial tools for funding environmentally conscious initiatives. Green bonds are essential to the fight against climate change and the shift to a green economy because they raise the capital required for these initiatives. The study indicates future avenues for multidisciplinary research and emphasizes the significance of green bonds as levers for good change in sustainability and economic growth.

**Keywords –** climate change, green bonds, green finance

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## 1. INTRODUCTION

Green bonds have emerged as a crucial financial tool for funding environmentally friendly initiatives in the light of concerns about climate change and global sustainability. These are securities that are only being offered to raise money for environmental projects including waste management, energy efficiency, renewable energy, and sustainable infrastructure. The market for green bonds is expanding quickly, which indicates that governments and investors have changed their perspectives on how to finance sustainable development. But as this market develops, a number of difficulties appear, such as problems with effect assessment, standards, and openness.
Investors are always concerned about the possibility of greenwashing, and measuring the true impact of projects financed by green bonds is challenging due to the absence of a standardized regulatory and evaluation framework. To guarantee that funds are spent sensibly and efficiently, it is crucial to establish precise criteria and certification procedures.
Prior research on green bonds has looked at a number of topics, such as the effects on sustainability, financial performance, and market structure. Theoretical examination of the justification for issuing green bonds and empirical research on their effect on issuers' financial performance are included in the body of existing literature. The impact of these tools on sustainable investments and their contribution to the global climate objectives have been studied in other research. In her 2021 study, Caroline Flammer examined how well green bonds work to raise money for environmentally friendly initiatives.
Flammer (2021) draws the conclusion that the issue of green bonds is linked to notable advancements in the environmental performance of businesses, but he also stresses the necessity of precise guidelines and more openness to prevent greenwashing. Tang and Zhang's (2020) investigation looked at how issuing green bonds

affected shareholder value. They discovered that companies issuing green bonds saw a considerable boost in shareholder value, indicating that the market views these businesses' dedication to sustainability favorably. The significance of green bond certification and standardization was studied by Ehlers and Packer (2017). They draw the conclusion that certification lowers financing costs and boosts investor trust, but they also stress the necessity of worldwide standardization.

Examining studies that have employed bibliometric techniques is crucial to comprehending advancements and trends in the field of green bond research. These evaluations offer a thorough understanding of scholarly advancements and pinpoint important articles, writers, and publications. Using bibliometric analysis, Cortellini and Panetta (2021), carried out a systematic review of the literature. They determined the key areas of study, well-known writers, and networks in the field of green bonds. Their conclusions emphasize the necessity of precise guidelines and more openness in the reporting of environmental effects.
Bibliometric analysis was employed by Nanayakkara and Colombage (2019) to investigate the relationship between green bond issuance and Environmental, Social, and Governance (ESG) performance. They discover that companies with excellent ESG performance are more likely to issue green bonds, and that these issuances have major positive effects on the company's finances and image. Gianfrate and Peri (2019) mapped the development of the green bond market and suggested future lines of inquiry using bibliometric analysis. Their conclusions highlight how crucial it is to create precise regulatory frameworks and foster global cooperation in order to enable this market's sustained expansion.

This work aims to do a systematic assessment of the literature on green bonds, evaluating and synthesizing previous research using bibliometric analysis. This study attempts to give a comprehensive picture of the present level of knowledge in this topic and to highlight future research paths by identifying the most significant works, authors, and journals. Additionally, the bibliometric analysis will make it possible to determine the temporal evolution of interesting themes and cooperation networks among scholars.
This work adds to the body of literature by offering a thorough and current summary of the findings about green bonds. The bibliometric approach may be used to map the academic landscape as well as pinpoint problems and gaps in the literature. The article will also include suggestions for future study, emphasizing areas that warrant more investigation as well as opportunities for creativity and advancement. As a result, this study advances theoretical understanding while also offering academics and practitioners in the field of green finance useful tools.

## 2. LITERATURE REVIEW

Upon reviewing the literature, it is evident that a substantial amount of study has been done on a number of topics related to green bonds, such as their financial performance, sustainability effects, and certification and regulatory frameworks. In addition, bibliometric approaches have been used in recent studies to investigate scholarly advancements in the discipline. The primary scholarly contributions are summarized in this study, emphasizing both accomplishments and knowledge gaps.

Green bonds have been investigated from a number of angles, including effects on sustainability and financial performance. Karpf and Mandel (2018), for instance, looked at whether issuers of green bonds profit monetarily from their issuance. Their findings indicate that investors are ready to accept a lower yield in exchange for funding green projects, as these bonds often have fewer financing costs than regular bonds. However, after examining how green bonds affect the environment, Baker et al. (2018) came to the conclusion that these financial instruments have a major positive influence on lowering carbon emissions and encouraging sustainable behaviors among issuing enterprises.

The regulation and certification of green bonds is another topic of interest in the literature. In this regard, the Climate Bonds Initiative (CBI) has been instrumental in establishing certification requirements that guarantee

the responsible use of the money obtained via the issuing of green bonds. Maltais and Nykvist (2020) underlined the significance of certification and showed that, as a result of heightened investor confidence, certified green bonds outperform non-certified green bonds in the market. This literature does, however, also point out the difficulties in achieving worldwide standardization, which would promote market comparability and transparency.

Bibliometric analysis offer important light on how the area of green bonds has developed academically. For instance, bibliometric analysis was carried out by Broadstock and Cheng (2019) to determine the primary areas of study and significant writers in the subject. Their analysis showed that the most common subjects in the literature are financial performance, environmental effect, and regulation. Additionally, they noted a notable rise in publications in recent years, which is indicative of increased scholarly interest in green bonds. Some studies, like the one by Reboredo (2018), have examined researcher collaboration networks using bibliometric analysis and emphasize the value of global cooperation in advancing green bond research.

The promotion of green bonds by government policies and institutional assistance has also been emphasized in the literature on the subject. For instance, Fatica et al. (2019) examined how legislative initiatives affected the growth of the European green bond market. They discovered that the issuing of green bonds was positively impacted by government backing in the form of tax breaks and advantageous laws, which aided in the market's explosive expansion. Likewise, Dorfleitner et al.'s (2013) study examined how banks and other financial organizations support green bonds, emphasizing how crucial public-private cooperation is to the financial product's success.

## 3. RESEARCH METHODOLOGY

This research uses a bibliometric approach to analyze the literature on green bonds. The article selection process and methodology applied are detailed below to ensure transparency and replicability of the study.
To identify relevant articles, we accessed the Web of Science database, known for its comprehensive coverage and rigorous indexing of academic articles. We selected a total of 717 articles published between 2012 and 2023 focused on the topic of green bonds. Articles were selected based on the following criteria:

a) Open Access: We included only "open access" articles to facilitate accessibility and reproducibility of results;

b) Topic Categories: Articles were selected from the following categories:" Environmental Sciences" OR" Business Finance" OR" Environmental Studies" OR" Economics" OR" Management" OR" Business" OR" International Relations".

c) Keywords: We used specific keywords to ensure the relevance of the articles: "environmental finance" OR "green bond" OR "green bond market" OR "greenium" OR "sustainable finance".

After collecting the articles, we used VOSviewer software version 1.6.20 to perform text mining and to map key terms and their connections. VOSviewer is a robust tool for bibliometric network analysis, allowing graphical visualization of the relationships between terms based on their co-occurrence in the corpus of literature analyzed.

Figure 1. TreeMap diagram - Web of Science categories by the number of articles in each domain

Source: Web of Science statistics, 2024

## 4. RESULTS AND DISCUSSIONS

Our bibliometric analysis provided a detailed picture of the conceptual structure and evolution of research in the field of green bonds. We identified the main research themes, influential authors and collaborative networks, providing a comprehensive perspective on this emerging field. Using VOSviewer facilitated a rigorous co-occurrence analysis of terms, highlighting key connections and contributing to a deeper understanding of the literature.

Table 1. Evolution of the published “green bonds” papers on Web of Science

| Publication Years | Record Count |
|---|---|
| 2023 | 201 |
| 2022 | 180 |
| 2021 | 150 |
| 2020 | 69 |
| 2019 | 56 |
| 2018 | 27 |
| 2017 | 13 |
| 2016 | 8 |
| 2015 | 7 |
| 2014 | 2 |
| 2013 | 3 |
| 2012 | 1 |

Source: Own data using Web of Science database, 2024

Based on data gathered through 2024, the Web of Science database's publication evolution of publications on "green bonds" shows a notable upsurge in scholarly interest in this area within the past ten years. Table 2, which shows the number of publications published yearly between 2012 and 2023, demonstrates this tendency.
There was only one paper on this subject published in 2012, which marked the start of the study of green bonds. The number of articles continued to be low in the next years, with only a few releases annually: three in 2013, two in 2014, and seven in 2015. This little rise is indicative of an early stage in the research process when green bonds were being considered as a viable financial tool for financing environmentally friendly initiatives.

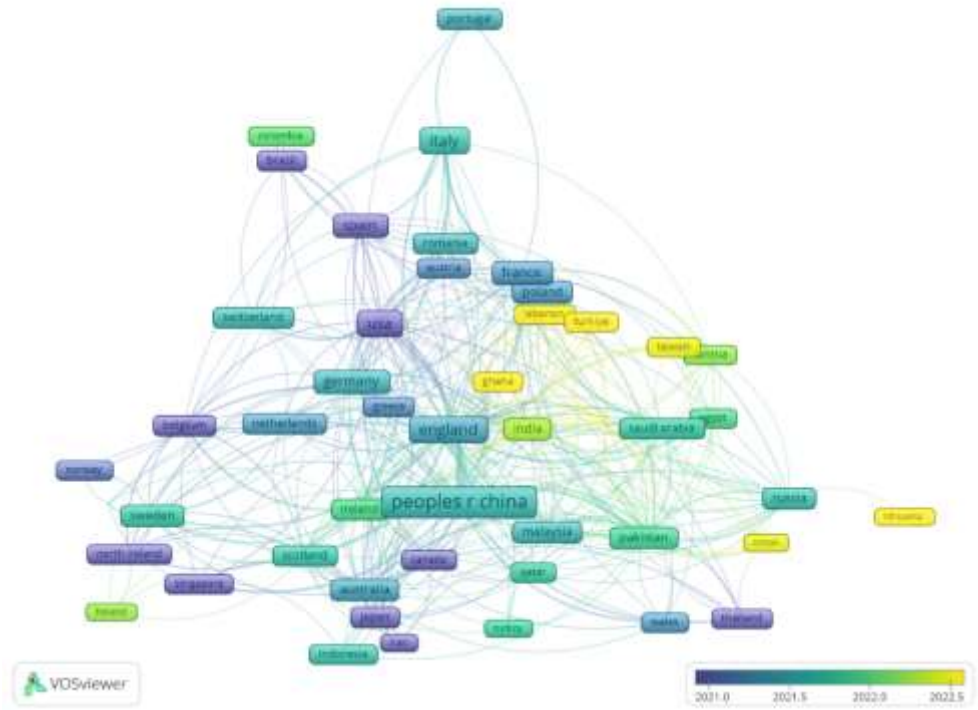
Eight articles were published in 2016 and thirteen in 2017, indicating a gradual rise in academic interest since 2016. This rise may be attributed to the increasing awareness of climate change and the necessity of funding environmental initiatives, as demonstrated by international initiatives like the 2015 Paris Agreement.

The trend continues in 2019 and 2020, with 56 and 69 articles, respectively, and becomes even more noticeable in 2018, when there are 27 pieces. The market for green bonds is expanding quickly at this time, and significant regulatory and standardization measures are being introduced, such as the International Capital Market Association's (ICMA) Green Bond Principles. Growing scholarly interest in green finance has also been facilitated by government and financial institution funding (Fatica et al., 2019).

With 150 publications released in 2021, there has been a significant uptick in the field's maturity and the increasing incorporation of green bonds into international financial strategy. With 180 and 201 papers, respectively, in 2022 and 2023, the rise is still there, demonstrating a burgeoning academic interest and an understanding of the significance of green bonds in the context of the shift to a sustainable economy.
The increasing number of symposia and conferences devoted to sustainable finance, together with the rise in research funds allotted to this field, are factors supporting this rising trend. Large financial organizations' and governments' adoption of green bonds has also sparked study in this field, including case studies and actual data for scholarly analysis (Maltais and Nykvist, 2020).

Figure 2's bibliometric map identifies the nations with the highest level of activity in the field of green bond research. This graphic depiction offers a thorough understanding of global cooperative networks and the impact of every nation in this field of research. The diagram's circles each represent a nation; the size of the circles denotes the quantity of publications, and the links between them show partnerships and reciprocal citations.

Figure 2. Bibliometric coupling of countries.




Source: Map create in VOSviewer (Authors' computation), 2024

With the strongest bibliometric connections to other nations, China is clearly the most productive country in the field of green bond research. This is mostly because of its sizable capital market and robust green bond

promotion programs from the government. For instance, China's stringent requirements for obtaining green bond designation have sparked a great deal of study and writing in this field.
The UK is the second most productive country in the world, as evidenced by the large number of worldwide publications and partnerships. This position is a result of substantial investment in sustainable projects and well-developed capital markets. In third position, the US is commended for both its supportive regulatory environment and its dedication to sustainable financing.

Notable Asian countries included on the bibliometric map include Japan and India. India highlights in several articles that it is interested in creating green bonds as a component of its sustainable financing plan. Japan maintains significant bibliometric linkages, showing partnerships and shared influences, despite having a lower number of publications than other top nations.
Europe is mostly represented by nations with sizable populations, including Germany, France, Italy, and Spain. These nations are renowned for their cutting-edge environmental regulations and vigorous financial market promotion of green bonds.
However, a few Latin American nations stand out for their attempts to include green financing into their plans for economic development, like Brazil and Colombia. Furthermore, an increasing number of Middle Eastern and African nations, including Saudi Arabia, Ghana, and Nigeria, are making an appearance in the field of green bond research, a sign of the potential for growth in these areas.
A crucial tool for comprehending the cooperative networks between these nations is bibliometric linkage. It happens when a third shared work, highlighting comparable issues and common research interests, is heavily cited in two papers from separate nations. The close ties between circles that symbolize various nations so point to close cooperation and scholarly interdependence in the advancement of our understanding of green linkages.

Table 2. The nations with the highest productivity in ”green bonds” research

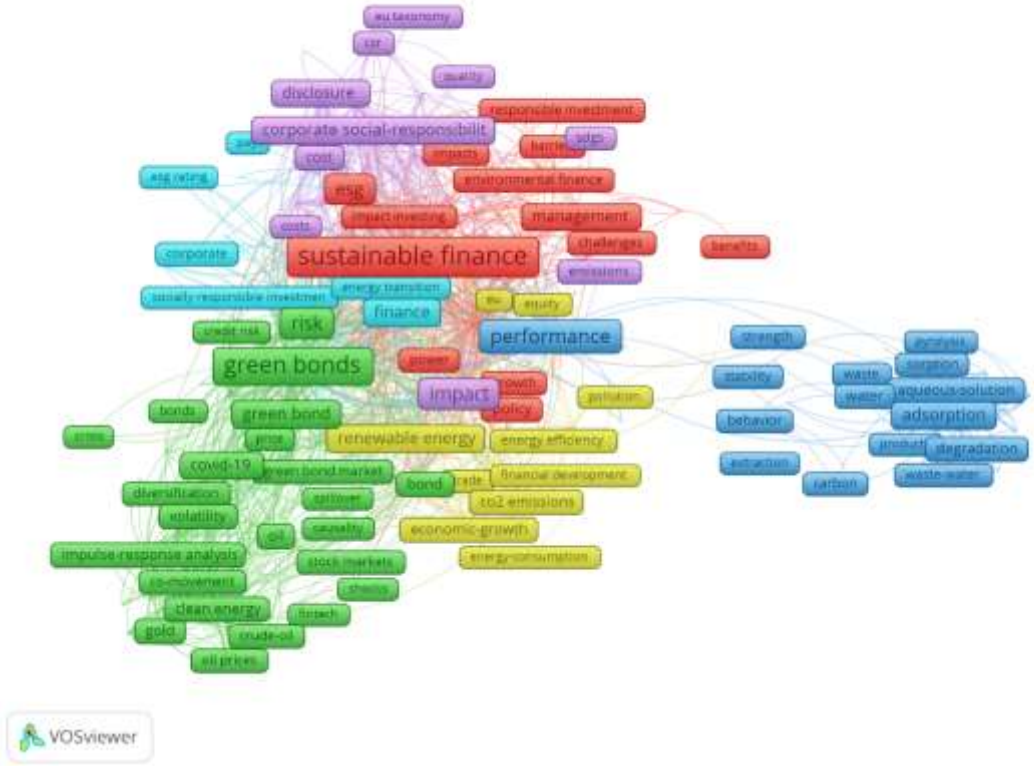
| Countries/Regions | Record Count |
|---|---|
| PEOPLES R CHINA | 171 |
| ENGLAND | 85 |
| USA | 72 |
| ITALY | 69 |
| FRANCE | 46 |
| SPAIN | 42 |
| GERMANY | 38 |
| INDIA | 32 |
| PAKISTAN | 29 |
| AUSTRALIA | 27 |
| POLAND | 27 |
| SWEDEN | 27 |
| MALAYSIA | 23 |
| RUSSIA | 23 |
| NETHERLANDS | 21 |
| SOUTH KOREA | 21 |
| IRELAND | 20 |
| JAPAN | 20 |
| VIETNAM | 20 |

Source: Own data using Web of Science database, 2024

The conceptual landscape and major topics in the literature on green bonds are depicted in depth in the keyword co-occurrence map created by the VOSviewer program. 213 of the 3798 terms in this research reached the

frequency requirement to be shown on the map. Each hue and cluster on the map denotes a set of terms that regularly appear together in literary publications, highlighting the main ideas and their connections (Figure 2).

Figure 2. Overlay visualization of keywords




Source: Map create in VOSviewer (Authors' computation), 2024

The green cluster concentrates on financial risk and green bonds. Phrases like "green bonds," "green bond market," "diversification," "covid-19," "credit risk," and "volatility" imply that evaluating the risks of investing in green bonds is very important, especially in light of large global economic upheavals like the COVID-19 pandemic. Research on green bonds and related topics including portfolio diversification and financial risk is reflected in this cluster.

Environmental, social, and governance (ESG) standards and sustainable financing are at the core of the red cluster. An increasing interest in responsible investment and the beneficial effects of finance on the environment and society is shown by terms like "sustainable finance," "ESG," "impact investing," "corporate social responsibility," and "environmental finance." This cluster focuses on how sustainable finance incorporates ESG criteria and investigates how investments might support sustainability goals.

Policy and performance related to the environment are covered under the blue cluster. Research on quantifying the effectiveness and energy efficiency of green bonds as well as their influence on emissions reduction and environmental performance is suggested by terms like "performance," "policy," "pollution," "CO2 emissions," and "energy efficiency." This cluster is devoted to evaluating the relationship between green bond investment performance and environmental legislation.

The yellow cluster highlights renewable energy and illustrates the connection between green bonds and economic development. The terms "economic growth," "renewable energy," "energy consumption," "bond," and "trade" refer to research that looks at the ways in which investments in clean and efficient energy may support economic growth through the use of green bonds. The significance of green bonds in fostering economic expansion and the switch to renewable energy sources is emphasized by this cluster.

The challenges of environmental chemistry and technology are the focus of the light blue cluster. Words like "degradation," "adsorption," "waste-water," "carbon," and "strength" imply studies on technology for cleaning and treating water as well as the adsorption of contaminants. With a focus on studies pertaining to environmental processes and pollution remediation, this cluster is highly technical.

## 5. CONCLUSION

The study offered a thorough analysis of the literature on green bonds, evaluating and synthesizing previous studies through the use of bibliometric techniques. An exponential rise in scholarly interest in green bonds was observed in the study of article publishing patterns, which began in 2012 and peaked in 2023. This pattern illustrates the necessity of a concerted effort to combat climate change as well as the increasing significance of green bonds in sustainable financing.

With the most publications and the best international collaboration linkages, China, the United States, and the United Kingdom are leading the way in green bonds research, according to the country bibliometric map. This cooperative network highlights how important international collaborations are to the advancement of knowledge and successful use of green bonds in global markets.

The thematic structure of research on green bonds was uncovered by the keyword co-occurrence map, which identified five main clusters: financial risk and portfolio diversification, environmental performance and policy, sustainable finance and ESG criteria, economic development and renewable energy, and environmental technologies. These clusters demonstrate the diversity and breadth of issues covered by the literature, which reflects the complexity and interconnection of the field's study.

We were able to map important concepts and assess the degree of relationships between them using the VOSviewer program, which gave us a clear image of the conceptual terrain of green linkages. We were able to pinpoint gaps in the literature and suggest new lines of inquiry thanks to our methodology. These objectives include the requirement for worldwide certification criteria harmonization, an examination of the long-term effects of green bonds, and multidisciplinary research that integrates social, environmental, and financial elements.

Green bonds are a crucial financial tool for the shift to a sustainable economy, to sum up. With the potential to significantly aid in the fight against climate change and advance sustainable economic growth, research in this field is flourishing. Our study offers a thorough and current synthesis of the literature, emphasizing the value of cross-border partnerships and multidisciplinary thinking in the advancement of knowledge and successful application of green bonds.

**Examples follow**:

**Journal Papers:**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