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*Corresponding author: Sandeep S Shenoy, Professor and Head, Department of Commerce, Manipal Academy of Higher Education, Manipal, India
E-mail: sandeep.shenoy@manipal.edu

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Ana Maria Lopez Narbona, University of Malaga: Universidad de Malaga, SPAIN

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GENERAL & APPLIED ECONOMICS | REVIEW ARTICLE

A state-of-the-art overview of green bond markets: Evidence from technology empowered systematic literature review

Abhilash¹, Sandeep S Shenoy^{2*} and Dasharathraj K Shetty³

Abstract: Though the green bond markets are growing expeditiously, the summary overview of this market literature is sparse. This study addresses the gap by employing a bibliometric analysis through a systematic review of the literature approach and provides a state-of-the-art overview of the current trends, status, and future development of the green bond markets. To do so, the study reviewed 265 articles retrieved from the Scopus database spanning from 2011 to 2022. Akin to this, the study unpacks the publication trend, most influencing articles, prolific authors, top contributing journals, countries, as well as affiliations in green bond research. The review shows that the publication trend has surged exponentially with an annual growth rate of 55.12%. The study also reveals major themes such as sustainable development, sustainability, green bonds, sustainable finance, green finance, and sustainable investment. The findings of the study suggest curating future research with the main emphasis on multiple types of green bonds, the impact of various green projects, the attention of various market participants, and the incorporation of advanced technology for the development of the green bond market. The study will help policymakers, regulators, and academicians to promote sustainability.

Subjects: Sustainable Development; Finance; Business, Management and Accounting

Keywords: sustainable development; green bond; sustainable finance; green projects; bibliometric analysis; systematic literature review

1. Introduction

Climate change is a problem of humankind, and the parties of respective nations are required to maintain sustainable development for a healthy and eco-friendly economy. In line with these, the global-level Paris Accord corroborated the idea of the drastic reduction of global emissions to achieve the objective of climate risk (UNFCCC, 2015). The Conference of Parties held at Marrakesh

PUBLIC INTEREST STATEMENT

The severe problems of climate change engendered the promotion of sustainability with the introduction of 17 Sustainable Development Goals. In response to the achieve these goals, the investment avenues towards sustainability as estimated by the various authorities proved insufficient. Akin to this, the green bond a tool of sustainable finance has emerged to deploy private capital towards climate finance. Moreover, green bonds as fixed income debt security pledged their use-of-proceeds for green projects. The paucity of literature on this new promising market resulted in immaturity in the overall market development. However, this review provides an overview of green bond markets research. The study provides several interesting insights into green bond research to fuel the growth of this market and promote sustainability across the global financial markets.

focused on how to combat climate problems and combine adaptation and mitigation risk with financing tools to reduce emissions and combat climate risk (HLCB, n.d.). The United Nations Development Program's Sustainable Development Goals (SDGs) for 2030 which is another international-level initiative emerged with the prime motive of eradicating poverty, and hunger and promoting peace, justice, and human rights through sustainability (United Nation, 2015). It has been reported that the United Nations Commission on Trade and Development estimates a \$5-7 trillion requirement by 2030 to meet SDGs (UNCTAD, 2014) and the challenges of the recent pandemic added the ingredients to it (Lukšić et al., 2022). The recent COP 26¹ in responding to the serious problem of climate change has pointed out that, the current provision towards climate finance to promote sustainability is insufficient, particularly in developing economies (COP 26, 2021).

The concept of sustainability has gained momentum on the part of academicians and researchers in search of a meaningful definition of it. It is likely noted that sustainability comprises the preservation and continuation of project outcomes. With the existence of various factors and their impact on project sustainability, the funding sources as one of the major obstacles was highly observed in the promotion of sustainability (Savaya et al., 2009). In response to sustainability and sustainable development, Green Bond, a new sustainable finance tool, has recently emerged (Kila, 2020). These increasing concerns led ethical investors to popularise this tool during the last decade (Hacıömeroğlu et al., 2022). Indeed, a sustainability-focused financial tool like green bonds is a better way to harness the opportunities with the growing demand of ESG-seeking investors (Sisodia et al., 2022). Moreover, in the order to align with the "Net-Zero Emission" target, it turned out that a GB could be a great pathway (CBI, 2021). Therefore, in the order to achieve the sustainability of the project by deploying the use-proceeds to various green projects, GB has come from the mainstream of sustainable finance (Park, 2020). The GB is defined as any type of bond where "the proceeds will be exclusively used to finance or re-finance, in part or in full, new and/or existing eligible green projects" (ICMA, 2017). The various green projects financed through GB include renewable energy, sustainable waste management, sustainable land use, clean transportation, biodiversity, green buildings, and clean water (ICMA, 2017).

The inception of the first global GB is traced back to 2007 when the European Investment Bank issued the first GB called the "Climate Awareness Bond" (Tu et al., 2020), followed by the World Bank which issued the second GB in the globe to finance green projects. Since then, many of the world's largest institutions, commercial banks, and municipalities, have started the issuance of GB (Banga, 2018). The global GB issuance has risen to one trillion in 2021, the USA topped in terms of total GB issuance followed by Germany, France, and China (CBI, 2021). Despite the growing issuance of GB across the world, the total share of GB is comparatively less than 1% of conventional bonds (Li et al., 2017; Yaya et al., 2022; Zhang et al., 2019).

As far as studies are concerned with the GB market's present status, overall development, and future scope as the way forward, the literature is sparse. As outlined by Zhang et al. (2019), issues concerned with green finance and its various elements are the major concerned topics. To this end, GB such as an element in the domain of green finance needs further studies (Bhatnagar & Sharma, 2022). Furthermore, this study is motivated by the study of (Kumar et al., 2022) which suggested enriching the proper understanding of sustainable finance tools. However, the study aims to fill this gap by studying the entire spectrum of articles on the GB markets. Moreover, this study makes use of an objective and most powerful method such as bibliometric analysis and systematic literature review for this focal point of discussion as this is a highly preferable method for reviewing different facets of the study (Paul et al., 2021). Following previous studies and their scope, the study aims to answer the below-framed research questions:

RQ1. What is the publication trend for GB market research?

RQ2. Which are the most influencing articles contributing to the GB market?

RQ3. Who are the top prolific authors, affiliations, and countries in GB market research?

RQ4. What are the major themes and studied topics on GB?

RQ5. What is the future scope of research on the GB market?

The findings of this review guide all stakeholders in several ways. Firstly, the potential and existing researchers can observe the publication trend which induces them to show interest in this arena (RQ1). The prospective researchers can identify key aspects of literature (RQ2), prolific collaborators (authors, country, institution) (RQ3), and the major themes that help to establish new knowledge (RQ4). Also, these findings lead various existing and potential researchers to further investigate this area to prove it as a new promising market for all stakeholders (RQ5).

The other sections of the paper are formulated as follows. The study begins with literature about the GB markets. Next, the paper describes the methodology employed, followed by the dissemination of major findings. Finally, the paper concludes the study and provides agenda for future research which helps in the further expansion of this GB market.

2. Literature review

The nexus between the GB and the sustainable economy is traced back to 2011 where the crucial role of GB in shifting the fossil fuel-based economy to a greener economy is exhibited to curb the “desatiation” trend (Mathews, 2011). The GB is also referred to as a climate bond or sustainable bond, and it was highlighted that climate bonds, as a new finance mechanism, urged for its deployment towards green projects where the active involvement of private parties and banking companies is highly encouraged (Bracking, 2015; Mathews & Kidney, 2012). Interestingly, the UN Paris Accord in its Climate summit in 2014 stressed the importance of GB in achieving a green economy, since then the growing literature on GB has increased accordingly (McInerney & Johannsdottir, 2016).

As far as flourishing literature on GB (Pham, 2016) with the notion of the volatility of GB, conducted a first empirical study on market volatility and found higher volatility in the label GB segment due to the spillover effects from conventional bond markets. Henceforth, this piece of work contributed to the initial growth of this market and accordingly laid a successive step for future studies. Since then, many researchers further investigated the market volatility and contributed to this body of knowledge by inferring the GB as a risk alleviating tool (Bilgin et al., 2018; Gatti & Florio, 2018; Jiang & Jia, 2022; Jin et al., 2020; M. Liu, 2022; Mensi et al., 2022; Ortolano & Nissi, 2022; Ren et al., 2022; Uddin et al., 2022; Wulandari et al., 2018; Yaya et al., 2022). It is likely noted that the extant literature deeply focused on GB market benefits brought to investors through portfolio diversification which in turn assists the various investors to take proper trading strategies with a better understanding of this green (Chatziantoniou et al., 2022; Gianfrate & Peri, 2019; Huynh, 2022; Huynh et al., 2020; Karim & Naeem, 2022; Rao, 2022; Sohag et al., 2022; Tsagkanos et al., 2022). With the increased concerns about the perceived behavior of the stock market towards eco-friendly tools, the other facets of the studies dealt with stock market reactions to GB announcement and succeeded in the dissemination of positive reactions from the market and strongly justified that the market reacts positively towards issuance with a signaling quality of issuers for their environmental commitments which further enhanced the issuance quality of GB (Bancel & Glavas, 2021; Baulkaran, 2019; Laborda & Sánchez-Guerra, 2021; Mohd Roslen et al., 2017; Tang & Zhang, 2020; Wang et al., 2020). It was a well-observed fact that the majority of the studies done from the demand side of GB, whereas only limited studies have investigated GB market from the supply-side perspective (Barua & Chiesa, 2019; Chiesa & Barua, 2019; Dou & Qi, 2019; Nanayakkara & Colombage, 2019; Russo et al., 2021; Tolliver et al., 2019).

With the growing interest in GB return comparison to convention bonds, major strands of literature was focused on the “Greenium”, the yield difference between green and conventional

bond (Bachelet et al., 2019; Deng et al., 2020; Hyun et al., 2020; Kanamura, 2020; Larcker & Watts, 2020; Nanayakkara & Colombage, 2019; Partridge & Medda, 2020), where strong evidence on the “greenium” was found with the existence of lower yield on GB against conventional bond (Agliardi & Agliardi, 2021; Dorfleitner et al., 2022; Huynh et al., 2022; Lau et al., 2022; Löffler et al., 2021; MacAskill et al., 2021; Teti et al., 2022). In the notion of GB and its impact on environmental performance, the studies shed light on ESG activities which demonstrated the favorable benefits (Fatica & Panzica, 2020; Glomsrød & Wei, 2018; Oguntuase & Windapo, 2021; Zhou & Cui, 2019). As the global financial markets witnessed instability due to the pandemic, recent studies were conducted on GB and its behavior with other forms of markets. It is likely noted that the GB is termed as a better investment avenue for investors during pandemic times with their increased return and demand due to its financial and non-financial benefits (Hacıömeroğlu et al., 2022).

Given the burgeoning research on GB, a few studies have attempted to present an overview of this market as a subset of sustainable finance (Zhang et al., 2019). Cortellini and Panetta (2021) provided a comprehensive review of GB with a sample of 53 articles focusing on greenium existence, market connectedness, GB supply-side trend, market performance, and stock market reactions. However, the review was only limited to specific aspects which are not adequately covered the overall market development of GB. Moreover, a review focusing on the environmental finance domain highlighted the financial instrument mechanism and the improvement of the green bond market mechanism as a way forward for the future (Tao et al., 2022). To this end, with the absence and need for an overview of the GB market, this is the first study that provides an overview of GB research with coverage of the entire spectrum of GB research.

3. Method

The study deploys bibliometric analysis through systematic literature review evidence. The bibliometric analysis is an extensively used approach to find the knowledge autonomy of any research field (Li et al., 2017). Particularly, this analysis encapsulates the proper use of quantitative techniques with the aid of bibliometric information which helps in the assessment of the entire corpus of articles in any research domain (Sahoo et al., 2022). Furthermore, the review also used a systematic literature review method. A systematic review of literature is a process that systematically synthesis and locates all studies with the alignment of a particular research question based on high transparency, and quality steps at each level (MacAskill et al., 2021; Stechemesser & Guenther, 2012). In this review, the systematic literature review is followed to synthesize the past literature (Blanco-Mesa et al., n.d.), which also limits the bias (Goyal & Kumar, 2021). This review particularly deploys “Scientific Procedures and Rationales for Systematic Literature Reviews” (“SPAR-4-SLR”) criteria shows in Figure 1. The rationale behind the choice of this method lies in the superior quality of SPAR-4-SLR over the PRISMA Guidelines. Moreover, this method follows three major stages which include “assembling”, “arranging”, and “assessing” articles (Paul et al., 2021). The review criteria are shown as follows:

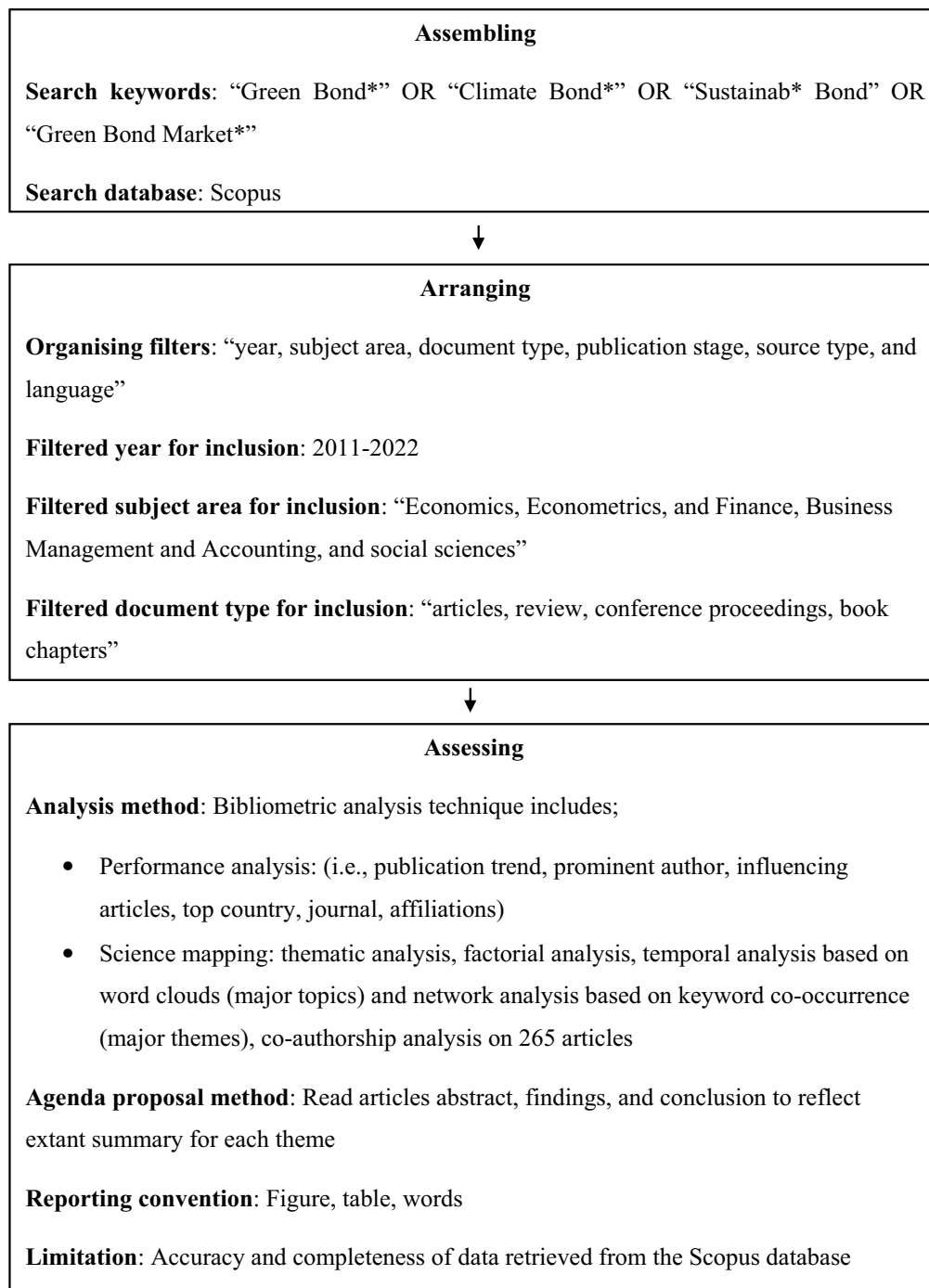
3.1. Assembling

To identify, and acquire the spectrum of articles on GB, the research reviewed the past scholarly work where necessary insights were obtained, and accordingly various combination of keywords was formed. The GB market research as a focal point of discussion in the study, following previous literature (Argandoña et al., 2022; Mathews, 2011) the alternative names of GB such as “climate bond”, and “Sustainable bond” are also included. In the first search strategy, keywords of “Green Bond” OR “Green Bond Market” were used which yielded 466 total documents. In the second search strategy, the keywords of “Green Bond” OR “Climate Bond” OR Sustainable Bond” OR “Green Bond Market” were used which yielded 488 documents. The final strategy was done using “Green Bond*” OR “Climate Bond*” OR “Sustainab* Bond” OR “Green Bond Market*” keywords which yielded a total of 499 documents.

In line with the identification of keywords, the search strategy was done on 09 August 2022 to gather articles in the field where the search string followed was based on title, abstract, and

Figure 1. The SPAR 4 SLR diagram.

Note: SPAR 4 SLR Protocol.



keywords. The review used the Scopus database as this is the major database with higher quality scholarly articles than other databases (Comerio & Strozzi, 2019; Norris & Oppenheim, 2007), which is particularly more suitable for bibliometric review (Baas et al., 2020). Similarly, the Web of Science, an alternative database was also used where relatively a smaller number of results were obtained. Hence, the Scopus database was finalized for the data extraction process, and a total of 499 documents were identified from the search process.

3.2. Arranging

For the sake of arranging the identified and acquired articles after the assembling stage, the study applied the category (code) function on the Scopus database to filter the gathered data according to “year, subject, document type, source type, publication stage, and language”. The search strategies were confined to “2022, Economics, Econometrics, Finance, Business Management, Accounting, and Social Sciences, articles, review, conference proceedings, book chapters, final, journal, and English” in those codes, respectively. However, the search results appeared only from 2011 to 2022 in the database. This led to yield a total of 314 articles.

Furthermore, the data were downloaded and exported to an MS excel sheet and each article was read with a special emphasis on abstract, findings, and conclusion which yielded a 265 corpus of articles for review on a random cross-checking basis with confirmed consent using other data-bases such as Elsevier, Sage, Springer, Emerald, Taylor & Francis, and Google Scholar (Goyal & Kumar, 2021).

3.3. Assessing

To evaluate the entire assembled 265 articles on the GB research, the study applies the bibliometric approach to review. To this end, the bibliometric analysis uses a quantitative technique that manifests scholarly works on a real-time basis (Donthu et al., 2021). In addition, the study integrates a systematic literature review method as it credibly increases the transparency of the study (Ellegaard & Wallin, 2015). Also, the bibliometric analysis mitigates bias and employs qualitative (subjectivity) review using quantitative (objectivity) tools (Burton et al., 2020) during the time of a large corpus of articles (100–1000 articles; Donthu et al., 2021), as in this review with 265 articles. The study deploys bibliometric analysis to do performance analysis and science mapping analysis using Biblioshiny and VOSviewer. The former unpacks publication trends, influencing articles, prominent authors, top countries, and affiliations, and the latter shows the major themes and topics of GB research (Castriotta et al., 2019; Donthu et al., 2021; Van Eck & Waltman, 2017). The review based on the synthesis of past literature curates further research in this domain. The next sections of the paper report findings, whereby the narratives are provided by tables and Figure

4. Results

4.1. Performance analysis

The study done performance analysis as this analysis shows the performance of any particular research area (Donthu et al., 2021), which is particular to GB research in this paper. Moreover, this analysis delineates the publication trend, most influencing article, top contributing author, affiliation, and countries. The study analysis tools are shown in Figure 2.

4.1.1. Publication trend of green bond research

The year-wise publication trend in GB has been depicted in Figure 3, which clearly shows the growing trend of publications in the area of GB. Notably, the year 2011 is pioneered for its first publication with a single article. Since then, the trend showed a smaller number of publications. From 2016 to 2017 the publications doubled, and thereafter the publications have surged drastically due to the introduction of the Paris Accord and the SDGs. However, between 2015 and 2021, the GB research gained momentum among various researchers with the announcements of green bond principles (ICMA, 2017). The year 2021 is highlighted for its high number of publications which is increased to 92 as compared to 2020. Overall. The publication trend has increased exponentially with an annual growth rate of 55.12%. It can be understood that with the increased level of awareness of sustainability, the annual scientific production for GB market research in the present scenario has increased and emerged as a timely topic.

4.1.2. Most influencing article

Table 1 shows the most influencing articles on GB research in terms of the total number of citations. It is observed that the article of Zerbib (2019) titled “The effect of pro-environmental

Figure 2. Bibliometric analysis tools used in the study.

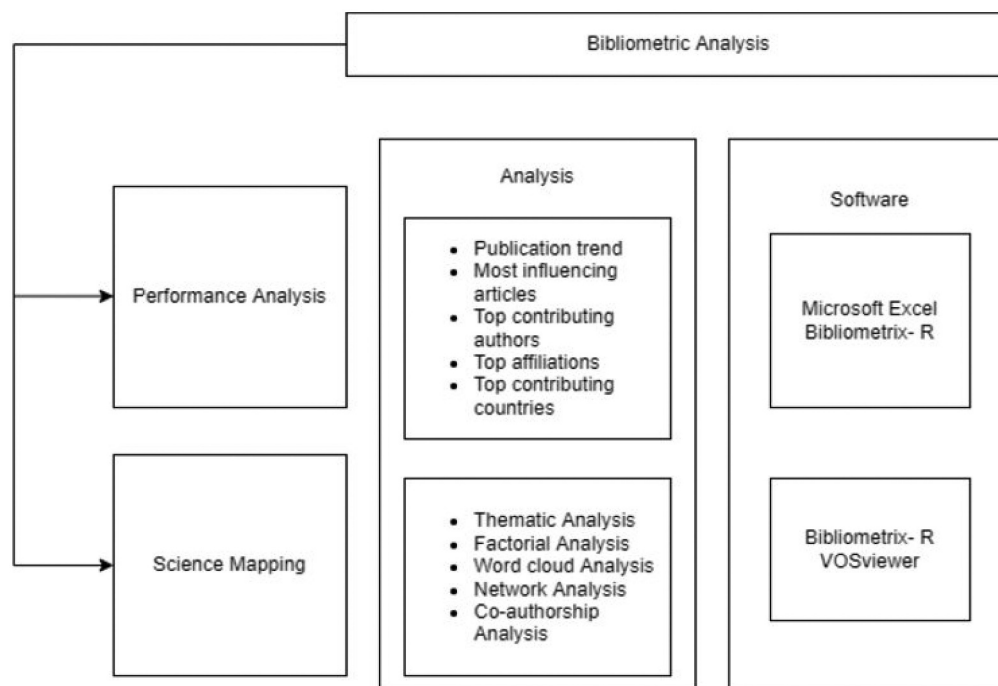
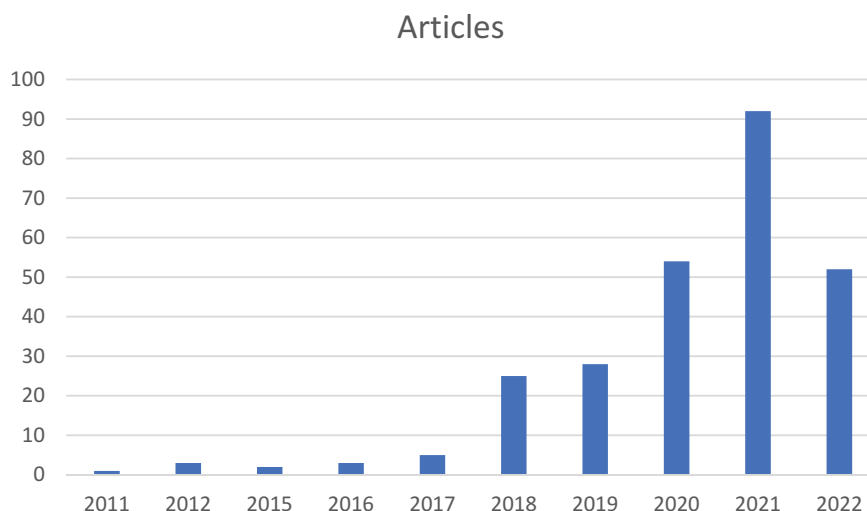


Figure 3. Scientific productions on green bond research.

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.



preferences on bond prices: Evidence from green bonds” is the most influential article on GB research published in the *Journal of Banking and Finance* with 198 total citations and 49.5 total citations per year followed by the article titled “Green bond and financial markets: co-movement, diversification and price spillover effects” written by (Reboredo, 2018) with its 151 total citations. Further, the top 10 most cited articles have amassed a total of 1,101 citations. Interestingly, these studies shed light on GB market pricing, its connectedness among other forms of markets, and the favorable diversification benefits to investors.

4.1.3. Top contributing journals

Table 2 shows the top journals contributing to GB research. It is noted that the *Journal of Cleaner Production*, *Sustainability*, and *Finance Research Letters* stand first and second respectively due to their significant contributions with 17 and 13 articles. However, in terms of total citations, *Energy*

Table 1. Most influential articles

| Author | Year | Source | Title | Total citations | Total citations per year |
|---------------|------|---|--|-----------------|--------------------------|
| Zerbib OD | 2019 | <i>Journal of Banking and Finance</i> | "The effect of pro-environmental preferences on bond prices: Evidence from green bonds" | 198 | 49.5 |
| Reboredo JC | 2018 | <i>Energy Economics</i> | "Green bond and financial markets: co-movement, diversification and price spill over effects" | 151 | 30.2 |
| Tang DY | 2020 | <i>Journal of Corporate Finance</i> | "Do shareholders benefit from green bonds?" | 131 | 43.667 |
| Gianfrate G | 2019 | <i>Journal of Cleaner Production</i> | "The green advantage: exploring the convenience of issue of green bonds" | 99 | 24.75 |
| Hachenberg B | 2018 | <i>Journal of Asset Management</i> | "Are green bonds priced differently than conventional bonds?" | 95 | 19 |
| Flammer C | 2021 | <i>Journal of Financial Economics</i> | "Corporate green bonds" | 93 | 46.5 |
| Reboredo JC | 2020 | <i>Economic Modelling</i> | "The price connectedness between green bonds and financial markets" | 89 | 29.667 |
| Bachelet MJ | 2019 | <i>Sustainability</i> | "The green bonds premium puzzle: the role of issuer characteristics and third-party verification" | 84 | 21 |
| Febi W | 2018 | <i>Finance Research Letters</i> | "The impact of liquidity risk on the yield spread of green bonds" | 82 | 16.4 |
| Banga J | 2019 | <i>Sustainable Finance and Investment</i> | "The green bond market: a potential source of climate finance for developing countries" | 79 | 19.75 |
| Pham L | 2016 | <i>Sustainable Finance and Investment</i> | "Is it risky to go green? A volatility analysis of the green bond market" | 76 | 10.857 |
| Broadstock DC | 2019 | <i>Finance Research Letters</i> | "Time-varying relation between black and green bond price benchmarks: Macroeconomic determinants for the first decade" | 71 | 17.75 |
| Karf A | 2018 | <i>Nature Climate Change</i> | "The changing value of the 'green' label on the US municipal bond market" | 65 | 13 |
| Nguyen TTH | 2021 | <i>Finance Research Letters</i> | "Time-frequency co-movement among green bonds, stocks, commodities, clean energy, and conventional bonds" | 64 | 32 |
| Reboredo JC | 2020 | <i>Energy Economics</i> | "Network connectedness of green bonds and asset classes" | 62 | 20.667 |

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.

Economics and *Journal of Cleaner Production* have amassed a total of 406 and 399 total citations, respectively. Noteworthy, these journals accounted for the 9 and 8 h-index with their increased contributions. It is also noted that among the top most contributing journals in terms of GB research, *Energy Economics* is considered the top-rated journal with A* ratings in the ABDC journal category.

Table 2. Top contributing journals

| Sources | Articles | Total citations | h-index | ABDC rank |
|--|----------|-----------------|---------|-----------|
| <i>Journal of Cleaner Production</i> | 17 | 399 | 9 | A |
| <i>Sustainability</i> | 17 | 241 | 8 | NR |
| <i>Finance Research Letters</i> | 13 | 374 | 9 | A |
| <i>Sustainable Finance and Investment</i> | 12 | 320 | 9 | NR |
| <i>Energy Economics</i> | 10 | 406 | 8 | A* |
| <i>Technological Forecasting and Social Change</i> | 6 | 195 | 5 | A |
| <i>International Review of Financial Analysis</i> | 5 | 60 | 3 | A |
| <i>Resources Policy</i> | 5 | 45 | 4 | B |
| <i>Business Strategy and the Environment</i> | 4 | 71 | 4 | A |
| <i>Journal of Alternative Investments</i> | 4 | 5 | 1 | B |

ABDC Journal rankings in 2021 given the Australian Business Dean Council, NR indicates Not Ranked.

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.

4.1.4. The most prolific authors

The most prominent authors in the field of GB research are shown in Table 3. It has been demonstrated that Agliardi E and Naeem MA are the most prominent authors in this field with a total of 6 publications each. It is worth noting that these articles throw light on the GB market volatility and its market connectedness with other forms of markets such as clean energy market, green equity markets, conventional bond markets, and commodities markets. All the prominent researchers show that GB is a new promising market for the future to all investors.

4.1.5. Top contributing Countries

Amongst the total contributions of countries across the globe towards GB research, Table 4 shows that China has become the top contributing country in the world followed by the USA with their total productions of 90 and 58, respectively. The noteworthy point here is that both China and the USA are not only the top contributing country to GB research, alongside they also emerged as the top GB issuing countries in the world, wherein the USA is the leading country followed by China (CBI, 2021). The other countries that have a higher number of contributions are the UK, Italy, Australia, India, France, and Spain accounting for 49, 35, 33, 27, and 22 articles, respectively.

4.1.6. The top affiliations

Table 5 shows the country affiliations in terms of their total article productions on GB research. In and around the world, the top contributing universities are, the University of Bologna, Italy, the University of Economics in Ho Chi Minh City, Vietnam, and the Griffith University of Finance and Economics, Australia accounted for 13, 11, and 10 articles, respectively.

4.2. Science mapping

The science mapping analysis is a major analysis that shows the existing body of knowledge on a particular research domain with a graphical representation (Donthu et al., 2021). It comprises thematic analysis, factorial analysis, temporal analysis, and network analysis. The thematic

Table 3. Most prominent authors

| Author | Year | Title | Source | Total citations | TCY |
|------------|------|---|--|-----------------|--------|
| Agliardi E | 2021 | "Corporate green bonds: understanding the greenium in a two-factor structural model" | <i>Environmental and Resource Economics</i> | 4 | 2 |
| Agliardi E | 2021 | "Pricing climate-related risks in the bond market" | <i>Journal of Financial Stability</i> | 6 | 3 |
| Agliardi E | 2021 | "Ambiguity in financing corporate mitigation policies" | <i>Handbook of Sustainable Politics and Economics of Natural Resources</i> | 0 | 0 |
| Agliardi E | 2020 | "Introduction: Special issue on the economics of climate change and sustainability (Part B)" | <i>Environment and Development Economics</i> | 0 | 0 |
| Agliardi E | 2019 | "Introduction: Special issue on the economics of climate change and sustainability (Part A)" | <i>Environment and Development Economics</i> | 0 | 0 |
| Agliardi E | 2019 | "Financing environmentally-sustainable projects with green bonds" | <i>Environment and Development Economics</i> | 35 | 8.75 |
| Naeem MA | 2022 | "Do global factors drive the interconnectedness among green, islamic and conventional financial markets?" | <i>International Journal of Managerial Finance</i> | 16 | 16 |
| Naeem MA | 2022 | "Dynamic and frequency spillovers between green bonds, oil and G7 stock markets: implications for risk management" | <i>Economic Analysis and Policy</i> | 11 | 11 |
| Naeem MA | 2021 | "Energy markets and green bonds: a tail dependence analysis with time-varying optimal copulas and portfolio implications" | <i>Resources Policy</i> | 11 | 5.5 |
| Naeem MA | 2021 | "Asymmetric relationship between green bonds and commodities: evidence from extreme quantile approach" | <i>Finance Research Letters</i> | 35 | 17.5 |
| Naeem MA | 2021 | "Asymmetric spillovers between green bonds and commodities" | <i>Journal of Cleaner Production</i> | 28 | 14 |
| Naeem MA | 2021 | "Time-frequency comovement among green bonds, stocks, commodities, clean energy, and conventional bonds" | <i>Finance Research Letters</i> | 64 | 32 |
| Pham L | 2022 | "Extreme directional spillovers between investor attention and green bond markets" | <i>International Review of Economics and Finance</i> | 1 | 1 |
| Pham L | 2021 | "Asymmetric tail dependence between green bonds and Other Asset Classes" | <i>Global Finance Journal</i> | 11 | 5.5 |
| Pham L | 2021 | "Frequency connectedness and cross-quantile dependence between green bond and green equity markets" | <i>Energy Economics</i> | 32 | 16 |
| Pham L | 2020 | "How does investor attention influence the green bond market?" | <i>Finance Research Letters</i> | 46 | 15.333 |
| Pham L | 2016 | "Is it risky to go green? A volatility analysis of the green bond market" | <i>Journal of Sustainable Finance and Investment</i> | 76 | 10.857 |
| VO XV | 2022 | "Oil shocks and volatility of green investments: Garch-Midas analyses" | <i>Resources Policy</i> | 0 | 0 |
| VO XV | 2022 | "Impacts of Covid-19 outbreak, macroeconomic and financial stress factors on price spillovers among green bond" | <i>International Review of Financial Analysis</i> | 2 | 2 |

(Continued)

| Author | Year | Title | Source | Total citations | TCY |
|-------------|------|---|---|-----------------|-------|
| VO XV | 2022 | "Dynamic and frequency spillovers between green bonds, oil and G7 stock markets: implications for risk management" | <i>Economic Analysis and Policy</i> | 11 | 11 |
| VO XV | 2021 | "Upside-downside multifractality and efficiency of green bonds: the roles of global factors and Covid-19" | <i>Finance Research Letters</i> | 9 | 4.5 |
| VO XV | 2021 | "Time-frequency comovement among green bonds, stocks, commodities, clean energy, and conventional bonds" | <i>Finance Research Letters</i> | 64 | 32 |
| Colombage S | 2022 | "Does compliance to green bond principles matter? global evidence" | <i>Australasian Accounting, Business and Finance Journal</i> | 1 | 1 |
| Colombage S | 2021 | "Does compliance with green bond principles bring any benefit to make g20's 'green economy plan' a reality?" | <i>Accounting and Finance</i> | 2 | 1 |
| Colombage S | 2020 | "Impact of credit quality on credit spread of green bonds: a global evidence" | <i>Review of Development Finance</i> | 0 | 0 |
| Colombage S | 2019 | "Do investors in green bond market pay a premium? Global evidence" | <i>Applied Economics</i> | 43 | 10.75 |
| Managi S | 2021 | "Ranking countries and geographical regions in the international green bond transfer network: a computational weighted network approach" | <i>Computational Economics</i> | 1 | 0.5 |
| Managi S | 2021 | "Green innovation and finance in Asia" | <i>Asian Economic Policy Review</i> | 32 | 16 |
| Managi S | 2020 | "Policy targets behind green bonds for renewable energy: do climate commitments matter?" | <i>Technological Forecasting and Social Change</i> | 36 | 12 |
| Managi S | 2020 | "Drivers of green bond market growth: the importance of nationally determined contributions to the Paris Agreement and implications for sustainability" | <i>Journal of Cleaner Production</i> | 57 | 19 |
| Park D | 2022 | "Go green or stay black: bond market dynamics in Asia" | <i>International Review of Financial Analysis</i> | 0 | 0 |
| Park D | 2021 | "Pricing of green labeling: a comparison of labeled and unlabeled green bonds" | <i>Finance Research Letters</i> | 5 | 2.5 |
| Park D | 2020 | "Volatility spillovers between equity and green bond markets" | <i>Sustainability (Switzerland)</i> | 24 | 8 |
| Park D | 2020 | "The price of going green: the role of greenness in green bond markets" | <i>Accounting and Finance</i> | 24 | 8 |
| Semmler W | 2022 | "Green bonds for the transition to a low-carbon economy" | <i>Econometrics</i> | 0 | 0 |
| Semmler W | 2021 | "De-risking of green investments through a green bond market—empirics and a dynamic model" | <i>Journal of Economic Dynamics and Control</i> | 4 | 2 |
| Semmler W | 2021 | "Financing climate change policies: a multi-phase integrated assessment model for mitigation and adaptation" | <i>Dynamic Modeling and Econometrics in Economics and Finance</i> | 0 | 0 |
| Semmler W | 2017 | "Financing climate policies through climate bonds—a three stage model and empirics" | <i>Research in International Business and Finance</i> | 58 | 9.667 |

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.

Table 4. Top contributing countries

| Country | Total production |
|-------------|------------------|
| China | 90 |
| USA | 58 |
| UK | 49 |
| Italy | 35 |
| Australia | 33 |
| India | 27 |
| France | 22 |
| Spain | 22 |
| Japan | 21 |
| Germany | 18 |
| Brazil | 16 |
| Sweden | 15 |
| Malaysia | 11 |
| New Zealand | 11 |
| Canada | 10 |
| Colombia | 10 |
| Turkey | 10 |
| Ireland | 9 |
| Ghana | 8 |
| Singapore | 8 |

Notes: Visualisation of data from Scopus done by authors using Biblioshiny R Package.

Table 5. Country affiliation/institutions

| Affiliations | Articles |
|---|----------|
| University of Bologna | 13 |
| University of Economics Ho Chi Minh City | 11 |
| Griffith University Queensland | 10 |
| Southwestern University of Finance and Economics | 9 |
| University College London | 9 |
| Kyushu University | 8 |
| Federation University Australia | 7 |
| Universidad Nacional de Colombia | 6 |
| Bocconi University | 5 |
| Central South University | 5 |
| China University of Mining and Technology | 5 |
| Climate Bonds Initiative | 5 |
| Durham University | 5 |
| Financial University Under the Government of the Russian Federation | 5 |
| Jinan University | 5 |
| Massey University | 5 |
| National University of Singapore | 5 |
| New School for Social Research | 5 |
| Sumy State University | 5 |

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.

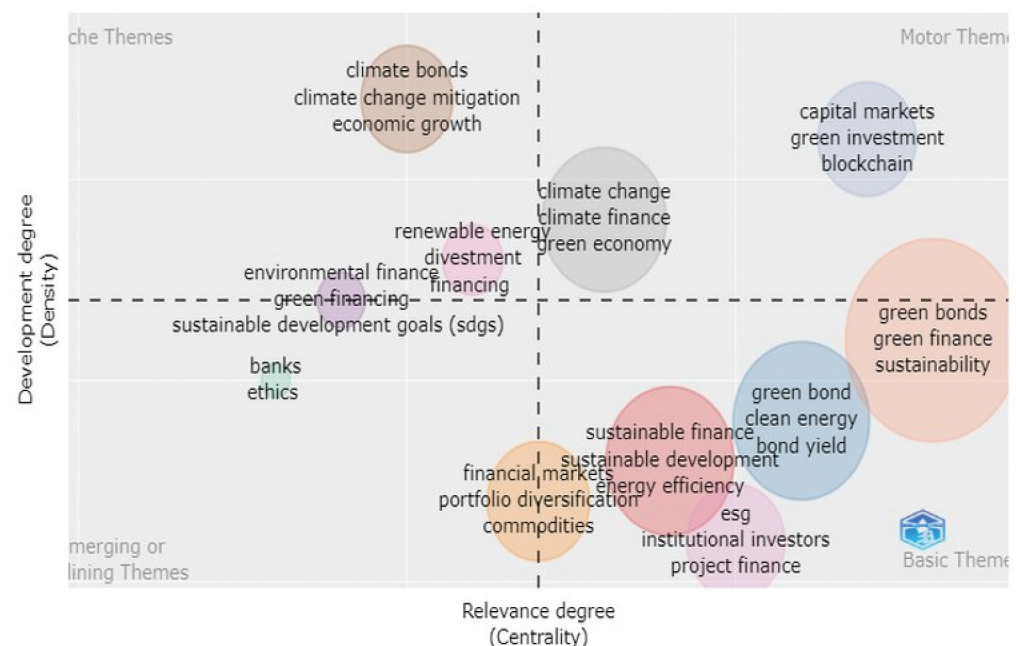
analysis is used to reveal major themes (Chandra et al., 2022), factorial analysis is used to investigate the intellectual structure of articles in a particular domain (Sahoo et al., 2022), and temporal analysis is used to uncover the major topics, and the word cloud analysis is employed to unpack the major themes about GB research (Kumar et al., 2022).

4.2.1. Thematic analysis

Figure 4 shows the thematic map in the field of GB study. This analysis was done using the Biblioshiny software. It is a software that gives several options such as author keywords, keyword plus, and titles and abstracts. The thematic map in the study is done based on author keywords as this option clearly shows the major themes associated with the author's keywords. The thematic map is attributed to density and centrality where the density is represented on the vertical axis, and centrality is represented on the horizontal axis. Further, the thematic map has been segregated into four major quadrants based on their importance in the field which is referred to as themes. The quadrant in the upper right side is referred to as a motor theme with high impact and high centrality. The keywords in this theme such as "climate change", "climate finance", "green economy", "capital markets", "green investment", and "blockchain" are highly developed and serve as a basic insight for the green bond market. It highlights the importance of climate finance with the prior objective of achieving a green economy due to the severe problems of climate change and its mitigations. To this end, it also emphasizes the proper deployment of private finance in terms of green investment with the effective usage of advanced technology and the capital markets. The quadrant in the bottom right quadrant is named as a base theme with high centrality and low impact. The topics in this theme include "green bonds", "green finance", "sustainability", "clean energy", "bond yield", "sustainable finance", "sustainable development", "energy efficiency", "ESG", "institutional investors", "project finance", "financial markets", "portfolio diversification", and 'commodities'- are central to green bond market though they exert low impact on the field. It is likely noted here that, future research could focus on new areas using these shown aspects across the different clusters rather than relying on these specific keywords. The quadrant in the upper left is known as a niche theme with high impact but low centrality. The keywords in this quadrant include 'climate bond', 'climate change mitigation', 'economic growth', 'renewable energy', 'divestment', 'environmental finance', 'green financing', and "sustainable development goals (sdgs)" are well developed and have a high impact on the field. Future

Figure 4. Thematic map.

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.



4.2.2. Factorial analysis

Figure 5. Factorial analysis.

2021; Pham, 2016; Russo et al., 2021; Wulandari et al., 2018; Zerbib, 2019). Cluster 2 includes keywords such as greenwashing, ESG, sustainable infrastructure, sustainable financing, project finance, and institutional investors. This cluster shows the major concerns in reducing information asymmetry on the part of various market participants by giving prominent importance to ESG performance and its disclosure, the presence of external review or second party opinion (Simeth, 2022), harmonization of existing guidelines to rule out unethical practices such as greenwashing (Teti et al., 2022) also, a good credit rating which in turn enhances the GB market (Li et al., 2019; Russo et al., 2021). Furthermore, the role of institutional investors in investing in sustainable assets such as green bonds is well observed (Baldacci & Possamai, 2022). The keywords that are nearer to the map indicate the closure of one element to another, and the keywords nearer to the edge points are referred to as narrowly researched keywords (Aria & Cuccurullo, 2017) which need to be explored further.

4.2.3. Temporal analysis based on word cloud map

The corpus of articles on GB study using author keywords is depicted in Figure 6. The word cloud analysis based on the author's keyword shows the advent of "green economy", "climate change", "finance", "green bond", "green finance", "financial market", and "capital market". Furthermore, the concept of "clean energy", "energy efficiency", "renewable energy", and "connectedness", have been delved into a deeper investigation. In addition, as a part of green innovation, countries such as "Europe", "China", and "ASEAN" are depicted as the major country regions in the domain of GB study process (Mathews, 2011; Mathews & Kidney, 2012).

4.2.4. Network analysis (keyword occurrence map)

Unlike temporal analysis using a word cloud map, the network analysis makes use of the keyword co-occurrence technique with the aid of VOSviewer. This analysis unpacks the major themes in the field of GB study. Moreover, this particular technique includes a corpus of articles that manifests the major themes which characterize the intellectual structure in GB research. The major themes of this analysis are illustrated in the table in Figure 7. Also, Table 6 includes a descriptive summary of various clusters with their respective keyword.

Figure 7 shows a network analysis that delineates the major themes in terms of six clusters in the GB study namely cluster 1 (red); sustainable development, cluster 2 (green); sustainability, cluster 3(blue); green bonds, cluster 4(yellow); sustainable finance, cluster 5 (purple); green finance, and cluster 6 (sky blue); sustainable investment. Table 6 shows an accompanied summary description including the total occurrence (TO) of each keyword, Links (L) of each keyword: which shows the unique occurrence of each term with other terms, and, total link strength (TLS): which shows the total occurrence of each term with other terms in the entire topic (Donthu et al., 2021). However, the summary of each theme or cluster is as:

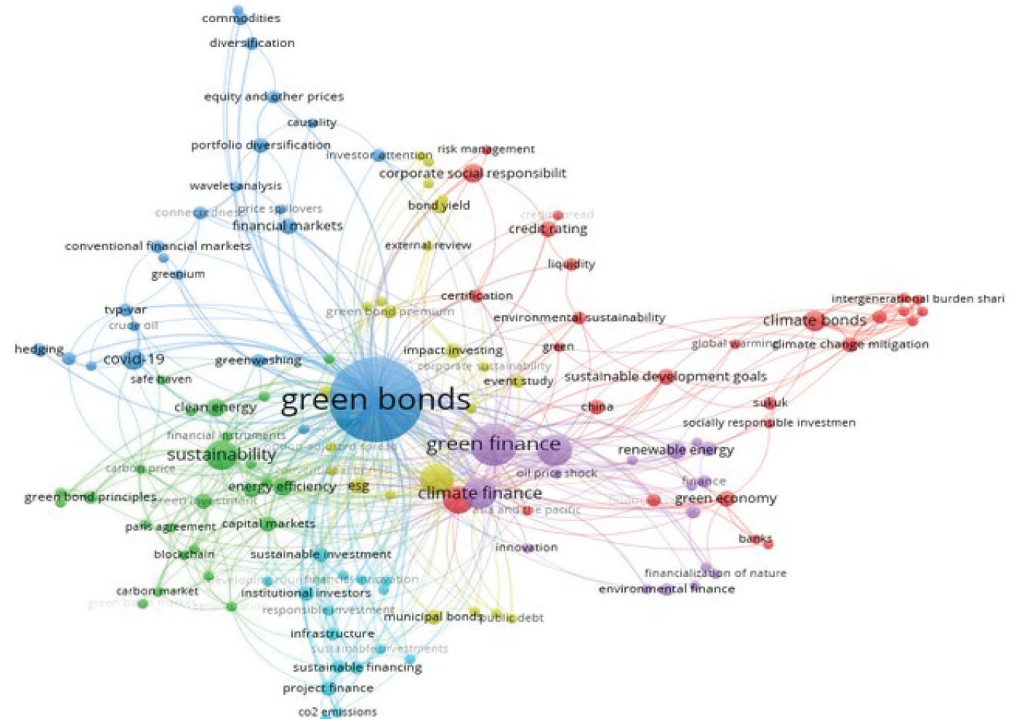
4.3. Cluster 1 (red): sustainable development

The largest cluster concerned with Sustainable Development comprises 31 items with 26 links and 14 occurrences in the network of GB research. The most popular keyword or topic on SD is Sustainable Development itself which accounted for 14 articles, 26 links, and 38 total link strengths. The other keywords of this cluster are climate bonds, SDGs, credit rating, climate change mitigation, green economy, and China. Under this cluster, it was highlighted that climate bonds as a new finance mechanism urged for its deployment towards green projects where the active involvement of private parties and banking companies is highly encouraged (Mathews & Kidney, 2012), and the emergence of green bonds to deploy proceeds towards sustainable development goals highly documented (Lukšić et al., 2022). Also, the major role of the macroeconomic environment (Flaherty & Semmler, 2016), the convenience of GB issuance (Gianfrate & Peri, 2019) with low-interest cost due to the impact of credit rating (Li et al., 2019), and the negligible effects of liquidity risks on bond yield spread (Wulandari et al., 2018) proved the GB as a safe tool in avoiding climate risk problem (Piñeiro-Chousa et al., 2021). Moreover, the vital role of China as a major GB issuer towards achieving a green economy is highly demonstrated with the identification of the

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.



Note: Visualisation of data from Scopus done by authors using VOSviewer.



4.4. Cluster 2 (green): sustainability

Page 16 of 27

Table 6. Descriptive summary of each cluster

| Keyword | TO | Links | TLS | Keyword | TO | Links | TLS |
|--------------------------------------|-----|-------|-----|----------------------------------|----|-------|-----|
| Cluster:1 Sustainable development | | | | Cluster:2 Sustainability | | | |
| Sustainable development | 14 | 26 | 38 | Sustainability | 16 | 25 | 43 |
| Climate bonds | 8 | 13 | 20 | Energy efficiency | 6 | 11 | 14 |
| CSR | 7 | 7 | 11 | Clean energy | 6 | 8 | 11 |
| SDGs | 5 | 10 | 13 | Capital markets | 4 | 20 | 22 |
| Green economy | 5 | 9 | 12 | ASEAN | 4 | 7 | 12 |
| Credit rating | 5 | 5 | 7 | Green investment | 4 | 7 | 7 |
| Climate change mitigation | 4 | 12 | 19 | Cluster:4 Sustainable finance | | | |
| China | 4 | 5 | 7 | Sustainable finance | 17 | 30 | 48 |
| Cluster: 3 Green bonds | | | | ESG | 5 | 17 | 19 |
| Cluster: 3 Green bonds | 131 | 110 | 264 | Impact investing | 4 | 9 | 13 |
| Covid 19 | 8 | 10 | 17 | Municipal bonds | 4 | 5 | 8 |
| Financial markets | 4 | 7 | 10 | Bond yield | 4 | 5 | 6 |
| Portfolio diversification | 4 | 6 | 10 | Cluster: 5 Green finance | | | |
| Cluster: 6 Sustainable investment | | | | Green finance | 33 | 37 | 77 |
| Project finance | 4 | 9 | 13 | Climate change | | | |
| Sustainable investment | 4 | 8 | 9 | Climate finance | | | |
| | | | | Renewable energy | | | |
| | | | | Investment | | | |
| | | | | 6 | | | |
| | | | | 7 | | | |

Note: TO, total occurrence (TO); L, link; TLS, total link strength. TO>4 included, total items limited to 15.

study evidenced the inverse relation between clean energy and GB with their positive financial benefits (Nguyen et al., 2021), the negative effect of green bonds on energy efficiency intensity exerted in the ASEAN countries (Quang & Thao, 2022), and the nexus between issuance of green bonds and energy efficiency projects found positive in OECD countries and also the increased need for investments towards energy efficiency and many others (Anh Tu & Rasoulinezhad, 2022). In addition, to achieve sustainability, it also turned out that GB is a new tool to finance green projects with double benefits for both issuers and investors (Teti et al., 2022).

4.5. Cluster 3 (blue): green bonds

The largest cluster concerned with green bonds comprises 25 items with 110 links and 131 occurrences in the network of GB research. The most popular keyword or topic on GB is green bonds itself which accounted for 131 articles, 110 links, and 264 total link strengths. The other keywords of this cluster are financial markets and portfolio diversification, covid 19. Under this cluster, the researchers show the vital role of financial markets in encouraging the private sector, and the increased return and reduced volatility of a GB portfolio (Piñeiro-Chousa et al., 2021); as a result, the GB is considered a safe tool in avoiding climate risk problem. Also, the need for production and utilization of renewable energy due to covid for a greener economy (Li et al., 2022) and the increased economic growth is well observed due to GB issuance (Argandoña et al., 2022). Furthermore, the better performance of GB issuing companies with signaling effect of their environmental commitments during pandemic (Sisodia et al., 2022).

4.6. Cluster 4 (yellow): sustainable finance

The largest cluster concerned with sustainable finance comprises 19 items with 30 links and 17 occurrences in the network of GB research. The most popular keyword or topic is sustainable finance which accounted for 17 articles, 30 links, and 48 total link strengths. The other keywords of this cluster are impact investing, ESG, bond yield, and municipal bonds. Under this cluster, the role of ESG on bond performance showed positively (Hachenberg & Schiereck, 2018; Russo et al., 2021), the higher yield of GB with fundamental characteristics in the US Green Muni bond (Karpf & Mandel, 2018), and the presence of greenium in US secondary market (Partridge & Medda, 2020) also observed in the study.

4.7. Cluster 5 (purple): green finance

The largest cluster concerned with green finance comprises 17 items with 37 links and 33 occurrences in the network of GB research. The most popular keyword or topic is green finance which accounted for 33 articles, 37 links, and 77 total link strengths. Other keywords of this cluster are climate change, climate finance, renewable energy, and investment. Under this cluster, the research is emphasized the various aspects of green finance where the faster developments of green finance are highly stressed (Gilchrist et al., 2021; Zhang et al., 2019) due to the severe problem of climate change, and highlighted the proper integration of sustainability in the financial system. The importance of a sustainable fiancé in funding sustainable projects (Chen & Zhao, 2021), the existence of the enduring effect of green finance on the environment (Saeed Meo & Karim, 2022), the plausible avenues of GB investment in renewable energy and clean energy projects (Mathews, 2011), and the effect of Nationally Determined Contributions on GB proceeds allocation to renewable energies investigated (Tolliver, 2019). The primary concentration of GB towards renewable energy, energy efficiency projects (Versal & Sholoiko, 2022), and the pivotal role of GB on renewable energy project finance during crisis periods are well illustrated (Li et al., 2022). As green finance gained prominence, green bonds, clean energy, and the green economy showed an inducing effect on the country's ESG practices, particularly in G7 economies (Yang et al., 2022).

4.8. Cluster 6 (sky blue): sustainable investment

The largest cluster concerned with green finance comprises 15 items with 8 links and 4 occurrences in the network of GB research. The most popular keyword or topic is project finance which accounted for 4 articles, 9 links, and 13 total link strengths. Other keywords of this cluster include sustainable investment. Under this cluster, the research reveals sustainable investment as a new

investment opportunity with climate risk provision (Shaydurova et al., 2018). In addition, the role of green projects in the development of the GB market (Devine & McCollum, 2022; Russo et al., 2021), as well as the crucial role of GB towards sustainable investment in terms of green projects demonstrated (Taghizadeh-Hesary et al., 2021).

4.8.1. Country collaboration trend

Figure 8 depicts a country collaboration map about GB research. It has illustrated that the collaborative works on GB research have been increased between China and USA, followed by UK and Australia with a total of 5 and 4 publications, respectively. It is well observed that the UK and USA are noted for their high number of collaboration networks with 13 and 12 countries which are relatively high as compared to other countries across the globe in this research arena. The other countries with a remarkable collaborative network include China, Australia, India, Germany, France, and Canada. However, due to the need for a financial shift toward the green economy various countries across the globe are required to collaborate among themselves to enhance the awareness about GB, and higher needs of necessary capital flow towards the developing countries.

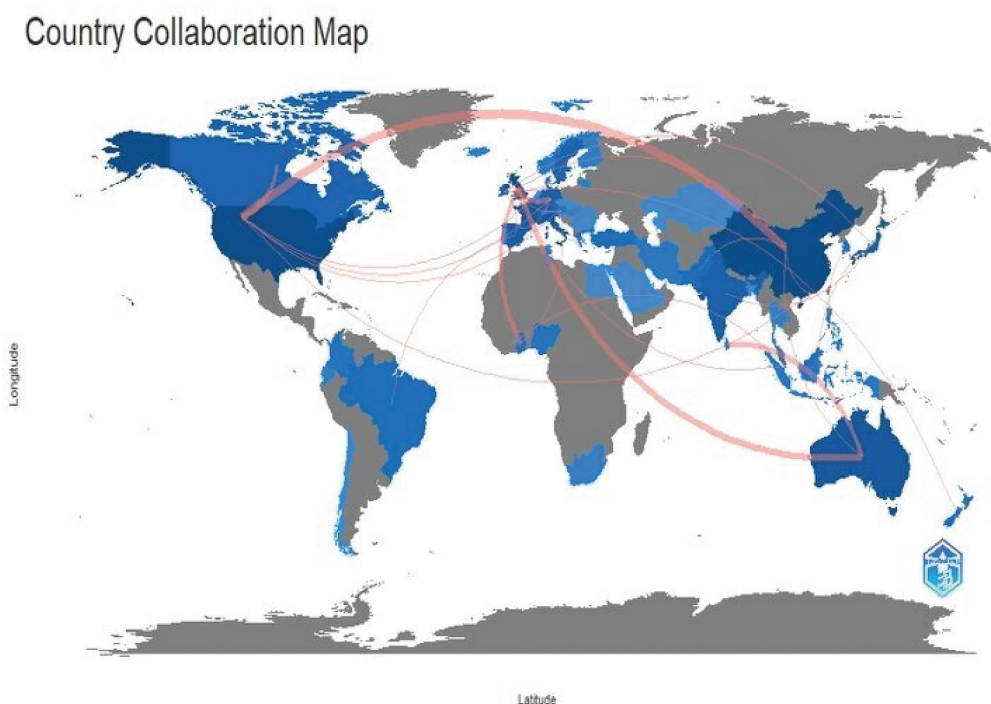
5. Green bonds: as the way forward

GB has been and will remain to be necessary for investors, financial institutions, financial markets, academicians, and regulators due to their high importance to attain the goal of a sustainable economy. Both developed and developing economies are in alignment with the movement of this particular market with their increased awareness of SDGs as set by international organizations (UNFCCC, 2015; United Nation, 2015) which could be understood by the recent hike in GB issuance and total publications. However, with the increased need for green innovation, many economies are required to introduce new forms of green financial tools to realize both financial and non-financial benefits (Tolliver et al., 2021). Furthermore, the growth of GB is increasing due to its high transparency, liquidity, and reputation (Reboredo, 2018).

Following the GB research, the review reveals that studies have increasingly focused on the demand and supply sides, specifically the financial aspects of the GB market (Barua & Chiesa, 2019). With the

Figure 8. Country collaboration map.

Note: Visualisation of data from Scopus done by authors using Biblioshiny R Package.



extensive use of past literature, this review has documented the rising trend of GB market around the world. As the study shows the major themes such as sustainable development, sustainability, green bonds, sustainable finance, green finance, and sustainable investment in and around the world, this review suggests curating future research as the way forward.

5.1. Multiple types of green bonds

The first GB was debuted in 2007 by European Investment Bank. Since then, many institutions such as corporates, governments, developmental banks, municipal corporations, and agencies started to issue these bonds around the world. The study shows that corporate, and municipal GB are investigated by most researchers (Karpf & Mandel, 2018; Li et al., 2019; Partridge & Medda, 2020; Simeth, 2021) whereas a deeper investigation into other types of GB such as agency GB, supranational GB, and sovereign GB are lacking, and there requires more research in this arena so that the major contributions of each type of green bond and their impact on various stakeholders could be analyzed (Russo et al., 2021).

5.2. The active role of market participants

GB as a new asset class in the financial markets is gaining vital importance among all market participants. However, the connectedness between bond and investor attention is studied rarely (Broadstock & Cheng, 2019) in the GB research though there exists a strong relationship between GB and investor attention (Piñeiro-Chousa et al., 2021). Furthermore, the potential impact of investors' perception of this market development is rising and it needs to be investigated further with the broader coverage of all plausible variables (Piñeiro-Chousa et al., 2022), and the role of market participants in the growth of the green bond market (Prajapati et al., 2021).

5.3. Technology-oriented financial innovation mechanism through bonds

With the technological advancements in the field of financial markets, the blockchain is coming by fits and starts where it facilitates the bond verification process by providing a safe, and, feasible project impact summary from GB issuance on a real-time basis (Sanderson, 2018). Hence, it requires proper studies about blockchain technology in the expansion of the GB market.

5.4. The potential impact of green projects

As GB are introduced to destine their proceeds to various green projects in the economy, the potential impact of green projects towards economic development with proper infrastructure creation is in great demand during this decade. Further, the project performance measures and their impact on GB development are also required to further investigation (Devine & McCollum, 2022; Russo et al., 2021; Versal & Sholoiko, 2022).

6. Discussions

The study deploying a bibliometric analysis and a systematic literature review throws light on the current status, growth, and future development of the GB market research in the global context. The review has demonstrated several interesting facts about GB research through performance analysis and science mapping. Though the first GB issuance dates back to 2007, research in this field started from 2011 onwards. Since 2015, the publication trend has gained momentum with the introduction of the Paris Accord and the Green Bond Principles, and thereafter the trends have been changing. The year 2021 is noted for its high number of scientific productions with 92 total publications and an annual growth rate of 55.12%, which shows the growing importance of GB across the globe. These findings show that GB ostensibly heralds the promises of various accords to mitigate climate risks. As in the case of most influencing articles, it turns out that "The effect of pro-environmental preferences on bond prices: Evidence from green bonds" is the most contributing article with a total of 198 citations (Zerbib, 2019), followed by "Green bond and financial markets: co-movement, diversification and price spillover effects" (Reboredo, 2018) sourced from *Journal of Banking and Finance* and *Energy Economics*, respectively. It is worth noting that these articles are known as the most influencing in this research arena as they engendered several contributions by examining GB behavior and financial and nonfinancial benefits to all stakeholders

particularly. It was observed that the *Journal of Cleaner Production and Sustainability* accounted for 17 articles each and was termed the top contributing journal in this domain. Amongst several authors, Agliardi E and Naeem MA are the most relevant authors in this segment accounting for a total of 6 publications each which is relatively high and led to the expansion of GB research. It is also evidenced that China is one of the largest major countries in the case of GB issuance (Tolliver et al., 2021), topped in terms of total contribution towards GB publication followed by the USA, and UK. Interestingly, the top affiliated institutions are from Italy, Vietnam, and Australia. These findings are highly supported by the evidence that overall, the developed countries, particularly the USA and UK, and others (except China) are showing overwhelming concerns about this market research. Indeed, all the aforementioned facts are reasonable to answer the framed research questions 1–3.

The burgeoning literature in the domain of the GB market-led one to investigate the trends in GB market research; thereby, this review casts light on the current status, and trends in GB research. The thematic analysis revealed major themes based on their centrality and impact. It shows that due to the severe problems of climate change the concept of climate finance is gaining prominence and urged for the promotion of a green economy. Akin to this, the capital markets, green investment, and blockchain have become popular among various researchers in this field. The topic of “green bonds”, “green finance”, “sustainability”, “clean energy”, “bond yield”, “sustainable finance”, “sustainable development”, “clean energy”, “ESG”, and “institutional investors”, and, “project finance” need to study with the integration of all different clusters rather than focusing them independently as they empower the perspectives to enrich the new insights into this field. The topics of “climate bond”, “climate change mitigation”, “economic growth”, “renewable energy”, “divestment”, financing”, “environmental finance”, “green financing”, and “sustainable development goals” though they are niche need to be investigated further due to their high impact, whereas bank and ethics depicted as emerging themes focus need to be given. Similarly, the results of factorial analysis corroborated the idea that sustainability, CSR, and GBP aspects have been investigated deeply due to the severe problems of climate change and its mitigation. It also shows GB as a climate risk-mitigating tool with a broader perspective of risk-return profile where the increased financial and non-financial benefits were justified by its reduced risks to various stakeholders (Flammer, 2021; Pham, 2016; Russo et al., 2021; Wulandari et al., 2018; Zerbib, 2019). Furthermore, the word cloud and network analysis evinced major themes in GB research. It is likely noted that due to the severe ongoing climate-related problems, the topic of climate change, green economy, finance, financial markets, capital markets, and GB market connectedness with other forms of the markets such as clean energy, commodities, conventional bond markets have appeared frequently with the proper justification of overall benefits available to all stakeholders. Various projects such as renewable energy, energy efficiency, and clean energy also appeared in the studies to a limited extent which needs proper examination to reveal their real impact on society. However, China, ASEAN, and Africa appeared as the major counties in this research area with their high concern about sustainability. Finally, the country’s collaboration network depicted different studies conducted across the globe. China-USA, and UK-Australia are the leading countries in terms of their collaborative outcomes. Countries such as the US and UK are witnessing a higher number of collaborative networks where their active involvement in this market segment necessitates other countries to collaborate among themselves. Therefore, the aforementioned results are reasoned to answer the framed research questions 4 and 5.

7. Conclusion

This review is based on a systematic literature review with bibliometric analysis being the first review study to present an overview of GB market research and thereby providing insights into the GB research. This overview presents several interesting insights into the extensive use of bibliometric analysis. Akin to this, it contributes differently by providing higher visibility within these techniques to unpack the most influencing articles, prolific authors, top contributing sources, affiliations, and countries. In addition, it also depicts the major themes, and topics through

temporal and network analysis of GB research, and accordingly the analysis reveals the summarised major key takeaways and their future implications.

The performance analysis indicates the growing case of scientific publications in this area, particularly after 2016 with the increased concerns towards UNO's SDGs, particularly in China, the USA, the UK, and Australia with the author's contributions from the USA, Italy, and Vietnam. This symbolizes the country's higher emphasis on GB. It is also observed by the trend of country collaboration networks where the aforementioned countries are dominating the GB market at a higher level. To this end, it is suggested to conduct research in other developed and developing countries in this domain.

The thematic map and factorial analysis-based results documented that climate change, climate finance, green economy, capital markets, green investment, and blockchain, green bonds, green finance, sustainability, clean energy, bond yield, sustainable finance, sustainable development, clean energy, ESG, institutional investors, and, project finance were highly studied topics. It is likely noted that various green projects such as renewable energy, clean energy, energy efficiency, China, ASEAN, and Arica have appeared as a topic of interest. Moreover, economic growth, infrastructure, project finance, impact investing, sustainable investment, greenwashing, and institutional investors are depicted as a barely researched topic that needs to be explored further for the growth of a green bond market.

As far as results are concerned with the network analysis, the major clusters in and around this domain include sustainable development, sustainability, green bonds, sustainable finance, green finance, and sustainable investment. Therefore, it has turned out that GB as a tool of sustainable finance led the researchers to investigate their overall benefits, particularly financial benefits as well as non-financial benefits for all stakeholders. However, more investigations are required to explore some of the untapped and unexplored key elements which include the consideration of multiple types of GB, the varied perceptions of different investors, integration of new mechanisms such as blockchain technology, and the major impact of projects. To this end, the review devises for policy framework and practical implications to understand the nuts and bolts of GB markets with the introduction of financial and non-financial benefits, particularly for issuers, investors, and society at large.

Despite the additional contributions from this review on GB research, the study highlights certain limitations. First, this study reviewed the entire corpus of articles within the data available through the Scopus database. Second, the articles were limited to the English language only. As this review sheds light on GB research by providing a state-of-the-art overview of green bond market research in the global context, green bond as a focal point of discussion at the country level is not well observed, and this study suggests curating future research at the country level with the main focus on developing countries to understand the overall state of GB markets by exploring the key drivers of this market segment and their greater impact to various stakeholders in attaining the goal of a green economy.

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Author details

Abhilash¹
Sandeep S Shenoy²
E-mail: sandeep.shenoy@manipal.edu
ORCID ID: <http://orcid.org/0000-0002-9848-9718>
Dasharathraj K Shetty³

¹ Department of Commerce, Manipal Academy of Higher Education, Manipal, India.

² Professor and Head, Department of Commerce, Manipal Academy of Higher Education, Manipal, India.

³ Department of Data Science and Computer Applications, Manipal Academy of Higher Education, Manipal India.

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Correction

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Note

1. COP 26 refers to the Conference of Paris Agreement Parties, which was held in Glasgow in 2021 where the parties discussed the problem of Climate Change and followed by certain remedies to combat those serious matters on the part of various countries using their specified pledges.

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