

## DO INVESTORS PAY FOR PURPOSE? A BIBLIOMETRIC ANALYSIS OF SUSTAINABLE BOND PREMIUMS

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**Abstract:** *This study maps research on sustainable bond pricing, focusing on greenium, socium, and sustainium. Using bibliometric and systematic analyses following PRISMA guidelines, 82 Scopus-indexed articles published between January 2019 and September 2025 were reviewed. RStudio with Bibliometrix and VOSviewer was used to visualize publication trends and thematic clusters. Results show rapid growth in research since 2019, along with an increase in the ESG market. Most studies identify a small but consistent greenium, while evidence on socium and sustainium remains limited and mixed due to emerging data and market maturity. Environmental factors are the main drivers of bond pricing, while social and governance factors strengthen transparency and investor trust. This study consolidates fragmented literature and outlines ESG-related determinants of sustainable bond premiums. Future research should examine emerging markets and innovative instruments, such as sustainability-linked bonds, to better understand market incentives for sustainable finance.*

**Keywords:** Greenium, Socium, Sustainable Bonds, Sustainable Finance, Sustainium

### INTRODUCTION

Sustainable finance has shifted from a niche into a central pillar of global finance, driven by agreements such as the 2015 Paris Agreement, which emphasize innovative financing for climate and development goals (Tolliver et al. 2019). Within this framework, sustainable bonds serve as a key instrument for integrating ESG considerations into capital market activities (Negi and Jaiswal 2024; Putri et al. 2025). Sustainable bonds encompass a broad spectrum of instruments, including green, social, sustainability, and sustainability-linked bonds, each characterized by distinct use-of-proceeds structures and incentive mechanisms. Green bonds are allocated explicitly to environmentally beneficial projects, while social

bonds finance initiatives with explicit social objectives, and sustainability bonds combine both (ICMA 2021; 2025b; 2025a). Sustainability-Linked Bonds (SLBs) tie financial features, such as coupon rates, to overall sustainability targets (ICMA 2024), rather than specific projects. Since the World Bank and European Investment Bank launched the first sustainable bonds in 2007–2008, the market has undergone rapid growth and substantial diversification (Banga 2019). The expansion of the sustainable bond market was further accelerated during the COVID-19 pandemic, notably through a surge in social bond issuances to fund public health, employment, and economic recovery programs (Torricelli and Pellati 2023). Recent evidence from Indonesia further highlights that ESG

practices and institutional contexts significantly shape firm performance ([Adnindya and Restuti 2025](#)) and investor perception ([Hasanah and Prabowo 2024](#)), highlighting the critical need to examine how ESG data is ultimately incorporated into market pricing.

The sustainable bond market has growth significantly over the past five years. By the end of 2024, total issuance of labeled sustainable bonds (including all key categories) reportedly exceeded USD 6 trillion ([World Bank 2025b](#)). For the first time, annual global issuance topped USD 1 trillion in 2024, rising about 20–30% from the prior year ([Climate Bonds Initiative 2025](#)). Green bonds led the market, making up about 57% of 2024 sustainable bond issuance ([World Bank 2025b](#)). The market is diversifying, with sustainability bonds gaining popularity, especially in developing countries with integrated climate and social agendas ([World Bank 2025b; 2025a](#)). Recently, the global value of outstanding green bonds neared USD 3 trillion in 2024, up from USD 500 billion in 2018 ([Cheng et al. 2024](#)), reflecting growing demand for ESG assets and policy support.

Amid this growth, an important question arises: do sustainable bond instruments offer issuers a funding cost advantage over conventional bonds? In other words, is there a price premium for sustainable bonds, manifested as a lower yield or higher price, due to the “green” or “social” label attached? In the literature, this phenomenon is known as the “greenium” (green premium) for green bonds, with analogous premiums for social and sustainability bonds termed “socium” (social premium) and “sustainium” (sustainability premium), respectively ([Larcker and Watts 2020; Poggensee 2025; Torricelli and Pellati 2023](#)). Specifically, greenium is the yield gap between a green bond and a comparable conventional bond, with the green bond yielding less due to investor preference for environmentally friendly assets ([Fandella and Cociancich 2024](#)). This concept is mirrored in social bonds (socium) and sustainability bonds (sustainium), suggesting

potential differences in funding costs associated with the ESG label. For issuers, the presence of this premium translates to cheaper debt; for investors, it reflects a willingness to accept lower returns to support sustainability goals ([Sangiorqi and Schopohl 2023](#)).

Academic debate continues whether greenium and similar premiums exist. Some early studies found cost savings for green bond issuers ([Merli et al. 2025; Singh et al. 2025](#)), while others found the opposite or minimal effects ([De Vincentiis and Abis 2025; Lau et al. 2022](#)). The markets for social, sustainability, and sustainability-linked bonds are new, so empirical conclusions are still limited. This lack of consensus presents both challenges and opportunities for better understanding pricing dynamics. With a rapidly growing literature since 2019 and diverse results, a systematic review is essential to map current research and highlight both agreements and differences. A bibliometric analysis can objectively map this field’s evolution, revealing patterns, gaps, and research directions ([Aria and Cuccurullo 2017](#)).

Given this background, the study addresses these key questions about sustainable bond pricing:

1. How have publication trends and the development of research on sustainable bond pricing dynamics progressed?
2. What is the empirical consensus on the existence of greenium, socium, and sustainium?
3. How do thematic research clusters illustrate the key determinants of green, social, and sustainability premiums?
4. What are the future research directions in this field?

By examining these questions, this study aims to comprehensively map scientific work on sustainable bond pricing and its implications for theory and practice.

### **Green Bonds and the Concept of Greenium**

Green bonds are debt instruments allocated explicitly to finance environmentally

beneficial projects ([ICMA 2025a](#)). Their defining feature is the “green” label, which promises environmental benefits while maintaining credit and risk profiles similar to those of conventional bonds ([Hyun et al. 2021](#)). Since the mid-2010s, the green bond market has grown rapidly alongside increasing awareness of climate risk in finance ([Del Giudice et al. 2025](#)). This growth has led to the emergence of the greenium, which refers to the yield gap between a green bond and a similar non-green bond. ([Koziol et al. 2022](#)).

The literature attributes greenium to two main factors: investors’ non-financial satisfaction from supporting environmental projects ([Fricke and Meinerding 2025](#)) and perceptions that green projects carry lower long-term risks ([Zenno and Aruga 2022](#)). Empirical findings are mixed but generally confirm a small, context-dependent premium of 1 to 20 basis points ([Lau et al. 2022](#); [Liang et al. 2025](#)). Some studies report no significant difference or even higher yields, creating what is termed the “green bond premium puzzle” ([Bachelet et al. 2019](#)).

Determinants of greenium include certification, issuer quality, and market conditions. Certified or verified bonds show stronger premiums due to higher investor confidence and lower greenwashing risk ([Mutarindwa et al. 2024](#)). Government and investment-grade bonds also exhibit larger greeniums ([Hu and Tian 2024](#)). Market liquidity and regional investor preferences matter as well, with European markets showing higher premiums due to stronger ESG demand ([Grishunin et al. 2023](#)).

### **Social Bonds and the Concept of Sotium**

Social bonds direct proceeds toward projects which are designed to finance projects generating measurable social outcomes, such as healthcare access, affordable housing, and employment support ([ICMA 2025b](#)). These instruments gained momentum after ICMA’s 2017 Social Bond Principles and saw sharp growth during the COVID-19 pandemic as governments and institutions financed recovery

efforts ([Torricelli and Pellati 2023](#)). The *sotium*, or social premium, mirrors the greenium, describes the potential yield advantage associated with social bonds ([Baldi and Ferri 2025](#)).

Empirical research remains limited but increasingly supports the existence of a small sotium. [García-Escobar et al. \(2025\)](#) documented a social premium, while [Torricelli and Pellati \(2023\)](#) found a statistically significant premium of about 1.2 basis points after controlling for liquidity and volatility. The premium tends to be smaller and more context-dependent than greenium, and is particularly pronounced for public-sector issuers, where transparency and accountability are higher. Bonds with standardized social goals, such as SME financing or healthcare programs, also show stronger pricing advantages ([Baldi and Ferri 2025](#)).

Investor trust and clear reporting are critical to maintaining sotium. Standardized disclosure helps prevent “social-washing” and enhances investor confidence, while lack of transparency can eliminate any observed premium. Overall, the literature highlights that the social bond market is still maturing, but increased standardization and credible reporting can strengthen its role in sustainable finance.

### **Sustainability and Sustainability-Linked Bonds (Towards Sustainium)**

Research on price premiums has recently extended to sustainability bonds and sustainability-linked bonds (SLBs). Sustainability bonds which combine environmental and social objectives ([ICMA 2021](#)), introduce the emerging notion of sustainium, a potential premium reflecting comprehensive ESG alignment ([Kumar 2022](#)). Evidence suggests that sustainability bonds may trade at slightly higher prices and lower yields due to strong investor demand, though the findings remain inconclusive. The magnitude of sustainium depends on project composition: if dominated by environmental objectives, it

resembles a greenium; if focused on social goals, it aligns with *socium* (Kumar 2022). However, limited historical data constrain empirical validation.

SLBs differ structurally in that they are tied to the issuer's sustainability performance rather than to specific project use. Their pricing includes a coupon step-up feature if sustainability targets are missed, which markets often price in advance. Studies find initial yields 1 to 2 basis points lower, reflecting investor optimism and the expected penalty cost for non-compliance (Feldhütter et al. 2024). Thus, the small observed premium in SLBs reflects risk adjustment rather than purely ethical preference.

Overall, *sustainium* remains an emerging concept. For sustainability bonds, premiums arise from investor preference for comprehensive ESG impact, whereas for SLBs, pricing reflects accountability and market efficiency. Both instruments remain underexplored but are expected to gain attention as data availability improves and ESG integration deepens.

## METHOD

This research employs an integrated approach that combines bibliometric techniques with a systematic literature review to examine existing studies in the field comprehensively. This approach was chosen to comprehensively map research on sustainable bond pricing (*greenium*, *socium*, *sustainium*) from both quantitative and qualitative perspectives. The methodological stages are divided into: (1) literature data collection, (2) screening and selection (PRISMA), and (3) bibliometric analysis and thematic mapping.

Literature data were gathered from the Scopus database, chosen for its broad coverage of international publications. The search process was completed in late September 2025 to encompass the most recent publications indexed up to 2025. This implies that the dataset for the year 2025 comprises articles that were formally published and fully indexed up to the

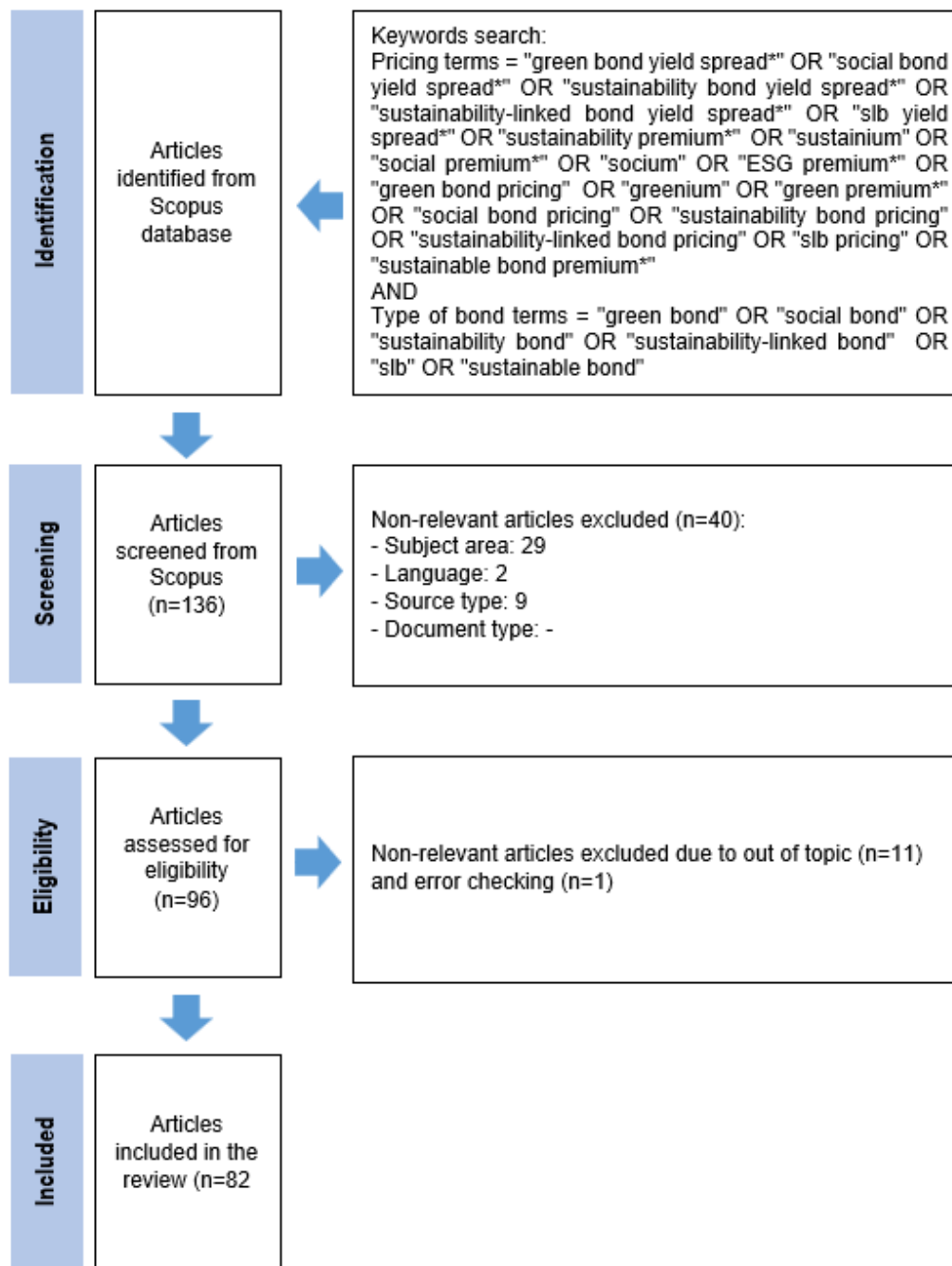
search date and represent verified year to date records. The time scope was constrained to focus on recent literature following the emergence of the *greenium*/*socium*/*sustainium* topics. Keywords reflecting the core topics were used, including: ("green bond yield spread\*" OR "social bond yield spread\*" OR "sustainability bond yield spread\*" OR "sustainability-linked bond yield spread\*" OR "slb yield spread\*" OR "sustainability premium\*" OR "sustainium" OR "social premium\*" OR "socium" OR "ESG premium\*" OR "green bond pricing" OR "greenium" OR "green premium\*" OR "social bond pricing" OR "sustainability bond pricing" OR "sustainability-linked bond pricing" OR "slb pricing" OR "sustainable bond premium\*") AND ("green bond" OR "social bond" OR "sustainability bond" OR "sustainability-linked bond" OR "slb" OR "sustainable bond"). Titles, abstracts, and keywords were used as the primary search fields, generating an extensive initial dataset. Next, the bibliographic data (metadata) for all selected documents was downloaded in CSV format, including titles, authors, sources, abstracts, keywords, and citations.

To maintain analytical rigor and ensure the relevance of the selected studies, this research applied the PRISMA framework for systematic reviews as proposed by Page et al. (2021). The review procedure was conducted through a structured sequence of stages, including identification, screening, eligibility assessment, and final inclusion. During the identification phase, all retrieved records were consolidated and duplicate entries were eliminated. Next, a screening stage was conducted by reading titles and abstracts to eliminate publications that were clearly not relevant. The inclusion criteria applied were: (a) the article falls under the subject areas of Economics, Econometrics and Finance, or Business, Management and Accounting; (b) the article is published in English; (c) the source type is a journal; (d) the article is an article or review article; (e) the main topic concerns at least one

of the following instruments: green bonds, social bonds, sustainability bonds, or sustainability-linked bonds and addresses aspects of pricing, yield, or premium. After screening, an eligibility evaluation was performed by reviewing the full texts of publications whose relevance remained

in doubt, and final inclusion was then determined.

The overall study selection process is summarized in the PRISMA flow diagram shown in Figure 1. In total, approximately 82 studies met the inclusion criteria and were included in the bibliometric analysis.



**Figure 1. PRISMA diagram flow.**  
Source: Author's own compilation, 2025.

**Table 1. Summary Of The Key Characteristics Of 82 Articles Analyzed**

Description	Results
<b>MAIN INFORMATION ABOUT DATA</b>	
Timespan	2019:2025
Sources (Journals, Books, etc)	48
Documents	82
Annual Growth Rate %	76.27
Document Average Age	1.54
Average citations per doc	33.02
References	514
<b>DOCUMENT CONTENTS</b>	
Keywords Plus (ID)	103
Author's Keywords (DE)	222
<b>AUTHORS</b>	
Authors	223
Authors of single-authored docs	0
<b>AUTHORS COLLABORATION</b>	
Single-authored docs	0
Co-Authors per Doc	5.39
International co-authorships %	26.83
<b>DOCUMENT TYPES</b>	
article	81
review	1

Source: Processed using the Biblioshiny R-package (Bibliometrix), 2025.

We then conducted bibliometric analysis and thematic mapping. We analyzed the final dataset in RStudio using the Bibliometrix package ([Aria and Cuccurullo 2017](#)) via the Biblioshiny interface, and used VOSviewer ([Eck and Waltman 2010](#)) for network visualization. The bibliometric analysis comprised two components: performance analysis and science mapping. Performance analysis was used to describe publication trends and significant developments. Subsequently, science mapping was conducted to examine research consensus and the thematic clusters of premium determinants. The entire process adhered to the principles of transparency and reproducibility: the list of analyzed publications and the R code used for analysis are available in line with open science practices. Thus, this methodology provides a strong foundation for producing a comprehensive and objective bibliometric review

of the pricing dynamics of sustainable bonds (greenium, socium, sustainium).

## RESULTS

### Descriptive Statistics of the Dataset

This subsection outlines the descriptive statistics of the final dataset, offering an overview of its scope and composition as a preliminary step before addressing the research questions. As summarized in Table 1, the analysis covers 82 Scopus-indexed journal articles published between January 2019 and September 2025. The dataset covers 48 academic journals and includes contributions from 223 authors, characterized by an average of 5.39 co-authors per article and an international collaboration rate of 26.83%. The average citation count per document is 33.02, indicating a relatively high scholarly impact for a rapidly emerging research field. These statistics

describe the basic characteristics of the dataset but do not yet explain how the research field has evolved over time.

### *RQ1: Publication Trends and Research Developments*

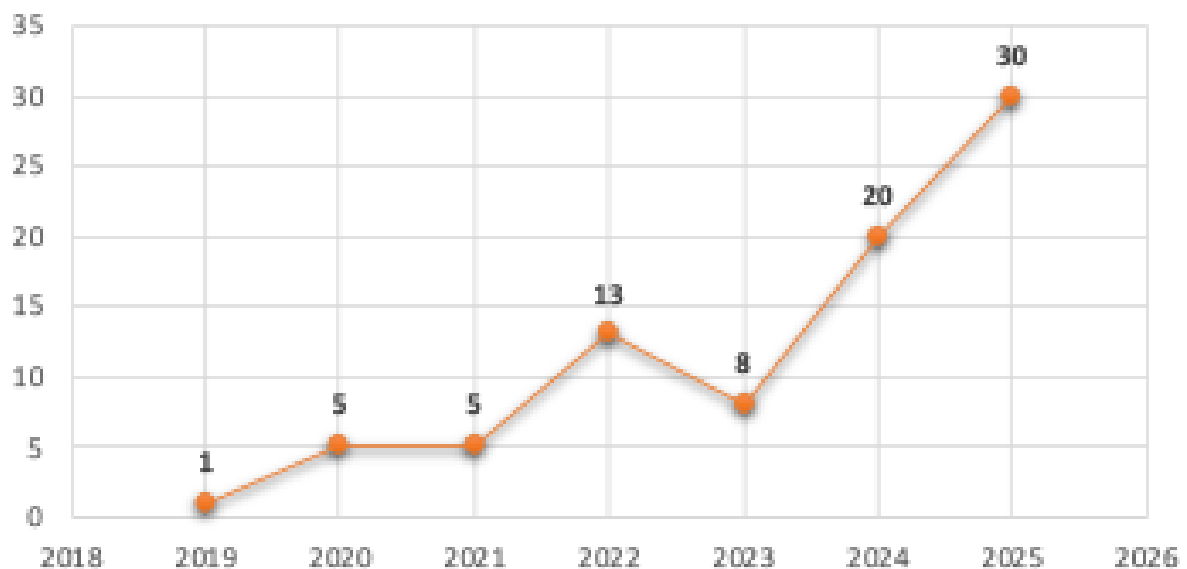
This section explicitly addresses RQ1 by examining publication trends and research development in the sustainable bond pricing literature, which is organized into dedicated subsections.

#### *Rapid Growth in Publications*

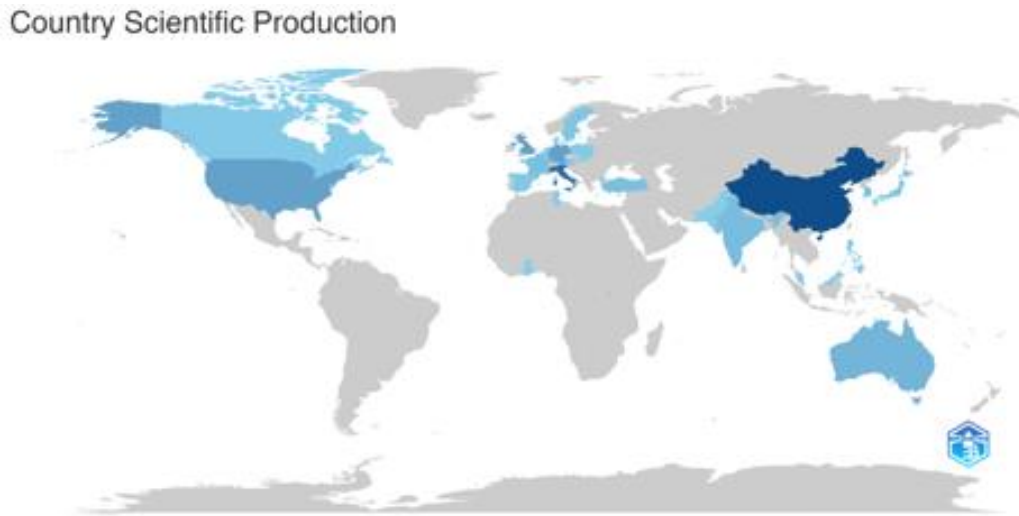
Figure 2 shows the evolution of scholarly output on sustainable bond pricing between January 2019 and September 2025, based on finalized and fully indexed Scopus records available as of the search date. The figure demonstrates a pronounced and

sustained growth in publication volume over time, with particularly strong growth observed after 2020. This pattern indicates a rapid expansion of academic interest in the pricing dynamics of sustainable bonds, supported by an annual publication growth rate of 76.27%, indicating a pronounced and sustained expansion in research output, especially in the post-2020 period. This surge did not occur in a vacuum; it aligns with significant developments in global financial markets. The strengthening of green finance practices and the heightened urgency of sustainable finance, accelerated by social bond issuance during the COVID-19 pandemic ([Torricelli and Pellati 2023](#)), have been the main drivers.

## Publication Trend



**Figure 2. Publication trend 2019 - Sept 2025**  
Source: Author's own compilation, 2025



**Figure 3. Country Scientific Production**

Source: Processed using the Biblioshiny R-package (Bibliometrix), 2025.

*Global Research Characteristics and Collaboration*

Along with this rapid growth, the research landscape has been shaped by its global scale and a high level of collaboration. The geographic distribution data in Figure 3 reinforce this dimension of international collaboration. Countries shaded darker blue published more articles. China and the United States are the most significant contributors, marked by the darkest blue. Several Western European countries (such as the UK, Germany, and Italy) and Asia-Pacific countries (such as

India and Australia) also show a moderate number of publications (lighter blue). This aligns with the fact that the largest sustainable bond markets are in China, Europe, and North America, most of the research originates from those regions. The dominance of China and the United States indicates high academic interest commensurate with the large volume of sustainable bond issuance in those countries. On the other hand, developing countries and different regions have relatively low contributions, indicating broader opportunities for cross-country research in the future.

**Table 2. Most Relevant Journals**

Journals	Articles	Total Citations	Quartile
Finance Research Letters	10	261	Q1
Journal Of Cleaner Production	4	263	Q1
Eurasian Economic Review	4	116	Q2
International Review Of Economics And Finance	4	50	Q1
Journal Of Risk And Financial Management	3	44	Q2
British Accounting Review	2	48	Q1
Energy Economics	2	46	Q1
Environmental And Resource Economics	2	79	Q1
Journal Of Asset Management	3	19	Q2
Journal Of Business Ethics	2	5	Q1
Journal Of Financial Economics	2	392	Q1

Source: Processed using the Biblioshiny R-package (Bibliometrix), 2025.

### Journal Map and Disciplinary Landscape

The publication mapping shows that research on sustainable bond pricing has evolved into a multidisciplinary field that integrates diverse aspects. According to Table 2, this research is most frequently published in *Finance Research Letters* (10 articles, Q1), followed by the *Journal of Cleaner Production* (4 articles, Q1), *Eurasian Economic Review* (4 articles, Q2), and *International Review of Economics and Finance* (4 articles, Q1). This pattern indicates that studies on greenium, socium, and sustainium are developing in finance and applied economics journals with a sustainability orientation. The presence of journals such as the *Journal of Risk and*

*Financial Management* and the *Journal of Asset Management* confirms that this topic extends to risk management and investment portfolio strategy. At the same time, publications in *Energy Economics* and *Environmental and Resource Economics* reflect its connection to energy economics. Moreover, the inclusion of *British Accounting Review*, *Journal of Business Ethics*, and *Journal of Financial Economics* indicates a strengthening of business ethics approaches, sustainability accounting, and conventional financial theory within this research stream. With high total citations in top-tier (Q1) journals, this distribution shows that research on sustainable bond pricing has become a holistic field of study.

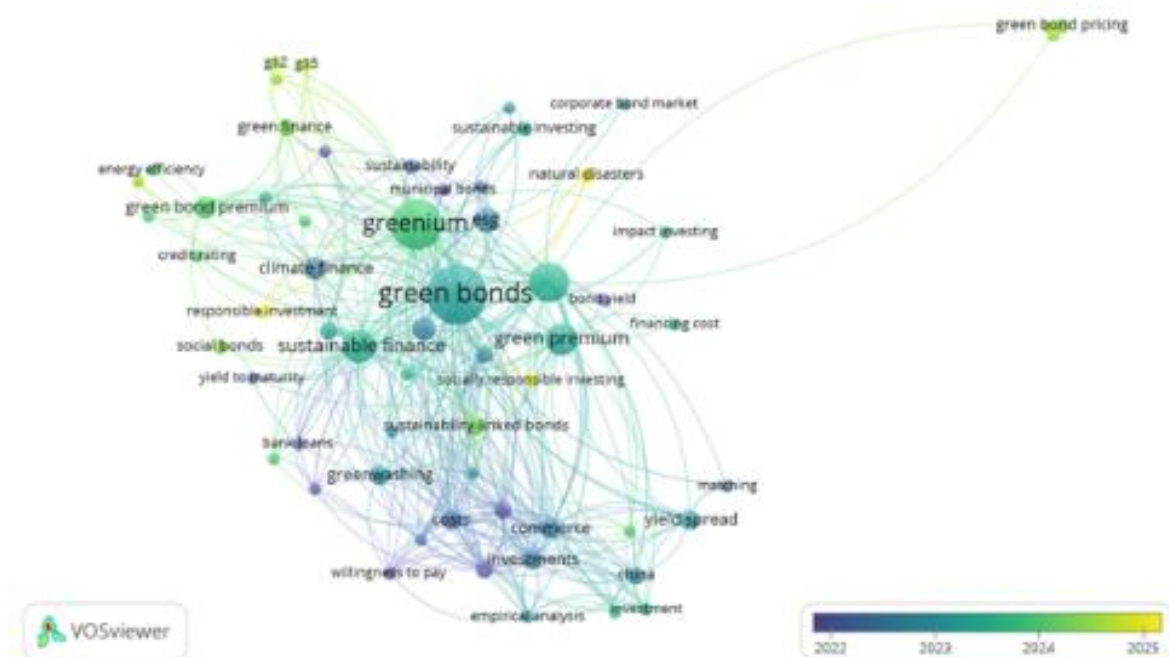


Figure 4. Overlay Visualization (Time-based).

Source: Processed using VoSviewer, 2025.

**Table 3. Most Cited Documents**

ID	Purpose	Subject	Method	TC	Reference
1	To analyze the historical performance of green assets and argue that recent high returns are due to unexpected increases in environmental concerns.	US stocks (Nov 2012-Dec 2020) and German "twin" bonds.	Return Analysis	381	<a href="#">(Pástor et al. 2022)</a>
2	To investigate whether investors are willing to trade financial benefits for societal benefits by comparing green municipal bonds with nearly identical non-green bonds.	640 matched pairs of US municipal bonds (green and non-green) issued on the same day.	Matching Analysis	306	<a href="#">(Larcker and Watts 2020)</a>
3	To provide evidence of the debt and stock market reaction to corporate green bond issuance in China.	159 corporate green bonds and their 297 conventional counterparts in China (2016-2019).	Multivariate Regression & Event Study	269	<a href="#">(Wang et al. 2020)</a>
4	To achieve a consensus on the existence of a green premium through a systematic literature review and to identify its determining factors.	15 academic and industry studies on the green premium (2007-2019).	Systematic Literature Review & Correlation Analysis	220	<a href="#">(MacAskill et al. 2021)</a>
5	To investigate the pricing of green bonds at issuance and explain why there is no "greenium" for financial institution issuers.	A large sample of bonds issued worldwide (2007-2018), including 1,397 green bonds.	OLS Regression	212	<a href="#">(Fatica et al. 2021)</a>

Source: Author's own compilation, 2025.

**Evolution of Research Trends**

Figure 4 presents an overlay visualization of the research keyword network for sustainable bonds. The color of each node indicates the average year of appearance of that keyword in publications (purple = earlier; yellow = more recent). Larger nodes indicate keywords that appear more frequently. In the early period (2019–2020, colored purple/blue), the dominant topics were "green bonds," "greenium," and "sustainable finance." This reflects an early stage of research concentrating on the core concepts of green bonds and green premiums within the sustainable finance literature. Subsequently, topics such as "climate finance" "green bond premium" (light green) emerged around 2021–2022, marking the beginning of

numerous empirical studies on green bond yield differentials. In the most recent period (2023–2024, shown in yellow), new keywords like "ESG," "natural disasters," and "yield spread" appeared. The emergence of ESG reflects a new research direction that links green bond performance to environmental, social, and governance (ESG) scores. Meanwhile, the increasing attention to natural disasters indicates an emerging body of research on the impact of physical climate risks on the bond market. Overall, this overlay shows that the research focus has shifted from merely proving the existence of a green premium toward a broader understanding, including sustainability factors (ESG, climate risk) and external shocks (e.g., the COVID-19 pandemic, natural

disasters) on the dynamics of sustainable bond pricing.

### *Key Studies*

As the number of publications has grown, the influence of a few key works has become very prominent in shaping the scientific discourse. Many new studies cite earlier papers considered foundational. In total, the 82 documents in the dataset have an average of 33 citations per document (Table 1), indicating a fairly high impact for a relatively young field. Table 3 shows the five most-cited articles. The study by [Pástor et al. \(2022\)](#) is the most influential, with 381 citations. This paper discusses the historical performance of green assets and how rising environmental concerns have driven their returns. Next is the study by [Larcker and Watts \(2020\)](#) (306 citations), which compares green vs non-green municipal bonds and is a key reference on whether investors are willing to sacrifice financial gains for social benefits. The research by [Wang et al. \(2020\)](#) (269 citations), examining stock and bond market reactions to corporate green bond issuance in China, is also highly cited. Additionally, a systematic review by [MacAskill et al. \(2021\)](#) (220 citations) and an empirical study by [Fatica et al. \(2021\)](#) (212 citations) have shaped the consensus on the existence of a greenium and its determinants. The high citation counts of these works indicate that the research community is using them as theoretical and methodological foundations for subsequent studies.

### *RQ 2: Empirical Consensus on Greenium, Socium, and Sustainium*

RQ 2 examines whether the literature reaches an empirical consensus regarding the existence of pricing premiums for sustainable bonds. A central issue in this strand of research is whether green, social, or sustainability bonds are priced at a premium relative to comparable

conventional bonds. In this context, a negative yield premium for green bonds is commonly referred to as a greenium, while the corresponding premiums for social and sustainability bonds are termed socium and sustainium, respectively. Overall, the empirical evidence points to a partial consensus. The majority of studies document a small but statistically significant greenium, whereas the evidence for socium and sustainium remains limited and mixed.

Figure 5 complements this discussion by visually synthesizing the distribution of empirical findings on greenium, socium, and sustainium across the reviewed studies, thereby reinforcing the current state of consensus in the literature. The co-occurrence network highlights that research on sustainable bond pricing remains strongly centered on the concepts of greenium and market performance, as indicated by the dominance of the red cluster. This concentration suggests that greenium remains the central theme in the academic literature, reflecting ongoing interest in understanding yield differentials between green and conventional bonds. The sustained focus on greenium aligns with the partial consensus found in empirical studies, which generally agree that a small but persistent premium exists under certain conditions ([Löffler et al. 2021](#); [MacAskill et al. 2021](#); [Pástor et al. 2022](#)). The clustering pattern further illustrates that scholars are increasingly investigating the determinants and contextual drivers of this premium, including factors such as market liquidity ([Yan et al. 2025](#)), certification and issuer reputation ([Mutarindwa et al. 2024](#)), and macroeconomic or regulatory influences ([Wang et al. 2020](#)). Collectively, this network visualization underscores that while the existence of greenium is partly established, the literature continues to evolve toward understanding the complex market mechanisms that sustain it.



linked bonds (SLBs) indicates that corporate SLBs may trade at slightly higher yields than traditional green bonds due to investor skepticism about meeting sustainability targets and concerns about greenwashing (Feldhütter et al. 2024). Overall, the available evidence suggests that while *socium* and *sustainium* represent critical new dimensions in sustainable finance, both concepts are still in formative stages, and further empirical research is needed to determine whether investors consistently assign pricing premiums to these instruments.

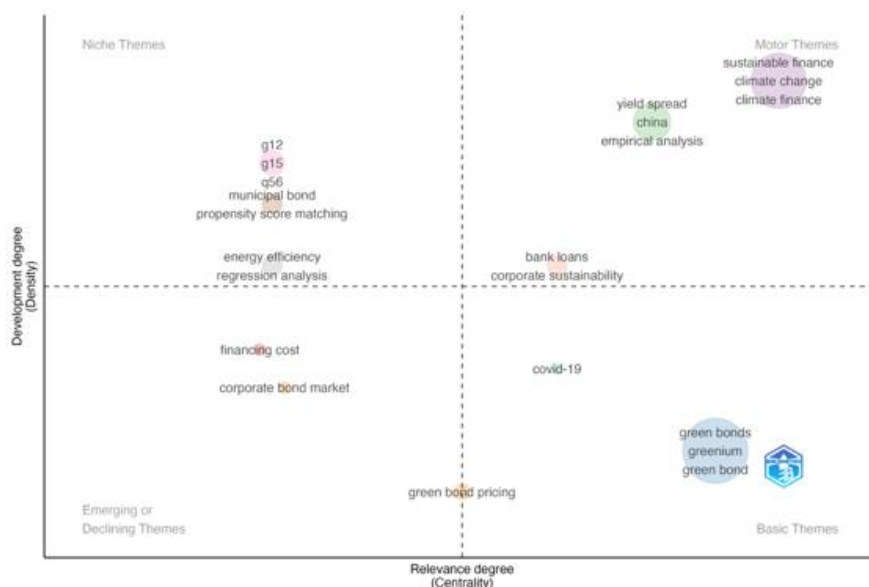
*RQ 3: Thematic Clusters and Determinants of Sustainable Bond Premiums*

RQ3 focuses on identifying thematic clusters and key determinants of sustainable bond premiums. Figures 6 and 7, supported by the quantitative metrics in Table 4, reveal three interrelated thematic dimensions aligned with the ESG framework: environmental, social, and governance, to highlight the key determinants of sustainable bond premiums through a transparent and data driven methodology.

*Environmental Dimension*

The environmental dimension, centered on climate and environmental factors, emerges as a Motor Theme due to its high centrality and density in the thematic map, which is

quantitatively evidenced by the massive betweenness centrality of green bond pricing at 1,455.167 and sustainable development at 1,202.731. This cluster highlights climate finance and climate change as major drivers of green premium research, emphasizing the role of green bonds in financing climate mitigation and attracting environmentally conscious investors (MacAskill et al. 2021). The prominence of climate finance reflects a consensus that environmental considerations are key determinants of the greenium, which is generally small, ranging from 1 to 9 basis points in secondary markets (MacAskill et al. 2021). Investor awareness of climate risks has strengthened demand for green bonds, reinforcing the link between environmental responsibility and pricing (Liang et al. 2025), while concerns over greenwashing undermine investor trust and weaken the green premium (Baldi and Pandimiglio 2022). The impact of physical environmental risks is further evidenced by the betweenness centrality score of natural disasters at 102.953, which directly influences default probabilities and bond pricing (Del Giudice et al. 2025). Overall, the environmental dimension underscores that credible climate commitment, transparency, and genuine allocation of funds to green projects remain essential determinants of the green premium.



**Figure 6. Thematic Map.**

Source: Processed using the Biblioshiny R-package (Bibliometrix), 2025



ensuring that transparency and certification are recognized as primary and independent determinants of the sustainable bond premium. These themes illustrate how governance factors, such as third party certification and transparent disclosure shown in the co-occurrence network, are essential for reducing information asymmetry and ensuring pricing efficiency (Hyun et al. 2021; Bachelet et al. 2019). The data from Table 4 shows that robust governance reduces the perceived risk of greenwashing, as reflected in its link to credit rating at 178.360 and primary market transparency at 110.305, both of which are vital for establishing market credibility.

Furthermore, certified or labeled green bonds tend to exhibit larger greeniums than uncertified ones (Mutarindwa et al. 2024), and similar effects are reported in China, where third-party certification narrows yield spreads through improved transparency (Zenno and Aruga 2022). Policy initiatives such as the ECB’s green

bond purchase program also reduce yields and increase liquidity (Arat et al. 2023), while stronger ESG regulations promote more accurate risk-based pricing (Hao and Guan 2025). By providing this level of institutional oversight, the governance pillar ensures that the positive environmental and social impacts of bond issuances are accurately priced, ultimately fostering a more efficient and trustworthy sustainable investment environment where the integrity of the market is maintained through rigorous disclosure standards.

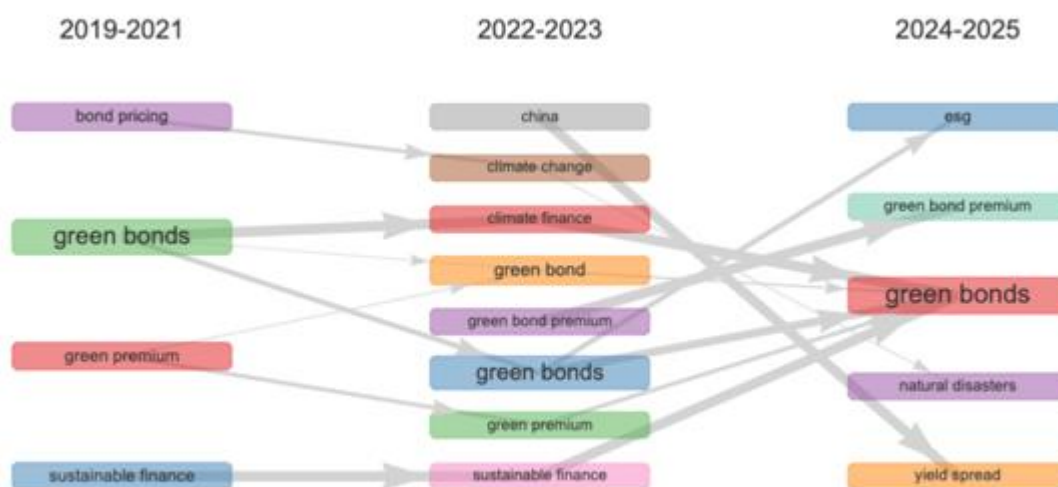
#### RQ 4: Future Research Directions

RQ4 addresses future research directions based on thematic evolution analysis. Figure 8 depicts the evolution of sustainable bond research themes across three time periods: 2019–2021 (left), 2022–2023 (middle), and 2024–2025 (right).

**Table 4. Most Representative Keywords**

Keywords	Thematic Cluster	Occurences	Betweenness Centrality
green bond pricing	green bond pricing	11	1,455.167
sustainable development	sustainable finance	4	1,202.731
yield spread	yield spread	3	906.027
financing cost	financing cost	2	738.640
financial markets	sustainable finance	4	609.349
sustainability-linked bonds	sustainable finance	4	552.549
green economy	sustainable finance	4	550.844
bank loans	bank loans	10	358.996
green finance	green bonds	2	259.296
responsible investment	green bonds	2	249.820
bond pricing	sustainable finance	4	242.825
bond yield	green bonds	2	190.055
credit rating	green bonds	2	178.360
sustainability	green bonds	2	162.038
primary market	green bonds	2	110.305
natural disasters	green bonds	2	102.953
impact investing	green bonds	2	72.650
social bonds	green bonds	2	29.779
socially responsible investing	green bonds	2	27.86

Source: Processed using the Biblioshiny R-package (Bibliometrix), 2025.



**Figure 8. Thematic Evolution**

Source: Processed using the Biblioshiny R-package (Bibliometrix), 2025

Each colored box represents a major theme/keyword in that period, with the size of the box proportional to the number of publications covering that theme. Arrows connect the same or related themes across periods. We can see that themes “green bonds” (green box) and “green premium” (red box) appear from the earliest period and continue consistently through the latest period, indicating that both are common threads in research from 2019 to 2025. Themes such as “climate change” and “climate finance” emerged in the middle period (2022–2023) and continued as part of the broader sustainability theme in 2024–2025. The appearance of “ESG” and “natural disasters” only in the 2024–2025 period shows that these topics have only recently received major attention. Conversely, themes “bond pricing” and “sustainable finance”, which were separate in 2019–2021, merged into a larger theme in the subsequent period. This evolution reflects a shift in research focus that is adaptive to context: from

the fundamentals of premiums to new factors such as ESG performance and climate risk

In line with the bibliometric findings above, it can be concluded that research on sustainable bonds will continue to expand in scope, integrating environmental, social, and economic aspects and adopting more sophisticated approaches. Researchers and stakeholders will continue to explore whether and how the bond market can support the transition toward sustainable development. Questions such as “Does the greenium reflect the price of saving the planet?” are likely to be raised more often, not only in financial terms but also from a policy perspective. As the literature evolves in that direction, the role of the bond market in achieving sustainable development goals (SDGs and the Paris Agreement) is expected to become clearer, whether through price incentives (green, social, sustainability premiums) or other mechanisms. In turn, this understanding can help policymakers mobilize capital more effectively to green and social

projects, and help investors allocate funds with consideration for both financial returns and sustainability impact. Academic inquiry into sustainable bond markets contributes to embedding sustainability objectives within financial innovation, encouraging the creation of a more inclusive and environmentally conscious financial system

## CONCLUSION

This research investigates the evolution of both the pricing mechanisms and the market development of sustainable financial instruments in response to the expanding global prioritization of environmental, social, and governance (ESG) issues. Research on greenium, socium, and sustainium has grown rapidly since 2019, reflecting the expansion of the green and social bond markets. The literature has shifted from proving the existence of price premiums to exploring the ESG factors that drive them. Findings indicate a general consensus that a greenium exists, although small and context-dependent, while socium and sustainium remain inconsistent due to limited studies and data.

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Environmental factors are identified as the main drivers of sustainable bond premiums, reflecting investor preference for climate-related projects. Social factors are gaining importance as attention to social impact increases, and governance ensures transparency, credibility, and investor trust. Together, these dimensions form an integrated framework for understanding pricing dynamics in sustainable finance. Future research should expand to cross-country contexts, particularly in emerging markets, and further examine sustainability-linked bonds and market mechanisms that incentivize issuers. Despite limitations related to language, data scope, and keyword dependence, this study provides a comprehensive overview of research trends and establishes a foundation for future work on ESG-related premiums in sustainable bond markets.

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