Exploring the ESG–Green Credit Nexus: Evidence from Bibliometric and Systematic Perspectives

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Abstract

This study explores the intersection between Environmental, Social, and Governance (ESG) practices and green credit, focusing on their reciprocal relationship in sustainable finance. The research combines bibliometric analysis and systematic review to map the ESG–green credit nexus, identifying key trends, leading authors, and thematic clusters in the field. Using tools like VOSviewer and Biblioshiny, the bibliometric analysis examines publication patterns and sources, while the systematic review synthesizes the ten most cited studies to uncover the causal mechanisms linking ESG and green credit. Findings indicate that green credit enhances environmental performance, while better ESG performance improves access to green financing and reduces costs, driving investment in sustainable innovations. Emerging trends include the integration of fintech and digital transformation in ESG reporting, where technologies like blockchain and AI improve transparency and the efficiency of green credit allocation. However, concerns about greenwashing highlight the need for stronger governance mechanisms to ensure the credibility of ESG practices. Despite these advances, challenges such as regional disparities and inconsistent ESG measurement standards remain. This study provides practical recommendations for policymakers and financial institutions, urging alignment of green credit policies with ESG goals to foster sustainable development and support the transition to a low-carbon economy.

Research purpose:

The purpose of this study is to explore the intersection between Environmental, Social, and Governance (ESG) practices and green credit, investigating the mutual relationship between these two dimensions of sustainable finance. By employing bibliometric analysis and systematic review, this research aims to map the structural landscape and identify critical mechanisms that link ESG performance and access to green financing.

Research motivation:

The growing emphasis on sustainability in business practices has led to increasing interest in the role of green credit in enhancing ESG performance. Despite the expanding literature, significant gaps remain in understanding how ESG and green credit interact, particularly across different geographic contexts. This research seeks to address these gaps, offering a more comprehensive understanding of their mutual relationship and implications for sustainable finance.

Research design, approach, and method:

This study employs a mixed-methods approach, combining bibliometric analysis and systematic review. The bibliometric analysis utilizes tools such as VOSviewer and Biblioshiny to identify trends, key authors, sources, and thematic clusters within the ESG and green credit research domain. The systematic review synthesizes the findings from the ten most influential articles, focusing on the causal mechanisms and empirical evidence linking ESG practices with green credit access.

Main findings:

The study reveals a strong reciprocal relationship between ESG practices and green credit. Green credit enhances environmental performance, while superior ESG performance improves access to green financing. Emerging trends include the integration of fintech, digital transformation in ESG disclosure and the rising concern over greenwashing risks. These factors highlight the need for stronger governance in green credit policies. However, regional disparities and inconsistencies in ESG measurement remain significant challenges.

Practical/managerial implications:

The findings suggest that policymakers and financial institutions should align green credit policies with ESG objectives to foster more sustainable business practices. By providing clear frameworks for ESG measurement and incentivizing green innovation, financial institutions can better support businesses in their transition towards sustainability. This research also highlights the importance of cross-country comparisons to inform global policies and standards.

Keywords: ESG, ESG performance, green credit, sustainable finance, innovation, greenwashing

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1. INTRODUCTION

In the face of pressing global challenges such as climate change, resource depletion, and social inequality, sustainable development has become a strategic priority for governments, businesses, and financial institutions alike. Among the frameworks that seek to promote corporate sustainability, Environmental, Social, and Governance (ESG) has emerged as a central paradigm. ESG encompasses three key dimensions: the environmental management of emissions and resources, the social responsibilities toward employees, customers, and communities, and the governance structures ensuring transparency, accountability, and shareholder rights. Far from being a purely non-financial metric, ESG performance has been shown to influence firm value, reduce financing costs, and enhance reputation and stakeholder trust (Li et al., 2021; De Giuli et al., 2023). The global surge of interest in ESG has been reinforced by the adoption of international reporting standards such as GRI, SASB, ISSB, and CSRD, along with the rise of responsible investment and green finance initiatives.

Beside, green credit has become a cornerstone of sustainable finance, directing capital flows toward environmentally friendly projects while restricting credit to polluting industries. Rooted in initiatives such as the Equator Principles (Wright & Rwabizambuga, 2006), green credit plays a dual role: mitigating environmental and social risks for lenders, and incentivizing firms to pursue sustainable transitions (Nandy & Lodh, 2012). Recent evidence suggests that green credit can act as both a driver and amplifier of ESG practices, improving innovation, reducing carbon emissions, and enhancing firms' resilience (Han, 2023; Jiang & Ma, 2024; Li et al., 2024; Kong et al., 2024).

Despite these advances, the literature on ESG and green credit remains fragmented and underdeveloped in several respects. Empirical studies are geographically concentrated, with a strong focus on China, leaving cross-country comparative insights scarce. Measurement practices for ESG are inconsistent across rating agencies and datasets, leading to divergent results and challenges in generalization. While findings suggest that green credit policies can strengthen ESG performance and lower financing costs, the causal mechanisms remain contested, particularly regarding the roles of financial constraints, innovation pathways, and potential credit spillovers. Moreover, concerns about greenwashing and credibility risks are increasingly recognized but still insufficiently theorized or empirically validated. Finally, emerging themes—such as fintech-enabled ESG disclosure, digital finance platforms, and advanced data analytics—have yet to receive systematic academic attention.

Against this backdrop, the present study seeks to provide a comprehensive overview of the ESG - green credit nexus by combining bibliometric analysis with systematic review. The bibliometric analysis maps publication trends, leading contributors, and thematic clusters (Donthu et al., 2021), while the systematic review synthesizes the contributions of the most influential studies to uncover causal mechanisms and empirical evidence (Pollock et al., 2018). This dual approach enables both a broad structural perspective and an in-depth content analysis, thereby offering a holistic understanding of the field.

Accordingly, the study is guided by the following research questions:

- RQ1: What are the prevailing trends, leading authors, relevant sources and core countries in the green credit and ESG research domain?
- RQ2: What are the primary thematic clusters that define the intellectual structure of this field?
- RQ3: What does a systematic synthesis of the most influential studies reveal about the causal mechanisms and empirical evidence linking green credit and ESG?
- RQ4: Based on the identified gaps and trends, what are the promising avenues for future research?

By addressing these questions, the paper contributes to consolidating a fragmented body of literature, offering theoretical and practical insights into how ESG and green credit can jointly advance the goals of sustainable finance and corporate responsibility. Section 2 describes in detail the database selection, search strategy, and screening process, followed by the bibliometric and systematic review methodologies. Section 3 presents the results of the bibliometric analysis, including performance indicators, scientific mapping visualizations, and the identification of core thematic clusters. Section 4 complements these findings with a systematic review of the most influential studies, providing deeper insights into the mechanisms linking ESG and green credit. Section 5 discusses the main contributions, highlights future research directions. Finally, section 6 concludes the paper by summarizing key findings and limitations.

2. METHODOLOGY

2.1. Data collection and screnning process

This study leverages Scopus, a renowned database offering extensive coverage (22,000+ journals) and well-structured scientific data. Its rigorous review process ensures data accuracy and reliability, making it a valuable tool for gathering information and conducting analyses (Donthu et al., 2021). The data collection and screening process followed the PRISMA 2020 guidelines (Page et al., 2021) to ensure transparency and replicability.

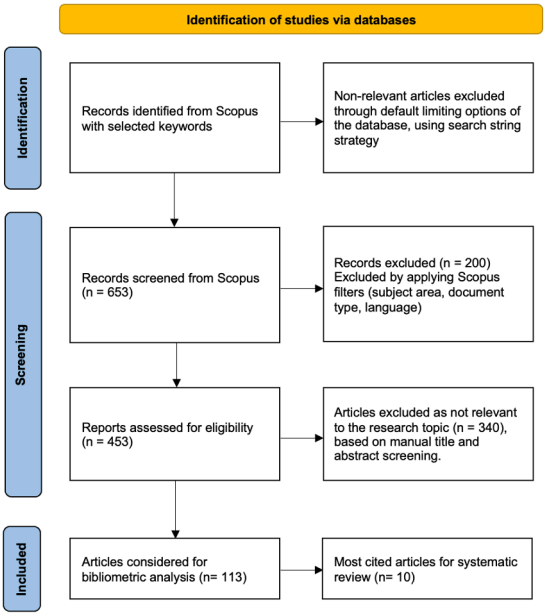

Fig. 1: PRISMA diagram

The initial search was conducted using the following string: ("ESG" OR "environmental, social, governance" OR "corporate sustainability" OR "sustainability performance") AND ("green credit" OR "green loan" OR "green bond" OR "sustainability-linked loan*" OR "sustainable bond*" OR "green finance" OR "environmental finance"). The search was limited to the period from 2012 to August 2025, which returned a total of 653 publications. This set of keywords was designed to capture a wide range of concepts in sustainable finance, combining ESG-related performance with various green financial instruments such as loans and bonds, thereby ensuring broad coverage of the research domain.

In the subsequent step, additional refinement criteria were applied. Publications were limited to the following subject areas: Economics, Econometrics and Finance; Social Sciences; Business, Management and Accounting; Environmental Science; Energy; and Decision Sciences. Moreover, only Articles and Reviews written in English were included. Applying these restrictions reduced the dataset to 453 publications. At the final screening stage, a manual screening of titles and abstracts was conducted to ensure relevance to the research scope. As a result, the dataset was further refined, yielding a total of 113 articles deemed highly relevant to the topic, which were then selected for in-depth analysis.

To deepen the insights, we further select the most 10 highly cited articles from the bibliometric dataset and subject them to an additional systematic review. This dual approach not only maps the broader structure of the field but also provides a qualitative understanding of the core contributions, thereby linking quantitative patterns with substantive theoretical and empirical developments.

2.2. Bibliometric analysis and systemetic review

Bibliometric analysis, increasingly popular in business and economic studies, was employed to comprehensively map the research landscape of ESG and green credit. This study utilizes Biblioshiny and VOSviewer to identify key trends and patterns. Performance analysis and science mapping were applied to assess research components and their interconnections (Donthu et al., 2021). Specifically, co-word, co – occurrence keywords and thematic analyses were combined to examine the

field's past, present, and future, revealing its knowledge structure (Iwami et al., 2020). The integration of these network metrics is essential for accurately defining the field's conceptual framework. Biblioshiny, a web-based R tool, was used for automation and adaptability (Van Eck et al., 2010), while VOSviewer complemented the analysis with advanced visualization capabilities for conceptual maps and research networks (Zupic et al., 2015).

A systematic review is a rigorous and structured method of synthesizing evidence to answer predefined research questions. Unlike narrative or traditional literature reviews, systematic reviews rely on explicit, transparent, and reproducible methods to identify, select, appraise, and synthesize relevant studies (Pollock & Berge, 2018). The process typically involves several key stages: defining clear research aims and eligibility criteria, conducting a comprehensive search across databases, screening and selecting relevant studies, critically assessing the methodological quality of included research, and synthesizing findings through narrative or quantitative approaches such as meta-analysis.

3. Bibliometric analysis

3.1. Performance analysis

Performance analysis, as a core technique of bibliometric analysis, evaluates the productivity and impact of a research field, thereby addressing **RQ1**. By using the bibliometric analysis, this analysis is like profiling of participants in research articles. In this study, the performance analysis is conducted to present publication and citation trends, the most influential journals and the most influential authors and countries. The primary data is presented in Table 1, accompanied by the average number of articles and citations received per year.

The performance analysis of the dataset reveals that research on ESG and green credit is a young but rapidly expanding field. Covering the period 2021–2025 (August), the final sample consists of 113 articles published across 63 different journals, indicating broad scholarly interest but without a single dominant outlet. The field exhibits remarkable dynamism, with an annual growth rate of 92.27% and an average document age of just one year, underscoring its recent emergence. Despite its youth, the articles demonstrate significant scholarly impact, receiving on average 29.29 citations per document, which reflects strong and immediate engagement by the academic community. The 113 documents collectively cite 6,679 references, suggesting that the literature builds on a substantial and diverse knowledge base. Authors' keywords are highly diverse (280 unique terms), pointing to the fragmentation and multidimensionality of research themes in this area. The dataset includes 347 unique authors, with an average of 3.16 co-authors per document, highlighting the collaborative and interdisciplinary nature of the field. Only seven papers (≈ 6%) are single-authored, further reinforcing the importance of research networks. Taken together, these indicators confirm that ESG and green credit represent a fast-growing, interdisciplinary, and high-impact domain, where research clusters are still consolidating and knowledge structures are actively evolving.

Table 1: Main information

Description	Results
Timespan	2021:2025
Sources	63
Articles	113
Annual Growth Rate %	92,27
Document Average Age	1
Average citations per doc	29,29
References	6679
Author's Keywords (DE)	280
Authors	347
Authors of single-authored docs	7
Single-authored docs	7
Co-Authors per Doc	3,16

3.1.1. Publication and citation trends

The annual distribution of publications indicates a rapid acceleration of research output on ESG and green credit, shown in Figure . The dataset covers the period from January 2021 to August 2025, with 2025 data being incomplete at the time of

analysis. When considering only the full years 2021–2024, the growth trajectory follows an exponential trend with R^2 = 0.9786, confirming the strong upward momentum of the field. Starting from just a few publications in 2021, the annual output expanded steadily, reaching more than 45 articles in 2024. Although the data for 2025 are partial, 41 articles had already been published by August, suggesting that the total for the year is likely to surpass previous records. This pattern highlights the increasing scholarly attention to ESG and green credit in recent years, reflecting its rising importance in both academic research and practical policy debates.

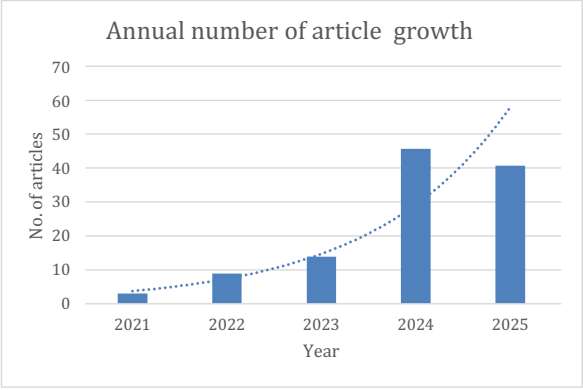

Fig. 2. The annual publication growth

The citation analysis by publication year, as shown in Table 2, indicates that the impact of early studies is particularly strong, reflecting the novelty and foundational role of initial contributions in this field. In 2021, although only three articles were published, they achieved an average of 41.67 citations per article (8.33 citations per year across five citable years). The impact peaked in 2022, where nine articles reached an average of 133 citations per article, corresponding to over 33 citations per year, underscoring the significant influence of early research on ESG and green credit. Publications from 2023 also demonstrate sustained visibility, with 14 articles averaging 81.71 citations per article (27.24 citations per year).

By contrast, more recent years naturally show lower citation averages due to limited time for scholarly uptake. Articles published in 2024 (N=46) and 2025 (N=41, partial) have received 16.09 and 2.54 citations per article, respectively, which is consistent with the shorter citation window (2 and 1 citable years). Nonetheless, the surge in publication volume in these years highlights the growing scholarly interest, while the relatively high early citation counts indicate that the field is rapidly gaining recognition and becoming embedded in broader academic and policy discussions.

Table 2. The citations analysis

Year	MeanTCperArt	No. of articles	MeanTCperYear	CitableYears
2021	41,67	3	8,33	5
2022	133,00	9	33,25	4
2023	81,71	14	27,24	3
2024	16,09	46	8,04	2
2025	2,54	41	2,54	1

3.1.2. Most relevant sources

Among the core journals analyzed, the top 10 most productive ones have been identified, as depicted in Fig. 3. The analysis of these sources highlights the multidisciplinary nature of research on ESG and green credit. Within the dataset of 113 articles, publications are spread across a wide variety of journals, with no single outlet dominating the field. Sustainability emerges as the leading source with 9 articles, reflecting its broad scope in sustainable development and corporate responsibility. This is followed by the International Review of Financial Analysis (8 articles) and Finance Research Letters (7 articles), which

underscores the strong interest from mainstream finance and investment journals.

Other notable outlets include Applied Economics (5 articles) and Energy Economics (4 articles), which suggest that research in this domain is closely tied to both economic modeling and energy-related financial policies. Additionally, journals such as Environment, Development and Sustainability, Environmental Science and Pollution Research, Journal of Cleaner Production, and Journal of Environmental Management (3 articles each) demonstrate the strong link between ESG, green finance, and environmental sciences.

Overall, the distribution of sources confirms that ESG and green credit research is inherently interdisciplinary, spanning sustainability studies, finance and economics, as well as environmental management. This diversity of outlets indicates that the topic is still in the process of consolidating a core body of literature, while also reflecting its wide-ranging relevance to multiple academic domains.

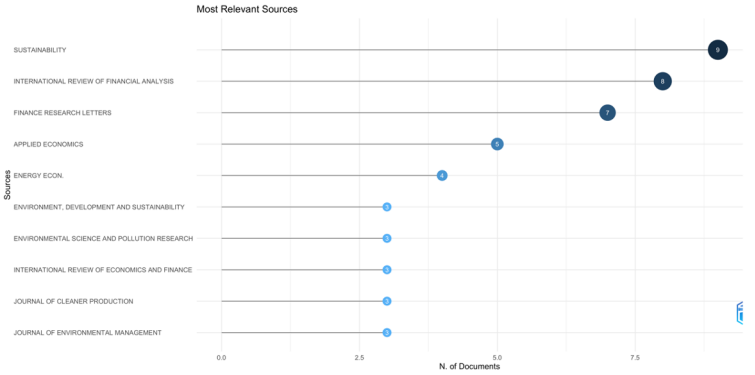

Fig. 3. The most relevant sources

3.1.3. Top 10 influential authors

Table 3 presents the top 10 most influential authors in the field of ESG and green credit. The citation and productivity indicators confirm that the field is still at an emerging stage, with most contributions published only in the last three years. Among the listed authors, Zhang Dongyang stands out as the most influential, with three publications since 2023 that have already accumulated 169 citations, giving him the highest h-index (3) and m-index (1) in the dataset. Other authors such as Jiang Wei (46 citations), Liu Xiangqiang (69 citations), and Wang Cao (37 citations) also demonstrate strong performance with two publications each, reflecting the rapid uptake and influence of their research within a short time frame. By contrast, authors including Chen Lifeng, Lai Jie, Li Xiaofan, and Zhang Hua have lower citation counts but represent the broadening base of contributors to the field.

Table 3: Most influential authors

Author	h_index	g_index	m_index	TC	NP	PY_start
Zhang Dongyang	3	3	1	169	3	2023
Chen Lifeng	2	2	0,5	12	2	2022
Jiang Wei	2	2	0,667	46	2	2023
Liu Xiangqiang	2	2	1	69	2	2024
Wang Cao	2	2	1	37	2	2024
Wenyao Zhao	2	2	1	12	2	2024
Lai Jie	1	2	0,5	7	2	2024
Li Xiaofan	1	2	0,5	14	2	2024

Zhang Hua	1	2	0,5	7	2	2024
Ab Rahim Fithriah	1	1	0,5	2	1	2024

TC: Total citations; NP: Number of article; PY_start: publication year start

Fig. 4 provides a temporal perspective on author productivity and impact. The size of the circles reflects the number of publications per year, while the color intensity indicates average citations per year. The results show that only limited contributions appeared in 2022 (e.g., Chen Lifeng), whereas from 2023 onwards, several authors—including Zhang Dongyang, Jiang Wei, Liu Xiangqiang, and Wang Cao—produced multiple articles and achieved high citation rates, as indicated by the larger and darker circles. In contrast, many authors who first published in 2024 (e.g., Lai Jie, Li Xiaofan, Zhang Hua) have contributed one or two articles with relatively lower citation levels, which is consistent with their more recent entry into the field.

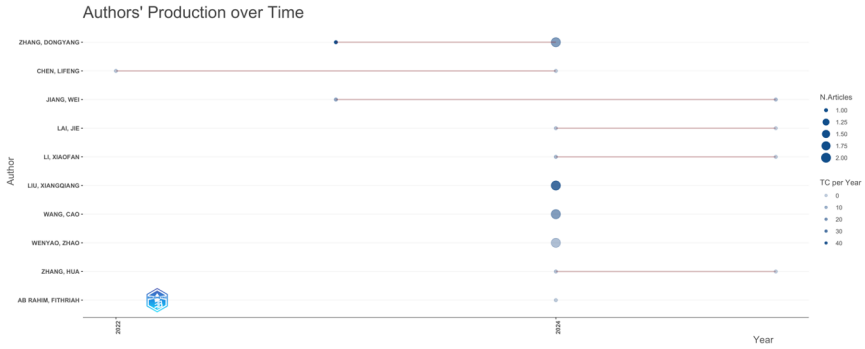

Fig. 4. Author's production over time

Taken together, the evidence from Table 3 and Figure 4 underscores that the author landscape is highly dynamic, dominated by a small group of highly cited scholars who have quickly established prominence, while new contributors continue to expand the research community. This pattern highlights both the fast-moving and citation-intensive nature of ESG and green credit research and suggests that author influence is still evolving as the field consolidates.

3.1.4. Most influential countries

Table 4 provides additional insights by analyzing corresponding authorship. China again leads with 74 publications, the majority being single-country outputs, underscoring its strong domestic research base. By contrast, countries such as Malaysia, Australia, and Canada stand out for their high levels of international collaboration, with 80% to 100% of their publications co-authored across borders. Korea and Thailand also demonstrate balanced collaboration, whereas Italy, France, and Egypt are primarily domestically focused.

Table 4: Corresponding author's countries

Country	**Articles**	**SCP**	**MCP**	**MCP %**
China	74	64	10	13,5
Malaysia	5	1	4	80
India	3	2	1	33,3
Italy	2	2	0	0
Korea	2	1	1	50
Thailand	2	1	1	50
Australia	1	0	1	100

Canada	1	0	1	100
Egypt	1	1	0	0
France	1	1	0	0

SCP: Single country publication, MCP: Multiple country publication

Fig.5 illustrates the global distribution of research output on ESG and green credit. The results show that scientific production is geographically concentrated, with China (237) emerging as the most prolific contributor, followed by countries such as Malaysia (11), India (8), Italy (6), USA (6) and Thailand (6). Other advanced economies, including Germany (5), Australia (3), Canada (2), France (4), and Korea (5), also appear in the dataset, though their contribution remains limited. This pattern highlights that while a few countries dominate in volume, research activity is gradually spreading across different regions, signaling the growing international relevance of the topic.

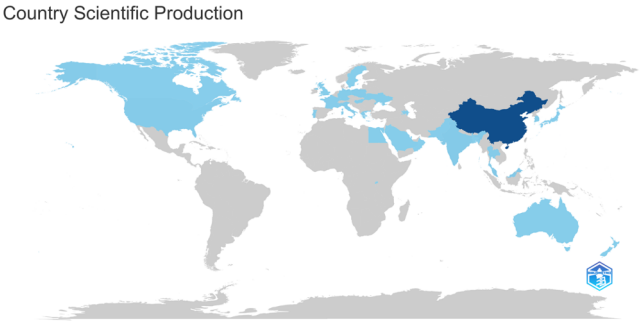

Fig. 5. Country scientific production

Overall, the combined evidence from Fig. 5 and Table 4 suggests a dual trend: while China dominates in terms of publication volume, smaller countries are leveraging international collaboration networks to enhance their visibility and impact in ESG and green credit research.

3.2. Science mapping

In practice, bibliometric analysis enables science mapping to explore the relationships among disciplines, specialties, and individual publications (Zupic & Čater, 2015). To capture the relatedness of research elements, the science mapping of ESG studies in this paper was conducted using three bibliometric techniques implemented in R Studio: co-word analysis, co – occurence network and thematic analysis. This science mapping process specifically addresses **RQ2**, aiming to identify the primary thematic clusters that define the intellectual structure of the ESG and green credit research domain.

3.2.1. Co-word analysis

The co-word analysis identifies the most frequently occurring author keywords and maps the conceptual structure of ESG and green credit research. As shown in Figure X (WordCloud) and Table Y (Most Frequent Keywords), the most prominent terms include “ESG” (37), “green finance” (30), “ESG performance” (28), and “sustainable development” (25). These keywords confirm that the field is anchored in the intersection of sustainability and green financial instruments, with a strong emphasis on measuring ESG outcomes and linking them to financial practices.

Other high-frequency terms such as “China” (22), “green innovation” (21), “ESG rating” (19), “green economy” (15), “sustainability” (15), and “financial constraint” (14) indicate the methodological and thematic orientation of current research. On one hand, there is a strong regional concentration on China as a case study hub, reflecting its active green finance policies. On the other hand, terms like green innovation and financial constraint reveal corporate-level dynamics, linking ESG adoption to innovation capacity and financing conditions. Additionally, the presence of “green credit policy,” “greenwashing,” “climate change,” and “difference-in-differences” points to the diversity of emerging subthemes. These keywords highlight both policy-oriented research (e.g., green credit policy, environmental regulations) and methodological approaches (e.g.,

difference-in-differences, governance approaches), underscoring the field's expansion into adjacent areas such as digital transformation, fintech, and disclosure practices.

Fig. 6. Co-word analysis based on author keywords

Overall, the co-word analysis reveals that ESG and green credit research is dominated by sustainability and green finance themes, while simultaneously branching into innovation, governance, methodological development, and policy evaluation. This structure reflects a dual trajectory: the consolidation of a core knowledge base, and the diversification of new and emerging thematic areas.

3.2.2. Co-occurence network analysis

Keywords act as conceptual labels that capture the core themes of the ESG and green credit literature. Following Zupic and Čater (2015), this study employed VOSviewer to conduct a co-occurrence analysis of author keywords in order to map the intellectual structure of the field. Fakhar Manesh et al., (2021), underlined the significance of this study since it enables the identification and clustering of theme regions, resulting in a visual depiction of the primary theoretical or underlying issues in the research field. From the dataset, 280 keywords were initially identified, and after applying a minimum occurrence threshold of 4, 25 were selected for analysis. The results are shown in Fig. 7 and Fig. 8, which display the keyword co-occurrence network and overlay visualization, respectively. In these figures, the size of the circles reflects keyword frequency, while links indicate co-occurrence strength.

The most frequent terms include "ESG," "green finance," "ESG performance," "sustainable development," and "green innovation", which together form the backbone of the field. These keywords highlight a strong concentration on the intersection of sustainability and financial mechanisms, with particular emphasis on how ESG performance is shaped by or linked to green financial instruments and related policies. Additional frequently occurring terms such as "ESG rating," "green credit policy," "financial constraint," and "sustainability" reflect both methodological approaches and policy-driven dimensions of the literature.

The co-occurrence analysis identified five clusters, each representing a distinct sub-area within ESG and green credit research. Cluster 1 (Red) addresses ESG evaluation and financial instruments (8 items), underscoring the central role of ESG measurement and its links to financial instruments, governance mechanisms, and risks such as greenwashing. Cluster 2 (Green) focuses on ESG performance, policy, and operations (6 items), emphasizing how green credit policies and ESG outcomes influence corporate innovation and sustainable practices. Cluster 3 (Blue) relates to finance policy and disclosure (5 items), reflecting methodological approaches and policy-oriented themes, particularly in disclosure practices, investment strategies, and econometric applications. Cluster 4 (Yellow) highlights innovation, value, and sustainable development (4 items), pointing to the role of green innovation and investment in shaping firm value and advancing sustainability goals. Finally, Cluster 5 (Purple) captures emerging digital and financial themes (2 items), namely digital transformation and financial constraints, which represent new frontiers in understanding how technological change and financing conditions shape ESG and green credit practices.

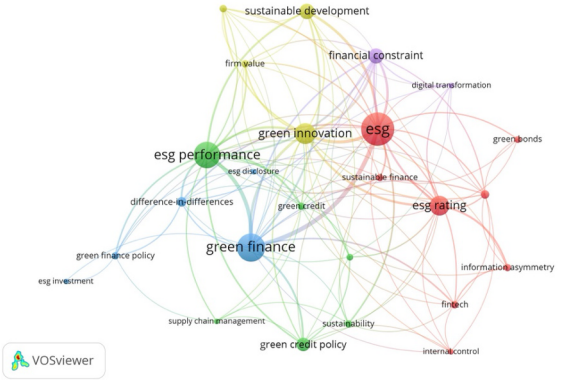

Fig. 7. Co – occurrence author keywords network visualization

Building on the keyword co-occurrence analysis, we can further explore the temporal dynamics of ESG and green credit research using the overlay visualization in VOSviewer. This tool displays the chronological distribution of keywords within the network, with colors ranging from purple (earlier years) to green and yellow (more recent years). As shown in Fig. 8, this visualization highlights the average publication year of keywords, thereby revealing the evolution of research interests over time. The results indicate that earlier studies (depicted in cooler tones) concentrated on sustainable development, green credit policy, and ESG performance, reflecting the establishment of foundational links between sustainability and finance. In contrast, more recent contributions (shown in warmer yellow tones) emphasize green innovation, ESG disclosure, fintech, digital transformation and information asymmetry, signaling a shift toward emerging themes that integrate technological change, transparency, and financial constraints into ESG and green credit debates.

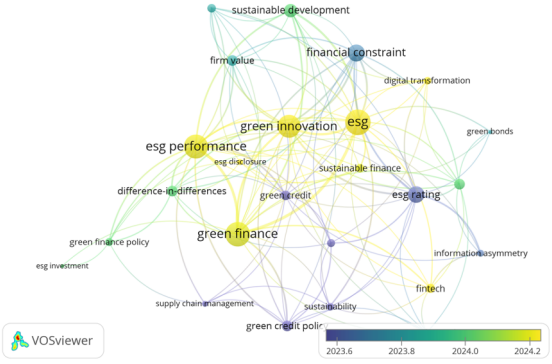

Fig. 8. Co – occurrence author keywords overlay visualization

Overall, the overlay visualization demonstrates that the field has moved from building its core sustainability–finance foundations toward addressing new frontiers such as digital transformation, governance mechanisms, and innovation-driven practices, confirming its status as a fast-evolving and dynamic research domain.

3.2.3. Thematic analysis

The thematic map offers a strategic overview of ESG and green credit research by positioning keyword clusters along two axes: centrality, which measures how strongly a theme is connected to other themes, and density, which captures how internally developed and cohesive a theme is. This allows the classification of research topics into four categories - motor themes, basic themes, niche themes, and emerging or declining themes - thereby providing insights not only into the conceptual structure of the field but also into the relative maturity and strategic importance of each theme (Aria M et al., 2017).

The results highlight that motor themes such as ESG performance, green innovation, and financial constraint are simultaneously well developed and highly connected, serving as the driving forces of the field. These themes reflect the central concern with how ESG outcomes intersect with corporate innovation capacity and financial viability, making them pivotal for both theoretical and practical developments. In contrast, basic themes like ESG, green finance, and sustainable development are broad and fundamental to the field, providing its conceptual anchors. Their high centrality shows their importance across studies, but their relatively low density indicates that more targeted theoretical and empirical refinement is still needed.

On the other hand, niche themes such as sustainability, sustainable finance, bank system, machine learning, and green development are well developed in specialized contexts yet relatively isolated from the broader field. These reflect ongoing explorations in areas like financial institutions' roles in ESG and the application of machine learning for sustainability assessment. Finally, emerging or declining themes include ESG investment, China, fuzzy DEMATEL, ESG rating, information asymmetry, staggered DID, green credit policy, supply chain management, and corporate sustainability. Some of these, such as ESG investment and supply chain management, appear to represent emerging lines of inquiry that could gain more significance over time, while others—such as China-specific case studies or methodological approaches like fuzzy DEMATEL—may remain peripheral or context-dependent.

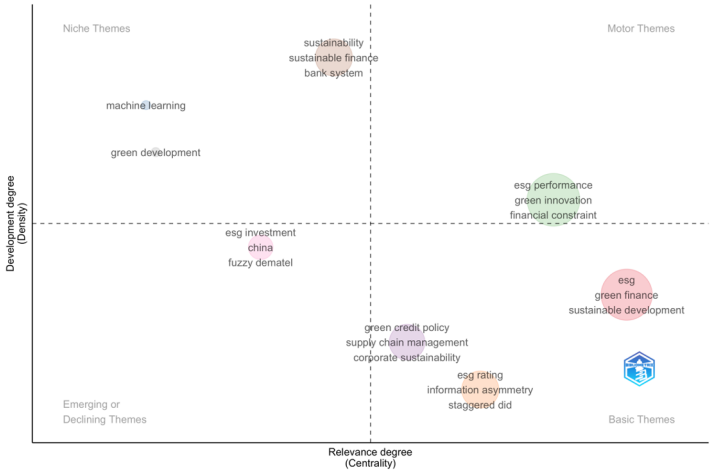

Fig. 9. Thematic map

Overall, the thematic map indicates that ESG and green credit research is grounded in fundamental yet still underdeveloped concepts, while being increasingly shaped by performance- and innovation-oriented motor themes. It is further complemented by specialized niche areas and enriched by a set of emerging topics. This pattern reflects not only the consolidation of established knowledge but also the dynamic opening of new research frontiers, underscoring the fast-growing and interdisciplinary nature of the field.

4. Systematic review

While the bibliometric analysis provides a comprehensive overview of the structural and thematic landscape of ESG and

green credit research, it is equally important to examine the substantive contributions of the most influential studies in greater detail. To this end, this study conducted a systematic review of the top 10 most cited articles within the dataset. These publications represent the intellectual backbone of the field, offering key theoretical insights, empirical evidence, and methodological approaches that have shaped subsequent research. This systematic review specifically addresses **RQ3**, revealing the causal mechanisms and empirical evidence that link green credit and ESG.

The systematic review follows a structured process, focusing on the research objectives, contexts, methodologies, and main findings of each article. By synthesizing these highly cited works, the review highlights both the areas of consensus - such as the role of ESG in influencing firm performance, financing costs, and policy effectiveness - and the areas where evidence remains fragmented or contested. Moreover, the analysis identifies critical mechanisms, such as innovation, disclosure, and governance, through which ESG and green credit interact.

This approach not only consolidates the core knowledge base established by the most impactful contributions but also allows us to detect conceptual gaps and underexplored issues. In doing so, the systematic review complements the bibliometric mapping by moving from a broad structural perspective to a more detailed content analysis, ultimately providing a more nuanced understanding of how ESG and green credit research has evolved and where it is likely to advance in the future.

4.1. Most influential articles

Table 5 presents the ten most influential articles in the ESG and green credit dataset, ranked by citation counts. Overall, the results highlight that although the field is relatively young, several studies have already achieved substantial global visibility.

Among them, Zhou (2022, Business Strategy and the Environment) stands out with 463 global citations (GC) and the highest local citation count (LC = 5), indicating that it is both widely recognized internationally and relatively well integrated within this dataset. Its normalized local citation (NLC = 7.50) further confirms its role as a cornerstone article that has shaped subsequent contributions.

Two other highly cited papers are Wang (2023, International Review of Financial Analysis) with 433 GC and Tan (2022, Technology in Society) with 425 GC. Despite their lack of local citations (LC = 0), both exhibit strong global influence, as reflected in their normalized global citation (NGC = 5.30 and 3.20, respectively). Similarly, Zhang (2023, Energy Economics) and Wu (2023, Technological Forecasting and Social Change) have received over 120 citations each within just one year of publication, confirming the rapid growth and relevance of this research domain.

Other influential contributions include Nabeeh (2021, Journal of Cleaner Production) with 108 GC, and Baldi (2022, Global Finance Journal) with 100 GC, both of which provide significant insights linking sustainability, corporate performance, and finance. More recent works, such as Gao (2023, Finance Research Letters) with 84 GC and Li (2024, International Review of Financial Analysis) with 83 GC, illustrate that even very recent studies quickly attract attention, as shown by Li's high normalized citation (NGC = 5.16). Finally, Lei (2023, Economic Modelling), with 61 GC, demonstrates the growing integration of ESG and green finance themes into mainstream economic modeling.

Table 5. Top 10 most influential authors

Document	Year	LC	GC	LC/GC (%)	NLC	NGC
Zhou G, 2022, Bus Strategy Environ	2022	5	463	1,08	7,50	3,48
Wang J, 2023, Int Rev Financ Anal	2023	0	433	0,00	0,00	5,30
Tan Y, 2022, Technol Soc	2022	0	425	0,00	0,00	3,20
Zhang D, 2023, Energy Econ	2023	0	132	0,00	0,00	1,62
Wu B, 2023, Technol Forecast Soc Change	2023	0	129	0,00	0,00	1,58
Nabeeh NA, 2021, J Clean Prod	2021	0	108	0,00	0,00	2,59
Baldi F, 2022, Global Financ J	2022	0	100	0,00	0,00	0,75
Gao W, 2023, Finan Res Lett	2023	0	84	0,00	0,00	1,03
Li W, 2024, Int Rev Financ Anal	2024	0	83	0,00	0,00	5,16
Lei N, 2023, Econ Model	2023	0	61	0,00	0,00	0,75

LC: Local citations, GC: Global citations, NLC: Normalized local citaions, NGC: Normalized global citations

Overall, the findings indicate that the field is currently shaped by a limited number of highly influential studies at the global level, most of which have appeared only within the past three years. The very low level of local citations suggests that these contributions are not yet strongly interconnected within the dataset, reflecting the fragmented character of the literature. Nonetheless, their rapid accumulation of global citations highlights both the academic significance and the accelerated growth trajectory of ESG and green credit research in the broader scholarly community.

4.2. Summary of the top 10 most influential articles

Building on the identification of the most influential articles in Section 4.1, this section provides a structured synthesis of their contexts, methodologies, and key contributions. To capture the breadth and depth of research linking ESG and green credit, the top ten most cited studies were systematically reviewed and summarized in Table 6. The table outlines essential elements of each study, including research setting, methodological design, analytical focus, main findings, implications, and limitations. This structured overview not only highlights the diversity of approaches - ranging from econometric analyses of policy shocks to conceptual frameworks and decision-support models - but also allows for meaningful comparison across studies. By consolidating the evidence from these highly cited works, the summary offers a foundation for thematic synthesis in the subsequent section and helps to identify converging insights as well as persistent gaps in the literature.

Table 6: Summary of the top 10 most influential studies on ESG and Green Credit

Authors & Year	**Context / Data**	**Methodology**	**Key Focus**	**Main Findings**	**Implications**	**Limitations**
Zhou G, 2022, Bus Strategy Environ	China, 167 listed firms, 2014–2018, SynTao ESG ratings, 835 obs.	Quantitative: Panel regressions with FE; mediation analysis (Baron & Kenny)	ESG ratings, market value via operating efficiency	ESG raises firm value; mediated by operating efficiency (non-SOEs)	ESG practices create value via efficiency; encourage SOEs to go beyond symbolic ESG	Small sample; binary ESG ratings; short timeframe
Wang J, 2023, Int Rev Financ Anal	China, A-share firms, 2013–2019, ~18,790 obs., SynTao ESG ratings	Quantitative: Multi-period DID with SynTao coverage; PSM, GMM; dynamic effects	ESG ratings, green patents (esp. invention); reduced constraints	ESG coverage raises green patents & quality; amplified in non-SOEs, constrained firms	ESG ratings enhance credibility, innovation; complement green credit goals	China-only; patent-based innovation measure; limited ESG coverage
Tan Y, 2022, Technol Soc	China, A-share firms, 2010–2018, SynTao ESG ratings, ~8,630 obs.	Quantitative: Quasi-natural experiment; DID + PSM-DID; mediation analysis	ESG ratings, green innovation; mediated by finance & awareness	ESG ratings improve innovation quality/quantity; stronger under regulation	ESG ratings complement green credit by guiding capital allocation	China-only; aggregate ESG; short horizon; possible self-selection
Zhang D, 2023, Energy Econ	China, listed firms, 2014–2020, provincial green finance index	Quantitative: Panel regressions, FE; greenwashing index; robustness OLS/probit	Green finance, greenwashing via innovation, constraints, profitability	Green finance curbs ESG hypocrisy; stronger in SOEs, polluting firms	Green finance system is key to reducing greenwashing	Single-country; ESG gap proxy; residual endogeneity
Wu B, 2023, Technol Forecast Soc Change	China, family firms, 2007–2019, ~9,249 obs., low-carbon patents	Quantitative: Panel regressions; investor network ESG modularity; moderation tests	Investor ESG network preferences, low-carbon innovation	Shared ESG investor preferences boost low-carbon patents; succession matters	Investor networks and green finance jointly drive innovation	Focus on family firms; network ESG measure indirect
Nabeeh NA, 2021, J Clean Prod	China, manufacturing sector, case study under GCP, SCM alternatives	Conceptual/Model-driven : Neutrosophic MCDM (GRA, DEMATEL, ANP, TOPSIS); case study validation	Green credit rating model for SCM strategies under uncertainty	Framework ranks SCM providers; supports GCP-driven sustainability	Structured tools help evaluate GCP effectiveness in uncertain contexts	Model-driven; case study; no real firm-level data
Baldi F, 2022, Global Financ J	Global sample, 199 public & 199 corporate GBs, 2012–2019	Quantitative: OLS regressions on GB yields; public vs corporate; greenwashing risk	ESG scores & greenwashing risk explain GB yields	Higher ESG & larger projects lower GB yields; greenwashing raises premia	Bond pricing shaped by ESG & greenwashing; standards needed	Small sample; cross-sectional; ESG inconsistency; risk proxy

						oversimplified
Gao W, 2023, Finan Res Lett	China, 722 listed firms, 2010–2020, ~7,077 obs., GCP 2012 shock	Quantitative: DID exploiting 2012 GCP; mediation via green tech innovation; PSM-DID	Green Credit Policy, ESG scores via green tech innovation	GCP improved ESG via innovation; offset by business credit expansion	Green credit directs firms toward green innovation; regulate credit leakage	China-only; ESG aggregate; regional variation; patents proxy
Li W, 2024, Int Rev Financ Anal	China, A-share firms, 2015–2020, ~13,000 obs., GFP 2017 shock	Quantitative: DID exploiting 2017 GFP; heterogeneity by size, SOE, industry	Green Finance Policy, cost of debt for high-ESG firms (env. score)	High-ESG firms enjoy lower debt costs post-GFP; discrimination by size/ownership	GFP effective but exacerbates inequality in credit allocation	China-only; rating threshold selection; discrimination persists
Lei N, 2023, Econ Model	China, A-share firms, 2007–2021, ~13,464 obs., GCP 2012 shock	Quantitative: DID exploiting 2012 GCP; triple interactions for channels; PSM-DID	Green Credit Guidelines, ESG via financing & investment efficiency	GCP improved ESG in restricted industries; effect stronger in SOEs, east China	Policy: tailor GCP by ownership/region; expand marketization	China-only; Bloomberg ESG aggregate; endogeneity concerns

***ABBREVIATION:**

ESG: Environmental, Social, and Governance; FE: Fixed Effects; DID: Difference-in-Differences; PSM: Propensity Score Matching; GMM: Generalized Method of Moments; OLS: Ordinary Least Squares; MCDM: Multi Criteria Decision Making; GRA: Grey Relational Analysis; DEMATEL: Decision Making Trial and Evaluation Laboratory; ANP: Analytic Network Process; TOPSIS: Technique for Order of Preference by Similarity to Ideal Solution; GB: Green Bonds; GCP: Green Credit Policy; GFP: Green Finance Policy; SOE: State-Owned Enterprises; MNC: Multinational Corporation; SCM: Supply Chain Management; obs: Observations.

Zhou et al. (2022), published in Business Strategy and the Environment, investigate how ESG performance influences firm market value through the mediating role of financial performance. Analyzing panel data from 167 Chinese listed firms during 2014–2018, the study finds that ESG engagement enhances corporate valuation, with the effect transmitted primarily through improvements in operational efficiency rather than profitability or growth. The mediating impact is stronger among non-state-owned firms, where ESG-driven operational gains translate more directly into higher market value, while state-owned enterprises exhibit weaker responsiveness. Despite limitations related to sample size and the simplified measurement of ESG ratings, the paper provides important evidence that ESG practices can generate market value by strengthening firms' operational capacity, thereby linking sustainability initiatives with financial performance outcomes.

Wang et al. (2023), in International Review of Financial Analysis, provide quasi-experimental evidence on the role of ESG ratings in promoting corporate green innovation and shaping access to sustainable finance. Using SynTao Green Finance's expansion of ESG coverage as an exogenous shock, the study applies a multi-period Difference-in-Differences design to a large panel of Chinese firms (2013–2019). The results show that ESG-rated firms significantly increase their green patenting activity, particularly invention patents, with further improvements in patent quality and collaborative innovation. Importantly, the analysis highlights that ESG coverage reduces financing constraints and strengthens the credibility of firms in capital markets, thereby functioning as a complementary mechanism to green credit policies. The effects are most pronounced among non-SOEs, financially constrained firms, and those with long-term investors. While the findings are context-specific and rely on patent-based proxies, the study underscores how ESG ratings can reinforce the objectives of green credit by directing capital toward genuinely innovative and sustainable firms.

Tan and Zhu (2022) investigate the impact of ESG rating events on corporate green innovation in China, framing ESG disclosure and ratings as a channel to improve firms' access to financing, including green credit. Exploiting the introduction of SynTao Green Finance ratings in 2015 as a quasi-natural experiment, they find that rated firms significantly increase both the quantity and quality of their green patenting. The mechanisms involve reduced financing constraints and heightened managerial environmental awareness, both of which align closely with the objectives of green credit policy, namely directing capital toward environmentally responsible firms. The study highlights that transparent ESG assessments can complement green credit systems by reducing information asymmetry and ensuring that financing flows to firms genuinely committed to sustainable innovation. Although the results are limited to the Chinese market, the research underscores the complementary role of ESG ratings in supporting green credit and guiding capital allocation in line with sustainability goals.

Zhang (2023) examines the disciplining role of green finance in mitigating corporate greenwashing, measured as the misalignment between ESG disclosure and independent ESG ratings. Using panel data from Chinese listed firms (2014–2020), the study shows that regions with stronger green finance systems - encompassing green credit, green securities, and carbon finance — are associated with significantly lower greenwashing risk. The effect operates through enhanced green innovation, reduced financing constraints, and improved profitability, thereby making genuine ESG investment more feasible. The effects are most evident in state-owned and pollution-intensive enterprises, where regulatory oversight is stronger. The findings suggest that green finance, and particularly green credit mechanisms, not only expand access to sustainable capital but also incentivize firms to align disclosure with real performance. While the single-country focus limits generalization, the paper provides robust evidence that developing green credit systems is key to curbing ESG hypocrisy and ensuring the credibility of sustainable finance.

Wu et al. (2023), in Technological Forecasting and Social Change, explore how institutional investors with shared ESG preferences influence low-carbon innovation in Chinese family-owned firms. Using a large panel dataset from 2007 to 2019, the authors develop a network-based measure of investor ESG convergence and link it to firm-level carbon-related patents. The analysis shows that stronger alignment among investors' ESG priorities significantly increases low-carbon innovation output, and this effect is amplified in regions with more developed green finance, though only under conditions of low economic uncertainty. Moreover, while family control tends to weaken the positive relationship, the succession of next-generation managers offsets this constraint, suggesting the importance of intergenerational transition in supporting sustainability goals. Despite being limited to Chinese family firms and relying on patent data as a proxy for innovation, the study provides important evidence that ESG-oriented investor networks and green finance can jointly drive corporate responses to climate change.

Nabeeh et al. (2021), in Journal of Cleaner Production, develop a decision-support framework to evaluate green credit ratings and their implications for sustainability performance. Drawing on China's Green Credit Policy, the study integrates multiple decision-making techniques—Grey Relational Analysis, DEMATEL, ANP, and TOPSIS—within a neutrosophic logic approach to handle uncertainty and indeterminacy. Applied to a case study of supply chain management alternatives, the model demonstrates its ability to rank strategies effectively under green credit criteria and to adapt flexibly to changes in judgment or weighting. While the approach is innovative in introducing neutrosophic theory to the field, the study is limited

by its reliance on simulated data rather than empirical firm-level evidence. Nonetheless, it provides an important methodological contribution by offering a structured tool for assessing green credit performance and guiding sustainable decision-making under complex conditions.

Baldi and Pandimiglio (2022), in Global Finance Journal, analyze how ESG scores and greenwashing risk influence the yields of public and corporate green bonds. Using a global sample of nearly 400 issuances between 2012 and 2019, the study shows that stronger ESG performance and larger project size are associated with lower yields, reflecting investors' willingness to accept reduced returns for credible sustainability commitments. Conversely, bonds issued by sovereign or supranational organizations, as well as manufacturing firms, carry higher premia due to greater perceived greenwashing risk, whereas local governments and services-sector issuers are rewarded with lower borrowing costs. Although limited by cross-sectional data and proxy measures of greenwashing, the paper contributes to bond pricing literature by demonstrating that ESG scoring and credibility concerns play a crucial role in shaping investor behavior in the green bond market.

Gao and Liu (2023), in Finance Research Letters, examine the impact of China's 2012 Green Credit Guidelines on corporate ESG performance. Using a Difference-in-Differences design with panel data from over 700 listed firms between 2010 and 2020, they find that the policy significantly improved ESG scores, with effects that strengthened over time. The mechanism analysis reveals that green credit promotes ESG performance primarily by stimulating green technology innovation, while the expansion of business credit partially offsets these gains. Although the study is limited by its single-country focus and reliance on aggregate ESG scores and patent-based innovation measures, it provides compelling evidence that green credit policy can enhance corporate sustainability by directing firms toward greener innovation pathways.

Li et al. (2024), in International Review of Financial Analysis, examine the effect of China's 2017 Green Finance Policy on the cost of debt for ESG-rated firms. Using a Difference-in-Differences approach with a large panel of A-share listed companies from 2015 to 2020, the study finds that high-ESG-rated firms benefit from significantly lower borrowing costs following the policy shock, with the effect driven mainly by environmental scores. The analysis further reveals heterogeneous impacts, as large firms, state-owned enterprises, and firms in non-polluting industries enjoy greater reductions, while smaller, private, and polluting firms benefit less. These results highlight both the effectiveness of green finance policies in incentivizing ESG engagement and the potential risks of discrimination in credit allocation. Although the findings are context-specific and hinge on ESG ratings as the policy transmission channel, the study underscores the central role of ESG in shaping access to green credit and lowering financing costs.

Lei et al. (2023), in Economic Modelling, assess the impact of China's 2012 Green Credit Guidelines on firms' ESG performance using a quasi-natural experiment design. Drawing on panel data from 2007 to 2021 and employing Difference-in-Differences models with robustness checks, the study finds that the policy significantly improved ESG scores in credit-restricted industries. The effect operates mainly through reduced financing constraints and enhanced investment efficiency, and is stronger among state-owned enterprises, firms in the eastern and central regions, and those located in provinces with higher levels of marketization. Although the analysis is limited to China and relies on Bloomberg's aggregate ESG scores, the study provides important evidence that green credit policy can serve as an effective tool to improve corporate ESG practices by reshaping financial constraints and investment behavior.

4.3. Thematic synthesis

The review of the ten most influential studies highlights several thematic clusters in the ESG and green credit literature. Three core themes emerge: the role of ESG ratings and disclosure in promoting green innovation, the impact of green credit policies on ESG performance, and the financial implications of ESG and green finance for cost of debt and firm value. Additional strands address the pricing of green bonds under greenwashing risk and methodological frameworks for evaluating green credit. Together, these clusters provide a structured view of how ESG and green credit are interconnected, forming the basis for identifying common insights as well as persistent research gaps.

The first theme centers on the role of ESG ratings and disclosure in fostering corporate green innovation. Studies such as Tan and Zhu (2022), Wang et al. (2023), and Wu et al. (2023) consistently show that the introduction of third-party ESG ratings enhances both the scale and quality of green innovation, primarily through reducing financing constraints and shaping managerial incentives. Wu et al. further highlight the role of institutional investor networks, where shared ESG preferences act as external governance mechanisms that encourage firms to pursue low-carbon innovation. Together, these studies underscore that credible ESG information can serve as a complementary tool to green credit by guiding capital allocation toward genuinely innovative firms.

The second theme focuses on the impact of green credit policies on ESG performance. Lei et al. (2023) and Gao and Liu (2023) use China's Green Credit Guidelines as a quasi-natural experiment and demonstrate that policy-driven credit

restrictions significantly improve ESG outcomes. These improvements are transmitted through increased investment efficiency and green technology innovation, though Gao and Liu note that the expansion of alternative credit channels can dilute these effects. Both studies emphasize that the effectiveness of green credit depends on firm characteristics, ownership structures, and regional financial development, pointing to uneven policy impacts across contexts.

The third theme examines the relationship between ESG, green finance, and firm-level financial outcomes such as the cost of debt and market value. Li et al. (2024) show that China's 2017 Green Finance Policy reduced borrowing costs for high-ESG firms, especially through improvements in environmental performance, while Zhou et al. (2022) find that ESG engagement enhances firm value primarily through operational efficiency, with stronger effects among non-SOEs. These findings provide evidence that ESG and green credit are not only instruments for sustainability but also mechanisms that shape firms' financial competitiveness.

A fourth theme is represented by Baldi and Pandimiglio (2022), who analyze the role of ESG scoring and greenwashing risk in green bond markets. Their results reveal that higher ESG credibility lowers yields, while perceived greenwashing risk increases the premium demanded by investors. This highlights the importance of ESG transparency in ensuring the integrity of green finance instruments such as green bonds, which function in parallel to bank-based green credit.

Finally, Nabeeh et al. (2021) introduce a decision-support perspective by proposing a neutrosophic multi-criteria decision-making framework to evaluate green credit rating under conditions of uncertainty. While model-driven and not based on large-scale empirical data, this contribution illustrates the potential of methodological innovations to support decision-making in the allocation of green credit.

Overall, these five themes illustrate that the literature on ESG and green credit is structured around complementary perspectives: ESG ratings and disclosure as governance tools, green credit policies as financial levers, and their joint impact on innovation, performance, and market outcomes. The evidence confirms that credible ESG information and well-designed green credit mechanisms can reinforce one another, but also reveals fragmentation across contexts, instruments, and methodologies.

5. Discussion and future research directions

This section addresses **RQ4** by analyzing the identified gaps and trends in the ESG and green credit literature. Through the detailed bibliometric analysis and systematic review presented above, we have highlighted key research areas, emerging themes, and the underlying causal mechanisms. Building on these insights, this section outlines promising avenues for future research, which can help bridge the existing gaps and push the boundaries of knowledge in the intersection of ESG and green credit.

5.1. Discussion

The combined bibliometric analysis and systematic review offers a comprehensive perspective on how the ESG–green credit nexus has evolved and where it is heading. The bibliometric evidence highlights a field that is both dynamic and fragmented. Research output has expanded rapidly since 2021, with a high growth rate and considerable international attention, yet the literature remains dispersed across journals, regions, and methods. Local citation levels among influential articles are relatively low, underscoring the lack of strong interconnections between studies and the ongoing consolidation of the knowledge domain. Keyword co-occurrence and thematic mapping reveal a dual structure: core themes such as ESG performance, green finance, and sustainable development form the foundation of the field. These areas are well-established, with a broad base of research exploring how businesses incorporate ESG principles and how financial systems adapt to promote sustainable development. However, emerging trends, including digital transformation, fintech, disclosure practices, and greenwashing, are beginning to shape the future trajectory of ESG and green credit research.

The rise of digital transformation in ESG practices, driven by technologies such as blockchain, AI, and big data analytics, is transforming how ESG data is collected, reported, and verified. These innovations improve transparency and accountability, enabling more accurate assessments of corporate sustainability performance and enhancing the efficiency of green credit allocation. Fintech is playing an increasingly vital role in facilitating access to sustainable finance, especially for underserved sectors, by using digital platforms and decentralized finance mechanisms to lower barriers to entry. Furthermore, disclosure practices are evolving as global regulations push for greater transparency in ESG reporting, with standards such as GRI, SASB, and ISSB shaping how firms disclose ESG metrics. This shift is not only important for investor decision-making but also for building public trust in corporate sustainability claims. However, the issue of greenwashing continues to be a significant challenge, as some firms falsely present their environmental practices to attract green financing. This phenomenon highlights the critical need for more robust regulatory frameworks and effective monitoring systems to ensure the credibility

of ESG claims in green credit markets. These emerging trends indicate a shift towards a more technology-driven, transparent, and accountable ESG landscape, opening up new opportunities for research in the integration of digital tools and financial technologies with ESG goals.

The systematic review of the top ten most cited studies reinforces this picture by identifying several converging insights. First, there is broad consensus that ESG ratings and disclosures play a complementary role in green credit systems by reducing information asymmetry, easing financing constraints, and encouraging firms to pursue green innovation. Studies by Tan and Zhu (2022), Wang et al. (2023), and Wu et al. (2023) consistently show that credible ESG assessments enhance innovation and capital allocation. Second, green credit policies are shown to be effective in improving ESG outcomes, particularly through mechanisms of green technology development and investment efficiency (Lei et al., 2023; Gao & Liu, 2023). Third, empirical findings confirm that ESG engagement has tangible financial implications: higher ESG performance is linked with lower cost of debt (Li et al., 2024) and greater firm value via operational efficiency (Zhou et al., 2022). At the same time, evidence from Baldi and Pandimiglio (2022) illustrates that greenwashing risks undermine credibility, raising the cost of capital in green bond markets.

Despite these areas of convergence, fragmentation remains a defining feature of the literature. Geographically, research is heavily concentrated in China, with limited cross-national comparison. Methodologically, ESG measurement is inconsistent, with diverse rating providers and indices producing divergent results. Empirically, some mechanisms - such as the interaction between credit expansion and ESG improvement - remain contested, as green credit policies can both stimulate green innovation and inadvertently create avenues for non-sustainable financing. Together, these patterns highlight that while ESG and green credit research has developed important insights, it remains a young and evolving field in need of greater theoretical integration, methodological rigor, and international scope.

5.2. Future research directions

Building on the gaps identified, several directions emerge for advancing the ESG - green credit literature:

- Cross-country comparative studies. Current research is dominated by China, reflecting the prominence of its Green Credit Guidelines. Future studies should expand to other regions - such as Europe, ASEAN, or North America - to examine how institutional settings, financial market structures, and regulatory frameworks shape the ESG - green credit nexus. Comparative analyses would provide insights into the transferability and adaptability of policy tools.
- Standardization and measurement of ESG. One of the most significant challenges lies in the heterogeneity of ESG ratings. Research should focus on developing harmonized frameworks or conducting cross-rating comparisons to assess robustness and mitigate measurement bias. This could include meta-analyses that synthesize findings across rating systems.
- Integration of digital transformation and fintech. Emerging bibliometric clusters highlight growing interest in digital transformation, fintech, and ESG disclosure. Future research should explore how technologies such as blockchain, AI, and digital credit platforms can enhance transparency, improve ESG data verification, and expand access to sustainable finance.
- Addressing greenwashing and credibility risks. More sophisticated metrics for assessing greenwashing are needed, alongside empirical studies that examine how markets and regulators respond to credibility risks. This is particularly important for instruments such as green bonds and sustainability-linked loans, where investor trust is paramount.
- Equity and inclusiveness in credit allocation. Evidence suggests that large firms and SOEs benefit disproportionately from green finance policies, while SMEs and polluting firms face disadvantages. Future research should investigate mechanisms to ensure inclusiveness, such as differentiated credit lines, subsidies, or targeted support for vulnerable firms.
- Methodological innovations. While most studies employ econometric techniques (e.g., DID, panel regressions), future work could adopt advanced causal inference methods (synthetic control, IV, RDD) or machine learning approaches to handle high-dimensional ESG data. Meta-analysis techniques could also be applied to synthesize effect sizes across studies, improving cumulative knowledge.

In summary, these directions provide a roadmap for deepening and broadening the ESG–green credit research domain, with opportunities for both academic contribution and practical relevance.

6. Conclusion

This study combined bibliometric analysis and systematic review to map and synthesize the rapidly expanding literature on ESG and green credit. The findings reveal that while the field is still young, it has developed along three main trajectories: (i) ESG ratings and disclosure as governance mechanisms that encourage green innovation, (ii) green credit policies as financial

levers that improve ESG outcomes, and (iii) the financial implications of ESG engagement, including reduced borrowing costs and enhanced firm value. Additional strands highlight risks of greenwashing in financial markets and innovative methodological approaches to evaluating credit allocation. Together, these contributions underscore that ESG and green credit are mutually reinforcing instruments that align sustainability objectives with financial performance, but also face fragmentation and uneven implementation.

The study makes three main contributions. First, it provides a structural mapping of the knowledge base, identifying core clusters and emerging themes. Second, it synthesizes the intellectual backbone of the field by reviewing the most influential works. Third, it highlights future pathways for advancing both academic and practical debates on sustainable finance.

Nevertheless, several limitations should be acknowledged. The dataset is restricted to Scopus-indexed articles published up to August 2025, which may exclude relevant studies in other databases or grey literature. The systematic review focuses only on the ten most cited works, potentially overlooking emerging but less-cited contributions. Furthermore, the analysis is largely confined to economics, finance, and management disciplines, leaving limited integration with perspectives from law, political science, or technology studies. Finally, no quantitative meta-analysis was conducted to aggregate effect sizes, meaning that causal estimates remain fragmented across individual studies.

Despite these limitations, this study offers a timely and comprehensive synthesis of the ESG–green credit literature, providing both scholars and policymakers with insights into how sustainable finance mechanisms can be designed and implemented more effectively. By highlighting consensus, fragmentation, and opportunities for future inquiry, the paper contributes to shaping a more coherent and impactful research agenda at the intersection of corporate responsibility and green finance.

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