ESG Ratings and Corporate Green Innovation: A CiteSpace-based Visualization Analysis

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DOI: 10.64649/yh.eg.issn3078-4794.20260520

Abstract: Guided by the dual-carbon goal, ESG ratings and green innovation have become hot topics in academia. With the help of bibliometric software CiteSpace, this paper conducts visual analysis on 325 Chinese papers concerning ESG ratings and green innovation collected from CNKI (2021-2026). The results show that publications in this field have increased remarkably since 2021 with diversified research perspectives. Keywords including green innovation, green finance, financing constraints and R&D investment are the research hotspots. The research boundary of this field keeps expanding, and numerous factors have been identified to explain the mediating mechanisms through which ESG ratings affect corporate green innovation. In the future, it is necessary to further promote the interdisciplinary integration of ESG ratings, formulate differentiated information disclosure requirements according to the characteristics of different industries, improve the ESG rating system, and carry out comprehensive and professional research.

Keywords: ESG Ratings; green innovation; bibliometrics; CiteSpace

0. Introduction

Global climate warming and environmental pollution are long-standing challenges for human society, and carbon reduction and pollution abatement have become important goals for economic and social development. ESG ratings comprehensively evaluate corporate sustainable development capacity from the dimensions of environment, social responsibility and corporate governance, while green innovation serves as a critical approach for enterprises to achieve green transformation. Visual analysis of the literature on ESG ratings and green innovation reveals that most existing studies focus on the influencing logic and mediating mechanisms of ESG ratings on green innovation. Few studies sort out the research context and achievements in this field from the perspectives of bibliometrics and knowledge mapping. Accordingly, based on the CNKI database, this paper adopts CiteSpace software to conduct visual analysis of 325 Chinese papers concerning ESG ratings and green innovation published from 2021 to 2026. It systematically summarizes the research status, hotspots and development trends in this field, so as to provide references for further exploration and expansion of relevant research.

1. Data Sources and Research Methods

The data for this paper were sourced from the China National Knowledge Infrastructure (CNKI) database. An advanced search mode was adopted for the retrieval, with a search cutoff date of September 28, 2026. The search criteria were: (Subject = ESG rating OR Title = ESG rating) AND (Subject = green innovation OR Title = green innovation) (Fuzzy matching): All; Database: Academic Journals, single-database search. A total of 325 Chinese-language articles were retrieved, and the literature was exported in RefWorks format. Based on relevant theories of bibliometrics, an in-depth analysis of the literature´s keywords, timeline maps, etc., was conducted using CiteSpace software, with the aim of gaining insight into the dynamic evolution and research trends within this research field.

2. Analysis of the Current State of Research

2.1 Trend Analysis of Publication Volume

The number of publications is an important indicator reflecting the research progress within a disciplinary field. Taking 325 Chinese-language articles on the themes of ESG ratings and green innovation from the China National Knowledge Infrastructure (CNKI) database (2021–2026) as a sample, this paper conducts a visual analysis of them. The results show that the earliest publication of the literature on this topic was in 2021. Since then, the annual publication volume has generally shown an upward trend, with the number of papers increasing from 1 in 2021 to 143 in 2026. There are obvious phased characteristics. The period from 2021 to 2022 was the initial stage of the research, and the accumulation of relevant results was relatively limited. The number of publications in 2022–2023 increased slightly, but it had not yet formed a research craze. After 2023, the research entered a rapid development stage, and the related research on ESG ratings and green innovation gradually became a hot topic in the academic community. The temporal changes in the number of publications are closely related to the availability of national macro policies and research data. The early number of publications was relatively small, indicating that the theoretical system of the research was not yet mature, and the relevant standards for ESG ratings in China had not yet been unified. Subsequent research can be based on the policy environment and rely on the continuously improved disclosure data to further deepen the discussion.

2.2 Analysis of the Authors of the Published Works

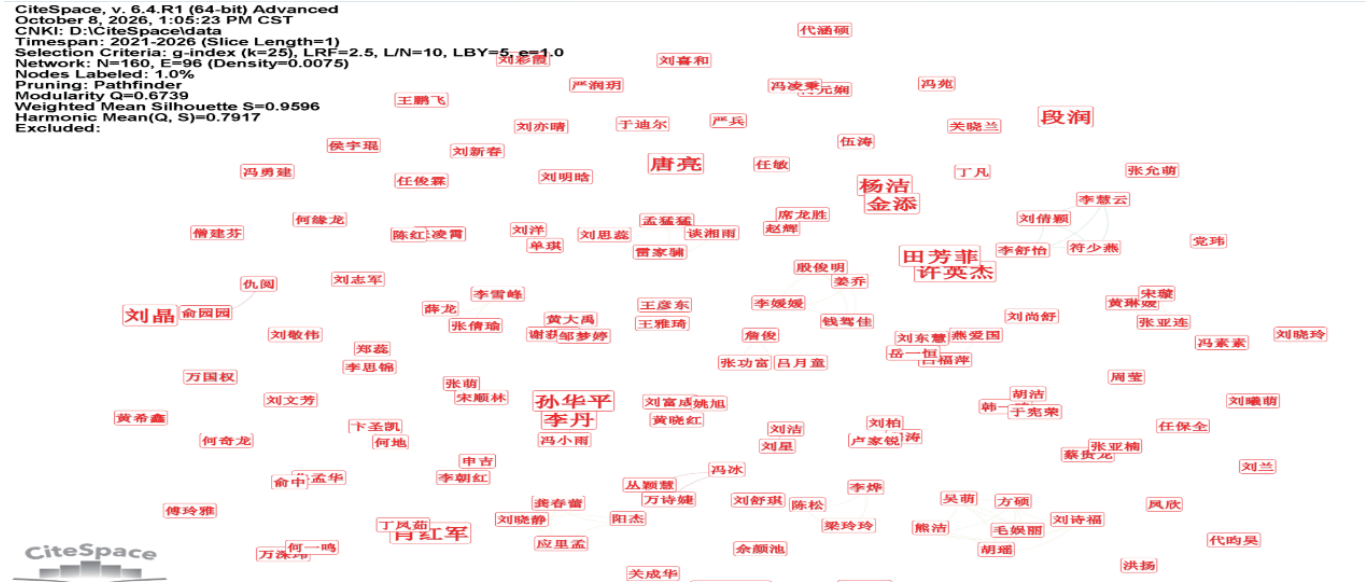


Figure 1. Author collaboration network graph

Figure 1 shows that the author collaboration network has a module value Q = 0.6739, which exceeds the threshold of 0.3; this indicates a significant clustering structure in the network and provides certain reference value. With N = 160 nodes and E = 96 edges, the data indicate that there were a relatively large number of authors conducting research in this field between 2021 and 2026, and that research on ESG ratings and green innovation has attracted considerable academic attention, becoming a research hotspot. The network density is 0.0075, suggesting that collaboration among authors is relatively low: only a small number of small-scale research teams have been formed, and a large-scale research community has not yet emerged. This dispersed structure, on the one hand, broadens research perspectives and reflects rich academic exchange; on the other hand, it can easily lead to the fragmentation of knowledge research and a lack of focused research priorities, resulting in insufficient orientation toward practical improvement and making it difficult to develop well-defined academic research modules. An analysis of publication volume from 2021 to 2026 further shows that the number of authors in this field is high and that

the network structure is clear and well-hierarchized, reflecting the fact that many scholars have chosen ESG ratings and green innovation as their research focus.

3. Research Hotspots and Trend Analysis

3.1 Analysis of Research Hotspots

Figure 2, the keyword co-occurrence network, shows 140 nodes (N=140), 155 links (E=155), and a network density of 0.0159. The low network density indicates weak correlation among keywords. Research perspectives in this field are diverse and research topics are relatively scattered, without fully converging on a single theme or entry point. Scholars conduct research from multiple perspectives such as digital economy, private enterprises and environmental regulation, yet the integration among themes remains limited.

An interconnected research network is formed among keywords, suggesting that scholars comprehensively consider the effects of numerous factors on ESG ratings and green innovation. In terms of node distribution, core keywords mainly include green innovation, financing constraints, green transformation, firm value, etc. Domestic research on ESG ratings is combined with the "dual carbon" goal and the concept of sustainable development, emphasizing the assessment of enterprises' efforts in green development and their social responsibilities.

According to the keyword co-occurrence map, scholars carry out research from diversified perspectives. Keywords for internal factors concentrate on corporate governance and capital issues, while external factors mostly explore the driving effect of national environmental policies. Fewer keyword co-occurrences are found for studies targeting industry-specific characteristics, which indirectly implies that there remains room for further research in this field.

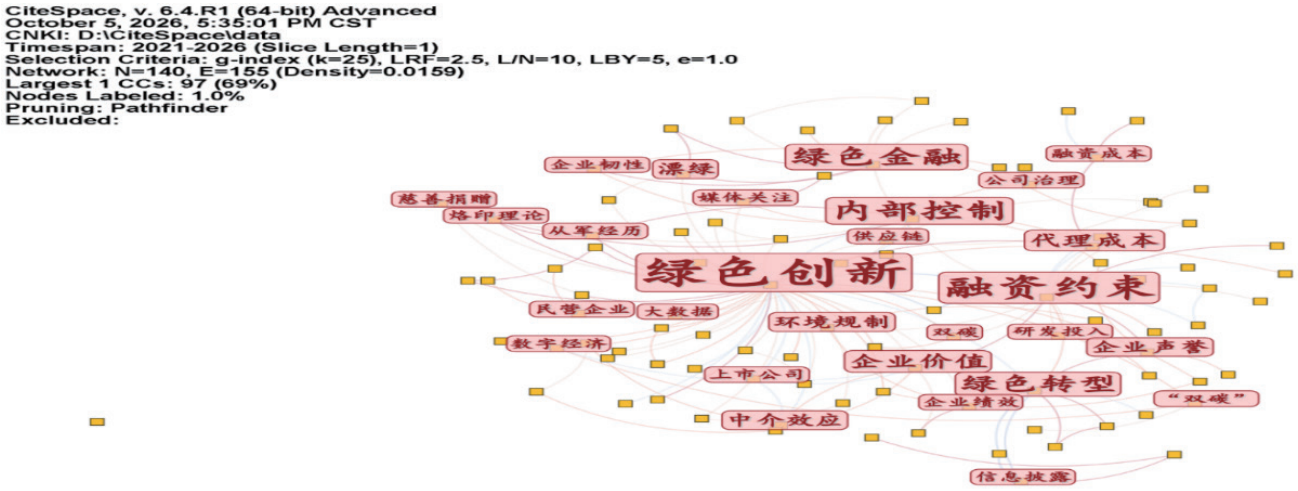


Figure 2. Keyword co-occurrence heatmap

To more precisely identify research hotspots in this field, the study extracted the top 10 high-frequency keywords and high-betweenness-centrality keywords for analysis. The results show that terms such as green innovation, financing constraints, firm value, green transformation, and green finance all rank high in both frequency and centrality, suggesting that domestic scholars have made the link between ESG ratings and corporate green development a core area of inquiry. From a business operations perspective, a large body of research centers on corporate financing constraints, agency costs, and how ESG ratings affect firm performance. Many domestic scholars use mediation models to empirically test the internal mechanisms through which ESG ratings or ESG performance generate economic benefits. This approach allows for a more comprehensive identification of the indirect effects of various influencing factors. It not only expands the theoretical framework of ESG research but also offers practical guidance for companies implementing ESG practices. Notably, "green innovation" appears 120 times, further confirming that research on ESG ratings and green innovation is a prominent frontier in this field.

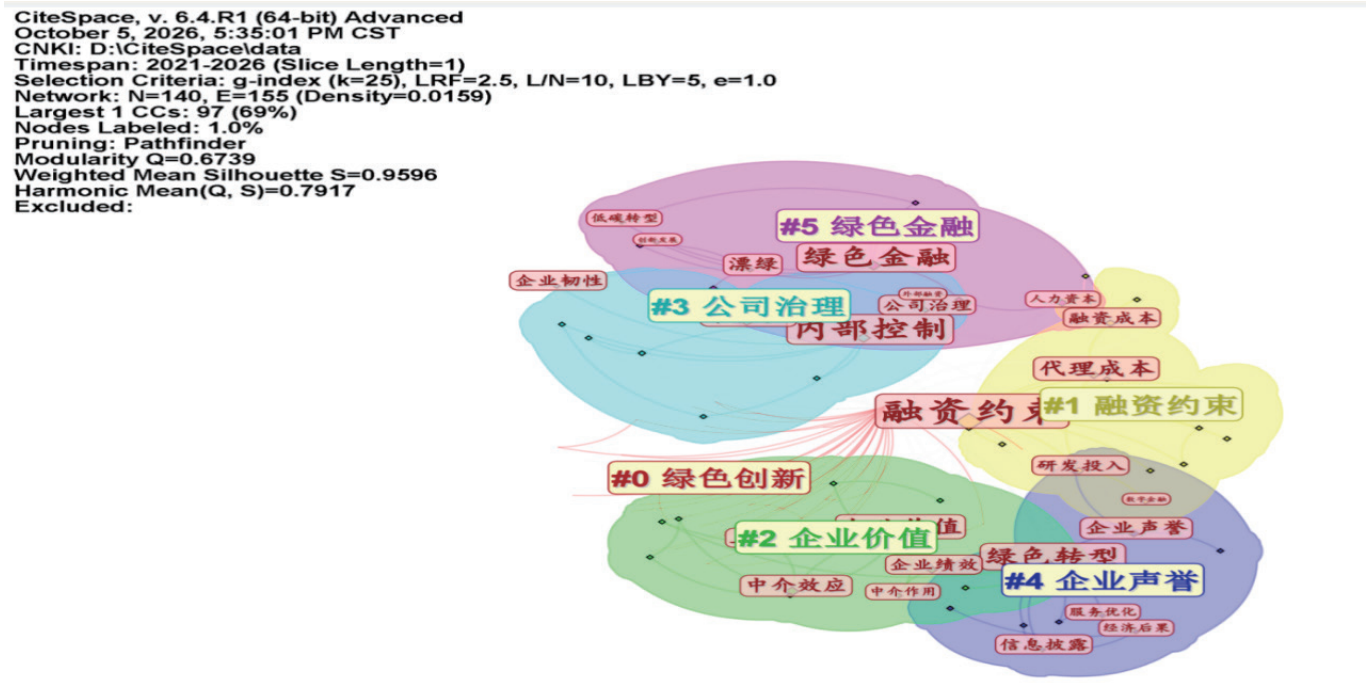


Figure 3. Keyword clustering map

A keyword clustering analysis was conducted on domestic literature on ESG ratings and green innovation from 2021 to 2026, producing a keyword clustering map (Figure 3). Based on the keyword clustering map, the modularity value Q was found to be 0.6739, and the fact that Q is greater than 0.3 indicates a significant clustering structure. The silhouette value S was 0.9596, which is higher than the boundary value of 0.5 for the average silhouette value, indicating a high degree of homogeneity within the clusters and a high level of reliability in the results. Based on the comprehensive data analysis, the names of the top six clusters are green innovation, financing constraints, corporate value, corporate governance, corporate reputation, and green finance. The clusters revolve around the diverse foundational relationships between ESG ratings and corporate green innovation, exploring the internal logic and driving factors of corporate green transformation. The research hotspots over the past five years are identified as follows:

First, the economic outcomes of ESG ratings (Cluster #0: green innovation; Cluster #2: corporate value). The large node size in Cluster #0 (green innovation) indicates that research on the association between ESG ratings and green innovation is a core topic. Cluster #2 (corporate value) encompasses corporate financial value, social value, and other dimensions. The considerable overlap between the two clusters suggests that domestic scholars link the realization of corporate value with corporate green innovation practices, with ESG ratings serving as a connecting link. Existing literature examines the mechanisms through which ESG ratings affect corporate green innovation and explores the pathways through which ESG ratings influence corporate performance. By enhancing their sustainable development capabilities through green innovation and presenting a positive social image, firms can improve their performance and realize value.

Second, the external resource conditions for ESG ratings (Cluster #1 Financing Constraints and Cluster #5 Green Finance). The keyword distribution of Cluster #1 Financing Constraints is broad, and it serves as a hub that connects research across themes. A considerable body of existing domestic literature has examined the impact of ESG ratings on firms' financing constraints. Yang et al. (2025) verified that financing constraints exert a negative moderating effect, hindering enterprises' green innovation by restricting access to capital resources.

Finally, the social effects of ESG ratings (cluster #3: corporate governance, cluster #4: corporate reputation). Cluster #3 focuses on the internal governance level and management systems of the company; cluster #4 is about the external image presentation. The two clusters are interrelated,

reflecting that scholars explore how the internal governance of the company and the social image presented externally will affect the ESG rating and subsequently what kind of driving effect it will have on the green innovation of the enterprise from both internal and external perspectives. Liu et al. (2025) clarify the influence mechanism of ESG ratings on corporate green technological innovation based on stakeholder theory, signal transmission theory and other theories, and verify that ESG ratings promote corporate green innovation through external media attention and internal control governance. Chi et al. (2026) propose that ESG ratings can convey the social image of enterprises that are willing to pursue green transformation and sustainable development, raising the social reputation cost of enterprises. Management should establish the philosophy of green development, continuously cultivate talents for green innovation, and promote corporate green innovation.

3.2 Research Trend Analysis

The keyword timeline map clearly visualizes the evolution of clustered research themes over time. Based on the timeline map of studies on ESG ratings and green innovation, the research can be divided into three stages:

The first stage is the initial research period (2021). Research on ESG ratings just emerged at this stage. Domestic ESG rating standards and systems remained immature, and enterprises only had a conceptual understanding of this non-financial performance evaluation indicator, resulting in a small volume of publications by scholars. In September 2020, China formally set the green development goals of peaking carbon dioxide emissions by 2030 and achieving carbon neutrality by 2060 to advance the greening and low-carbon transformation of industries. Accordingly, keywords in this period mainly focused on the relationships between ESG ratings and corporate green innovation as well as financing constraints. Meanwhile, enterprises prioritized capital access. Existing literature examined the mediating effect of financing constraints, analyzing whether higher ESG ratings can ease corporate financing constraints, help enterprises obtain more investment funds and government support, and channel more capital into green innovation. Although publications and keyword research advanced slowly in this period, most studies merely explored simple linear relationships without forming a multi-perspective research network, yet they laid a foundation for subsequent research.

The second stage is the research expansion period (2022–2025). The country promoted the implementation of green development concepts, integrated green and low-carbon orientations into all sectors of the national economy and production activities, and accelerated the formation of green production and lifestyles. In December 2024, the *Sustainable Disclosure Standards for Enterprises — Basic Standards (Trial)* issued by the Ministry of Finance standardized the information disclosure criteria for environmental, social and governance (ESG) performance, promoted the standardized development of assurance, rating and supervision, and improved the accessibility of ESG-related data. The number of publications rose during this period, with keywords concentrated on "corporate value", "corporate performance", "corporate governance" and "corporate reputation". Econometric models and theoretical frameworks were gradually enriched. The research focus shifted from directly investigating the influence and mechanism of ESG ratings on green innovation to exploring the effects of multiple mediating factors and the economic consequences brought by ESG ratings. Zhao et al. (2024) argued that ESG ratings improve enterprises' green technological innovation by reducing agency costs, alleviating financing constraints and strengthening the environmental awareness of management. Research in this stage covered diverse themes, improved research methodologies in the field of ESG ratings and corporate green innovation, and facilitated the systematic development of empirical research.

The third stage is the optimization and analysis period (2025–2026). Green finance, an emerging cluster theme, received widespread attention in this phase. As an innovative financial model integrating environmental concepts, green finance can establish an interaction mechanism

between environmental performance and financing costs(Liu et al., 2023). The development of green finance can curb corporate greenwashing and incentivize enterprises to improve their ESG performance (Xu et al., 2026). Literature of this period analyzed enterprises' implementation of ESG ratings and enriched theoretical research on the green finance system. High-impact keywords include "imprinting theory", "greenwashing", and "service optimization", among which "green innovation" and "financing constraints" remain prevailing research hotspots.

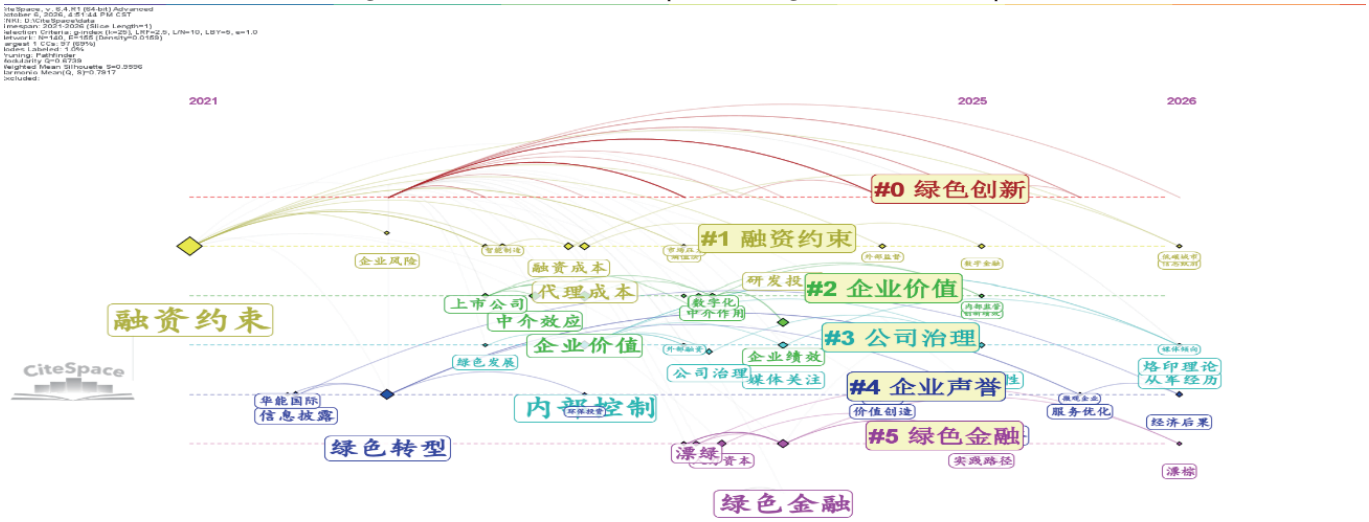


Figure 4. Keyword Timeline Map

4. Conclusions

The literature of this paper is retrieved from the CNKI academic journal database. Advanced retrieval is adopted to collect Chinese literature, with the retrieval condition set as: (Theme = ESG rating OR Title = ESG rating) AND (Theme = green innovation OR Title = green innovation). No time restriction is imposed during retrieval, and 325 papers are obtained in the initial search. Given that domestic cross-research on ESG rating and corporate green innovation started relatively late, the sample literature is mainly published from 2021 to 2026. CiteSpace, a bibliometric analysis software, is used to conduct visual analysis of all 325 valid documents and generate knowledge maps. Combined with the analysis of the knowledge maps and existing research findings published by domestic scholars in the field of ESG rating and green innovation, the main conclusions are summarized as follows: First, this research field shows obvious phased characteristics, and the core keywords maintain strong continuity. Second, keywords including green innovation, green finance and financing constraints are research hotspots in domestic studies on ESG rating and green innovation. Third, with the continuous improvement of relevant theories and advancement of research, the research boundary of this field has been gradually expanded. Scholars no longer merely examine the basic relationship between ESG rating and green innovation; they further explore the influencing paths of mediating factors such as agency relationship and financing constraints between the two. Fourth, the future research trends include the improvement of national ESG rating standards, exploration of practical approaches for enterprises to promote green innovation based on ESG ratings, and cross-industry and interdisciplinary research.

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Acknowledgments

This work was supported by the 2026 Provincial College Students´ Innovation and Entrepreneurship Training Program of Guangzhou City University of Technology (Project No. S202612617075), entitled "The Reverse-Forcing Mechanism of ESG Rating Divergence on Green Innovation in Heavily Polluting Enterprises: A Dual Perspective of Financing Constraints and Media Attention."

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