



A Bibliometric Review of Signaling Theory in Sustainability Research

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ABSTRACT

This study provides a comprehensive bibliometric review of how signaling theory has been applied in sustainability research during the period 2015–2025. Although signaling theory has been widely used to explain how firms reduce information asymmetry through sustainability communication, its rapid expansion has led to conceptual fragmentation. To address this issue, the study analyzes Scopus-indexed publications using VOSviewer to map scientific production, influential authors, collaborative networks, co-citation patterns, and keyword clusters. The results show a significant growth of sustainability-related signaling studies, with strong contributions from the United States, China, and several European countries, reflecting a globally interconnected research landscape. Citation networks highlight foundational works on sustainability reporting, legitimacy, greenwashing, and environmental performance as core theoretical anchors. Keyword co-occurrence analysis reveals that signaling theory is increasingly integrated with themes such as ESG disclosure, CSR, corporate governance, environmental values, consumer behavior, and green innovation, indicating a broad and interdisciplinary application of sustainability signals. However, the findings also show persistent inconsistencies in how signals are conceptualized, particularly regarding the credibility and authenticity of sustainability disclosures. Overall, this study offers an updated intellectual mapping of the field, clarifies dominant theoretical patterns, and identifies conceptual gaps. Future research is encouraged to strengthen theoretical integration, expand focus on emerging markets, and explore new forms of digital and AI-driven sustainability signaling.

Keywords: signaling theory, sustainability, bibliometric analysis, ESG disclosure, CSR

1. INTRODUCTION

Signaling theory is used in an increasing amount of entrepreneurial literature, however as the subject grows, it has become more difficult to understand the fundamental ideas of the theory (Bafera & Kleinert, 2022). Management researchers have used signaling theory to analyze the effects of information asymmetry in research

settings and to explain the behavior of parties with different access to information (Connelly et al., 2011). This growing complexity underscores the need for a structured, up-to-date mapping of how signaling theory is applied across sustainability research, enabling scholars to clearly trace its core concepts, evolving themes, and theoretical contributions over time.

Signaling theory suggests that firms with strong environmental performance tend to disclose richer environmental information to distinguish themselves from weaker performers and to ensure their positive actions are not mistaken for greenwashing (Zhang et al., 2023). Magness and Bewley (2012) examine the link between environmental performance and the kind and number of environmental disclosures made by Canadian mining and oil and gas corporations between 1985 and 2008. According to the report, businesses with lower pollution levels utilize disclosure as a signaling strategy to set themselves apart from those with greater emissions based on environmental performance indicators (EPI).

Furthermore, the view that the *quality* of environmental disclosure provides stronger legitimacy signals than disclosure volume (Hasseldine et al., 2005) aligns with the core patterns expected in a bibliometric mapping of signaling theory within sustainability research, where credibility, transparency, and signal strength repeatedly emerge as dominant thematic clusters. This connection reinforces the relevance of your review, as it highlights how sustainability scholars increasingly conceptualize environmental reporting,

ESG practices, and green innovation as strategic signals designed to reduce information asymmetry and shape stakeholder expectations.

In this study, management acts as the signaler and investors as the receivers of sustainability information, which aligns with the bibliometric objective of mapping how signaling theory is applied within sustainability research. By examining disclosures related to ESG, waste, water, biodiversity, energy, climate initiatives, social practices, and employee welfare, the study highlights how these elements function as strategic signals in the literature, shaping stakeholder perceptions and illustrating the evolving role of sustainability reporting as a core signaling mechanism.

Although prior studies have examined signaling theory using various methodological and theoretical approaches, such as systematic review (Bafera & Kleinert, 2022; Shahid et al., 2024) and bibliometric (Elwisam et al., 2024), this study is different from previous studies with focus on signaling theory and sustainability issues including ESG, green innovation, green finance, and CSR in current periods of 2015-2015.

2. LITERATURE REVIEW

In the sustainability domain, Friske et al. (2023) demonstrate how signaling theory helps explain the dynamic value of voluntary sustainability reporting, showing that although such reporting is initially costly and may reduce firm value, it ultimately becomes beneficial as investor expectations and institutional norms evolve. Their findings reinforce a core theme identified in bibliometric studies of sustainability research, that the effectiveness of sustainability signals depends not only on what firms disclose but also on how receivers interpret these signals within a shifting signaling

environment, where credibility can be strengthened through external verification such as third-party assurance.

In the other field, drawing from Shahid et al. (2024) synthesis of signaling theory in international marketing, this study applies a bibliometric approach to examine how the theory has been utilized within sustainability research. Just as signals help reduce information asymmetry in marketing, sustainability disclosures, ESG reporting, and green initiatives serve as key signals to stakeholders. By mapping publications from 2015–2025, this review identifies major themes,



influential works, and evolving research fronts, showing that signaling theory has become an increasingly central framework in explaining how firms communicate sustainability efforts and build legitimacy.

Building on Bafera & Kleinert (2022) observation that the rapid expansion of signaling theory has led to conceptual ambiguities, this bibliometric study addresses similar challenges within sustainability research by mapping how signal constructs are defined and applied across environmental disclosure, ESG reporting, and green innovation studies. While Bafera systematized 172 entrepreneurship articles to clarify boundaries and theoretical linkages, our analysis of sustainability-focused publications from 2015–2025 identifies parallel inconsistencies in how sustainability signals are conceptualized and interpreted. Through co-citation, keyword clustering, and thematic evolution analyses, this review highlights the dominant theoretical patterns, emerging themes, and gaps that require clearer signal definitions. This approach not only advances understanding of signaling theory in the sustainability domain but also offers a foundation for future conceptual development and integration with complementary theories.

Together, these prior reviews demonstrate that signaling theory is expanding across multiple domains but often suffers from conceptual inconsistencies and fragmented applications. By applying a bibliometric approach to sustainability research, the present study offers a structured mapping of how signaling concepts, constructs, and theoretical linkages have evolved from 2015–2025. This synthesis provides a clearer foundation for future sustainability scholars to refine signal definitions, strengthen theoretical coherence, and advance more integrated

research on sustainability communication.

3. RESEARCH METHOD

This study adopts a methodological approach that follows the procedures applied in Sayuti and Aprianto (2023), particularly in the use of bibliometric techniques to systematically map the development of a theoretical domain. Similar to their study, the present research utilizes Scopus (Sayuti & Aprianto, 2023; Tubarad et al., 2022; Wahyuningrum et al., 2023) as the primary database, applies clearly defined keyword combinations, and restricts the search to titles, abstracts, and keywords to ensure precise retrieval of relevant documents. In line with their analytical framework, this study employs VOSviewer (Ramirez et al., 2022; Sayuti, 2025; Sayuti & Aprianto, 2023; Tubarad et al., 2022) to generate co-authorship, co-citation, and keyword co-occurrence networks, allowing for a comprehensive visualization of intellectual structures and thematic evolution within sustainability research using signaling theory.

Table 1 provides a structured roadmap for examining the intersection of signaling theory and sustainability-related topics in the business, management, and accounting literature. It organizes the research process from database selection and keyword strategy to detailed bibliometric analyses, including annual scientific production, top journals, authors, and countries, as well as co-authorship and co-citation networks. By specifying the period, document types, and language, the framework ensures a focused and contemporary dataset. Moreover, the table highlights essential steps for data cleaning and preparation, which are

crucial for improving the accuracy and reliability of subsequent network and thematic analyses.

The table also outlines advanced analytical approaches, such as keyword co-occurrence and density mapping, thematic maps, thematic evolution, and historiographs, to uncover research trends, hotspots, and influential publications in the field. In particular, the inclusion of a dedicated analysis of the top 10 most-cited signaling-sustainability papers bridges bibliometric results.

4. RESULTS AND DISCUSSIONS

Figure 1 shows that citation–document map displays a central cluster dominated by highly cited foundational works such as *Cho (2015)* and *Seele (2017)*, which act as the field’s core intellectual structures. Surrounding these are several medium-sized nodes (e.g., *Su 2016*; *Bhagwat 2020*; *Torelli 2020*) that demonstrate the expansion of sustainability disclosure and signaling-related research. Newer contributions appearing at the periphery reflect emerging topics that are still gaining traction. Overall, the dense interconnected structure suggests that sustainability and signaling-related studies form a cohesive, mature research domain with continuously evolving sub-themes.

Furthermore, Figure 2 shows that the co-author country network illustrates a global and interconnected research landscape, with the **United States**, **United Kingdom**, and **China** emerging as the most influential hubs. These countries show the largest nodes and the densest collaboration links, indicating their central role in producing high-impact research on sustainability and signaling theory. **India** also stands out as a rapidly growing contributor,

forming strong partnerships with both Western and developing-country institutions, which reflects its expanding presence in sustainability scholarship.

In Asia, China serves as the anchor connecting countries such as **Indonesia**, **Vietnam**, **Singapore**, and **Macao**, highlighting a regional ecosystem that is becoming more active and collaborative. Meanwhile, European countries, including **Germany**, **the Netherlands**, **France**, **Switzerland**, and **Spain**, form well-connected clusters focused on sustainability governance and ESG-related themes. Overall, the network reveals a research field characterized by strong cross-regional collaboration, where North America, Europe, and Asia work closely together to advance theories and empirical evidence in sustainability research.

The keyword co-occurrence map shows that research connecting **signaling theory** with **sustainable development**, **corporate social responsibility**, and broader **sustainability** themes is highly integrated and interdisciplinary. Figure 3, show that large, central nodes such as *signaling theory*, *sustainable development*, *environmental values*, and *CSR* indicate dominant research focuses, while surrounding clusters, ranging from consumer behavior and economic–social impacts to environmental economics, sustainability reporting, artificial intelligence, and manufacturing, demonstrate how signaling mechanisms are applied across diverse contexts. The dense linkages among these keywords reflect a research field that increasingly blends behavioral insights, corporate strategy, stakeholder communication, and environmental policy, suggesting that sustainability-related signals are now examined not only at the firm level but also in consumer markets, technological innovation, and global environmental governance.

Table 1 Bibliometric Analysis Plan: Signaling Theory and Sustainability

Aspect	Suggestion / Approach	Notes / Justification
Database & Tools	Continue using Scopus for comprehensive coverage; use VOSviewer for visualizations.	Scopus ensures quality in peer-reviewed journals, and VOSviewer is suitable for network and co-occurrence analyses.
Keywords & Search Strategy	"signaling theory" OR "signalling theory" OR "signal theory" OR "sustainable*" OR "environmental disclosure" OR "ESG" OR "green innovation" OR "green finance" OR "corporate social responsibility" OR CSR OR "sustainability reporting" Search in title, abstract, keywords.	This strategy ensures focus on literature combining signaling theory and sustainability-related topics.
Document Selection	Include articles, book chapters, conference papers, reviews, notes, books; English only; period 2015–2025; subject: Business, Management, Accounting.	Ensures a contemporary and relevant dataset that aligns with your research scope.
Data Cleaning & Preparation	Deduplicate records; standardize author names, institution names, keywords; merge synonyms (e.g., “CSR” = “corporate social responsibility”).	Improves accuracy of co-authorship, co-citation, and keyword analyses.
Analysis 1 – Annual Scientific Production	Line chart showing number of publications per year (2015–2025).	Identifies trends and growth patterns of signaling theory in sustainability research.
Analysis 2 – Top Journals / Authors / Countries	Bar chart and table showing: top 15 journals, authors, countries; include total citations and h-index.	Highlights leading contributors and most influential outlets.
Analysis 3 – Co-authorship Network	Network map of countries and institutions; visualize collaborations.	Reveals global collaboration patterns and key research hubs.
Analysis 4 – Co-citation Network	Clustered network of cited references; label clusters by topics (e.g., CSR signaling, ESG disclosure, green innovation).	Shows foundational literature and how knowledge is structured.
Analysis 5 – Keyword Co-occurrence & Density	Map most frequent keywords; density map highlights research hotspots.	Identifies main themes and research focus areas.
Analysis 9 – Top 10 Most-Cited Signaling-Sustainability Papers	Table with: title, authors, year, journal, citations, and short notes on signaling arguments (e.g., signaling CSR as a competitive advantage).	Directly links bibliometric results with signaling theory mechanisms in sustainability.
Interpretation / Discussion	Link trends to signaling theory in sustainability disclosure, highlight geographic and disciplinary patterns, and identify gaps such as green finance signaling in emerging markets.	Ensures your bibliometric study contributes to both academic understanding and practical insights.

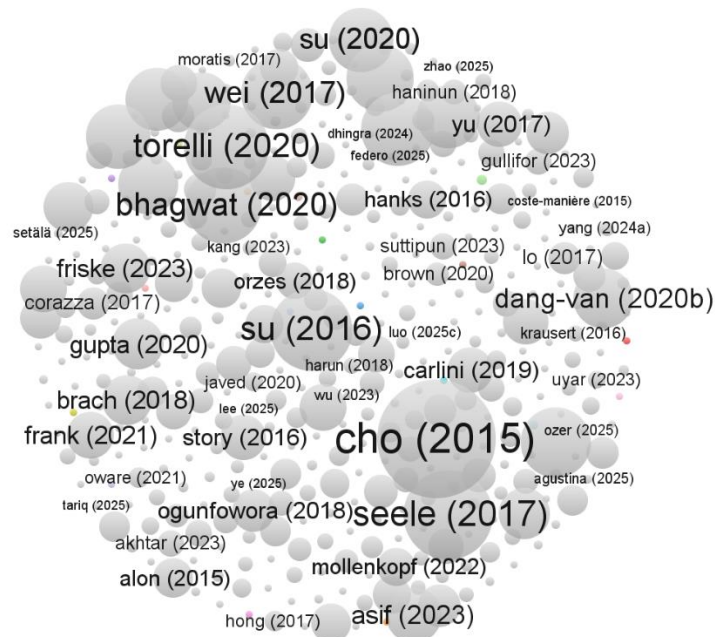


Figure 1The VOSviewer citation–document

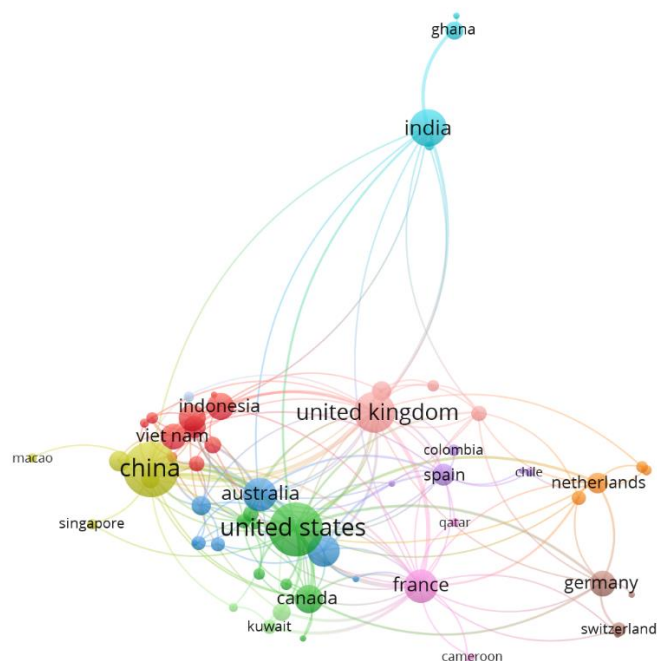


Figure 2 Co-Authors-Country

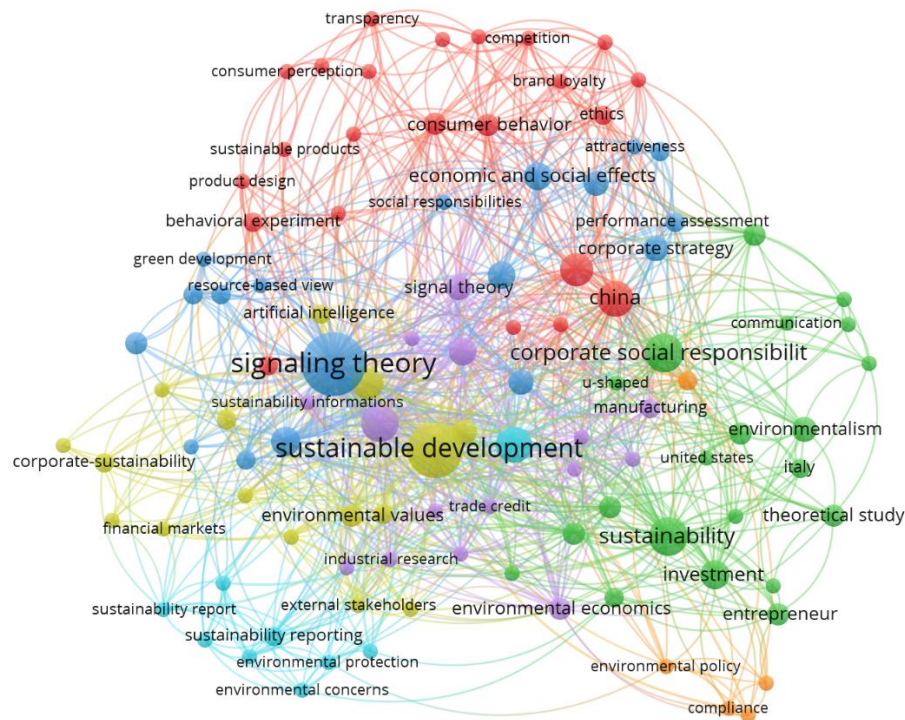


Figure 3 Co-occurrence- index keywords

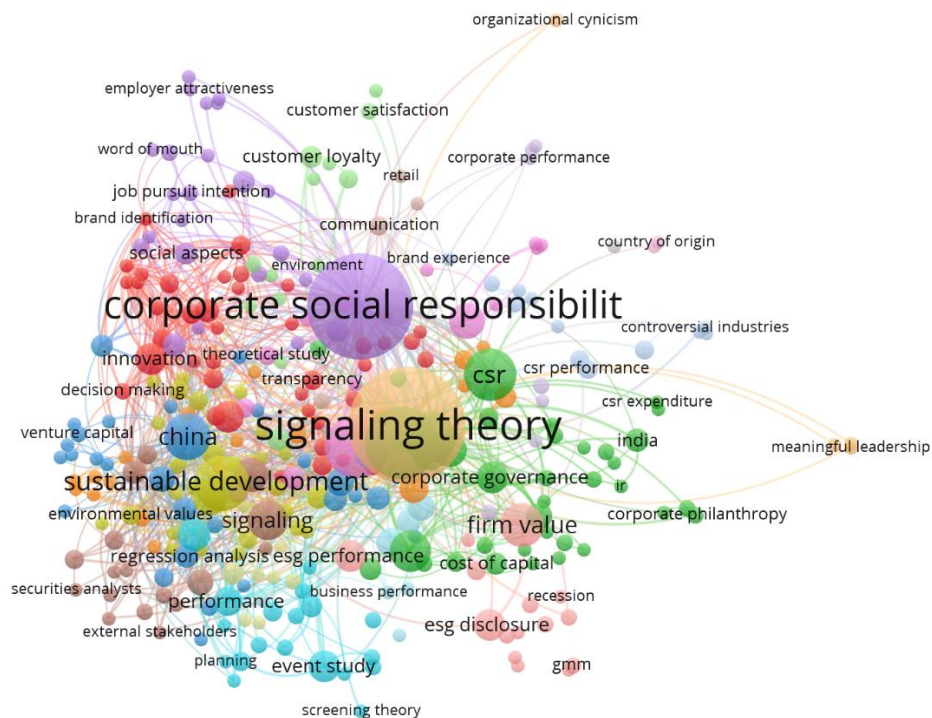


Figure 4 Co-occurrence-all keywords

The co-occurrence network of all keywords highlights a broad and interconnected research landscape centered on **signaling theory**, **corporate social responsibility (CSR)**, and **sustainable development**, which appear as the most dominant and frequently used terms. Figure 4 shows dense linkages to themes such as corporate governance, ESG disclosure, firm value, cost of capital, environmental values, stakeholder communication, and consumer-related concepts like customer loyalty and employer attractiveness. This wide dispersion reflects how signaling mechanisms are applied across corporate reporting, financial performance, stakeholder perception, investment decisions, and organizational behavior. The presence of methodological terms, such as regression analysis, event study, and GMM, also signals a strong empirical orientation in the literature, indicating that the field integrates both theoretical development and rigorous quantitative testing.

Compared with the index-keyword map, the all-keywords map displays a far richer, more detailed, and more fragmented network because it includes every author-provided keyword, not just controlled terms. As a result, Figure 4 captures additional concepts related to behavior, performance metrics, methodologies, and industry-specific topics—showing a more realistic and granular picture of how signaling theory is used in sustainability research. Meanwhile, the index-keyword map is more structured and theory-focused, emphasizing major conceptual anchors such as sustainability, environmental economics, CSR, and signaling theory. In short, index keywords reveal the **core theoretical domains**, whereas all keywords expose the **full diversity and practical extensions** of the research,

including methods, contexts, and applied themes.

Table 2 shows the distribution of co-author contributions by country in the analyzed publications. The United States and China lead in document output, with 73 and 77 publications respectively, but the U.S. has a higher citation count (3841) compared to China (1985), indicating greater influence or visibility of U.S.-based research. European countries like France, Italy, and the U.K. also show strong citation impact despite producing fewer documents, suggesting high-quality contributions. Smaller contributors, such as Finland, Kuwait, and Hong Kong, have lower publication numbers but maintain notable citation counts, reflecting specialized or highly-cited research in those regions. Overall, the table highlights both productivity and impact differences across countries in co-authored sustainability research.

Table 2 Most Co-Authors Country

Authors	Documents	Citations	Link
United States	73	3841	63
China	77	1985	48
France	29	1773	45
Canada	20	1490	21
Australia	29	1452	31
Italy	27	959	13
Hongkong	8	834	12
United Kingdom	43	777	51
Finland	4	720	5
Kuwait	5	563	10
India	36	545	17

Table 3 The argument related with signaling theory in sustainability research

Authors	Keywords	The argument related with signaling theory in sustainability research
(Cho et al., 2015)	Unknown	Sustainability disclosures often act as weak signals because firms can make positive claims without real environmental action. This turns many reports into legitimacy tools rather than credible indicators of performance.
(Kuzey & Uyar, 2017)	Application level; Assurance; Firm value; GRI; Report; Sustainability	Companies use GRI-based sustainability reporting as a signal to convey transparency and attract investor trust. But the limited use of assurance shows that many firms still avoid the costly steps needed to make these signals fully credible.
(Kiliç et al., 2015)	Banking industry; Board structure; Corporate social responsibility; Disclosure; Ownership structure; Turkey	Banks with stronger governance structures use CSR reporting as a signal to show transparency and reduce information asymmetry. The rising level of disclosure reflects how sustainability communication is increasingly used to build credibility with stakeholders.
(Uyar et al., 2020)	CSR; ESG; Greenwashing; Logistics; Performance; Reporting; Signaling	Firms with stronger CSR performance use reporting as a credible signal , showing that their disclosures genuinely reflect underlying practices. This positive performance–reporting link suggests that, in this sector, sustainability reporting functions more as a trustworthy signal than as greenwashing.
(Wei et al., 2017)	Environmental corporate social responsibility; Institutional theory; Legal incompleteness; Legal inefficiency; Legitimacy; Signaling theory	Drawing on signaling theory, firms use environmental CSR (ECSR) as a signal to convey their commitment to sustainability and responsible practices to stakeholders. In contexts with weak or inefficient institutions, these sustainability signals can enhance business and political legitimacy, indirectly improving firm performance.
(Torelli et al., 2020)	corporate social responsibility; environmental communication; experiment; greenwashing; legitimacy theory; signalling theory	Signaling theory posits that firms use environmental claims to signal sustainability, but greenwashing misleads stakeholders. Genuine signals build trust, while misleading ones trigger negative reactions.

Table 3 highlights how signaling theory is applied in sustainability research to understand the role of corporate disclosures in conveying environmental responsibility. Several studies (e.g., Kuzey & Uyar, 2017; Kiliç et al., 2015; Wei et al., 2017) show that firms use sustainability reporting, CSR disclosures, and ECSR initiatives as signals to demonstrate transparency, reduce information asymmetry, and enhance business and political legitimacy. When these signals are credible and backed by actual performance, they can strengthen stakeholder trust and indirectly improve firm performance, especially in contexts with weak or inefficient institutional environments.

However, the literature also emphasizes the risks of weak or misleading signals. As noted by Cho et al. (2015) and Torelli et al. (2020), some disclosures may serve primarily as legitimacy tools rather than accurate reflections of environmental action, amounting to greenwashing. In such cases, the signaling effect is undermined, and stakeholders may respond negatively to perceived inconsistencies, especially during environmental scandals. This dual perspective underscores that the impact of sustainability signals depends critically on their credibility and alignment with actual corporate practices.

5. CONCLUSION

This bibliometric review provides a structured mapping of how signaling theory has been applied within sustainability research from 2015–2025. The analysis shows that signaling theory has become increasingly central in explaining how firms communicate sustainability efforts, reduce information

asymmetry, and shape stakeholder perceptions through mechanisms such as ESG disclosure, CSR reporting, environmental initiatives, and green innovation. The intellectual structure of the field is anchored by highly cited works on sustainability reporting, legitimacy, greenwashing, and corporate transparency, indicating that the credibility of sustainability signals remains a core concern in contemporary research.

The findings also demonstrate strong global collaboration, with the United States, China, and several European countries emerging as key contributors to the theoretical and empirical development of sustainability-related signaling. Keyword networks reveal that sustainability signals are now studied across diverse contexts—including firm value, governance, consumer behavior, and environmental policy—showing the expansion of the theory beyond traditional corporate reporting applications. At the same time, the literature highlights persistent challenges related to signal credibility, particularly the tension between meaningful sustainability communication and practices that may resemble greenwashing.

Overall, this study clarifies the thematic evolution of signaling theory within sustainability research and identifies inconsistencies in how signal constructs are defined and operationalized. Future studies should deepen theoretical integration between signaling and complementary frameworks such as legitimacy theory or stakeholder theory, expand research in emerging markets, and explore new forms of sustainability signals driven by digital reporting, AI-based disclosures, and evolving global ESG regulations. These directions offer opportunities to strengthen conceptual clarity and enhance the relevance of signaling theory for understanding sustainability



communication in a rapidly changing institutional environment.

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