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Sustainability signaling in finance: An evolutionary systematic review from dividend signals to ESG value signals

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Abstract

This study conducts an evolutionary systematic review to map how financial signaling has transformed from traditional mechanisms such as dividends, leverage, and disclosure into multidimensional sustainability oriented signals including ESG metrics, green finance instruments, and market-based sustainability indicators. Guided by PRISMA 2020 and structured through the Watase U-AKE framework, the review synthesizes 49 Scopus-indexed studies published between 2015–2025. Bibliometric analyses using VOSviewer reveal five dominant clusters traditional financial signals, disclosure quality, ESG reporting, green finance, and sustainability market metrics indicating a clear conceptual shift toward integrated socio-environmental communication within financial markets. The synthesis identifies multilevel mechanisms shaping signal credibility, including institutional pressures, internal governance capabilities, sustainability-specific infrastructures, and heterogeneous stakeholder interpretation systems. Findings show that sustainability signals exert financial and non-financial effects through complex pathways involving risk perception, information asymmetry reduction, legitimacy enhancement, and market-based valuation processes. However, the review also uncovers persistent fragmentation, methodological inconsistencies, greenwashing risks, and limited theoretical integration across signaling, institutional, legitimacy, and stakeholder perspectives. This study offers a unified integrative framework that connects signal evolution, credibility mechanisms, and outcome pathways, thereby advancing theoretical clarity and providing a foundation for future empirical and policy-oriented research on sustainability signaling in finance.

Keywords

Sustainability signaling, ESG disclosure, Green finance, Information asymmetry, Financial market signals

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Introduction

Signaling theory has been a theoretical pillar in financial economics illustrating how organizations inform the market chu privately held information by employing costly yet credible strategic actions (Chen & Liu, 2021). An extensive body of literature has shown that information asymmetry between managers and investors is often mitigated through share buybacks, a practice perceived by investors as signals of firm undervaluation or future earnings upgrades (R. Li, 2020). Additional research indicates that various capital structure changes, debt covenants, and loan loss provisions are also perceived as financial signals that inform the market about concerns surrounding the firm's operational risk, quality of the operations or the firm's net cash flows over the long run (Ambrose & Diop, 2021). Within the classical theory, dividend payout, and leverage, and changes in the financing of the firm (disclosure of the firm's financials) are seen as reliable indicators of the firm's financial status, its willingness to take risks and the risk management along with the optimism of the manager about future are in the firm's operations.

The past few years have seen international attention turn towards environmental, social, and governance (ESG) issues, and that attention, and the multidimensional ESG metrics that accompany it, have had impact on traditional signaling and impact assessments (Jeong, 2021). Recently published reports suggest that stakeholders can identify and differentiate between authentic and insincere sustainability activism by examining the responsiveness of organizations to environmental disclosure, transparency of emissions, and communication of climate change risks (Bajpai et al., 2025). Consequently, instruments of finance, such as green bonds and environmental financing, have emerged as positive indicators of an organization's commitment to sustaining, and even enhancing, environmental (stewardship) risks and have been seen to alter (or change) the risk perception of potential investors (R. Li, 2020). Kölbel (2021) documents these multidimensional ESG metrics, in the form of various indicators like ESG rating, CSR score, certificates of sustainability, etc., and illustrates their impact on the financial markets and decision making to sustainability information and reactions to that information. Combined, these captures suggest a change in the nature of trust building, investor expectation, and legitimacy across modern financial instruments.

Even though research on sustainability signaling is rapidly progressing, existing empirical research continues to be disjointed and spread across various thematic areas, which complicates building an integrative evolutionary perspective on the development of sustainability signals over time.

Numerous investigations have focused on the credibility of sustainability signals regarding ESG disclosure quality, the risk of greenwashing, and the potential for market metrics to assess whether companies actually adopt sustainable practices, as opposed to developing superficial environmental narratives (Xu et al., 2025). Other studies focus on the impact of certain environmental and CSR related activities on the financial metrics of an organization, such as bond yields, debt, reputation, cost of debt, and the

overall legitimacy of the organization. However, these conclusions are contextually limited, as these studies focus on certain industries or geographical locations (Rim, Swenson, et al., 2019) Furthermore, the documented studies on certain green finance tools, including green bonds, capital expenditures on the environment and sustainability linked finance have yet to be integrated into an overall evolutionary framework concerning the historical evolution of these tools of financial signaling (Bertacchini et al., 2025). There seems to be a gap in the literature concerning the internal firm level drivers such as corporate governance, the idiosyncrasies of the CEO, ownership structure, and the organizational capabilities in influencing the credibility and, subsequently, the dissemination of sustainability signals (Chen, 2021). Also, the external organizational factors such as mandatory disclosure, investor protections, environmental treaties, ISO and other sustainability agreements, and sustainability standards have yet to be analyzed for developing and receiving sustainability signals, from a unified perspective, as those factors are seen as institutional pressures on signaling.

Moreover, there is a lack of theory integration concerning the unique roles played by each of the different actors, such as the investors, analysts, creditors, rating agencies, regulators, and the general public, whose views of sustainability data can lead to different financial and non-financial (Jeong, 2021 outcomes); thus, the aforementioned lack of theory integration (R. Li, 2020). All these gaps point to the need for a systematic review that documents the movement from traditional financial signaling to sustainability related signaling in an organized and cohesive manner.

Evidence of diverse grand theory intersections provide an understanding of the production, communication, and consumption of sustainability knowledge in financial markets, demonstrating that sustainability signaling is anchored in multiple rather than a single theoretical perspective in the RIS dataset.

Signaling theory applies to the context of asymmetric information because it enables the understanding of how companies are able to use expensive, yet credible, actions, whether of a financial nature or otherwise, to signal stakeholders the information of which they are privy (Kölbel, 2021). Agency theory gives further explanation to this theory, indicating that the absence of alignment of interests between the firm managers and shareholders motivates the firm managers to signal, for instance, through issuance of ESG, CSR initiatives, and/or sustainability certificates. Information asymmetry theory emphasizes the value of third party legitimization, climate risk reporting, and sustainability assurance in strengthening the signals of sustainability in a complex market (Rim, 2019). Institutional theory addresses how regulatory pressures, normative expectations, and social standards affect the behavior of corporations, thus compelling them to adopt sustainability practices that are congruent with the institutional framework, while legitimacy theory provides the explanation as to why corporations desire sustainability signals for social acceptance and to avoid reputational damage (Jeong, 2021). An evolutionary approach to the analysis of the signaling of sustainability

is valuable for financial managers, investors, and regulators because, it enables them to reliably discern between credible and symbolic sustainability signals and appreciate the contextual factors that enhance or negate signal effectiveness (R. Li, 2020). Conclusively, this systematic review integrates a number of grand theories in a cohesive manner for theoretical contribution and it serves market players by portraying the circumstances under which sustainability signals materially affect financial decision making for practical contribution.

In consideration of the established theoretical foundations and the gaps in the literature, the purpose of this study is to construct an evolutionary systematic review that focuses on the evolution of signaling in finance from traditional finance to the new focus on sustainable finance.

This literature review is designed to assess how signals concerning the sustainability of finance are created, communicated, and understood across different national contexts, industries, and regulatory regimes (Ambrose, 2021). The data which this work is based upon contains five primary groups of signals (R. Li, 2020). These data groups are traditional financial signals, corporate disclosure signals, ESG and sustainability signals, green finance signals, and market based sustainability signals. These data groups will be addressed as a function of a firm's internal drivers; external and internal stakeholder interpretive institutions; and financial and non-financial outcomes. The literature review dissects the domain into three queries. The first is to trace the evolution of financial signaling from traditional financial signals (e.g. dividends, leverage, buybacks, and disclosure) to sustainability related signals (e.g. ESG disclosure, green finance instruments, and market based sustainability signals). The second of the three queries is to define the internal drivers, external institutions and/or regulatory mechanisms which give credibility to, and enhance the ability of sustainability signals to move and function within financial markets. The last of the three questions is to define the mechanisms with which different stakeholders (e.g. investors, creditors, regulators, public, rating agencies) interpret and transforms the value, risk, cost, reputation, and legitimacy of a firm. These queries and aims, are intended to provide a descriptive synthesis of the phenomena signaling sustainability within the finance of the modern world. The integrative evolutionary framework presented here contributes to research literature by combining previously disparate financial and sustainability signaling research that have been considered and studied separately.

Utilizing the entirety of the RIS dataset, the review creates a cohesive narrative that captures the gradual transition from the reliance on traditional financial signals to incorporating sustainability signals, describing the situations, institutions, and organizations that shape the context of credibility and the impact of signals on the market (Chen, 2021). In addition, the study describes all the interconnections of the five categories of signals and five categories of mechanisms with seven grand theories, giving an all-encompassing analytical framework aimed at comprehending how sustainability signals can be strategically deployed in various financial market

communications (Li, 2025). The useful contributions encompass the understanding of effectiveness in ESG signaling, the impact of sustainability regulation on stopping greenwashing, and the pathways through which the market systemizes sustainability to alter its risk perception, capital distribution, and corporate legitimation (Jeong, 2021). The article is organized in the following manner: the introduction presents the motivation behind the study and the associated research questions, the methodology describes the procedures followed in the systematic review, the results section is arranged according to the three research questions posed, the discussion includes the theoretical contributions and the practical contributions thus rounded off, and the conclusion highlights the limitations of the study and the directions for future research (Bajpai, 2025). The arrangement highlights the primary goal of expanding the research on sustainability signaling in finance, as well as building a firm basis for further scholarly activity on the topic.

Despite the rapid growth of sustainability signaling research in finance, the existing literature remains theoretically fragmented, conceptually inconsistent, and methodologically uneven. Prior studies tend to examine traditional financial signals, ESG disclosures, green finance instruments, and market-based sustainability indicators in isolation, without articulating how these heterogeneous signals co-evolve within an integrated signaling system. As a result, the literature lacks a coherent evolutionary explanation of how financial signaling has transitioned from cost-based financial indicators to multidimensional sustainability-oriented signals, why certain sustainability signals gain credibility while others lead to greenwashing accusations, and under what institutional and organizational conditions these signals translate into financial and non-financial outcomes.

Moreover, most empirical studies adopt static and context-specific approaches, focusing on single signal types, limited geographical settings, or isolated stakeholder responses. This has produced inconsistent findings regarding the effectiveness of sustainability signals, particularly concerning firm value, risk perception, cost of capital, legitimacy, and stakeholder trust. The absence of an integrative evolutionary framework that connects signal types, credibility mechanisms, stakeholder interpretation processes, and outcome pathways represents a critical gap in the finance and sustainability signaling literature.

Consequently, there is a pressing need for a systematic and theory-integrative review that reconstructs the evolution of financial signaling toward sustainability, synthesizes fragmented empirical evidence, and clarifies the mechanisms through which sustainability signals operate across different institutional and stakeholder contexts.

Method

This study follows the PRISMA 2020 framework to ensure transparency, replicability, and systematic evidence extraction. The review focuses on the evolution of financial

signaling toward sustainability-oriented signals, integrating both qualitative synthesis and bibliometric mapping.

Scope

The review covers peer-reviewed journal articles indexed in Scopus between 2015–2025, written in English, and situated within finance, management, accounting, and sustainability fields. Only studies examining signaling phenomena traditional financial signals, disclosure-related signals, ESG and sustainability signals, green finance instruments, and market-based sustainability indicators were included. The review also restricts itself to studies that apply or reference major theoretical frameworks relevant to signaling and sustainability (e.g., signaling theory, agency theory, information asymmetry, institutional theory, legitimacy theory, RBV, or stakeholder theory).

Search strategy

Searches were conducted in **Scopus**, using keyword strings derived using the **Watase UAKE framework**, which ensures deductive inductive keyword construction rooted in core constructs (e.g., signaling theory, ESG disclosure, sustainability reporting, green finance, environmental performance). Boolean operators and TITLE–ABS–KEY filters were applied to narrow results. The initial search produced **132 records**, which were exported in RIS format for structured processing via Watase.

Inclusion & exclusion criteria

Studies were included if they met all of the following:

1. Examined signaling within a financial or sustainability-related context.
2. Addressed at least one relevant signal category (dividend policy, disclosure quality, ESG metrics, green bonds, sustainability indicators).
3. Employed or referenced one of the core theoretical perspectives.
4. Reported financial or non-financial outcomes (e.g., firm value, cost of capital, risk, legitimacy, reputation, innovation).

Studies were excluded if they:

1. Did not analyse signaling mechanisms,
2. Belonged to unrelated signaling fields (e.g., biology),
3. Provided no theoretical grounding,
4. Discussed sustainability purely operationally without signaling relevance,
5. Lacked financial or institutional outcomes.

After removing duplicates and irrelevant records, 84 articles proceeded to screening; 58 full texts were retrieved; and 49 studies met all eligibility criteria for final synthesis.

Study Selection Process

This study explicitly adopts the PRISMA 2020 framework as a methodological backbone to ensure transparency, replicability, and rigor in the systematic review process. The PRISMA protocol was adapted to accommodate the interdisciplinary nature of sustainability signaling research, which spans finance, management, accounting, and sustainability studies.

The PRISMA process was implemented through four sequential stages: identification, screening, eligibility, and inclusion. During the identification stage, a comprehensive search was conducted in the Scopus database using structured keyword strings derived from the Watase U-AKE framework, resulting in 132 initial records. Duplicate records were systematically removed using RIS-based filtering, ensuring consistency in dataset preparation.

In the screening stage, titles and abstracts were evaluated against predefined signaling-related criteria, focusing on relevance to financial signaling, sustainability disclosure, ESG metrics, green finance instruments, and market-based sustainability indicators. This stage reduced the dataset to 84 records. The eligibility stage involved full-text assessment to ensure theoretical grounding, signaling relevance, and the presence of financial or non-financial outcomes. Studies lacking explicit signaling mechanisms, theoretical anchoring, or outcome relevance were excluded, resulting in 58 eligible articles. Finally, 49 studies met all PRISMA eligibility requirements and were included in the qualitative synthesis and bibliometric analysis. This process ensured consistent, bias-controlled screening.

Figure 1 presents the PRISMA 2020 flow diagram summarizing the selection process, exclusion reasons, and final inclusion decisions. This structured application of PRISMA enhances methodological transparency and minimizes selection bias in synthesizing the sustainability signaling literature. The PRISMA workflow included:

1. Identification: database search and duplicate removal using Watase.
2. Screening: title/abstract filtering for conceptual relevance.
3. Eligibility: full-text assessment according to predefined signaling-based criteria.
4. Inclusion: final selection of 49 articles.

Data extraction & coding

Using Watase's structured extraction system, each study was coded along five dimensions:

1. **Signal Type** (traditional, disclosure, ESG, green finance, market-based);
2. **Mechanism/Driver Category** (internal drivers, institutional/regulatory pressures, stakeholder interpretation, sustainability functions, outcome mechanisms);
3. **Theoretical Grounding**;

4. **Outcome Variables;**
5. **Context** (industry, country, method).
6. This coding enabled systematic comparison and cross-study synthesis.

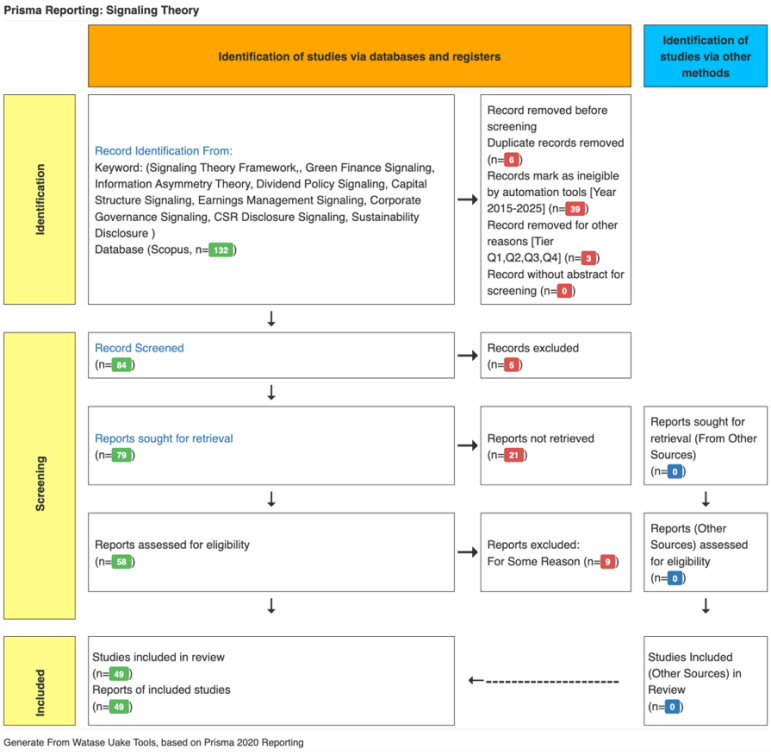

Figure 1. PRISMA 2020 flow diagram Signalling Theory

Bibliometric mapping (VOSviewer)

To complement qualitative synthesis, bibliometric analysis was conducted using **VOSviewer**. Co-occurrence mapping helped identify conceptual clusters such as:

1. ESG disclosure and sustainability reporting,
2. Green finance and environmental innovation,
3. Market-based sustainability signals,
4. Governance and agency related signaling,
5. CSR, legitimacy, and stakeholder perception.

These visual patterns supported the identification of thematic structures and the evolutionary trajectory of signaling research, enriching the narrative synthesis.

Synthesis approach

The final synthesis triangulates coded data and bibliometric insights to address the research questions:

- **RQ1:** Evolution of signal types.
- **RQ2:** Internal and institutional mechanisms shaping credibility.

- **RQ3:** How stakeholders interpret sustainability signals and how outcomes emerge.

The combined use of PRISMA, Watase UAKE extraction, and VOSviewer mapping provides a rigorous and integrative methodological foundation while maintaining efficiency and transparency.

Results

Descriptive / Bibliometric Results

a) Publication trends by year

Publication trends over time reveal the intellectual evolution and maturation of sustainability signaling research, reflecting how scholarly attention has shifted from traditional financial signals toward ESG oriented and market based indicators. The year by year trajectory illustrates not only rising publication intensity but also the field's increasing methodological and theoretical diversification (Figure 2), signaling its transition into a more dynamic and interdisciplinary research domain.

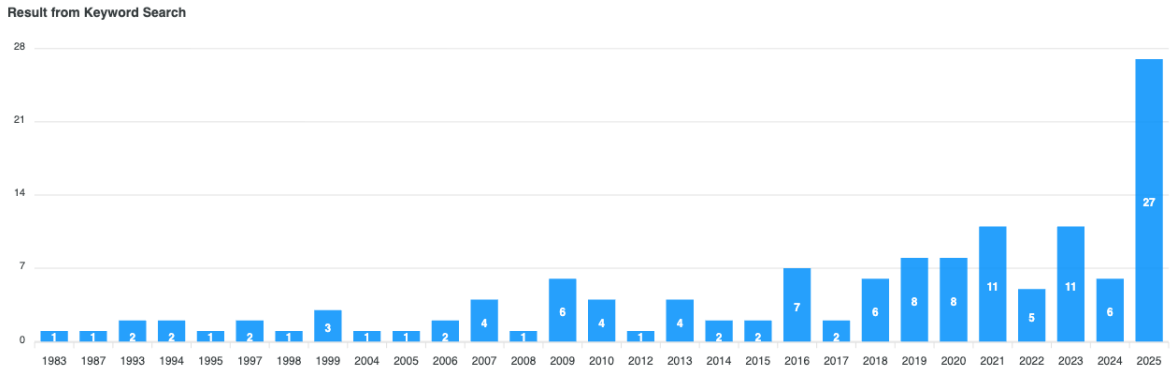

Figure 2. Publication trends by year

The year-by-year publication pattern demonstrates a clear intellectual progression in sustainability signaling research, reflecting its transition from a niche extension of traditional financial signaling into a distinct and rapidly expanding scholarly domain. Early studies from the late 1980s through the 2000s appeared only sporadically, typically one or two articles per year, and were largely grounded in classical financial signals such as dividends, leverage, and earnings quality. Sustainability-related signaling had not yet emerged, and occasional publication peaks for instance in 1999 and 2009 represented isolated thematic explorations rather than sustained academic engagement.

A noticeable shift begins after 2010, when research activity rises steadily in response to global interest in corporate transparency, governance reforms, and voluntary sustainability disclosure. During this period, annual output increases to four to seven articles in key years such as 2013, 2016, 2018, and 2019. Conceptually, signaling theory expands beyond purely financial indicators toward issues of environmental performance, CSR communication, and corporate reputation. This steady growth

marks the field's evolution from traditional financial roots toward hybrid socio-environmental frameworks shaped by regulatory expectations and stakeholder scrutiny.

The most significant escalation occurs after 2020. Publication counts rise sharply eight articles in 2020, eleven in 2021, and sustained growth through 2022–2024 mirroring global momentum around ESG investing, climate-risk disclosure, and sustainable finance policy. The dramatic peak in 2025, with 27 publications, indicates the consolidation of sustainability signaling as an established research stream. This surge reflects increasing regulatory convergence, heightened concerns regarding greenwashing, and the financial market's demand for credible sustainability-related signals. Overall, the trend line captures the maturation of a field that has moved decisively toward interdisciplinary and market-relevant inquiry.

b) Journal distribution

The distribution of journals publishing on sustainability signaling reflects the field's multidisciplinary nature, spanning finance, management, accounting, and environmental research outlets. This dispersion across diverse journal categories indicates the broad relevance of signaling constructs and highlights the growing scholarly recognition of sustainability as a cross-cutting theme in contemporary business research.

Figure 3. Journal distribution

Figure 3 demonstrated the distribution of journals reveals that sustainability signaling research is highly dispersed across multiple academic fields, highlighting its multidimensional character. *Sustainability* contributes the largest share with six articles, indicating its role as a central outlet for work that integrates signaling theory with ESG considerations. *The International Review of Financial Analysis*, with four publications, underscores growing interest from mainstream finance in understanding how sustainability-related signals shape market behavior.

A second tier of journals including the *Journal of Environmental Management*, *Journal of Cleaner Production*, and *Review of Managerial Science* each contribute two articles,

reflecting the field's intersection with environmental science, operations, and managerial scholarship. Similarly, *Business Strategy and the Environment*, *Eurasian Business Review*, and *The Scandinavian Journal of Economics* demonstrate how sustainability signaling has expanded into strategic management, international business, and economics.

Additional contributions from outlets such as the *International Journal of Managerial Finance*, *Industrial Management & Data Systems*, *Human Resource Management Journal*, and *European Accounting Review* reveal that the topic is no longer confined to financial theory, but increasingly embedded within human capital, accounting, and organizational studies.

Single-article contributions across diverse journals including *Corporate Social Responsibility and Environmental Management, Cogent Economics & Finance, Business Perspectives and Research, Borsa Istanbul Review, Buildings,* and *Asia-Pacific Financial Markets* further illustrate the topic's global and interdisciplinary relevance. Overall, the journal distribution confirms sustainability signaling as a heterogeneous and internationally resonant research domain.

c) Countries

The geographical distribution of studies on sustainability signaling demonstrates substantial variation across national contexts (figure 4), with research heavily concentrated in a few dominant economies. This pattern reveals how institutional environments, regulatory maturity, and market development shape the intensity and focus of scholarly attention in this domain.

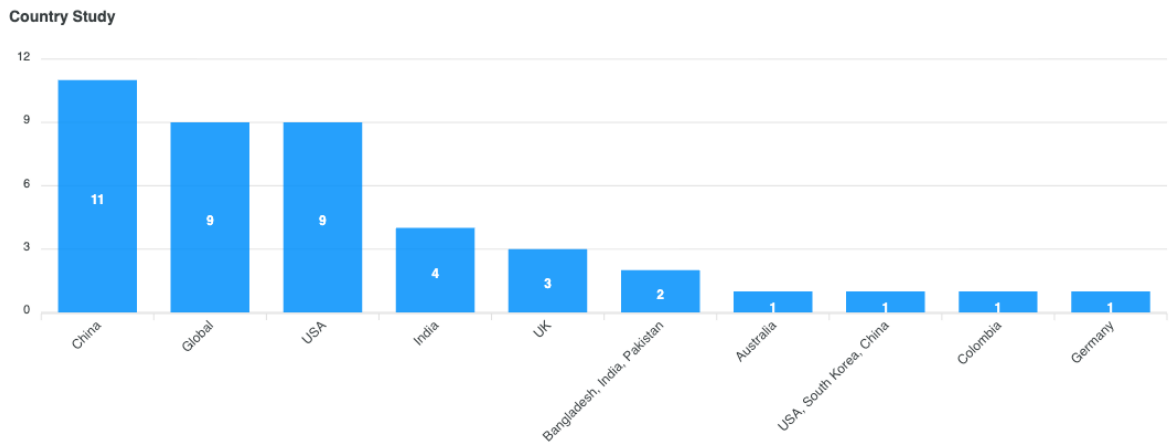

Figure 4. Countries

China has the highest number of publications, totaling eleven, which confirms its preeminence in the field of sustainability signaling research. China's remarkable publication number is attributed to its rapid economic growth, increasing regulatory demands concerning the disclosure of environmental impacts, and growing interest in the finance of green projects. The USA and global multi country studies also

published nine papers each, which proves the field's considerable scholarly interest in more advanced economies. The global studies suggest that signaling mechanisms are being studied in a variety of institutional settings, thus broadening the scope of the research. This early concentration of studies suggests that both China and the USA are the principal empirical centers of the growing field of research on sustainability signaling.

Moderate participation was noted with a comparative growing inclination toward sustainability reporting and ESG targeted financial activity in developed and emerging markets in India (4 studies) and the UK (3 studies). India's increase coincides with the progress of south Asia sustainability regulations and the growing importance of ESG investment in the region. The UK's contributions mirror the country's long standing emphasis on corporate governance and institutional transparency as well as integrated reporting. Moreover, the two studies by the regional clusters of Bangladesh, India, and Pakistan signal that South Asia is starting to be a significant region for the examination of sustainability disclosure and signaling practices. These regions as a whole make up the middle tier of contributors that enhance the diverse geography represented in the literature.

Australia, South Korea, China (cross country), Colombia, and Germany each present a single publication. Although these studies are smaller in number, they broaden the literature by adding perspectives from different institutions, regulations, and cultural contexts. Their presence illustrates the global diffusion of literature on sustainability signaling, despite the research being primarily in economically advanced countries. The inclusion of countries from Asia, Latin America, and Europe shows that the application of signaling theory to sustainability questions is relevant in both advanced and developing countries. All these studies together confirm that sustainability signaling has become a global field of research, and the research contexts are empirically diverse.

d) Keyword co-occurrence clusters

Figure 5 show the keyword co-occurrence clusters reveal the intellectual structure of sustainability signaling research by mapping how core concepts consistently appear together across studies. This visualization highlights dominant thematic linkages such as signaling theory, corporate governance, CSR, green finance, and information asymmetry and shows how these clusters collectively shape the field's evolving knowledge landscape.

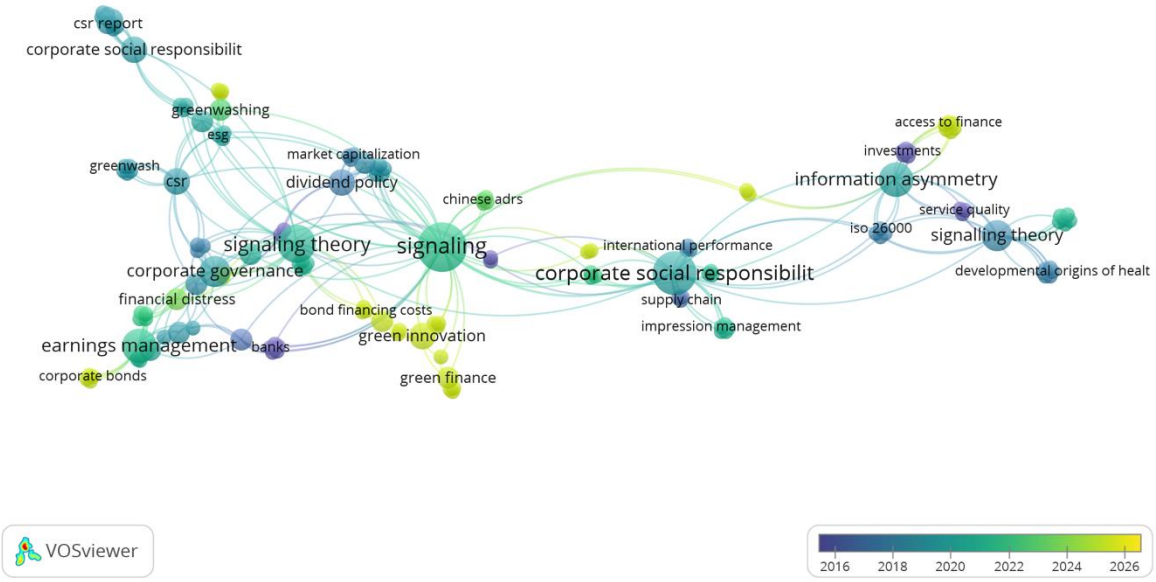

Figure 5. Keyword co occurrence clusters

The chronologically ordered overlay visualization shows the evolution of the main research focus over the years, with the older publications represented with darker colors and the more recent studies with lighter colors. Terms like signaling, signaling theory, corporate governance, and earnings management are represented in darker blue, meaning these topics were the most concerned with the earlier strand of the literature. As the research matured, the green and yellow nodes green innovation, green finance, corporate social responsibility began to shine, indicating the focus transition to sustainability signaling. The bright yellow nodes surrounding ESG and greenwashing are particularly indicative of research flowering in the most recent years, with 2020 onwards being particularly notable. The gradual transition of colors primarily captures the change from focusing on financial signals to transparency and sustainable ESG signaling.

The virtualization, too, shows that there is more new research that merges new fields, as evidenced by the connections between the more recent yellow nodes and the blue nodes that have been around longer. The terms information asymmetry, investments, and access to finance, are shown in lighter colors, signifying that there is greater relevance to those terms, as there is more focus by investors on the ESG financial aspects of these terms. The more recent terms like ISO 26000, supply chain, and impression management, suggest more focusing of the research on the institutions as well as on the stakeholders and their perceptions within the sustainsbility signaling. Also, the position of corporate social responsibility and signaling, that is in the middle with a green color that is of medium brightness, is an indicator of the retention of importance of these terms in multiple periods. In all, the overlay visualization suggests there are signals with respect to multiple aspects of sustainability that have gained the importance to shape the to be used the most in signaling theories.

- WordCloud based on variabel extraction

The wordcloud generated from variable extraction provides a concise visual summary of the constructs most frequently examined within sustainability signaling research (Figure 6). This representation highlights the centrality of themes such as ESG performance, disclosure quality, legitimacy, risk, and firm value, illustrating the core variables that consistently drive empirical inquiry in the field.

Figure 6. WordCloud based on variabel extraction

The word cloud derived from variable extraction underscores that most of the variables analyzed in the signaling literature are CSR, earnings management, dividend payout, corporate reputation, and green bond, all of which play a central role in financial and sustainability signaling. The signaling literature also acknowledged the variables green innovation, environmental performance, and sustainability disclosure, indicating the integration of environmentally and socially responsible governance (ESG) aspects with traditional finance. The variables perceived competence, perceived service quality, and employee commitment indicate a newly emerged interest in the signaling of sustainability from a behavioral and perceptual perspective. At the same time, variables such as default risk, bond financing cost, private placements, and asset mispricing corroborate the strong financial bias of earlier signaling studies. The wide range of corporate governance variables insider ownership, board diversity, political connections suggests the significance of institutional and managerial aspects in determining the credibility of the signals. All in all, the word cloud demonstrates a multidimensional research environment where financial parameters, sustainability outcomes, governance and behavioral variables intersect in defining modern applications of signaling theory.

Discussion

Synthesis of findings vs Research questions

RQ1. How has financial signaling evolved from traditional financial signals such as dividends, leverage, buybacks, and disclosure to sustainability oriented signals including ESG disclosure, green finance instruments, and market based sustainability indicators?

There is now clear evidence that financial signaling has evolved from single dimension cost driven to more complex, multidimensional, and sustainability focused signaling. Traditional financial signals such as payout policy, capital structure, and indicators of distress dominated previous literature as it framed signaling as a costly managerial action used to reduce asymmetry under classic market imperfections. Literature then began focusing on corporate disclosure as a signaling mechanism to address transparency and reporting quality before shifting the debate to the governance of voluntary disclosures. This point in the literature provided the basis for the integration of ESG and sustainability signals; moving the debate from solely financial indicators toward signals that encapsulated the environmental, social, and governance aspects as core to the quality and long term value of the firm. The most recent point in the literature has integrated green signals and market indicators of sustainability i.e. green bonds, sustainable investing ratings and market reactions to ESG (highly in demand). This shows that sustainability is embedded in financial instruments, pricing, and capital allocation. Overall, the literature demonstrates that financial signaling is impactful and will not be limited to the signals available, hence not 'replacing' traditional pillars of signaling, but expanding on them to include complex and diverse value sustainable signaling.

RQ2. What firm level internal drivers and external institutional or regulatory mechanisms shape the credibility, transmission, and effectiveness of sustainability signals in financial markets?

The synthesis demonstrates that the formation of the credibility of sustainability signaling rests on the integration of external institutional pressure, internal capabilities, and operational mechanisms at the sustainability level of the firm. Closely integrated institutional and regulatory external drivers such as disclosure requirements, ESG reporting, market sanctions, and national governance frameworks provide the minimum conditions that compel firms to construct signals that are more verifiable, standardised, and costly to fabricate. Within these structural conditions, internal drivers at the firm level, such as governance, managerial motivation, human and operational resources, and the technical focus of the firm, determine to On what level firms will have the ability to substantively underpin the sustainability claims they purport. Inputs from sustainability specific mechanisms such as environmental certification, decarbonisation, green assurance, innovation strategies, and the extent of sustainability integration into the economic core of the firm are needed to support the claim that these signals are

credible and substantively supported. Hence, the mechanisms provide a layered credibility structure: the institutional environment provides the coercive and moral pressure to act, the firms have the capactity and authenticity, and the sustainability mechanisms provide the costly, verifiable signals that transform claims into action. Hence, signals on sustainability become effective not simply via disclosure but via the interplay of regulatory disclosure, internal firm capabilities, and such firm actions that are sustainability driven.

RQ3. How do stakeholders investors, creditors, regulators, rating agencies, and the public interpret sustainability signals, and through which financial and non financial outcome mechanisms do these signals influence firm value, risk, cost of capital, reputation, and legitimacy?

The perceptions of the stakeholders are formed by the mechanisms of the ecosystem and investor information as well as how genuine and convincing the signals of sustainability are. Investors and lenders respond to ESG signals as if are "seeing" indicators of low risk, long term strategic orientation, and governance excellence. They are able to monetize sustainability actions through high valuation, low finance cost, and improved risk sustainability assessments. To regulators and rating agencies some signs are distinguished from others using logics of compliance, comparability, and standardization, which affects a firm's regulatory risk and external rating. Suspicions and responsibility of the public to stakeholders are the main drives behind the reception of those signals which will shape the firm and public reputation, and the trust of those public stakeholders as well as the long-term legitimacy of the capital. Both of these processes, reputation in particular, trust and social acceptance of stakeholders, will solidify the firm's value and will activate investment. Stakeholders can activate non-linear attributes of social or social value in reputation, trust legitimacy. When signals are consistent and verifiable, they generate positive social value; when only symbolic or inconsistent, they generate social value skepticism, penalty social value of social attributes, and greenwashing accusations. Hence, the stakeholders are the ones to receive the non-linear attributes of the social value of the signals and sustain signals reputation.

Connection to theories

This review illustrates the interconnected nature of the phenomenon of sustainability signaling as a function of the interplay of markets, institutions, actors, and firm capabilities. Centered in category 1, the evolution of signaling theory helps explain the paradigm shift in what firms predominantly signaled financially, to what they signaled sustainability, while, of course, maintaining the same signaling logic of costly, observable actions that help reveal underlying quality, although it is not explicit. It is not a deviation from signaling logic that markets change what is relevant and credible to them, and therefore, explain the transitions from dividends, leverage, and earnings signals to ESG disclosure, green finance instruments, and sustainability indicators, anchored in the market. This logic more than sufficiently explains the mechanisms in

RQ1 and RQ3, as it explains that signal costliness, consistency, and verifiability, explains why stakeholders expect a reaction positive or punitive. The theory also explains why the stakeholders expect a reaction positive or punitive based on the perceived signal costliness, consistency, and verifiability.

The information asymmetry theory explains why sustainability signals happen when there are gaps in the market on the environmental and social activities of firms. Because the gaps are based on unobservable sustainability quality, firms refine and reduce gaps through disclosure, certificates, and investments in sustainability. For example, Category 2 evidences ESG scores, carbon disclosure, and green bonds in circulation. Such signals reduce information risk and enhance the credibility of the sustainability claims in question. Thus, this theory addresses RQ2 and RQ3 in light of the assumption that better quality, verified, and comparable sustainability information engenders stronger responses from stakeholders and better financial results.

The agency theory explains the internal motivations that complement the external information gaps. There are incentive misalignments between managers and shareholders of firms, and these may lead to sustainability signals that are, strategically, either trust-building or perception-management. The results show that the extent of governance, oversight systems, and managerial incentives determine whether firms engage in positive, substantive sustainability actions or merely symbolic greenwashing. This helps clarify how internal factors shape the credibility of the sustainability signals, and explains the mechanisms anticipated in RQ2, namely, the influence of the quality of internal governance on the authenticity of the sustainability signals.

The different aspects concerning sustainability signaling pertaining to different actors from the perspective of Institutional Theory highlight the intensification of sustainability signaling across the globe. As already established, firms take on sustainability signals and sustainability-related disclosures due to regulations, reporting requirements, and normative and industry standard pressures. Such pressures affect the sustainability signaling along the coercive and normative pressures from regulators, society, and imitators within the industry. Hence, Institutional Theory explains both RQ1 and RQ2 as the external environment defines what signals to design, and the design of the signals' credibility towards stakeholders.

From Legitimacy Theory, the non-financial aspects Sustainability signaling, as discussed in Categories 1 and 2, would suggest that the Corporations engage the intensification of Sustainability signaling in order to retain societal acceptance and avoid collapse of social legitimacy. These signals, when composed of and aligned with institutional norms with regards to ESG and sustainability, the Corporations benefit in terms of social capital, social trust, and the social legitimacy for the long term. The erosion of social legitimacy will in turn lead to the deterioration of social capital, social trust, and socio-legal legitimacy along with increased social scrutiny as the dominance of the signals portrayed within the system as tokenism. This aspect also directly answers RQ 3 as it

explains the non-financial aspects in social legitimacy, social trust, and social capital as integral to the legitimacy of sustainability signaling.

Stakeholder Theory simultaneously integrates the different patterns of response documented during the review by showing how different stakeholder constituencies perceive and respond to signals of sustainability according to their specific priorities, information requirements, and evaluative standards. While investors are concerned with the risks and value over the long term, creditors analyze the risks of insolvency and downside bailee; regulators assess compliance and standards, and the public focuses on the ethical and social dimensions. The variation in responses documented across the evidence base are, in the most direct way, an embodiment of the prediction of stakeholder theory that firms need to respond to a multiplicity of different expectations in order to succeed on many different fronts. This makes stakeholder interpretation mechanisms crucial to the question RQ3 is addressing, in illustrating that the effects of sustainability signals differ according to the evaluators and the evaluative criteria they employ.

Ultimately, the Resource-Based View and the Theory of Dynamic Capabilities form the core of the internal strentgh of sustainability signaling. Research demonstrate that the most credible sustainability signals result not from cleraly and completely dislosing something, but from having the abilities of green innovation, envirnmental system performance, carbon reduction, and adaptive sustainability evolution. These abilities create signals that are extremely credible in the logic of signaling and costly to outrun. Capability steaming from Dynamism describes the firms> competencies of sustainability and the competencies to outperform and advance deeply to the changes in the institutional and market environment. Together, these explain why firms sustain the most internal competencies and high performance in signaling sustainability.

Comparison with existing literature: what supports vs. what contradicts

The results of the review defend the prevailing signaling theory positing that companies engage in sustainability disclosure and undergo sustainability practices as expensive signals in an attempt to diminish information asymmetries and demonstrate an undetected quality to the financial markets.

Sustainable corporate social responsibility (CSR) compliance, effective ESG reporting, and sound environmental practices are having a positive ESG market reactions, strengthening the propositions arguing for the sustainability impact. As a consequence, several authors (Su et al., 2016; Bae et al., 2018; Kölbel & Busch, 2021; Epure, 2022; Uyar et al., 2020; (Xu et al., 2018); Desjardine et al., 2019; Jeong & Jiang, 2021; Wang & Yao, 2025); Nazari & Poursoleyman, 2025) argue that the sustainability content serves as a key signaling mechanism in contemporary finance. of corporate finance signaling literature, as Ambrose & Diop (2018), Lin & Milhaupt (2021), Ho & Wei (2016), Cheynel & Levine (2020), Guest et al. (2020), Rim et al. (2019), Nagurney & Nagurney (2015), Gu & Guo (2023) concludes that greater transparency, reporting on governance, and the

quality of reporting and disclosure impact stakeholders perceptions and gain trust, closing the gap between financial and sustainability signaling. Also, the literature on Green finance signals further validates that when sustainability is directly integrated into financial instruments, especially in green bonds and structures of green finance, it becomes more influential to investors and borrowers, and the condition of the signal is highly verifiable (Li et al., 2025; Arhinful, Obeng, et al., 2025). Last but not least, the traditional financial signaling literature remains supportive of this position.

These authors also show the evolution of credibility given the dependence on consistency and costliness and the content in question changing from dividends/earnings to ESG and green finance (Curcio & Hasan, 2015; Dinh et al., 2016; Pham et al., 2019; Smith & Pennathur, 2019; Vishnani et al., 2019; Albanez & Schiozer, 2022; Dumitrescu et al., 2025; Chhillar & Lellapalli, 2022; Zhao, 2023; Gupta & Aggarwal, 2018; Esqueda, 2016; Chen & Liu, 2020; 2024).

Simultaneously, the analysis also identifies various inconsistencies and limitations compared to the existing literature, particularly in regard to the degree to which sustainability-related signals consistently yield favorable outcomes in the marketplace.

Although positive outcomes in valuation and legitimacy are documented in many studies, other studies suggest the outcome weakens and reverses as the signal is perceived as merely greenwashing, inconsistent, or lacks verification, demonstrating the greenwashing risk and the weak signals involved (Rim, Kim, et al., 2019; Guest et al., 2021; Cheynel & Levine, 2019; Kölbel & Busch, 2019; L. Wang et al., 2025; Lin et al., 2025; Perez et al., 2019). The risk of greenwashing is further evidentially tangled by the noisy and heterogeneous state of ESG discourse and its disparate metrics and contexts, where stakeholders are found toigno, and/or to fiercely unsustainably misinterpret, to substantive signal the sustainability information ESG commands (Nazari & Poursoleyman, 2025; Epure, 2021; Uyar et al., 2020; Xu et al., 2018; McCullough et al., 2020; López-Santamaría et al., 2021; Moratis, 2018). Discrepancies in stakeholder evidence, particularly in investors and regulators, are further documented; while border institutional pressure is evidenced to yield compliance-driven disclosure, it is suggested this disclosure does not reflect real capability, and in turn indicates that mandatory disclosure alone lacks credibility and is insufficient unless further sustained by real internal drivers, and incorporation of sustainability-specific frameworks (Lin & Milhaupt, 2021; Jiang et al., 2020; Su et al., 2016; Ho & Wei, 2016; Gu & Guo, 2023; Bertacchini et al., 2024; Adetutu & Stathopoulou, 2021; Zhu & Li, 2024).

Public analysts, depending upon the firm and industry history, industry standards, and perceived materiality, show skepticism toward the same ESG signal (Li, 2020; DesJardine et al., 2021; Jeong & Jiang, 2021; Chen & Liu, 2020; Pham et al., 2017; Dinh et al., 2016). Rather, these Irregularities acknowledge the signaling role of sustainability by framing these evidence. Sustainability signaling, unlike most forms of signaling, works provided there is an appropriate context and higher credibility axes than is the case with traditional forms of financial signaling.

By looking at the data together, you may conclude that your work not only expands the literature, but also integrates your work with the previous literature rather than simply repeating it. The studies that were reviewed demonstrate a consolidation movement that is evolutionarily expanding that positive signal to the financial domain and now to include sustainability. However, the studies also revealed an integrated systemic paradox from the gaps in verification, the noise of the ESG ratings, symbolic disclosure, and the varying interpretations within the stakeholders. This integration presents a synthesis of the positive vision of the evolution of the domain and the impact of sustainability signalling on value versus the negative view of the evolution of the domain and the impact on the sustainability signalling of the system. The literature is universally accepted on one main point and this is that sustainability signalling costs. Sustainability signalling costs and operationally and contextually grounded. Furthermore, sustainability signalling costs and operationally and contextually grounded. They also lose value and can backfire if the sustainability signalling is perceived by stakeholders to be poorly executed, illusory, or detached from genuine effort (C. Li et al., 2025, Rim et al. 2019, Kölbel and Busch 2019, Moratis 2018, McCullough et al. 2020, Arhinful, Mensah, et al., 2025). This unique paradox is the basis for your argument and provides the reasons that sustainability signalling should be examined concurrently within Category 1 evolutionary, Category 2 strategies for assessing credibility, and within a multi-theoretical framework.

Conceptual model or Integrative framework

This study proposes an integrative conceptual framework (Figure 9) that synthesizes the evolution of financial and sustainability-related signals with the internal, institutional, and stakeholder mechanisms that shape their credibility and impact. The framework illustrates how diverse signal categories interact within a unified system, enabling a clearer understanding of the pathways through which sustainability signals generate financial and non-financial outcomes.

- Evolutionary pathway

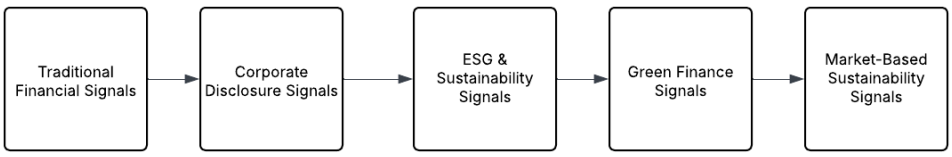

Figure 7. Evolutionary pathway

The conceptual model illustrates the evolutionary progression of signaling mechanisms from traditional financial indicators toward more complex sustainability-oriented signals. It begins with Traditional Financial Signals, such as dividends, leverage, and earnings quality, which historically served as the primary channels through which firms conveyed information to reduce asymmetry. Over time, firms expanded these mechanisms into Corporate Disclosure Signals, emphasizing transparency, governance quality, and broader reporting practices. As stakeholder expectations evolved,

organizations increasingly adopted ESG & Sustainability Signals, integrating environmental, social, and governance dimensions into their communication strategies. This development paved the way for Green Finance Signals, where financial instruments such as green bonds or sustainability-linked loans act as explicit, high-credibility indicators of long-term environmental commitment. The model culminates in Market-Based Sustainability Signals, reflecting how markets themselves generate sustainability information through pricing dynamics, ratings, and investor reactions. Together, the sequence portrays a coherent shift from purely financial signaling toward integrated, multidimensional sustainability communication within modern financial systems.

- Mechanism model

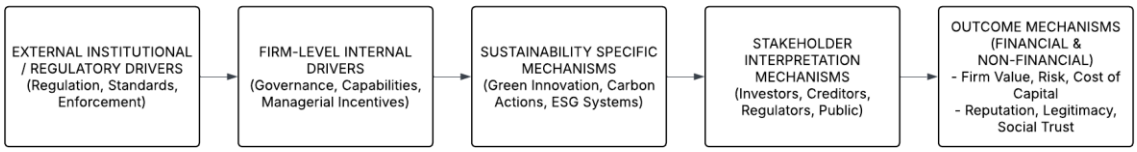

Figure 8. Mechanism model

The framework mechanisms model shown in Figure 8 posits the starting point of the model framework in the context of sustainability signaling in the Financial Market as having external institutional and regulatory mechanisms that set the bottom boundary of the model and as having enough credibility to set external boundaries of disclosure requirements and enforcement levels. Internal mechanisms from the Firm Level then determine the authenticity of these signals by evaluating the absence and/or presence of the governance mechanisms, ability, and managerial motivational levels required to achieve these initiatives. These mechanisms then merge into sustainability- specific mechanisms that emit costly, credible signals in the form of green innovation certificates, environmental certifications, and carbon removal initiatives, and these initiatives all account for the governance and managerial motivational levels. Mechanisms of stakeholder interpretation moderate the flow of these signals and convert them into sustainability actions. These actions can be evaluated and critiqued using varying information sets, allowing investors, debt holders, regulators, and the public to assess and critique them. To conclude, non-financial and financial outcomes of reputation, legitimacy, value, risk, and cost of capital can be synthesized by mechanisms that convert these positive signals into outcomes. The model, as a whole, accounts for and provides explanations as to the presence of signals of sustainability in the present day Capital Market.

- Conceptual framework diagram

Figure 9. Conceptual framework diagram

The movement of the signal crossing from one financial metric to another, then to ESG and sustainability signals, along with other financial indicators of sustainability, with a focus on dividends and leverage, is advancing towards sustainability-focused finance and integrating ESG with other dimensions of performance on green cash flow instruments and sustainability indicators of performance in the market. This also pertains to sustainability-focused finance, ESG, and the literature on signalling in financial markets. According to the response from the ESG signal, Collins provided an explanation of the advancement towards sustainability-focused finance and integrating ESG with other dimensions of performance on green cash flows. Collins, Collins, Collins, and Collins explained the moving signal across Collins in finance, signalling that Collins is advancing towards sustainability-focused finance and integrating ESG with performance dimensions. The literature on signalling provides the explanation, which is elaborated on by Collins, Collins, Collins, Collins, Collins, and Collins in finance. Collins has advanced towards sustainability-focused finance, and this is detailed in the finance signal from Collins.

Implications

Theoretical implications

This study is valuable because of what it contributes, both in terms of practice and theory. This study helps enhance scholarly discussions on sustainability signaling within contemporary financial markets in the following ways. First, the study contributes to the extension of Signaling Theory, which postulates that sustainability-related disclosures, green finance instruments, and market-based ESG indicators are not simply informational beacons but institutional signals of varying order in context (i.e., regulatory, normative, and market governance). This movement within Signaling Theory evidence departure from tightly incorporating organizations, costs, and market efficiencies toward more encompassing frameworks in which institutional and stakeholder environment drives the buoyancy, credibility, and persistence of signals. This is seen in the second contribution to this study reviews Legitimacy Theory, and Institutional Theory, and Information Asymmetry Theory, adding the novel concept of sustainability signaling to include green innovation systems; third-party assurance; carbon management infrastructures; and ESG rating ecosystems. Each are means through which organizations gain and maintain legitimacy, diminish persistence informational asymmetry, and meet the institutional environment. This theory also contributes to the review and identification of the systems of sustainability signals

mechanisms and how they are diffused, interpreted, and reacted toward from various heterogeneous stakeholder systems to include investors, creditors, regulators, analysts, and the public. These mechanisms elucidate how market variability outcomes are produced by the synergistic alignment of institutional dynamics, firm resources, and stakeholder evaluation frameworks rather than the single attributes within the signals.

Together, these contributions improve and advance the theoretical understanding concerning the evolution of sustainability signals, the reasons as to why they gain this credibility, and the ways in which they influence tangible and intangible results in modern-day financial markets.

Methodological Implications

This review identifies several methodological aspects that can stimulate additional empirical work on sustainability signaling. First, this synthesis reveals major methodological shortcomings in prior investigations, especially the scant incorporation of multi-level data, inconsistent operationalization of sustainability variables, and over-reliance on cross-sectional or single-country datasets. An alarming number of studies regard sustainability signals as static variables, failing to consider the temporal attributes, cross-market spillovers, and institutional interdependencies. Second, prior investigations had methodological shortcomings such as endogeneity, lack of signal credibility measurement, piecemeal use of ESG rating data, and lack of clarity due to disparate disclosure standards. Many studies lack adequate identification of the causal chain through the adoption of quasi-experimental designs or event studies with tightly controlled temporal windows, or the use of multi-period flexible models, limiting the inferences to determining the impact of sustainability signals on market outcomes. Third, these shortcomings present evident openings for novel methodology. Other studies have the opportunity to incorporate longitudinal and multi-country panel-data econometric models to investigate the potential for dynamic effects, structural equation modeling (SEM) or PLS-SEM for the study of intricate mediation and moderation, and text mining, NLP, sentiment analysis, and machine learning, to quantify sustainability disclosures, evaluate potential indicators of greenwashing, and analyze unstructured data on ESG narratives at scale.

Utilization of advanced methodology i.e., Difference-in-Difference, Synthetic Control, Propensity Score Matching, Instrumental Variable Method can drastically increase the validity of conclusions drawn from the research. Taken as a whole, these methodologies will shed even more nuanced, sophisticated, and contextualized research on the ways and means of how sustainability signals emerge and sustain through mechanisms-building credibility and influencing varying outcomes, both financial and non-financial.

Practical / Managerial / Policy implications

This review provides numerous practical, managerial, and policy implications for corporate firms, industries, regulators, investors, and ESG information intermediaries. For managerial corporate executives, sustainability signals cause most positive market

reactions if and when corporates commit to making substantive, highly costly, and verifiable sustainability commitments and actions. Managers, therefore, must not only avoid symbolic disclosure, but also focus on constructing and developing internal systems, such as carbon managerial systems, environmental performance monitoring, and climate adaptive green innovation funnels that would more credibly focus managerial sustainability signals. Consistency between disclosed information and operational practices over a reasonable time period, and the sustainability strategies, is vital to avoid greenwashing, and sustain trust. Corporations should also incorporate sustainability signaling into their corporate governance systems, ensuring board governance and oversight, independent guarantee and verification systems, as well as coherence between sustainability objectives and corporate executives.

Industry practitioners should integrate sustainability across the supply chain and industry ecosystems. For example, the energy, manufacturing, logistics and finance industries should implement sector specific metrics and reporting standards that enhance comparability, minimize information noise and build confidence for investors. Furthermore, industry associations should collaborate to develop frameworks for best practices for transition risk reporting, climate readiness assessments, and the management of sustainability-related risks. In addition, businesses in sectors that are characterized by complex supply chains should adopt traceability and integrated ESG data management systems, to ensure sustainability signals are transmitted seamlessly from upstream to downstream supply chain actors.

For policymakers and regulators, the review emphasizes the need for unambiguous, enforceable, and symmetrical sustainability reporting standards that should minimize the information asymmetry and enhance the credibility of ESG disclosures. Policymakers should also strengthen the control of false and misleading sustainability claims by describing legal sanctions for ESG reports that are inconsistent, as a means to minimize dubious or opportunistic behavior. Finally, the review highlights the need for international cross-border cooperation between regulatory authorities in order to minimize fragmentation, improve global comparability and support the development of international standards for ESG reporting.

For investors and financial institutions, the findings underline the growing importance of incorporating sustainability signals into risk management, asset pricing and portfolio construction. Investors need to analyze sustainability signals multi-dimensionally, paying particular attention to the substance of the actions involved and the institutional context of the Produced signals. The due diligence process needs to examine signal timeliness, the risk of legitimacy, the governance context, and the potential for greenwashing. In particular, institutional investors can focus on sustainability signals to identify companies with superior dynamic capabilities and long-term resilience and readiness for the transition, so that investment decisions can be made with higher confidence.

For ESG analysts, data providers and rating agencies, the review accelerates the need to fix rating discrepancies, noise in measurement, and opacity of measurement. The analysts need to increase the transparency of scoring methodologies, tighten their verification processes, and use more real-time data on sustainability generated by advanced technologies such as NLP, satellites, and automated systems for carbon measurement. ESG data and measurement systems will have greater market relevance as alignment with regulations improves and interoperability with other ESG datasets increases.

Market Sustainability Signals Impact on Expected Cost of Capital and Corporate Legitimacy Review of the Capital Market Ecosystem Sustainability underscores the importance of capital markets and the sustainability of these markets. The system is dependent on the quality of the information and the regulatory system in place that would allow the information to be evaluated, sculpting the demand for responsible investment, diminishing systemic risk, and promoting the capital system for global sustainability.

Future research agenda

1. **Gap-based framework**

   Despite how far the field of Sustainability Signaling Studies has come over the years, there still does not seem to be a coherent definition of how to merge together traditional financial signaling, most of which are not adaptive to contemporary business practices, with ESG and other so-called 'green finance' signalling constructs in the literature. Almost all of the literature appears to be conceiving of sustainability signals rather linearly, and not in what is a more evolutionary way unto itself. This disconnect within the literature inhibits the ability to see how different constructs signal the market's sustainability focus, how different signals within the constructs might be mutually reinforcing, or how signals within the construct might actually be contradictory. Additionally, the literature appears to be lacking a consistent terminology and framework to identify and differentiate between what might be considered real and substantive signals (versus greenwashing or being superficial in performance disclosures). Such gaps clearly call out for analytical sophistication, and for using more evolutionary and integrative frameworks to marry traditional financial communication with modern sustainability communication.

   Standard methodological challenges remain as well, namely over-relying on cross-sectional methodologies, single nation-studies, and self-reported sustainability disclosures in the literature. There is often an absence of consideration for endogeneity or feedback loops/interactions, and a failure to identify the multi-layered mechanisms which affect the perceived credibility and actual effectiveness of the sustainability signals used in the studies. Inconsistency in the literature itself often appears to come from the different ESG metrics used, the range of data assembled for the studies, and a relative lack of robust mechanisms to identify

supposed causal links or relationships. Meanwhile, the field itself appears to have largely under-utilized advanced methodologies, particularly within the sub-domains of empirical studies, such as studies utilizing panel-data econometrics with NLP and machine learning mechanisms, or within designed quasi-experimental frameworks. Each of the methodological challenges outlined here impact the precision and robustness, as well as the external validity of the empirical and theoretical studies undertaken in this field.

There is a heavy skew towards a few select geographical contexts in prior work, such as China, the U.S, or the EU, which results in a lack of emphasis on emerging economies, frontier markets, and varied regulatory contexts. The differences in culture, governance, and expectations towards sustainability are often not compared across countries and this leads to a lack of robust comparative analyses. This gap leads us to lack a nuanced understanding of how the institutional context affects the credibility, meaning and impact of the sustainability signals. Furthermore, cross-industry research is particularly lacking, and there are significant differences in sustainability materiality in some industries versus others, e.g., the energy and finance or manufacturing sectors. This is a gap that suggests the need to approach this work from a more geographically and sectorally heterogeneous perspective.

Despite the existence of research that shows how sustainability signals impact the financial variables like firm value, cost of capital, stock reaction, there is a considerable lack of analysis of how such signals impact other variables like legitimacy, stakeholder trust and engagement, reputation, employee commitment, or even alignment towards long term strategy. In addition, little evidence exists on the negative or unintended impact of such signals, if any, such as stakeholder backlash erosion or lack of confidence due to perceived greenwashing and loss of engagement. Furthermore, not much attention has been focused towards how the interaction of multiple signals can create compound or cascading outcomes. All of this suggests the need to broaden the analysis towards more multidimensional outcomes.

While Signal Theory has become a standard reference, having a center and a significant proportion of attention, there has not been much of a theoretical integration with other theories such as Information Asymmetry Theory, Legitimacy Theory, Institutional Theory, Stakeholder Theory, and the Resource-Based View. Most of the studies make use of these theories in isolation and do not attempt to analyze them together in explaining the credibility, interpretation, and performance effects of sustaining signal a sustainable strategy. As the complexity of sustaining strategy signaling increases, the use of one theory approach in explaining the problem becomes more unhelpful and the work becomes more fragmented. There also appears to be a lack of theorization pertaining to the boundary conditions of when and why these signals will work and when and why they will fail. Working in

these gaps encourages the development of a more comprehensive, unifying model which will draw on a number of theories in the analysis of sustainability signaling.

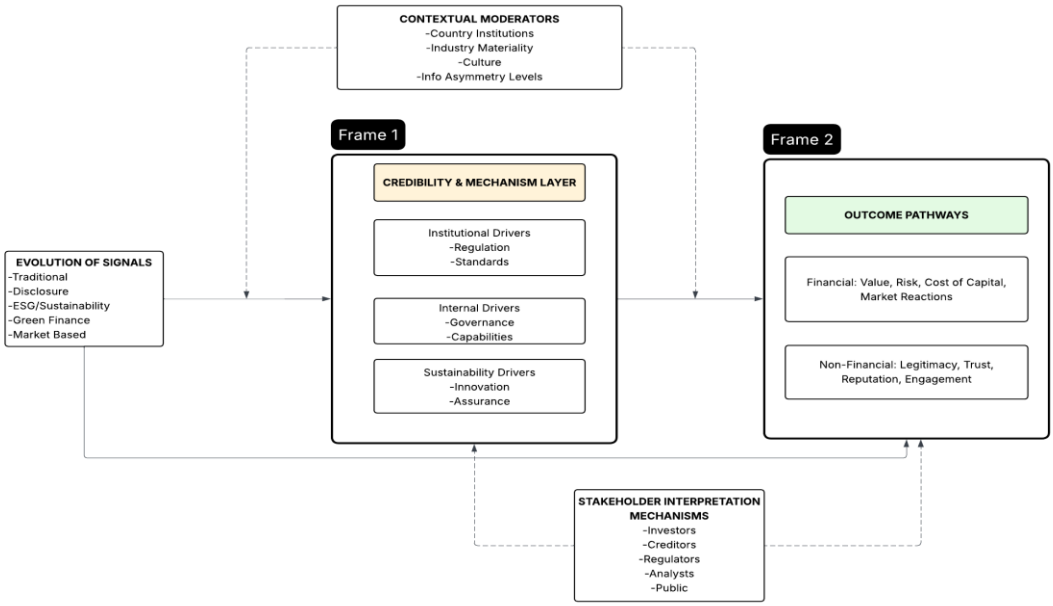

Figure 10. Future research

The conceptual model visually encapsulates the core gaps identified in the sustainability signaling literature and translates them into a structured, multi-layered research architecture (Figure 10). The leftmost block Evolution of Signals directly addresses the conceptual gap, illustrating how traditional financial signals, disclosure-based signals, ESG/sustainability signals, green finance indicators, and market-based mechanisms have evolved but remain theoretically fragmented in the literature. The model highlights the field's failure to integrate these heterogeneous signal types into a coherent evolutionary pathway, thereby reflecting the absence of a unified conceptual understanding noted in the gap analysis. By positioning Evolution of Signals as the entry point into Frame 1, the model demonstrates that sustainability signals cannot be studied linearly but must be understood as part of a dynamic system of interrelated constructs.

Frame 1 the Credibility & Mechanism Layer corresponds directly to the methodological gap and theoretical integration gap. Within this block, the model synthesizes institutional drivers, internal governance and capability drivers, and sustainability-specific mechanisms such as innovation and assurance. This aligns with the methodological critique that prior studies fail to uncover multi-layered mechanisms, rely excessively on cross-sectional or single-country methods, and rarely model endogeneity, feedback loops, or multi-mechanism pathways. Furthermore, because the literature overwhelmingly relies on single theories in isolation, Frame 1 visually represents the need for integrating Signaling Theory with Institutional Theory, Legitimacy Theory, Information Asymmetry Theory, Stakeholder Theory, and RBV. The model thus operationalizes the call for a more sophisticated and theoretically pluralistic approach to understanding how sustainability signals gain credibility and translate into meaningful effects.

Frame 2 Outcome Pathways addresses the outcome gap, highlighting that current research rarely investigates multidimensional consequences beyond financial performance. By distinguishing financial outcomes (value, risk, cost of capital, market reactions) from non-financial outcomes (legitimacy, trust, reputation, engagement), the diagram reflects the gap in understanding the broader firm-level and societal implications of sustainability signaling. Additionally, the loop connecting Frame 2 back to Stakeholder Interpretation Mechanisms demonstrates that outcomes are not static but shape future interpretations, perceptions, and market reactions capturing the overlooked feedback loops mentioned in the gap analysis. This recursive logic underscores the field's need to model sustainability signaling as an evolving system rather than a one-directional causal chain.

The upper and lower contextual boxes Contextual Moderators and Stakeholder Interpretation Mechanisms map directly onto the contextual gap. The literature's heavy concentration on China, the U.S., and Europe, combined with the lack of cross-industry heterogeneity, has hindered the development of generalizable insights. In the model, moderators such as country institutions, industry materiality, cultural systems, and information asymmetry levels demonstrate how context shapes credibility and modifies the strength and direction of signaling effects. Meanwhile, the stakeholder interpretation layer operationalizes how different audiences investors, creditors, regulators, analysts, and the public attach meaning to sustainability signals, thereby determining whether they are rewarded, ignored, or penalized. This speaks directly to the need for comparative, multi-context, and multi-stakeholder research emphasized in the gap narrative.

Together, the integrated diagram and the gap-based framework present a unified vision for the future of sustainability signaling research. The model demonstrates that addressing the five major gaps conceptual, methodological, contextual, outcome, and theoretical requires a holistic architecture linking signal evolution, credibility mechanisms, stakeholder interpretation layers, contextual moderators, and multidimensional outcome pathways. The structure thereby offers a visually coherent and theoretically grounded roadmap for advancing sustainability signaling studies toward higher analytical rigor and integrative theoretical development.

Conclusion

This systematic review shows that the shift focus in financial signaling from a short-sighted focus on firm-value through dividends, debt, and payout, to a multi-dimensional and sustainability-focused firm-value through ESG disclosure, green finance, and sustainability metrics valuation has changed systemically. In the review, the question RQ1 is decisively answered about the evolution of financial signaling caused by institutional pressures, stakeholder anticipation, and the necessity of firms to demonstrating communicative long-term strategic readiness. RQ2 is answered by showing that, both internally and externally, organizational and regulatory

environments systemically converge to determine the credibility and efficacy of sustainability signals. RQ3 is answered by stakeholders signaling financially through asymmetrical information. There is the perception of legitimacy, socially integrated structures, and changed systemically in the cost of capital and the trust, legitimacy, and reputation of the organization.

Integrative reviews attempt to make contributions at synthesis and analysis levels. In this case, the synthesis combines previously unconnected pieces of evidence into one unified evolutionary framework outlining how, why, and under which circumstances sustainability signals function, why they are important and under what conditions they flourish or flounder. With this contribution, the case study enriches the development of new theories by exploring the intersections of the signaling theory with the theory of institutions, legitimacy, and stakeholders, while also pointing to new and diverse evidence and context configurations. The signal is obvious. The role of sustainability signaling is at the forefront of modern financial communication and alters the competitive landscape of capital acquisition, legitimacy attainment, and value creation over time. Researchers are encouraged to continue with the same zeal in clarifying concepts, improving the methodologies, and examining other countries and sectors in order to defend sustainability signaling that is accurate, transparent, and impactful.

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