Sustainability Disclosures and Their Influence on Cost of Capital: A Comprehensive Bibliometric Study

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Department of Commerce, University of Punjab, Gujranwala Campus, Pakistan, Head of Department, Riphah International College, Gujranwala, Pakistan, Assistant Professor, Lahore School of Accountancy and Finance, The University of Lahore, Pakistan, CEO RAH International Lecturer, Lahore School of Accountancy and Finance, The University of Lahore, Pakistan, Lecturer, Lahore School of Accountancy and Finance, The University of Lahore, Pakistan, Professor, School of Accounting, Dongbei University of Finance and Economics, Dalian, Liaoning Province, China, Professor, Abu Dhabi School of Management (ADSM), UAE, University Paris 1 Pantheon Sorbonne, France, Associate Professor, Minhaj University Lahore, Lahore, Pakistan

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Sustainability Disclosures and Their Influence on Cost of Capital: A Comprehensive Bibliometric Study

Kiran Fatima[1], Habiba Azam[2], Fiaz Ahmad Sulehri[3], Syeda Ambreen Fatima Bukhari[4], Hafiz Khalique Ur Rehman Virk[5], Yunjiang Geng[6], Marc Audi[7], Muhammad Saleem Ashraf[8]

Abstract

Since the beginning of the twenty-first century, corporate social responsibility (CSR) has emerged as a global phenomenon in the business sector, capturing the attention of all stakeholders. Both early-stage and established firms often engage in high levels of voluntary disclosure, thereby reducing their cost of capital. This study synthesizes existing literature related to the impact of CSR on the cost of capital, focusing on sustainability and environmental disclosure. Utilizing the Scopus database, we conducted a bibliometric analysis through VOSviewer, analyzing 76 research articles from reputable academic journals published between 2002 and 2022. Our analysis identified three primary clusters: (1) the red cluster, titled "CSR and ESG disclosure and its impact on cost of capital" with 43 articles examining corporate social performance strategies, environmental risks, and green support; (2) the green cluster, titled "CSR activities and environmental or voluntary disclosure" with 21 articles focusing on corporate social investment, greenhouse gas emissions, voluntary disclosure, and their impact on cost of capital; and (3) the blue cluster, titled "sustainability disclosure or toxic release" with 12 articles centered on corporate social decoupling and toxic release. Our findings provide valuable insights for enhancing a firm's environmental and economic performance and offer guidance for decision-makers, lenders, investors, shareholders, and policymakers on reducing a firm's cost of capital through sustainability policies and strategies. Additionally, we highlight unexplored dimensions for future research, including forecasting firm investments using decoupling techniques, exploring the mediating role of CSR on the cost of capital, and examining the relationship between carbon intensity, greenhouse gases, and toxic release.

Keywords: corporate social responsibility, sustainability, cost of capital

1. Introduction

Corporate social responsibility has become increasingly significant for firms in today's global business environment. Engaging in corporate social responsibility (CSR) activities not only cultivates goodwill and enhances firm value but also serves as a crucial avenue for reducing the cost of capital. Moreover, prominent institutional investors tend to favor firms involved in CSR initiatives (Guenster, 2010). Firms work on different dimensions of sustainability, such as corporate social responsibility (Lindgreen & Swaen, 2010), corporate social performance (Wood, 2010), environmental social governance (Lagasio & Cucari, 2019), carbon disclosure (Borghei, 2021), voluntary disclosure (Dontoh, 1989), sustainability disclosure (Michelon, 2011), and green financing from a cost of capital perspective (Cheynel, 2013; Zhong

[1] Department of Commerce, University of Punjab, Gujranwala Campus, Pakistan
[2] Head of Department, Riphah International College, Gujranwala, Pakistan
[3] Assistant Professor, Lahore School of Accountancy and Finance, The University of Lahore, Pakistan
[4] CEO RAH International & Lecturer, Lahore School of Accountancy and Finance, The University of Lahore, Pakistan
[5] Lecturer, Lahore School of Accountancy and Finance, The University of Lahore, Pakistan
[6] Professor, School of Accounting, Dongbei University of Finance and Economics, Dalian, Liaoning Province, China
[7] Professor, Abu Dhabi School of Management (ADSM), UAE, University Paris 1 Pantheon Sorbonne, France
[8] Associate Professor, Minhaj University Lahore, Lahore, Pakistan

& Gao, 2017; Thomä & Gibhardt, 2019; Choi et al., 2021). However, despite its importance, CSR disclosure remains underemphasized in many countries (Hemingway & Maclagan, 2004). The term "sustainability" gained widespread acceptance with the 1987 report "Our Common Future" by the World Commission on Environmental Disclosure (Imperatives, 1987). CSR disclosure benefits stakeholders, investors, and corporate governance, reducing agency costs and enhancing external financing (Carroll & Shabana, 2010; Wang & Ahmad, 2018; Yan & Chen, 2019). Factors such as bank dependence and ownership structure also influence sustainability disclosure and CSR (Goss & Roberts, 2011). As demand for CSR practices grows among employees, communities, investors, and stakeholders, some firms prioritize CSR strategies and practices (Sheikh & Ahmad, 2020; Amorelli & García-Sánchez, 2021; Westermann & Schunk, 2022).

CSR activities influence the cost of capital, which is defined as the minimum profit or rate of return a firm must earn. Previous studies have shown mixed results: while some report a reduction in the cost of capital with sustainability assurance (Martínez-Ferrero & García-Sánchez, 2017; Armitage & Marston, 2008), others find varying impacts based on different contexts (Cai, 2023; Wang et al., 2019). Using bibliometric analysis through VOSviewer, this study aims to synthesize the existing literature on the impact of capital cost on sustainability and environmental disclosure. Several theories explain the link between corporate social responsibility (CSR) and the cost of capital, helping us understand how and why CSR activities might affect financial performance. One such theory is the legitimacy theory, which says that companies do CSR activities to make their operations seem more legitimate to stakeholders, which improves their reputation and lowers the cost of capital (Johnson et al., 2006). On the other hand, firms that actively disclose CSR information can moderate environmental risks, which in turn lowers their financing costs (Maurer, 1971).

In addition to this, signaling theory emphasizes that firms use CSR disclosures to signal their commitment to sustainability and ethical practices, thereby reducing information asymmetry between the firm and its investors (Spence, 2002). Transparent and comprehensive CSR reports of firms can enhance investor confidence and increase the potential of their cost of capital (Goranova et al., 2007). Stakeholder theory emphasizes that firms align their practices with the interests of various stakeholders, including investors, employees, and communities (Freeman et al., 2010; Kabir & Rashid, 2019; Ali & Afzal, 2019). Hence, by engaging in CSR activities, firms build trust and support from these stakeholders, which leads to reduced agency costs and a lower cost of capital (Brown & Forster, 2013; Kumar, 2018; Toth & Paskal, 2019; Farhadi & Zhao, 2024). The prior studies focused on the impact of CSR disclosures on the cost of capital, and several studies have found that CSR disclosures may reduce the cost of capital. According to Martínez-Ferrero and García-Sánchez (2017), sustainability assurance reports boost investor confidence, resulting in increased investment and a lower cost of capital. Similarly, Bhuiyan and Nguyen (2020) reported that CSR disclosures negatively affect both the cost of debt and equity, as investors may be satisfied with lower returns due to reduced business risks.

In contrast, some studies suggest that the impact of CSR disclosures on the cost of capital is more likely to be context-dependent. While sustainability disclosures generally reduce the cost of debt, they can have a mixed overall effect on the cost of capital, as found by Armitage and Marston (2008). Cai (2023) categorized the cost of capital into 3 stages: post-disclosure cost of capital, pre-disclosure cost of capital, and overall cost of capital, and defined that the overall cost of capital affects enterprise decision-making processes related to production. However, pre- and post-disclosure capital

costs increase enterprise profitability but may have no effect on enterprise marginal cash flow. Other research indicates that CSR disclosures may have a neutral or insignificant effect on the cost of capital. Yeh et al. (2020) observed that in China, sustainability disclosures primarily reduce the cost of debt, with no significant impact on the cost of equity.

Using bibliometric analysis, our study identifies three primary clusters. The first is a red cluster named CSR and ESG disclosures and their impact on the cost of capital: This cluster includes 43 articles examining the role of corporate governance, CSR performance strategies, and environmental risks on the cost of capital. The second is a green cluster titled CSR activity and environmental or voluntary disclosure. This cluster comprises 21 articles and focuses on the effects of CSR activities, greenhouse gas emissions, and voluntary disclosures on the cost of capital. The third one is a blue cluster labeled sustainability disclosure or toxic release. This cluster of 12 articles centers on the relationship between corporate social decoupling, toxic release, and the cost of capital.

After reviewing prestigious journals and special editions, our study addresses the following research questions:

- What are the influential aspects, tendencies, top trends, and considerations regarding CSR that influence the cost of capital literature?
- How do ESG disclosure, corporate governance, green support, economic sustainability, CSR rating, and strategies affect the cost of capital?
- How do environmental or voluntary disclosure, carbon emissions, and investment disclosure positively affect the overall cost of capital?
- What is the relationship between toxic release, CSR decoupling, and the cost of capital?

This study makes several contributions to the fields of corporate finance and environmental research. First, it uses bibliometric analysis via big data technology to examine the relationship between CSR and capital cost. Second, it identifies important journals, countries, and authors in the field based on published articles and citations. Third, it explains three research clusters: the red cluster (43 articles) on corporate governance and CSR performance, the green cluster (21 articles) on carbon emission and voluntary disclosure, and the blue cluster (12 articles) on CSR decoupling and toxic release. Lastly, it suggests future research directions and unexplored dimensions that add value to the body of knowledge. We have organized the remaining sections of this article as follows: Methodology illustrates the conceptual framework, research design, and methods used. Findings present the key factors identified, Cluster Explanation provides detailed cluster analysis; Future Research Directions discusses potential areas for further study; and Conclusion summarizes the study's contributions and implications.

2. Methodology

This study employs a systematic literature review using bibliometric analysis to understand the importance of CSR and its impact on the cost of capital, building on the following conceptual framework. We chose bibliometric analysis because it can analyze large volumes of academic literature, identify key research trends, and map the intellectual structure of a research field.

2.1. Conceptual Framework

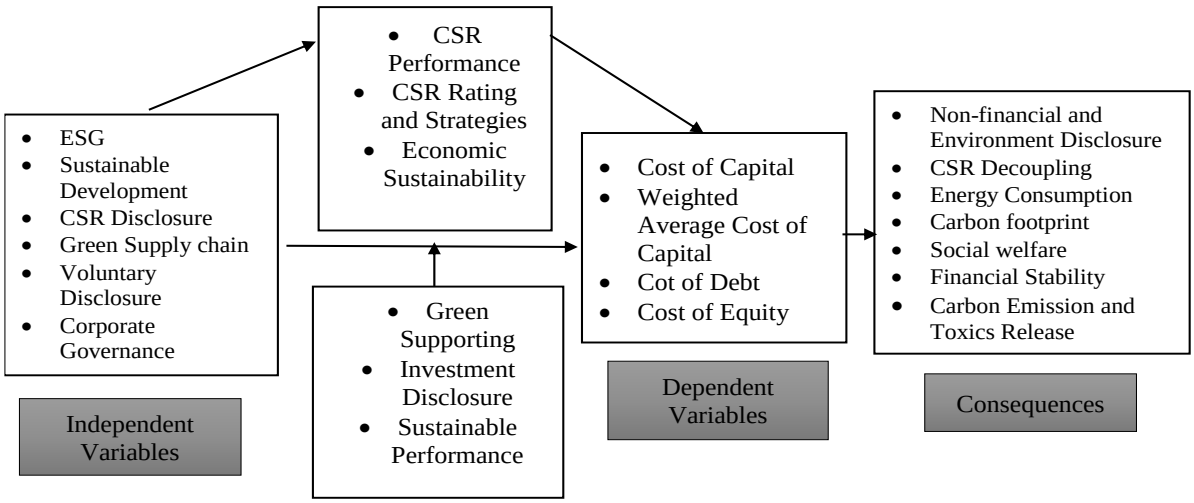

Fig. 1: Conceptual framework

2.2. Research Design and Methodology

2.2.1. Data Sources

We selected the Scopus database as the data source for this study because of its comprehensive and high-quality collection of peer-reviewed articles. Researchers recognize Scopus for its extensive coverage of journals in environmental science, econometrics, finance, social science, accounting, and business management (Gu, 2004; Pitsouni et al., 2008; Rousseau, 2016). The selected time frame for the literature review is 2002–2022. We selected this 21-year period to capture the evolution of CSR practices and their impact on the cost of capital over a long period of time, reflecting changes in regulatory frameworks, market conditions, and stakeholder expectations. The 2002 starting point is particularly relevant, as it marks the early stages of widespread adoption of CSR practices following major corporate scandals and the subsequent emphasis on corporate transparency and sustainability.

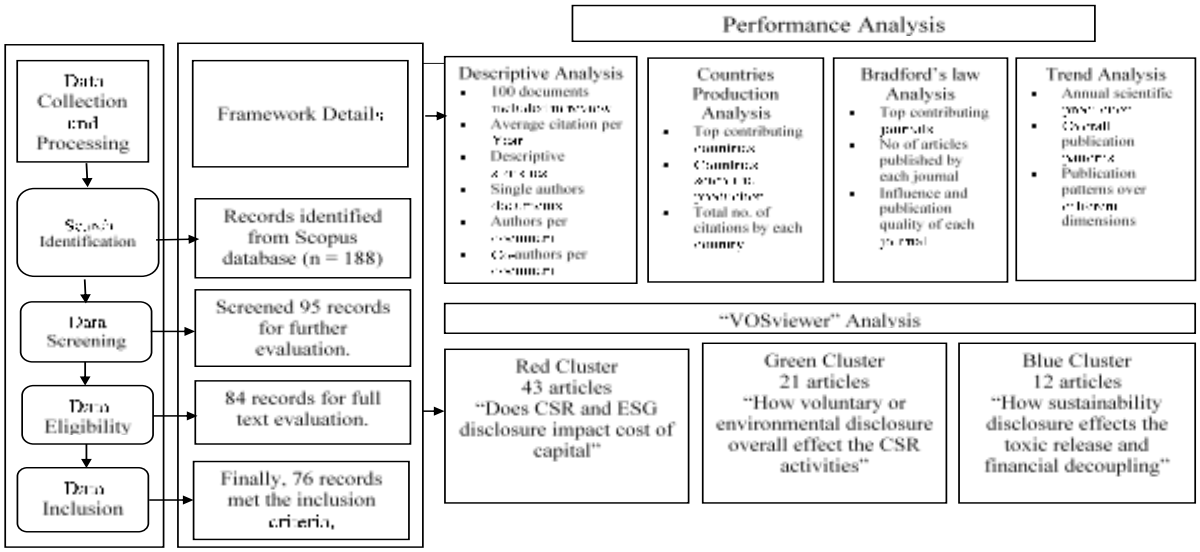

Fig. 2: Research design and methodology

Keywords play an important role in that extensive search and in getting all the related published articles and documents. We consulted a panel of experts to identify the most relevant keywords for this study. The researchers conducted an advanced search on Scopus on September 23, 2022, using the following query: (TITLE-ABS-KEY ("corporate social responsibility disclosure" OR CSR OR sustainability OR "sustainability disclosure*" OR "environmental disclosure*" OR "corporate social responsibility disclosure*" OR "CSR disclosure*" OR "Corporate responsibility disclosure*" OR "corporate social disclosure*" OR "corporate environmental disclosure*" OR "sustainability disclosure*" OR "sustainable disclosure*" OR "voluntary disclosure*") and TITLE-ABS-KEY ("cost of capital" OR "WACC" OR "weighted average cost of capital") and (LIMIT-TO (LANGUAGE, "English") and (LIMIT-TO (SRCTYPE, "j"). The above query searches the keywords in inverted commas from titles, abstracts, and keywords of all articles available on Scopus.

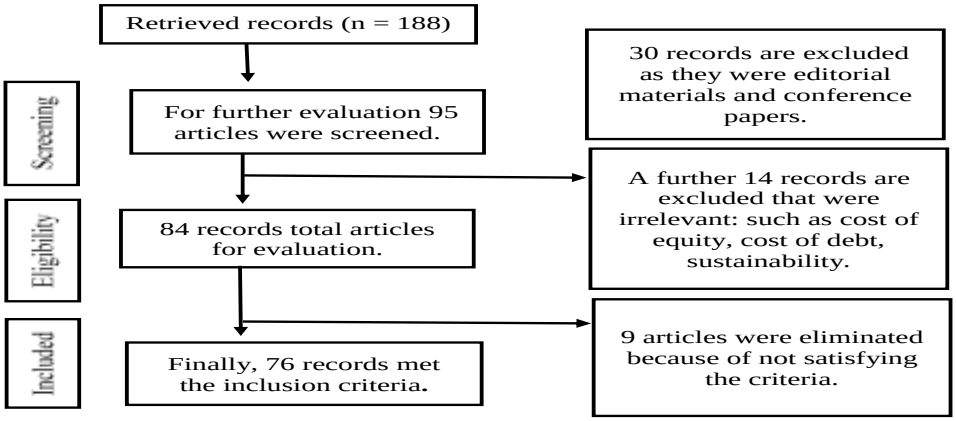

Fig. 3: Flow diagram of the study selection process

We then restrict the initial search results to English-language peer-reviewed journals that cover the following subject areas: environmental science, econometrics, finance, social science, accounting, and company management. During the initial stage, we independently reviewed the abstracts and titles of all the articles, resulting in 188. The overall criteria, requiring both variables (corporate social responsibility disclosure and cost of capital) to be present, further eliminated a significant number of articles from the list. We finalized 76 articles after deeply reading their abstracts and titles. We eliminated unrelated articles after consulting with some experts, as shown in Fig. 3.

3. Bibliometric Analysis

VOSViewer software then analyzed the selected articles for cluster recognition, dividing them into groups based on their commonalities using the bibliographic coupling option. The bibliographic coupling technique identifies similar articles and develops clusters based on them (Vogel & Güttel, 2013). Bibliometric analysis is the most appropriate technique to identify clusters and a stable number of references. Depending on citation, one may use other techniques for bibliometric analysis, but over time, citations vary and older articles receive more citations than recent ones (Yousaf et al., 2017; Achy & Lakhnati, 2019). The VOSViewer software performs bibliometric coupling, presenting data in different clusters and assigning different colors to each cluster (Van Eck & Waltman, 2014). Furthermore, each cluster's distance indicates

the relatedness of the references; clusters with high density are closer to each other. We identified 76 articles in three different colors of cluster, such as red, green, and blue, from the list of bibliometric couplings. Articles with the same colors have the same references and dimensions as our main topic in the research stream. The next step involves reading the articles, gathering qualitative information, analyzing them qualitatively, and presenting all the data in a spreadsheet to ensure clear understanding and exploration of future directions in less explored areas.

4. Findings

The analysis of sustainability disclosure and cost of capital literature from 2002 to 2022 reveals an increasing trend in publications, indicating growing interest in this topic over time. Our study included 76 articles from 66 journals, with an average of 47.38 citations per document, highlighting the scholarly impact and relevance of this research area. Key metrics include 237 authors, 2.82 authors per document, and a collaboration index of 2.99, reflecting the collaborative nature of research in this field.

Table 1 provides a summary of the basic details related to sustainability disclosure and the cost of capital. The annual increase in publications, particularly from 2014 onwards, signifies the heightened academic and practical interest in understanding the link between CSR activities and financial performance.

Table1: Basic description of cost of capital and corporate social responsibility literature

Description	Results
Time span	2002:2022
Sources (Journals, Books, etc.)	66
Documents	76
Average citations per documents	47.38
Article	79
Authors	237
Authors per Document	2.82
Co-Authors per Documents	2.99
Collaboration Index	2.99

4.1. Geographic Distribution

The geographic distribution of publications indicates that the USA, Italy, and China are the leading contributors, with 29, 23, and 21 articles, respectively. The high citation count from the USA (i.e., 1345 citations in total with an average of 46.4 per article) underscores the influence of American research in this field. Australia also makes a significant contribution, with an average citation of 38.9 per article. Italy, despite possessing a substantial quantity of publications, maintains the lowest citation average of 1.9 per article in the list.

4.2. Journal Quality and Influence

Table 2 uses Bradford's law to categorize journals into three zones based on their impact and quality. Zone 1 includes high-impact journals such as "Sustainability (Switzerland)," "Business Strategy and the Environment," "Journal of Business Ethics," and "Social Responsibility Journal," which collectively published 28 articles. This categorization underscores the concentration of high-quality research in a few key journals, reinforcing the importance of these publications in advancing the field.

Table 2: According to Bradford's law journal rankings

Source	Rank	Freq	Zone
Sustainability (Switzerland)	1	6	Zone 1
Business Strategy and The Environment	2	4	Zone 1
Journal of Business Ethics	3	4	Zone 1
Social Responsibility Journal	4	3	Zone 1
Ecological Economics	5	2	Zone 1
Investment Management and Financial Innovations	6	2	Zone 1
Journal of Cleaner Production	7	2	Zone 1
Journal of Corporate Finance	8	2	Zone 1
Management Decision	9	2	Zone 1
Academia Revista Latinoamericana De Administracion	10	1	Zone 1

4.3. Annual Production Trends

Table 3 shows the annual scientific production of articles on capital costs and sustainability disclosure. The upward trend from 2014 to 2022 reflects increasing scholarly attention and the emerging importance of CSR in financial decision-making. The noticeable spike in publications in recent years highlights the growing recognition and relevance of sustainability in the corporate financial landscape. Additionally, bibliometric coupling with VOSviewer identifies three primary clusters. The Red Cluster (CSR and ESG Disclosures and Their Impact on Cost of Capital): Encompassing 43 articles, focusing on the effects of corporate governance, CSR performance strategies, and environmental risks on cost of capital. The Green Cluster (CSR Activities and Environmental or Voluntary Disclosure): Comprising 21 articles, it focuses on CSR activities, greenhouse gas emissions, and voluntary disclosures. The Blue Cluster (Sustainability Disclosure or Toxic Release) includes 12 articles that center on the relationship between corporate social decoupling, toxic release, and the cost of capital.

Fig. 4 demonstrates that the red cluster, comprising 43 articles, significantly contributes to the literature. Meanwhile, the green cluster, positioned adjacent to the red cluster, defines environmental disclosure and corporate social responsibility activities. Meanwhile, the blue cluster elucidates carbon release and corporate sustainability disclosure, but its impact is limited due to a smaller number of publications.

Table 3: Annual production of articles

All articles		Red cluster		Green cluster		Blue cluster	
Year	Articles	Year	Articles	Year	Articles	Year	Articles
2002	1	2011	2	2002	1	2007	1
2005	1	2012	3	2005	1	2008	1
2007	1	2014	4	2009	1	2013	1
2008	1	2015	3	2010	1	2015	1
2009	1	2016	1	2013	2	2017	1
2010	1	2017	2	2014	2	2020	2
2011	2	2018	3	2015	1	2021	4
2012	3	2019	7	2016	1	2022	1
2013	3	2020	5	2017	3		
2014	6	2021	6	2019	1		
2015	5	2022	7	2020	3		
2016	2			2021	3		
2017	6			2022	1		
2018	3						
2019	8						
2020	10						
2021	13						
2022	09						

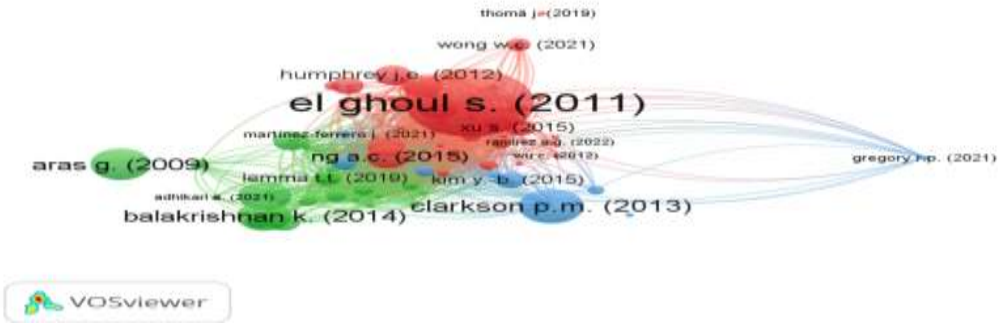

Fig. 4: Red cluster articles

Table 4 displays the top studies of each cluster. The red cluster, which includes 43 articles and is the largest cluster in our co-citation analysis, presents the following findings in response to our research questions:

RQ1: What are the influential aspects, tendencies, top trends, and considerations regarding CSR that influence the cost of capital literature?

There is a positive correlation between corporate governance performance and cost of capital, and it is believed that corporate governance performance differs from CSR in other aspects. It argues that firms with high corporate governance and CSR performance have the advantage of lowering their liquidity risk and market risk (Chen et al., 2020). Moreover, Tobins Q (TQ), Price to Book Value (PBV), and Price Earnings Ratio (PER) measure firm performance. While the cost of capital adversely affects Corporate Social Responsibility (CSR) and corporate governance, the implementation of corporate governance can enhance the firm's image and performance, both internally and externally, and foster investor trust. This, in turn, leads to an increase in affordable funding, thereby lowering the cost of capital and boosting the firm's value (Muhieddine, 2018; Moeljadi et al., 2019; Rakot, 2019). While the Malaysian firm's corporate governance and ESG strategies are very beneficial for stakeholders, corporate governance and corporate social performance have a negative but significant association with the firm's cost of capital, which is working for family-owned companies but non-significant for non-family-owned companies (Hsieh et al., 2020; Batten et al., 2021; Masri & Wimanda, 2024). Firms that have higher corporate ESG performance and idiosyncratic risk can access the cheaper and more affordable cost of financing (cost of capital) that they achieve through sustainability incentives and corporate governance (Sandra et al., 2021). Furthermore, corporate governance and CSP have a positive impact on bank dependency, the weighted average cost of capital, and debt costs (Suto & Takehara, 2017; Tang & Azman, 2024).

Table 4: Top articles related to individual clusters

	Red Cluster (43 papers)		Green Cluster (21 papers)		Blue Cluster (12 Papers)	
Rank	Articles	T.C	Articles	T.C	Articles	T.C
1	Guedhami et al. (2011)	2688	Aras and Crowther (2009)	708	Fang et al. (2013)	625
2	Ng and Rezaee (2015)	336	Hail (2002)	650	Voinov and Farley (2007)	139
3	Tharyan et al. (2014)	301	Billings et al. (2014)	609	An et al. (2015)	120
4	Harjoto and Jo (2015)	257	Collett and Hrasky (2005)	296	Becken and Simmons (2008)	86
5	Lee et al. (2012)	251	Cheynel (2013)	166	Martínez-Ferrero and García-Sánchez (2017)	86
6	Banerjee et al. (2016)	220	Cuadrado-Ballesteros et al. (2014)	162	Hussain et al. (2021)	53
7	Jamali et al. (2011)	184	Feedman et al. (2019)	73	Lai et al. (2020)	40
8	Liu et al. (2015)	131	Garcia-Sanchez et al. (2016)	69	Stead et al. (2021)	21
9	Kobeissi et al. (2014)	74	Michaels and Grüning (2017)	68	Majumdar and Sinha (2021)	11
10	Ok and Kim (2019)	61	Albers and Günther (2010)	67	Schena et al. (2022)	8

4.4. Red Cluster (43): CSR and ESG Disclosures' impact on Cost of Capital

According to Kumar et al. (2022), firms that implement corporate social responsibility (CSR) strategies experience an increase in their cost of capital and a decrease in their cost of debt. However, when CSR has a moderate effect, both the cost of capital and the cost of debt rise. Although firms in China that have high CSR performance will not be able to reduce their cost of debt or cost of equity substantially, that's why firms use capital structure as a moderator, but capital structure does not properly play the role of moderator and only reduces the cost of debt with the help of high CSR performance. This happened due to less market efficiency and more information asymmetry (Lin et al., 2020; Situngkir,

2024). Further, it was argued that higher-level managers and investors who follow the corporate social responsibility performance measure are able to make good business strategies and investments without causing any financial cost in terms of risk (Lee et al., 2012; Bibi et al., 2024). Therefore, a positive relationship is found between corporate social responsibility, long-term growth, and reducing the cost of equity. However, it reduces the firm's risk, but this result is not applicable to all the CSR dimensions (Sharma et al., 2014; Audi, 2024).

RQ2: How do ESG disclosure, corporate governance, green support, economic sustainability, CSR rating, and strategies affect the cost of capital?

Lozano and Reid (2018) examined how developed countries have a more sustainable and operative generation mix model, which helps them control the GDP, cost of capital, carbon prices, and make more use of renewable energy in the new generation mix model. Responsible investors, agents, and managers within the firm strive to create an ideal and sustainable generation mix model. Moreover, the cost of capital limits the green supporting factors, not the Brown penalty itself. The availability of brown penalties, which promote green financing, would lead to a decrease in brown assets and capital costs. Furthermore, green projects would have the same impact on capital costs as brown penalties do (Thomä & Gibhardt, 2019). Moreover, a high level of financial and sustainability disclosure is believed to reduce the firm's financial burden, with a significant but negative relationship between them. Financial burden also has a strong impact on the cost of capital (Morrone et al., 2022).

Vena et al. (2021) reveal that in Italy, small and medium enterprises contributed a major part of earnings to CSR and environmental risk disclosure. Small and medium enterprises will use environmental risk disclosure techniques to increase their capital costs, but SMEs ignore CSR factors when compared to larger companies. Moreover, the first year of earnings will see a decrease in environmental risk and cost of capital due to governance disclosure, but after that, these factors will increase. Initially, there is a significant but negative correlation between environmental disclosure and the cost of capital, but as time progresses, this relationship becomes non-significant. Monsalve et al. (2022) found that the environmental pillar score, despite its strong support for environmental factors and cost of capital, does not exhibit a significant relationship with governance disclosure and cost of capital.

Environmental disclosure often receives less attention from Vietnam's listed companies, leading to a negative impact on equity costs. However, research indicates that CSR practices and environmental disclosure can yield significant profits for these companies (Yilmaz, 2022). Environmental risk disclosure has an inverse relationship with the environmental social governance score and cost of capital; furthermore, it creates financial value for shareholders and increases the firm's worth (Le and Van, 2019; Du Sert et al., 2019). On the other hand, environmental disclosure negatively impacts operational and financial performance while positively reducing the cost of capital, which in turn influences market performance (Buallay, 2019). Environmental risk leads to an increase in capital costs after tax increases, necessitating firms to implement strict environmental policies that aid in decision-making (Barbier & Burgess, 2018).

4.5. Green cluster (21): CSR Activities and Environmental or Voluntary Disclosure

Firms that disclose their information have the advantage of lowering their capital costs compared to those that do not. The cost of capital positively correlates with voluntary disclosure, suggesting that a low level of voluntary disclosure increases risk (Cheynel, 2013). According to Filatotchev et al. (2009), increased corporate governance information and

voluntary disclosure in Australian firms will lead to a rise in the cost of equity, but this is not the firm's intended outcome. In Switzerland, most of the firms have a low level of voluntary disclosure. That's why there is a highly significant and positive relationship between the cost of capital and voluntary disclosure. Firms that adopt the voluntary disclosure technique can easily reduce their capital costs, enjoy numerous benefits, and control many other variables, such as firm size, risk characteristics, and so on.

Furthermore, the capital market and institutional factors support both voluntary disclosure and the cost of capital (Hail, 2002). Firms in the growth and maturity stages exhibit a high level of voluntary disclosure, while mature firms can significantly reduce their risk level and overall cost of capital through voluntary disclosure. Furthermore, firms that are in the declining stage can also use voluntary disclosure activities to lower their capital costs (Novaes & Almeida, 2020). Firms, on the other hand, reduce their weighted capital cost through voluntary disclosure (environmental disclosure or social disclosure). This reduction is only possible when the market is in excellent condition, and information asymmetry is also necessary for an effective market (Mohamad et al., 2017). Using voluntary disclosure not only reduces capital costs but also increases firm value and improves firm liquidity (Billings et al., 2014).

Lindrianasari et al (2019) used a variety of theories, such as legitimacy theory, signaling theory, and stakeholder theory, to understand the relationship between environmental disclosure and capital costs. Their findings reveal a positive correlation between capital costs and environmental disclosure, with environmental risk serving as a moderator. To implement the theories, the firms disclose their environmental management and the environmental issues on which they are currently working, which is also helpful for the firm to gain the trust of investors and stakeholders.

RQ3: How do environmental or voluntary disclosure, carbon emissions, and investment disclosure positively affect the overall cost of capital?

Implementing environmental disclosure and controlling carbon emissions and gases can reduce the cost of capital. China introduced the emissions trading scheme (ETS) and regulation, which state that the cost of capital increases when carbon disclosure falls below a certain level and decreases when carbon disclosure increases. Firms that participate in a no-heavy pollution scheme will have a significant impact on capital costs (Choi et al., 1999). Controlling corporate carbon risk disclosure levels can reduce the cost of capital through carbon disclosure. Although firms that work on carbon disclosure will need more returns, companies that pay attention to carbon emission policies provide high-quality carbon disclosure and try to avoid negative market conditions by providing carbon emission information (Lemma et al., 2019). According to the theory of voluntary disclosure, carbon emissions negatively affect capital costs, but the company's effective carbon performance will mitigate this impact. However, according to legitimacy theory, there is an opposite relationship between carbon performance, carbon disclosure, and the cost of capital (Tang et al., 2013).

U.S. firms use the Carbon Disclosure Project (CDP) to measure the effect of voluntary carbon emissions on the capital market. Companies that find it difficult to share their carbon emission or disclosure information for their carbon disclosure project may encounter the issue of information asymmetry. Moreover, carbon emission disclosure will reduce the ask-bid spread. The carbon disclosure project works not only on CSR activities to increase shareholder value and cost of capital but also on environmental disclosure and information asymmetry, which is helpful for the public (Adhikari & Zhou, 2021). Jiménez and Zorio-Grima (2021) argued that sustainability reports that define environmental, social,

and governance activities result in decreasing the cost of equity in the integrated market. Corporate social transparency and sustainability will reduce the cost of capital when conflicts and agency theories are present in an organization. Although firms whose performance is sustainable can influence voluntary disclosure, cost of capital, and value in the Global Reporting Initiative (GRI) index, companies share their sustainability report or performance due to a feeling of responsibility towards shareholders and investors rather than lowering the cost of capital (Albers & Günther, 2010).

4.6. The Blue Cluster (12): Sustainability Disclosure or Toxic Release

In this study, the blue cluster is the smallest cluster identified. Sustainability performance reduces the cost of equity, despite the inverse relationship between sustainability disclosure and the cost of capital. Sustainability disclosure and strategic management both increase capital costs and world GDP (Stead et al., 2021). Malaysian firms focus on economic sustainability disclosure to only lower their cost of debt and use social sustainability to reduce the cost of equity. Furthermore, firms involved in environmental and social sustainability disclosure will earn a strong reputation in the economy, which will help them reduce capital costs and improve company performance (Lai et al., 2020).

RQ4: What is the relationship between toxic release, CSR decoupling, and the cost of capital?

With 615 citations, Fang et al. (2013), the most cited in this cluster, argued that the use of toxic release inventory positively relates to the cost of capital, while voluntary environmental disclosure negatively impacts both the cost of capital and toxic release. Further, corporate social responsibility strategies and environmental strategies help to reduce toxic releases and increase firm stock. The Korean government launched the concept of greenhouse gases in 2010 and showed that the cost of equity capital is positively associated with carbon intensity (carbon risk). Furthermore, companies that work to improve or control carbon productivity reduce capital costs, and effective management helps firms reduce the negative impact of greenhouse gases on equity and carbon risk.

According to Charitou (2015), overall CSR finance will reduce the cost of equity and have a negative or positive impact, depending on the conditions of the capital market. Despite US firms' use of the decoupling concept, a significant relationship exists between CSR decoupling and the cost of capital. So, the forecast error enhances this effect (Hussain et al., 2021). Some European countries use signaling and legitimacy theories to assess their CSR assurance and finances. Higher assurance quality statements provided by enterprises have a positive effect on the cost of capital, and investors confidently take investment decisions that are considered favorable for firms. The company will gain more goodwill, capture the economic market, and reduce its capital cost due to CSR restatements and financing (Ruiz-Barbadillo et al., 2021). Furthermore, Gusarova et al. (2021) assert that the cost of capital will repair various factors such as sales, profitability, operating environmental costs, production, employee costs, labor expenditures, and environmental protection costs for fixed assets.

5. Discussions Based on Clusters

To address our primary research question, we focus on influential aspects, trends, and considerations concerning the impact of sustainability disclosures on the cost of capital literature. Our research has yielded the following key insights:

Firstly, our investigation has shed light on several new insights into the relationship between corporate social responsibility (CSR) and the cost of capital. Our findings have identified the following factors as crucial based on the conducted research:

1. The upward trend in this topic increases the publication every year, and we selected 76 papers from our list that show a significant relationship between the cost of capital and sustainability. This implies that further research on this topic is possible in the future. Furthermore, our paper's cluster explanation focuses on the cost of capital and corporate social responsibility, which is a strong aspect of our study.
2. Sustainability (Switzerland), Business Strategy and the Environment, Journal of Business Ethics, and Social Responsibility Journal are the most important journals according to Bradford's Law on the relationship between cost of capital and sustainability disclosure, publishing 6, 4, 4, and 3 studies, respectively.
3. Guedhami et al. (2011) published the most influential articles with 2,688 citations, describing the significant positive association of sustainability disclosure, GHG emissions, environmental social disclosure, and corporate social strategies or ratings with the cost of capital in the United States.
4. The USA, Italy, China, and Spain are the most contributing countries, having published 29, 23, 21, and 15 papers, respectively. However, articles from the USA, Australia, UK, and China have more importance due to high citation counts of 1,345, 506, 296, and 172 citations, respectively.

Secondly, how do ESG disclosure, corporate governance, green support, economic sustainability, CSR rating, and strategies affect the cost of capital?

Ijeama et al. (2015), Cooper and Uzun (2015), and Farooq and Noor (2021) highlighted that sustainable disclosure aids prudent management in reducing equity costs, yet environmental management alone does not entirely enhance firm value. However, corporate social disclosure offers a responsible avenue to access capital at a reduced level. Additionally, Lozano and Reid (2018) observed that developed countries boast a more sustainable and efficient generation mix model, facilitating control over GDP, capital costs, carbon prices, and increased integration of renewable energy into the new generation mix paradigm. Conversely, within firms, responsible investors, agents, and managers strive to develop an optimal and sustainable generation mix model. Furthermore, the cost of capital (COC) may negatively influence CSR and corporate governance. Effective corporate governance improves a firm's internal and external image and performance, fostering investor trust, leading to cheaper funding, and reducing capital costs. As a result, as the cost of capital decreases, the firm's profitability increases, contributing to an increase in value (Moeljadi et al., 2019).

Thirdly, do environmental or voluntary disclosure, carbon emissions, and investment disclosure positively affect the overall cost of capital?

Jiménez and Zorio-Grima (2021) argued that sustainability reports, which delineate environmental, social, and governance activities, lead to a decrease in the cost of equity in integrated markets. Corporate social transparency and sustainability initiatives can mitigate the cost of capital when conflicts and agency theories are prevalent within organizations. Moreover, firms with sustainable performance can influence voluntary disclosure, reduce the cost of capital, and enhance their value within the Global Reporting Initiative (GRI) index. Furthermore, Albers and Günther (2010) found that companies share their sustainability reports or performance due to a sense of responsibility towards

shareholders and investors, rather than solely aiming to reduce their capital costs. While voluntary disclosures of investment forecasts can lower the cost of capital in the first year of investment, the absence of such disclosures may lead to an increase in the cost of capital in subsequent years. Information over time also influences the cost of capital and investment forecasts (Shimada, 2020).

Fourth, is there a relationship between toxic release, CSR decoupling, and cost of capital?

Becken and Simmons (2008) discussed that in New Zealand, the tourism sector plays a significant role in financial sustainability disclosure and the cost of capital for the economy. While the tourism sector generates CO2 emissions from extensive travel, sustainability disclosure initiatives aim to mitigate their impact and subsequently lower their capital cost. Furthermore, Fang et al. (2013) proposed a positive correlation between the use of toxic release inventory and the cost of capital. On the other hand, voluntary environmental disclosure has a negative impact on both capital costs and toxic releases. Additionally, CSR strategies and environmental initiatives aid in reducing toxic releases while simultaneously enhancing firm stock. Certain European countries use signaling and legitimacy theories to assess their CSR assurance and finances. Enhanced quality assurance statements issued by enterprises have a positive impact on capital costs, instilling investor confidence and leading to investment decisions in favor of firms. Companies gain greater goodwill, expand their economic market share, and consequently reduce their capital costs through CSR restatements and financing (Martínez-Ferrero et al., 2021).

6. Conclusions

Environmental pollution poses a significant threat to all economies, whether developed or developing. The increasing shareholder interest in corporate social responsibility (CSR) has driven researchers to explore this domain. Previous research on the cost of capital and CSR has looked at what affects CSR performance (Timberland), the different types of CSR, like voluntary disclosure and economic sustainability, and how they change the structure of a business. Furthermore, these studies have investigated the cost of capital components, such as the cost of debt, the cost of equity, the overall cost of capital, and firm value. Using a bibliometric review method, this study not only adds to streams that have already been identified, but also finds new ones. These include CSR decoupling, investment disclosure, green supporting strategies, toxic release, and non-financial economic disclosure. Utilizing a Scopus query, we selected a total of 76 articles from key countries and journals published between 2002 and 2022. We analyzed the data using VOSviewer software, which used bibliographic coupling to categorize the articles into three clusters. The red cluster, comprising 43 articles, is the largest and focuses on sustainability disclosure and its relationship with the cost of capital. The green cluster includes 21 articles discussing voluntary disclosure, carbon emissions, and the cost of capital. The blue cluster consists of 12 articles examining CSR decoupling, sustainability disclosure, and the cost of capital.

6.1. Key Findings

- Inexpensive Funding and CSR: Corporate governance and CSR have a significant impact on sustainability disclosure, resulting in more affordable funding.
- Applying the brown penalty technique reduces capital requirements, suggesting firms should focus on green supporting factors (GSF) and brown penalty policy instruments.

- Emission Trading Scheme: This scheme effectively controls carbon disclosure levels for both listed and unlisted firms, indicating the need for cross-sectional studies.
- Economic Booms and Recessions: During economic fluctuations, sustainability disclosure effectively controls company conditions.
- Market Conditions: Sustainability disclosure has a significant impact on market conditions, financial drivers, and capital costs.
- Family-Owned Firms: These firms benefit more from CSR reports compared to non-family-owned firms, enhancing their competitive edge.

Countries like the USA, Italy, China, and Spain have published the most articles on the cost of capital and CSR, with the USA leading in citations. Journals such as Sustainability (Switzerland), Business Strategy and the Environment, Journal of Business Ethics, and Social Responsibility Journal are prominent contributors to the literature on CSR and cost of capital, falling into Bradford's Law Zone 1 of high-ranked, quality journals. The most cited paper, with 2,688 citations, emphasizes the importance of CSR in influencing capital costs. We employed keywords in queries to differentiate countries, journals, and papers aligned with cost of capital and CSR research streams. This comprehensive literature collection provides an insightful exploration of various sustainability dimensions and their influence on the cost of capital.

6.2. Practical Implications

- For firms: Enhancing sustainability disclosure reports can support environmental, social, and financial performance.
- For policymakers: Insights from this research can aid in developing regulations that promote consistent sustainability-related disclosures.
- Investors: These findings help investors make informed decisions and allocate resources to companies that prioritize sustainable practices.

6.3. Future Research Directions

This study identified several unexplored and new areas that are important for future research:

- CSR and corporate governance: These factors increase inexpensive funding for firms. When CSR has a mediating effect, the cost of capital decreases and firm reputation increases, attracting more investment (Felmania, 2014). Future research should focus on the type of company, its impact on corporate capital, and policy-making strategies for inexpensive funding.
- Family-Owned Firms: CSR activities are more beneficial for family-owned firms compared to non-family-owned firms. Family firms with high CSP can decrease their cost of capital and capture competitive markets easily (Hsieh et al., 2012). Future research should focus on top management decision styles and risk-taking approaches in family-owned businesses.
- Economic Conditions: Sustainability disclosure controls company conditions during economic booms and recessions. High CSR activities lower financing costs, while the cost of equity capital rises during economic

fluctuations (Gao, 2009). Future research should include unlisted firms and cross-country analysis to examine CSR's impact on the cost of capital.

- Brown Penalty: This helps to reduce brown assets and capital requirements. Brown assets are highly valuable and define high-carbon and low-carbon instruments; the brown penalty creates more capital charges for banks (Thomä & Gibhardt, 2019). Future research should focus on GSF and brown penalty policy instruments.
- The Emission Trading Scheme is used to regulate carbon disclosure levels. Corporate financing impacts carbon disclosure, providing more accurate information to shareholders. Future research should include both listed and unlisted companies, as well as cross-sectional studies.
- Voluntary Disclosure: Firms at maturity and growth stages have a high level of voluntary disclosure, which decreases the cost of capital. In contrast, firms in decline experience an increase in the cost of capital (Novaes & Almeida, 2021). Future research should focus on financial drivers, market conditions, transparency, market analysts, and social and environmental information.

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