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SMEs and Climate Finance: A Hybrid Review

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ABSTRACT

The growing importance of sustainability and environmental practices, along with a recent surge in related research, motivated this review of environmental management and climate finance within the SME sector. Starting with an initial sample of 2063 articles, we refined the dataset, resulting in a final sample of 124 key publications. Using a hybrid approach that combines bibliometric and content analysis, we identify the leading authors, countries, institutions, and influential articles shaping this field. Our analysis reveals four major research streams: (1) sustainability, environmental practices, and climate change; (2) climate finance and SME performance; (3) financing cleantech in SMEs; and (4) environmental practices in family firms. Finally, we provide recommendations and outline future research directions to further advance the field.

1 | Introduction

As widely acknowledged, SMEs are a critical component of the global economy, contributing significantly to employment and economic output (OECD Activity Report 2024; Suarez Maria Camila 2025). However, their operations also have considerable environmental and social implications. According to the European Commission, SMEs represent 99.8% of all businesses in the EU and account for 65.1% of total employment, but they also contribute to a substantial share of greenhouse gas emissions and other environmental impacts (Schulze Brock et al. 2025). A study by the International Trade Centre (ITC) revealed that SMEs are responsible for approximately 50% of global carbon emissions, emphasizing their potential to influence climate change and environmental sustainability (International Trade Centre 2021).

However, achieving SME decarbonization is fundamentally an investment problem: environmental upgrading requires upfront capital for cleaner technologies, process redesign, certification, monitoring, and reporting (Llonch et al. 2018; Hillary 2004). In practice, SMEs face persistent financing frictions, including credit rationing, limited collateral, higher perceived risk, and informa-

tion asymmetries, which constrain their ability to mobilize both bank and market-based finance for green investments (Cowling and Liu 2023; Nanda et al. 2014). As a result, climate finance, including green credit, guarantees, public support schemes, and alternative financing channels, becomes a critical determinant of whether SMEs can translate sustainability intent into measurable environmental outcomes.

The empirical literature on environmental performance in the context of SMEs is extensive (Adomako et al. 2021; Hoogendoorn et al. 2015; Madrid-Guijarro and Duréndez 2024; Simpson et al. 2004). However, none of the literature reviews published in top-tier journals have focused exclusively on this aspect of environmental management in SMEs except (Miroshnychenko et al. 2022) which has recently conducted meta-analysis with a focus on family firms only.

Prior reviews in this domain have largely focused on broad sustainability and climate finance themes (Kumar et al. 2025; Long et al. 2022), sustainability–financial performance linkages in SMEs (Bartolacci et al. 2020), or the general effectiveness of SME financing (Kersten et al. 2017), leaving several gaps. First,

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these studies predominantly rely on conventional systematic reviews or bibliometric/meta-analytic techniques, with limited integration across these approaches. Second, the resulting evidence remains fragmented with respect to how specific climate-financing mechanisms shape SMEs' environmental management and performance. Third, existing reviews either discuss climate and sustainable finance at an aggregate level without examining SME-specific constraints and transmission channels (Kumar et al. 2025; Long et al. 2022), or they analyze environmental-financial performance relationships in SMEs without explicitly incorporating climate finance as a key enabling or constraining factor in environmental upgrading.

In this review, we focus on environmental sustainability in SMEs, which, unlike larger firms, often face tighter financial constraints that limit their capacity to invest in eco-friendly technologies and infrastructure (Calabrese et al. 2021). This raises a fundamental question as to whether an orientation toward environmental sustainability is economically viable for SMEs and under what conditions it translates into improved performance (Momtaz and Parra 2024). Accordingly, we critically examine the climate-finance literature and its implications for SMEs' environmental management and firm outcomes. To address the identified gaps, we adopt a hybrid review design that combines bibliometric mapping with in-depth content analysis to structure and synthesize the evidence on environmental management and climate finance in SMEs and to develop a focused agenda for future research. Specifically, we address the following research questions:

- RQ1: What are the influential aspects of literature dealing with environmental management and climate finance within the SME sector?
- RQ2: What are the leading streams discussing the literature on environmental management and climate finance within the SME sector?
- RQ3: What are the directions for future research to expand the knowledgebase of literature on environmental management and climate finance within the SME sector?

To this end, we analyze and review 72 articles published within the period of 1985 to 2025. The result reveal that most of literature on environmental management and climate finance in SMEs is concentrated within European regions with leading authors, institutions, countries from Europe, followed by China. Further, we also identify that literature on environmental management and climate finance in SMEs is discussed in four broader streams including: (1) Sustainability, environmental practices and climate change; (2) Climate Finance and SME performance; (3) Financing cleantech in SMEs and lastly; and (4) Environmental practices and family firms. To grow the literature on SMEs and climate finance, we also present the present the direction for future within each identified stream which is vital part of any review-based studies to expand the literature.

We organize the remaining paper in the following chronological order. Section 2 describes the review protocols including methodology and the data selection. Section 3 present the detailed discussion of our findings, followed by network visualization

in Section 4. In Section 5, we summarize recommendations for future research while Section 6 concludes our paper.

2 | Review Protocols

2.1 | Methodology

To conduct this review, we apply cross-cutting approach of hybrid review which incorporates both bibliometric analysis (quantitative) and content analysis (qualitative). This approach is widely used in the recent literature within the domain of business and finance (Joshapura et al. 2025; Khan et al. 2020; Alon et al. 2018).

Price (1965) introduced bibliometric analysis to understand the scholarly network of articles. Content analysis is the qualitative way of discussing the dynamics and trends of literature (Khan et al. 2020; Paltrinieri et al. 2023).

Following the above methodological framework, we conduct the analysis in the following five dimensions: (1) Bibliometric citation analysis; (2) Bibliometric co-authorship analysis; (3) Keyword/cartography analysis; (4) Bibliographic coupling analysis; (5) Content analysis. We also provide visualization networks by VOSviewer (Khan et al. 2020; Paltrinieri et al. 2023; Van Eck and Waltman 2010) which are among the best known and widely used to analyze bibliometric data (Khan et al. 2020; Paltrinieri et al. 2023).

2.2 | Data Selection

The sample selection process of the papers follows three main steps. The first is related to the choice of the database to extract the data for bibliometric analysis. For this review, we select the database of the Web of Science (WOS) which is one of the most authentic and reliable databases for conducting bibliometric analysis. WOS is widely used in literature and provides the articles from journal across publishers and does not reflect biases towards any publisher (Bahoo et al. 2020; Ding et al. 2014). Second, we search for relevant literature using keywords.

Our keywords search criteria are twofold. Firstly, since the primary objective of this study is to assess role of environmental management and climate finance in SMEs, we use a very generic keyword and its variants, that is, "environmental" and "SMEs" to search them in the TITLE of the articles. This exercise provides us with a total of 356 articles. Based on 356 articles extracted data, we run the keyword analysis through VOSviewer to extract the most widely used keywords which might be synonymous in nature and cover all the aspects of literature discussing environmental management and climate finance in the SMEs.

Secondly, we then search combination of the following keywords (extracted from keyword analysis) using Boolean operator "OR/AND".

"SME*", "Small Medium enterprise*", "Small, Medium enterprise*", "Small and Medium enterprise*", "Family own*", "Family firm*", "Climate change", "climate finance", "Biodiversity",

TABLE 1 | Query description of sampled literature on environmental management and climate finance in SME. This table summarizes the main data selection procedure to extract the final literature of 72 sampled papers analyzed in our bibliometric review.

Query description		
Category	Criteria	No. of refined documents
	Query outcomes before search refine	2063
Access	Types including both open access and other journals.	0
Years	Including all years to date (21/01/2026)	(0)
Subject area	Limit the search to the following subjects: Economics Business Finance Management Business	(1535)
	We excluded International Relations, Political science, History and other subjects.	
Document type	Restricting the document types to Articles, Early Access, and Reviews, while excluding Proceedings Papers, Book Chapters, Editorial Materials, Corrections, and Book Reviews.	(32)
	We exclude all book series	(0)
Language	We excluded all languages other than English.	(5)
	ABS ranking 1 and above	
	Final number of documents (After search refine)	391
	After careful examination of all articles by two independent researchers, we left with 124 articles	124

“ESG”, “Environmental social and governance”, “Environmental, social and governance”, “ESG”, “carbon emission*”, “sustainable finan*”, “environmental performance”, “environmental practic*”, “green finan*”, “green bond”, “green bank*”, “crowdfunding” and “finance”.

We search the aforementioned keywords in the TITLE, Abstract and Author’s keyword of the article for the period of 1985 to January 21, 2026, which yield us a total of 2063 articles.

Following the previous literature to clean the data (Chiaramonte et al. 2023, 2025), we apply the following four main filters: (1) The scholarly publication should be published within the theme of Economics, Business Finance, Business and Management; (2) We select publications in the forms of articles, reviews, early access and published in English Language; (3) Lastly, to ensure the quality of scholarly publications, we extract the articles published in journals which are ranked by Association of Business Schools (ABS) 1 or above. Table 1 presents the details of our query and subsequent steps to extract the data.

The third and final step is the careful examination of each article which is thoroughly reviewed by two independent researchers to confirm the relevance of each article. We include only those articles which discussed environmental management and its relationship with any aspects of finance within SMEs. As a result, the final sample used for analysis in VOSviewer comprised 124 articles.

In Figure 1, we summarize our methodological approach with key findings.

3 | Results

3.1 | Publication Trend in Environmental Management, Climate Finance and SMEs

Figure 2 shows the distribution of papers and their average citation levels across time. We notice that research and its impact (average citations) was almost neglected until 2019, followed by a gradual increase in the following years with a big leap in 2023 and subsequent years. This can be associated with two main reasons: (1) The Paris Agreement has recognized the financial sector, especially private finance, to play a central role to provide financial resources to combat climate change and to achieve net zero greenhouse gas emission by 2050 (Cojoianu et al. 2025) and (2) SMEs represent the 90% and 99% of business globally and in OECD countries (International Finance Corporation 2024; Wildnerova et al. 2024) and without the participation of SMEs, it is difficult to achieve the goals set in Paris agreement. Consequently, SMEs have become the focal point of research by academicians and policymakers to design and propose the green financing options for SMEs (Mukherjee et al. 2024).

3.2 | Key Journals for Research on Environmental Management, Climate Finance and SMEs

Table 2 shows trending journals publishing studies on environmental management, climate finance and SMEs. All leading journals have impact factors with majority of them having ranked ABDC either A* or A and ABS ranking 3 and fall broadly within the domain of Business Management and Economics and Finance with the exceptions are IEEE Transactions on

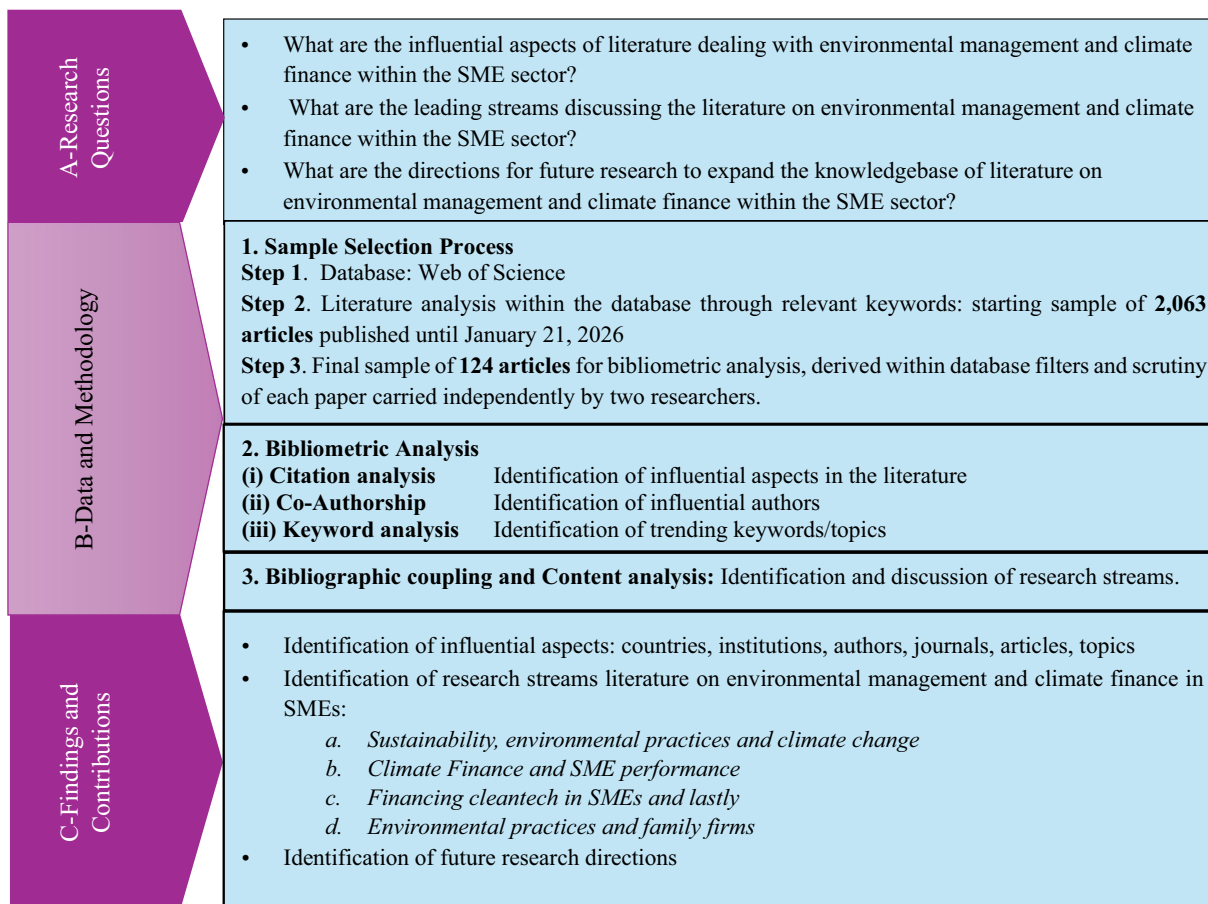


FIGURE 1 | Methodological approach. This figure describes and illustrates the methodological approach adopted in this paper. [Colour figure can be viewed at wileyonlinelibrary.com]

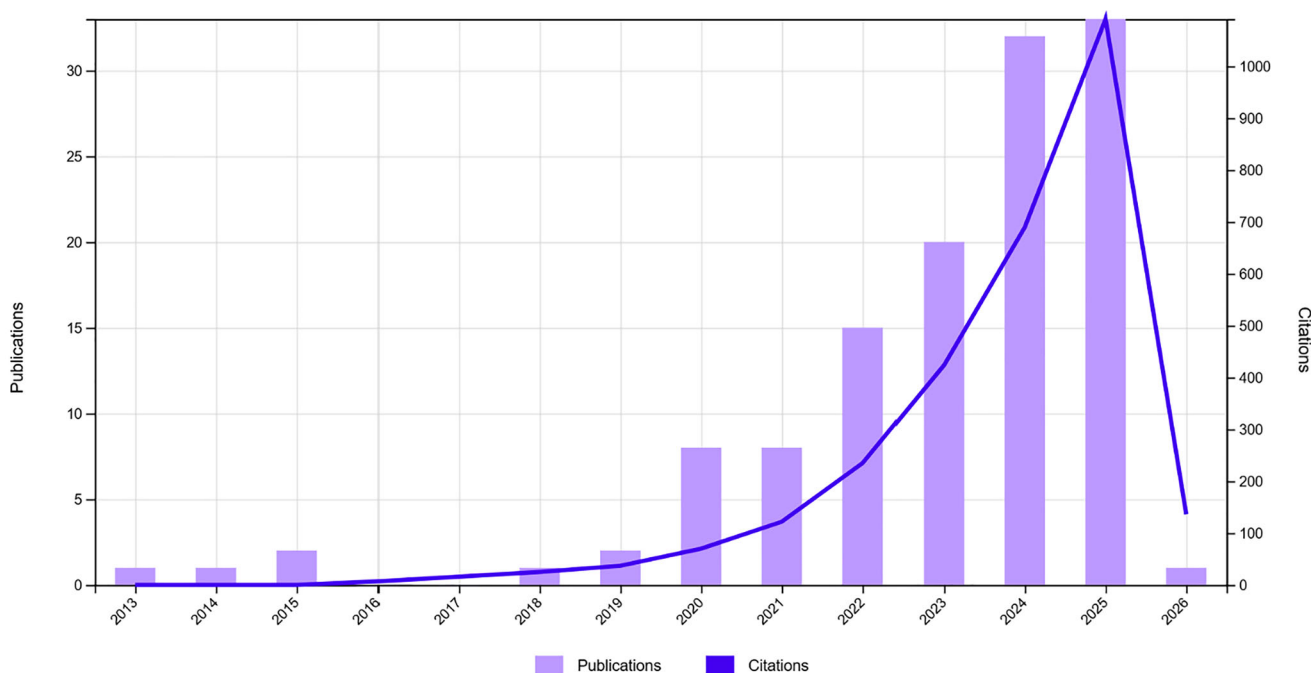


FIGURE 2 | Publication growth trends. This figure presents the evolution of the number of articles published each year, as well as the number of citations received by sampled papers. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 | Top journals in environmental management and climate finance in SMEs. This table presents the leading indicators describing the top journals present in our sampled papers, including their weight, the Impact Factor (IF), the rankings accordingly to the Australian Business Deans Council (ABDC) and the Academic Journal Guide—Association of Business Schools (ABS), the Web of Science (WOS) research category.

Sr. No.	Journal	No. of articles	% of total sample	Total citations	Publisher	IF	ABDC ranking	ABS ranking	WOS research category
1	Business Strategy and the Environment	15	12%	640	Wiley	12.5	A	3	Business Management
2	Corporate Social Responsibility and Environmental Management	9	7%	95	Wiley	9.1	C	1	Business Management
3	IEEE Transactions on Engineering Management	6	5%	135	IEEE	4.6	A	3	Engineering
4	Small Business Economics	5	4%	360	Springer	6.5	A	3	Economics
5	Finance Research Letters	5	4%	75	Elsevier	7.5	A	2	Finance
6	Technological Forecasting and Social Change	4	3%	257	Elsevier	12.9	A	3	Business Management
7	Energy Economics	4	3%	99	Elsevier	13.6	A*	3	Economics
8	Research in International Business and Finance	4	3%	41	Elsevier	6.3	A	2	Finance
9	Journal of Small Business Management	3	2%	67	Taylor & Francis	5.3	A	3	Business Management
10	Global Business Review	3	2%	7	Sage	1.9	B	1	Business Management

Engineering Management which is indexed in the category of Engineering¹.

Clearly, leading journals publishing on environmental management, climate finance and SMEs mostly belong to Business Management (34 articles) and Economics/Finance (18 articles), while the remaining 6 articles are from Engineering.

The Business Strategy and the Environment journal published the most (15 articles, or 12% of our sample), followed by Corporate Social Responsibility and Environmental Management (9 articles), IEEE Transactions on Engineering Management (6 articles), Small Business Economics, and Finance Research Letter (5 articles by each journal).

3.3 | Leading Countries and Institutions

Table 3 shows the most influential countries (Panel A) and institutions (Panel B) contributing to the literature on environmental management, climate finance in SMEs. The China is the most influential country (33 articles), followed by the Italy and United Kingdom (31 and 27 articles, respectively). We also noticed that literature is mostly concentrated in China, Europe and North America.

China has peaked the Industrial development shifting from labor-intensive to capital-intensive, however, this development come with environmental damage (Lv et al. 2021). Consequentially, China has developed several 5-year plans to establish green finance program to protect climate and reduce the greenhouse gas emissions (Y. Zhang et al. 2025). These developments to support green financial markets give the opportunity to the researcher to understand the dynamics of climate finance in relation to SMEs in China (S. Yang et al. 2024; X. Yang 2023; S. Zhang and Cheung 2025).

In Europe, 99.8% of all businesses are SMEs (Gorgels et al. 2022). The UK and Europe have shown significant commitment to boost climate finance and to help SMEs transition to adopt environmental-friendly practices. For example, the United Kingdom has committed £11.6 billion between 2021/2022 to 2025/2026 to support research and development to protect environment². Similarly, Europe has introduced several initiatives and proposals tailored toward energy, climate, and related tax incentives for businesses, with the aim to reduce greenhouse gas emissions by at least 55% by 2030³.

Similarly, the universities from UK (Middlesex University and University of Lancaster) and Italy (University of Campania Luigi Vanvitelli, Università Cattolica Sacro Cuore and Free University of Bozen-Bolzano) have published the most on environmental management, climate finance in SMEs, followed by China (Qingdao University and City University of Macau) and Excecia Business School from France.

3.4 | Influential Authors

Table 4 report the influential authors in terms of published articles (Panel A) and total citations (Panel B). We identify the list

TABLE 3 | Most Influential Courtiers and Institutions. This table presents the ranking of top-10 countries (Panel A) and institutions (Panel B), based on the number of publications, within our whole sample.

Panel A: Leading countries by total publications			
Rank	Country	No. of articles	Share in sample
2	China	33	27%
3	Italy	31	25%
1	United Kingdom (UK)	27	22%
4	France	13	10%
6	Spain	7	6%
8	Usa	7	6%
7	Pakistan	6	5%
5	Australia	5	4%
9	Canada	5	4%
10	Germany	4	3%

Panel B: Leading institutions by total publications			
Rank	Institute name	No. of articles	Share in sample
1	University of Lancaster, UK	4	3%
2	University of Campania Luigi Vanvitelli, Italy	4	3%
3	Middlesex University, UK	4	3%
4	Excelia Business School, France	4	3%
5	Università Cattolica Sacro Cuore, Italy	3	2%
6	Lebanese American University, Lebanon	3	2%
7	Qingdao University, China	3	2%
8	University of Waikato, New Zealand	3	2%
9	City University of Macau, China	2	2%
10	Free University of Bozen-Bolzano, Italy	2	2%

of these authors mainly for two reasons: (1) to identify key authors who have contributed to the field of environmental management, climate finance for SMEs; (2) to recognize their legacy in the literature.

We find that Robyn Owen from the Middlesex University as the leading author, followed by Nawazish Mirza from Excelia Business School and Muhammad Umar from Lebanese American University. These author has mainly focused on the topic of financing innovative and cleantech SMEs (Owen et al. 2021; Owen and Vedanthachari 2023), green lending to SMEs and bank performance (Zheng et al. 2025; Mirza et al. 2023), economic returns and financing options for circular economy (CE) for SMEs (Antonioli et al. 2022; Ghisetti and Montresor 2020) and financial constraints and external support to adopt eco-innovative practices in European SMEs (Bodas-Freitas and Corrocher 2019; Cecere et al. 2020).

Similarly, we also present the leading authors based on total citations (Panel B of Table 4). Nicoletta Corrocher from Bacconi University is among the top authors in this ranking, followed by Grazia Cecere from Institut Mines-Télécom, Business School, France and Maria Luisa Mancusi from Università Cattolica del Sacro Cuore Milan. These three authors have jointly authored an article, which has received 140 total citations, on the topic of financial constraints and role of government funding for SMEs in adopting eco-innovation (Cecere et al. 2020).

3.5 | Trending Articles on Climate Finance in SMEs

The highly cited and trending articles in any research field highlight the scope and set the direction of the literature. Using citation analysis, we set the minimum threshold of 50 citations for an article to be included in the following list, as reported in Table 5.

TABLE 4 | Most influential Authors in environmental management and climate finance in SMEs. This table presents the ranking of top-10 authors by total publications (Panel A) and citations (Panel B), including their affiliation, country and first publication year.

Panel A: Leading authors by total publications					
Rank	Author	University	Country	Published articles	Total citations
1	Robyn Owen	Middlesex University	United Kingdom	4	86
2	Nawazish Mirza	Excellia Business School	France	3	72
3	Muhammad Umar	Lebanese American University	Lebanon	3	72
4	Nicoletta Corrocher	Bocconi University	Italy	2	202
5	Claudia Ghisetti	University of Milan—Bicocca	Italy	2	142
6	Ishmael Tingbani	University of Southampton	United Kingdom	2	106
7	Ivan Miroshnychenko	IMD Business School	Switzerland	2	90
8	Alfredo De Massis	Free University of Bozen-Bolzano	Italy	2	90
9	Francesco Gangi	University of Campania Luigi Vanvitelli	Italy	2	69
10	Imen Bouchmel	University of Tunis	Tunisia	2	53

Panel B: Leading Authors by total citations					
Rank	Author	University	Country	Published articles	Total citations
1	Nicoletta Corrocher	Bocconi University	Italy	2	202
2	Grazia Cecere	Institut Mines-Télécom, Business School, LITEM	France	1	171
3	Maria Luisa Mancusi	Università Cattolica del Sacro Cuore	Italy	1	171
4	Daniela Guerra	Católica Lisbon School of Business & Economics	Portugal	1	148
5	Brigitte Hoogendoorn	Erasmus School of Economics	Netherlands	1	148
6	Peter van der Zwan	Leiden University	Netherlands	1	148
7	Qiuyang Gu	Zhejiang University of Technology	China	1	144
8	Jiaqiang Liu	Zhejiang University of Technology	China	1	144
9	Zijia Liu	Zhejiang University of Technology	China	1	144

We observe a strong correlation between journal rankings and citations. Most of the trending articles are published in leading Business Management and Economics journals. Only one article is published in mainstream finance journal.

The main research questions explored in the trending studies are summarized below:

1. How do internal and external financial sources impact eco-innovation in European SMEs, and how does public funding influence this relationship (Cecere et al. 2020)?
2. What are the determinants of environmental practices in SMEs (Hoogendoorn et al. 2015)?
3. Do family firms invest differently in environmental initiatives than non-family firms when shareholder and societal interests coincide or diverge (Abeysekera and Fernando, 2020)?
4. Does shared preference among institutional investors for ESG promote low-carbon innovation in family firms (Wu et al. 2023)?
5. How does ESG affect the cost of debt in SMEs and if family ownership plays any role to mediate this relationship (Gjergji et al. 2021)?
6. How does green finance impact the total factor productivity of heavily polluting enterprises (Zhao et al., 2023)?
7. environmental performance in SMEs (Lewis et al. 2015)?
8. What are the financial implications of environmental practices in UK-based SMEs (Boakye et al. 2020)?
9. To what extent is the adoption of CE practices by SMEs associated with their financing choices (Ghisetti and Montresor 2020)?
10. What is the impact of green financing to SMEs on the performance of banks (Mirza et al. 2023)?

4 | Network Visualization of Literature

4.1 | Trend Analysis

Following the earlier literature (Chiaromonte et al. 2023; Joshipura et al. 2025; Mohd Nashruddin et al. 2025), we run the

TABLE 5 | Trending Articles on environmental management and climate finance in SMEs. This table presents the top-10 articles ranked by the total number of citations, including the journal's name, and providing the number of citations received since their publication.

Authors	Article title	Source title	Total citation
Cecere et al. (2020)	Financial constraints and public funding of eco-innovation: empirical evidence from European SMEs	Small Business Economics	187
Hoogendoorn et al. (2015)	What drives environmental practices of SMEs?	Small Business Economics	187
Abeysekera and Fernando (2020)	Corporate social responsibility versus corporate shareholder responsibility: A family firm perspective	Journal of Corporate Finance	155
Wu et al. (2023)	Clustered institutional investors, shared ESG preferences and low-carbon innovation in family firm	Technological Forecasting and Social Change	147
Gjergji et al. (2021)	The effects of environmental, social and governance disclosure on the cost of capital in small and medium enterprises: The role of family business status	Business Strategy and The Environment	140
Zhao et al. (2023)	Impact of green finance on total factor productivity of heavily polluting enterprises: Evidence from green finance reform and innovation pilot zone	Economic Analysis and Policy	112
Lewis et al. (2015)	SMEs and the Potential for A Collaborative Path to Environmental Responsibility	Business Strategy and The Environment	105
Boakye et al. (2020)	Sustainable environmental practices and financial performance: Evidence from listed small and medium-sized enterprise in the United Kingdom	Business Strategy and The Environment	90
Ghisetti and Montresor (2020)	On the adoption of circular economy practices by small and medium-size enterprises (SMEs): does financing-as-usual still matter?	Journal Of Evolutionary Economics	86
Mirza et al. (2023)	The impact of green lending on banking performance: Evidence from SME credit portfolios in the BRIC	Economic Analysis and Policy	84

trend analyses which guide us to understand and intellectualize the evolution and development of literature on environmental management and climate finance in SMEs.

To conduct the trend analysis as presented in Figure 3, we limit the minimum inclusion criteria of three times for a particular keyword to be included in the analysis. This yields us a total of 82 keywords, with a total link strength of 2303. We observe that the analysis is limited to 2020 to 2025 which implies the restricted frequency of keywords outside aforementioned range.

Figure 3 reports that “environmental performance”, “SMEs”, “green innovation”, “sustainability” and “family firms” are the most frequent keywords. Further, it reveals that early literature (before 2020 and 2021–2022) incorporates the adoption of environmental practices, eco-innovative technologies and drivers of environmental practices in SMEs. The following phase (2022–2023) highlights research on green innovation and environmental

performance in SMEs and its reaction to climate change. The last phase (2024–2025) is mostly incorporate the research on call for designing green finance instruments, if being green reduces the cost of debt for SMEs, improve the stability and risk profile of SMEs and create value for SMEs.

4.2 | Bibliographic Coupling and Content Analysis

The main objective of using bibliographical coupling is to explain the dimensions and streams of literature on a research field. Figure 4 provides the results, using colors to differentiate streams in the literature on environmental management and climate finance in SMEs.

We identify four leading streams: (1) Sustainability, environmental practices and climate change (Red stream); (2) Climate Finance and SME performance (Green stream); (3) Financing cleantech in SMEs (Blue stream); and lastly (4) Environmental

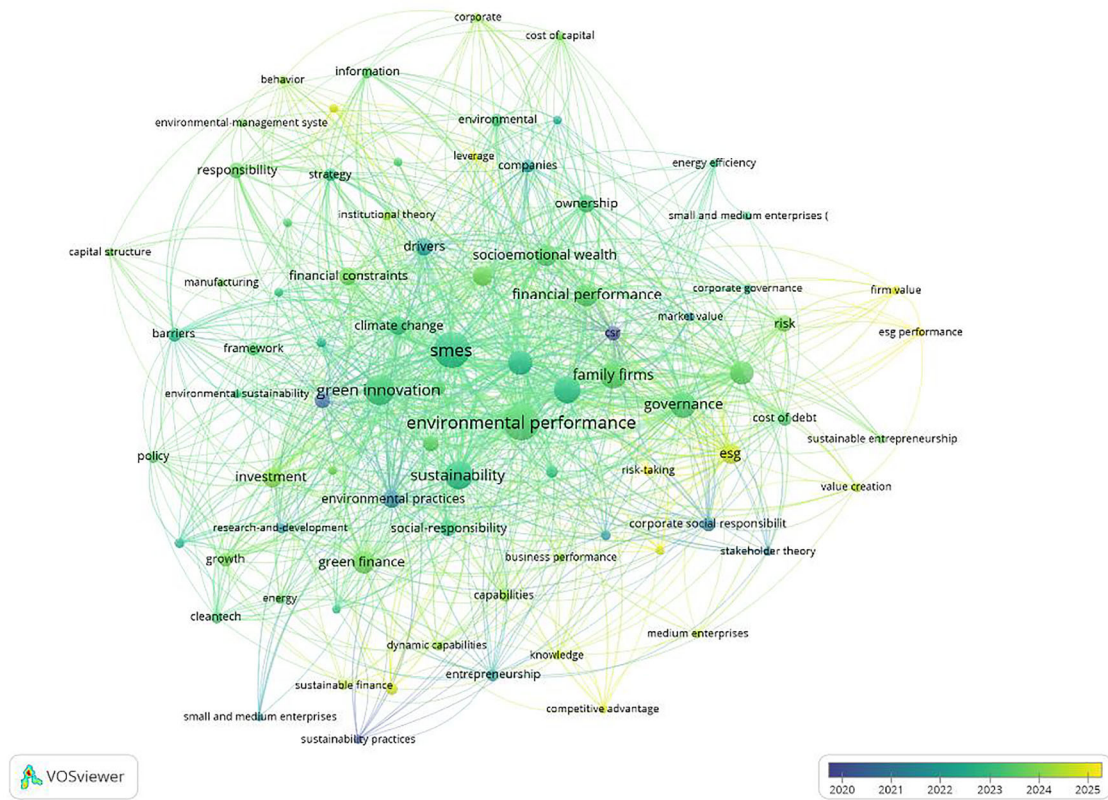


FIGURE 3 | Trend analysis. This figure visualizes the connections across keywords, their evolution across time, and their relative weight (bubble size) within sampled papers. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

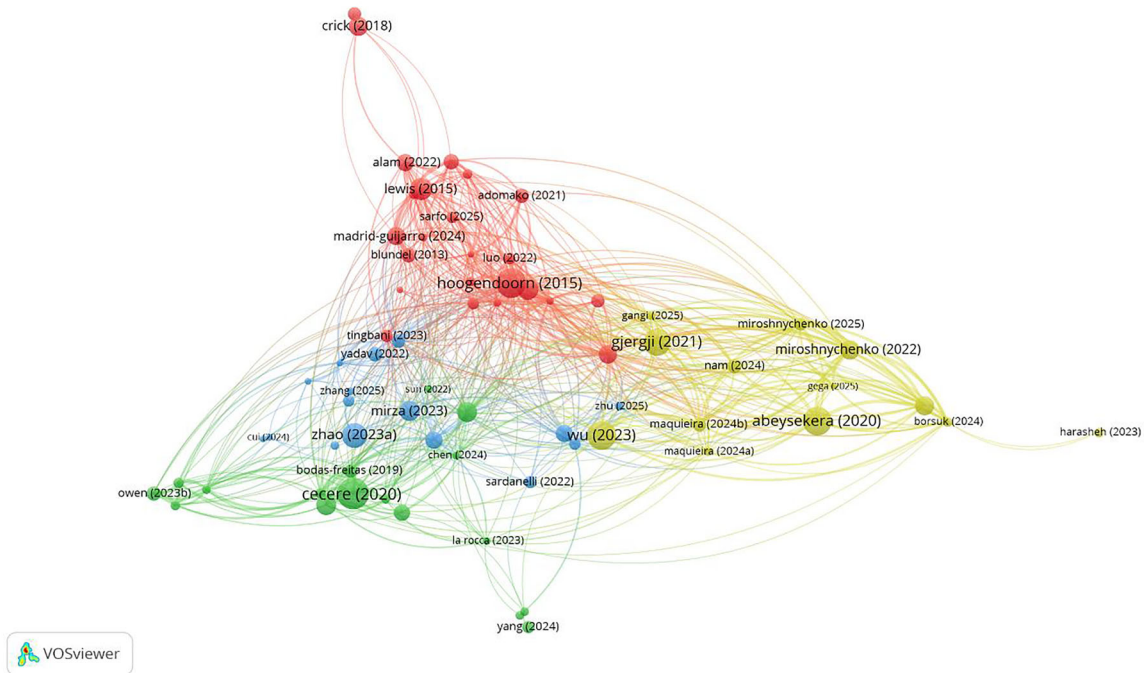


FIGURE 4 | Network visualization of research streams. This figure visualizes connections across published papers (author/year), as well as their belonging to our four research streams: (1) Sustainability, environmental practices and climate change (Red stream); (2) Climate Finance and SME performance (Green stream); (3) Financing cleantech in SMEs (Blue stream); and lastly (4) Environmental practices and family firms (Yellow stream). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

practices and family firms (Yellow stream). We review in the following paragraphs each of these streams separately.

4.2.1 | Sustainability, Environmental Practices and Climate Change

Over the past few decades, there has been growing concern about the role businesses should play in protecting the climate and the broader ecological system. However, the potential contributions of SMEs to environmental and climate protection have been largely overlooked in early literature, which predominantly focuses on large corporations (Gillan et al. 2021; Khan 2022). This stream of research has 25 articles and key research mainly focuses on the adoption of environmental initiatives (Adomako et al. 2021; Afolabi et al. 2023; Lewis et al. 2015; Olekanma et al. 2024; Tyler et al. 2024), barriers and challenges (Madrid-Guijarro and Duréndez 2024; Studer et al. 2006) and main drivers of environmental practices in SMEs (Arend 2014; Hoogendoorn et al. 2015; Lefebvre et al. 2003; Williamson et al. 2006).

Despite smaller in size, SMEs contribute 40% of commercial waste, industrial pollution and greenhouse gas emissions (Wildnerova et al. 2024). Therefore, they are facing increasing pressure from all stakeholders including regulatory bodies and civil societies to install environmental-friendly operations (Afolabi et al. 2023). Historically and attitudinally, the manager of SMEs consider that their businesses have no negative impact on the environment (Simpson et al. 2004) and expect governments and regulatory bodies to be responsible for environment and to maintain level-playing field while implementing environmental regulations (Lewis et al. 2015; Rutherford et al. 2000). In this regard, (Lewis et al. 2015) found that managers with positive attitudes toward regulation and voluntary standards are more likely to implement environmental practices. Further, they also overcome size issue and collaborate with other firms to adopt more sustainable practices.

Similarly, (Tyler et al. 2024) and (Adomako et al. 2021) found that SMEs with proactive orientation tend to adopt environmental practices in their operations. While many SMEs limit their actions to compliance with legal requirements, the presence of strong regulatory pressure has been shown to amplify the positive influence of proactive orientation on the adoption of environmental initiatives. External stakeholder pressure is another important factor influencing SMEs' engagement in environmental initiatives. According to Afolabi et al. (2023), SMEs often implement sustainability measures not only to enhance their access to financing from banks but also to strengthen and preserve positive relationships with their customers.

SMEs also face severe barriers in attempting to adopt environmental practices. Prior research frequently cited resource scarcity such as insufficient capital and technical capacity to invest in cleaner technologies (Carvajal and Didier 2024). As noted above, SMEs lacks financial resources and environmental practices are costly (Boakye et al. 2020), thus, they prioritize cost reduction and business survival over adopting environmental practices (Rodriguez-Melo and Mansouri 2011). Further, SMEs also have limited awareness and information about environmental laws and available support programs to greening their business

practices. Though this lack of information and awareness is considered barriers to SME performance, but it is more pronounced when it comes to environmental domain. In practice this means that even when managers express positive environmental attitudes, uncertainty about the feasibility, costs and benefits of new green technologies leads to under-investment (OECD 2022).

Few researchers within this stream also focused on the drivers of environmental practices and how SMEs respond to climate related shocks. For example, (Hoogendoorn et al. 2015) categorized the environmental practice in two types, namely, greening process and green product and services offered by the SMEs. By using comprehensive data of 8000 SME, they reported that firm specific characteristics have heterogenous impact on both types of environmental practices and environmental regulations are strong driver of environmental practices in SMEs.

Further, climate related risks are also affecting the business operations regardless of their size, especially for SMEs due to having limited resources and technical efficiency to deal with it (Hampel-Milagrosa et al. 2015). Since, predicting climate remains unknown, it requires technical knowledge and skill to make complex decision to combat climate shock under deep uncertainty conditions (Crick et al. 2018). For example, (Williams and Schaefer 2013) conducted a qualitative study in East England and found that SMEs managers had prior knowledge of environmental issues which help them to develop a strong sense of responsibility toward climate actions. (Crick et al. 2018) proposed sustainable and unsustainable adaptation measures. This study reported that financial barriers often lead SMEs to adopt unsustainable adaptation strategies to mitigate climate risk, whereas access to business support, information technology, and adaptation assistance promotes more sustainable responses.

Climate related shocks also push firms to invest in research and development. In this regard, (Alam et al. 2022) investigated the impact of climate change on the innovation performance. Though, the impact varies across firms and industries, climate change generally has positive impact on the SME innovation with 1% standard deviation in climate change resulted in 6.6% increase in SMEs innovation.

4.2.2 | Financing Cleantech in SMEs

Cleantech, or clean technology, refers to the development of products, services, or processes that rely on low or zero non-renewable resources and generate less waste compared to conventional technologies (Cumming et al. 2016). In pursuit of net-zero carbon emissions by 2050, investment in clean energy is rapidly increasing which has surpassed USD 2 trillion between 2016 and 2020, with projections reaching USD 5 trillion by 2030 and USD 4.5 trillion by 2050 (IEA 2021).

This stream of literature (17 articles) primarily addresses access to finance for cleantech implementation in SMEs (Caporale et al. 2023; Cecere et al. 2020; Chen et al. 2024; Cowling and Liu 2023; Cumming et al. 2016), energy pricing mechanisms (Triguero et al. 2014) and CE practices within SME operations (Antonioli et al. 2022; Bodas-Freitas and Corrocher 2019; Ghisetti and Montresor 2020).

As noted above, financial resources remain the critical challenge for SMEs in general and it is more pronounced when SMEs are pursuing cleantech (Bouchmel et al. 2024). These firms often encounter greater credit rationing than their non-cleantech counterparts due to several factors such as high capital intensity, long time horizons, intangible asset profiles, and inherent technological risk of cleantech projects (Ghosh and Nanda 2010; Nanda et al. 2014). (Cowling and Liu 2023) find that “going-green” SMEs in the UK show a higher demand for external finance, yet traditional finance providers (e.g. commercial banks) frequently fall short in meeting this demand. As a result, these firms increasingly turn to government-backed sources, such as subsidies or guarantees, though even these may inadvertently crowd out private sector investments in high-tech cleantech ventures.

Although there is rise of private finance options such as angel investor (Botelho et al. 2023), equity crowdfunding (Hörisch and Tenner 2020) and venture capital (Cumming et al. 2016), early-stage green startups and SMEs often struggle to secure funding due to uncertainties and a lack of market validation. To overcome the funding gap, (Mukherjee et al. 2024) emphasize for innovative public-private co-financing models to de-risk investments and increase its commercialization. Similarly, Owen et al. (2021) and Owen (2023) reported similar findings.

The recent research also stressed the need for coordinated research involving all stakeholder including universities being the anchoring resource for early-stage cleantech-focused SMEs (Owen and Vedanthachari 2023) and designing a targeted climate finance policy agenda (Owen et al. (2021) which should be focused on tailoring financial instruments to early-stage cleantech SMEs (Owen 2023).

The research also investigated the role of energy prices which can act as both a constraint and an incentive for SMEs. For Example, Triguero et al. (2014) differentiate between types of environmental practices, showing that high energy prices are significantly associated with adoption of basic practices such as recycling, but not with more advanced cleantech investments. They conclude that energy cost pressures alone are insufficient to drive transformative innovation, which typically requires internal capabilities and external support. Chen et al. (2023) provide UK-specific evidence that SMEs demonstrating energy-efficient behaviors tend to face fewer financial constraints, suggesting that financiers perceive such behaviors as indicators of good financial health. This implies that promoting energy efficiency could indirectly improve creditworthiness and financial access for SMEs. Caporale et al. (2023) further note that while internal financing consistently supports energy-saving measures, external financing (especially private) becomes more effective when combined with energy audits or internal monitoring mechanisms.

Bodas-Freitas and Corrocher (2019) examine the relationship between external support, both financial and advisory, and the adoption of resource efficiency practices among European SMEs. They find that direct financial support correlates with significant production cost reductions, while advisory services enhance the breadth and depth of adoption. This suggests a complementary role for different types of external support in enabling energy and resource-efficient transitions.

An evolving strand of literature on CE practices in SMEs which reveals both potential economic benefits and significant challenges. In this regard, Antonioli et al. (2022) argue that CE-related eco-innovation is not easily analogous to standard technological innovation due to the dual presence of knowledge and environmental externalities. They found that economic benefits of CE practices are often limited or even negative in the short term for SMEs, especially when implemented in isolation. While Ghisetti and Montresor (2020) explore the role of finance in enabling CE adoption and find that “financing-as-usual” (i.e. self-financing and debt) still plays a significant role while public funding has larger impact on the CE adoption in SMEs than self-financing lower than debt financing option.

4.2.3 | Climate Finance and SME Performance

SMEs are widely recognized as crucial to achieving climate and sustainability goals, yet they face persistent difficulties in accessing the finance needed for green investments. Global climate finance flows have grown reaching an estimated \$1.5trillion annually in 2023⁴, but only a tiny fraction trickles down to SMEs and local small-scale projects. For example, Chiriac and Naran (2020) reported that climate finance directed at small-scale agriculture (often composed of small enterprise farmers) accounted for merely 1.7% of total tracked climate finance which illustrates a substantial climate finance gap. Further, SMEs are not receiving commensurate financing from green investment channels despite collectively representing a large share of greenhouse gas emissions (Mukherjee et al. 2024).

This stream (16 articles) of literature primarily explores the role of climate finance and environmental practices in SMEs, (Bouchmel et al. 2024; Cui et al. 2024; Wellalage et al. 2022; X. Yang 2023), supply-chain financing for environmental protection in SMEs (Gao et al. 2024; Wang et al. 2023) and role of banks in facilitating climate finance for SMEs (Flögel et al. 2024; Mirza et al. 2023).

To begin with, (Bouchmel et al. 2024) investigated the impact of financial sources and constraints on the environmental performance in Eastern European SMEs. They distinguish climate finance based on pure and mixed green investment. The results shows that internally generated funds are major source of climate finance and have positive impact on environmental performance while leverage and financial constraints reduces the investment in environment practices. Financial constraints also reduce sustainability and innovation performance in SMEs (Cui et al. 2024).

Since SMEs typically borrow from local banks, their climate finance largely depends on banks’ willingness and ability to offer suitable loan products. Banks, however, often perceive small climate-related projects as high-risk or lack skill-set to assess SME sustainability plans (OECD 2023; Sinha et al. 2018). As a result, there is a structural mismatch, thus, decentralized, individual financing for SME transition plans is needed rather than one-size-fits-all disclosure regimes (OECD Activity Report 2024).

In 2011, China also introduced a market mechanism based on Carbon Emission Trading (CET) where firms can trade emission credit or allowances (S. Yang 2023). In this regard, (S. Yang et al. 2024) documented that the introduction of CET offered

double dividend for SMEs, that is, it reduced the sulfur dioxide emission by 2%–3% and increase employment by 6%–7%. Further, environmental performance also led to ease in access to finance during crises time (Wellalage et al. 2022) found that environmental performance in SMEs build trust during COVID-19 and helps them to tap external financial market at favorable terms.

Firms working under low-carbon supply chains⁵ usually face financial constraints to install innovative technologies for carbon reduction. Consequently, (Gao et al. 2024) examine P2P lending as a financing tool for low-carbon supply chains using Stackelberg game models under two cost-sharing scenarios. The P2P platform sets service terms, the manufacturer chooses the carbon emission reduction (CER) level, and the retailer sets the price. The study found that P2P lending has mixed effects on platform profit and that cost sharing does not always improve CER outcomes. However, P2P lending complements bank credit by enhancing social welfare and supporting CER efforts. Similarly, supply chain finance also improves the corporate sustainability and environmental performance (Wang et al. 2023).

Few studies also focused on the role of banks in climate finance from the lens of SMEs. For example, (Mirza et al. 2023) and Zheng et al. (2025) investigated the impact of SME green lending on bank specific characteristics in BRIC and European countries, respectively. The results showed the SME green lending improve the default risk and profitability of the banks with higher net interest margin which implies banks consider SME green lending riskier and charge them higher interest rate. This is further confirmed by (Gjergji et al. 2021) which conclude that ESG increase the cost of capital for SMEs. Environmental performance also improves the probability of loan approval albeit the SME is led by a male (D. Zhang et al. 2022). Nonetheless, it is difficult for banks to screen environmental performance of SMEs and to integrate systematic climate impact assessments into routine lending (Flögel et al. 2024).

4.2.4 | Environmental Practices and Family Firms

This stream (13 articles) mainly focused on the environmental practices in family firms. Family firms, as unique entities blending economic pursuits with non-financial goals (Miroshnychenko et al. 2022; Wagner et al. 2015), exhibit complex behavior in the intersection of environmental practices and financial performance (Gómez-Mejía et al. 2025). Across the literature, these firms display a marked duality in their approach to environmental responsibility. While some adopt progressive sustainability practices, others remain relatively inactive or even regressive (Miroshnychenko et al. 2025). This heterogeneity is often attributed to varying degrees of socioemotional wealth (SEW) preservation (Mariani et al. 2023), risk aversion (Miller et al. 2008), resource constraints (Chua et al. 2018) and generational influence (Miroshnychenko et al. 2025; Miroshnychenko et al. 2022).

Institutional investor influence also plays a critical role in green-ing family firms (Wu et al. 2023, 2024). Clustered investors with shared ESG preferences can stimulate low-carbon innovation in family firms, particularly when supported by green finance in

low-uncertainty environments. However, the strength of family control can dilute this influence unless a next-generation successor is present, which tends to align better with innovation and sustainability goals (Wu et al. 2023). Similarly, (Wu et al. 2024) find that institutional investor ESG activism promotes green innovation in family firms, and that the presence of financial slack and family involvement can strengthen this relationship.

On the financial side, ESG performance interacts with firm risk and capital structure in complex ways. For SMEs, the disclosure of environmental activities tends to increase the cost of capital amid of higher perceived risk and trivial investor preference towards investing in such firms (Gjergji et al. 2021). When these SMEs are family-owned, this relationship inverts and reduces the cost of debt which implies the potential role of family ownership serving as a moderating factor through the channel of enhancing trust and stakeholder confidence (Gjergji et al. 2021; Kong 2023).

Further, the presence of strong ESG performance, especially from environmental and social front, increase the stability of family firms (Maquieira et al. 2024) and as well as improve the underpricing by alleviating information asymmetry prior to launching the Initial Public Offering (IPO) of family-based firm (Harasheh 2023). Using a comprehensive dataset from the USA, (Fu et al. 2023) reported that improved ESG disclosure is associated with reduced IPO failure risk, greater post-IPO stability, and enhanced long-term firm performance.

5 | Recommendations and Direction for Future Research

The bibliometric analysis coupled with content analysis allows us to identify potential gaps in the literature, by identifying future research questions vital for the understanding of environmental management and climate finance in SMEs. Table 6 present the detailed future research questions in each stream.

5.1 | Sustainability, Environmental Practices and Climate Change

Prior research indicates that institutional and stakeholder pressures can encourage SMEs to adopt sustainability practices, but their influence on environmental performance operates largely through managerial commitment and is often weakened by resource and capability barriers (Madrid-Guijarro and Duréndez 2024). Accordingly, future research should move beyond static observations and adopt longitudinal designs to capture the dynamic nature of SME sustainability, tracing how managerial commitment develops and translates into measurable environmental performance over time.

Notwithstanding rising stakeholder and regulatory demands, SMEs often restrict environmental adoption to minimum-compliance practices, reflecting resource constraints and the tendency to view sustainability as a cost (Boakye et al. 2020). Tyler et al. (2024) show that proactive orientation explains heterogeneity in SMEs' environmental-practice adoption and that regulatory pressure strengthens this relationship by stimulating opportunity search and strategic differentiation. However, the channels

TABLE 6 | Future research direction. This table presents directions for future research in each stream.

Stream	No.	Research question	Reference
Sustainability, environmental practices and climate change	1	How do SMEs' behaviors and management commitment to environmental performance evolve over time? This research question calls for longitudinal studies to understand environmental practices in SMEs from the channel of management commitment.	Madrid-Guijarro and Duréndez (2024)
	2	How do different stakeholder pressures (e.g. competitive, supplier, customer, community) moderate the relationship between SMEs' proactive orientation and their adoption of environmental practices?	Tyler et al. (2024)
	3	What mechanisms do SMEs use to respond proactively to regulatory pressures in adopting environmental practices?	Tyler et al. (2024)
	4	How do a country's culture and institutional quality influence the relationship between climate change and SMEs' innovation?	Alam et al. (2022)
Financing cleantech in SMEs	1	What are the most effective public policy mixes to de-risk cleantech investments and stimulate private sector involvement in emerging and developed markets?	Mukherjee et al. (2024); Owen and Vedanthachari (2023)
	2	What types of investor behaviors and preferences influence green investment decisions, and how can public policy better align with these preferences?	Mukherjee et al. (2024)
	3	What is the detailed nature and associated risk of the clean technologies adopted by SMEs, and how do these influence funding decisions by public and private financial markets?	Cowling and Liu (2023)
Climate Finance and SME performance	1	How do carbon emissions trading schemes affect broader macroeconomic outcomes, spatial dynamics, and supply chain transmission effects?	S. Yang et al. (2024)
	2	Recent research has also proposed supply chain financing through peer-to-peer (P2P) lending to finance low carbon supply. This proposal considers interest rates exogenously determined without taking into account credit rating of borrowers, thus, call for future research on incorporating credits rating of borrowers within such lending arrangement.	Gao et al. (2024)
	3	How can banks facilitate SMEs in adopting environmental practices, and what role do financial institutions play in promoting environmental sustainability among SMEs?	Author's Suggestion
	4	How do strict credit scrutiny and high interest rates imposed by banks on SMEs influence their environmental performance and financial health?	Author's Suggestion
	5	Does involvement in green lending to SMEs reduce the cost of deposits for banks?	Author's Suggestion
	6	How do challenges in sustainability and environmental disclosure affect banks' ability to assess SME credit applications	Author's Suggestion
Environmental practices and family firms	1	How do environmental practices differ between family-owned and non-family-owned firms?	Miroshnychenko et al. (2025)
	2	Does environmental sustainability lead to a reduction in the cost of debt in family-owned SMEs?	Maquieira et al. (2024)

through which different stakeholder pressures (e.g. competitors, suppliers, customers, and communities) shape adoption remain insufficiently theorized and empirically examined, calling for future research to understand these mechanisms and their boundary conditions. In the similar line of research, research should also investigate how macro-level context, particularly national culture and institutional quality, conditions SMEs'

innovation responses to climate change and the translation of environmental intent into measurable practice (Alam et al. 2022).

5.2 | Financing Cleantech in SMEs

Prior research indicates that cleantech investment is difficult to scale because projects are capital intensive, long-horizon,

and exposed to policy and revenue uncertainty, which reduces private investors' willingness to commit capital (Criscuolo and Menon 2015). At the same time, the literature emphasizes that "cleantech" is highly heterogeneous and that limited technology-level granularity constrains accurate risk pricing and the design of fit-for-purpose financial instruments (Cowling and Liu 2023). Accordingly, future studies should document the specific clean technologies adopted by SMEs, characterize their associated risk profiles, and examine how these features shape funding decisions in public and private capital markets.

Moreover, green investment cannot be understood solely through the supply of capital, as investor decisions reflect heterogeneous preferences, information frictions, and uncertainty regarding technologies, markets, and regulatory conditions (Mukherjee et al. 2024). Future research should therefore investigate investor behaviors and decision heuristics and identify policy designs that better align with these preferences by enhancing credibility, predictability, and the strength of signals used in project evaluation.

5.3 | Climate Finance and SME Performance

Building on evidence from China's carbon emissions trading scheme (CET), S. Yang et al. (2024) emphasizes that existing evaluations are predominantly micro-level, focusing on firm outcomes identified through quasi-experimental designs (e.g. time-varying DID in pilot regions). While such approaches are well suited to estimating within-firm policy effects, firm-level estimates do not fully capture general-equilibrium implications and cross-sectional spillovers, including how carbon-cost shocks diffuse across regions and propagate through production networks. Accordingly, future research should leverage richer data integration and longer horizons to examine macro-level outcomes, spatial dynamics, and supply-chain transmission channels of carbon trading policies.

Furthermore, while recent literature introduces peer-to-peer (P2P) lending as a viable mechanism for financing low-carbon supply chains, current models often rely on exogenously determined interest rates (Gao et al. 2024). These frameworks frequently overlook the specific credit risk profiles of borrowers. Consequently, future research should focus on integrating borrower credit ratings into P2P lending arrangements to ensure more accurate risk pricing and sustainable financial growth.

Finally, the role of financial intermediaries warrants more explicit theorization and empirical testing in the SME climate-finance literature. Recent evidence suggests that SME lending can enhance banks' profitability and improve their risk profiles (Zheng et al. 2025; Mirza et al. 2023). Building on this, future research should examine the specific channels through which banks support SMEs' environmental upgrading, including advisory services, dedicated green credit lines, and sustainability-linked covenant design, and should assess whether scaling up green SME lending affects banks' own funding conditions, particularly the cost and stability of deposits. Moreover, given persistent evidence that SMEs face constrained access to finance that limits investment in environmental infrastructure (Boakye et al. 2020; Chiriac and Naran 2020), further work is needed to evaluate how tighter credit

screening and higher borrowing costs influence SMEs' capacity to undertake environmental investments and maintain financial resilience.

5.4 | Environmental Practices and Family Firms

Family-owned SMEs constitute a distinctive organizational form in which long-term legacy considerations may outweigh short-term financial objectives (Miroshnychenko et al. 2025). Yet evidence remains limited on how green finance and environmental management operate in family firms and whether these dynamics differ systematically from those in non-family SMEs. Future research should therefore undertake explicit comparative analyses of family versus non-family firms' environmental trajectories, with particular attention to the underlying governance and behavioral mechanisms that shape sustainability choices. An especially relevant question is whether stronger environmental performance and credible green strategies generate a "greenium" for family SMEs, for example through a lower cost of debt or improved credit terms (Maquieira et al. 2024).

6 | Conclusion

In this paper, we explore the bibliometric and content features of the literature on environmental management and climate finance in SMEs. Focusing on the period 1985–2025, we filtered 124 articles, allowing us to critically discuss the intersection of environmental management and climate finance in SMEs and future research possibilities.

Our findings reveal that the literature mostly focuses on its berries and drivers of environmental practices, SMEs response to climate change in relation with financial dynamics such as financial instruments and cost of debt, including cleantech-based small business and family-based SMEs. We also revealed that the research is mostly concentrated in Europe and China.

Moreover, we find that the sharp increase both in citations and published articles on the environmental management and climate finance, suggesting great interest and growing attention to the topic from scholars. Additionally, we run a content analysis aimed at reviewing existing research streams on the topic. The results indicate that the literature on environmental management and climate finance in SMEs may be classified into four streams: (1) Sustainability, environmental practices and climate change; (2) Climate Finance and SME performance; (3) Financing cleantech in SMEs and lastly; and (4) Environmental practices and family firms.

These streams highlight that climate finance is best understood as a set of transmission channels, through banks, public programs, capital markets, and emerging fintech models, whose effectiveness depends on information frictions, risk perceptions, and institutional quality. For policymakers, the implications are twofold: effective SME decarbonization requires financial architectures that reduce risk and transaction costs (e.g. guarantees, blended finance, sustainability-linked lending), and complementary measures that strengthen SMEs' reporting capacity and

managerial capabilities, thereby improving the credibility and bankability of green projects.

Finally, we identify a number of potential gaps in the literature and suggest potential directions and research questions for future analyses. This study is also subject to one limitation. Our search of literature was restricted to the WOS database, which may have excluded relevant studies not indexed in WOS. Accordingly, future reviews could strengthen coverage by conducting a meta-literature review of climate finance and SMEs using multiple databases, including Scopus and Google Scholar.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

¹ WOS can list a journal in multiple categories. Although they appear in various research areas, we have considered only their primary category of focus for this analysis.

² Please see the following link for details. <https://www.gov.uk/guidance/international-climate-finance>

³ Please see the following link for details. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

⁴ See the following link for detail on the landscape of climate finance. <https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2024/>

⁵ A Low-Carbon Supply Chain (LCSC) is a supply chain model that integrates greenhouse gas emissions as constraints or objectives in its design and planning. Its goal is to balance economic performance with environmental sustainability by delivering low-emission, energy-efficient goods or services aligned with low-carbon consumer preferences

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