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ESG and climate-related risks versus traditional risks in commercial banking: A bibliometric and thematic review

Zbigniew Korzeb¹ , Paweł Niedziółka^{2*} , Danuta Szpilko³ and Filippo di Pietro⁴

Abstract

The aim of this study is to classify scientific research on the impact of ESG and climate-related risks on the conduct of the banking business. The systematic literature review was based on a bibliometric analysis of articles found in the Scopus and Web of Science databases. The search was confined to materials published between 2000 and August 2023. After applying criteria limiting the search, the final result was 869 unique literature items which were later analysed towards establishing the relationship of ESG and climate-related risks ('new banking risks') with other (so-called 'traditional') banking risks and identifying research gaps at the interface between traditional and new banking risks. This article introduces a variety of findings, including the most productive authors, organisations, countries and journals, the most cited articles and keyword distribution. In addition, a map of the evolution of the approach to ESG risk in banking was constructed on the basis of the literature review. The study identified 11 clusters of banking risk influenced by ESG risk and 10 clusters of banking risk affected by climate-related risk.

Keywords Banks, ESG risk, Climate risk, Bibliometric analysis

JEL G21, G32, Q01

Introduction

The idea of sustainable development implies that a company should not only and exclusively focus on achieving measurable economic goals, but that its activities should benefit all stakeholder groups, the local community and the environment. The last decade saw a tremendous

growth in sustainability initiatives, with which the ESG concept synthesising and quantifying a company's efforts and results in achieving its sustainability goals, closely corresponds. It consists of three pillars: environmental (E), social (S) and corporate governance (G). Through the credit and investment channel, the role of the banking sector in implementing environmental, social and governance initiatives in the economy is significant, but it is an indirect role. The direct contribution of banks, arising from their own activities, to their sustainability objectives must be considered limited. This corresponds to a transparent, consistent, coherent and comprehensive information policy, including the disclosure policy of banks on their direct environmental impact measured by the consumption of utilities (electricity, water, heat, natural gas and others), use of typical office supplies (paper, toner, etc.) as well as generation of municipal waste and air pollution.

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Focussing on the indirect channel, the increasing role of environmental and climate criteria in credit assessment procedures and investment portfolio construction processes should be highlighted. Restrictions relating to the financing of carbon-intensive sectors and preferences for projects favouring a reduction in energy intensity or aimed at the emergence of renewable energy sources are enshrined in the banks' lending and investment policies and strategies. This is due, on the one hand, to the values declared by the banks, and these must correspond to the values of the banks' stakeholders: shareholders, customers, employees and counterparties.

Also educating existing and potential clients and employees are other activities that, while not obligatory, fit perfectly into the effort to provide security and accessibility of sustainable banking products and services. The social pillar of the sustainability concept in the banking industry has also been considered to be a philanthropic act whereby banks—through their activities in culture, art, sport, education or assisting local communities—support values that protect the well-being of the local society [76, 100, 139].

In the sphere of corporate governance, the banks' activities focus on respecting the disclosure obligations towards all stakeholders and the rights of all shareholders (including minority shareholders), as well as maintaining in their policies the principle of diversity, tolerance and non-discrimination with regard to the employment structure at each level of the organisation and to remuneration. Governance is also an action aimed at the transparency of management processes and the application of objective criteria in them 22.

The importance of ESG is evidenced by the findings of the latest World Economic Forum report. As many as 8 of the 10 identified as the most significant global risks in the next 2 and 10 years are ESG risks 131. Obviously, they have financial implications and the analysis in this article focuses on these relationships in the context of commercial bank activities, although it should be clearly emphasised that ESG risks are the subject of interdisciplinary research.

After a broad review of articles containing bibliometric analyses, a research gap was identified, which boils down to the lack of bibliometric studies related to three areas. Firstly, there exist no bibliometric studies aimed at identifying and structuring research streams dedicated to the relationship between new banking risks (ESG and climate-related risks) and traditional banking risks (in particular credit, market and liquidity risks). Secondly, there are no bibliometric studies to delineate a taxonomy of research methods used in the analysis of the relationship between new and traditional banking risks. Finally, there is no analysis of research trends, neither a projection of

research directions on the basis of a comprehensive literature review. This study presents an analysis of the current state and future potential research directions resulting from the identified research gaps as well as the taxonomy of research methods applied in the analysis of association between ESG or climate-related risk with traditional bank risks.

This research idea is needed because of the following reasons. Firstly, the growing importance of sustainable banking and ESG risk analysis as a distinct area of research requires a comprehensive review of the existing literature. Secondly, the research relies on much broader databases than previous bibliometric analyses, i.e. both the Web of Science and Scopus, which allows for a comprehensive approach and the diagnosis and categorisation of existing trends in the research in question.

The aim of the analyses carried out in this article is to systematise scientific research on the impact of ESG and climate-related risks on the risk of doing banking business and to identify the most relevant, from the point of view of research intensity, connotations of the above-mentioned risk factors with other ('traditional') banking risks.

The systematic literature review was based on a bibliometric analysis of articles found in the Scopus and Web of Science databases. The search was confined to materials published between 2000 and August 2023. After applying limiting criteria in the search process, 625 records were obtained from the Scopus database and 616 from the Web of Science. After removing duplicates, a set of 869 unique literature items was extracted for further analysis.

This article introduces a variety of findings, including the most productive authors, organisations, countries and journals, the most cited articles and keyword distribution. In addition, a map indicating how the topic of ESG risk in banks (keywords) has evolved over the years is also presented. The study identified 11 clusters of bank risk influenced by ESG risk and 10 clusters of bank risk influenced by climate-related risk.

The remainder of this article is structured as follows. Sect. "Literature review" reviews the most significant literature. Sect. "Methodology" describes the data and methodology employed in the empirical research. Sect. "Research results" outlines the results. Finally, Sect. "Discussion" summarises the main conclusions.

Literature review

ESG risk—identified with 'sustainability risk'—is defined as an environmental, social or governance event or condition that, if it occurs, could cause an actual or a potential material negative impact on the value of the investment 50. In turn climate-related risks refer to financial risks posed by the exposure of financial institutions to physical

or transition risks caused by or related to climate change, for example, damage caused by extreme weather events or a decline in asset value in carbon-intensive sectors 98. Climate-related risks are commonly understood to comprise two main risk drivers 48:

- Physical risk refers to the financial impact of a changing climate, including more frequent extreme weather events and gradual changes in climate, as well as of environmental degradation, such as air, water and land pollution, water stress, biodiversity loss and deforestation. Physical risk is therefore categorised as ‘acute’ when it arises from extreme events, such as droughts, floods and storms, and ‘chronic’ when it arises from progressive shifts, such as increasing temperatures, sea-level rises, water stress, biodiversity loss and resource scarcity. This can directly result in, for example, damage to property or reduced productivity, or indirectly lead to subsequent events, such as the disruption of supply chains;
- Transition risk refers to an institution’s financial loss that can result, directly or indirectly, from the process of adjustment towards a lower-carbon and more environmentally sustainable economy. This could be triggered, for example, by a relatively abrupt adoption of climate and environmental policies, technological progress or changes in market sentiment and preferences.

The issue of the impact of green lending on bank risk and the integration of ESG and climate-related risks with traditional risks is widely discussed in the literature. In general, the current literature suggests a negative relationship between banks’ ESG performance and riskiness profile (e.g. [37, 55, 104]). This strand of research emphasises that, according to stakeholder theory, economic and social objectives are complementary. Therefore, banks with strong ESG scores may be perceived as having better governance policies and efficient risk management systems. Additionally, [33, 34]) found that the total ESG score, as well as its sub-pillars, reduce bank fragility during periods of financial distress. di Tommaso and Thornton [45] note, however, that high ESG scores are also associated with a reduction in bank value consistent with the ‘overinvestment’ view of ESG whereby scarce resources are diverted from investment. Liu and Xie [85] come to the conclusion that ‘enhanced ESG performance can mitigate liquidity risk in commercial banks by reducing the proportion of non-performing loans and improving overall financial performance’. Al-Qudah et al. [7] find that the ratio of green loans has a negative impact on the NPL ratio, i.e. it contributes to a decrease in credit risk. In turn,

Zhou et al. [138] state that while the implementation of green credit policy reduces credit risk for major state-controlled banks, it increases credit risk for municipal and regional commercial banks. To integrate ESG and climate-related risks with ‘old’ bank risks, Capelli et al. [31] propose a new risk metric that combines Value-at-Risk and ESG factors.

The article organises the existing research areas and set out potential directions for further research. The study expands on the strands of research dedicated to the interaction between ‘new’ banking risks (ESG and climate-related risks) and traditional risks, such as credit, market, liquidity and operational risks. It also presents the evolution of the approach to ESG and climate-related risks in terms of their integration in the risk management system.

Breitenstein et al. [26] focus on environmental and climate-related risk management in the whole financial sector in their research conducted with the use of EBSCOhost, Emerald Insight and ScienceDirect databases over the period 2008–2020. However, this study does not refer to the association between different types of bank risks. Hence, these authors ask two questions. First, how is environmental risk approached to and practiced within the current risk management framework in the financial industry? Second, what are the current challenges to environmental risk management and sustainable businesses?

Mngadi and Twinomurizi [93], on the other hand, focus only on credit risk by conducting a study based on 1,018 sources from the Web of Science database over the period 1991–May 2022. Their study provides an analysis of the research on climate change, credit risk and the associated losses, and specifically identifies methods that could contribute to quantifying the causal relationships between climate change and credit risk. Also, Kashi and Shah [68], in their cross sectional study based on 723 publications from the Scopus database, devote one section to the issue of ‘risk profile of sustainable banks’. However, their conclusions are limited to credit risk only.

To date, the most comprehensive bibliometric compilation conducted by Galletta et al. [54], covering the years 1986–2021 and 271 publications from the Web of Science database, is associated with a cross sectional approach aimed at assessing intellectual development, characteristics of the authors and manuscripts pertaining to ESG in the banking industry, as well as investigating research trends. Aracil et al. [8] offer a similar literature study of 676 articles published between 1995 and 2019 in the Web of Science database. The above-mentioned researchers provide a comprehensive perspective of the nine clusters or thematic areas in sustainable banking literature embedded in three domains: Ethical Foundations, Sustainable Products and Business Case.

Da Silva Inácio and Delai [41] try to better understand the concept of sustainable banking and identify adequate measures of sustainability in this sector. They use a sample of 63 papers and ask a question: ‘does the paper present aspects of measurement?’ Relying on the definition of the sustainability measurement system (SMS) provided by Searcy [114], who identifies the SMS with a system of indicators that provides information needed to help in the short- and long-term management, controlling, planning and performance of the economic, environmental and social activities undertaken by an organisation, Da Silva Inácio and Delai conclude that the found models are still fragmented and do not have an accepted standard.

Sarma and Roy [112] highlight that green banking is yet to be properly explored as only 178 articles were found on different portals. The study identifies 6 different dimensions, namely the conceptual, legal, model, stakeholder, green performance of banks and financial aspect.

Still, other bibliometric studies focus on selected elements of the ESG concept. For example, the research by Secinário et al. [115] involves the social dimension. By conducting an analysis based on 270 articles from the Web of Science database, they extract five theoretical and practical clusters: (1) people’s well-being combined with technological innovation, (2) governance, (3) ethical investment and sustainable development, (4) corporate social responsibility (CSR), and (5) transparency.

Hidalgo-Oñate et al. [63] focus on climate-related prudential regulation tools in the context of sustainable and responsible investment. They define five prudential regulatory tools: disclosure requirements, climate-related stress testing, differentiated capital requirements, targeted refinancing lines as well as green finance guides and frameworks. At the same time, they identify several research gaps which include: green bubble, double materiality, interaction between policies, compound risks, banking governance, and small and medium-size enterprise (SME) banking. Khatib et al. [72] analyse board gender diversity within financial institutions as well as other characteristics of diversity, such as nationality, age, tenure, experience, education, ethnicity and religion. Admittedly, they focus only on 91 studies from 66 top-ranked journals in accounting, finance and economic fields, using Scopus and Web of Science databases and covering all publications until May 2020. This theme appears to be

popular in the research on the impact of Corporate Governance Mechanisms on Corporate Social Responsibility (CSR) or ESG.

In contrast, De Giuli et al. (2023) rely on the Scopus database with a sample of 589 documents published in the period 1983–2022. Their main objective is to find answers to the research question: what is the current trend of research that analyses ESG and risk? By conducting a survey on all articles—not only those related to the banking sector—they identify research gaps in terms of: (i) the need for a clearer taxonomy of ESG risk, (ii) clarification of how ESG risk distributes and spreads from one sector to another, and (iii) the inclusion of emerging economies and small and medium-sized enterprises in the samples. Also Khan [71] in his bibliometric review identifies risk as one of the most important future research directions. In his view, future research should be devoted to, among other issues: the nonlinear relationship between corporate social performance and evaluating the risk return trade-off of high-ranked ESG securities with those that have low/no ESG profile.

Trotta et al. [124] in their bibliometric review draw attention to issues related to risks resulting from the use of modern technologies: measuring spillover effects of risk volatility in ESG investments or the use of machine learning techniques in risk assessment.

Methodology

The analysis of scientific activity serves as an important indicator of the impact of research within a given area on the scientific community [78]. To analyse the scientific output in the field of ESG in the banking sector, the research was conducted in two stages (Fig. 1). Stage 1 involved bibliometric analysis; while, Stage 2 comprised a systematic literature review.

Bibliometric analysis involves the use of quantitative data related to scientific publications to assess the scientific activity of researchers, research units and even entire countries. It is used to observe the development of science and to identify trends in a given research area. This method is often employed by researchers when exploring a specific topic for the first time. With a large number of available publications, it facilitates the identification, synthesis, analysis, and critical evaluation of their content [25, 69]. By employing quantitative techniques,



Fig. 1 Research stages. *Source* own elaboration

it allows for the identification of the current state and developmental trends within a specific research area. The results provide insight into the main research directions, trends and changes in the number of publications over a given period. Moreover, this method enables the creation of rankings of the most productive authors, journals, research units and countries in a particular field of study [102, 121]. Bibliometric analysis is applicable to both well-established research areas in the literature [59, 133] and emerging ones [118].

A systematic literature review is a form of research that deals with existing publications and applies a systematic methodology to synthesise already published data [123]. It involves identifying all primary studies related to a specific review question, critically evaluating them, and synthesising the results [105]. A systematic literature review is fundamental for deepening knowledge. It highlights the path of previous research, integrates and summarises the information available in a given research area, while maintaining a high level of objectivity [77]. It helps to identify gaps in the literature that may provide opportunities for developing new ideas [81]. With a broad scope, a systematic literature review helps the researcher to extract knowledge [47].

In this study, the volume of scientific data was large (869 documents) and the range of topics was broad. Therefore, the authors deemed it necessary to use both bibliometric analysis and a systematic literature review. Figure 2 illustrates the operationalisation of the process employed in this article using the bibliometric analysis method.

The methodology of bibliometric analysis consists of seven steps, including the selection of bibliographic databases (I), the selection of keywords (II) and criteria for limiting publication searches (III), data extraction and removal of duplicate publications (IV), as well as the analysis of unique publications (V). The last two phases involved identifying research areas (VI) and subsequently creating thematic clusters (VII) (Fig. 2).

In the first step of the study, the bibliographic databases Scopus and Web of Science were selected to present a broad spectrum of scientific publications. Scopus and WoS are global platforms that index publications in various fields. These databases are widely used by researchers for conducting review studies. The choice of databases was dictated by their accessibility and thematic breadth across all scientific disciplines [121].

In step 2, keywords related to the thematic area, namely 'bank' and 'ESG', were selected. An initial search for the terms 'bank' and 'ESG' across the entire set of articles in the first trial yielded 5473 records in Scopus and 357 records in the Web of Science (Table 1). A preliminary analysis of the results indicated that many publications

did not pertain to the research area. Therefore, in the second trial, the search was limited to publications containing the specified phrase in titles, abstracts and keywords. The preliminary analysis of the results obtained from the second search showed a significant reduction in the number of records. Searching for the phrase in titles, abstracts and keywords yielded 261 records in the Scopus database and 321 in the Web of Science. It was noted that this resulted from using only the acronym ESG. Therefore, in the third trial, additional words (including those closely related to the expansion of the acronym ESG) such as 'environmental', 'social', 'governance', and 'climate risk' were added. The third search yielded 651 records in the Scopus database and 632 in the Web of Science. The review of the obtained records was satisfactory in terms of content; and thus, the next research step was initiated.

In the third step, specific restriction criteria were applied to enhance the precision of the search. The search was confined to materials published between 2000 and 2023. For in-depth analysis, articles, conference proceedings, books, book chapters, reviews, editorials and early access publications were deemed eligible. Conversely, publication types such as retracted articles, conference reviews, notes, errata and letters were excluded. Furthermore, articles in languages other than English (e.g. Chinese, Russian, and Portuguese) were also excluded. The search outcomes are detailed in Table 2.

The search for the term 'bank' AND (ESG OR (environmental AND social AND governance) OR 'climate risk*') across the complete set of papers resulted in 651 records retrieved from Scopus and 632 records from the Web of Science. Following the application of restrictive criteria, 625 records from Scopus and 616 from the Web of Science were obtained.

In step 4, files downloaded from Scopus and WoS databases were merged using MS Office Excel 19. The complete records in *csv format were consolidated into a single file, resulting in a combined total of 1241 records. This process was challenging since the data in individual columns varied in structure depending on the database. After merging the databases, duplicates were removed based on the title, authors and DOI information. These three criteria were applied since the selection based only on titles and authors did not yield satisfactory results. The entries for titles and author names in the databases sometimes contain errors or inconsistently formatted characters, such as quotation marks and hyphens. After removing duplicates, a subset of 869 unique records was selected for further analysis.

In the fifth—utilising the acquired dataset—step, diverse analyses were conducted to investigate the frequency of publications within specific time intervals and identify the most productive authors, institutions,

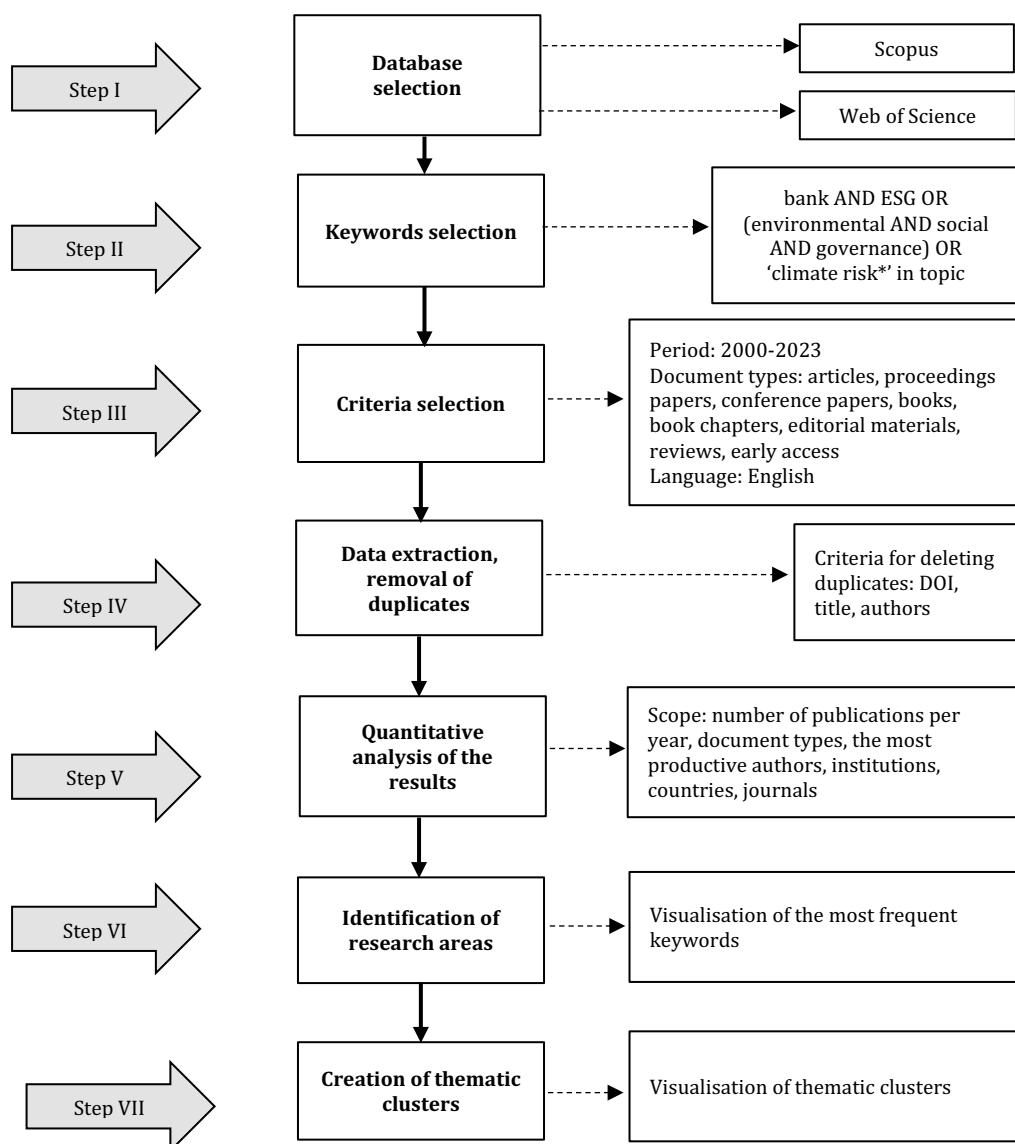


Fig. 2 Methodology of bibliometric analysis. Source own elaboration

Table 1 Preliminary search results. Source authors' work based on the Scopus and Web of Science databases – August 2023

Stage	Scopus	WoS
<i>First search</i>		
Research query	ALL (bank AND ESG)	ALL = bank AND ESG
Number of articles before inclusion criteria	5473	357
<i>Second search</i>		
Research query	TITLE-ABS-KEY (bank AND ESG)	TS = bank AND ESG
Number of articles before inclusion criteria	261	231
<i>Third search</i>		
Research query	TITLE-ABS-KEY (bank AND ESG OR (environmental AND social AND governance) OR 'climate risk*')	TS = bank AND (ESG OR (environmental AND social AND governance) OR 'climate risk*')
Number of articles before inclusion criteria	651	632

Table 2 Principal search result. *Source* own elaboration based on the Scopus and Web of Science databases – August 2023

Stage	Scopus	WoS
Research query	TITLE-ABS-KEY (bank AND ESG OR (environmental AND social AND governance) OR'climate risk*'))	TS=bank AND (ESG OR (environmental AND social AND governance) OR'climate risk*'))
Number of articles before inclusion criteria	651	632
Number of articles after inclusion criteria	625	616

countries and journals. The research also aimed to pinpoint notable articles, specifically those with the highest citation counts. Analyses were conducted using individual and combined records from the Scopus and WoS databases, with MS Office Excel 19 used for this purpose (Table 3). In addition, a co-citation analysis of authors and a bibliographic coupling of countries were carried out using VOSviewer software version 1.6.19. Two authors (two publications) are co-cited when a third author (publication) quotes both authors (both publications). The greater the number of authors (publications) by which two authors (two publications) are co-cited, the stronger the co-citation relationship between authors (publications), [125]. Bibliographic coupling, on the other hand, is the opposite category. Two publications are bibliographically coupled if there is a third publication that is cited by both publications. The bibliographic coupling relationship between countries (publications) is greater, the greater the number of common references between two countries (two publications), [125]. The detailed results of the analyses are presented in Sect. "Methodology" of the article (Figs. 3, 4, 5 and 6, Tables 4, 5).

Furthermore, in the sixth step of the bibliometric analysis, a comprehensive exploration of recurrent keywords was undertaken, culminating in the construction of a map illustrating the co-occurrence of keywords related to the field of ESG in the banking sector. The development of the keyword co-occurrence map was achieved

using VOSviewer software version 1.6.19 (Table 3). The co-occurrence analysis made it possible to identify elements that co-occur in scientific publications, and then to identify thematic clusters [107]. To ensure precision and relevance, an additional thesaurus file [57, 126] was prepared to eliminate duplicate terms with similar meanings (e.g. Corporate Social Responsibility and CSR) or terms not pertinent to the study (e.g. article, state, research, and analysis). This file was formulated through keyword analysis and a thorough review of the collection of publications. The result of this analysis facilitated the identification of thematic clusters representing primary and emerging research directions. The detailed results of the analysis are presented in Sect. "Methodology" (Fig. 5). Based on the results of the analysis in step 7, a network analysis of influential keywords was conducted. This analysis identified five sub-areas (thematic clusters) of ESG in the banking sector (Table 6).

After completing the first stage of the study using bibliometric analysis, the third stage, which is a systematic literature review, was initiated. As part of this stage, 869 articles (abstracts or full versions) were subjected to detailed qualitative thematic analyses. The qualitative analysis aimed to determine banking risk clusters affected by ESG and climate-related risks. It also facilitated the preparation of future research questions on the subject. The detailed results of the analysis are presented in the next section (Tables 7, 8).

Table 3 Objectives, methods and tools of the study

Objectives	Methods	Tool
Identification of publication dynamics by year and type of publication	analysis of data from individual and merged Scopus and WoS databases	MS Office Excel 19
Identification of the most productive authors, institutions, countries, journals	analysis of data from the merged Scopus and WoS databases	MS Office Excel 19
Determining the thematic structure of keywords	co-citation analysis of authors	VOSviewer version 1.6.19
	bibliographic coupling of countries	VOSviewer version 1.6.19
	co-occurrence analysis of author keywords	VOSviewer version 1.6.19
Identification of research sub-areas	network analysis of influential keywords	VOSviewer version 1.6.19

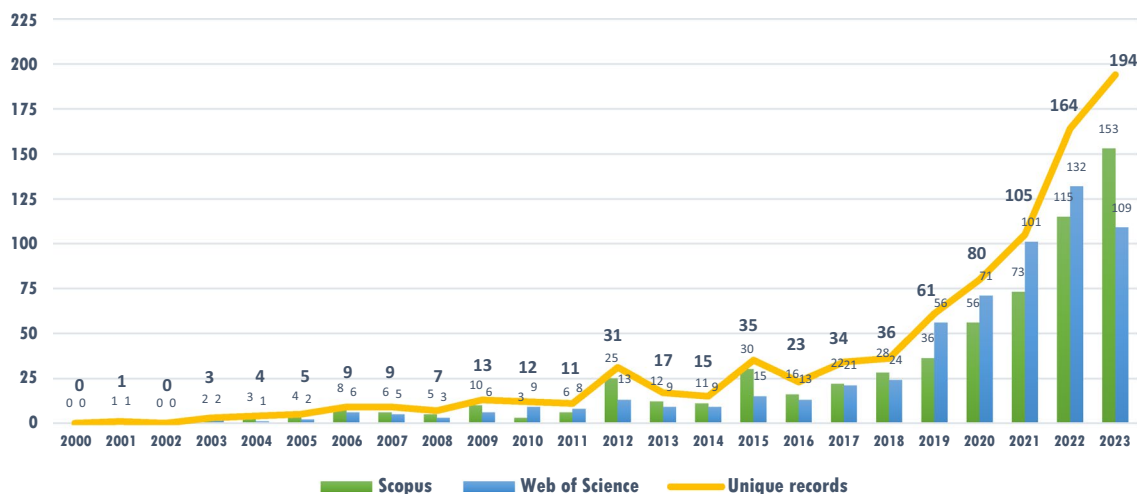


Fig. 3 Number of publications in the field of ESG in the banking sector in the Scopus and Web of Science databases (indexed from January 2000 to August 2023). *Source* own elaboration based on the Scopus and Web of Science databases

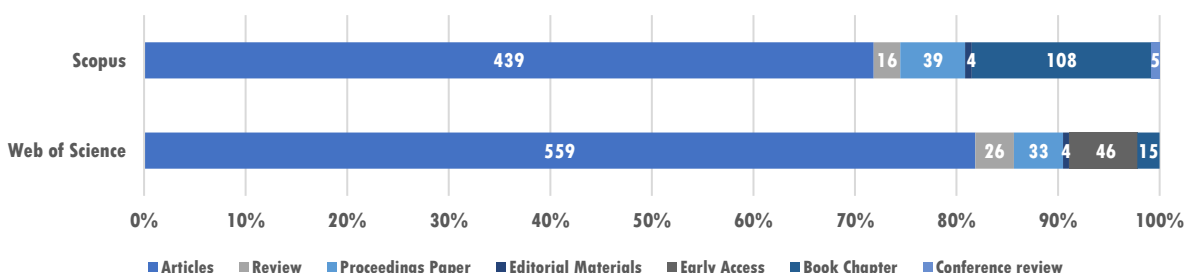


Fig. 4 Type of documents of publications in the field of ESG in the banking sector in the Scopus and Web of Science databases (indexed from January 2010 to August 2023). *Source* own elaboration based on the Scopus and Web of Science databases

Research results

Between 2000 and August 2023, a notable volume of publications surfaced in both databases (Fig. 3). Interest in the subject commenced an accelerated ascent of around 2016. The cumulative count of citations for publications registered within the Scopus database reached 7825, while in the Web of Science it reached 8636. There were 207 publications in Scopus and 159 in the Web of Science that did not receive citations.

In both the Web of Science and Scopus databases, the predominant form of publications was articles (constituting 90.8% and 70.2%, respectively). Additionally, book chapters constituted a substantial proportion, amounting to 17.3% within Scopus. Conference papers, reviews, editorials and early access materials formed a smaller segment. The distribution of publications based on document types is visualised in Fig. 4.

The most productive authors in this context were identified as Iannuzzi, with 8 publications, and Bualay, with 7 publications. In contrast, 6 articles each on ESG in banks were published by Galleta, Birindelli and

Seyfang (Table 4). An analysis of the authors’ co-citations shows that the works of the following researchers in particular are of greatest mutual interest (with the highest number of links): Monasterolo, Battiston, Serafeim, Scholtens, Dafermos. It can be concluded that these authors have the greatest influence on the development of research in ESG topics in banks. A map of 20 authors with the highest number of co-citations is presented in Fig. 5.

In terms of geographical distribution, the majority of publications originate from the United Kingdom (111), followed by the United States (94) and Italy (80). Considering author affiliations, Brunel University London, University of London, and Università degli studi di Bari Aldo Moro produced the highest number of publications (each with 10 publications), (Table 4). The countries with the strongest bibliographic coupling are Italy, the United Kingdom, the United States and China. Among these countries the largest number of references on the topic of ESG in banks can be observed. A map of 20 countries with the highest bibliographic coupling is shown in Fig. 6.

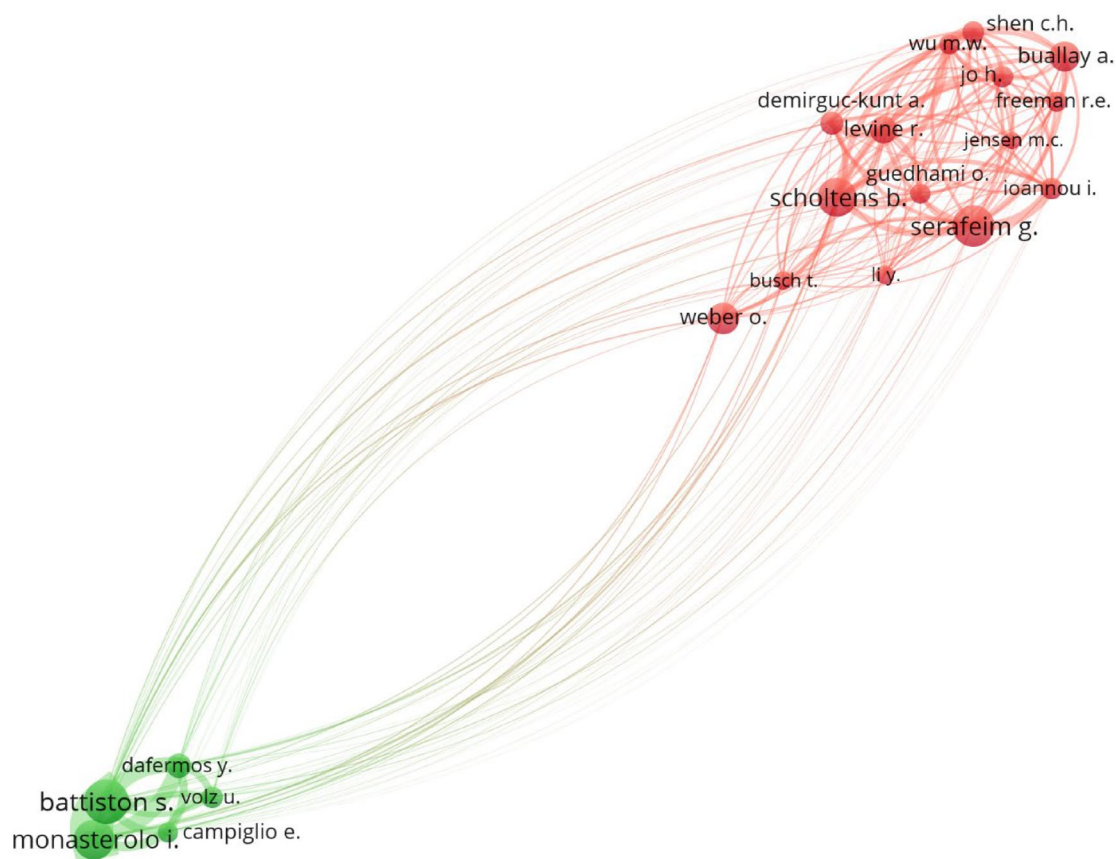


Fig. 5 Map of co-citation of authors in the field of ESG in the banking sector. *Source* Authors' own elaboration using VOSviewer software

Regarding the ranking of the most productive journals, Sustainability (Switzerland) secured the top position with 61 publications, followed by Corporate Social Responsibility and Environmental Management with 19 publications, and CSR Sustainability Ethics and Governance Environmental Science and Pollution Research, each with 14 publications. A comprehensive list of the most productive authors, institutions, countries and journals in the realm of ESG within the banking sector is presented in Table 4.

The cumulative citation count for publications focusing on ESG in the banking sector amounted to 8636 in the Web of Science and 7825 in Scopus. Among the ten most cited works, two were published in the journal 'Corporate Social Responsibility and Environmental Management'. Notably, four of these top-cited works originated from the year 2017.

The most cited publication, with 532 citations in Scopus and 467 in the Web of Science, was the 2013 work by Claessens and Yurtoglu, entitled 'Corporate Governance in Emerging Markets: A Survey'. Following this, the article by Ali et al. in 6, entitled 'Determinants of Corporate Social Responsibility (CSR) Disclosure in Developed

and Developing Countries: A Literature Review', and the 2004 article by Robertson, entitled 'The Neoliberalization of Ecosystem Services: Wetland Mitigation Banking and Problems in Environmental Governance', were prominent. The total citation counts for these articles were somewhat lower than for the first, with Scopus counts of 464 and 401, and Web of Science counts of 417 and 345, respectively (Table 5).

In the context of the bibliometric analysis, keywords recurrently linked to the topic of ESG in the banking sector were extracted. The analytical process utilised the VOSviewer software. The resulting compilation comprised 243 words or phrases that appeared at least five times in the keywords of the 869 articles examined.

This collection also encompassed words synonymous with abbreviations or repetitions (for example, 'Corporate Social Responsibility', 'CSR', 'human', 'humans'), as well as terms not pertinent to the study and those not inherently linked to the central theme of analysis (such as 'article', 'analysis', 'state', 'conceptual framework', 'research'). A thesaurus file was curated and applied to systematise the set of words. The primary search keywords 'bank' and 'ESG' were deliberately excluded from

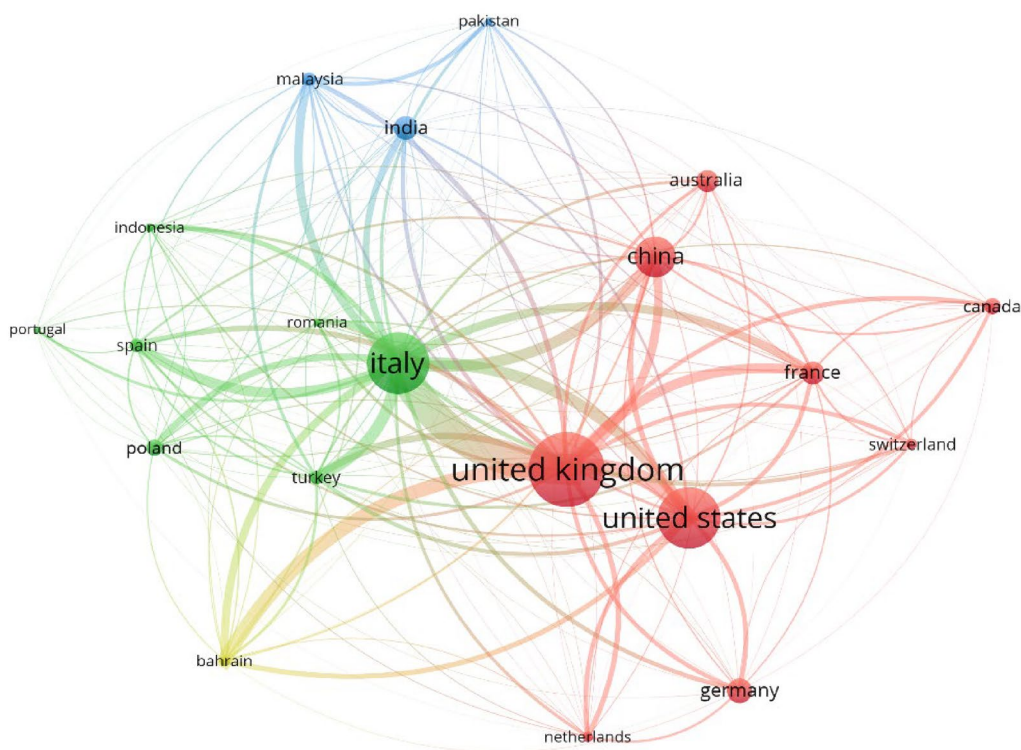


Fig. 6 Map of bibliographic coupling of countries in the field of ESG in the banking sector. *Source* Authors' own elaboration using VOSviewer software

this compilation. The nomenclature of terms and abbreviations sharing similar meanings was standardised; while, terms unrelated to the analysis were discarded. The refined collection ultimately consisted of 118 keywords. The most prevalent terms and their interconnections are visualised in Fig. 7.

Among the most prevalent keywords associated with ESG in the banking sector are: governance (167), CSR (147), sustainability (124), climate change (105), financial performance (57), climate risk (43), finance (34), environmental disclosure (34), risk (32), commercial banks (32), investment (31), World Bank (30), environmental performance (30), ownership (29), risk management (28), environmental (27), sustainability reporting (26), financial stability (25), stakeholders (24), firms (22), developing countries (22), energy (20). The size of the circle in Fig. 7 corresponds to the frequency of occurrence of a given keyword. It is also noteworthy that these terms exhibit the most connections to other terms. An in-depth analysis of the most frequently occurring keywords enabled the identification of five thematic clusters (Table 6).

Figure 8 shows a map of how the themes of ESG and climate risk in commercial banks (keywords) have evolved over the years.

Discussion

The bibliometric study carried out confirms the diversity of concepts related to bank sustainability. Quite often such terms as ESG banking, sustainable banking, green banking, CSR, ethical banking are used interchangeably. ESG and climate-related risks are not treated as separate categories, but as the so-called cross-cutting risks, which, to some extent and through different transmission channels, affect traditional bank risks, such as credit risk, market risk, operational risk, liquidity risk or reputation risk. The results of the study make it possible to identify 11 areas of bank risk influenced by ESG risk and 10 types of bank risk impacted by climate-related risk (Table 7).

The conducted literature review allows to conclude that research on the relationship between ESG risks and traditional banking risks, as well as the impact of climate-related risks on traditional banking risks, can be divided into 3 main groups: quantitative, qualitative and mixed studies. Within the former, these include: GMM techniques [65, 108], regression models [27, 28, 74, 75, 85, 129, 134], difference-in-difference estimations [43], value at risk models (Capelli et al, 2024), risk valuation methods [113] and stress testing [130]. Qualitative research includes: interviews [106], case studies [84, 137], surveys [5] and economic law analysis aiming at integrating

Table 4 Most productive authors, organisations, countries and journals. *Source* own elaboration based on the Scopus and Web of Science databases

No	Item	NP	[%]
<i>Authors</i>			
1	Iannuzzi, A.P	8	0.9
2	Buallay, A	7	0.8
3	Galleta, S	6	0.7
4	Birindelli, G	6	0.7
5	Seyfang, G	6	0.7
6	Aras, G	5	0.6
7	Battiston, S	5	0.6
8	Monasterolo, I	5	0.6
9	Scholtens, B	5	0.6
<i>Countries</i>			
1	United Kingdom	111	12.8
2	United States	94	10.8
3	Italy	80	9.2
4	China	66	7.6
5	France	35	4.0
6	Spain	34	3.9
7	Germany	32	3.7
8	Malaysia	32	3.7
9	Australia	31	3.6
10	India	27	3.1
11	Canada	26	3.0
12	Poland	21	2.4
<i>Organisations</i>			
1	Brunel University London	10	1.2
2	University of London	10	1.2
3	Università degli studi di Bari Aldo Moro	10	1.2
4	Bucharest University of Economic Studies	9	1.0
5	The Australian National University	8	0.9
6	Ahlia University Bahrain	8	0.9
7	Sapienza Università di Roma	8	0.9
8	The World Bank, USA	8	0.9
9	University of Oxford	7	0.8
10	International Islamic University Malaysia	7	0.8
11	Universite de Sfax	7	0.8
<i>Journals</i>			
1	Sustainability (Switzerland)	61	7.0
2	Corporate Social Responsibility and Environmental Management	19	2.2
3	CSR Sustainability Ethics and Governance	14	1.6
4	Environmental Science and Pollution Research	14	1.6
5	Business Strategy and the Environment	12	1.4
6	Finance Research Letters	11	1.3
7	Journal of Cleaner Production	10	1.2
8	Climate Policy	9	1.0
9	International Review of Financial Analysis	9	1.0
10	Corporate Governance the International Journal of Business in Society	7	0.8
11	Journal of Financial Stability	7	0.8

NP — number of publications, [%] — percentage of the total 869 publications

Table 5 Most cited articles in the field of ESG in the banking sector. Source own elaboration based on the Scopus and Web of Science databases

No	Authors	Article title	Journal	citations	
				Scopus	WoS
1	Claessens, S., Yurtoglu, B.B. 38	Corporate governance in emerging markets: A survey	Emerging Markets Review, 15, pp. 1–33	532	467
2	Ali, W., Frynas, J. G., Mahmood, Z. 6	Determinants of Corporate Social Responsibility (CSR) Disclosure in Developed and Developing Countries: A Literature Review	Corporate Social Responsibility and Environmental Management, 24(4), pp. 273–294	464	417
3	Robertson, M. M. 110	The neoliberalization of ecosystem services: wetland mitigation banking and problems in environmental governance	Geoforum 35(3), pp. 361–373	401	345
4	McAfee, K., Shapiro, E. N. 90	Payments for Ecosystem Services in Mexico: Nature, Neoliberalism, Social Movements, and the State	Annals of the Association of American Geographers, 100(3), pp. 579–599	332	301
5	Khan, M. H. U. Z. 70	The effect of corporate governance elements on corporate social responsibility (CSR) reporting: Empirical evidence from private commercial banks of Bangladesh	International Journal of Law and Management, 52(2), pp. 82–109	331	281
6	Battiston, S., Mandel, A., Monasterolo, I., Schütze, F., Visentin, G. 12	A climate stress test of the financial system	Nature Climate Change, 7(4), pp. 283–288	285	264
7	Cucari, N., De Falco, S. E., Orlando, B. 40	Diversity of Board of Directors and Environmental Social Governance: Evidence from Italian Listed Companies	Corporate Social Responsibility and Environmental Management, 25 (3), pp. 250–266	272	244
8	Jizi, M. 67	The Influence of Board Composition on Sustainable Development Disclosure	Business Strategy and the Environment, 26(5), pp. 640–655	224	202
9	Hasan, I., Hoi, C. K., Wu, Q., Zhang, H. 60	Social Capital and Debt Contracting: Evidence from Bank Loans and Public Bonds	Journal of Financial and Quantitative Analysis, 52(3), pp. 1017–1047	214	201
10	Xu, X., Li, J. 136	Asymmetric impacts of the policy and development of green credit on the debt financing cost and maturity of different types of enterprises in China	Journal of Cleaner Production, 264, 121,574	173	156

Table 6 Sub-areas of ESG in banking sector research. *Source* own elaboration

No	Cluster name	Words
1	Sustainable development (red)	sustainable, climate change, climate risk, finance, risk, risk management, financial stability, firms, environmental economics, financial institutions, financial system, pandemic, green finance, ESG rating, CO ₂ emissions, commerce, environmental risk, capital, central bank, climate finance, credit risk, accountability, green banking, sustainability performance, adaptive management, credit, debt, green economy, social performance, socially responsible investment, emerging markets, ESG risk, insurance, renewable energy, bank lending, crisis, emission control, fintech, investors
2	Global aspects (green)	investment, World Bank, developing countries, energy, environmental management, economic development, policy making, human, developing world, financial markets, SDGs, government, environmental protection, neoliberalism, institutions, poverty, future prospect, healthcare, agriculture, greenhouse gases emission, human rights, environmental impact assessment, global governance, urbanisation, drought, globalisation, political ecology, rivers, social impact, water management
3	Social responsibility (blue)	CSR, financial performance, environmental disclosure, commercial banks, environmental performance, ownership, board of directors, ESG performance, board diversity, firm performance, gender diversity, Islamic banks, board composition, social responsibility disclosure, bank performance, women, earnings management, voluntary disclosure, diversity, firm value, institutional investors, gender, listed companies, stakeholder engagement, CEO duality, environmental responsibility
4	Governance aspects (yellow)	Governance, sustainability reporting, corporate sustainability, companies, markets, business, legitimacy, ESG disclosure, law, developed countries, economy, integrated reporting
5	Ethics (violet)	Stakeholder, financial crisis, social, environmental, performance assessment, valuation, ethics, financial services, financial risk, business ethics, corporate strategy

systems for managing different risks in a bank (Brindelli et al. [18, 18]). On the other hand, mixed methods, or those that cannot be attributed to either quantitative or qualitative methods, include: Fuzzy Cognitive Maps (Zioło et al.), linear ordering [17], text mining [88] and Supervised Machine Learning (Bonacorsi, 23).

The analysis has shown that in most cases the publications of a descriptive nature predominate. The authors focus primarily on the issue of implementing processes that take into account ESG and climate-related risk in banks' business models, present case studies, and focus on proposals for recommendations and regulations that should be introduced by banking supervisory institutions. A relatively large part of the articles is also devoted to the implementation of the best practices in the banking sector and to the risks arising from the implementation of green products into the banks' offerings. Thus, we can confirm the conclusions of Riegler [109], who states that: 'the concept of sustainable banking is descriptive in nature and that generally applicable, clear-cut criteria are absent. Academics are working on various models for assessing and measuring sustainable banking, but a standard will only be achieved through legal regulatory requirements.'

Also the area of efforts to develop uniform reporting rules for ESG initiatives does not seem to be sufficiently explored. Inconsistent and fragmented reporting—even within the same group of companies—results in a lack of commonly used indicators for assessing and managing ESG risks; and thus, it is not possible to compare performance measurement in this area. ESG scorings,

whose low cross-correlation is reported by Bernardelli et al. [16], among others, are of no help here. The need to estimate to what extent ESG risk or climate-related risk affects traditional banking risks is very difficult. Authors—particularly from developing countries—quite often point out that some commercial banks do not publish information on sustainability measures or do not include them on their own websites. This may indicate that bank managements, oriented towards the primary objective of contemporary banks, i.e. the creation of shareholder value, underestimate the importance of the impact of non-financial factors on this value. Moreover, some of the information is provided with a rather long delay.

Some bank activities, described in the reports as serving the sustainability objectives, can hardly be explicitly recognised as such when they primarily contribute to improving the banks' financial performance. They include *inter alia*: (i) adherence to a basic code of principles of good banking practice and a code of professional ethics towards all stakeholders, (ii) the prevention of 'money laundering' and the use of industry exclusions whose activities cannot be credited because they involve too much risk, (iii) the creation of equal opportunities for employees in their careers and opportunities to develop and acquire new qualifications and skills, (iv) the absence of behaviours and attitudes indicative of discrimination against others on the basis of age, gender, race, religious beliefs, political convictions or nationality, (v) the rationalisation of costs related to the consumption of utilities (electricity,

Table 7 Banking risk clusters affected by ESG and climate-related risks. *Source* own elaboration

No	Risk	Specification	Studies
<i>Esg risk</i>			
I)	Credit	Probabilities of default (pd) and loss given default (lgd) of exposures within sectors or geographies vulnerable to risk Risks associated with financing entities subject to environmental exemptions and fossil fuels industry Risk of inadequacy of procedures for assessing the creditworthiness of customers in the context of the impact of environmental, social and governance factors	Liu et al. [27, 86][28]) Bernardelli et al. [16], mésonnier [91] Chen et al. [32]
li)	Market	Portfolio and shareholder value risk	Ersoy et al. [49], azmi et al. [10], miralles-quirós et al. [92]
lii)	Failure to meet financial targets	Risk of a negative change in the financial result Risk of reduced operational efficiency	Nizam et al. [103], shakil et al. [116], bātae et al. [11] Veltri et al. [127], forgione et al. [53]
lv)	Default	Liquidity risk Capital adequacy risk	Citterio and king [33, 34, 37], Neisen et al. [97], gonenc and scholtens [56]
v)	Business model	Risk of a lack of product offerings in the field of green products that meet market needs Inconsistent pricing of products and services (e.g. Commissions and credit margins)	Birindelli and palea [21] Mohammad et al. [64, 94]
vi)	Reputational	Risks associated with the negative perception of the entity's image by customers, counterparties, investors, shareholders, supervisors, regulators and the general public Risks associated with the bank's negative impact on the environment through its own operations	Adebah et al. 1 , murè et al. [95], dell'atti, s. Et al.44 Samaniego-medina and giráldez-puig [111], wendt [132]
vii)	Corporate governance	Failure to provide adequate working conditions, discrimination and mobbing, lack of equal opportunities in access to jobs and in remuneration, inadequate approach to employee health and safety management Risks resulting from a sub-optimal organisational and competence structure, lack of dedicated units and positions in the organisational structure, e.g. Chief sustainability officer Lack of mechanisms to promote and monitor the bank's compliance with ethical principles, building an ethical organisational culture and adherence to the principles of social responsibility Risk of sub-optimal structure of the bank's board structure Lack of transparency and accountability	Borbor et al. [24] Dicuonzo et al. [46] Shen and zheng [117] Birindelli et al. [20], cucari et al. [40], jizi, m. 67 Heimstädt and dobusch [61], srivastava [120], wali et al. [128]
viii)	Reporting	Risks arising from the lack, scope, low reliability and timeliness of management information and inadequately structured reporting processes	Gunawan et al. [58], danila et al. [42]
ix)	Systematic	Risks of disruption to the financial system due to banks' inability to meet their obligations	Aevoae et al. [2], li et al. [82], lupu et al. [87]
x)	Regulatory, incl. Compliance	Risks related to changes in laws and regulations, compliance with them and enforceability of contracts and related liability	Bruno and lagasio [29], cho et al. [35]
xi)	Model	Flaws in risk estimation model assumptions, interpretation of results and model validation	Agosto et al. [3], bax et al. [13]
<i>Climate-related risk</i>			
I)	Credit	Probabilities of default (pd) and loss given default (lgd) of exposures within sectors or geographies vulnerable to risk Risk that climate issues are not taken into account in creditworthiness assessment procedures	Aslan et al. [9] Aguais and forest [4]
li)	Failure to meet financial targets	Risk of negative earnings developments	[18, 19])

Table 7 (continued)

No	Risk	Specification	Studies
lii)	Liquidity	Risk of a run on banks in climate-affected areas	Lang et al. [79], lee et al. [80]
lv)	Default	Liquidity risk	Nguyen et al. [99]
V)	Business model	Risk of not taking climate risk into account in the bank's asset and liability management	Cosma et al. [39], toma and stefanelli [122], feridun and güngör [51]
		Inconsistent pricing policies for products and services (e.g. Commissions and credit margins)	Javadi and masum [66]
Vi)	Reputational	Risk related to the negative perception of the entity's image by customers, counterparties, investors, shareholders, supervisors, regulators and the public	Choi et al. [36]
Vii)	Corporate governance	Risk resulting from a sub-optimal organisational and competence structure, lack of dedicated units and positions in the organisational structure	Light and skinner [83]
Viii)	Systematic	Risk of disruption to the financial system due to banks' inability to meet their obligations	Wu et al. [135], nieto [101]
lx)	Regulatory, incl. Compliance	Risks related to changes in laws and regulations, compliance with them and enforceability of contracts and related liability	Hess [62]
X)	Model	Flaws in assumptions of risk estimation models, interpretation of results and validation of models, stress tests, etc.	Battiston et al. [12]

water, heat, natural gas and others), use of typical office supplies (paper, toner, etc.) and generation of municipal waste and air pollution, (vi) segregation of waste, etc.

An analysis of the sustainable development activities carried out by commercial banks leads to the conclusion that it is very difficult to separate the actual activity carried out in this area from a carefully thought-out and consistently applied marketing and promotional strategy. This is because many sponsorship activities are primarily aimed at highlighting the bank's brand.

Another conclusion from the bibliometric analysis is the multitude of studies emphasising the prevalence of highlighting ESG areas in which the bank has a track record or presents itself favourably compared to its competitors, while ignoring unfavourable results for the bank in other ESG areas. This appears to be a kind of greenwashing, a marketing strategy of misusing environmental terms, overstating environmental benefits or hiding negative environmental impacts.

Another stream of research noted is the publications on Islamic banks. According to the authors of the analysed studies, these banks are more sensitive to sustainability due to their core operating principles. Islamic banks are assumed to act ethically towards a range of stakeholders, including investors, clients, government authorities and the general public, as prescribed by Islamic (Shariah) jurisprudence. One of the most important pillars of Shariah is the protection of the interests of all parties, rather than the conventional goal setting of maximising financial performance. This principle is a core value of stakeholder theory and the

derived concept of corporate social responsibility [30, 73].

The results of the systematic literature review provide an opportunity to discuss the current state of research and the challenges facing approaches to banking risk. In summary, the evolution of the academic discussion as seen through the lens of this bibliometric study diagnoses potential research gaps to be addressed in the future as well as methods that can be applied to answer the research questions (Table 8).

Conclusions

The conclusions drawn as a result of the analysis carried out in this study allow, on the one hand, the identification of the most important research streams related to ESG and climate-related risks in contemporary banking, and, on the other hand, the indication of 11 clusters of traditional banking risks influenced by ESG risks and 10 clusters impacted by climate-related risks. The proposed solutions can be applied in a wide range of ways, both as a decision support tool for future business models and risk management procedures in banks themselves, and to provide additional knowledge on the topic for other stakeholders, including bank supervisors and investors. Indeed, existing literature reviews on ESG issues did not provide a complete picture of the situation regarding the nature of the risks discussed. Comprehensive insights into the theories and research methods used should also support regulators in developing risk-reducing regulations and proactive risk monitoring and management models.

Table 8 Future research questions. *Source* own elaboration

Type	Risk	Future research questions	Research method
Esg risk	Credit	How can esg criteria taken into account in the credit assessment process influence credit rationing and pricing (margins, commissions)?	Rvm
		What is the level of fossil fuels financing by banks, does it change over time and for what reasons, and can patterns in the characteristics of banks financing fossil fuels be established?	S, lo
		What is the impact of the need for borrowers to adapt their business to esg (transition risk) requirements on their creditworthiness?	St, eal
		How can the decline in assets value resulting from esg risk taken as collateral (stranded assets) be measured?	St, rvm
	Liquidity	What is the impact of esg risk on bank liquidity, availability and cost of funding?	R, gmm, did
	Operational	What is the impact of esg risk, especially physical risk, on operational risk?	R, gmm, did
	Capital adequacy	Should esg risk be considered in the capital adequacy calculation methodology and based on which algorithm?	Eal, st
	Regulatory	Should sanctions for fossil fuels or greenwashing be set, and on the basis of which principles?	Eal
	Reporting	In which areas is harmonisation of esg risk reporting necessary?	Eal, s, i
		Should the same reporting standards be applied to all types of banks (sifi's, commercial banks, investment banks, cooperative banks, banks recognised as community banks, such as grameen bank, banks with a statutory or regulatory environmental focus)?	Eal, s, i
Model	How can the veracity of esg information and data (greenwashing) be verified?	Tm	
	How to take esg risks into account in risk estimation models, stress tests, etc. ?	Rvm	
	Is there any credibility in research that bases its methodology solely on keyword searches of bank reports and their websites?		
Climate-related risk	Credit	How does climate risk affect the financial performance of borrowers (e.g. Through disruptions to production and supply chains, increased operating costs or changes in consumer behaviour and preferences)?	St, i, s
		How can a decrease in the value of assets taken as collateral due to climate risk be measured?	Var
	Market	What is the risk of loss of bank and shareholder value as a result of the materialisation of climate risk?	St, ml, var, r, es
		What is the risk of loss of asset value as a result of the materialisation of climate risk?	St, ml, var
	Operational	How should the risk of the bank not being able to conduct its business or incurring losses as a result of extreme events such as earthquakes, hurricanes, floods, etc., the risk of disruption to the bank's business as a result of disruption to it and telecommunications systems be quantified?	Rvm
	Model	How to include climate risk in risk estimation models, stress tests, etc.?	I, s

GMM, GMM technique; *R*, regression model; *DiD*, difference-in-difference; *ML*, machine learning; *ES*, event study; *Var*, value at risk; *I*, in-depth interview; *S*, survey; *ST*, stress testing; *EAL*, economic analysis of law; *LO*, linear ordering; *TM*, text mining; *RVM*, risk valuation methods

The results obtained may therefore be useful for at least three groups of stakeholders. The first is academics, for whom this bibliometric analysis and systematisation of the literature on ESG and climate-related risks in banking may be useful at the stage of selecting the research problem and assigning the literature review to it, in order to ultimately define the research gap and formulate original research hypotheses. For this group of stakeholders, the methodology of the present study may also be useful for an in-depth and structured literature review. The second group of recipients of the results achieved in this paper are commercial bank authorities (management and supervisory boards). Structuring the results of academic research published in reputable academic journals and

establishing the linkages of ESG and climate-related risks with traditional banking risks can support decision-making processes and provide an opportunity to build not only a risk map, but also scenarios based on interactions between different risks.

The recent financial crises (especially the subprime crisis) have revealed the relevance of the macroprudential approach, systemic risk and stress testing in the process of constructing the regulatory architecture; hence, it remains crucial to reveal the mechanisms linking the different types of risk. The conclusions of this study are original and significant in that the authors do not refer to a specific geographical area, group of analysed entities, method and time period, but, on the basis of, among

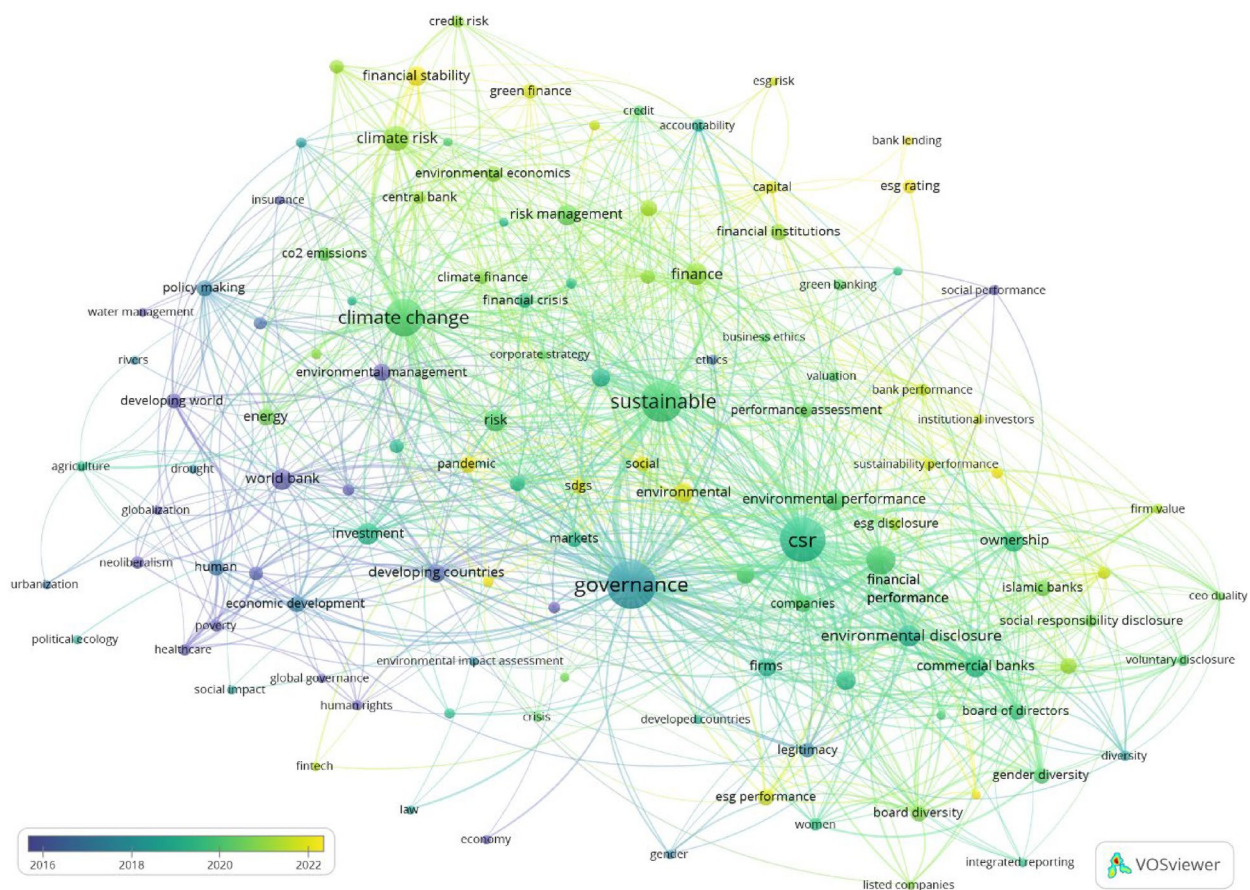


Fig. 8 Map in the field of ESG in the banking sector over the years 2000-08.2023. *Source* Authors' own elaboration using VOSviewer software

migrant groups within the population pie,' as Sikdar and Kumar [119] suggest.

The conducted analysis indeed has some limitations, which include, first and foremost, the methodology relying only on the Scopus and Web of Science databases. Although this is one of the broadest samples used so far in bibliometric analyses, covering the most highly cited journals, it does not include a number of other studies that address the issue at hand. It therefore seems reasonable to repeat this study in the future based on an expanded database.

Abbreviations

- ESG Environmental, Social and Governance
- CSR Corporate Social Responsibility
- SMS Sustainability Measurement System
- SME Medium Size Enterprise

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Availability of data and materials

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where the data supporting their findings can be found. If you do not wish to share your data, please state that data will not be shared, and state the reason.

Declarations

Ethics approval and consent to participate

Manuscripts reporting studies involving human participants, human data or human tissue must: include a statement on ethics approval and consent (even where the need for approval was waived) include the name of the ethics committee that approved the study and the committee's reference number if appropriate. Studies involving animals must include a statement on ethics approval. Studies involving plants must include a statement specifying the local, national or international guidelines and legislation and the required or appropriate permissions and/or licences for the study. If your manuscript does not report on or involve any animals, humans, human data, human tissue or plants, please state "Not applicable" in this section.

Consent for publication

If your manuscript contains any individual person's data in any form, consent to publish must be obtained from that person, or in the case of children, their parent or legal guardian. All presentations of case reports must have consent to publish. If your manuscript does not contain any individual persons data, please state "Not applicable" in this section.

Competing interests

All financial and non-financial competing interests must be declared in this section. See our editorial policies for a full explanation of competing interests. If you are unsure whether you or any of your co-authors have a competing interest please contact the editorial office.

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