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Evaluating climate risk in banking: A bibliometric analysis

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ABSTRACT

This review presents and explores the research priorities and evolutionary trends in banking-related climate risk research. It identifies four key areas of study illustrating the different perspectives comprising the banking-related climate risk research landscape, including: (i) ESG, green financing and climate risks, (ii) financial intermediation and risk management, (iii) sustainable development and economic transformation and (iv) monetary policy and financial stability. The empirical evidence indicates a rising and relatively recent scholarly engagement with climate-related risks and their consequences for the banking industry, although the literature is still in its formative stage. Overall, the analysis offers a broad overview of the academic terrain, emphasizing both consolidated insights and persisting gaps in knowledge concerning the ways in which climate risks are reshaping banking practices and financial stability.

1. Introduction

Climate change represents a global challenge, characterised by its rapid onset and the uncertainty it engenders. It has become a major concern and challenge for financial regulators. In this sense, climate change has been increasingly recognised as a major source of risk for the banking system. Physical, and transitional risks are transmitted to the banking sector through traditional financial risks, including credit, market, liquidity, operational, and reputational risks (Chenet et al., 2021). As these risks intensify, they pose a direct threat to financial stability, prompting central banks and financial regulators to develop policies for mitigating climate change impacts and adapting to them (NGFS, 2019). These policies not only safeguard the resilience of banking institutions but also ensure the stability of the broader financial system in the face of climate-related shocks. Additionally, banks with increased exposure to climate risks demonstrate weaker balance sheets due to the intensification of traditional risks raising the difficulty and cost of banks' access to finance, as investors demand a higher return due to these risks (Azmi et al., 2021) and clients are more reluctant to deposit their funds at institutions with compromised reputations (Paulet et al., 2015). Equally, the banking sector plays a crucial role in the fight against climate change, as it can channel investment flows towards clean activities, mobilise resources, or create financial products that promote sustainability (Spinaci, 2021).

The literature has placed strong emphasis on financial environmental sustainability, reflecting the increasing international efforts to address climate change and the critical role of the banking sector in financing such initiatives. In this context, it has evolved from a traditional perspective that focuses on environmental, social, and governance (ESG) dimensions to a more specific approach in which environmental impact becomes the primary focus. This evolution has led to new concepts within the financial system, such as green finance and climate finance. While these concepts differ slightly, both fundamentally refer to the development and implementation of financial instruments and mechanisms for addressing climate change (Zhang et al., 2019). However, the increasing relevance of green

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and climate finance cannot be understood in isolation from the growing recognition of climate-related risks permeating every aspect of the banking system. Thus, banks have become increasingly concerned with assessing and understanding the exposure of their activities to these risks. This growing awareness has driven a rapid expansion of the literature examining the intersection between climate risks and the banking sector.

In this context, several studies have employed bibliometric approaches to examine the intersection of climate change and finance, with much research focusing on ESG, sustainability, and green finance, while more recent work addresses the specific domain of climate finance (Tao et al., 2022; Kashi and Shah, 2023; Carè & Weber, 2023). Concurrently, literature has explored the impact of climate-related risks on the broader financial system (Zhou et al., 2023; Mngadi and Twinomurinzi, 2023; Suciati, 2025). In contrast, studies concentrating exclusively on the banking sector investigate sustainable banking or green finance initiatives (Akomea-Frimpong et al., 2022; Aracil et al., 2021). Analyses of climate-related risks to banks remain partial, often focusing on specific risk categories (De Bandt et al., 2024) or on monetary authorities, such as central banks (Carè et al., 2024; Omeir and Vasiliauskaite, 2025), without encompassing the full spectrum of risks across the banking system.

This study aims to fill this gap by conducting a comprehensive analysis of the manifestation of climate-related risks within the banking sector. The study considers literature on the topic published between January 2010 and December 2024, combining bibliometric citation and content analysis (Patel et al., 2022). We establish a group of clusters to synthesize current knowledge and identify existing and future trends in the literature (Zhang et al., 2019).

Recent research emphasises the growing importance of climate-related risks within the banking sector. Employing a bibliometric analysis of 236 publications from 2010 to 2024, this study identifies key trends, thematic clusters, and gaps in the literature. The findings reveal that, although research is still emerging and largely concentrated in Europe and China, climate risks are gaining prominence in leading finance journals, with data fragmentation—particularly for smaller banks—remaining a critical challenge. Four principal thematic streams are identified: the progression from ESG to green and climate finance, emphasizing the development of financial instruments such as green bonds to mitigate climate-related risks; the microeconomic effects of climate change on banks' operations, credit quality, and risk management; the macroeconomic impacts on banking systems and the wider economy; and the role of central banks in safeguarding financial stability and developing monetary policies to address climate change. Collectively, the results highlight the need to integrate climate considerations into banking strategies, regulatory frameworks, and risk management practices to strengthen resilience and foster sustainable development.

The remainder of this paper is organised as follows: Section 2 introduces the theoretical background. Section 3 outlines the methodology employed, detailing the process of data collection and its treatment. Section 4 presents the empirical analysis and results. Section 5 presents future research questions. Lastly, Section 6 concludes the study.

2. Theoretical background

Climate change is a significant concern and a major challenge for the banking sector (Chalabai–Jabado and Ziane, 2024) and is a source of risk that causes serious economic losses and affects the stability of financial markets and banking systems (Battiston et al., 2021). According to the World Economic Forum's 2025 Global Risk Report, extreme weather events are considered the most significant global threat over the next decade. In the long term, the systemic challenges posed by this risk may surpass those experienced during the 2008–2009 Global Financial Crisis (Chiavuzzo, 2018).

In this regard, following the 2015 Paris Agreement, the banking sector has become increasingly involved in climate change discourse (Battiston et al., 2021), as it plays a pivotal role in channelling funds towards climate change mitigation and adaptation (Caby et al., 2022; Cregan et al., 2024). Furthermore, as climate change poses a significant threat to banking system stability (Zhang et al., 2022; Sahbir et al., 2024), it becomes relevant to the mandates of central banks and financial supervisors. This acknowledgement is the primary catalyst for the establishment of the Network for Greening the Financial System (NGFS), an international coalition comprising central banks, financial supervisors, and researchers which focuses on the adaptation of financial policy to address the risks posed by climate change and the transition to a low-carbon economy (NGFS, 2019).

Climate change poses risks to the banking sector that can be categorised into physical and transition risks (Carney, 2015). Physical risks include gradual changes in weather patterns and climate variability such as erosion or permafrost thaw (named "chronic"), and extreme weather events such as floods, heatwaves, and earthquakes (named "acute"). They can severely affect the economy, resulting in substantial financial losses. Transitional risks include all possible situations in line with a low-carbon pathway; they can be categorised according to i) climate regulation or policies, ii) changes in technologies, or iii) market perceptions. In this respect, climate change is a notable component of traditional financial risks, such as credit, market, liquidity, operational, or reputational risk, rather than being treated as a separate and distinct risk category (Beard et al., 2021; Basel Committee on Banking Supervision, 2021; Chenet et al., 2021). Fig. 1 categorises the main physical and transitional climate risks, detailing how each is transmitted through transmission channels, as well as their potential effects on the traditional risks inherent within the banking system. It also identifies key sources of variability in climate risk for banking, which encompass geographical heterogeneity, amplifiers, and mitigants. Geographical heterogeneity reflects differences in local exposures, sectoral structures, and institutional settings, implying that similar climate drivers can have markedly different consequences across locations or jurisdictions. Amplifiers denote mechanisms that intensify impacts, such as interactions between physical and transition risks,

propagation through multiple transmission channels, and financial feedback loops. Mitigants, by contrast, attenuate risk through factors such as banks business models, insurance coverage, securitisation, capital markets maturity, and physical resilience (Basel Committee on Banking Supervision, 2021).

From a microeconomic perspective, companies and households must adapt to the consequences of rapidly increasing climate

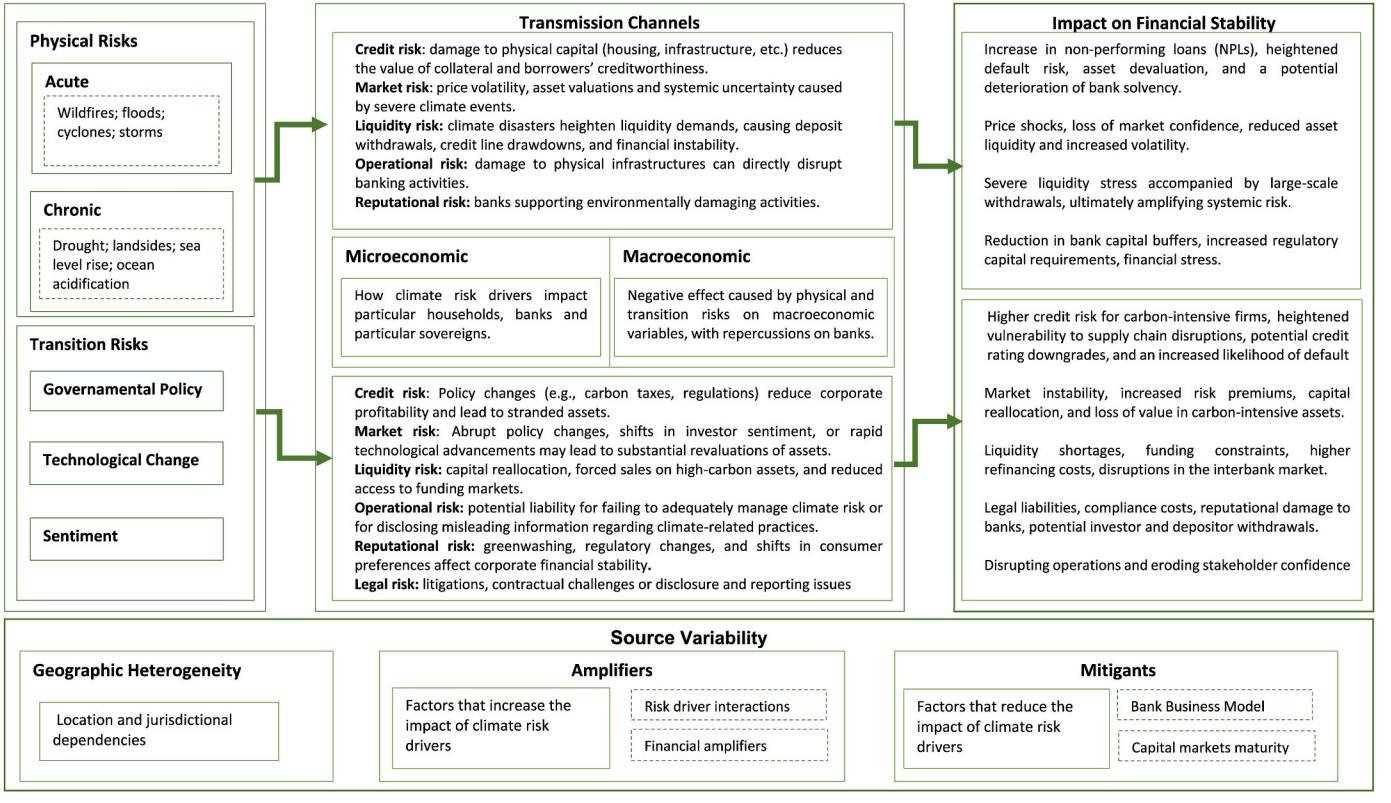

Fig. 1. Climate-related financial risks: Transmission channels and impacts on financial stability.
Source: Authors' elaboration upon the information provided by the Bank for International Settlements (2021).

variability, and banks that finance them must plan to adapt their capital adequacy (Chabot & Bertrand, 2023). Reghezza et al. (2022) observe that firms with high emissions receive less bank credit and must reduce their investments. According to Conlon et al. (2024), climate risk exposure increases banks' individual risk, and banks reduce lending and increase loan loss reserves after experiencing of an unexpected climate shock. Similarly, Li and Wu (2023) report that climate risk has a significant negative effect on bank loan supply, a

Table 1
Previous reviews papers.

Title/authors/years	Research objectives	Methodology (sample, technique, database, period)
Bibliometric review on sustainable finance (Kashi and Shah, 2023)	Identify research themes and gaps in the sustainable finance (SF) literature.	Bibliometric analysis of selected articles from the Scopus database over the period 2001–2021.
A bibliometric analysis of green finance: Current status, development, and future directions (Zhang et al., 2019)	Provide a comprehensive review of the relevant academic literature on the topic, focusing on the body of green, climate and carbon finance literature.	Bibliometric analysis of selected articles from the Web of Science database related to the topic over the period 2001–2018.
Bibliometric analysis of green finance and climate change in post-Paris Agreement era (Muchiri et al., 2022)	Map the evolution of research on green finance and climate change in the post-Paris Agreement period.	Bibliometric analysis of selected articles from the Web of Science database related to the topic over the period 2015–2022.
Environmental finance: an interdisciplinary review (Tao et al., 2022)	Provide a holistic understanding of environmental finance-related topics.	Bibliometric analysis of selected articles from the Web of Science database related to the topic over the period 1971–2019.
Systematic literature review and bibliometric analysis of green finance and renewable energy development (Muhmad et al., 2024)	Examine and discuss publications on green finance initiatives and renewable energy development.	Systematic literature review and bibliometric analysis of 128 selected articles over the period 2010–2023.
Climate finance: What we know and what we should know? (Long et al., 2022)	Summarise the research in climate finance, including a quantitative assessment of performance and a qualitative assessment of the themes.	Bibliometric analysis of selected articles from the Scopus database, related to the topic over the period 1990–2021.
How much finance is in climate finance? A bibliometric review, critiques, and future research directions (Carè & Weber, 2023)	Examine the research topics and evolutionary trends in climate finance research, providing guidance for future research directions.	Bibliometric and content analysis of selected articles from the Scopus database related to the topic over the period 2004–2021.
A review of the financial sector impacts of risks associated with climate change (Zhou et al., 2023)	Provide a systematic review of studies on the impact of climate-related physical risks on the financial sector.	Comprehensive literature review, synthesising a range studies and quantitative modelling research from across the financial sector.
Quantifying causality between climate change and credit risk: a bibliometric study and research (Mngadi and Twinomurinzi, 2023)	Investigate the impact of climate change on credit risk, the financial products influenced by such risk and evaluate the methodologies employed to quantify these effects.	Systematic review from the Web of Science database, related to the topic up until 2022.
Environmental hazards and risk management in the financial sector: A systematic literature review (Breitenstein, 2021)	Investigate how environmental risks influence risk management while also exploring the methodologies employed to evaluate environmental threats.	Systematic literature review of 19 articles over the period 2008–2020.
The role of financial stability in mitigating climate risk: A bibliometric and literature analysis (Suciati, 2025)	Synthesize the literature on climate risk and financial stability.	Systematic review and bibliometric analysis of 174 articles from the Scopus database related to the topic over the period 1988–2024.
Climate risk disclosures and global sustainability initiatives: A conceptual analysis and agenda for future research (Ngo et al., 2022)	Provide a conceptual review of the Taskforce on Climate-Related Financial Disclosures (TCFD).	Conceptual and narrative literature review anchored in TCFD framework.
Sustainable banking: a literature review and integrative framework (Aracil et al., 2021)	Conduct a comprehensive review that organises the literature of sustainable banking as a research field.	Literature review of selected articles from the Web of Science database related to the topic over the period 1995–2019.
A review of studies on green finance of banks, research gaps and future directions (Akomea-Frimpong et al., 2022)	Analyse existing relevant studies on green finance in the context of the banking sector.	Systematic literature review of selected articles from the Scopus database over the period 1990–2019.
A bibliometric analysis of ESG performance in the banking industry: From the current status to future directions (Galletta et al., 2022)	Assess the intellectual development, characteristics of authors, and manuscripts pertaining to ESG in the banking industry,	Bibliometric analysis of 271 articles from the Web of Science database related to the topic over the period 1986–2021.
ESG and climate-related risks versus traditional risks in commercial banking: A bibliometric and thematic review (Korzeb et al., 2024)	Analyse and classify research emphasizing the impact of ESG considerations on the operations of the banking sector.	Bibliometric analysis of 869 articles from the Web of Science and Scopus database related to the topic over the period 2000–2023.
The effects of climate change-related risks on banks: a literature review (De Bandt et al., 2024)	Review recent empirical studies on how climate change affects banks, focusing on credit risk, market risk, and lending standards, with an emphasis on micro-level evidence.	Literature review of selected articles over the period 2010–2023.
Central banks and climate risks: Where we are and where we are going? (Carè et al., 2024)	Examine and evaluate the research priorities and evolving trends in central banking regarding climate risk.	Bibliometric analysis of 82 articles from the Web of Science database related to the topic over the period 2007–2022.
Climate change challenges in central banking: A systematic review with bibliometric and content analysis (Omeir and Vasiliauskaite, 2025)	Identify the key areas of focus for central banks in managing climate-related risks.	Bibliometric and content analysis of 320 articles from the Web of Science database.

Source: Authors' elaboration.

phenomenon that is particularly pronounced for banks located in coastal areas vulnerable to rising sea levels. Choi et al. (2022) observe that banks with higher reputational risk due to environmental concerns experience a decline in deposits. Ginglinger and Moreau (2023) find that firms with greater climate risk exposure reassess their operating costs, which leads them to reduce their leverage while, Lee et al. (2022a) demonstrated that climate sensitivity and exposure have a detrimental effect on overall bank liquidity creation, whereas climate adaptation exerts a positive effect. This impacts banks, as the lower leverage taken by firms may translate into a lower bankruptcy probability, thereby lowering the default risk of banks. Giacchetta and Giacometti (2024) identify that major European banks exhibit a dynamic climate risk premium that is negatively correlated with transition risk exposure. However, Ehlers et al. (2022) find that, although banks do account for climate policy risks in their pricing, the extent to which these risks are priced remains limited when compared to the magnitude of the underlying material climate-related risks. Reinders et al. (2025) analyse the negative impact that climate policies can have on the market value of assets on banks' balance sheets.

Macroeconomic factors have a profound influence on the impact of climate change on the banking industry, particularly in terms of economic growth, inflation rates, interest rates, and shocks such as the COVID-19 pandemic or armed conflicts (Basel Committee on Banking Supervision, 2021). Boldrini et al. (2023) claim that the economic and financial risks resulting from nature loss and degradation affect over half of global GDP (EUR 40 trillion). In addition, Gourdel et al. (2024) find that under a disorderly transition scenario combined with elevated physical climate risks, real GDP is projected to decline by 12.5 % by 2050. Climate risks raise the government's average cost of debt (Buhr et al., 2018), leading to higher taxes, lower government spending, and reduced economic activity, and may indirectly impact banks' credit risk (Basel Committee on Banking Supervision, 2021). In relation to inflation, Qi et al. (2025) demonstrated that climate change can raise inflation in the short term by exerting adverse effects on the economy. In response, central banks may lower interest rates to stimulate economic activity, which could inadvertently exacerbate inflationary pressures. Furthermore, Cevik and Gwon (2024) underscore the potential of weather anomalies to disrupt supply chains, thereby contributing to the development of inflationary pressures. Aguila and Wullweber (2024) posit that elevated interest rates delay the transition towards a green economy by increasing the cost of sustainable investments. Similarly, Wu et al. (2024) find that banks located in countries with higher loan interest rates, poorer regulatory quality, and higher carbon emission intensity are more affected by climate risk, increasing the systemic threat of these banks mainly driven by worsening credit quality. Consequently, the impact of climate risks on banks may exacerbate bank contagion and increase banks' systemic risk level (Curcio et al., 2023; Kanas et al., 2023; Ojea-Ferreiro et al., 2024).

Climate-related financial risks are distinguished by their extensive impact, unpredictability, and irreversibility. These risks, both endogenous and systemic in nature, can affect the entire economy and banking systems (NGFS, 2019). As such, the incorporation of climate-related physical, and transitional risks into the policy framework of central banks and financial regulators is essential for macro-financial stability (Dikau & Volz, 2021). Failure to address these risks may undermine the stability of the banking system and disrupt the effective transmission of monetary policy, threatening price stability. Nevertheless, the implementation of such climate policies may be excessively ambitious, and thus could be postponed or even reversed (for example, the withdrawal of the United States from the Paris Agreement), resulting in sudden asset revaluations and an increased likelihood of debt default (Battiston et al., 2021). Chan et al. (2024) establish that if a policy encourages a bank's green transition, financial stability is compromised due to a rise in default rates. D'Orazio and Popoyan (2023) demonstrate that the complexity of financial stability governance frameworks enhances the effectiveness of climate-related banking policy adoption. In this regard, certain regulatory authorities have undertaken climate stress tests and scenario analyses to assist banking institutions in the management of climate-related risks and to assess the impact of climate policies (Acharya et al., 2023; Xu et al., 2024; Reinders et al., 2025). Additionally, other adopted regulatory policies or initiatives may include green differentiated capital requirements (GDCRs), which promote the transition to a low-carbon economy and can affect loan spreads and credit provision. However, although GDCRs can reduce physical risks, they may also generate transition risks (Dafernos and Nikoladi, 2021; Dunz et al., 2021) or climate-related financial disclosures (Kraus, 2024; Nieto & Papathanassiou, 2023). Therefore, policy regulators must adopt suitable policies for mitigating and adapting to climate change to maintain financial stability.

The proliferation of international and national regulations and policies, coupled with the growing impact of climate change on the banking sector, has led to a diversification of the body of literature on sustainable finance. Several studies use bibliometric analysis to examine the literature on climate change mitigation and sustainable finance from a broad financial and economic perspective (see Table 1). For instance, Kashi and Shah (2023) conduct a bibliometric analysis to examine the responsiveness of depositors to sustainability performance and the ESG factor. Other studies concentrate on the field of green finance literature (Zhang et al., 2019; Muchiri et al., 2022; Tao et al., 2022; Muhmad et al., 2024), defined by the IFC (2017) as "investment financing that provides environmental benefits, without consideration of the social and governmental aspects". In the domain of green finance, as defined within the 2015 Paris Agreement (COP 21), a novel concept was introduced: 'Climate Finance'. This term denotes the financing mechanisms at the local, national, or transnational levels that provide resources to address the challenges of climate change adaptation and mitigation. Long et al. (2022) and Carè and Weber (2023) review the literature from this perspective and agree that the main research streams are the contribution of financial markets and investments for sustainable development through green bonds or climate bonds and the impacts of climate policy in the financial mitigation and adaptation to climate change. In fact, while climate finance is a key aspect of green finance, it is not the only focus under this area. It is evident that climate change poses a considerable risk to the financial sector. In this regard, Zhou et al. (2023) conducted a review of the impacts of natural disasters and physical risks associated with climate change on various components of the financial system, including banking, insurance, stock and bond markets, and international capital flows. Mngadi and Twinomurinzi (2023) focused exclusively on credit risk within the context of the financial sector, overlooking a broader range of risks. Breitenstein et al. (2021) analyse climate-related risk management in the financial sector, while Suciati (2025) links climate risks to financial stability. Furthermore, Ngo et al. (2022) review the existing literature on climate-related financial risk disclosures, with a particular focus on articles related to the Task Force on Climate-related Financial

Disclosures (TCFD).

The aforementioned analyses do not specifically address the banking sector. In contrast, studies that do focus on banks often explore concepts such as ESG criteria, sustainable finance, and green finance (Akomea-Frimpong et al., 2022; Aracil et al., 2021; Galletta et al., 2022; Korzeb et al., 2024). Nevertheless, these studies do not explicitly examine the risks associated with climate change. While other research addresses climate-related risks within the banking sector, it tends to do so by focusing on specific categories of bank risk rather than providing a comprehensive analysis. De Bandt et al. (2024) explore credit risk, market risk, and lending standards, while examining the specific impact of climate change on certain types of portfolios. While valuable, they capture only part of the picture, as banks are exposed to climate risks through multiple, interconnected channels that cannot be fully understood in isolation. In contrast, other analyses focus on the transmission of climate risks through central banks, limiting their scope to monetary authorities rather than the broader banking sector (Carè et al., 2024; Omeir and Vasiliauskaite, 2025). Although these contributions are steps forward, there remains a need for a comprehensive, system-wide analysis that integrates all categories of climate risk and their interdependencies across the entire banking sector.

In light of this, a clear research gap is identified. To the best of our knowledge, no existing analysis focuses on identifying and structuring research streams that examine the impact of all types of climate risks (physical, and transitional risks), along with their transmission channels, on the entire banking industry. This study contributes to the literature not only by mapping key authors, institutions, and countries active in the field and integrating and synthesising the main research streams on climate-related banking risks, but also by providing a foundation for more targeted studies and highlighting future research directions based on the gaps observed in the current literature.

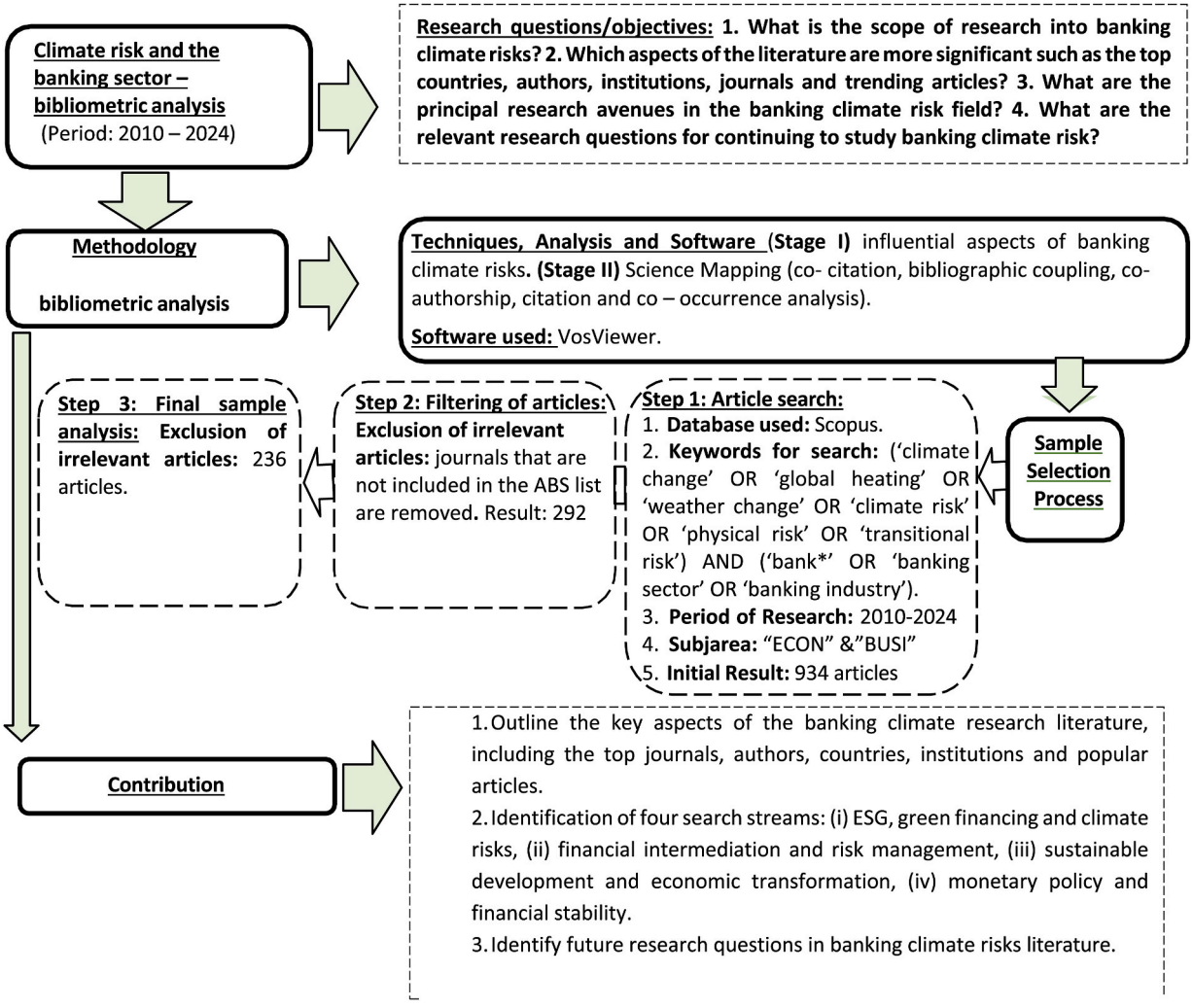

Fig. 2. Methodology.
Source: Authors' elaboration based on Migliavacca et al. (2022).

3. Methodology

3.1. Sample selection process

The data collection process comprises three distinct phases, as illustrated in Fig. 2. First, we select an appropriate database to facilitate the collection of bibliometric data (Bahoo et al., 2020). We use the Scopus database due to its comprehensive and inclusive nature; it also enables the extraction of essential elements such as references and institutional affiliations (Long et al., 2022).

Second, we identify papers based on the keywords ('climate change' OR 'global heating' OR 'weather change' OR 'climate risk' OR 'physical risk' OR 'transitional risk') AND ('bank*' OR 'banking sector' OR 'banking industry') appearing in titles, abstracts, and keywords between 2010 and 2024. We initially identify 5122 papers. To further refine the data collection procedure and as inclusion criterion, we only include articles published in the following subject areas: 'Economics, Econometrics and Finance' (ECON) and 'Business, Management and Accounting' (BUSI). We limit the search to articles published in English to ensure relevance to a broader audience (Carè et al., 2024; Shashi et al., 2021).

Third, we exclude irrelevant articles from the initial filtered sample of 934 papers. Bibliometric studies commonly apply a cut-off to select a manageable and representative subset of articles, with the literature recommending an ideal range of 200–300 papers (Campobasso and Boscia, 2022). In the business and finance field, the selection process often entails filtering journal articles based on their rankings in recognised sources, such as the Chartered Association of Business Schools (ABS) Academic Journal Guide (Migliavacca et al., 2022; Patel et al., 2022; Goodell et al., 2023; Kumar and Tripathy, 2025). Accordingly, we refine our sample by including only journals listed in the 2024 ABS rankings, thereby ensuring the quality and relevance of the selected articles. The number is reduced to 292. We further streamline our selection by applying Zott et al.'s (2011) criteria, ensuring that any article we discuss, examine, or analyse directly addresses the topic of climate risk in banking. To this end, the titles and abstracts of all articles are reviewed and examined in accordance with the defined criteria, ensuring that literature that does not sufficiently address the subject is excluded (Breitenstein et al., 2021; Akomea -Frimpong et al., 2022; Muchiri et al., 2022). Table A in the Appendix lists the excluded studies along with the corresponding reasons for exclusion. A study is excluded if: (i) it addresses climate change–related topics but lacks a banking perspective, as some papers were included through keyword filtering for 'bank,' inadvertently capturing works referencing World Bank data, seed banks, or riverbanks without analyzing the banking sector itself; (ii) it is a reading note, call for papers, or erratum rather than a research article; and (iii) it does not specifically address climate change, but merely mentions the concept in the abstract as one of several potential shocks—such as pandemics or geopolitical instability—that can affect the economy, without focusing on its specific impacts. These exclusions are essential to ensure the quality, focus, and consistency of the bibliometric analysis. After the exclusions, the final sample consists of 236 articles.

4. Findings

This section outlines the findings of the bibliometric analysis and is divided into two sub-sections: performance analysis results and scientific mapping results. The performance analysis evaluates the input of the research elements, whereas the scientific mapping concentrates on the interconnections between these elements. We use VOSviewer because it is a well-known tool for visualising similarities through network graphs (Bajaj et al., 2022) and identifying networks and clusters in various forms and colours based on citation data (Patel et al., 2022). Table 2 presents the objectives, methods, and analytical tools applied in this study.

4.1. Performance analysis

Performance analysis is a qualitative approach that examines the existing scientific contribution in a particular field of research (Cobo et al., 2011). We identify the most relevant aspects of the banking climate risks literature, such as annual publications, authors (see Table 3), countries (see Tables 4 and 5), institutions (see Table 4), funding sponsors (see Table 5), journals (see Table 6), and influential articles and topics (see Table 7).

Fig. 3 illustrates the annual distribution of publications throughout the study period (from 2010 to 2024). The 2010–2024

Table 2
Objectives, methods and tools of the article.

Objectives	Methods	Tools
Analysis of annual trends and publication types.	Performance analysis	Scopus database & MS Office Excel
Identification of the most prolific authors, institutions, countries, journals, and articles.	Performance analysis	Scopus Database & Ms Office Excel
Recognition and analysis of clusters.	Co-ocurrence analysis of keywords	VOSviewer version 1.6.20
Examination of thematic structures.	Co-authorship analysis Co-citation analysis of documents Bibliographic coupling of documents Citation Analysis	VOSviewer version 1.6.20

Source: Authors' elaboration.

Table 3
Most influencing authors (n > 2).

Authors	Country	Affiliation	TP	TC	H – Index
D'Orazio,P	Germany	Chemnitz University of Technology	5	273	12
Battiston,S	Switzerland	University of Zurich	4	510	40
Dafermos, Y	England	SOAS, University of London	4	789	12
Monasterolo,I	Netherlands	Utrecht University, School of Economics	3	390	22
Volz,U	England	SOAS, University of London	3	431	18
Ziane,Y.	France	Université Paris 1 Panthéon-Sorbonne	3	136	6

Source: Authors' elaboration.

Table 4
Most influential countries and institutions.

Countries/Regions		Institutions		
Country	TP	Institutions	Country	TP
Euro Area*	150	The World Bank, USA	USA	10
China	56	Università degli studi di Bari Aldo Moro	Italy	7
UK	54	Universität Zürich	Switzerland	6
USA	53	Università Ca'Foscari Venezia	Italy	6
Australia	16	SOAS University of London	UK	6
Canada	10	London School of Economics and Political Science	UK	5
Switzerland	9	Ruhr – Universitat Bochum	Germany	5
South Africa	9	European Central Bank	EU	5
*Italy 42, Germany 35, France 30, Netherlands 14, Spain 7, Austria 6, Greece 5, Ireland 4, Belgium 3, Luxembourg 3, Slovakia 1		WU Vienna University of Economics and Business	Austria	4
		Universiteit Utrecht	Netherlands	4

Source: Authors' elaboration.

Table 5
Studied countries and funding sponsor.

Studied countries (>1)		Funding Sponsor (>2)	
Country/Region	N°	Sponsor	N°
China	25	National Natural Science Foundation of China	19
EU	24	European Comission	12
USA	14	World Bank Group	8
Italy	6	European Central Bank	8
Sub-Saharan Africa	5	Universität Zürich	6
G20 Countries	4	Horizon 2020 Framework Programme (EU)	6
Germany	4	National Office for Philosophy & Social Science (China)	5
Bangladesh	4	Fundamental Research Funds for the Central Universities (China)	4
UK	3	Bundesminiterium für Bildung und Forschung	4
BRICS	3	Economic and Social Research Council (UK)	3
Vietnam	2	Bank of England	3
France	2		
Brazil	2		

Source: Authors' elaboration.

Table 6
Most prolific and impactful journals.

Most impactful journals			
Journals	Papers	Journals	Papers
Journal of Cleaner Production	17	Economic change and restructuring	9
Journal of Sustainable Finance and Investment	15	International Review of Financial Analysis	9
Journal of Financial Stability	15	Technological Forecasting and Social Change	7
Ecological Economics	11	Energy Economics	7
Business Strategy and the Environment	10	Finance Research Letters	6

Source: Authors' elaboration.

Table 7
Top cited articles.

Trending Articles					
Rank	Article	Journal	Main findings	Citations	FWCI
1	Environmental externalities and cost of capital. Chava (2014)	Management Science	Firms with poor environmental profiles face higher costs of equity and bank debt. Lenders charge them higher interest rates, and fewer banks join their loan syndicates.	846	3.38
2	Climate change, financial stability and monetary policy. Dafermos et al. (2018)	Ecological Economics	Climate damages increase corporate defaults, depress bond prices, and reduce credit expansion, threatening financial and economic stability.	418	8.00
3	Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change. Hepburn et al. (2020)	Oxford review of Economic Policy	Fiscal recovery packages post-COVID-19 will shape economic systems, influencing credit risk and investment priorities.	409	26.56
4	Central bank mandates, sustainability objectives and the promotion of green finance. Dikau and Volz (2021)	Ecological Economics	Analyzes how climate-related risks align with central bank mandates, finding only 12 % have explicit sustainability goals. However, 40 % support government policies that often include sustainability.	335	18.27
5	Climate risks and financial stability. Battiston et al. (2021)	Journal of Financial Stability	Offers new methods to help central banks and supervisors integrate climate risks into policy and risk assessments.	296	141.98
6	The impact of climate change on the cost of bank loans. Javadi and Masum (2021)	Journal of Corporate Finance	Firms located in areas with greater climate risk face significantly higher bank loan spreads. Additionally, firms whose customers are exposed to climate risks also incur higher borrowing costs.	271	10.90
7	A review of studies on green finance of banks, research gaps and future directions. Akomea -Frimpong (2022)	Journal of Sustainable Finance and Investment	Reviews green finance products in the banking sector, including green bonds, credit, and insurance.	265	25.67
8	Fostering green investments and tackling climate-related financial risks: Which role for macroprudential policies? D'Orazio (2019)	Ecological Economics	Explores how prudential policies can incentivize banks to decarbonize their balance sheets and shows under what conditions macroprudential policy can promote green lending while managing climate-related financial risks.	219	7.67
9	The pricing of green bonds: Are financial institutions special? Fatica et al. (2021)	Journal of Financial Stability	Green bonds issued by financial institutions do not carry a green yield premium. Banks issuing green bonds tend to reduce lending to carbon-intensive sectors, but only within loans where they act as lead lenders.	199	18.39
10	Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. Chenet et al. (2021)	Ecological Economics	Proposes a precautionary financial policy framework integrating climate- related financial risks fully into prudential, macroprudential, and monetary policies to better address these risks.	168	8.71

Source: Authors' elaboration.

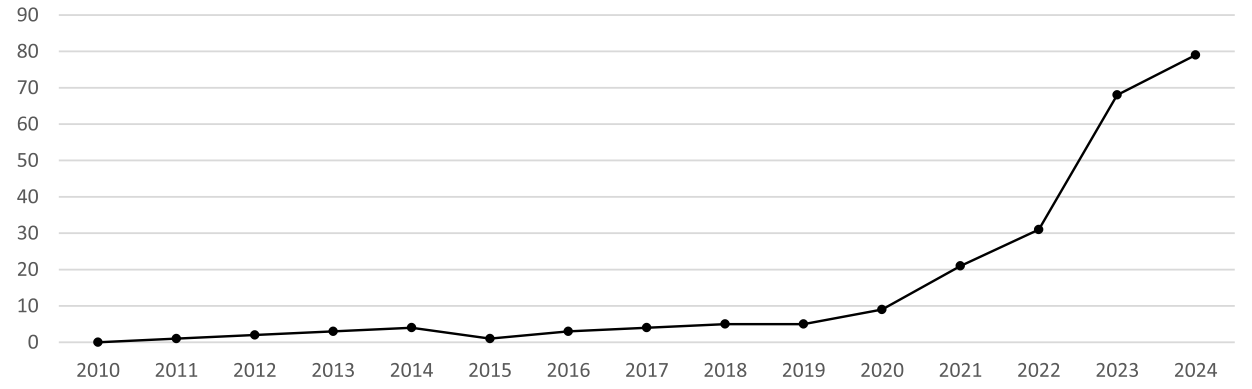

Fig. 3. Annual publications related to banking climate risks.
Source: Authors' elaboration.

timeframe is selected because the literature on the topic prior to 2010 is limited. As illustrated in Fig. 3, research on climate risks in the banking sector has expanded substantially, with a pronounced surge occurring during the 2020s. From 2020 onward, the growth trajectory has changed, showing a marked and continuous year-on-year increase in publication output. Remarkably, over 88 % of all identified publications are produced during this recent period, underscoring the rapid acceleration of scholarly interest in this field. This increasing significance of climate-related risks in the banking sector can be attributed to three key factors: (i) the escalating

frequency and intensity of extreme weather events; (ii) expansion of banking policies and regulatory frameworks addressing climate change; and (iii) enhanced availability and transparency of climate-related data, which has facilitated more rigorous analysis and risk assessment.

In 2024, global temperatures reached record highs, and 605 extreme weather events were reported worldwide, surpassing all previous records and leading to severe global economic losses (WMO, 2025). The increasing uncertainty and complex impacts associated with climate change significantly affect banking activities, as they heighten financial risks, disrupt market stability, and challenge traditional risk management frameworks (Conlon et al., 2024; Li & Wu, 2023). In response, international organisations have intensified their efforts to guide the banking sector in addressing climate-related risks. In 2017, the TCFD was established to provide recommendations for disclosing climate-related information, while the NGFS was launched to integrate climate and environmental risks into financial supervision and risk management. Simultaneously, banks are increasingly committing to voluntary initiatives promoting sustainable finance and climate risk mitigation, such as the Principles for Responsible Investment, Principles for Responsible Banking, and Net-Zero Banking Alliance (NZBA).

Climate-related data has become more accessible through platforms such as the Carbon Disclosure Project (CDP), Bloomberg ESG & Climate Data, Refinitiv ESG, ESG rating agencies, and banks' own sustainability reports, which has significantly facilitated research and analysis in this field. In parallel, the development of advanced analytical tools, including climate stress testing models, the Climate Policy Assessment Tool (CPAT), CLIMAFIN, and the NGFS Climate Scenario Explorer, has enhanced the capacity to evaluate the potential impacts of climate risk on the banking system. Despite these important advances in data accessibility and methodological innovation, there remains a pressing need for policy action to improve the consistency, reliability, and comparability of climate-related ratings and disclosures (Cregan et al., 2024).

Table 3 presents the most influential authors on the topic based on the total number of papers (TP) and total citations (TC). The H-index, which measures both the productivity and citation impact of an author's publications, is also included. The relatively small number of authors with extensive publication records highlights the novelty of the field and underscores the need for further consolidation of research in this area. Notably, authors with the highest publication counts often collaborate closely, contributing to a concentrated body of work.

The most prolific authors investigating climate risks in banking are affiliated with European institutions. This pattern is due to several factors. First, Europe has been a pioneer in integrating climate change considerations into financial regulation, exemplified by initiatives such as the EU Sustainable Finance Action Plan and the European Green Deal. These policies have likely driven increased academic interest and research funding in this domain. Second, European institutions benefit from well-established research infrastructures and dedicated funding programs focused on sustainability and climate-related finance, which foster higher research productivity. We identify the countries and institutions actively engaged in researching climate risks within the banking sector. Thus, based on the volume of publications authored by affiliated researchers, we have identified the top countries and institutions contributing to this field (see Table 4).

Given the harmonised regulatory and supervisory framework established through the European Banking Union and the role of the European Central Bank (ECB), eurozone countries are analysed as a single group. Banks within this area are subject to uniform guidelines—such as the ECB's climate risk recommendations, the EU-adapted Basel III standards, climate stress testing, and the EU Green Taxonomy—under a shared monetary policy. This regulatory convergence contributes to a relatively homogeneous exposure to climate-related risks across the region (D'Orazio et al., 2024). Notably, the Euro area leads in academic output on this topic, with 150 publications, significantly ahead of China (56), the United Kingdom (54), and the United States (53).

The European Union (EU) has long positioned itself as a global leader in sustainability and rigorous ESG regulations (Nieto & Papathanassiou, 2023), a stance that is reflected in the region's strong academic output on the topic. Publications from European countries focus primarily on financial stability and climate-related risks (Battiston et al., 2021; Diluiso et al., 2021; Roncoroni et al., 2021), as well as on the development and assessment of regulatory climate policies (Feldkircher & Teliha, 2024; Reghezza et al., 2022). However, a recent shift in the region's regulatory priorities has emerged, as growing concerns have arisen regarding the impact of excessive bureaucracy on economic performance given the strong EU compliance with climate targets. In fact, The Draghi Report on Competitiveness in Europe (European Commission, 2024) highlights that such regulatory burdens may hinder economic growth and undermine the global competitiveness of European companies. In this context, the strict climate commitments enforced by the ECB have been cited as a deterrent for countries such as the Czech Republic and Poland to join the Euro area (Vollmer, 2024). Thus, on February 26, 2025, the EU adopted the Omnibus Directive, with the aim of alleviating administrative pressure by streamlining regulations related to sustainable finance reporting. Hence, increasing awareness of environmental risks is essential, and European banking institutions must consider these risks as an urgent and central strategic priority (Gambacorta et al., 2024). Regulators are required to assess and disclose banks' climate-related risks (Chabot & Bertrand, 2023), as the extent and quality of voluntary climate-change disclosures within the banking sector remain unclear (Caby et al., 2020). While raising awareness among banks regarding climate-related risks remains critical, recent developments suggest that the relaxation of climate regulations may prioritise economic competitiveness over environmental sustainability.

China has emphasised sustainable development and ecological progress, issuing strategic guidelines that require banks and insurers to embed green finance into their operations. These policies direct financial institutions to support green, low-carbon, and circular economy sectors. However, China's approach is primarily top-down, state-driven, and lacks transparency or clear limitations—contrasting with the EU's bottom-up, consultation-based, and mandate-limited model (Larsen, 2023). Liu et al. (2024) highlight notable differences in the quality of environmental information disclosure (EID) between banks in China and those in the NZBA. They find that NZBA banks provide significantly higher-quality EID, particularly in terms of balance, accuracy, and clarity. Furthermore, the People's Bank of China (PBoC) requires banks to align their loan portfolios with national green credit strategies, using

economic incentives to ensure compliance with government objectives (Baer et al., 2021). These findings suggest that while China leads in policy volume and publication output, the quality of environmental reporting may be compromised by a centralised, compliance-driven framework, thus raising questions about the effectiveness and credibility of its green finance efforts.

Institutions that focus on climate change from a banking perspective are expected to play a pivotal role in advancing research on this topic. Notably, the countries of origin of the leading publishing institutions generally align with the most productive countries. However, although China is among the leading countries in terms of total publications, none of its institutions rank among the top individual publishers. This is explained by the fact that while no single Chinese institution dominates, there are 14 Chinese institutions collectively contributing to research in this area.

Table 5 shows the most studied countries or regions. The search has been done manually, with a focus on the countries for which the analyses have been carried out. The results align with the countries that publish the most on the subject, mainly developed countries and China. In addition, some articles do not focus on just one country; in fact, they propose a multi-country analysis (Caby et al., 2022; Lang et al., 2023; Boungou & Urom, 2023).

China has been the focus of extensive research on climate risk and finance (Wu et al., 2023; Shu & Tan, 2023; Li & Wu, 2023) and has been one of the largest carbon-emitting countries globally. In response to growing environmental challenges, PBoC introduced one of the world's first green finance policies in 2017, requiring commercial banks to consider the environmental performance of firms in their financial decisions (Li et al., 2024). In 2020, the Chinese government announced its carbon peaking and neutrality goals to be achieved by 2060 (Xu et al., 2024; Zhang et al., 2024). This milestone marked a turning point, promoting the development of a low-carbon economy and significantly expanding the green financial market through a series of policies and regulatory frameworks aimed at aligning the economy with these environmental targets. As a result, most academic articles on the topic have been published after that year. In addition, East Asian countries—led by China—receive 43 % of total global climate finance flows (UNEP, 2023), underscoring the region's growing importance in the transition to a sustainable financial system. Furthermore, studies with a focus on China frequently receive financial support from governmental sources, including the National Social Science Fund of China and the National Natural Science Foundation of China. Whilst these funding mechanisms aim to promote research in strategic areas, they also encourage academic output that aligns with the values and policy interests of the Chinese government.

The EU has taken a leading role in global climate action (Alessi et al., 2024), having established some of the most ambitious and legally binding targets for reducing greenhouse gas emissions. It has also developed a comprehensive regulatory framework for the banking sector. In this context, EU climate-related financial policies in the banking sector focus on three key areas: (i) specification of concepts and frameworks, (ii) creation of methodologies for evaluating risks, and (iii) reporting and disclosure of risk data. Under the first category, the EU Taxonomy Regulation and the Banking Package (CRR/CRD revisions, 2021–2025) establish a framework to define sustainable activities and integrate environmental risks into prudential regulation. The Low Carbon Benchmarks Regulation and the EU Green Bond Standard further enhance transparency and reliability of sustainable finance instruments, reducing greenwashing risks. Regarding risk assessment, the ECB's 2022 climate stress tests and the planned 2025 climate risk adjustment factor in its collateral framework represent advances in forward-looking risk modelling. The European Banking Authority (EBA) complements these efforts through transition plan guidelines (2025) and climate data templates (2023–2024). Finally, disclosure is strengthened by the Sustainable Finance Disclosure Regulation, the EU Disclosure Regulation, and the EBA's climate risk monitoring dashboard based on Pillar 3 ESG disclosures, alongside non-binding climate reporting guidelines aligned with TCFD and other international frameworks, with the aim of improving transparency on climate-related financial risks. Given the importance placed on climate policy and the availability of data and methodologies, it is not surprising that the EU is one of the most extensively studied regions in this field. These studies primarily focus on monetary policy analysis, climate reporting mechanisms, and the role of central banks in climate-related decision-making.

Similarly, the United States is also among the most researched countries due to the availability of financial and climate data and its high vulnerability to climate change. Many studies examine how natural disasters affect borrowers' ability to meet their financial obligations to banks (Vollmar and Wening, 2024; Apergis, 2023; Oh & Kim, 2023). However, the return of Donald Trump to the presidency has led to a rollback of several climate-related financial initiatives. These include the withdrawal of the Office of the Comptroller of the Currency (OCC) climate guidance, exit from the NGFS, and the decision of major U.S. banks, such as Bank of America and JPMorgan Chase, to pull out of voluntary frameworks such as the NZBA, all of which point to a reduced level of regulatory oversight. Furthermore, the United States has again withdrawn from the Paris Agreement. Alessi et al. (2024) observe that investors had reduced their holdings in high-carbon firms in response to the Agreement, but this trend reversed following the U.S. announcement of its withdrawal. Indeed, the consequences of these shifts could offer a valuable direction for future research. In this context, most U.S.-based studies primarily focus on physical climate risks, particularly in relation to bank lending (Curcio et al., 2023; Kanas et al., 2023; Turnbull, 2023; Walker et al., 2023). By contrast, research on transition risks remains limited, which may be attributed to the Federal Reserve's reluctance to engage directly in climate-related policymaking (Masciandaro & Russo, 2024).

Notably, the case of the United Kingdom presents a paradox. Although it is among the most active countries in publishing research on climate-related financial risk, few studies focus on the United Kingdom (Bell et al., 2023; Garbarino & Guin, 2021; Saudey et al., 2022). A possible explanation lies in co-authorship patterns. Many UK-based authors collaborate with international researchers, leading to case studies centred on other regions, such as China (Ho et al., 2024; Liu et al., 2024), the Euro area (Beirne et al., 2024; Diluiso, 2021), U.S. (Kanas et al., 2023; Nguyen et al., 2023b), and emerging economies (Adu et al., 2024; Aslan et al., 2022; Sakariyahu et al., 2023). Thus, there is a gap between institutional affiliation and empirical focus.

Latin America Countries (LAC) is a region that remains under-researched despite being particularly vulnerable to climate change and its effects due to its geographic and climatic conditions, as well as its socioeconomic and demographic characteristics. This research gap is due to various reasons. First, data availability and quality, both climate and financial, for LAC are generally lower

compared to other regions. Climate-related disclosures are not mandatory in most countries, and many banks do not publish sustainability reports, which limits access to reliable and consistent information. Moreover, most financial regulators in the region have yet to incorporate climate-related risks into their regulatory frameworks or supervisory practices. There are delays in the implementation of climate commitments. While most LAC have signed agreements, such as the Paris Agreement, these commitments have not yet been translated into concrete regulatory measures. On the financial side, LAC receive only about 6 % of global climate finance (UNEP, 2023), which significantly constrains their ability to invest in climate resilience and adaptation measures. Finally, academic researchers in LAC face structural barriers, including language limitations, limited funding, and restricted access to indexed journals, which results in lower visibility of existing studies at the international level. However, Brazil is an exception. In 2017, the Central Bank of Brazil implemented a policy requiring banks to incorporate social and environmental risks into their capital adequacy assessments. In 2021, the Central Bank of Brazil passed a resolution mandating the disclosure of climate-related risks and opportunities (Banco Central do Brasil, 2021)

Meanwhile, Australia presents an interesting case. Although it is among the leading countries publishing research on this topic, and its regulatory body (Australian Prudential Regulation Authority) is at the forefront by conducting climate vulnerability assessments with major banks to evaluate their exposure to climate-related risks, studies examining the impact of climate change on the banking sector do not rely exclusively on Australian data. Instead, much of the existing research adopts an international perspective (Le et al., 2023; Sajjad et al., 2024) or focuses on other countries, particularly Bangladesh (Bose et al., 2018; Rana et al., 2023).

Central banks must develop policies and regulations concerning climate risks, as the expected impact of climate change is likely to vary widely across countries. Indeed, climate legislation and policy affect banks' business models and assets differently (Ghosh, 2023; Xu et al., 2023). Indeed, Horky and Fidrmuc (2024) demonstrate that cultural and policy-induced factors play a significant role. This clearly illustrates that general statements based on specific country samples can be challenging due to the presence of different non-observable factors. Therefore, extrapolating results between countries with different banking structures, regulations, and social, economic, and geographic characteristics is difficult. Generally, the extent of climate change research in a country depends on the presence of relevant regulations and policies, public awareness, and availability of data and methodologies. The structure of the national banking system also plays a role, alongside barriers such as armed conflicts, competing socioeconomic priorities, language constraints, and publication accessibility.

Table 6 presents the ten most influential journals in the field of banking and climate risk based on the total number of publications. Notably, among the most prominent journals in this area, only three—*Journal of Financial Stability, International Review of Financial Analysis, and Finance Research Letters*—are ranked among the top 50 finance journals according to the Scimago Journal Rank (SJR) (Scimago Journal & Country Rank, 2024). This indicates that the topic is a relatively new area of focus in finance, and that most top journals have traditionally concentrated on classical topics such as corporate finance, market efficiency, and asset pricing. Consequently, much of the early literature on climate risks in banking has been published in interdisciplinary journals or journals from adjacent fields such as environmental economics (e.g., *Ecological Economics*, *Economic Change, and Restructuring, Technological Forecasting and Social Change*).

However, this trend is beginning to shift. An increasing number of top finance journals are incorporating climate-related financial risks into their editorial scope, reflecting the growing recognition of this topic within the field of finance. Notably, in 2024, the *Journal of Sustainable Finance and Investment* is ranked 65th among the 100 most influential finance journals in the SJR, marking its first inclusion in this ranking. This journal focuses on sustainability, with particular emphasis on environmental, developmental, social, and governance principles as they relate to financial markets, managed investments, banking, and microfinance (SJR, 2024). This milestone highlights the increasing relevance of climate-related financial issues to the finance discipline. The growing interest among leading finance journals is likely driven by several interrelated factors: (i) First, the introduction of climate-related regulations and policies has reshaped the financial landscape. Institutions such as the Network of Central Banks and Supervisors for Greening the Financial System (NGFS), the Financial Stability Board (FSB), and the European Central Bank are implementing guidelines and regulatory measures—including climate stress tests, the Guide on Climate-Related and Environmental Risks, and the Task Force on Climate-related Financial Disclosures (TCFD)—to mitigate climate-related risks. (ii) Second, investors and financial markets are increasingly attentive to these risks, as they directly affect banks through portfolios and client exposures, regulatory compliance or because banks play a critical role in channeling investment flows toward sustainable activities. Moreover, climate change can trigger economic shocks that affect overall financial stability, making both the banking sector and investors highly interested in research examining how these risks influence banking operations and financial systems. (iii) Third, the availability of high-quality data and advanced analytical tools has enabled more precise, robust, and policy-relevant research. Multi-year datasets derived from regulatory disclosures, stress tests, and scenario analyses facilitate empirical studies with greater rigor. (iv) Finally, heightened public awareness and media attention on extreme climate events—such as wildfires, hurricanes, and droughts—have amplified the academic focus on the financial consequences of climate risks.

Table 7 presents the most relevant and influential articles in the field, identified based on citation counts. Each entry includes the article title, journal of publication, year of release, a summary of the main findings, and the Field-Weighted Citation Impact (FWCI)—a metric that compares the number of citations received by an article to the global average for similar publications, adjusted by subject area, document type, and publication year. Citation analysis is widely recognised as a useful tool for identifying impactful research and prominent authors within a discipline (Liu, 2023). Generally, citation counts serve as a proxy for both academic influence and perceived research quality (Shashi et al., 2021). Most of the most-cited articles have been published in recent years, underscoring the growing relevance of the topic in both academic and policy circles. Importantly, all articles listed demonstrate high FWCI scores and are published in leading journals.

The comparison between citation counts and Field-Weighted Citation Impact (FWCI) in the table illustrates a crucial distinction in

evaluating academic influence. While citation counts reflect the popularity and reach of an article, they do not always correlate with its true scholarly impact. For instance, Chava's (2014) article, with 846 citations, has a relatively low FWCI of 3.38, suggesting its influence within the field is modest despite high visibility. On the other hand, Battiston et al. (2021) has fewer citations (296) but an extraordinarily high FWCI of 141.98, indicating that its impact is significantly greater relative to other works in the same domain. This highlights that FWCI offers a more nuanced view of academic significance, adjusting for factors like field-specific citation patterns, and demonstrates that high citation counts alone do not always equate to higher academic impact. Therefore, FWCI provides a clearer measure of an article's true influence in its scholarly context.

In summary, the literature on banking and climate risks remains in an early stage of development. Identifying and engaging with the most influential and emerging works in this area is therefore essential, as they not only shape the current academic discourse but also set the direction for future research in the field.

4.2. Science mapping

Scientific mapping is a method of investigation which explores the connections between publications in order to demonstrate the structural and dynamic aspects of scientific research. It is a spatial representation of how articles, authors, fields or topics relate to each other (Donthu et al., 2021). This methodology has been recognised as a reliable means of conducting a structured, transparent, and replicable review (Carè et al., 2024; Carè & Weber, 2023), enabling researchers to identify the most significant scholarly contributions. In order to explore the field in greater depth, a science mapping approach was adopted, incorporating keyword co-ocurrence, co-citation, bibliographic coupling, co-authorship and citation analysis. The present analysis was conducted utilizing the VOSviewer software.

4.2.1. Co-occurrence analysis

The term 'co-occurrence' is used to describe the frequency with which specific keywords are found in conjunction with other keywords. This approach is employed to identify the principal issues and areas of research; that is, it aims to provide a comprehensive understanding of the current research landscape on a given topic and to indicate the direction of future research. The analysis of co-occurring words involves examining the content of publications themselves, with the unit of analysis being the keywords used in each document. We carry out this analysis with VOSviewer, which clusters articles with similar keywords together. This is because keywords are used to describe the content of articles. The keywords have to appear at least seven times, and the relevance of each keyword is reflected in the size of its corresponding circle. The relationship between the elements is represented by lines, with a stronger relationship being indicated by a shorter distance (Jan van Eck & Waltman, 2023). As shown in Fig. 4 and Table 8, the analysis yields four clusters comprising 31 key terms (nodes) and 282 links, with a total link strength of 840. Notably, the interrelationship among the clusters is strong. This indicates that these topics are not isolated; rather, they form an interconnected research ecosystem focused on understanding the impact of climate change on finance.

The co-occurrence analysis identifies four main streams of research in the literature: (1) ESG, green financing and climate risks, (2) financial intermediation and risk management, (3) sustainable development and economic transformation, and (4) monetary policy and financial stability. These themes provide a reliable picture of the main issues explored by the authors.

4.2.1.1. Cluster 1: ESG, green financing and climate risks – yellow. This first thematic cluster encompasses key themes such as ESG, green finance, climate finance, and climate risk. Its formation may be attributed to a thematic convergence, whereby the concept of climate risk—despite being more technical and emergent—has progressively been integrated into the ESG and green finance frameworks, both in academic literature and financial regulation. This integration likely resulted in a high degree of terminological co-occurrence, thereby justifying their grouping in the bibliometric analysis. It reflects the evolution of traditional sustainability approaches toward the inclusion of more specific dimensions of climate risk. Furthermore, this cluster underscores the pivotal role of the banking sector in mitigating climate-related risks through the development and issuance of specialized financial instruments aligned with their ESG commitments.

The integration of ESG factors into the strategic frameworks of banking institutions is not a recent development. Initially, ESG practices in the banking sector were primarily associated with corporate social responsibility (CSR) initiatives and reputational considerations, with academic and regulatory attention largely focused on the social and governance dimensions. However, academic focus has increasingly shifted toward the environmental dimension, as the banking sector's exposure to climate risks has become more obvious (Galletta et al., 2022). This shift is evident in the evolution of environmental-related regulation supported by disclosure requirements, and standardized taxonomies (Giakoumelou et al., 2024). This regulatory emphasis aligns with empirical findings that underscore the relevance of environmental factors over the other dimensions. For instance, Azmi et al. (2021) highlight that environmental transparency and emissions reduction are among the most significant contributors to bank stability, suggesting that investors assign greater importance to environmental performance than to conventional governance indicators. Similarly, Li et al. (2024) show that among ESG dimensions, environmental scores exert a more pronounced influence on firms' cost of debt compared to social or governance scores.

This shift in direction has also been reinforced by intergovernmental directives and global sustainability strategies, which have catalysed the development of green finance as a key mechanism for aligning financial flows with environmental objectives. In 2010, the Green Climate Fund was established, with the aim of providing financial support to mitigate greenhouse gas emissions and facilitate climate adaptation efforts on an international scale. Since then, the concept of green finance has attracted growing academic

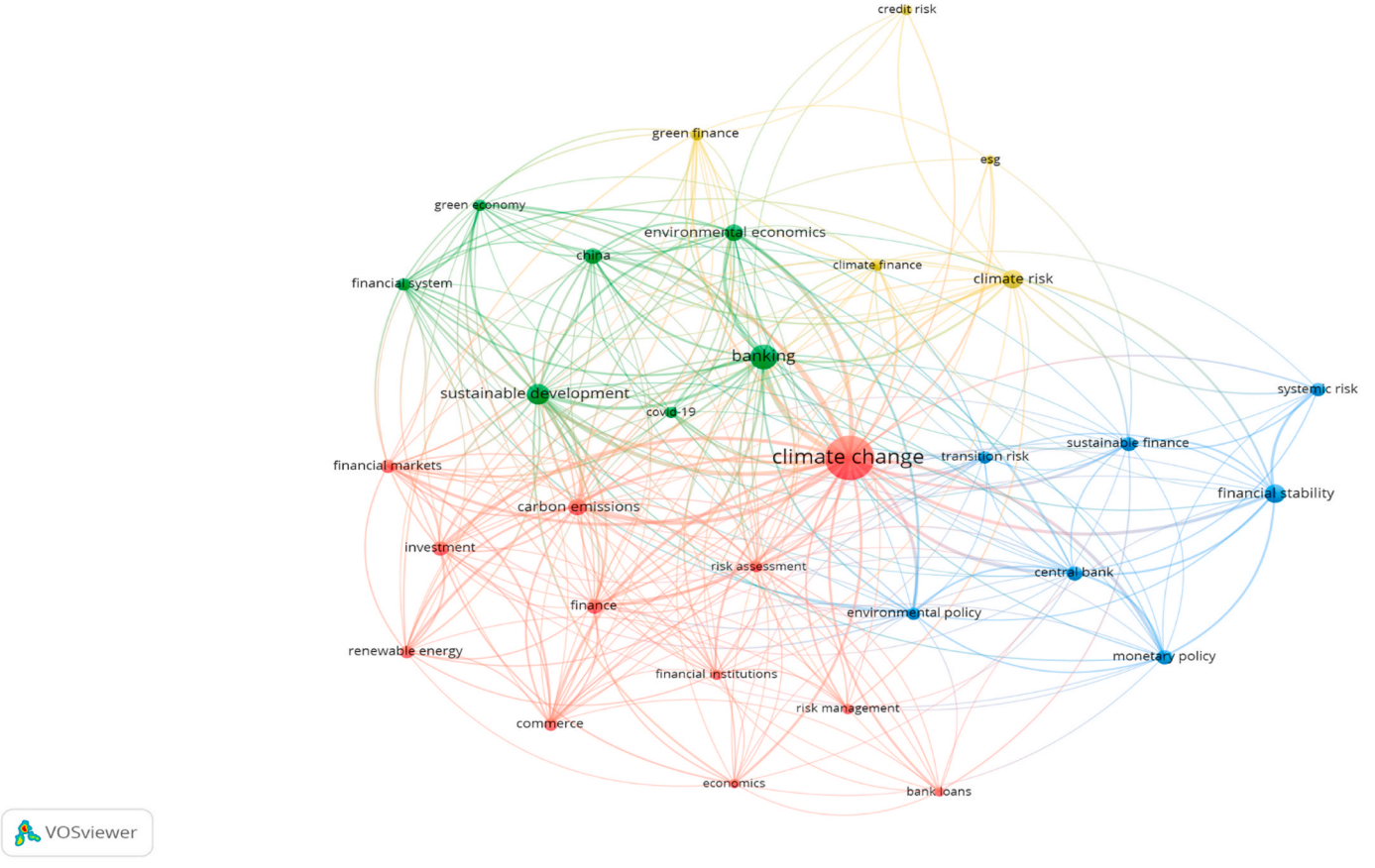

Fig. 4. Co-Occurrence analysis. The analysis identifies keywords under each research stream. A word must appear at least seven times to be included.
Source: Authors' elaboration using VOSviewer.

Table 8
Frequent keywords.

Cluster	Keywords	Co-Ocurrence
1	Climate Finance	9
	Climate Risk	25
	Credit Risk	8
	ESG	7
	Green Finance	12
2	Bank loans	7
	Carbon emissions	20
	Climate Change	141
	Commerce	11
	Economics	7
	Finance	15
	Financial institutions	8
	Financial markets	13
	Investment	16
	Renewable energy	11
	Risk assessment	9
	Risk management	8
3	Banking	43
	China	18
	Covid-19	10
	Environmental Economics	20
	Financial System	11
	Green Economy	9
	Sustainable Development	31
4	Central Bank	16
	Environmental Policy	12
	Financial Stability	26
	Monetary Policy	16
	Sustainable Finance	15
	Systemic Risk	13
	Transition Risk	11

Source: Authors' elaboration.

interest (Zhang et al., 2019). Green finance refers to "the financing of investments that provide environmental benefits" (IFC, 2017). In this context, banks—being key providers of credit within the economy—are uniquely positioned to channel capital towards environmentally positive activities. Their participation is vital given that more than $8 trillion is needed annually through 2030 to meet international climate targets (Cregan et al., 2024; Nguyen et al., 2022). In this sense, developing economies should reform financial regulations and make green finance performance part of bank evaluation or audit processes (Lin et al., 2024).

At the COP 21 in Paris in 2015, a novel concept pertaining to green finance emerged, referred to as climate finance.

According to the United Nations Framework Convention on Climate Change (UNFCCC), it is defined as "local, national, or transnational financing, drawn from public, private, and alternative sources, that seeks to support mitigation and adaptation actions addressing climate change." The risks associated with climate change are categorised as physical and transition risks. Physical risks are linked to extreme weather events, which can result in significant economic losses; transition risks arise from technological and policy changes that facilitate the transition to a low-carbon economy (Bayangos et al., 2020; Chalabi-Jabado and Ziane, 2024). Banks are exposed to climate risks due to network effects and financial interlinkages (Campiglio et al., 2022). The banking sector is pivotal in mitigating climate risks by developing and deploying green financing instruments. As such, the literature identifies specific instruments through which banks can contribute to climate change mitigation. Green bonds have emerged as one of the most prominent debt instruments for mobilizing capital toward projects with positive environmental or climate impact, positioning them as a cornerstone of green finance (Sartzetakis, 2020). Large banks and those publicly committed to a green transition are more likely to issue green bonds, whereas smaller banks often rely on them more persistently and for proportionally larger amounts (Bedendo et al., 2023). Although green bonds do not provide a clear pricing advantage over conventional bonds for banks, their issuance is associated with a strategic reallocation of syndicated lending toward less polluting activities (Fatica et al., 2021). Additionally, demand among banks for green bonds demonstrates elasticity, reflecting sensitivity to market conditions (Boermans, 2023). Banks also play a key role in global climate finance through accreditation in mechanisms such as the Green Climate Fund (GCF), which provides financial support to developing countries for both greenhouse gas mitigation and climate adaptation (Zhang et al., 2019; Amighini et al., 2022). Complementary instruments include sustainability-linked loans, which adjust interest rates based on the borrower's achievement of pre-established environmental metrics (Pohl et al., 2023), and green sukuk, which channel Islamic finance toward environmentally beneficial projects (Keshminder et al., 2022). Furthermore, the integration of ESG ratings into banking regulation increasingly serves to incentivize sustainable investment and mitigate climate-related risks across banks' portfolios (Li et al., 2024).

4.2.1.2. Cluster 2: Financial intermediation and risk management – Red. This cluster encompasses research at the intersection of climate change and banking activities, with a particular focus on how climate change impacts the financial operations of banks and how these

institutions respond from a microeconomic perspective. Additionally, this stream examines capital flows, risk management practices, and investment decisions that directly influence the transition toward a low-carbon economy. The most prominent keywords associated with this cluster include *climate change, bank loans, carbon emissions, renewable energy, investment*, and *risk management*.

Banks have become increasingly aware of the environmental implications of their investment and financing activities, as they face exposure to climate-related financial risks. These risks primarily manifest through credit default risk but can also propagate via market, liquidity, and reputational channels, which represent key microeconomic transmission mechanisms through which climate-related shocks can affect individual financial institutions.

Within this context, the literature provides substantial evidence of the financial repercussions of climate risk. Lang et al. (2023) finds that banks in countries with higher climate risk levels are more likely to experience liquidity issues. Schubert (2021) finds that the costs associated with realised flood disasters negatively affect banks' profits and capital ratios. Similarly, Vollmer and Wening (2024) examine U.S. community bank loans and report a deterioration in overall credit quality in institutions operating in heat-exposed regions. Li and Wu (2023) further demonstrate that climate risk exerts a significant negative effect on bank loan supply, particularly among banks located in coastal areas vulnerable to rising sea levels. Turnbull (2023) finds that both physical and transitional climate risks increase the probability of default, while Lv et al. (2023) show that climate risk is negatively associated with mortgage exposure and deposit growth.

In response to these challenges, Alsan et al. (2022) reveal that banks have increasingly restricted credit extension to more polluting firms and climate-vulnerable regions, incorporating climate risk into their credit provisioning processes. Similarly, Pinto-Gutiérrez (2023) reports that banks explicitly consider climate risks when making lending decisions, especially in cases where borrowers lack the capacity to minimize these risks. Reghezza et al. (2022) also document that financial institutions have gradually reallocated resources away from high-carbon activities, reducing the share of loans allocated to highly polluting firms. Additionally, Zhang (2021) finds that banks are more likely to extend lines of credit and impose fewer collateral requirements on environmentally friendly firms. Beyond lending, recent studies also explore the broader implications of climate risk for firms' capital structure and financial strategies (e.g., Smith et al., 2022; Brown et al., 2021).

Parallel to the reallocation of capital, a growing body of research examines the pricing of climate risk in financial instruments, focusing on how environmental risks are incorporated into asset valuations and credit conditions. Ge et al. (2024) show that banking institutions impose higher interest rates on borrowers deemed to be more exposed to climate-related risks. Similarly, Degryse et al. (2023) explore the role of environmental consciousness in shaping credit pricing, finding that "green banks" tend to offer more favourable loan terms to environmentally responsible firms. Ehlers et al. (2022) further demonstrate that in the aftermath of the Paris Agreement, financial institutions began applying explicit risk premiums to borrowers with higher carbon intensities, reflecting the growing integration of climate considerations into pricing mechanisms. The implications of climate risk are particularly pronounced in real estate and mortgage markets. Nguyen et al. (2023b) show that lenders charge higher mortgage interest rates for properties located in areas highly vulnerable to sea-level rise, accounting for the anticipated financial losses associated with physical climate risks. Similarly, Javadi and Masum (2021) find that firms operating in regions with high exposure to climate change face significantly higher loan spreads, underscoring the perception of climate change as a material financial risk. At the firm level, Chava (2014) demonstrates that companies with poor environmental performance face higher equity and debt costs, as banks not only charge them higher interest rates but are also less likely to participate in their loan syndicates.

Another prominent line of inquiry focuses on the assessment and management of climate-related financial risks. This stream examines how banks integrate climate considerations into their credit assessment processes and risk management frameworks. The first step in this process involves establishing systematic procedures for the identification, assessment, and management of climate-related risks, which are subsequently integrated into a bank's broader risk management strategy. Cucinelli et al. (2024) highlight the crucial role of the risk management function in increasing the awareness of risks and opportunities associated with climate change among banks. Friedrich et al. (2022) find that while many banks demonstrate a high quality of reporting on general risk management, only few fully incorporate climate-related risks into their lending operations. To support the financial sector's capacity to evaluate environmental risk, Sylos Labini and Nyenno (2023) propose a methodological framework designed to assist decision-makers in the banking industry in responding proactively to changes in the environmental and business landscape.

4.2.1.3. Cluster 3: Sustainable development and economic transformation – green. The key terms that characterise this cluster include *banking, environmental economics*, and *sustainable development*. **Cluster 3** focuses on the macroeconomic impacts of climate change on banking systems and the wider economy, illustrating how risks transmitted through banks influence critical macroeconomic variables, while also shaping the structural transition of banking systems and economies toward sustainable development. This research stream is framed from a macroeconomic perspective and situated within a global context shaped by disruptive events.

Climate change has profound negative impacts on both environmental and socio-economic systems. In fact, climate change can translate into material risks within traditional financial risk categories, ultimately affecting traditional banking activities and the broader economy. These risks can manifest through their influence on key macroeconomic variables such as economic growth, labour productivity, government debt, and Gross Domestic Product (GDP), while also driving significant socio-economic transformations. Consequently, the design and implementation of effective macroprudential policies are essential to control climate-related risks. Indeed, delayed implementation of climate policies—commonly referred to as a disorderly transition—significantly worsens the economic performance of the Euro area. Moreover, under a disorderly transition scenario, combined with elevated physical climate risks, real GDP is projected to decline by 12.5 % by 2050 compared to an orderly transition pathway (Gourdel et al., 2024). Cevik and Gwon (2024) discover that weather anomalies could disrupt supply chains, which can subsequently result in inflationary pressures.

Additionally, transitional risk can prompt the banking system to raise interest rates to curb inflation, which may inadvertently exacerbate the decline in economic activity, leading to reductions in GDP and employment (McKibbin et al., 2020). In this context, Wu et al. (2024) find that banks operating in countries characterised by higher loan interest rates, weaker regulatory quality, and greater carbon emission intensity are more severely affected by climate risk. Furthermore, Aguila and Wullweber (2024) emphasise that elevated interest rates significantly hinder the green transition by increasing the cost of sustainable investments, thereby slowing the structural shift toward sustainability. Alessi et al. (2024) utilise advanced simulation models to study the European banking sector, demonstrating the existence of a critical threshold effect. Their findings indicate that shocks which initially appear limited in scope may escalate into substantial system-wide losses, underscoring the need to account for contagion channels and concentration risks. Similarly, Acharya et al. (2023) emphasise the importance of evaluating risk environments where climate-related threats intersect with traditional economic pressures, exacerbating interconnected vulnerabilities and increasing structural fragility.

In response, international organisations and national governments have implemented initiatives such as the Sustainable Development Goals and the Paris Agreement to supervise climate change effects and foster sustainable development (Adu & Roni, 2023). Within this context, the banking sector functions as a key institutional actor driving the long-term transformation of economies toward sustainability while safeguarding economic growth (Odeku, 2017). Recent research emphasises the importance of governance structures, regulatory frameworks, and collaboration between public and private actors in redirecting financial flows toward strategic sectors that support sustainable transitions (Caby et al., 2020). Policy recommendations include strengthening government oversight of the financial sector and requiring environmental impact assessments as a prerequisite for project approval, ensuring that banks critically evaluate environmental suitability before issuing loans, as well as streamlining administrative procedures to accelerate the financing of green initiatives (Pu et al., 2024). Structural reforms, such as legally redefining the calculation of dividends to decouple economic systems from greenhouse gas emissions, are also proposed (Lainé, 2023). Overall, the greater engagement by banks in addressing climate-related challenges not only promotes sustainable development but also generates positive economic outcomes (Birindelli et al., 2022; Shakil et al., 2019).

4.2.1.4. Cluster 4: Monetary policy and financial stability – blue. The main keywords of this cluster are *central bank, financial stability, monetary policy, and sustainable finance*. This cluster examines the interaction between climate-related risks, the financial sector, and monetary policy, to understand how climate change affects financial practices, policies, and stability.

Climate change poses substantial risks to economies and constitutes a pressing global challenge, generating significant adverse consequences for the environment, society, and economic systems (Lee & Alam, 2024). As Ahmad and Satrovic (2023) observe both acute climate-related shocks and the transition toward a low-carbon economy are expected to shape the conduct of monetary policy. This growing involvement and interest of central banks in the impact of climate change on monetary policy and financial stability is reflected in the establishment of the NGFS in 2017, which provides a collaborative platform for central banks and financial supervisors committed to addressing climate change and its economic consequences (Feldkircher & Teliha, 2024). Simultaneously, the literature highlights the destabilising effects of climate risks on financial systems. However, Liu et al. (2024) show that the implementation of well-designed macroprudential policies plays a crucial role in preserving financial stability in countries particularly vulnerable to climate-related shocks. In this context, central banks play a central role in managing climate-related financial risks, safeguarding financial stability, and steering economies toward more sustainable practices (Diluiso, 2021). Given that climate-related risks affect the formulation and implementation of monetary policy, their integration into central banking agendas has become relevant (Vollmer, 2022). Indeed, numerous studies within this cluster underscore that central banks can help address climate change by facilitating the green transition and advancing sustainable finance initiatives (Campliglio, 2018; Diluiso et al., 2023; D'Orazio and Popoyan, 2023; Ham et al., 2024). The academic literature on climate change and central banking can be broadly divided into two main strands. The first strand examines the consequences of climate change and related policy measures for financial stability, as well as their implications for the ability of central banks to effectively fulfil their monetary policy mandates (Durrani et al., 2020; Jawadi et al., 2024; Masciandaro & Russo, 2024; Vollmer, 2024). The second strand explores the extent to which central banks can actively contribute to minimize climate change and alleviating its associated economic consequences (Feldkircher & Teliha, 2024; Alessi et al., 2024; D'Orazio & Popoyan, 2019).

Central banks' functions are significant, as the effective implementation of environmental policies and the adoption of stricter regulatory measures aimed at enhancing environmental sensitivity within the banking sector are essential to reduce the effects of climate change on financial stability (D'Orazio and Popoyan, 2023; Chiaramonte et al., 2024). However, the expected climate impact of such interventions may remain minimal (Masciandaro & Russo, 2024; Ferrari and Nispi Landi, 2023). Furthermore, sustainability is still far from being the priority for most central banks, which continue to prioritise price stability, despite the growing need to integrate climate-related risks into their policy frameworks to safeguard financial stability (Dikau & Volz, 2021).

Simultaneously, policies and initiatives advanced by central banks to address climate change can give rise to transition risks, which pose notable challenges to financial stability at both institution and financial system levels (Chabot & Bertrand, 2023). Banks are more exposed to systemic disruptions under a disorderly transition although the fiscal costs associated with stabilizing the most vulnerable institutions remain relatively contained (Ojea-Ferreiro, 2024). Hence, adopting well-calibrated policies capable of reducing the incidence and severity of climate-related crises is necessary to ensure the preservation of financial stability (Curcio et al., 2023).

The studies in this cluster also examine the manner in which climate change can exacerbate financial systemic risk, thereby affecting the stability of the entire financial system (Wu et al., 2023). As demonstrated by Curcio et al. (2023), the interconnectedness between financial markets and institutions could amplify the impacts of climate risk through indirect equity losses and self-reinforcing feedback loops. Thus, financial institutions are more inclined to transfer the risk of losses to other entities through close financial

connections with various economic institutions, triggering a widespread risk contagion that further exacerbates systemic risk (Cao et al., 2021). The increased bank systemic risk due to higher climate risk is mostly driven by worsened credit quality rather than by other factors, and the adverse impact of climate risk is minimized when banks have higher profitability or capital adequacy (Wu et al., 2024).

4.2.2. Co - citation

Co-citation analysis is a science-mapping technique based on the premise that publications frequently cited together are likely to exhibit thematic similarities (Donthu et al., 2021). It enables the structural mapping of scientific fields by analysing bibliographic data obtained from selected databases (Zupic & Cater, 2015). In this study, author co-citation analysis was employed to identify the most influential scholars in the field, with the aim of uncovering hidden patterns of relationships among authors based on their publications (Migliavacca et al., 2022). The results reveal that these authors exert a significant impact on the development of research on climate-related risks in banking (Korzeb et al., 2024). From the 238 articles selected, a total of 13477 references were extracted. Following the approach of Carè et al. (2024), and utilizing the VOSviewer software, the analysis was restricted to authors who had received a minimum of 35 citations, thereby yielding a final sample of 33 authors out of a total of 19,114. In Fig. 5, node thickness represents the strength of co-citation relationships, while the spatial proximity of nodes reflects closer citation connections. The resulting co-citation network identified four distinct clusters among these 33 authors, encompassing 484 links and a cumulative link strength of 21782.

As demonstrated in Fig. 5, authors belonging to the same cluster exhibit a marked tendency to address thematically proximate issues. In particular, the authors grouped in the red cluster (Campiglio, 2016; Dafermos et al., 2018; Dikau & Volz, 2021; Dikau et al., 2024) focus on the governance and monetary policy dimensions of sustainable finance. This strand of research highlights the role of central banks, financial regulators, and international organisations in steering banking institutions towards sustainability. The green cluster (Bressan et al., 2022; Monasterolo et al., 2024; Roncoroni et al., 2021), which is closely related to the previous one, focuses on banking sector initiatives addressing climate risks, as well as the broader implications of such risks for financial stability. The blue cluster (Abedifar et al., 2024; Bolton & Kacperczyk, 2023; Krueger, Sautner, & Starks, 2020; Nguyen et al., 2022) explores how financial markets, institutions, and investors incorporate climate change considerations, with particular attention to risk assessment, carbon emissions, renewable energy financing, and the consequences for asset pricing and portfolio allocation. Finally, the yellow cluster (Chen et al., 2022; Chen et al., 2023; Shan et al., 2023) connects climate-related banking practices with sustainable development, the green economy, and the structural responses of the financial system to global challenges. The four primary research streams are in alignment with the division confirmed by the co-ocurrence analysis, being this analysis conducted as a robustness test for the purpose of ensuring the reliability of the study (Migliavacca et al., 2022).

4.2.3. Bibliographic coupling

Bibliographic coupling is defined as the occurrence of citation of the same third publication by two publications (Korzeb et al., 2024). In fact, bibliographic coupling is a technique for science mapping that operates on the assumption that two publications sharing common references are also similar in their content (Donthu et al., 2021). Indeed, the bibliographic coupling analysis map is constructed based on the number of citations received by the sampled articles, as well as the total strength of the links between them. In this context, bibliographic coupling provides insights into current research trends and helps identify the topics that are actively being investigated within the field (Migliavacca et al., 2022).This connection reflects a shared intellectual background and indicates thematic similarity between the documents, thereby serving as an effective robustness test for the co-occurrence analysis. The strength of the bibliographic coupling relationship between two articles increases with the number of references they have in common. By examining these connections, researchers can identify clusters of related work, map the structure of a research field, and uncover patterns of knowledge dissemination. As illustrated in Fig. 6, the bibliographic coupling of documents is represented by citations, with a minimum of 45 citations (Donthu et al., 2020).

The bibliographic coupling analysis identifies five thematic clusters, with overall link strength reflecting how closely each article is linked to others in the dataset (Table 9). The red cluster gathers studies that examine the relationship between climate risk, monetary policy, central banking, and financial stability (Dafermos et al., 2018; Baer et al., 2021). Within this cluster, the study by Dafermos and Nikolaidi (2021), which holds the highest total link strength, develops a dynamic macrofinancial model showing that green differentiated capital requirements can reduce climate risk while promoting sustainable investment. The second most interconnected article (Chenet et al., 2021) also addresses regulatory responses, advocating for a precautionary approach to financial policy under conditions of radical uncertainty, and challenging the adequacy of traditional risk-based methods. Similarly, Dafermos et al. (2018) analyse the limitations of conventional monetary policy in managing climate risks, emphasizing the need for central banks to integrate climate concerns into their frameworks.

Closely related, the yellow cluster focuses on macroeconomic strategies to redirect capital flows toward green investments (D'Orazio & Popoyan, 2019; Roncoroni et al., 2021), and maintains strong linkages with the red cluster through shared attention to regulatory and policy-based solutions. Curcio et al. (2023) provide empirical evidence that climate-related risks contribute significantly to systemic vulnerabilities in U.S. banks, reinforcing the growing call for the integration of climate considerations into financial regulation. In contrast, the green cluster centers on the micro-level financial effects of climate change, particularly how it impacts banks' economic activities and lending portfolios (Alessi et al., 2021; Javadi & Masum, 2021; Reghezza, 2022). Meanwhile, the blue and purple clusters are less integrated with the rest of the network and thematically more diffuse, featuring articles with broader perspectives, such as those examining financial performance or ESG (Caby, 2020; Li et al., 2024; Shu & Tan, 2023).

Taken together, the articles with the highest total link strength are predominantly located in the red and yellow clusters, reflecting a

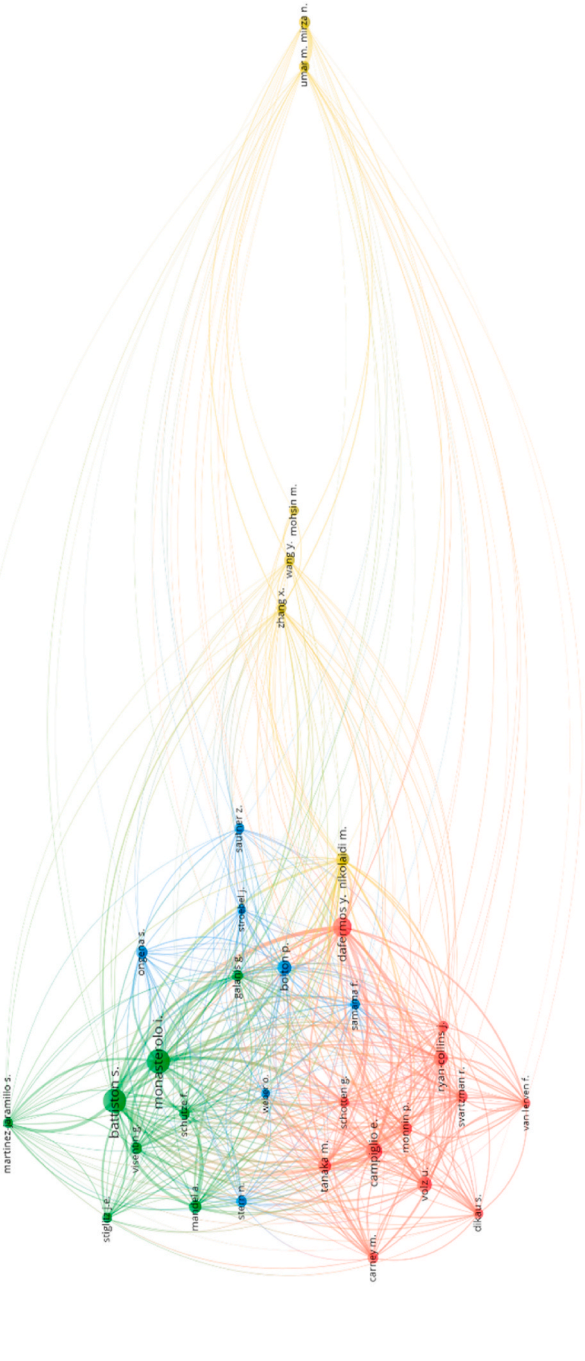

Fig. 5. Co – citation network of most contributing authors.
Source: Authors' elaboration using VOSviewer.

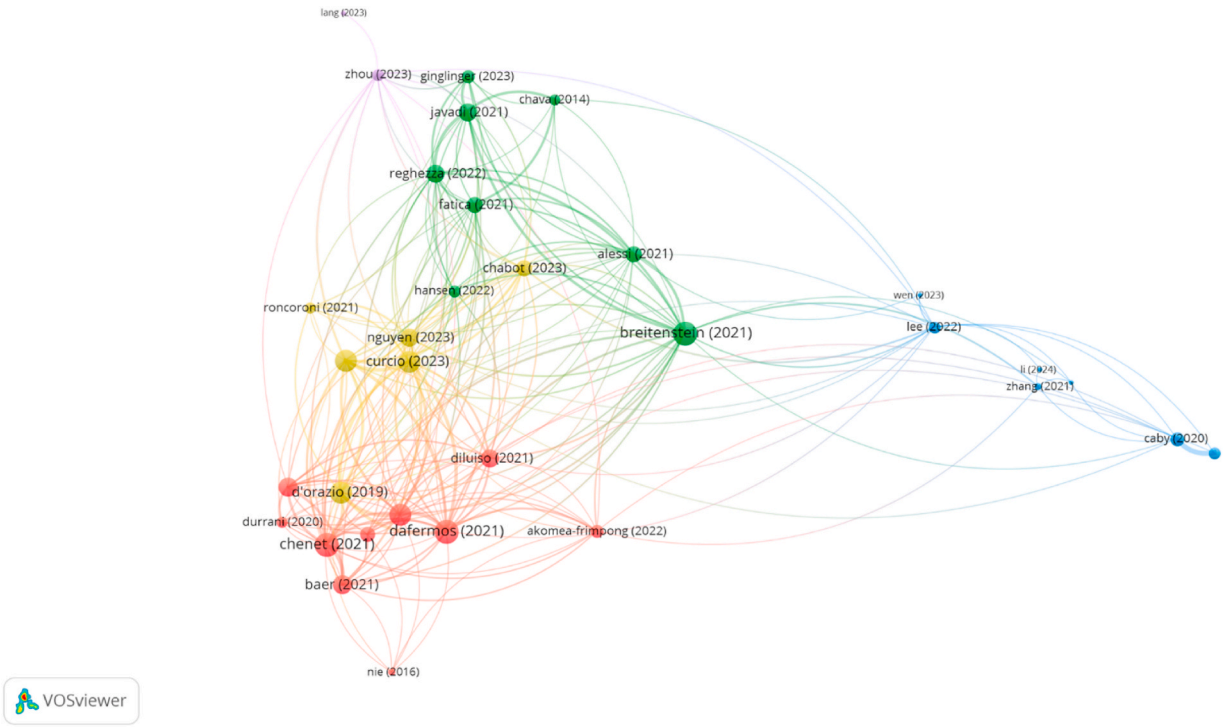

Fig. 6. Bibliographic Coupling. Minimum number of citations of a document is 45.
Source: Authors' elaboration using VOSviewer.

Table 9
Bibliographic coupling analysis.

Rank	Article	Link Strength	Direction
1	Dafermos, Y., and Nikolaidi, M. (2021). How can green differentiated capital requirements affect climate risks? A dynamic macrofinancial analysis. *Journal of Financial Stability, 54*, 100871. https://doi.org/10.1016/j.jfs.2021.100871	73	Green financial policy to address climate risks
2	Chenet, H., Ryan-Collins, J., and van Lerven, F. (2021). Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. *Ecological Economics, 183*, 106957. https://doi.org/10.1016/j.ecolecon.2021.106957	70	Proposes a precautionary financial policy to address climate related financial risks.
3	Breitenstein, M., Nguyen, D. K., and Walther, T. (2021). Environmental hazards and risk management in the financial sector: A systematic literature review. *Journal of Economic Surveys, 35*(4), 1074–1110. https://doi.org/10.1111/joes.12411	69	Analyses environmental and climate-related risk management in the financial sector.
4	Curcio, D., Gianfrancesco, I., and Vioto, D. (2023). Climate change and financial systemic risk: Evidence from US banks and insurers. *Journal of Financial Stability, 66*, 101132. https://doi.org/10.1016/j.jfs.2023.101132	63	Climate change and financial systemic risk.
5	Dafermos, Y., Nikolaidi, M., and Galanis, G. (2018). Climate change, financial stability and monetary policy. *Ecological Economics, 152*, 219–234. https://doi.org/10.1016/j.ecolecon.2018.05.011	62	Financial stability and climate risks.

Source: Authors' elaboration based on Galletta et al. (2022).

strong current focus in the literature on the development and evaluation of regulatory and financial policy frameworks to address climate-related risks. This concentration underscores a shift from purely theoretical or descriptive approaches toward applied, policy-oriented research aimed at strengthening financial system resilience in the face of climate change.

4.2.4. Co-authorship

Fig. 7 presents a co-authorship network generated using VOSviewer, illustrating the collaborative relationships among researchers focusing on climate risk in banking (Paltrinieri et al., 2023). The main reason behind conducting this analysis was to recognize those scholars who are actively contributing together in this research field (Migliavacca et al., 2022). The network was constructed using a minimum scale of one document per author and a minimum of 95 citations per author (Carè et al., 2024). The results of the analysis indicate the presence of four primary clusters, comprising a total of 17 researchers. These researchers are engaged in collaborative investigations pertaining to diverse aspects of climate-related risks and the banking sector. Within the network, each node represents

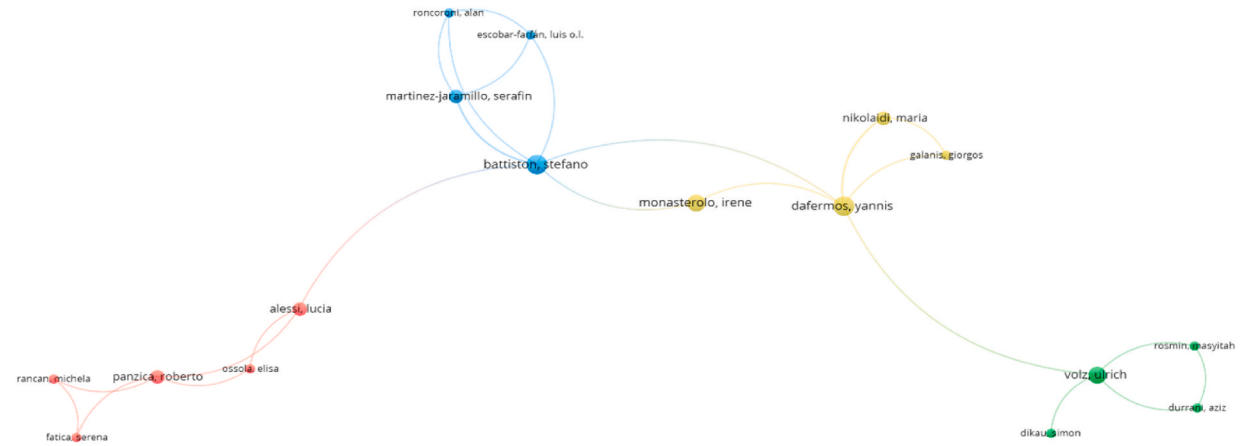

Fig. 7. Co - Authorship analysis. Minimum number of documents per author is one. Minimum number of citations of an author is 95.
Source: Authors' elaboration using VOSviewer.

an individual researcher, with the size of the node corresponding to the researcher's citation impact. Links between nodes are used to denote co-authorship ties, with the thickness of the link reflecting the strength of collaboration between the two researchers. This co-authorship analysis underscores the pivotal function of collaborative networks in promoting research on climate-related financial risks, facilitating knowledge dissemination, and fostering cross-institutional and interdisciplinary collaborations. Table 10 provides details of this authors.

The co-authorship network generated by VOSviewer illustrates four distinct clusters (A–D), each reflecting close collaborations among scholars working on climate-related financial risks. These clusters reveal both institutional affiliations and thematic orientations, highlighting how knowledge production in this field is shaped by concentrated but interconnected research groups. From the co-authorship network, several insights can be drawn. Authors who publish frequently on climate risk in banking tend to form close collaborative relationships, which collectively contribute to advancing research in this field. Such collaborations are often driven by professional connections, such as working at the same institution, either currently or in the past, or through affiliations as visiting scholars.

Cluster A (red) is dominated by researchers affiliated with the European Commission's Joint Research Centre, including Panzica, Alessi, and Fatica, alongside collaborators such as Ossola and Rancan. This group exhibits strong intra-institutional collaboration and focuses primarily on empirical assessments of green finance and the regulatory impacts within the EU context. Cluster B (green), by contrast, encompasses more globally distributed authors, such as Volz (SOAS), Dikau (LSE), and Serafin Martinez-Jaramillo (The World Bank), together with collaborators from Malaysia, including Rosmin and Durrani, the latter having served as a visiting senior fellow at the Grantham Research Institute on Climate Risk and the Environment at the London School of Economics (LSE). This cluster

Table 10
Social Network of authors.

Co-Author Network	Author	Institution	TP	TC
D	Dafermos, Yannis	SOAS, University in London, UK	4	804
C	Battiston, Stefano	University of Zurich, Switzerland	4	485
B	Volz, Ulrich	SOAS, University of London,UK	3	434
D	Monasterolo, Irene	Utrecht University, School of Economics	3	363
D	Nikoladi, Maria	University of Greenwich, London	2	498
A	Panzica, Roberto	European Commission, Joint Research Centre, Italy	2	320
C	Martinez-Jaramillo, Serafin	The World Bank, USA	2	167
A	Alessi, Lucia	European Commission, Joint Research Centre, Italy	2	131
D	Galanis, Giorgios	School of Business and Management, Queen Mary University of London, UK	1	423
B	Dikau, Simon	London School of Economics and Political Science (LSE), UK	1	337
A	Fatica, Serena	European Commission – Joint Research Centre, Italy	1	202
A	Rancan, Michela	Marche Polytechnic University, Italy	1	202
C	Roncoroni, Alan	University of Zurich, Switzerland	1	160
C	Luis O.L. Escobar-Farfán	Banco de Mexico, Mexico City, Mexico	1	160
A	Ossola, Elisa	University of Milano-Bicocca, Italy	1	118
B	Rosmin, Masyitah	Research and Training Centre, Kuala Lumpur, Malaysia	1	96
B	Durrani, Aziz	Research and Training Centre, Kuala Lumpur, Malaysia	1	96

A = Red (Cluster 1); B = Green (Cluster 2); C = Blue (Cluster 3); D = Yellow (Cluster 4)

Source: Authors' elaboration.

is oriented towards financial stability, central banking, and policy applications in emerging markets. Cluster C (blue) centers around Battiston (University of Zurich) and his collaborators, including Roncoroni and Martinez-Jaramillo, with a focus on network-based modelling, and climate stress testing; notably, Battiston and Martinez-Jaramillo's joint work at the Bank of Mexico in 2018 illustrates how institutional affiliations can foster collaborative research and strengthen the development of this academic domain. Finally, Cluster D (yellow) gathers key figures such as Dafermos, Monasterolo, and Nikolaidi, who are recognised for their contributions to macro-financial modelling and the integration of climate risks into monetary and fiscal policy.

4.2.5. Citation

In citation analysis, the impact of a publication is assessed by the number of citations it receives, which enables the identification of the most influential works within a particular research domain (Donthu et al., 2021). Country-level citation analysis constitutes a bibliometric approach that evaluates the contributions of individual nations to a specific field, based on the citations garnered by articles authored by researchers affiliated with those countries (see Fig. 8).

The findings of this study, derived from performance analysis, are largely consistent with these observations. A consolidated examination of the Eurozone's output reveals that these countries maintain a dominant position in the field, consistently exhibiting the highest levels of both productivity and scholarly impact. This dominance is further reflected in the substantial number of citations their publications attract, which frequently rank among the most cited within their respective areas. Following the Eurozone, China, the United Kingdom, and the United States also demonstrate strong citation performance.

The analysis additionally highlights the interconnectedness of nations, with European countries exhibiting particularly dense citation linkages among themselves. Notably, the United Kingdom stands out for its exceptionally high degree of international collaboration, with its most significant citation connection established with China.

5. Main findings and future research avenues

5.1. Main findings

Academia has increasingly acknowledged the significance of climate-related risks in the banking sector, as evidenced by a notable increase in publications addressing these issues. The study reveals that since 2020, the level of attention being directed towards this subject by researchers and journals has notably increased. This surge is driven by several factors, including record-high extreme weather events and financial losses observed in recent years, heightening awareness among banks of the severe economic consequences of climate change. As a result, banking institutions are under increasing pressure to integrate climate-related risks into their

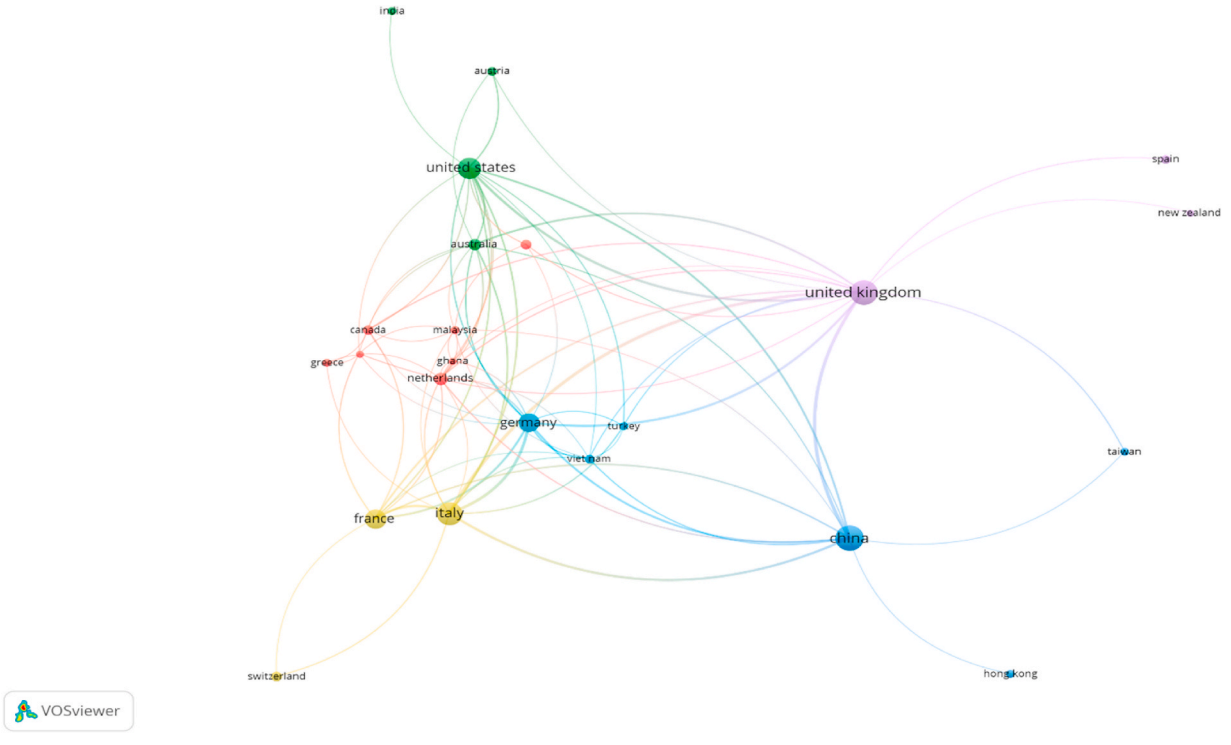

Fig. 8. Citation country analysis.
Source: Authors' elaboration using VOSviewer.

investment strategies and risk management frameworks. This process has been further reinforced by international initiatives, such as the TCFD and NGFS, and a series of climate-related policies.

This analysis has several findings. First, a well-established core of researchers dedicated to this topic has yet to emerge. This is evidenced by the fact that nearly 91 % of the 591 identified authors have only contributed a single publication. Second, most of the leading authors on climate risks in banking are affiliated with European institutions. These authors tend to collaborate closely with one another, fostering a network of expertise that collectively drives progress and advances knowledge in this field. Third, the Euro area leads in academic output on this topic, as it has long positioned itself as a global leader in sustainability and rigorous ESG regulations. However, a recent shift in regulatory priorities has emerged in Europe (Omnibus package), as growing concerns have arisen regarding the impact of excessive bureaucracy on economic performance given the strong EU compliance with climate targets. Fourth, China is a prominent contributor to the literature, placing significant emphasis on sustainable development and ecological policies. However, these initiatives are largely top-down and state-driven, often lacking transparency or clearly defined limitations. Hence, the quality of environmental reporting may be compromised, raising concerns about the effectiveness and credibility of China's green policies. Fifth, the United Kingdom is among the countries with the highest publication output; however, only a few studies focus on the country itself. This pattern may be explained by co-authorship dynamics, as many UK-based researchers collaborate with international partners, resulting in case studies that focus on other regions. Sixth, China is a highly studied country, as articles that focus on China frequently receive financial support from governmental sources. Seventh, an increasing number of specialized finance journals are engaging with the topic of climate risks, highlighting its growing relevance. Eighth, climate-related data have become more available through various platforms and tools, including the CDP, Bloomberg ESG & Climate Data, Refinitiv ESG, banks' sustainability reports and climate stress tests, and advanced analytical tools. However, in many cases, the information remains fragmented or limited, particularly for smaller banks. This underscores the need to enhance data availability and consistency, which serve as essential foundations for conducting more rigorous and comprehensive empirical analyses.

The co-occurrence analysis and subsequent cluster examination reveal several notable insights. Cluster 1 represents the conventional perspective on the role of banking finance in addressing climate change, highlighting the integration of climate-related risks within the traditional ESG framework, with particular emphasis on the environmental dimension. In this context, the banking sector is regarded as pivotal in mitigating the impacts of climate-related risks through the incorporation of green finance practices. Cluster 2 provides a microeconomic perspective on the interaction between climate risks and the banking sector. Specifically, this cluster explores the repercussions that climate risks exert on their operations, influencing their capital flows, assets, and loans, among other factors. The cluster focuses on risk management practices and examines how each bank's strategic orientation toward a low-carbon economy is reflected in its operational and financial performance. The studies in this cluster demonstrate that banking institutions in regions with a high degree of exposure to extreme weather events have experienced a deterioration in their overall credit quality. In response, banking institutions have restricted credit extension to polluting firms and increased interest rates or higher risk premiums for borrowers who are more exposed to climate risk to compensate for the uncertainties associated with climate-related exposures (Huynh & Xia, 2021; Javadi & Masum, 2021). However, banks may still prefer carbon-intensive energy production, which could have a negative impact on renewable energy consumption (Horky & Fidrmuc, 2024). This cluster also explores the importance of managing and assessing how climate risks affect banking institutions, as these processes are essential for ensuring their proper functioning. Cluster 3 offers a macroeconomic perspective on the interplay between climate risk and the banking sector. Studies in this cluster explore the effects that climate change has on variables such as economic growth, labour productivity, inflation, and GDP through the intermediary role of the banking sector. Furthermore, the cluster focuses on the efforts of international organisations and governments to promote sustainable finance among banking institutions, examining the extent to which such policies and practices have been implemented. Finally, Cluster 4 focuses on how climate change influences both financial stability and the conduct of monetary policy. It highlights the pivotal role central banks play in addressing climate-related risks and safeguarding the stability of the financial system. Dikau and Volz (2021) advocate for integrating climate considerations into central bank mandates. Specifically, the literature on climate change and central banking can be broadly divided into two main strands: (i) studies investigating the consequences of climate change and related policy measures for financial stability, and their implications for central banks' ability to effectively fulfil their monetary policy mandates (Durrani et al., 2020; Jawadi et al., 2024; Masciandaro & Russo, 2024; Vollmer, 2024); and (ii) research examining the extent to which central banks can actively contribute to mitigating climate change and alleviating its associated economic impacts (Feldkircher & Teliha, 2024; Alessi et al., 2024; D'Orazio & Popoyan, 2019).

5.2. *Future research avenues*

Climate risk in the banking sector is a relatively novel research topic; hence, this research area needs to be further explored. This study proposes future research directions in accordance with the methodological recommendations outlined by Bahoo et al. (2020), Carè and Weber (2023), and Carè et al. (2024). The study establishes a prospective research agenda for this subject. In this context, to identify future research gaps in the literature on climate change and banking, we applied a four-step method: (i) conducted a bibliographic analysis to identify the topics that are actively being investigated within the field and the main articles; (ii) performed a content analysis of these articles in each cluster to extract explicitly or implicitly stated research gaps; (iii) reformulated the identified gaps into clear research questions or thematic opportunities; and (iv) refined the list by removing duplicates and overlaps. This approach yielded a set of structured future research directions categorised into key thematic areas. The resulting set of guidelines ensures an integrative and finance-based approach to future research. Table 11 outlines the proposed future research directions.

Table 11
Future research directions.

Research Cluster	Q#	Research Question	References and suggested reading
Cluster 1- Yellow ESG, Green Financing and Climate Risks	1	Examine how regulatory shifts, such as climate stress tests, may trigger excess bank demand for green bonds and affect investor behavior and prices.	Boermans (2023); Fatica et al. (2021)
	2	Develop or refine methodologies to measure green finance effects in banking.	Lin et al. (2024)
	3	Analyse ways in which banks can turn climate-related risks into opportunities by investing in sustainability, offering green financial services, and developing innovative financial products.	Chalabi – Jabado and Ziane (2024)
	4	A comparison of the performance of private commercial banks before and after the development of green financing practices. Analyse the influence of reputation.	Nguyen et al. (2023a)
Cluster 2 – Red Financial Intermediation and Risk Management	5	Assess the adequacy of climate risk pricing in the banking sector.	Monasterolo (2020)
	6	Investigate potential increases in lending rates for community or small banks affected by climate change.	Vollmar and Wening (2024)
	7	Examine how financial institutions adjust risk management and lending in response to carbon tax policies.	Han et al. (2024)
	8	Assess how physical and transition risks affect banks' liquidity and operational risks.	Lee et al. (2022); Lang et al. (2023); Choi et al. (2023)
	9	Assess whether bank risk management tools lead to measurable improvements in environmental outcomes.	Cucinelli (2023)
Cluster 3 - Green Sustainable Development and Economic Transformation	10	Analyse which policies are most appropriate for green transformation in an economic environment of price stability.	Aguila and Wullweber (2024); Cevik and Gwon (2024)
	11	Examine the implications on climateflaction, fossilflaction and greenflaction.	Aguila and Wullweber (2024); Cevik and Gwon (2024)
	12	Analyse the sensitivity of green investments to changes in interest rates and credit supply.	Aguila and Wullweber (2024); Cevik and Gwon (2024)
	13	Investigate the quantitative relationship between adopting sustainable business models and key banking system outcomes such as profitability or customer loyalty.	Grijalvo and García-Wang (2023)
	14	Analysis of climate transition risks' impact on public debt sustainability through banking sector feedback loops	Alessi et al. (2024)
Cluster 4 - Blue Monetary Policy and Financial Stability	15	Examine the extent to which central banks should actively promote environmental policies within the banking sector.	Dikau and Volz (2021)
	16	Further investigation is needed into the implications of new policies and their interaction with existing ones.	Dafermos and NIkoladi (2021); Chenet et al. (2021)
	17	Compare financial systems across different regions (EU, Asia, Latin America, Africa) to examine whether the effects of climate impacts on systemic risk are similar or heterogeneous.	Wu et al. (2023)
	18	Analyse the response of systemic risk in the banking sector of developing countries to climate disasters and assess whether climate exposure and a lack of financial resilience amplify these systemic risks.	Curcio et al. (2023)
	19	To what extent is monetary and fiscal policy involved in climate -financing initiatives?	Dafermos et al. (2018); Chen et al. (2021)
	20	Which financial stability governance model leads to more effective climate-related polices.	D'Orazio and Popoyan (2023)
	21	Analyse the impact of the Omnibus package on bank disclosures.	Authors'review

Source: Authors' elaboration.

6. Conclusions

In recent years, there has been a growing need to manage the social and economic impacts of climate change. Coupled with the climate risks faced by financial institutions, the increasing regulation of the financial sector, in terms of sustainability - stress tests, taxonomy, Quantitative Easing (QE) - and the changing behaviour of individuals demanding increasingly greener investments, has led to a boom in academic research into banking climate risk.

This study explores the growing recognition of climate change and its profound implications for the banking sector, with the focus on how climate-related risks influence banking operations and stability. The findings underscore the critical importance of integrating climate risk considerations into banking strategies, regulatory frameworks, and risk management systems to enhance resilience and sustainability within the sector. To achieve this, a bibliometric approach was employed to systematically map the research landscape at the intersection of banking and climate risks. This method enabled the identification of research trends, key themes, and existing gaps in the literature, thereby offering a comprehensive perspective on the interconnectedness of climate-related risks and the banking sector. The analysis covers scholarly contributions published between 2010 and 2024, encompassing a total of 236 publications sourced from the Scopus database. The bibliometric investigation was conducted in two stages: performance analysis and science mapping, utilizing the VOSviewer software to visualize relationships among authors, institutions, and thematic clusters. Overall, this study provides meaningful contributions to the literature by offering a structured overview of how climate risks are being examined within the banking sector. By uncovering patterns, trends, and research gaps, it not only addresses the initial research questions but also lays the groundwork for advancing scholarly inquiry in this rapidly evolving field.

The analysis shows that research on climate risk in banking is still emerging, with most authors contributing only one publication and strong collaboration networks concentrated in Europe. The euro area leads in output due to its long-standing ESG focus, while China is also prominent, though its top-down policies often lack transparency. The United Kingdom has high publication activity but limited country-specific studies, reflecting international co-authorship. Climate risks are gaining visibility in leading finance journals, yet data remain fragmented—particularly for smaller banks—underscoring the need for greater consistency and accessibility to support rigorous empirical research.

The cluster analysis reveals four main thematic streams. Cluster 1 captures the evolution of the topic, beginning with the traditional ESG approach and progressively emphasizing the environmental dimension, which has led to the emergence of concepts such as green finance and climate finance. In this context, banks can play a key role in mitigating the impact of climate-related risks by developing green financing instruments. Cluster 2 adopts a microeconomic perspective to examine how climate-related risks propagate through banks' internal channels, affecting credit quality and asset performance, operational and financial risk management, and strategic decision-making. Cluster 3 focuses on the macroeconomic impacts of climate change on banking systems and the wider economy, illustrating how risks transmitted through banks influence critical variables such as economic growth, GDP, labor productivity, government debt, and interest rates, while also shaping the structural transition of financial systems and economies toward sustainable development. Finally, cluster 4 focuses on central banks, exploring how climate-related risks impact financial stability and monetary policy, and the extent to which central banks can actively support climate change mitigation.

Lastly, this study highlights the evolution of the literature within each thematic stream and outlines promising directions for future research. Future research should focus on evaluating how financial markets and institutions adapt to climate-related risks, policies, and innovations. Key areas include improving climate risk pricing, understanding the effects of carbon taxes and sustainable practices on banking strategies, and assessing the resilience of vulnerable groups and developing economies. Additionally, studies should explore the effectiveness of green financial instrument and how banks can transform climate risks into opportunities through innovation and green products. Furthermore, although the availability of data and methodological tools is gradually increasing, there remains a need for further progress. Future studies must prioritise the creation of comprehensive datasets, advanced models, and innovative methodologies to deepen the understanding and management of climate risks within the financial system. Addressing these gaps will be essential for strengthening the resilience of banks and supporting a sustainable transition in the global economy.

Like any scientific investigation, this study is not without limitations, which also provide valuable avenues for future research. First, the analysis was based on a predefined search query designed to capture a broad range of literature on climate risk in the banking sector. While this approach allowed us to identify key themes and trends within the field, the inclusion of additional or alternative keywords could yield a more comprehensive dataset, potentially uncovering further empirical insights. Second, the study relied exclusively on peer-reviewed academic articles. It is important to acknowledge, however, that many institutional reports produced by various organisations are later adapted and published as journal articles. Consequently, some of these institutional perspectives may already be indirectly reflected in our dataset. Finally, as the research was conducted using a single bibliographic database – Scopus -, the findings may be influenced by the scope and coverage of that source. Future studies would benefit from incorporating multiple databases to enable cross-validation and provide a more robust comparative perspective.

Overall, this study represents an important step toward leveraging bibliometric analysis to advance understanding of climate risk in the banking sector.

Credit author statement

Violeta Bringas Fernández: Conceptualization, Data collection, Methodology, Formal analysis, Writing & Editing. Begoña Torre Olmo: Conceptualization, Methodology & Editing. María Cantero Saiz: Conceptualization, Methodology & Editing.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Appendix

Table A
Excluded articles from the sample as they result irrelevant for the focus of the study. Reasons for exclusion: (i) it addresses climate change–related topics but lacks a banking perspective, as some papers were included through keyword filtering for 'bank,' inadvertently capturing works referencing World Bank data, seed banks, or riverbanks without analyzing the banking sector itself; (ii) it is a reading note, call for papers, or erratum rather than a

research article; and (iii) it does not specifically address climate change, but merely mentions the concept in the abstract as one of several potential shocks—such as pandemics or geopolitical instability—that can affect the economy, without focusing on its specific impacts.

Article	Objective	Reason of the exclusion
Induced innovation in clean energy technologies from foreign environmental policy stringency? (Herman & Xiang, 2019).	Investigate whether stricter foreign environmental policies induce innovation in clean energy technologies.	i) "We have obtained the data from the OECD, World **Bank …**"
Ecological footprint, air quality and research and development: The role of agriculture and international trade (Alvarado et al., 2021).	Analyse the relationships between ecological footprint, air quality, and research and development (R&D), focusing on the roles of agriculture and international trade in influencing environmental outcomes.	i) "Used the World **Bank** classification of regions."
*Potentials for prosperity without growth: Ecological sustainability, social inclusion and the quality of life in 38 countries (*Fritz & Koch, 2014).	Explore the possibilities for achieving prosperity without economic growth by examining ecological sustainability, social inclusion, and quality of life across 38 countries.	i) "Data from sources such as The World **Bank**."
Temperature shocks, short-term growth and poverty thresholds: Evidence from rural Tanzania (Letta et al., 2018).	Investigates the impact of temperature shocks on short-term economic growth and poverty thresholds in rural Tanzania.	i) "Using the LSMS-ISA Tanzania National Panel Survey by the World **Bank"**
A study of climate-smart farming practices and climate-resiliency field schools in Mindanao, the Philippines (Chandra et al., 2017).	Examines the adoption of climate-smart farming practices and the role of climate resiliency field schools in enhancing the adaptive capacity of farmers in Mindanao, Philippines.	i) "The establishment of community seed **banks**"
Determinants of firms' greenness towards sustainable development: A multi-country analysis (Horbach et al., 2022).	Investigates the key determinants that influence firms' commitment to environmental sustainability across multiple countries.	i) "Analysis based on recent World **Bank** data"
Trust in government and willingness to pay taxes in transition countries (Anderson, 2017).	Examines how trust in government influences individuals' willingness to pay taxes in transition economies.	i) "Data are from the European **Bank** for Reconstruction"
*Population, poverty, and climate change (*Das Gupta, 2014*).*	Explores the complex interactions between population growth, poverty, and climate change, analyzing how these factors influence development outcomes and policy responses.	i) "Published in World **Bank** Research Observer"
*Debunking Murray-Darling Basin water trade myths (*Wheeler, 2022*).*	Examine and debunk common misconceptions about water trading in the Murray-Darling Basin, focusing on its economic and environmental impacts.	i) "Markets have been blamed for a range of issues, including claims of unsustainability, inequity, farm **bank**ruptcy, etc. "
Water in circular economy and resilience (WICER) framework (Delgado et al., 2024).	Presents the Water in Circular Economy and Resilience (WICER) framework, aiming to integrate water management within circular economy principles to enhance resilience and sustainability in utility services.	i) "The Framework grew out of a literature review and was informed by the knowledge of the World **Bank."**
Strategic solutions for the climate change social dilemma: An integrative taxonomy, a systematic review, and research agenda (Rashidi-Sabet et al., 2022).	Develops an integrative taxonomy of strategic solutions to address the social dilemma posed by climate change.	i) "Next, we look at the climate action recommendations of leading organisations that grew out of the League of Nations – the United Nations, the World **Bank**, etc."
Public perception of offshore wind farms in Ireland (Cronin et al., 2021).	Examines public perception and attitudes toward offshore wind farms in Ireland, aiming to understand social acceptance and potential barriers to the development of renewable energy infrastructure.	i) "a focus group involving five members of the public with regular exposure to Ireland's only wind farm, Arklow **Bank** Wind Park, was held."
Rural households in a changing climate (Baez et al., 2012).	Analyzes how rural households adapt to changing climate conditions	i) "Published in World **Bank** Research Observer"
Party competition and industrial structure in the 2012 elections: Who's really driving the taxi to the dark side? (Ferguson et al., 2014).	Investigates the relationship between party competition and industrial structure during the 2012 elections.	i) iii) It does not focus on climate change neither on the banking sector.
*Climate change and agricultural development in West Africa: Role of renewable energy and trade openness (*Ali, 2021).	Examines the impact of climate change on agricultural development in West Africa, focusing on how renewable energy adoption and trade openness can mitigate negative effects.	i) "World **Bank** data from 1990 to 2015"
Open innovation using satellite imagery for initial site assessment of solar photovoltaic projects (Nagendra et al., 2022).	Explores the use of open innovation and satellite imagery technology to enhance the initial site assessment process for solar photovoltaic (PV). projects, aiming to improve decision-making and project efficiency.	i) "The selection of sites whose knowhow may not rest with all the stakeholders supporting (e.g., **banks** financing the project)"
Improving infrastructure (Jones & Llewellyn, 2019).	Examines strategies and policies aimed at improving infrastructure quality and investment, highlighting the economic benefits of enhanced infrastructure for growth and productivity.	i) "Establish a National Investment **Bank** to offer project guarantees"
"Low carbon city development" (LCCD) as a strategy for sustainable cities: The case of Rio de Janeiro, Brazil (Rescalvo et al., 2013).	Explores the concept of Low Carbon City Development (LCCD) as a strategic approach for promoting sustainable urban development, using	i) "the World **Bank** and DNV KEMA Energy and Sustainability"

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Table A (*continued*)

Article	Objective	Reason of the exclusion
	Rio de Janeiro as a case study to analyse policies, technologies, and practices aimed at reducing carbon emissions in cities.	
Clive Palmer's claims against Australia for billions renew pressure to remove investor rights to sue governments from trade agreements (Ranald, 2024).	Analyzes the renewed debate sparked by Clive Palmer's legal claims against the Australian government, focusing on the pressure to reform or remove investor-state dispute settlement (ISDS) provisions that allow investors to sue governments under trade agreements.	i) "the United Nations and World **Bank** institutions"
Call for Themed Collections for *The Economic and Labour Relations Review*. (Kelly, 2023)	This article issues a call for submissions to themed collections for *The Economic and Labour Relations Review*, encouraging researchers to contribute papers on specific topics relevant to economic and labor relations.	ii) It is a call paper.
Erratum regarding missing Declaration of Competing Interest statements in previously published articles. ()	Erratum	ii) Erratum
Erratum: Quasi-experimental evidence on carbon pricing. ()	Erratum	ii) Erratum
Off dependence on the highway to hell and on to the stairway to heaven (Glock, 2022).	This article critically examines the economic and social consequences of dependence on harmful economic practices.	i) "Entreating supply shocks will be more akin to returning Apollo 13 to Earth than it will be to burying **bank** notes."
A conversation with Maureen Cropper (Cropper, 2019).	Presents an in-depth interview and discussion with Maureen Cropper, focusing on her contributions to resource economics, including environmental valuation, climate change economics, and policy analysis.	i) "Together with many collaborators-including former students and colleagues at the University of Maryland, World **Bank**, EPA."
Reflections on COP27: How do technological innovations and economic freedom affect environmental quality in Africa? (Sakariyahu, 2023).	Examines how technological innovations and economic freedom influence environmental quality in Africa, particularly in the context of the global climate discussions following COP27.	i) "World **Bank** Database"
The green and digital twin transition: EU vs US firms (Veugelers et al., 2023).	Compares how firms in the EU and the US are progressing in the twin transition toward green and digital technologies.	i) "We use information from the 2021 European Investment **Bank** Investment Survey on firms"
Climate change, corruption, and business bribes in South Asia (Lee & Moumbark, 2022b).	Investigates the relationship between climate change, corruption, and the prevalence of business bribes in South Asia.	i) "Level data for five South Asian countries from the World **Bank** Enterprise Survey."
SSP economic growth projections: Major changes of key drivers in integrated assessment modelling (Koch & Leimbach, 2023).	Analyzes how recent changes in key economic drivers affect the Shared Socioeconomic Pathways (SSP) economic growth projections used in integrated assessment models.	i) "Using the most recent economic data and short-term projections by the World **Bank** and International Monetary Fund"
Grassroots mobilization in Brazil's urban Amazon: Global investments, persistent floods, and local resistance across political and legal arenas (Martins Dias et al., 2021).	Examine how grassroots mobilizations in Brazil's urban Amazon respond to persistent urban flooding, global investment pressures, and environmental injustices.	i) "Inter-American Development **Bank** and local government"
Striving for carbon neutrality and economic prosperity in the top ten emitting countries: Testing N shape Kuznets curve hypothesis (Khan et al., 2023).	Examines the relationship between carbon emissions and economic growth in the top ten carbon-emitting countries.	i) "The data used in this research was taken from various sources, such as the International Energy Agency and the World **Bank**."
Inner Mongolia must leapfrog the energy mistakes of the western developed nations (Clark & Isherwood, 2010).	Advocates for Inner Mongolia to bypass ("leapfrog") the environmentally harmful energy development paths taken by Western industrialized nation.	i) "The purpose of the Asian Development **Bank** Report was to investigate and study the energy infrastructure development."
The value of advanced end-use energy technologies in meeting U.S. climate policy goals (Kyle et al., 2011).	Assesses the role and value of advanced end-use energy technologies in achieving U.S. climate policy goals.	i) "When the policies allow intertemporal shifting in the emissions pathways (i.e., **banking** and borrowing)."
The role of public and private interventions on the evolution of green innovation in China. (Ali, 2024).	Investigates how public and private sector interventions influence the development and evolution of green innovation in China.	i) "We relied on public repositories, such as the World **Bank"**
Effects of industrialization on business and economic climate in Nigeria: Evidence from sectoral analysis (Udoh, 2024).	Examines the effects of industrialization on the business environment and economic climate in Nigeria through a detailed sectoral analysis.	i) "The data set was sourced and collated from the World **Bank** Development Index."
Understanding the effect of an emissions trading scheme on electricity generator investment and retirement behaviour: The proposed carbon pollution reduction scheme (Lambie, 2010).	Examines how an emissions trading scheme (ETS), specifically the proposed Carbon Pollution Reduction Scheme (CPRS), influences electricity generator investment and retirement behaviour.	i) "Provisions for **banking**, borrowing and internationally trading permits"
Understanding the cyclical patterns of carbon dioxide emissions to mitigate climate change:	Analyzes the cyclical patterns of carbon dioxide emissions in the QUAD countries (United States, Japan, India, and Australia).	i) "Utilizing the Hodrick-Prescott filter on annual data from 1970 to 2020, sourced from the World **Bank** and Our World in Data"

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Table A (*continued*)

Article	Objective	Reason of the exclusion
Evidence from the QUAD countries (Mahajan, 2024).		
The impact of climate change on the Palestinian sectoral reallocation of labor (Hallaq & Daas, 2024).	Investigates how climate change affects the reallocation of labor across different economic sectors in Palestine.	i) "Across the West **Bank** from 1999 to 2018"
Blue carbon as a potent strategy in the pathway to achieve net zero (Gandhi, 2024).	Explores the role of blue carbon ecosystems as an effective strategy for achieving net-zero carbon emissions.	i) "The Blue Economy, as defined by the World **Bank."**
Is climate change a source of economic disparities between regions in Benin? Evidence from the spatial effect's analysis method (Acacha-Acakpo et al., 2024).	Examines whether climate change contributes to economic disparities between regions in Benin.	i) "The secondary data are extracted from the World **Bank**'s Climate Knowledge Portal "
Climate policy is macro policy: 2022 Volcker lecture at NABE conference (Carney, 2022).	Argues that climate policy should be integrated into macroeconomic policy frameworks.	ii) Lecture
Promoting economic development in a volatile world (Indrawati, 2016).	Discusses strategies for promoting economic development amid global economic volatility.	i) The World Bank is the author's institution.
Technological innovation and green growth in the Organization for Economic Cooperation and Development economies (Mensah, 2019).	Examines the impact of technological innovation on green growth in OECD countries, assessing whether innovation contributes to economic growth while reducing environmental degradation	i) "Data sourced from OECD library statistics and World **Bank"**
Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American West (Lempert, 2010).	Develop and assess robust, adaptive policy responses for water management agencies in the American West through the use of Robust Decision Making (RDM).	i) "Agency's groundwater **banking** programs"
Influence of institutional access and social capital on adaptation decision: Empirical evidence from hazard-prone rural households in Bangladesh (Alam, 2016).	Explores how institutional access and social capital influence adaptation decisions in hazard-prone rural households in Bangladesh.	i) "To support adaptation locally and to enhance vulnerable households' resilience to better cope with river**bank** erosion and other climatic change issues."
Integrating biodiversity offsets within Circular Economy policy in China (Ali, 2018).	Examines how China can incorporate biodiversity conservation into its growing circular economy framework, which aims to minimize waste and maximize resource efficiency.	i) It does not focus directly or indirectly on the banking sector.
Sea level damage risk with probabilistic weighting of IPCC scenarios: An application to major coastal cities (Abadie, 2018).	Evaluates the risk of sea level rise for major coastal cities using probabilistic weighting of IPCC scenarios.	i) "We analyse expected damage and risk according to World **Bank** country income groups."
Shrimp aquaculture as a vehicle for Climate Compatible Development in Sri Lanka. The case of Puttalam Lagoon (Harkes, 2015).	Examines how shrimp farming can contribute to both economic development and climate resilience by promoting sustainable practices that adapt to climate change.	i) "Mechanisms that could enable this change include subsidies, insurance and **bank** loans which will also facilitate investment."
Linking permit markets multilaterally (Doda, 2019).	Explores the concept of **linking permit markets multilaterally,** focusing on how different countries or regions can connect their carbon trading systems.	iii) The article does not concentrate on the issue of climate change.
Net valence analysis of iris recognition technology based FinTech (Al-Debei et al., 2024).	Evaluates the **emotional response** and **perceived value** associated with the adoption of iris recognition for authentication and security in financial services.	i)"Despite considerable investments by **banks** and other financial institutions in this FinTech"
An optimal hybrid emission control system in a multiple compliance period model (Yu, 2015).	It explores the combination of different emission control strategies (such as technological improvements and policy interventions) to achieve the most cost-effective balance between environmental impact and economic feasibility.	i) "Where **banking** and borrowing of emission permits is allowed."
A Time for Action and a Time to Lead: Democratic Capitalism and a New New Deal for the US and the World in the Twenty-first Century (Carayannis & Kaloudis, 2010).	Explores the concept of **democratic capitalism.**	i) "Such as **banks"**
Digitalization and the prospects of cryptocurrency in Islamic finance (Tlemsani & Matthews, 2023).	It explores the potential for integrating digital technologies and cryptocurrencies into Islamic financial systems, considering the principles of **Shariah law** that govern financial transactions.	iii) The article does not concentrate on the issue of climate change.
Maintaining Stable Macroeconomic Conditions (Jones & Llewellyn, 2019).	Explores the key factors that contribute to macroeconomic stability, including **price stability, full employment,** and a **balanced budget.**	iii) The article does not concentrate on the issue of climate change.
Timber harvesting in New Zealand (Kumar & Luo, 2022).	Examines **timber harvesting in New Zealand,** focusing on the practices, challenges, and sustainability of the country's forestry sector.	i) "Increase in income, radiata pine prices, number of farms, horticulture plantation and **bank l**oans."
Overcoming Recession and Financial Instability in a Global Financialised Economy? The Contribution of the 'Crank Heretic' Robert Eisler (Löscher & Wenzlaff, 2023).	The paper revisits the overlooked economic proposals of Robert Eisler, dubbed a "monetary heretic," who, in response to the Great Depression, devised an innovative reform package aimed at	iii) The article does not concentrate on the issue of climate change

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Table A (*continued*)

Article	Objective	Reason of the exclusion
Solving policy problems, at the Federal Reserve and elsewhere (Ferguson, 2020).	stabilizing price levels, combating unemployment, and preventing economic crises. It highlights the complexity of tackling major U.S. policy issues, such as retirement, and health care, emphasizing the need for collaboration and innovative solution.	i) "Play into conversations about central **banking.**"

Source: Authors' elaboration.

Data availability

Data will be made available on request.

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