

ADVANCING KNOWLEDGE IN FINANCIAL RISK MANAGEMENT: A BIBLIOMETRIC APPROACH

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Abstract

This study delves into the intricate strategies for managing financial risks within a global environment marked by market volatility, macroeconomic uncertainty, and geopolitical fluctuations. Employing bibliometric analysis through the Web of Science database and the VOSviewer software for graphical visualization, the research synthesizes academic literature, mapping international collaboration networks and interconnections among the field's core concepts. These are elucidated through the co-occurrence of keywords and co-authorship structures.

The study underscores the diversification of risk mitigation methods, including the utilization of financial derivatives, insurance mechanisms, and strategic reserves, with particular emphasis on literature pertaining to emerging economies within the context of globalization. Citation analysis facilitates the evaluation of the impact and influence of prominent authors and pivotal works in the field, identifying key contributions and outlining future research trajectories.

The novelty of this research lies in the application of advanced methodologies to provide a comprehensive perspective on the evolution of essential concepts and theories in financial risk management, highlighting both theoretical innovations and existing gaps. The findings have practical relevance, pinpointing major trends and influential works that can serve as benchmarks for subsequent research endeavors. This multidimensional approach establishes a robust foundation for further exploration in financial risk management and significantly enriches academic knowledge within this critical sector.

Keywords: Financial risk management, bibliometric analysis, risk assessment, scholarly trends, citation network.

JEL Classification: G32, C89, G17, D81.

1. Introduction

In a global context where financial risks are becoming increasingly diverse and unpredictable, organizations are compelled to adopt sophisticated strategies for identifying and managing these challenges. The volatility of financial markets, macroeconomic uncertainties, and geopolitical fluctuations necessitate a theoretically robust and methodical approach to financial risk management. Recent studies underscore the diversification of methods and techniques employed to mitigate the impact of risks, particularly within the framework of emerging economies and the globalization of the world economy. Additionally, specialized literature reflects growing interest in risk financing solutions, with a focus on utilizing financial derivatives, insurance mechanisms, and strategic reserves.

This study seeks to examine the relevant literature through the lens of major academic contributions, exploring collaborative structures between countries and organizations via co-authorship analysis and highlighting the interconnection of central concepts within the field through keyword co-occurrence analysis. Particular emphasis will be placed on citations from diverse

academic sources to evaluate the impact of existing research and to identify the authors and organizations with the greatest influence in advancing knowledge in the domain of financial risk management.

The primary aim of this study is not only to highlight international collaboration networks and key contributions but also to outline future research directions in financial risk management, based on trends identified in the literature. Through the application of bibliometric methodologies, the study seeks to provide a comprehensive perspective on the evolution of essential concepts and theories, emphasizing both theoretical advancements and existing knowledge gaps.

Methodologically, the study will utilize the Web of Science database, one of the most reputable sources of scientific information worldwide. The VOSviewer software will be employed to create graphical visualizations of relationships among authors, organizations, and keywords, enabling a more detailed evaluation of the field's structure. The novelty of this endeavor lies in its ability to synthesize data from a wide range of sources and deliver an in-depth analysis of the current state of knowledge in financial risk management.

The practical value of the research lies in identifying major developmental trajectories in financial risk studies and highlighting the most influential works, authors, and organizations, which can serve as reference points for future research. The study will be structured into several sections, each addressing a critical component of the analysis: international collaborations, keyword co-occurrence, and citation analysis, followed by a synthesis of conclusions and future research directions. Thus, this study will provide a robust foundation for further exploration of the domain and contribute to the advancement of academic knowledge regarding financial risk management.

2. Materials and methods

Donthu et al. (2021) thoroughly examined and elucidated bibliometric analysis as a critical methodology for evaluating the intellectual structure and emerging themes within a research domain. They contended that co-citation analysis is among the essential techniques of scientific analysis, as it allows researchers to uncover fundamental thematic clusters based on the most frequently co-cited publications. This method is particularly beneficial for identifying foundational publications and the knowledge base of a specific field, although it tends to overlook recent or niche works. Consequently, while co-citation analysis provides a clear depiction of the historical intellectual structure of a domain, it may not accurately capture its recent or emerging developments.

Öztürk et al. (2024) emphasized the utility of bibliometric analysis in investigating the intellectual structure and evolution of a research field. They highlighted that co-citation analysis could reveal core thematic groups and essential publications within a domain. Their study proposed a detailed methodological framework for researchers aiming to conduct rigorous bibliometric investigations, emphasizing the necessary steps and stages for obtaining valuable results. When applied correctly, bibliometric analysis offers a transparent view of the accumulated knowledge within a domain and existing gaps, facilitating the identification of future research trajectories.

In their work, Perianes-Rodriguez et al. (2016) presented a comparative analysis of full and fractional counting methods in constructing bibliometric networks, such as co-authorship and co-citation networks. The authors argued that fractional counting is preferable in many scenarios as it assigns equal weight to each co-citation or co-authorship action, regardless of the number of authors or cited publications. This approach ensures greater fairness in evaluating contributions and provides a more accurate representation of bibliometric network structures. Additionally, the authors illustrated these differences with empirical examples and theoretical arguments, concluding that fractional counting offers a more precise depiction of academic collaborations and interconnections among publications in many cases.

Qi et al. (2023) investigate banking risks over the period 1978–2022, employing bibliometric analysis to map the conceptual structure of knowledge in the field of banking risk. They emphasize three primary themes in banking risk research: the adoption of risk management practices, the effective management of banking risks during financial crises, and the interrelations between corporate governance and banking risks. Their bibliometric analysis reveals a marked increase in academic interest in topics related to banking risk, particularly following the 2008 global financial crisis.

In their study, Valášková et al. (2018) examine financial risk management in Slovak companies, using regression analysis to identify key determinants influencing their financial development. The research focuses on bankruptcy prediction, a critical element in financial risk management, with findings highlighting that indicators such as net return on equity, liquidity metrics, working capital, and financial debt ratios are significant in assessing a company's financial health. By applying multiple regression analysis, they develop a model capable of quantifying financial risks and predicting bankruptcy based on these key factors.

Hao et al. (2023) explore risk science from 1996 to 2021, utilizing bibliometric analysis to map developments and trends within the field of risk research. They underscore the effectiveness of bibliometric analysis in identifying influential publications and uncovering the intellectual structure of a research domain. Their study focuses on identifying the most cited works and critical contributions to risk knowledge, offering a comprehensive perspective on prominent topics within the literature. Analyzing 10,950 articles from the Web of Science database, they apply VOSviewer to visualize collaboration networks among countries, institutions, and authors, as well as to analyze the evolution of research trends in the field. Their findings highlight a significant increase in the number of publications and citations, reflecting growing academic interest in risk-related topics.

Rashid et al. (2024) conducted a comprehensive bibliometric analysis of bankruptcy research in small and medium-sized enterprises (SMEs), spanning 68 years and evaluating 282 articles from 175 sources. The authors highlighted that bankruptcy research in SMEs has gained increased significance in recent years, particularly in the context of recent economic crises such as the 2008 global recession and the COVID-19 pandemic. They identified key themes in SME bankruptcy research, including bankruptcy prediction, the impact of financial risks, and international collaboration in this field. This review provides valuable insights for researchers, policymakers, and practitioners, suggesting future research directions based on the methodologies and conclusions presented.

Nobanee et al. (2021) conducted a bibliometric analysis of risk management and sustainability practices, focusing on their impact at individual, corporate, and economic levels. Using VOSviewer software, they identified the most cited sources and authors in risk and sustainability literature, offering a clear overview of the primary research themes.

Syed and Bawazir (2021) performed an extensive bibliometric assessment of financial risk literature in business, focusing on recent trends and developments in this domain. Covering a ten-year period, their study explored a broad range of sources and provided insights into key academic contributions and influential publications. Through detailed analysis, they identified fundamental aspects of financial risks, such as credit risk, liquidity risk, and operational risk.

Similarly, Aivaz et al. (2024), using an integrated bibliometric approach, analyzed economic fraud and associated risks, emphasizing the necessity of adapting to new technologies and the dynamics of financial markets. Their study underscored the importance of rigorous risk assessment to prevent economic fraud, with methodologies based on data analysis from Scopus and other scientific databases.

In related industries, process safety and risk analysis have shown significant advancements. Amin et al. (2019) emphasized the critical contributions of countries such as the USA, China, and Iran, which lead in process safety research. Their bibliometric analysis revealed an increase in the

number of publications, reflecting global interest in developing effective risk management solutions.

Nazarova et al. (2021) address the analysis of economic and financial risks in companies, based on both financial and non-financial reports. Methodologically, their research employs a systematic framework, combining methods of generalization, comparison, and bibliometric analysis with the assistance of VOSviewer software. Data collected from Scopus for the period 1988–2021 were processed to highlight major themes and research networks. In addition to statistical analysis, the study introduces a set of essential financial indicators for risk assessment, such as liquidity risk, financial risk, and credit risk. This methodological framework contributes to a better understanding of economic risks specific to the food industry and proposes practical solutions for their efficient management.

Aryati et al. (2023) utilize a bibliometric methodology to analyze research trends in enterprise risk management (ERM). For this analysis, they collected data from the Web of Science Core Collection, filtering 510 articles published between 2004 and 2023. The data were processed using Biblioshiny software, part of the Bibliometrics package in R, which provides an intuitive platform for the quantitative analysis of scientific production. This methodology enables the discovery of hotspots in the literature and emerging themes, offering clear insights into the development of the field and future research directions.

Baker et al. (2019) employed techniques for quantifying and mapping bibliographic data. Their research also included evaluating journal impact through indicators such as the h-index and recursive impact factors, providing an overview of the influence of published works. Among the major themes identified were corporate governance and financial market performance.

The methodology used by Liu et al. (2023) for the bibliometric analysis of the impact of FinTech on banking risk was based on a comprehensive and detailed approach, focused on evaluating studies published between 2013 and 2023. The data were collected from the Scopus database, which provides broad coverage of academic works across various fields, including finance and technology. Rigorous filtering allowed for the selection of 813 relevant scientific works, which were subsequently analyzed using VOSviewer to visualize co-author networks and bibliographic coupling. Mies (2024) systematically explores the empirical literature related to banking risk reporting, focusing on relevance and current trends in the field. By applying a combined methodology of bibliometric analysis and systematic literature review (SLR), the author provides a detailed analysis of how international banking regulations, such as those under Basel III and IFRS 7, have influenced risk identification.

Judijanto et al. (2023) conduct a comprehensive bibliometric analysis of financial risk management, focusing on recent trends and influential contributions in the field. The study centers on thematic clusters, keyword frequency, and the most cited works, revealing interconnections between business strategies, corporate social responsibility, and risk management. Special attention is given to liquidity risk, corporate governance, and the integration of theoretical frameworks into practice. Through this analysis, the authors outline the dynamic landscape of financial risk management research, offering valuable insights for researchers, practitioners, and policymakers in navigating contemporary financial challenges.

3. Results

This study focused on financial risks within organizations, employing bibliometric techniques to evaluate the evolution of research in financial risk management, risk identification, and risk financing. This section details the methodology applied, including the selection of keywords, database usage, and adjustments made to ensure the relevance and accuracy of the results obtained.

To ensure a comprehensive and coherent coverage of the topic of interest, three main keywords were used: (1) financial risk management; (2) identifying financial risks; (3) financing financial risks. The choice of these terms was based on the specialized literature, which highlights the interdependence between identifying and managing financial risks, as well as financing solutions. The use of the AND operator between keywords in querying the Web of Science Core Collection aimed to identify exclusively publications that integrate these concepts, thus offering a unified perspective on financial risk research. The Web of Science database is one of the most reputable and comprehensive global research databases, providing access to publications across various fields, enabling the analysis of a wide range of relevant scientific contributions.

The initial query returned 1,269 results from the Web of Science Core Collection. This relatively high number reflects the breadth and complexity of the field studied. However, to ensure a rigorous and focused analysis, several additional filters were applied. First, the time period was adjusted to 2010–2024. This decision was motivated by the need to focus on recent contributions that reflect the current state of knowledge in financial risk management. The rapid developments in this field necessitate a temporal limitation that includes only research relevant to contemporary economic and financial conditions, thus providing a clear picture of recent trends.

In addition to temporal adjustments, we narrowed the types of documents included in the analysis. Specifically, we filtered the publications to include only scientific articles, proceeding papers, review articles, and book chapters. The choice of these document types was motivated by the aim to focus on scientifically validated contributions recognized by the academic community. Scientific articles represent the most commonly used form of disseminating research results, while proceeding papers reflect findings presented at prestigious academic conferences, often serving as reference points in many fields. Review articles provide a critical synthesis of existing literature, contributing to an understanding of the state of knowledge, while book chapters sometimes expand theoretical and methodological perspectives in a comprehensive manner. By excluding other types of documents, such as technical reports or informal reviews, we aimed to maintain a high standard of quality and academic relevance.

Applying these filters reduced the total number of publications to 1,167. This adjustment allowed for a more precise focus on publications that present significant contributions to the field of financial risk management. The final count of 1,167 publications provides a solid basis for bibliometric analysis, enabling us to identify international collaboration networks, evaluate the impact of various works, and establish connections among fundamental concepts in the specialized literature.

Therefore, each methodological step in this analysis was justified by the need to obtain a relevant and rigorous dataset that would allow us to assess key contributions in the field of financial risk management and financing.

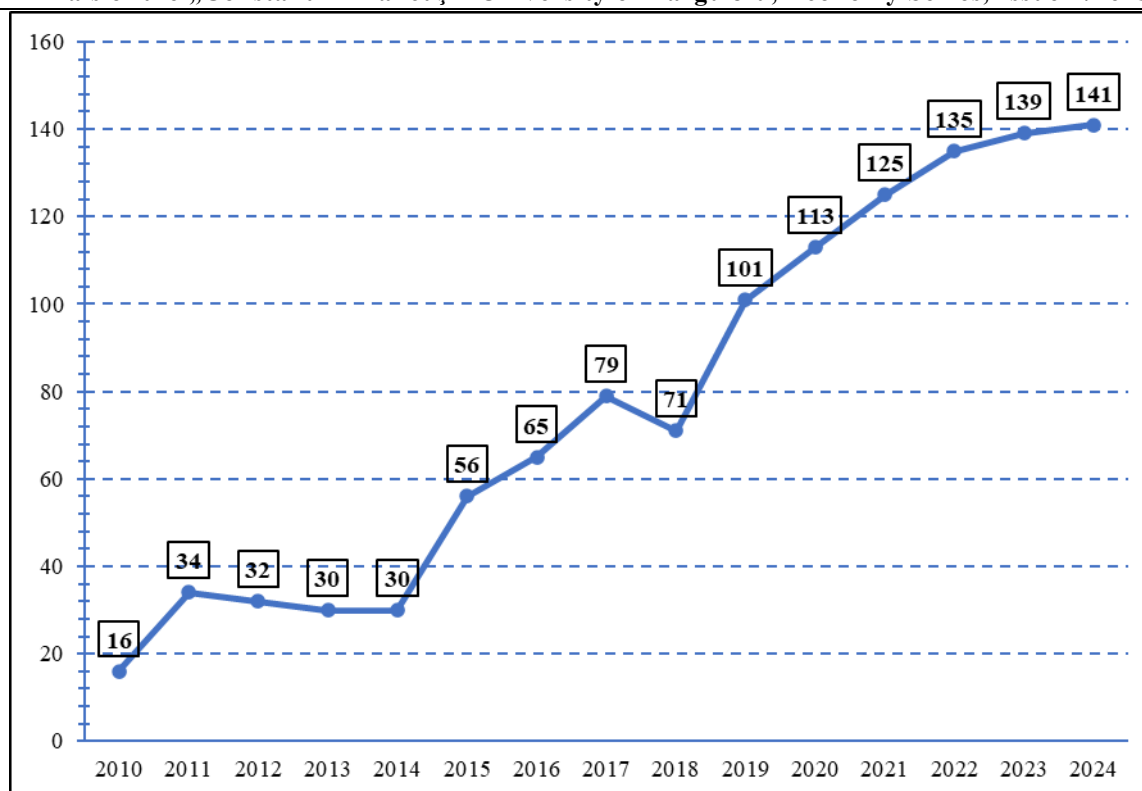


Figure 1 Evolution of the number of publications by year

Source: own work based on the study of specialized literature"

From a methodological perspective, the temporal distribution of publications on financial risks in organizations, as illustrated in the previous table, provides a significant perspective on the evolution of research in this field between 2010 and 2024. This type of temporal analysis aids in understanding general trends in the literature and reflects the growing interest in this area of study over the past decade.

Based on the data presented, a progressive increase in the number of publications can be observed, with a significant turning point beginning in 2015, where the number of publications nearly doubles compared to previous years. This growth can be attributed to the heightened importance of financial risks following the 2008 global financial crisis and subsequent economic crises. Studies conducted during this period seem to reflect an increasing interest in risk management and the development of more robust financial mechanisms in recovering economies.

After 2015, the number of publications continues to grow, peaking significantly in 2020 with 113 publications, followed by a steady increase through 2024, when data already indicate 141 publications. The consistent growth from 2020 to 2024 can be correlated with global transformations caused by the COVID-19 pandemic, which had a major impact on world economies and posed new challenges in financial risk management, necessitating a reevaluation of existing methods.

The upward trend observed during the period 2021–2024 is also noteworthy, with a continuous increase in the number of publications driven by the pandemic and geopolitical instability caused by wars, reaching a peak in 2024. This development reflects an intensified interest in financial risk research within a post-pandemic context and the current wartime environment. Economic uncertainties and emerging risks have prompted organizations and the academic community to pay heightened attention to this field.

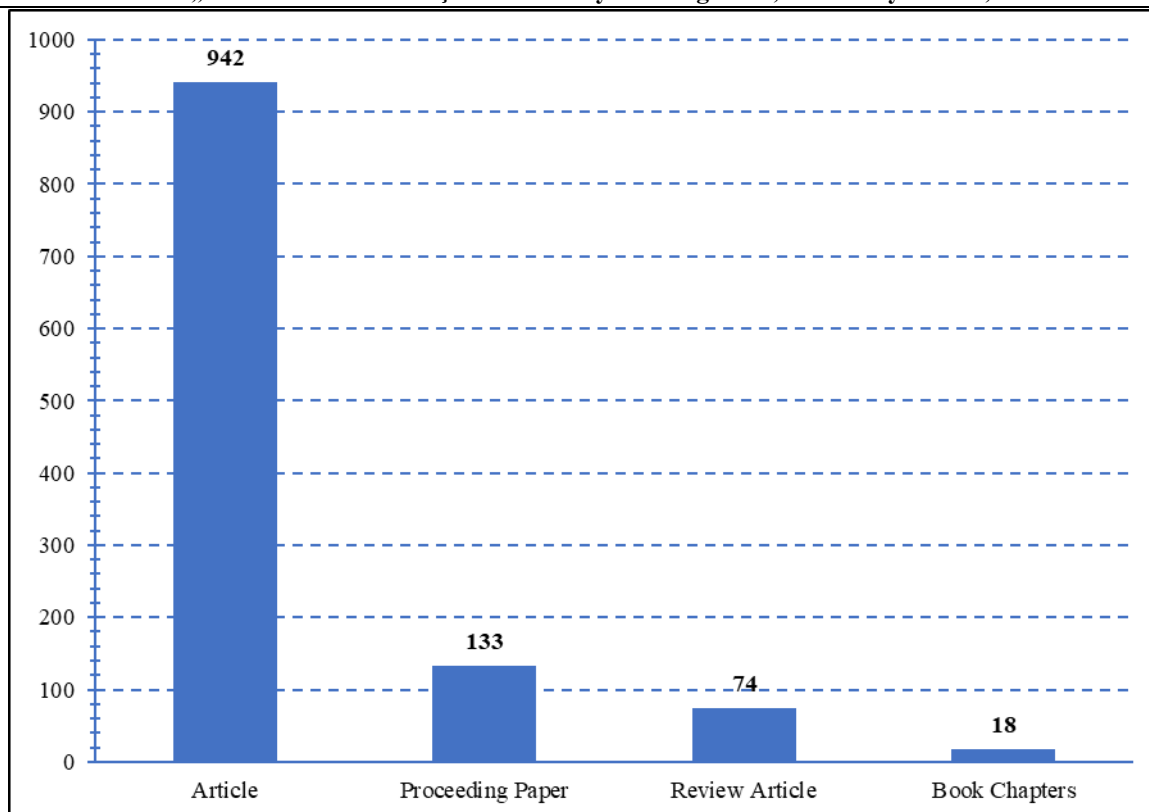


Figure 2 Number of publications by document type

Source: own work based on the study of specialized literature

The vast majority of the identified publications are scientific articles, totaling 942. This highlights the importance of articles as the primary means of disseminating academic research. Articles are the most accessible and recognized format for publishing new findings and discussing recent theories and methodologies. The large number of articles reflects the dynamism of this field and suggests that financial risks are a topic of great interest to both researchers and practitioners.

Proceeding papers, totaling 133, provide an ideal framework for discussing new ideas and preliminary results, reflecting a more dynamic and immediate approach to research before formal publication in specialized journals. The relatively high number of proceeding papers indicates intense activity at academic conferences on the topic of financial risks, contributing to the creation of active research communities and the rapid exchange of knowledge in this area.

Review articles, totaling 74, offer valuable syntheses of the current state of knowledge and emerging trends. These types of documents are essential for researchers as they provide an overview of existing literature, identifying gaps and future research directions. The smaller number of such publications suggests that, while financial risks are a heavily researched topic, comprehensive reviews in this field are rarer and tend to focus on niche areas or specific theoretical approaches.

Book chapters, totaling 18, represent contributions included in books or collective volumes, typically offering a more theoretical or exploratory approach to the subject. The small number of book chapters can be attributed to the fact that they are not as prevalent as articles or proceeding papers in the field of financial risks, where the focus tends to be on presenting concrete results and new methodologies rather than extended theoretical perspectives.

The distribution of document types suggests that research on financial risks is predominantly published in the form of articles, with a significant presence at academic conferences. Review articles and book chapters, though less frequent, play a crucial role in synthesizing and deeply exploring the theory and practice in this domain.

3.1 Co-authorship relationship – country analysis unit

Figure 3 illustrates the collaborative relationships among researchers from different countries, revealing distinct groups (clusters) that frequently collaborate, allowing us to observe power centers and the dynamics of international collaborations. The largest cluster, represented in shades of blue, includes countries such as China, the USA, Australia, Canada, and England. These countries play a dominant role in the research network on financial risks, highlighting their importance as essential centers of scientific production in this field. The presence of the United States and China at the center of this cluster suggests that researchers from these countries have a high level of collaboration with each other and with other key nations like Australia and England. This reflects the influence of these countries in developing and disseminating knowledge on financial risks. Moreover, collaborations between the USA and China might be explained by the large number of joint publications and researcher mobility between these countries.

In the green cluster, there is a concentration of European countries, including Germany, Italy, France, Spain, and Poland. This cluster indicates a strong European collaborative network, suggesting a significant regional approach to financial risk research. This group might also reflect the influence of the European Union's common economic policies on research interests in this field. The countries in this cluster are well-connected with one another and with countries from other clusters, demonstrating that financial risk research has a well-developed international component, involving most countries from Western and Central Europe.

The red cluster is centered around Asian countries, with significant contributions from India, Malaysia, and Indonesia, as well as Middle Eastern countries such as Iran and Saudi Arabia. This regional grouping suggests a strong collaborative network among researchers from these nations, which can be explained by both geographical proximity and shared challenges in managing financial risks. However, countries in this cluster collaborate less with those in clusters dominated by the USA and Europe, possibly indicating regional fragmentation in financial risk research production.

Another notable aspect is the reduced visibility of some Eastern European countries, such as Romania, which, although internationally connected, are on the periphery of the collaboration network. This might suggest a lower level of participation in major international projects or limited integration into global research networks on financial risks. Nevertheless, the presence of links to larger research centers indicates potential growth in international collaborations in the future.

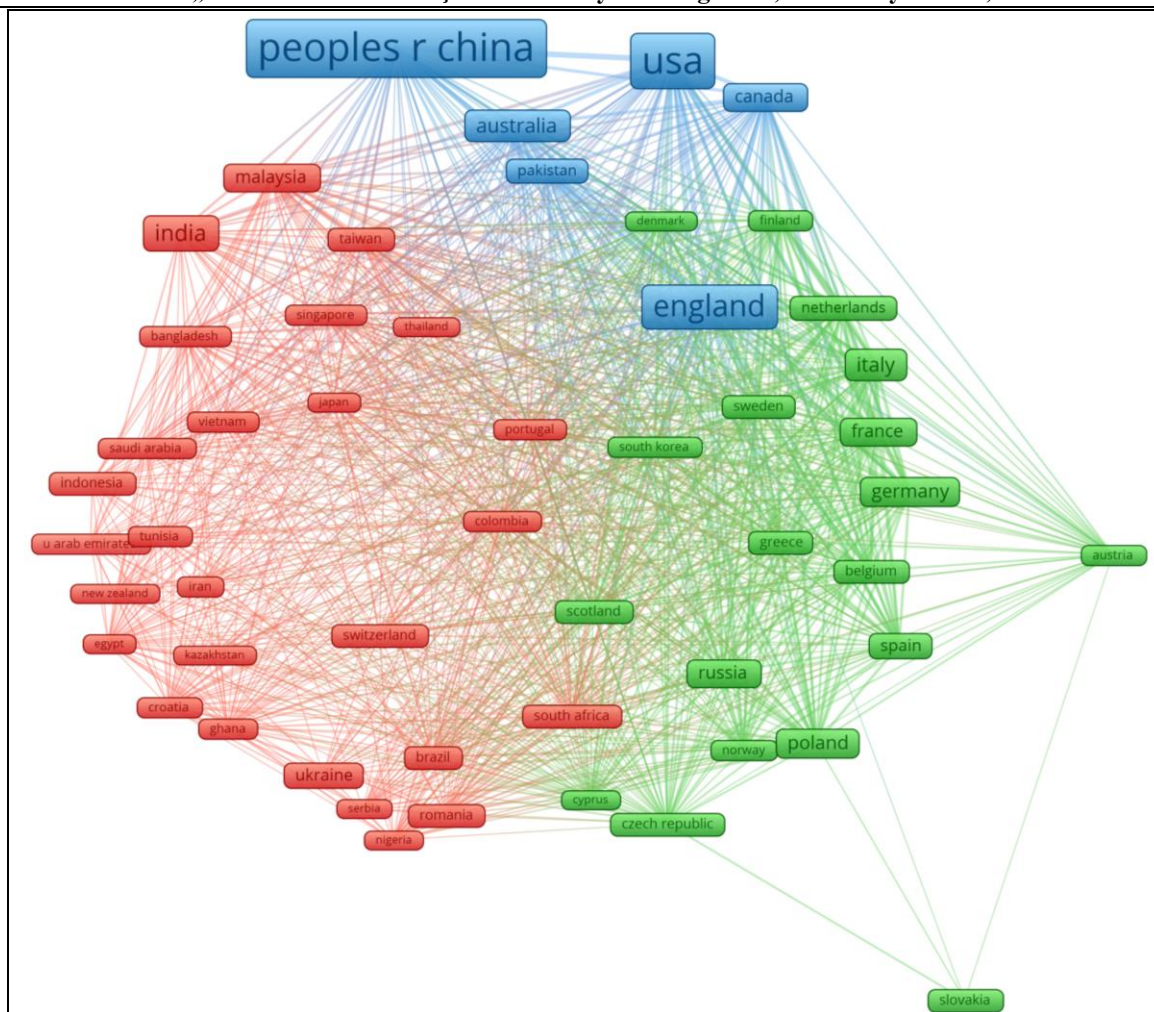


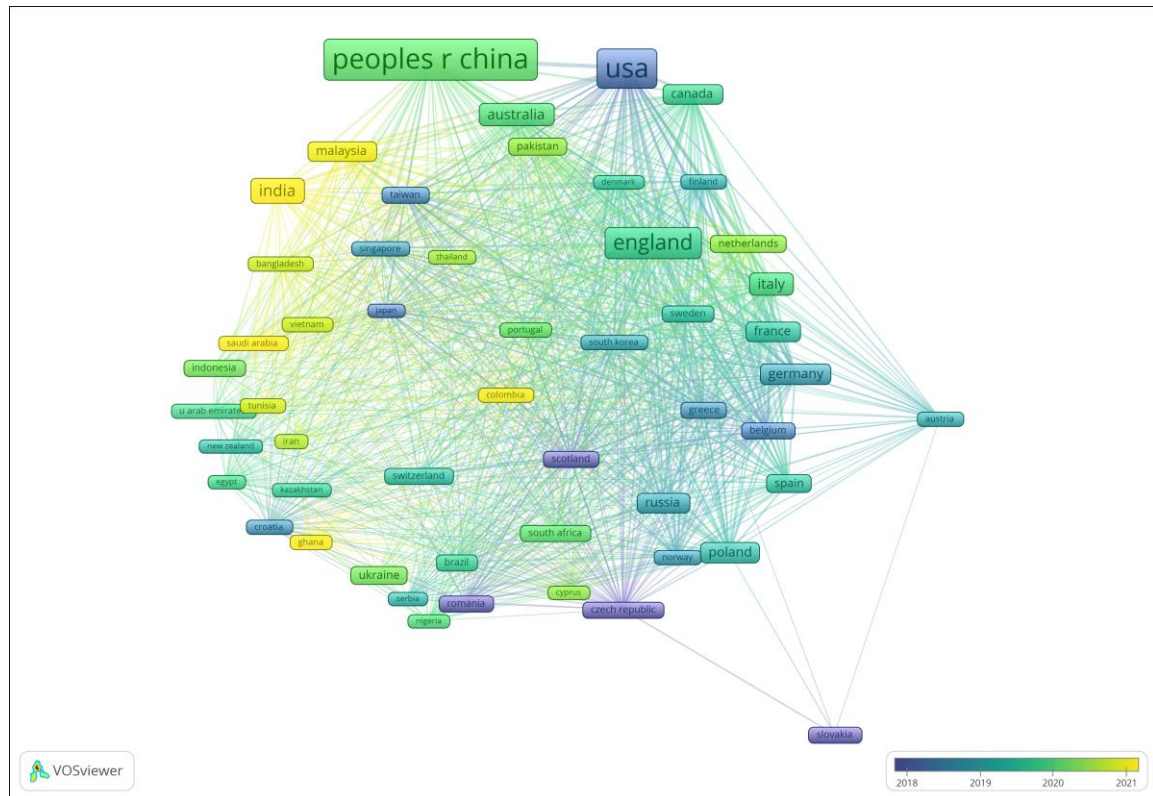
Figure 3 Collaborative relationships between researchers from different countries

Source: own work based on the study of specialized literature

The analysis of the co-authorship network at the country level highlights major centers of scientific production, transnational collaborations, and regional groupings. The USA and China dominate the global research network, while Europe exhibits a well-connected network of researchers, and Asia and the Middle East form a distinct cluster. These collaborative dynamics are essential for understanding how financial risks are studied and addressed globally.

Figure 4 presents the co-authorship network among countries, based on a temporal analysis of scientific contributions, providing additional insights into the dynamics of international collaborations in financial risk research. The node coloring, ranging from yellow (indicating more recent contributions starting in 2021) to dark blue (reflecting earlier contributions from 2018–2020), offers a temporal perspective on how these collaboration networks have developed over time.

Countries highlighted in yellow, such as India, Malaysia, and Saudi Arabia, indicate recent interest in financial risk research, with a growing volume of international collaborations beginning in 2021. These countries appear to be emerging players in the global research network, focusing on recent issues related to financial risks and establishing significant collaborations with other nations, particularly in Asia and the Middle East. The increasing interest in these countries can be correlated with economic developments and regional financial crises, prompting a reassessment of risk management strategies.



Source: own creation based on the study of specialized literature

Another interesting aspect involves Western and Northern European countries (Italy, France, the Netherlands, and Sweden), which, although highly connected within the collaboration network, primarily contributed to scientific works published during the 2019–2020 period. This pattern indicates an earlier phase of academic activity growth. It may reflect a period of research maturity in these regions, where the accumulation of knowledge provides a strong foundation for future research, albeit with a reduced volume of recent contributions.

In the co-authorship analysis at the organizational level, a minimum publication requirement of five documents per organization was imposed to ensure the relevance and consistency of the analyzed dataset. Out of 1,828 organizations, only 48 met this criterion,

suggesting that many organizations contribute sporadically or in isolation to research on financial risks. This criterion allowed us to focus on organizations with consistent involvement in the field, providing a targeted analysis of centers of excellence and institutions that significantly contribute to the development of specialized literature.

Furthermore, among the 48 eligible organizations, only 24 were interconnected, while the rest operated independently, with no significant collaborations with other organizations. This approach aimed to exclude organizations with isolated contributions and focus on those integrated into international academic collaboration networks. Thus, the analysis provides a clearer picture of the organizations playing a central role in disseminating and advancing knowledge in financial risk management, fostering the formation of well-defined and interconnected research networks.

Figure 5, depicting the co-authorship network at the organizational level, highlights the main academic centers involved in financial risk research and their reciprocal collaborations. This map visualizes cooperation networks among organizations and identifies central nodes, representing universities that play an essential role in disseminating and developing knowledge in this field.

Monash University and The Hong Kong Polytechnic University are the two central nodes of the network, with the most connections and significant collaborations with other organizations. Monash University, positioned at the center of the network, is connected to prestigious universities worldwide, such as the University of Toronto, the University of Oxford, and Nanyang Technological University. These connections indicate an extensive academic network and underscore the major role Monash University plays in advancing financial risk research.

The Hong Kong Polytechnic University is another central actor in this network, establishing significant connections with prominent universities such as Cornell University, Tsinghua University, and Islamic Azad University. This density of connections suggests that Hong Kong Polytech Univ acts as an important academic hub for international collaborations, particularly in the Asia-Pacific region. Its connectivity with universities across various regions indicates a strong capacity to attract global partnerships.

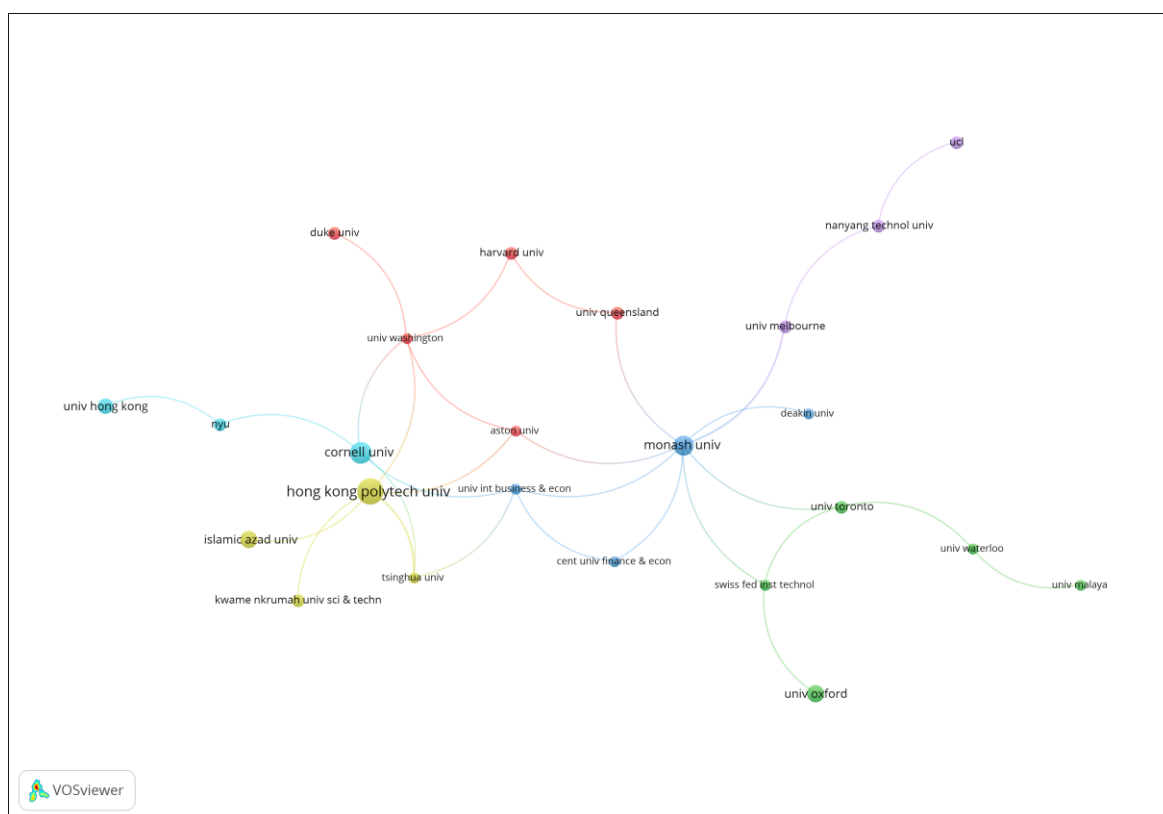


Figure 5 – Co-authorship network at the organizational level

Source: own work based on the study of specialized literature

Universities such as Harvard, Duke, and the University of Washington are positioned at the periphery of the network, establishing a few significant collaborations but remaining less connected than the central nodes. Despite their prestige, their lower number of collaborations may indicate a focus on internal research or isolated projects within the global financial risk study network.

This analysis highlights a well-connected network of collaborations among the world's top universities, with Monash University and Hong Kong Polytech University serving as leaders. These institutions act as main hubs for knowledge transfer and international collaboration, facilitating the exchange of ideas and the development of new approaches in the field of financial risks.

3.3 Co-occurrence relationship – the unit of keyword analysis

Regarding the co-occurrence of keywords, a minimum threshold of 15 occurrences was imposed. This rule was justified by the need to ensure the relevance and consistency of the analyzed dataset. Out of a total of 5,579 keywords, only 82 met this criterion, reflecting that the remaining terms were either used sporadically or lacked significant importance in the academic discussions within the analyzed field. By applying this filter, we focused on those keywords that are frequently used in the literature, indicating central research themes and major concepts structuring the field of study. In other words, this approach aimed to eliminate noise created by occasional or niche terms, allowing for a focus on academically recognized terms. Additionally, this filtering helps identify main research themes and highlight the connections among them, providing a broad overview of the major topics in the field of financial risks. Consequently, the analysis concentrates on the most representative keywords, which are fundamental for understanding research directions and theoretical developments in this domain.

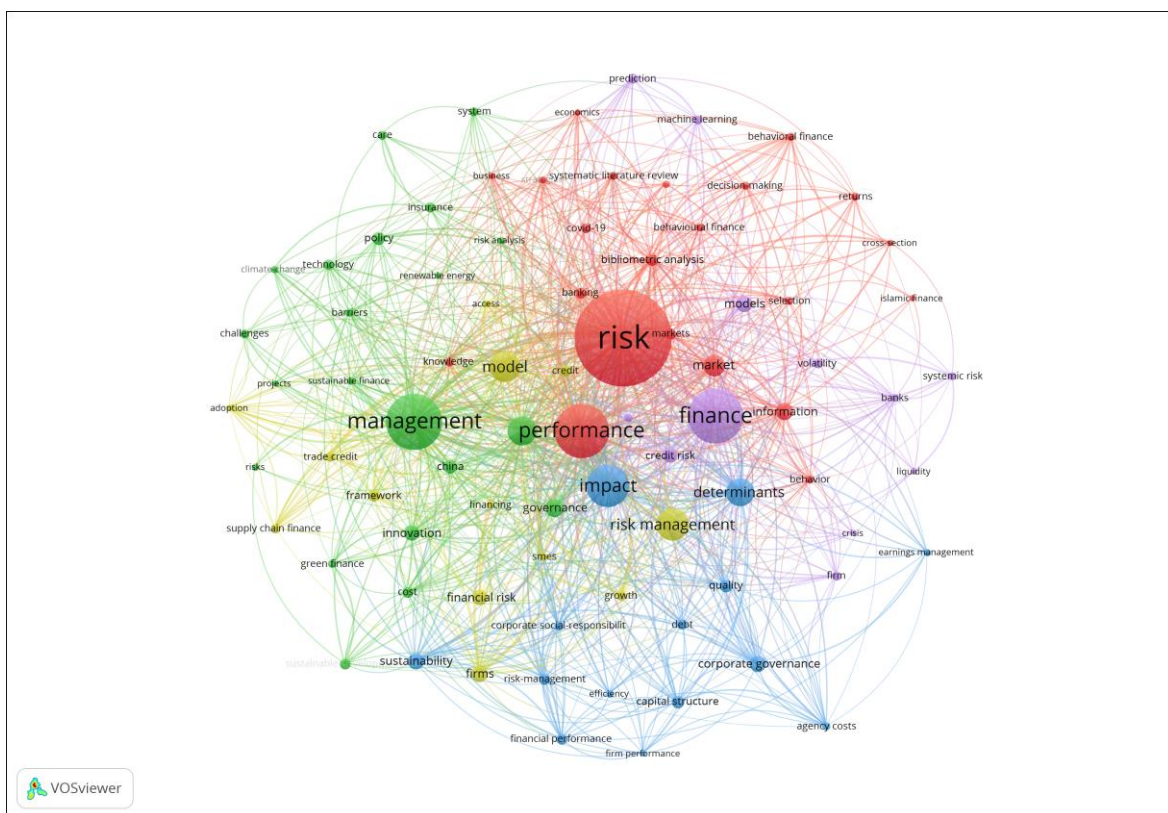


Figure 6 – Keyword co-occurrence network

Source: own work based on the study of specialized literature

The red cluster, centered around the term risk, represents the core of financial risk research, highlighting a complex network of interconnected concepts. Globally, risk is the dominant concept, with the most links to key terms from related fields, such as performance, finance, model, and market. This emphasizes that financial risk is inextricably tied to the financial performance of organizations and market developments, both of which are essential themes in risk evaluation and management. The strong link between risk and performance suggests that a significant portion of research focuses on how financial risks impact organizational performance. This is particularly relevant during periods of financial volatility, where heightened risks can have a direct negative impact on a company's economic outcomes. Similarly, the terms model and models are closely associated with risk, indicating the extensive use of financial models to assess risks and develop appropriate management strategies. Models are critical for risk prediction and for testing various scenarios that could affect organizations.

At the same time, the terms finance and market are closely tied to risk, reflecting ongoing concerns about assessing financial risks in a market context. Links with volatility indicate that market fluctuations and the risks associated with financial instability are major areas of interest for researchers, particularly during global economic crises or in emerging markets. Additionally, the term credit is notably significant in this cluster, underscoring that credit risk and default risk are essential topics within general financial risk research.

Another interesting aspect of this cluster is the presence of emerging terms like bibliometric analysis and Covid-19, indicating that recent financial risks have been explored in the context of the global pandemic. Recent research has relied on bibliometric methods to map the field's dynamics. This inclusion shows that pandemic-associated risks have significantly influenced recent literature on financial risk management, opening up new directions for research.

The green cluster, centered on the term management, reflects major concerns related to financial risk management in this field of research. Management serves as the concept connecting a series of essential sub-themes, such as financial risk, innovation, sustainability, and policy. This indicates that the literature on financial risks focuses on exploring risk management strategies by adopting innovative solutions integrated into sustainable organizational practices and aligned with current policies. An important aspect is the connection between management and innovation. This relationship suggests that researchers are paying special attention to how technological and methodological innovations contribute to improving risk management. Innovation plays a crucial role in the efficient management of financial risks, providing new tools and approaches to help organizations adapt to market challenges and economic uncertainties.

Additionally, the term sustainability is closely linked to management, indicating a trend of integrating sustainability considerations into risk management. Research increasingly highlights the necessity of adopting sustainable financial practices that account for environmental impact and long-term risks associated with climate change. Concepts such as green finance and sustainable finance emphasize that financial risks are not only economic but also ecological and social in nature.

Furthermore, policy and technology emerge as relevant terms in this cluster, suggesting that public policies and emerging technologies play a role in shaping risk management strategies. Technological advances, combined with the implementation of effective policies, provide a stable framework for developing efficient mechanisms to assess and manage risks.

Thus, the green cluster highlights a multidimensional approach to financial risk management, where innovative strategies, sustainability considerations, technological advancements, and regulations play complementary roles in developing effective solutions to global financial challenges.

The purple cluster in the co-occurrence keyword analysis centers on the term finance and reflects several interconnected topics essential for understanding the dynamics of financial risks in the context of markets and financial decision-making. This cluster reveals strong links to concepts

such as credit risk, systemic risk, volatility, liquidity, and crisis, emphasizing the significance of financial risks in the context of market instability and economic vulnerabilities.

First, the term finance is strongly connected to credit risk and systemic risk, indicating that much of the research in this cluster focuses on understanding credit risks and systemic risks at the financial market level. Systemic risk, in particular, highlights concerns about how financial shocks can affect the entire economic system, with significant repercussions for market liquidity and global financial stability.

Another critical aspect of this cluster is its connection to the term volatility. Volatility is a central concept in the literature and reflects uncertainties related to rapid and unpredictable fluctuations in financial asset prices. This link suggests that research in this cluster concentrates on how market volatility influences financial decisions and manages the risks associated with these fluctuations. The term liquidity is also closely tied to finance, underscoring concerns about how liquidity risks impact markets and financial organizations. In this context, research explores how a lack of liquidity can amplify systemic risks and destabilize financial markets, particularly during crises.

The terms crisis and earnings management complete this network of concepts, highlighting that financial risks are often amplified during economic crises, making the management of earnings and financial performance a major challenge for organizations. The connection between these terms underscores the interdependence of financial risks, crisis management, and strategic financial decisions, particularly in minimizing the adverse effects of risks on financial performance.

This cluster also includes significant links to terms such as prediction, machine learning, and models. These connections point to an emerging research direction focused on using advanced technologies and machine learning methods to anticipate and manage financial risks.

The term prediction is closely associated with finance and models, reflecting the extensive use of predictive models in financial risk analysis. Predictive models are essential tools for forecasting future risks, especially in volatile contexts, and they enable researchers and practitioners to develop proactive risk management strategies. In this context, financial predictions based on advanced models become central to the strategic planning of organizations.

Machine learning is another relevant term in this cluster, suggesting that recent research is moving towards the use of machine learning algorithms to improve the accuracy of financial predictions and identify complex patterns in financial data. Specifically, machine learning technologies are utilized to analyze large datasets and build predictive models that can manage risks more effectively, offering innovative solutions to challenges in the financial domain.

The link with models underscores that mathematical and statistical models remain fundamental in evaluating financial risks. These models are crucial for quantifying risks and simulating various economic scenarios, enabling organizations to make informed decisions. Simultaneously, the integration of machine learning and predictive models contributes to the development of more advanced and precise tools for risk management.

Therefore, the purple cluster reflects not only traditional concerns related to credit risk and volatility but also an increasing integration of emerging technologies such as machine learning and predictive models to more effectively anticipate and manage financial risks. This represents a promising research direction, combining traditional risk assessment methods with advanced technologies to develop innovative solutions and address current challenges in the financial domain.

The blue cluster, with impact, risk management, and corporate governance as central terms, highlights a complex network of concepts related to corporate governance, financial performance, and capital structure. One of the most significant terms in this cluster is determinants, which has multiple connections with other concepts in the network, suggesting that research in this field focuses on identifying the factors that influence risk management and organizational performance.

The strong connection between risk management and determinants indicates that researchers aim to understand which internal and external factors contribute to the effectiveness of risk management. These factors can range from organizational structure and governance decisions to macroeconomic conditions and market volatility. This link underscores the importance of a thorough understanding of the context in which risk management processes occur to develop effective strategies.

Another essential term in this cluster is corporate governance, which plays a central role in risk management processes. Research shows that strong corporate governance is crucial for implementing effective risk management practices. Additionally, the terms capital structure and debt are closely linked to this concept, reflecting concerns about how capital structure and debt influence the risks organizations undertake. Choosing an appropriate capital structure is vital for balancing risks and optimizing financial performance, particularly in the context of market volatility.

Corporate social responsibility (CSR) is another important term in this cluster, reflecting increased interest in how social responsibility can help mitigate financial risks. Socially responsible practices can reduce long-term risk exposure and improve organizational reputation, suggesting an integrated approach to financial risk that includes social and environmental factors. Earnings management and financial performance are also significant terms in this cluster, indicating a focus on how companies manage earnings and financial performance in the face of risks. Earnings management and optimizing financial performance are closely tied to risk management processes, and governance decisions can significantly impact financial outcomes.

This cluster highlights a body of research focused on the relationship between corporate governance, capital structure, and financial performance, with particular emphasis on identifying the determinants influencing risk management. The complex connections within this cluster underscore the importance of an integrated risk management approach that includes not only financial considerations but also social responsibility and corporate governance.

The yellow cluster in this co-occurrence analysis focuses on the term model and highlights a significant research axis centered on using mathematical and economic models to evaluate and manage financial risks. Model plays a central role in this cluster, connecting to other key concepts such as performance, management, financial risk, and impact. This suggests that models are extensively used to understand and predict the financial behavior of organizations and markets.

The connection between model and performance indicates that models are essential for evaluating financial performance, particularly in the context of uncertainty and financial risks. Models allow for the simulation of various scenarios, helping researchers and practitioners understand how different risk management strategies can influence organizational performance. Similarly, the term financial risk is closely linked to model, emphasizing that models are used to evaluate financial risks and develop mitigation methods. Another important aspect of this cluster is the link with management and risk management. This suggests that models play a crucial role in managerial decision-making processes and are used to optimize risk management strategies. Models are fundamental tools that provide managers with a solid basis for risk assessment and implementing appropriate control measures.

The term impact is also strongly connected to this cluster, indicating that models are employed to evaluate the impact of financial risks on organizations and the economy as a whole. This highlights researchers' concerns about understanding the long-term effects of risks and developing strategies to minimize these effects.

The connection with financing suggests that models are used to analyze and plan organizations' financing strategies, particularly in the context of financial risks. Financial models are critical for evaluating financing options and determining the optimal capital structure in an uncertain economic environment.

In conclusion, the yellow cluster reflects a strong orientation toward using models to evaluate financial performance, manage risks, and understand their impact on organizations. Models are essential for decision-making processes and optimizing financial strategies, providing a robust foundation for future research in financial risk management.

Figure 7 provides a temporal perspective on the use of key terms in financial risk research, reflecting thematic evolution between 2019 and 2022. The color of each term represents the year when it was predominant in the analyzed research, ranging from dark blue (for terms from 2019 and earlier) to light yellow (for those from 2022 and beyond).

One key observation is that the term risk dominates the network, with the most connections and central positioning, suggesting that financial risks have remained a constant and major area of interest throughout the period. Alongside this, terms like management, finance, performance, and risk management were frequently used across all temporal stages, represented in darker shades (predominantly in 2019 and 2020). This indicates that these terms had significant presence even in the early phases of the analyzed period.

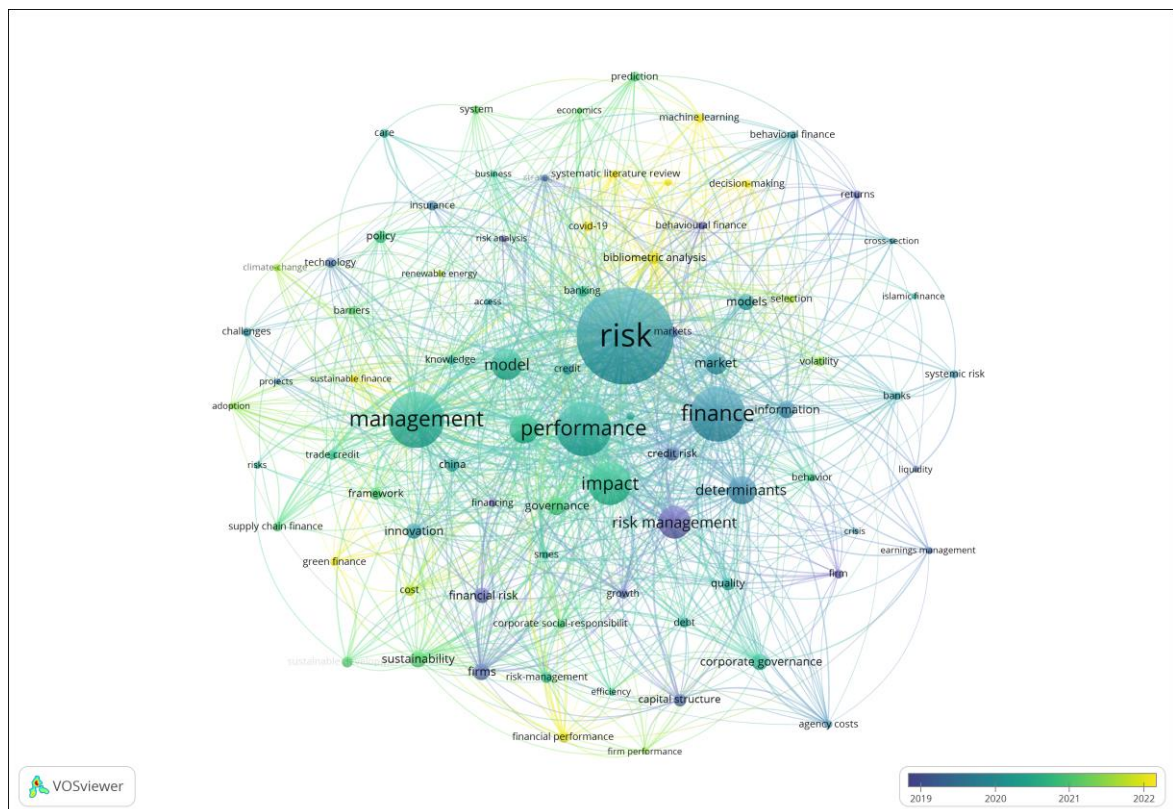


Figure 7 Overlay view of the keyword co-occurrence network

Source: own creation based on the study of specialized literature

Terms related to corporate governance and capital structure, such as corporate governance, capital structure, and agency costs, are highlighted in lighter shades, indicating increased interest in these topics beginning in 2021 and peaking in 2022. This suggests that financial risks and corporate governance have become more relevant research themes in light of recent economic events, including the COVID-19 pandemic and global market volatility.

Another group of terms, such as machine learning, systematic literature review, and behavioral finance, stand out for their more recent usage, represented in yellow shades. This indicates an emerging trend in the application of advanced technologies, like machine learning, to evaluate and manage financial risks. This trend highlights the growing integration of modern

analytical methods in the literature, offering new perspectives on market behavior and financial decision-making.

Terms like green finance and sustainability, located near the term management, also appear in lighter shades, reflecting the rising prominence of sustainable finance and practices in recent financial risk literature. This demonstrates the increasing focus on integrating sustainable approaches into financial and risk management strategies.

Thus, this graph illustrates a strong interconnectedness between fundamental themes like risk, management, and performance, alongside emerging trends in corporate governance, advanced technologies, and sustainability. This indicates a diversified thematic evolution and a growing research direction toward innovative and sustainable solutions in financial risk management.

3.4 The citations relationship – document analysis unit

In the citation relationship analysis, a minimum threshold of 5 citations per document was imposed to ensure the relevance and consistency of the analyzed dataset. Out of a total of 1,167 documents, only 557 met this criterion, indicating that many initially extracted documents either lacked significant academic impact or were recently published and had insufficient time to accumulate a substantial number of citations. This filter was essential to focus on works with clear recognition in the scientific community, contributing to the theoretical and practical foundations of the analyzed field.

From the 557 selected documents, a set of 26 was identified as the most relevant based on their citation networks. These documents form dense, interconnected networks, suggesting their essential role in advancing the literature in this field. This narrower selection was justified by the need to focus on high-impact works, as the networks formed by these documents reflect significant knowledge transfer and provide a solid basis for understanding developments in financial risk research.

The remaining documents, while valuable, form smaller or isolated networks. These works are either insufficiently connected to others or inconsistently cited in the literature, limiting their impact on advancing knowledge in this domain. The decision to exclude these documents from the final set stems from the focus on works that have generated significant academic discussions and influence. In this context, documents with smaller or isolated networks may not offer as meaningful insights into the core themes of the field.

Therefore, the imposition of the citation threshold and the selection of a narrower set of documents are justified by the need to evaluate only those works that have had a significant influence on the development of financial risk management theories and practices, contributing to a more relevant and focused analysis.

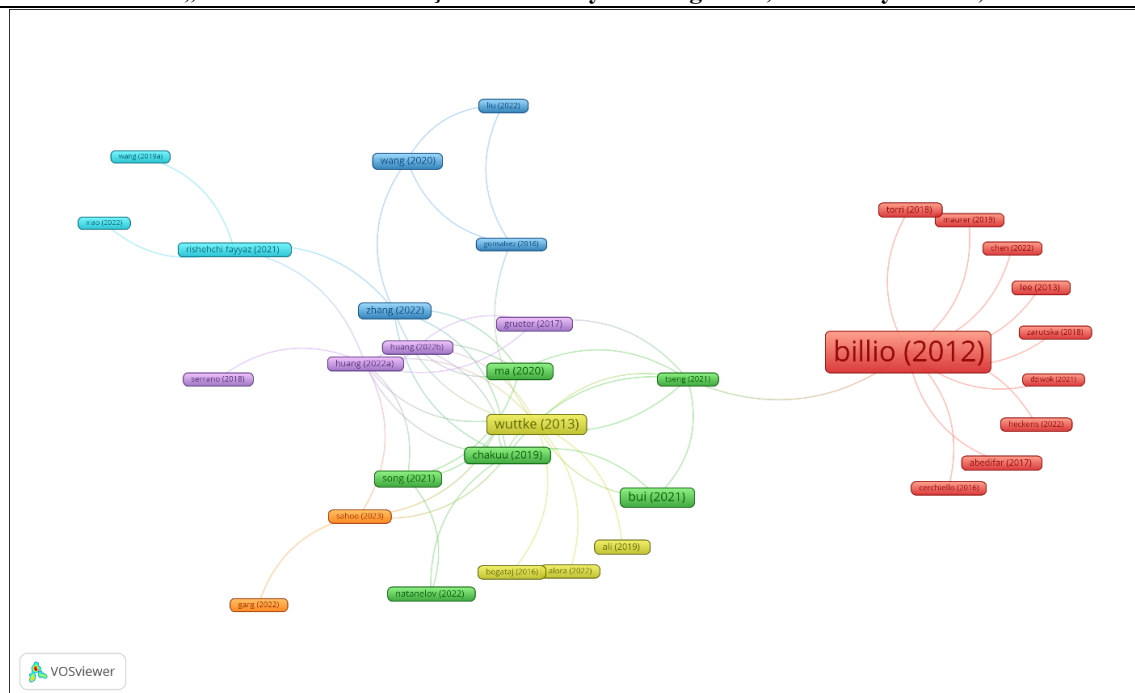


Figure 8 Document citation network

Source: own work based on the study of specialized literature

The red cluster, with Billio (2012) as its central work, demonstrates significant influence on subsequent research in systemic risk. This frequently cited study has created a network of research extending and deepening the analysis of financial risks. For instance, connected documents like Torri (2018), Maurer (2019), and Chen (2022) suggest that this literature continues to investigate various aspects of systemic risks and methods for managing them.

The works within the red cluster are primarily focused on the interactions and propagation of risks in a macroeconomic context, offering insights into market instability and financial vulnerabilities. This influence is reinforced by recent citations, such as Heckens (2022) and Dziwok (2021), indicating that Billio (2012) remains relevant in both systemic risk analysis and contemporary literature.

An intriguing connection is made with Tseng (2021), which bridges this cluster with other areas of risk management literature. This link may reflect an integrated research approach, exploring systemic risks at the macroeconomic level and their applications in organizational risk management.

The green cluster revolves around Chakuu (2019), which appears to be a central node in this network. The connections among documents in this cluster suggest a shared theme related to risk management and strategies applied in various economic contexts. Works such as Bui (2021) and Song (2021) indicate active collaboration and interdependence among these studies, highlighting a common interest in topics within the domain of risk management. The yellow cluster includes Wuttke (2013) as its focal point, extending to other relevant documents such as Bogataj (2016) and Ali (2019). The relatively close connections among these works suggest they explore similar themes, possibly related to performance evaluation and economic risks. This cluster exhibits coherence around a core of interconnected research. The purple cluster is relatively fragmented and includes documents like Huang (2022a) and Serrano (2018). This group appears more diverse, with a broader network of connections. Its lower density compared to other clusters suggests a wider exploration of subjects without a strongly centralized core. The blue cluster, featuring works such as Wang (2020) and Liu (2022), reflects a network of studies with strong interconnections. The concentrated links in this cluster imply a well-defined shared interest among these documents. It is a relatively homogeneous cluster with frequent cross-citations among its works. The turquoise

cluster comprises documents like Fayyaz (2021) and Xiao (2022). This network suggests an emerging research direction, characterized by relatively recent works, as indicated by the connections. Although the network is more fragmented, it reflects growing interest in the topics addressed by these studies. The orange cluster, centered on works by Sahoo (2023) and Garg (2022), is a newer cluster with fewer interconnected works. This network indicates that the research is relatively recent and still developing its connections. While smaller, the orange cluster reflects an expanding research direction.

3.5 The citations relationship – the organization unit of analysis

The blue cluster centered around Hong Kong Polytechnic University highlights the citation strength and connections of this institute with other top organizations worldwide. Significant links to institutions such as Renmin University of China, Beijing University of Technology, and the University of Chinese Academy of Sciences reflect a strong influence in technological and financial research. The citation relationships among these universities suggest solid academic collaboration and influence, focusing on well-defined research themes, likely in engineering, finance, and technology. Additionally, Hong Kong Polytechnic University is connected to Texas A&M University and Macau University of Science and Technology, indicating a global network of researchers contributing to scientific knowledge through mutual citation. The frequent citations among these institutions imply that their research has significant impact in their respective fields, often serving as foundational references in subsequent scientific literature.

The pink cluster centered on Coventry University reflects an extensive network of academic institutions collaborating in various research fields. Coventry University plays a crucial role in establishing a global academic platform, with connections to numerous universities worldwide. Among the most notable connections is Kwame Nkrumah University of Science and Technology in Ghana, known for its contributions to scientific and technological research. This partnership highlights the relevance of collaborations between Coventry University and African universities in addressing global challenges through multidisciplinary research. In the pink cluster, another essential connection is with Purdue University, an institution with a solid reputation in engineering and applied sciences. This link indicates close collaboration in advanced technological research, a field in which both universities are heavily involved. The connection with Aston University suggests collaborations in fields such as management and economic sciences, reflecting Aston's focus on developing managerial and entrepreneurial skills.

Another interesting aspect is the collaboration between Coventry University and National Taiwan Ocean University, suggesting a shared interest in oceanographic studies and environmental research—an increasingly relevant theme amid climate change. The link with Chongqing University in China could bring significant benefits to joint research projects in engineering and green technologies, considering China's commitment to sustainable development initiatives. The University of Manchester is also part of this network, indicating a notable academic partnership between two of the UK's largest universities. This collaboration likely spans a diverse range of fields, from applied sciences to social studies. Furthermore, connections with Georgia Institute of Technology underscore the importance of international partnerships in engineering and technology—two priority areas for both Coventry University and American universities.

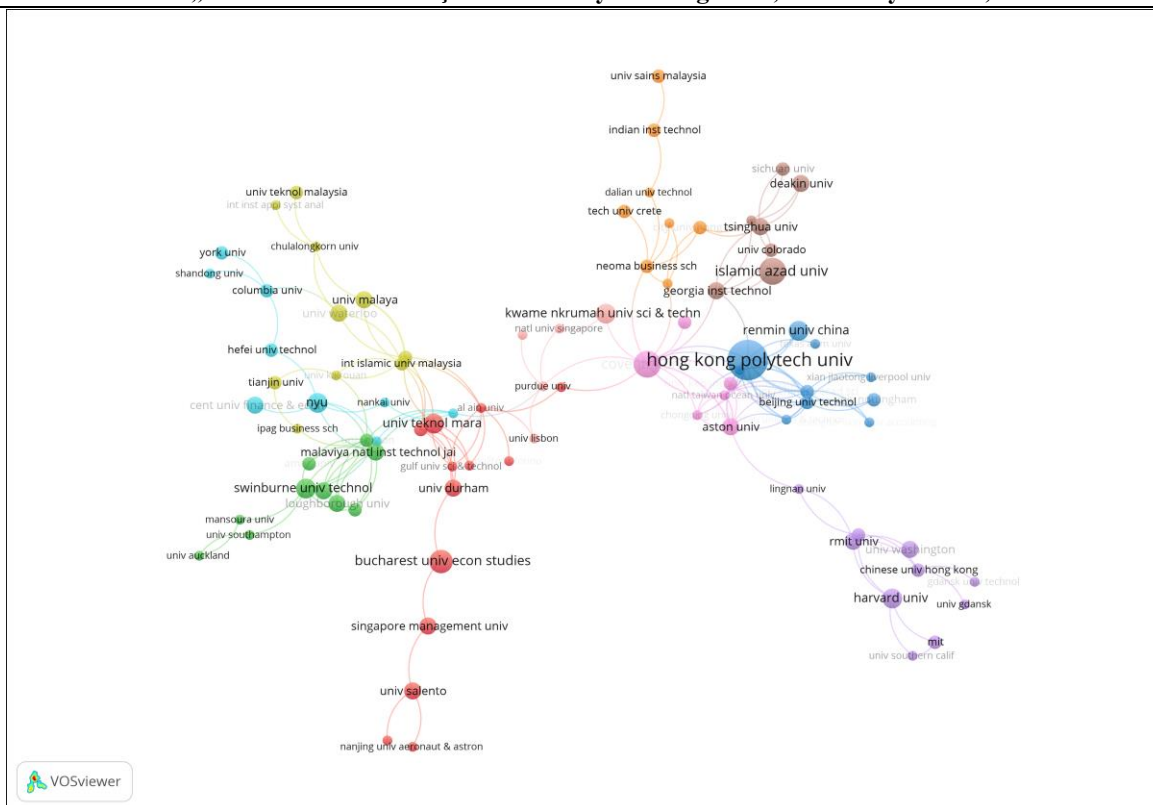


Figure 9 Network of citations by organization

Source: own work based on the study of specialized literature

The extended partnership of Coventry University includes Purdue University, Aston University, and Kwame Nkrumah University of Science and Technology, showcasing intensive collaboration in key areas for the future of international research.

The red cluster centers around the Bucharest University of Economic Studies, acting as a pivotal node in the citation network. This university connects with institutions such as Singapore Management University, University of Salento, and Nanjing University of Aeronautics and Astronautics, all contributing to fields like management and economics. Interestingly, this cluster not only brings together European universities but also includes institutions from Asia and the Middle East, reflecting significant international collaboration. Durham University, in northern England, is another key node, suggesting a continuous flow of research between British universities and those in Central and Eastern Europe. Universities like Politecnico di Torino and Gulf University for Science and Technology add another layer of complexity to the network, emphasizing interdisciplinarity in fields such as technology and management. Additionally, the cluster encompasses institutions such as Universiti Teknologi MARA in Malaysia and the University of Lisbon, which play significant roles in international collaborations within this study domain.

The brown cluster, centered on Islamic Azad University, stands out as a distinct network in the analysis of organizational citation relationships. It maintains strong connections with other major universities, including Tsinghua University, Beihang University, and Deakin University, indicating active knowledge exchange and citation relationships among these institutions. This suggests that research developed at Islamic Azad University is influential, with the university playing a significant role in advancing knowledge in shared research domains. Key partners also include Georgia Institute of Technology, renowned for its technological innovations and advanced research. Islamic Azad University also links with the University of Colorado, which may imply a shared focus on scientific or technological domains that attract frequent citations. Tsinghua University, a highly prestigious institution, further strengthens this partnership through its

connections with Islamic Azad University, highlighting robust research and development collaboration. Moreover, links with Deakin University and Sichuan University indicate that this cluster actively contributes to producing internationally cited research, significantly impacting various scientific fields.

The green cluster in this graph demonstrates an extensive citation network among renowned universities in technical and scientific domains. At the center is Swinburne University of Technology, which shows significant connectivity with institutions such as Loughborough University, Mansoura University, the University of Auckland, and the University of Southampton. These strong connections indicate substantial influence in academic literature through research in areas like engineering, emerging technologies, and resource management. The citation relationships between Swinburne University and Loughborough University, for instance, reflect constant knowledge exchanges and collaborations, contributing to the expansion of technological research fields. Additionally, universities such as Malaviya National Institute of Technology and Mansoura University contribute notably to this cluster through citations in studies on green technologies, sustainability, and advanced engineering.

The purple cluster, centered around institutions like Harvard University, MIT, and the University of Washington, highlights a network of relevant citations indicating a high level of academic interconnectivity. Notably, universities from different geographical regions are strongly linked through academic works addressing common or complementary research areas. Harvard University serves as a central node in this cluster, maintaining multiple links with universities like MIT and the University of Southern California. These connections emphasize that the publications from these institutions are frequently cited by others, reflecting consistent influence in fields such as social and technological sciences. MIT also plays a critical role in the network, connecting with Harvard and other international universities, suggesting intensive partnerships and collaboration in technological and scientific domains. Institutions like RMIT University and the University of Washington are linked to both MIT and other universities, showcasing an international citation network spanning multiple academic disciplines. The Chinese University of Hong Kong and the University of Gdansk are examples of Asian and European institutions with significant influence in the network, connecting to both Harvard and MIT. This suggests that their research is recognized globally, and the citations reflect their importance in the international academic context.

3.6 Co-citation network

In the co-citation analysis, a minimum threshold of 100 citations per source was established. Out of 24,705 available sources, only 66 met this criterion. The co-citation analysis method assumes that publications frequently cited together tend to be thematically similar. This approach reveals the intellectual structure of a research field by identifying fundamental themes and central sources contributing to the academic domain.

The primary advantage of this method is its ability to pinpoint influential publications and thematic groups dominating a specific area. For instance, it helps identify foundational works in subfields such as risk management, financial innovation, or sustainability.

However, it is crucial to note the limitations of co-citation analysis. This method tends to overlook recent works or niche publications that have not yet accumulated significant citations but might offer valuable insights for future research. As such, co-citation analysis is particularly useful for researchers aiming to uncover foundational works and the established knowledge base within a field.

The turquoise cluster, represented by sources such as Journal of Finance (J Financ), Journal of Financial Economics (J Financ Econ), and Review of Financial Studies (Rev Financ Stud), is the most important in the co-citation network from our analysis, with a very high total number of citations and strong connectivity within financial research. With a total of 1,401 citations and a total link strength of 50,453, Journal of Finance is the most cited source in this cluster, having a

major influence on works in the field. Journal of Financial Economics follows closely, with 1,166 citations and a very similar link strength (50,377). This suggests that the two journals are frequently used together in scientific literature and are considered foundational sources for research in finance. Review of Financial Studies (Rev Financ Stud) has a smaller number of citations (605) but significant connectivity (29,876), indicating that this journal is also highly relevant, albeit to a lesser extent than the first two. Noteworthy is also the importance of the Journal of Behavioral Finance (J Behav Financ), with 176 citations and a link strength of 17,681, highlighting the growing interest in research analyzing investor behavior in financial markets. Finally, European Financial Management (Eur Financ Manag), with 105 citations and a link strength of 7,262, completes the turquoise cluster, having a more modest but significant role in financial studies. These journals are the main pillars of modern financial research, providing a framework for the development of new theories and their application in empirical studies.

The red cluster in the journal co-citation network revealed several sources with significant influence on the literature in finance and business ethics. At the forefront of this cluster, with the highest number of citations and strongest link strength, is the Journal of Banking and Finance, with 718 citations and a total link strength of 20,529. This is an essential academic journal in the fields of banking and finance, focusing on financial analysis and the economic aspects of financial institutions. Its importance is reflected not only in the high number of citations but also in its connections with other sources in the same field, signaling that it is a central pillar in discussions about financial risks, banking management, and corporate governance. The second most influential journal in this cluster is the Journal of Business Ethics, with 408 citations and a link strength of 15,651. This journal explores the ethical dimensions of business and focuses on topics such as corporate social responsibility, sustainability, and ethical behavior in business management. Through its connections with other sources in the cluster, this journal raises critical issues about how companies can navigate ethical challenges in an increasingly globalized world.

Another notable journal in this cluster is Sustainability-Basel, which has 493 citations and a link strength of 13,199. It focuses on sustainability and sustainable development, exerting significant influence on discussions about integrating sustainability principles into business and economic practices. Its importance in the cluster reflects the growing global interest in sustainable practices and their impact on corporate performance.

The International Review of Financial Analysis, with 336 citations and a total link strength of 11,740, plays a role in disseminating advanced financial analyses and research related to the evaluation of financial risks. This journal is highly influential in the context of empirical and theoretical financial research, focusing on the interactions between financial markets and economic behaviors. On the other hand, Financial Research Letters, with 272 citations and a link strength of 10,755, is a relatively new journal but highly active in financial research, providing a platform for innovative work and discussions on recent developments in economics and finance.

Prominent scientific publications such as Science (104 citations) and Nature (109 citations) are included in the cluster, adding an intersection between social and natural sciences. These journals provide innovative and transdisciplinary perspectives that help explain complex phenomena in economics and society.

The blue cluster, composed of sources with a significant number of citations, represents a strong core of publications in the fields of management sciences, corporate finance, accounting, and quantitative finance. These sources have remarkable influence on contemporary research in areas essential for financial and managerial theory and practice. The most cited source is Manage Sci, with 388 citations and a link strength of 13,580. This flagship journal is well-known for its contributions to the development of management theory and the application of quantitative methods in decision-making. Articles published here cover essential management topics, including organizational theory, decision-making, and business strategy, with an emphasis on the practical applicability of theories. Next, J Corp Financ enjoys a nearly similar link strength (13,401) with 266 citations. This journal makes significant contributions to the field of corporate finance, covering topics such as capital structure, corporate governance, and financial strategies. Together with Manage Sci, these publications form a crucial foundation for understanding corporate-level financial strategies.

Account Rev (273 citations and a link strength of 12,314) completes this triad, being one of the most cited sources in accounting. This journal examines the latest innovations and theories in accounting and financial reporting, having a considerable impact on how accounting practices are implemented in organizations. Additionally, sources like Strategic Manage J (249 citations and 10,846 link strength) and J Financ Quant Anal (233 citations and 10,382 link strength) make notable contributions to understanding organizational strategies and quantitative financial analyses. Strategic Manage J is essential for studying competitive and innovative strategies, while J Financ Quant Anal is vital for deepening methodologies used to assess financial risks and investment performance.

J Account Econ (199 citations and a link strength of 9,371) and J Account Res (127 citations and a link strength of 7,634) enrich the blue cluster with rigorous discussions on organizational accounting and its impact on global financial markets. These sources are crucial for understanding the interactions between accounting decisions and financial market dynamics.

The purple cluster highlights publications that have been highly relevant in the fields of production and operations management. Among the most important journals in this cluster is Journal of Cleaner Production, which received 437 citations and has a total link strength of 15,919, indicating a major influence in the literature on sustainable production and clean processes. This journal is central to this cluster, having a significant impact on the development of topics related to sustainable production. Second in this cluster is the International Journal of Production Economics, with 371 citations and a link strength of 11,672. This journal addresses topics in production economics, offering analyses and perspectives on the efficiency and optimization of industrial processes. Another key player in this cluster is the European Journal of Operational Research, with 445 citations and a link strength of 11,271. This journal is essential for research in operational research and decision management, playing a critical role in improving operational efficiency across various industries.

International Journal of Production Research completes this core, with 141 citations and a link strength of 6,962. Although it has fewer citations, the journal plays an important role in understanding and improving production processes. Additionally, Expert Systems with Applications is notable with 357 citations and a link strength of 6,048, emphasizing the importance of expert systems in solving complex problems in operations and decision-making.

The yellow cluster in the co-citation network analysis includes important sources in energy and sustainability, contributing significantly to research on environmental and energy economics topics. The most cited journal is Energy Economics (361 citations, 12,658 link strength), which

plays a central role in economic approaches to energy resources. Next is Energy Policy (285 citations, 7,193 link strength), another influential journal covering energy policies and their global economic impacts. Journal of Econometrics (144 citations, 4,305 link strength) provides an econometric approach to energy issues, contributing to the economic and statistical modeling of these challenges. Additionally, Renewable and Sustainable Energy Reviews (167 citations, 3,954 link strength) is another key journal in renewable energy, examining sustainable energy sources and their efficiency. Resour Policy (116 citations, 3,677 link strength) focuses on the political and economic aspects of natural resource use, while Renewable Energy (129 citations, 3,676 link strength) analyzes sustainable solutions for energy challenges. Environ Sci Pollut Res (114 citations, 2,556 link strength) explores energy's environmental impact, addressing the issue of pollution.

Finally, the International Journal of Project Management (138 citations, link strength of 1,704) and Journal of Construction Engineering and Management (147 citations, link strength of 1,313) address the implementation of large-scale infrastructure projects, including those in the energy sector.

The next comparative assessment focuses on the influence of financial risk on organizations, drawing from a series of studies, evaluation methodologies, and significant findings. This evaluation is based on a selection of relevant articles, each contributing significantly to understanding economic risks. We will analyze the methodologies employed in these studies and the key findings that shape how financial risks are assessed and managed. This approach will enable us to highlight the differences between traditional risk assessment models and the latest techniques used in practice, providing an overview of the contemporary financial risk landscape.

Table 1 Comparative summary of financial risk to organizations

Authors	Article title	Methodology	Key results
Billio et al. (2012)	Econometric measures of connectedness and systemic risk in the finance and insurance sectors	The article uses econometric measures based on principal component analysis and Granger causality tests to quantify the degree of interconnectedness between hedge funds, banks, brokers and insurance companies. The study is based on monthly data on their returns, using specific indices weighted by assets under management and market capitalization.	The research shows that the financial and insurance sectors have become increasingly interconnected in recent years, increasing systemic risk in these industries. An asymmetry in the propagation of financial shocks has been highlighted, with banks playing a key role in transmitting these shocks to other financial institutions. At the same time, the proposed measures can identify and quantify periods of financial crisis.
Gabriel et al. (2014)	Hazardous times for monetary policy: what do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking?	The study uses an extensive dataset of 23 million bank loans to analyze the effects of monetary policy on credit risk-taking. The econometric model uses a two-stage framework, in which the first stage investigates the approval of credit applications and the second focuses on the outcomes of approved loans. The data are collected from the Spanish credit registers, covering a period of six years, and macroeconomic variables and specific banking	The study shows that a low policy rate leads thinly capitalized banks to lend more to high-risk firms, which increases the likelihood of subsequent default. The results suggest that expansionary monetary policy increases risk-taking by banks and contributes to financial instability.

		indicators are used.	
Wuttke et al. (2013)	Focusing the Financial Flow of Supply Chains: An Empirical Investigation of Financial Supply Chain Management	A significant study examining financial supply chain management (FSCM) through eight case studies based on 40 interviews. The main objective of this article was to build a theoretical foundation for financial flow management in supply chains and to explore the ways in which this management influences organizational performance.	The study methodology included qualitative interview analysis to understand the financial processes and decisions of organizations in supply chains. The study focused on two categories of FSCM: pre-shipment and post-shipment, identifying the determinants and performance effects of each category. These categories were analyzed from a transaction cost economics perspective and were compared according to their impact on working capital and financial risks in supply chains. Key findings of the study showed that firms implementing FSCM have better management of financial flows and, implicitly, a reduction in financial risks for organizations. The study also showed that the use of FSCM is often influenced by a firm's working capital position and its dependence on its suppliers.
Wieczorek-Kosmala (2019)	The Concept of Risk Capital and Its Application in Non-Financial Companies: A Sustainable Dimension	Conceptual and discursive analysis of the application of venture capital in non-financial companies.	The article argues for the integration of venture capital into non-financial companies, highlighting its importance in sustainable risk management and financial resilience. Venture capital is presented as a financial reserve to cover unexpected losses, providing practical insights into traditional and alternative sources of venture capital.
Popkova și Sergi, (2021)	Dataset modelling of the financial risk management of social entrepreneurship in emerging economies	The methodology used in this article is econometric modeling of data sets, through which an analysis of the financial risks specific to social entrepreneurship in emerging economies was carried out. The authors used a regression model to identify dependencies between classical financial factors of commercial entrepreneurship and those specific to sustainable development. The analysis was based on data from 2021 and involved variables such as stimulating long-term investment, creating future markets, investing in research	The results of the study demonstrated that financial risks in social entrepreneurship differ from those in commercial entrepreneurship. Classical financial factors (such as receiving loans or protecting minority investors) do not have a significant impact on social entrepreneurship, but factors specific to sustainable development have a significant influence. Among the financial risks identified are: decreased incentives for long-term investment, reduced investment in research and development, and insufficient

		and development, and investing in skills for future jobs.	expansion of investment in skills for the jobs of the future. The study highlights that appropriate management of financial risks can increase social entrepreneurship by 99.61%, significantly contributing to achieving the sustainable development goals.
Mashrur et al. (2020)	Machine Learning for Financial Risk Management: A Survey	The methodology of this article consists of a systematic literature review, focusing on the application of machine learning methods in financial risk management. The authors create a taxonomy of risk management tasks and correlate them with relevant machine learning methods. The articles are also categorized according to their applicability to various risk categories, such as market risk, credit risk, operational risk, and insurance risk. The authors use the literature review to highlight emerging challenges and research directions, such as the use of advanced machine learning methods for estimating and mitigating financial risks.	The article identifies the main challenges in applying machine learning for financial risk management, such as the lack of public data, the volatile nature of financial data, and the presence of noise in the data. Another important result of the study is the proposal of new research directions, such as the use of meta-modeling methods and federated learning to overcome current limitations. The authors emphasize that advanced machine learning methods, such as deep neural networks and reinforcement learning, have significant potential to improve financial forecasts and decisions in high-risk contexts.
Ślusarczyk și Grondys, (2019)	Parametric Conditions of High Financial Risk in the SME Sector	The methodology used involves the use of logistic regression to analyze the impact of parametric factors on financial risk in the Polish SME sector. The data sample comes from a survey of 496 small and medium-sized companies in Poland, the majority of which were micro-enterprises (60.3%). The variables analyzed included company size, internationalization, time on the market, and risk management. Each variable was entered into a logit model to estimate the probability of high financial risk.	The study concluded that internationalization and risk management are the most relevant factors influencing financial risk in SMEs, especially the risk of insufficient profits. The results showed that firms operating in international markets are more likely to register insufficient profits, but this probability decreases significantly if the company has implemented risk management practices. In contrast, firm size and operating time were not significant indicators of other financial risks, such as the use of foreign capital or the inability to pay its obligations.
Li, (2024)	Identification of Enterprise Financial Risk Based on Logistics Model	The methodology used in this study is to use the logistic regression model to build a corporate financial risk identification system. The research analyzed 36 listed companies in China, of which 18 had financial difficulties, to evaluate the effectiveness of the model in identifying risks. The	The results of the study showed that the logistic regression model had an accuracy of 94.68% in identifying financial risks within the analyzed companies. This model proved to be more effective than traditional models, such as Z-score and SVM, due to its ability to

		logistic model was compared with other models, such as Z-score and DE-SVM (Differential Evolution-Support Vector Machine), but it demonstrated superior accuracy in predicting financial risks, having the ability to effectively manage both traditional financial indicators and those related to cash flows.	evaluate the complex relationships between different financial indicators. The study highlighted the importance of integrating cash flow indicators to increase the sensitivity of the model in identifying financial crises. The main conclusion is that the logistics system can improve the financial stability and competitiveness of enterprises in a complex market environment.
Radu și Dragomir (2022)	The Relationship between Integrated Thinking and Financial Risk: Panel Estimation in a Global Sample	The methodology used is panel regression applied to a sample of 7,111 non-financial companies from 85 countries, for the period 2017-2021. The data were collected mainly from the Refinitiv Eikon database, and the variables analyzed include weighted average cost of capital (WACC), financial leverage and liquidity. Random-effects models were used to estimate the relationship between ITR and financial risks. The impact of sustainability-related compensation on financial risk was also taken into account.	The results showed that integrated reporting and integrated thinking (ITR) have a significant negative relationship with the weighted average cost of capital (WACC), suggesting that implementing an integrated reporting strategy can reduce the cost of financing by improving transparency and reducing financial risk. In addition, the results indicated a positive relationship between ITR and liquidity measured by the liquidity ratio, suggesting that companies with an integrated thinking strategy have better liquidity, thereby reducing financial risk. Also, the introduction of sustainability-related executive compensation schemes contributed to reducing financing costs.

Source: own work based on research methodology

4. Conclusion

The multiplication and diversification of risks in the context of recent developments affected by turbulence and uncertainties obliges organizations to give crucial importance to strategies for identifying and managing financial risks and the entire risk management process. Noting that the interest in approaching financial risks has grown permanently, but intensified in the last decade, an observation demonstrated by the increase in the methods and techniques used in risk management and financing, we set several research objectives summarized in this study.

We used bibliometric techniques to analyze the evolution of research in the field of financial risk management, financial risk identification and financing using three main keywords: financial risk management; identifying financial risks; financing financial risks and the Web of Science database. We used the VOSviewer software to create graphical visualizations of the relationships between authors, organizations and keywords, which allowed us to perform a robust analysis.

The contribution of this study was to synthesize data from a wide range of sources and present, through graphs and tables, consistent results on the current state of knowledge in financial risk management. Furthermore, the directions of development of studies in the field of financial

risks were identified and the most influential works, authors and organizations that can be used as reference points for future research were highlighted.

Our results show that there is a visible trend of increasing the number of studies indicating that the interest in the study of financial risk management is growing. The number of publications and citations increased rapidly after 2015, reaching a significant peak in 2020, followed by a constant increase until 2024. This result can be correlated with the global transformations caused by the COVID-19 pandemic that had a major impact on world economies and generated new challenges in terms of financial risks, requiring a reassessment of the methods of managing them. Geopolitical instability caused by wars also contributed to the peak in 2024.

The analysis of collaborative relationships between researchers from different countries allowed us to observe the centers of power and the dynamics of international collaborations. The largest cluster includes countries such as China, the USA, Australia, Canada and England. These countries have a dominant role in the financial risk research network, which indicates that they are essential centers of scientific production in this field. The USA and China dominate the global research network, while Europe presents a well-connected network of researchers and Asia and the Middle East form a distinct cluster. To provide additional insight into the dynamics of international collaborations in financial risk research, we developed a temporal analysis of scientific contributions that shows that countries such as India, Malaysia and Saudi Arabia have shown a recent interest in financial risk research, with an increased volume of international collaborations since 2021. The results of the analysis of co-authorship at the organization level, respecting the restrictions introduced, show that Monash University and the Hong Kong Polytechnic University are the two central nodes of the network, having the most connections and establishing significant collaborations with other organizations. We highlighted a well-connected network of collaborations between top universities that act as main nodes for knowledge transfer and international collaborations, facilitating the exchange of ideas and the development of new approaches in the field of financial risk.

By following the keywords that are frequently used in the literature, indicating central research themes and major concepts for understanding research directions and theoretical developments in this field, after applying the filters it resulted that the term *"risk"*, reflects the central core of research on financial risks and highlights a complex network of interconnected concepts. Globally, risk is the dominant concept, with the most links to important terms from related fields, such as performance, finance, model and market. This highlights the fact that financial risk is inextricably linked to the financial performance of organizations and market developments, both of which are essential themes in risk assessment and management. We also note the results regarding the terms *"model"* and *"models"* which are strongly connected with risk, indicating the extensive use of financial models to assess risks and to develop appropriate strategies for their management. Models are essential in predicting risks and in testing different scenarios that may affect organizations. Also interesting is the presence of emerging terms such as *"bibliometric analysis"* and *"Covid-19"*, which show that recent financial risks have been explored in the context of the global pandemic and recent research has relied on bibliometric methods to map the dynamics of the field.

Filters were also applied in the analysis of citation relationships in order to evaluate only those works that have had a major influence on the development of financial risk management theories and practices, thus contributing to a more relevant and focused analysis. The work *"Econometric measures of connectedness and systemic risk in the finance and insurance sectors"* (Billio et al., 2012) is the most renowned work in the analysis of systemic risks and in contemporary literature. This axis of study on the citation relationship allowed us to observe an integrated approach to risk research, exploring both systemic risks at the macroeconomic level and their applications in risk management at the organizational level.

Next, the most influential publications were identified, as well as thematic groups that dominate this field or some subfields such as risk management, financial innovation or sustainability. "Journal of Finance" is the most cited source, having a major influence on the works in the field, followed closely by "Journal of Financial Economics", two journals being frequently used together in the scientific literature and are considered basic sources for research in the financial field.

The conclusion of the last study axis derived from the realization of a comparative summary of the financial risk on organizations allowed us to highlight the differences between traditional risk assessment models and the most recent techniques used in practice, providing an overview of the contemporary financial risk landscape.

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