

Risk and Uncertainty in Decision-Making: A Bibliometric Review

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ABSTRACT

This study provides a systematic bibliometric review of risk and uncertainty in financial management decision-making, mapping the intellectual structure, collaborative networks, and thematic evolution of this research domain. A quantitative bibliometric approach is employed using 688 articles indexed in the Scopus database. VOSviewer software is applied to conduct co-authorship mapping (authors and countries) and co-occurrence analysis. The analysis reveals that research on risk and uncertainty has expanded significantly, supported by extensive international collaborative networks. Three dominant thematic clusters emerge: risk management and investment decisions, behavioral finance and cognitive biases, and the integration of uncertainty with analytical and technological approaches. The integration of artificial intelligence represents an evolving research hotspot. The findings provide researchers and practitioners with a structured roadmap of the field, identifying high-impact collaboration opportunities and understudied thematic intersections that warrant future empirical investigation. This study offers the first holistic bibliometric review that simultaneously maps the knowledge structure, scientific collaboration patterns, thematic clusters, and future research directions in risk and uncertainty within financial management decision-making.

Keywords: risk, uncertainty, decision-making, financial management, bibliometric analysis

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INTRODUCTION

Risk and uncertainty constitute foundational elements in financial management decision-making, confronting practitioners with market volatility, economic fluctuations, and persistent information asymmetry (Knight, 1921; Arrow, 1971; Aven, 2016). Frank Knight's seminal distinction categorizes risk as quantifiable uncertainty measurable through probability distributions, while genuine uncertainty remains inherently non-probabilistic and beyond formal prediction. This conceptual boundary continues to shape how financial economists model asset pricing, portfolio construction, and hedging strategies, domains in which assumptions of perfect rationality are frequently contested (Markowitz, 1952; Sharpe, 1964; Berk and DeMarzo, 2020). The relevance of this distinction has intensified in the aftermath of the 2008 global financial crisis and the COVID-19 pandemic, episodes that exposed the fragility of risk models calibrated under stable conditions and underscored the distinction between calculable risk and deep uncertainty (Bernanke, 2009; Goodell, 2020).

Parallel advances in behavioral finance have reinforced the importance of integrating psychological dimensions into risk analysis, challenging the normative frameworks of expected utility theory (Kahneman and Tversky, 1979; Barberis, 2018; Thaler, 2016). The integration of artificial intelligence and big data analytics into risk management represents the most recent frontier, enabling the real-time processing of high-dimensional information and supporting more adaptive decision-making under uncertainty (Camuffo et al., 2020; Vogt et al., 2020). These developments are particularly visible in emerging markets, where institutional uncertainty compounds market risk and where AI-assisted tools increasingly mediate managerial judgment (Baker et al., 2016; Bouteska and Regaieg, 2022). Bibliometric approaches have proven highly effective for synthesizing this rapidly evolving body of knowledge, offering structured, quantitative insights into publication patterns and intellectual structure (Donthu et al., 2021; Mukherjee et al., 2022).

Despite the breadth of research, a comprehensive bibliometric review that holistically maps the knowledge structure, scientific collaboration, and thematic evolution of risk and uncertainty in financial management decision-making remains notably absent. Initial exploration of the Scopus database using the query combining terms such as "risk and uncertainty," "decision under uncertainty," "decision making," "investment decision," and "financial decision" retrieved 688 indexed articles, confirming sustained and high-volume scholarly interest. However, quantitative analysis of publication patterns, citation networks, international collaboration structures, and emergent thematic clusters has not been systematically undertaken for this domain (Aven and Renn, 2019; Mawadah et al., 2026). Existing bibliometric studies in adjacent domains, such as decision-making in crisis management and public financial management, confirm that such analyses are essential for identifying research trajectories and underexplored intersections (Maulana et al., 2026; Azmi et al., 2026).

Bibliometric analysis provides a rigorous and reproducible methodology for uncovering scientific dynamics that remain invisible through conventional literature reviews (Zupic and Cater, 2015; Aria and Cuccurullo, 2017). By combining performance analysis with network science approaches, researchers can identify the most influential documents, authors, institutions, and countries based on citation metrics such as h-index and total citations (Hirsch, 2005; Waltman and van Eck, 2012), while co-occurrence analysis of keywords reveals the thematic clusters and research hotspots structuring the field (van Eck and Waltman, 2010; Baker et al., 2021). These methods are especially well-suited for risk and uncertainty research, which spans multiple disciplines, including financial economics, organizational behavior, and computational

science. Comparable bibliometric studies in digital transformation and financial management have demonstrated the utility of this approach for establishing research baselines and guiding future inquiry (Wibowo et al., 2026; Chairani et al., 2026).

This study investigates the intellectual structure and thematic evolution of risk and uncertainty research in financial management decision-making, drawing on 688 Scopus-indexed articles covering the period from the early 1980s to the present. The research encompasses four specific objectives: (1) mapping co-authorship networks among individual researchers and countries to identify collaboration structures; (2) identifying research hotspots, including the integration of behavioral finance with risk analysis and the application of artificial intelligence; (3) uncovering dominant thematic clusters through keyword co-occurrence analysis; and (4) providing empirically grounded recommendations for future research directions. The remainder of this paper is organized as follows. Section 2 reviews the theoretical foundations and key empirical themes in risk and uncertainty scholarship. Section 3 describes the data collection procedures and bibliometric methodology. Section 4 presents and interprets the findings from co-authorship and co-occurrence analyses. Section 5 concludes with theoretical contributions, practical implications, and directions for future research.

LITERATURE REVIEW

The conceptual distinction between risk and uncertainty introduced by Knight (1921) remains the foundational framework for research in this domain, classifying risk as probabilistically computable while reserving the term uncertainty for situations in which no stable probability distribution can be assigned. This distinction was subsequently incorporated into general equilibrium theory by Arrow (1971) and into portfolio optimization by Markowitz (1952) and Sharpe (1964), establishing the theoretical basis for quantitative financial risk management. In the context of contemporary financial management, the Knight-Arrow-Markowitz framework continues to underpin risk measurement practices, although its limitations have been increasingly acknowledged as markets have grown more interconnected and prone to non-linear disruptions (Aven, 2016; Hunziker, 2021). Behavioral extensions of this framework, most prominently prospect theory (Kahneman and Tversky, 1979), reorient attention from objective probability assessments toward the subjective valuation of gains and losses, documenting systematic deviations from rational expected utility maximization that have far-reaching implications for financial decision-making (Barberis, 2018; Thaler, 2016).

Human decision-making under uncertainty is systematically shaped by cognitive heuristics that simplify complex information environments at the cost of introducing predictable biases. Overconfidence, anchoring, and representativeness are among the most consistently documented heuristics that distort financial judgments, with overconfidence being particularly prevalent in investment contexts where agents systematically overestimate their predictive accuracy (Kaaronen, 2020; Mensah et al., 2021). The literature on bounded rationality, reviewed bibliometrically by Azmi et al. (2026), documents how information constraints and cognitive limitations interact with uncertainty to produce decision outcomes that deviate systematically from normative models, particularly under time pressure and in high-stakes environments. Špaček (2021) further argues that uncertainty in contemporary organizational contexts is qualitatively distinct from the calculable risks addressed by classical financial models, requiring adaptive rather than optimization-based decision approaches. These findings are reinforced by the entrepreneurship literature,

where individuals operating under genuine uncertainty rely disproportionately on prior experience and risk tolerance rather than formal probabilistic models (Mensah et al., 2021).

Systemic uncertainty exerts profound effects on financial market behavior, particularly during periods of crisis when information quality deteriorates and herding behavior amplifies price volatility (Nelson and Katzenstein, 2014; Baker et al., 2016). Organizational responses to uncertainty in financial management range from conservative investment deferral to sophisticated scenario planning and quantitative risk modeling (Chapman, 2019; Švecová and Kacin, 2019). The risk-return framework developed within capital asset pricing theory provides a foundational rationale for accepting measurable risk, while enterprise risk management frameworks extend this logic to organizational settings by integrating strategic, operational, and financial risk categories (Hunziker, 2021; Crawford and Jabbour, 2024). Empirical studies have further established that risk and uncertainty permeate public financial management, as documented by Maulana et al. (2026), who identify institutional fragmentation and political uncertainty as distinctive features of public sector financial decision-making that significantly complicate risk assessment relative to corporate contexts. In investment analysis, structured risk assessment tools consistently improve decision quality by enabling more systematic evaluation of probabilistic outcomes and expected returns (D'Alpaos and Canesi, 2019; Hines, 2025).

The integration of computational methods into risk and uncertainty research has fundamentally transformed how organizations identify, assess, and respond to financial risks (Vogt et al., 2020; Camuffo et al., 2020). Machine learning algorithms and big data analytics now enable the real-time processing of high-dimensional datasets, supporting the identification of non-linear risk patterns that evade conventional statistical approaches (Brousseau and Trapp, 2025). This technological evolution is particularly consequential for financial markets research, where AI-assisted models are increasingly applied to volatility forecasting, credit risk assessment, and portfolio optimization under uncertainty (Bouteska and Regaieg, 2022). Bibliometric analyses of digital transformation and financial management, including Wibowo et al. (2026) and Chairani et al. (2026), confirm that technology-mediated decision-making is now among the most active research frontiers across management disciplines, with risk management applications constituting a central strand. The intersection of AI with behavioral approaches to uncertainty represents a particularly fertile domain for future research, given that machine-generated insights must ultimately interface with human judgment processes shaped by the cognitive biases and heuristics reviewed above (Kaaronen, 2020; Cerroni et al., 2023).

Bibliometric analysis has established itself as a rigorous and widely adopted methodology for mapping the intellectual structure of management and finance research, offering quantitative evidence on publication trends, citation impact, and collaborative networks (Zupic and Cater, 2015; Donthu et al., 2021). Baker et al. (2021) applied bibliometric methods to behavioral finance, identifying dominant theoretical streams and emergent research gaps. Adjacent bibliometric studies reviewed by Azmi et al. (2026) on bounded rationality and decision-making, Mawadah et al. (2026) on decision-making in crisis management within financial management, and Maulana et al. (2026) on public financial management collectively confirm that decision-making under uncertainty is fragmented across specialized sub-literatures without an integrating bibliometric overview. Mukherjee et al. (2022) provide methodological guidelines for advancing theory through bibliometric research, underscoring that well-executed bibliometric reviews not only describe the existing literature but generate actionable hypotheses for future empirical studies. The present review addresses this identified gap by providing the first systematic bibliometric synthesis

specifically focused on risk and uncertainty within financial management decision-making, building on the analytical approaches established by these predecessor studies (Aria and Cuccurullo, 2017; Wibowo et al., 2026).

METHODOLOGY

This study obtained bibliometric data from the Scopus database, one of the most comprehensive and internationally recognized scientific repositories, which is widely recommended for bibliometric research due to its extensive metadata coverage and citation tracking capabilities (Donthu et al., 2021; Mukherjee et al., 2022). Data retrieval employed a structured Boolean query combining terms relevant to the research topic: TITLE-ABS-KEY(("risk and uncertainty" OR "decision under uncertainty") AND ("decision making" OR "investment decision" OR "financial decision")). The initial search yielded 688 articles. Subsequent filtering retained only English-language peer-reviewed journal articles with direct relevance to risk and uncertainty in the context of decision-making, yielding a final dataset of 688 articles spanning publications from the early 1980s to the present. This temporal scope was deliberately selected to capture the full evolution of the field, from the foundational operationalization of Knight's (1921) framework through the contemporary era marked by digital transformation and post-pandemic economic uncertainty (Schwab, 2017; Donthu and Gustafsson, 2020).

All bibliometric analyses were conducted using VOSviewer (version 1.6.20), a specialized software program designed for constructing and visualizing bibliometric maps based on similarity measures (van Eck and Waltman, 2010). VOSviewer is particularly suited for large datasets and provides robust visualization capabilities for co-authorship and co-occurrence networks, which are the primary analytical techniques employed in this study. Four complementary analytical techniques were applied. First, co-authorship analysis at both the author and country levels was conducted to identify collaborative networks and the structure of scientific partnerships in the risk and uncertainty domain (Borner et al., 2018). Second, keyword co-occurrence analysis was performed to map thematic clusters and identify research hotspots that have attracted sustained scholarly attention (Baker et al., 2021; van Eck and Waltman, 2010). Third, text-based co-occurrence analysis was applied to extend thematic mapping beyond author-assigned keywords to the full conceptual vocabulary of the corpus. Fourth, publication trend analysis was carried out to document the quantitative growth of the field and identify periods of accelerated scholarly output. These techniques have been validated in comparable bibliometric reviews of decision-making and financial management (Azmi et al., 2026; Mawadah et al., 2026).

The research procedure followed the systematic protocol recommended by Donthu et al. (2021) and Mukherjee et al. (2022) for conducting rigorous bibliometric analyses. The process proceeded through six sequential stages: (1) topic definition and keyword strategy formulation; (2) data extraction from Scopus using the specified Boolean query; (3) data cleaning and eligibility filtering based on language, document type, and topical relevance; (4) data import into VOSviewer for network construction; (5) iterative analysis and visual interpretation of co-authorship and co-occurrence maps; and (6) synthesis of findings into thematic conclusions with implications for future research. Minimum thresholds were applied in VOSviewer to ensure that only entities with sufficient co-occurrence or co-authorship frequency were included in network visualizations, following established norms in the bibliometric literature (van Eck and Waltman, 2010; Aria and Cuccurullo, 2017).

RESULTS AND DISCUSSION

Overview of Publication Trends

The 688 articles retrieved from Scopus document a pattern of sustained and accelerating scholarly output on risk and uncertainty in financial management decision-making. Publication volume remained relatively modest through the 1980s and 1990s, corresponding to a period in which the field was primarily theoretical and anchored in the mathematical formalization of risk under the capital asset pricing and portfolio optimization frameworks (Markowitz, 1952; Sharpe, 1964). Growth accelerated markedly in the 2000s, coinciding with the behavioral finance revolution and the emergence of policy uncertainty indices (Baker et al., 2016; Kahneman and Tversky, 1979). The most pronounced growth phase is evident in the period following the 2008 global financial crisis, with a secondary acceleration beginning in 2020, reflecting the COVID-19 pandemic's disruption of financial management practices globally (Goodell, 2020; Bernanke, 2009). These trends are consistent with bibliometric analyses of adjacent domains, including decision-making in crisis management and public financial management, which similarly document crisis-driven surges in scholarly activity (Mawadah et al., 2026; Maulana et al., 2026).

Co-Authorship Network: Authors and Countries

Figure 1 presents the co-authorship network among individual authors, with each node representing a researcher and each link indicating a co-authored publication. Node size reflects cumulative publication output and link thickness indicates the strength of collaborative ties. The network reveals a fragmented structure characterized by multiple distinct clusters of tightly collaborating authors with relatively sparse inter-cluster connections. This fragmentation indicates that risk and uncertainty research in financial management has developed within segmented scientific communities, each operating around a distinct theoretical tradition or methodological approach, with limited cross-community knowledge integration. The pattern is consistent with findings from bibliometric analyses of behavioral finance (Baker et al., 2021) and bounded rationality research (Azmi et al., 2026), both of which identify similar fragmentation within their respective co-authorship networks. This structural characteristic simultaneously represents a limitation of the current research ecosystem and an opportunity, as bridging connections between existing clusters hold significant potential for accelerating conceptual innovation and methodological cross-fertilization (Donthu et al., 2021; Borner et al., 2018).

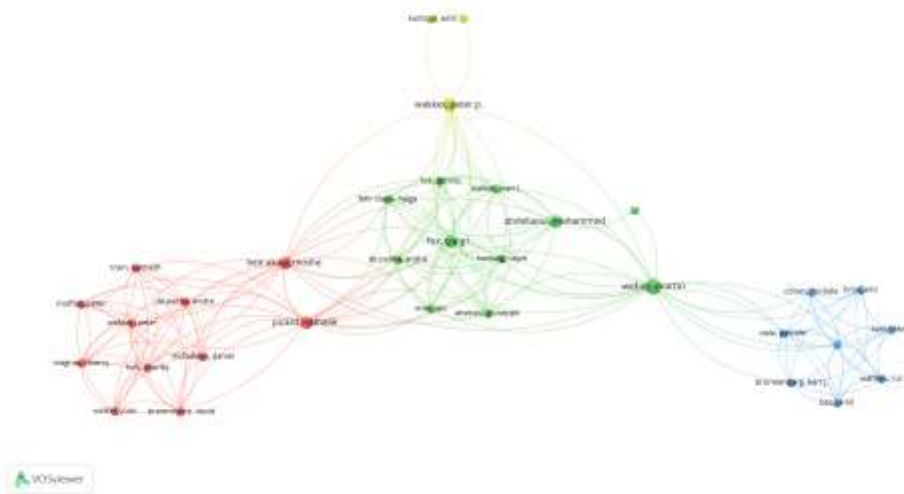


Figure 1. Co-Authorship Network Among Authors (VOSviewer visualization)

Figure 2 maps the co-authorship network at the country level, revealing that a small number of countries occupy dominant positions in global scientific collaboration on risk and uncertainty. The United States, the United Kingdom, and several continental European economies exhibit the largest node sizes and the highest density of international linkages, reflecting their structural advantages in terms of research infrastructure, journal editorial influence, and established academic networks. While cross-national knowledge flows enrich the conceptual diversity of the field, the concentration of collaborative activity among a limited set of high-income economies raises important questions about representativeness and the generalizability of dominant findings to emerging market contexts. This geographic concentration parallels documented patterns in financial management globalization research (Wibowo et al., 2026), where knowledge production remains skewed toward institutional environments with well-developed financial systems. Greater inclusivity in international collaboration would likely accelerate both the diversification of research contexts and the practical applicability of theoretical frameworks to a broader range of economic settings (Borner et al., 2018; Mawadah et al., 2026).

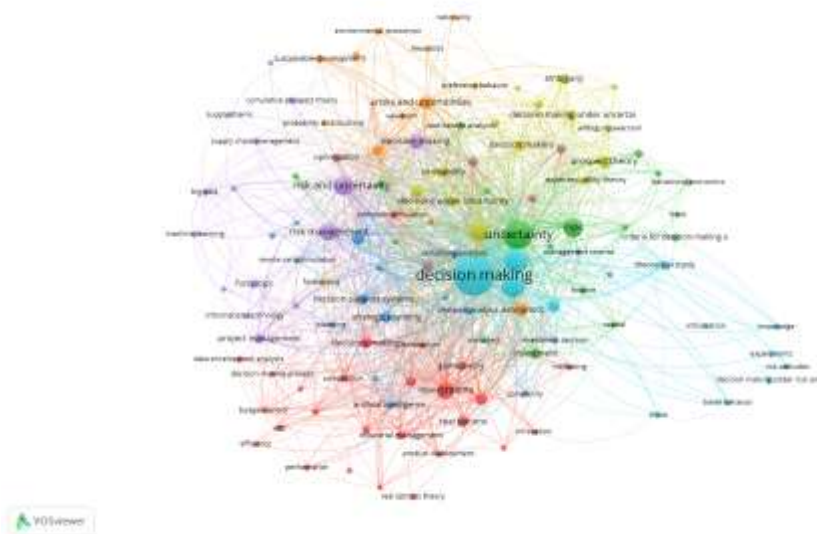


Figure 2. Co-Authorship Network Among Countries (VOSviewer visualization)

Keyword Co-Occurrence Analysis: Thematic Clusters

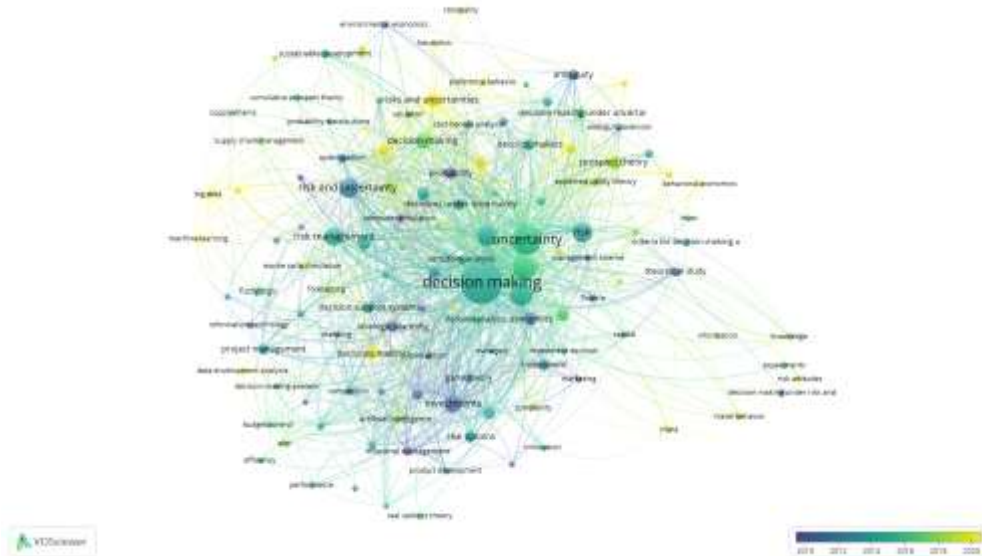


Figure 3. Keyword Co-Occurrence Network (VOSviewer visualization)

Figure 3 displays the keyword co-occurrence network, in which three dominant thematic clusters are identifiable through color-coded groupings. The first cluster centers on risk management and investment decision and encompasses the classical financial risk literature, including asset pricing, portfolio theory, and capital budgeting under uncertainty. This cluster reflects the enduring influence of the Markowitz-Sharpe tradition and its practical applications in corporate finance and investment analysis (Markowitz, 1952; D'Alpaos and Canesi, 2019). The second cluster is anchored by behavioral finance and prospect

theory, incorporating concepts such as overconfidence, loss aversion, and investor sentiment, and reflects the substantial influence of Kahneman and Tversky's (1979) work on the field's empirical agenda (Barberis, 2018; Bouteska and Regaieg, 2022). The third cluster captures the integration of uncertainty with analytical and technological approaches, including simulation-based risk modeling, machine learning applications, and policy uncertainty measurement (Vogt et al., 2020; Baker et al., 2016). The emergence of a distinct technology-oriented cluster corroborates bibliometric evidence from digital transformation and financial management studies (Wibowo et al., 2026; Chairani et al., 2026), confirming that computational methods have become a structural feature of contemporary risk research rather than a peripheral subfield.

Text-Based Co-Occurrence Analysis

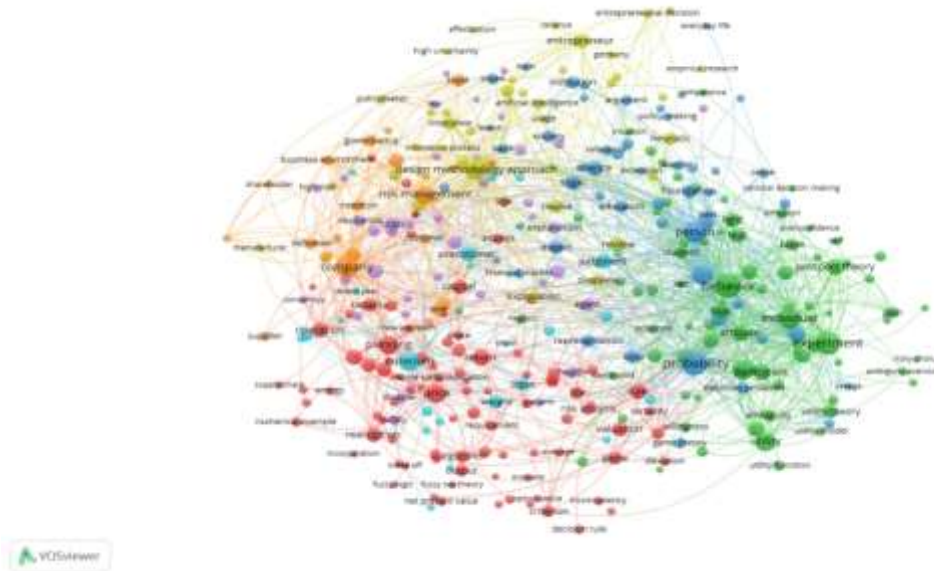


Figure 4. *Text-Based Co-Occurrence Map (VOSviewer visualization)*

Figure 4 presents the results of the text-based co-occurrence analysis, which extends thematic mapping to the full conceptual vocabulary of the 688-article corpus beyond author-assigned keywords. The map reveals that concepts of risk and uncertainty are systematically co-located with economic dynamics, organizational strategy, and technological applications, confirming the multidisciplinary character of contemporary risk research (Vogt et al., 2020; Cerroni et al., 2023). Notably, terms associated with behavioral decision-making, such as heuristics, overconfidence, and loss framing, appear in close conceptual proximity to terms from formal risk modeling, suggesting that the two traditions are increasingly integrated within individual articles rather than operating in parallel siloed sub-literatures (Kaaronen, 2020; Chapman, 2019). This conceptual convergence is significant for the field's theoretical development, as it suggests an emerging synthesis between rational and behavioral frameworks for analyzing financial decisions under uncertainty, a trajectory also documented in bibliometric analyses of bounded rationality (Azmi et al., 2026). The co-occurrence patterns further identify crisis management, public sector finance, and policy uncertainty as emergent conceptual bridges linking the core financial management literature to broader social science applications (Maulana et al., 2026; Mawadah et al., 2026).

Intellectual Evolution and Future Directions

Taken together, the four analytical layers examined in this study document a field that has undergone substantial quantitative expansion and qualitative conceptual transformation. Risk and uncertainty research in financial management has evolved from a predominantly theoretical domain focused on equilibrium asset pricing toward a multidisciplinary, empirically rich field that integrates behavioral economics, organizational theory, and computational science (Donthu et al., 2021; Brousseau and Trapp, 2025). The fragmentation of collaborative networks indicates that significant opportunities remain for cross-cluster synthesis, particularly at the intersection of behavioral and computational approaches to risk under uncertainty. The dominance of high-income country contributors suggests a need for research designs that explicitly address emerging market contexts, where institutional uncertainty and data limitations create distinctive challenges for standard risk assessment frameworks (Aven and Renn, 2019; Gomez-Mejia et al., 2021). Future research should prioritize longitudinal empirical studies that test the relative predictive validity of behavioral versus rational models across different market environments, the development of AI-assisted risk assessment tools validated against behavioral benchmarks, and cross-national comparative studies that systematically examine how cultural and institutional factors shape risk tolerance and decision quality (Cerroni et al., 2023; Hines, 2025). Bibliometric studies of related disciplines, including international finance (Yahya et al., 2026) and intrahousehold financial decision-making (Simangunsong et al., 2026), further confirm that interdisciplinary integration represents a productive frontier for advancing the theoretical and applied dimensions of risk and uncertainty scholarship.

CONCLUSION

This study investigates the intellectual structure and thematic evolution of risk and uncertainty in financial management decision-making, drawing on a bibliometric analysis of 688 Scopus-indexed articles using VOSviewer. The co-authorship analysis reveals a fragmented collaborative landscape dominated by a limited number of high-productivity author clusters and geographically concentrated among high-income economies, indicating both the maturity and the inclusivity limitations of the current research ecosystem. The keyword co-occurrence analysis identifies three dominant thematic clusters: risk management and investment decision, behavioral finance and cognitive biases, and the integration of uncertainty with analytical and technological approaches. Text-based co-occurrence analysis confirms the progressive multidisciplinary nature of the field, with conceptual bridges forming between financial economics, organizational theory, and computational approaches to risk. These findings collectively document a field in active transition from predominantly mathematical risk modeling toward an integrated framework that incorporates behavioral insights, institutional contexts, and AI-assisted analytical tools.

For researchers and practitioners, this study highlights the strategic value of interdisciplinary collaboration in advancing risk and uncertainty scholarship beyond its current fragmented structure. The documented convergence of behavioral and computational approaches identifies a particularly productive research frontier where theoretical synthesis can generate novel decision-support tools with direct practical applications. This study contributes to the literature by providing the first holistic bibliometric synthesis of risk and uncertainty in financial management decision-making, complementing prior bibliometric work on adjacent domains including bounded rationality, crisis management decision-making, and public financial management. The study is limited by its reliance on a single database and keyword-based retrieval, which

may exclude relevant publications indexed under alternative terminology. Future research should expand the corpus through multi-database retrieval and longitudinal sub-period analyses to track the evolution of thematic clusters with greater temporal precision.

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