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Uncertainty and Risk in Financial Markets: A Global Bibliometric Study

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ABSTRACT

Uncertainty and risk are enduring concerns in the study and practice of financial markets, especially in light of recent global disruptions such as geopolitical tensions, the COVID-19 pandemic, and climate-related events. This study conducts a comprehensive bibliometric analysis to map the intellectual structure, thematic evolution, author collaboration networks, and global research distribution in the domain of financial market uncertainty and risk. Using data from the Scopus database spanning 2000–2025, and employing VOSviewer for visualization, we identify key research clusters—ranging from risk assessment and stochastic modeling to emerging topics such as geopolitical risk and climate uncertainty. Overlay and heatmap visualizations reveal a temporal shift from traditional quantitative finance to interdisciplinary approaches integrating economic, environmental, and policy-driven risks. Co-authorship and country collaboration analyses highlight the pivotal roles of the United States, China, and Europe in shaping the global discourse, alongside growing contributions from emerging economies. The findings suggest that financial risk research is becoming increasingly global, data-driven, and responsive to systemic challenges, offering valuable insights for scholars, policymakers, and practitioners navigating the complexities of modern financial systems.

Keywords: *Financial Risk, Market Uncertainty, Bibliometric Analysis, VOSviewer, Markets*

1. INTRODUCTION

Uncertainty and risk are central to the functioning of financial markets. From individual investors to institutional players, decisions are routinely made under conditions of incomplete information and volatility. Financial theories, particularly those grounded in modern portfolio theory and behavioral finance, recognize that uncertainty influences asset pricing, investment decisions, and the behavior of financial actors [1], [2]. Over the past two decades, with the rapid globalization of capital flows and the rise of complex financial instruments, managing uncertainty has become a defining challenge for financial market participants and regulators alike.

The global financial crisis of 2007–2008 served as a wake-up call regarding the fragility of financial systems under conditions of heightened uncertainty. Systemic risks, fueled by opaque financial derivatives, inadequate risk assessment, and over-leveraged positions, culminated in a near collapse of major financial institutions. In its aftermath, research into risk management, contagion effects, and regulatory mechanisms gained significant momentum [3]. Similarly, the COVID-19 pandemic further intensified interest in the topic, exposing new vulnerabilities in financial markets and drawing attention to the unpredictability of macroeconomic shocks [4]. These events underscore the necessity of understanding how financial systems respond to both endogenous risks and exogenous uncertainties.

Technological advancements have introduced both opportunities and challenges to managing financial uncertainty. High-frequency trading, algorithmic decision-making, and artificial intelligence now play crucial roles in asset valuation and risk prediction. While these innovations have enhanced efficiency, they have also introduced new layers of risk, including flash crashes, model overfitting, and system-wide shocks caused by automation [5], [6]. At the same time, the

emergence of decentralized finance (DeFi) and cryptocurrencies has added further complexity and volatility to the financial landscape, calling into question traditional models of risk management [7].

Moreover, uncertainty in financial markets is no longer confined to purely economic indicators. Geopolitical developments, climate change, and sociopolitical unrest increasingly affect investor sentiment and capital mobility. For instance, trade tensions between major economies, regulatory unpredictability in emerging markets, and global environmental policy shifts all contribute to market volatility [8]. These factors emphasize the multidimensional nature of uncertainty and necessitate an interdisciplinary approach to analyzing financial risk. As such, scholarly inquiry into these themes has grown substantially, driven by the need to better model, predict, and respond to increasingly complex financial phenomena.

Given this expanding scope, a bibliometric approach offers a valuable lens for synthesizing the intellectual landscape of research on financial market uncertainty and risk. Bibliometric analysis enables the identification of key themes, dominant authors, influential journals, and evolving research trends across time and geography [9]. By systematically mapping the literature, researchers can uncover knowledge gaps, trace conceptual developments, and suggest future research directions. In the field of finance, where scholarly contributions are vast and multidimensional, bibliometric studies help create structured overviews and highlight the dynamics of intellectual discourse.

Despite the growing body of research on uncertainty and risk in financial markets, there remains a lack of consolidated knowledge regarding the intellectual evolution of this field. While many scholars have addressed subtopics such as volatility modeling, risk contagion, and behavioral finance, there is limited understanding of how these themes interact, evolve, and converge over time within the broader literature. Moreover, most existing reviews are narrative or focused on niche areas, lacking the quantitative rigor and comprehensiveness that bibliometric tools can provide. This fragmentation poses a challenge for both newcomers to the field and seasoned scholars seeking to build upon foundational knowledge.

Therefore, this study seeks to address a fundamental gap in the finance literature: the absence of a comprehensive bibliometric review on global research related to uncertainty and risk in financial markets. As financial systems continue to face unpredictable shocks—from pandemics to policy changes—mapping the intellectual terrain of risk-related research becomes increasingly urgent. Understanding which topics have received significant attention, which regions dominate the discourse, and which theories have evolved or faded can aid researchers, practitioners, and policymakers in navigating future financial uncertainties more effectively. The objective of this study is to conduct a global bibliometric analysis of academic publications that focus on uncertainty and risk in financial markets.

2. METHODS

This study adopts a quantitative bibliometric approach to explore global research trends on uncertainty and risk in financial markets. Bibliometric analysis allows for the systematic evaluation of large volumes of academic literature by uncovering patterns in citations, co-authorships, keyword occurrences, and thematic clusters. The method is particularly suited to synthesizing fragmented academic fields and providing a comprehensive overview of intellectual developments. The focus of this analysis is to identify the evolution, structure, and influential contributions within the domain of financial market uncertainty and risk across multiple countries and disciplines.

To conduct the analysis, a comprehensive dataset was retrieved from the Scopus database, selected for its wide coverage of peer-reviewed journals in finance, economics, and related fields. The search query combined relevant keywords such as "financial risk," "market uncertainty," "volatility," "systemic risk," and "investment uncertainty," filtered by title, abstract, and keywords. The time span for inclusion was set from 2000 to 2025, capturing developments before and after major global financial events, including the 2008 financial crisis and the COVID-19 pandemic. The data were exported in CSV format, including information on authors, titles, publication years, sources, abstracts, and references. Only English-language journal articles and reviews were included to ensure quality and consistency.

For visualization and analysis, VOSviewer was used to generate bibliometric maps. The software enabled the construction of co-authorship networks, keyword co-occurrence maps, and citation-based clusters. Minimum thresholds were applied (e.g., authors with at least five documents or keywords occurring at least 10 times) to filter out less significant nodes and enhance clarity.

3. RESULTS AND DISCUSSION

3.1 Network Visualization

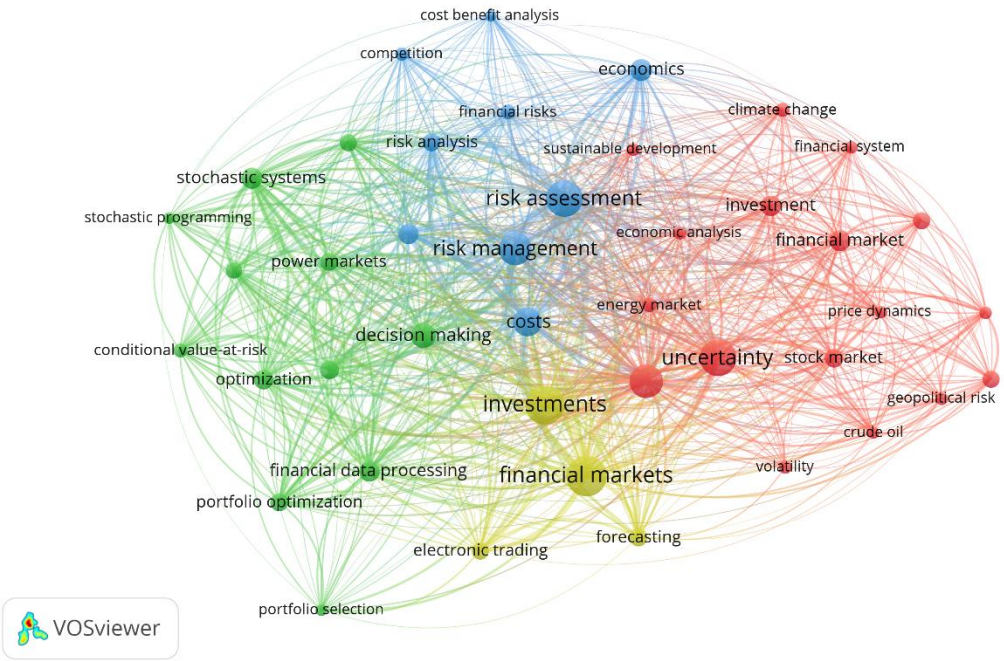

Figure 1. Network Visualization

Source: Data Analysis Result, 2025

Figure 1 maps the co-occurrence of keywords related to uncertainty and risk in financial markets. Each color in the map represents a thematic cluster, and the proximity between terms reflects the frequency with which they appear together in the literature. The node size indicates the relative frequency of each keyword's occurrence, while the links (edges) represent co-occurrence relationships. At a glance, we can observe four major clusters that illustrate how the research field is organized: risk management and assessment (blue), stochastic modeling and optimization (green), market and investment systems (yellow), and uncertainty-driven topics (red). The **red cluster**, centered around the keyword *uncertainty*, dominates the right side of the map and includes strongly interconnected terms like *geopolitical risk*, *financial market*, *volatility*, *climate change*, *crude oil*, and *stock market*. This suggests that current research heavily emphasizes external and macroeconomic sources of uncertainty, particularly in connection with market volatility and global events. The inclusion of

climate change and *energy markets* indicates a growing interest in environmental risks and how they propagate through financial systems. These topics are particularly relevant in the post-COVID and geo-political conflict era, where uncertainty is no longer driven solely by economic cycles.

The **blue cluster** is centered around the terms *risk assessment*, *risk management*, and *costs*, reflecting foundational research themes in quantitative finance and decision science. This area includes traditional approaches to evaluating and mitigating risks, often through cost-benefit analysis and financial modeling. The strong connection to *economics* and *financial risks* in this cluster indicates interdisciplinary research that bridges finance, economics, and management. This cluster suggests a continued scholarly interest in methods for quantifying risk and integrating it into broader decision-making frameworks, particularly in corporate finance and policy planning. On the **left side**, the **green cluster** highlights *stochastic programming*, *optimization*, and *conditional value-at-risk* as core techniques used in advanced risk modeling. This cluster represents a more technical and mathematical strand of the literature, with keywords like *portfolio optimization*, *financial data processing*, and *stochastic systems* forming its backbone. These terms point to studies that develop and test models aimed at improving asset allocation and managing exposure under uncertainty. The emphasis on *power markets* and *electronic trading* within this group signals the application of these models in highly dynamic and data-intensive environments, such as energy and algorithmic trading sectors.

The **yellow cluster** connects closely with both the red and green clusters and revolves around terms like *financial markets*, *investments*, *forecasting*, and *portfolio selection*. This indicates a bridging role between more abstract modeling and real-world applications in investment strategy. The keyword *electronic trading* sits at a strategic position between the yellow and green clusters, reflecting the convergence of data-driven technologies with investment decision-making. The prominence of *forecasting* also shows that forward-looking analysis remains a central concern in financial research, especially in uncertain environments where traditional models may be inadequate.

The map presents a coherent and multidimensional landscape of the literature on uncertainty and risk in financial markets. The interconnectivity among clusters shows that while distinct subfields exist, there is a high degree of cross-disciplinary dialogue. Emerging risks such as *geopolitical instability* and *climate change* are not isolated topics; they are deeply embedded in discussions on investment strategy, risk modeling, and market behavior. This visualization affirms the field's dynamic nature and highlights the necessity for integrated approaches that combine quantitative rigor with sensitivity to real-world uncertainties.

3.2 Overlay Visualization

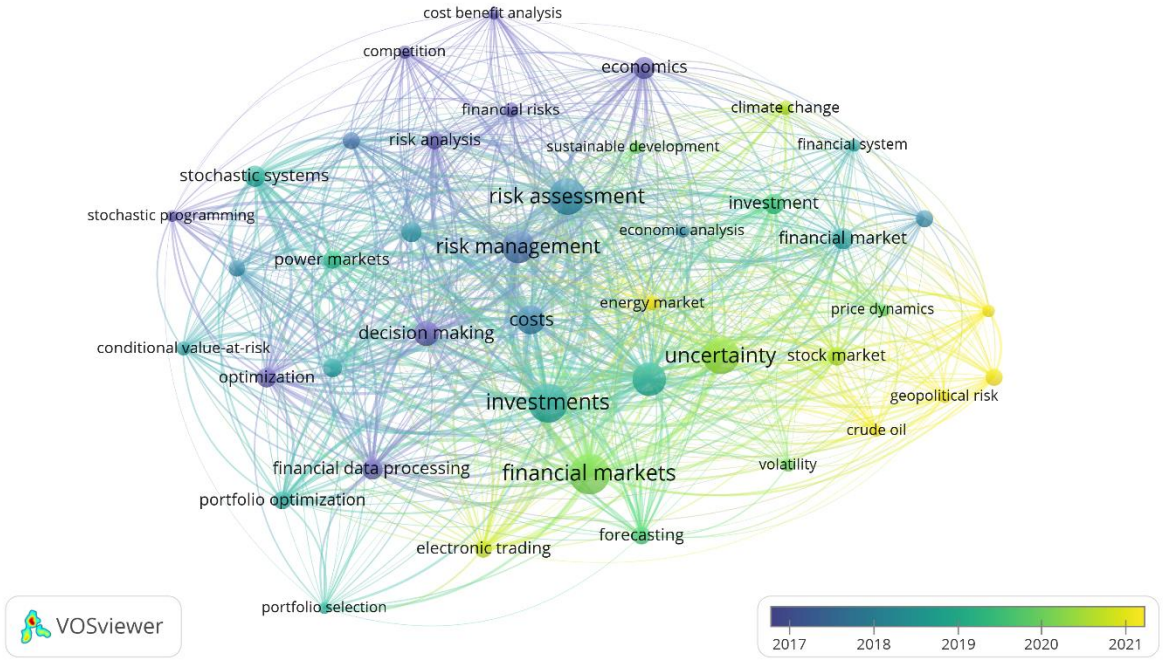

Figure 2. Overlay Visualization

Source: Data Analysis Result, 2025

Figure 2 presented above illustrates the **temporal evolution** of research themes related to uncertainty and risk in financial markets. Generated using VOSviewer, this map assigns color gradients to keywords based on the average publication year, with **dark blue representing older research (around 2017)** and **bright yellow denoting newer research (closer to 2021)**. From the map, we can observe that foundational topics like *risk assessment*, *risk management*, *optimization*, and *decision making* appear predominantly in blue and green shades, suggesting that these were the core focus of earlier studies. These topics form the backbone of traditional financial risk research, rooted in stochastic modeling, quantitative forecasting, and portfolio optimization. In contrast, **recent scholarly attention (2019–2021)** has shifted toward emerging and macro-level issues, which appear in yellow. Keywords such as *uncertainty*, *geopolitical risk*, *climate change*, *price dynamics*, and *crude oil* are all located on the right side of the map and are brightly colored, indicating newer areas of focus. This trend reflects a growing interest in external, systemic risks influenced by global crises such as the COVID-19 pandemic, oil price shocks, and political instability. It also signals the increasing relevance of environmental and socio-political factors in financial market behavior—areas that were previously peripheral to mainstream financial risk modeling but are now taking center stage in academic discourse. Additionally, the overlay map shows a **convergence between traditional and contemporary themes**, as evidenced by the close positioning and connections between older blue nodes and newer yellow ones. For example, *forecasting* and *financial markets* act as bridges between the technical/mathematical models and the more recent context-driven concerns. This suggests an integration of advanced computational methods with real-world uncertainties, pointing to a more holistic and interdisciplinary approach in current financial risk research.

3.3 Citation Analysis

Table 1. The Most Impactful Literatures

Citations	Authors and year	Title
1651	[10]	Risks for the long run: A potential resolution of asset pricing puzzles
1638	[11]	Financial markets under the global pandemic of COVID-19
863	[12]	Securitized banking and the run on repo
463	[13]	Endogenous steroids and financial risk taking on a London trading floor
444	[14]	A critical review on deployment planning and risk analysis of carbon capture, utilization, and storage (CCUS) toward carbon neutrality
417	[15]	Worst-case conditional value-at-risk with application to robust portfolio management
415	[16]	Economic policy uncertainty: A literature review
365	[17]	What's going on with young people today? the long and twisting path to adulthood
355	[18]	Successes and limitations of phytotechnologies at field scale: Outcomes, assessment and outlook from COST Action 859
355	[19]	Collective risk management in a flight to quality episode

Source: Scopus, 2025

3.4 Density Visualization

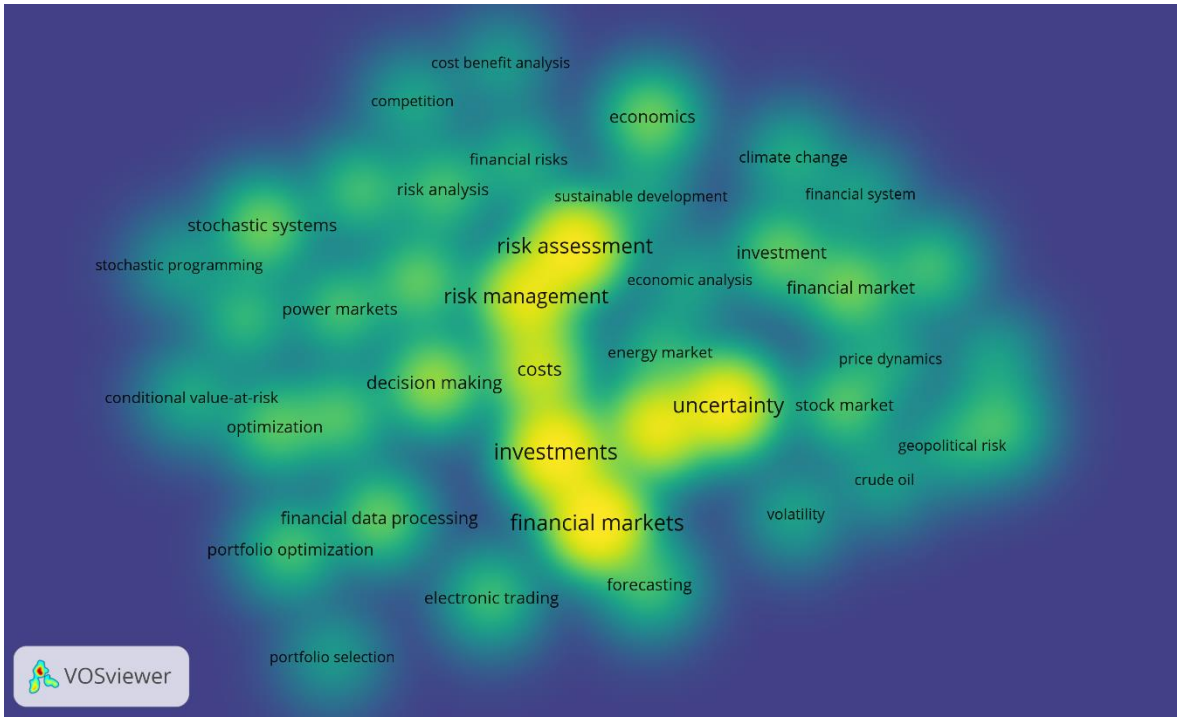

Figure 3. Density Visualization

Source: Data Analysis Result, 2025

Figure 3 illustrates the intensity of keyword co-occurrence in the literature related to uncertainty and risk in financial markets. The bright yellow regions indicate areas with the highest frequency of co-occurring keywords, suggesting dense research activity, while green and blue regions reflect moderate to low density. Notably, keywords such as risk assessment, risk management, financial markets, investments, and uncertainty appear in the most concentrated zones, highlighting them as the central pillars of scholarly discourse in this field. These terms form the conceptual core around which other themes are structured, emphasizing their foundational role in financial risk research. Surrounding this dense core are more specialized or emerging terms such as *climate change*, *geopolitical risk*, *crude oil*, *volatility*, *forecasting*, and *electronic trading*, which appear in slightly less intense but still significant areas. Their presence on the heatmap indicates growing scholarly interest and their increasing integration into mainstream discussions. Particularly, the clustering of *geopolitical risk*, *climate change*, and *energy market* near *uncertainty* suggests a shift toward examining **external and systemic factors** influencing financial volatility.

3.5 Co-Authorship Network

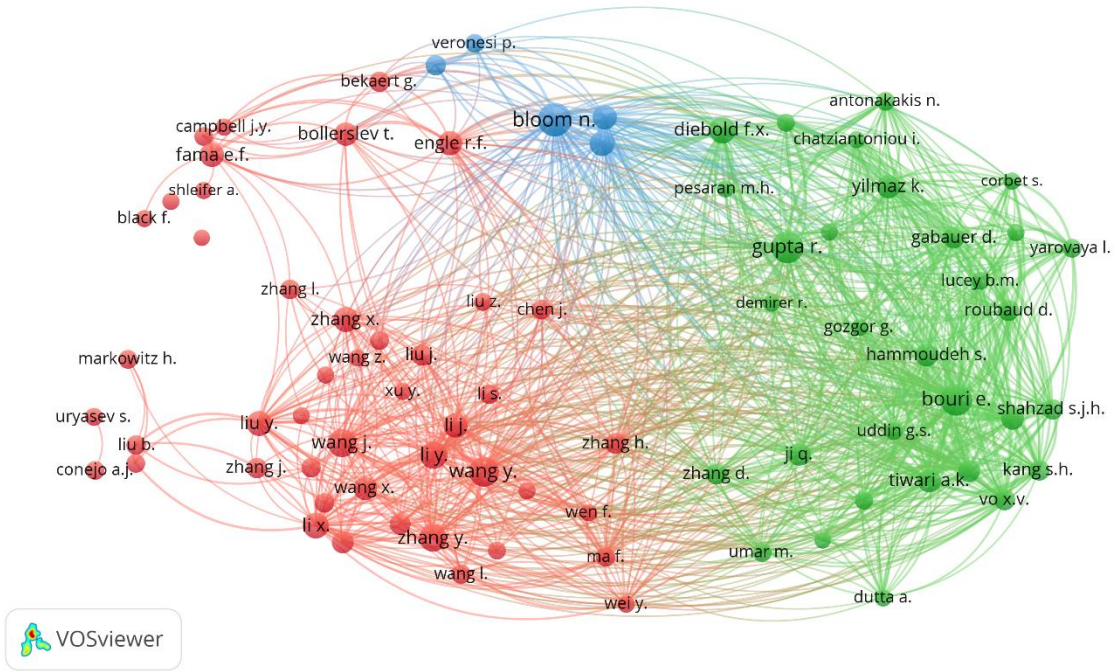

Figure 4. Author Visualization

Source: Data Analysis Result, 2025

Figure 4 above reveals the intellectual structure and collaborative patterns among influential authors in the field of financial market uncertainty and risk. Each node represents an author, and the connecting lines indicate co-authorship relationships, with colors denoting distinct collaborative clusters. The **green cluster** is the largest and most interconnected, led by prominent scholars such as *Gupta R.*, *Bouri E.*, and *Yarovaya L.*, who are heavily engaged in research related to systemic risk, emerging market volatility, and

geopolitical uncertainty. The **red cluster** is another significant group, featuring prolific authors like *Wang Y.*, *Zhang Y.*, and *Liu J.*, indicating strong regional or institutional collaboration, particularly within Chinese academic circles. The **blue cluster**, though smaller, is anchored by *Bloom N.*, *Diebold F.X.*, and *Engle R.F.*, representing foundational figures in macroeconomic uncertainty and econometric modeling. Interestingly, legacy scholars like *Fama E.F.*, *Markowitz H.*, and *Black F.* appear more peripheral, suggesting their influence is foundational but not central to recent collaborative activity.

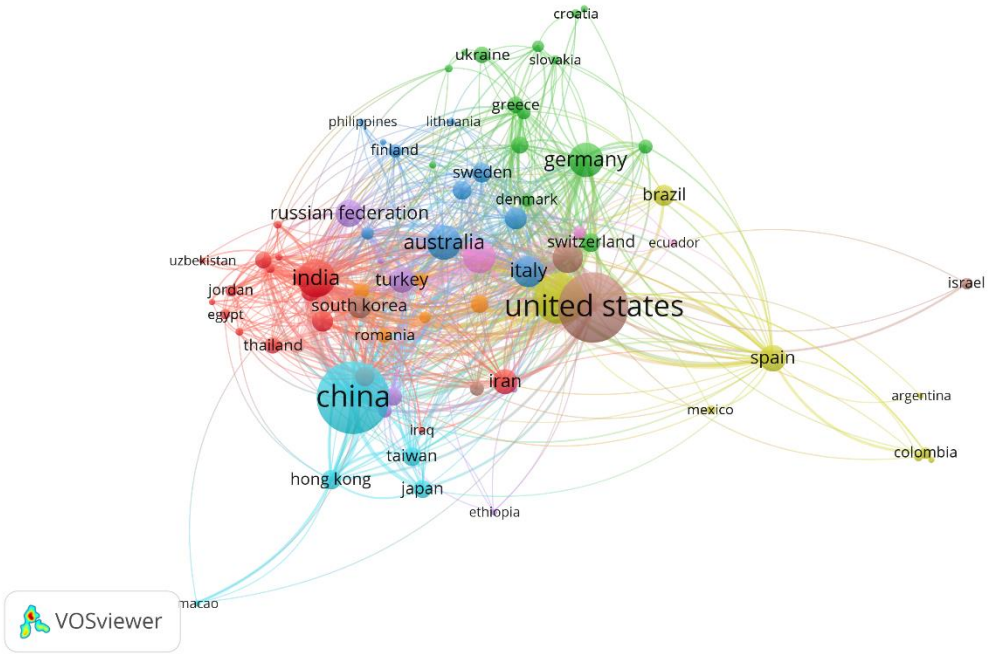

Figure 5. Country Visualization
Source: Data Analysis Result, 2025

Figure 5 above highlights the global distribution and international co-authorship networks in the field of financial market uncertainty and risk. The United States emerges as the most dominant hub, with the largest node and extensive connections to nearly every region, signifying its central role in global scholarly collaboration. Surrounding the U.S. are other major contributors such as China, Germany, Italy, Spain, and India, each forming their own strong regional clusters while also maintaining links to global partners. Notably, China appears highly collaborative with countries in Asia and Oceania, such as Australia, Japan, and Hong Kong, reflecting a robust East Asian research network. Meanwhile, Germany, Switzerland, and Greece are key players within the European cluster, promoting intra-European collaboration. Smaller nodes like Colombia, Israel, and Ethiopia indicate emerging participation in the field, though with fewer connections.

Discussion

1. Thematic Core and Emerging Frontiers

The keyword co-occurrence map identified four major thematic clusters in the literature, each representing a key subdomain. At the core lies *risk assessment* and *risk management*, surrounded by related terms such as *costs*, *decision making*, and *financial risks*. These concepts are foundational in financial theory and have long served as the bedrock for studies in asset allocation, portfolio optimization, and regulatory oversight. Their prominence in both frequency and connectivity

suggests that despite the growing complexity of financial markets, the fundamentals of identifying, evaluating, and managing risk remain vital concerns [20], [21]. The second thematic cluster revolves around *stochastic systems*, *optimization*, *portfolio selection*, and *conditional value-at-risk*, reflecting the mathematical and modeling-driven side of the field. These topics indicate the enduring influence of quantitative finance and operations research in informing risk strategies. Researchers in this cluster often focus on simulation models, predictive algorithms, and robust decision-making under uncertainty. As observed in past literature, such techniques are crucial for addressing portfolio volatility and dynamic risk adjustment in real-time trading environments [22]–[24]. A third cluster captures themes related to *financial markets*, *investments*, *forecasting*, and *electronic trading*. This segment signifies the applied aspect of financial risk research, where theory meets market practice. The positioning of *forecasting* and *financial markets* at the center of several other themes suggests the integration of risk evaluation into forward-looking investment strategies. Here, scholars engage with issues such as capital flow volatility, asset pricing models, and investor behavior, echoing findings in behavioral finance and market efficiency theory [25], [26].

2. Temporal Dynamics and Research Evolution

The overlay visualization map provides a deeper understanding of the field's temporal evolution. Foundational topics such as *risk assessment*, *decision making*, and *optimization* are colored in darker shades, indicating their prominence in earlier years (2017–2018). These topics likely represent the first wave of research, largely influenced by the aftermath of the 2008 financial crisis and the rise of data-driven modeling in risk analytics. In contrast, the more recent research focus (highlighted in yellow and light green) shifts to *uncertainty*, *geopolitical risk*, and *climate change*. These themes gained momentum around 2020–2021, corresponding with global disruptions such as the pandemic, oil market instability, and heightened political tensions. The inclusion of *climate change* also suggests growing scholarly interest in environmental risk disclosure, ESG investment strategies, and climate-related financial stress testing, aligning with the increasing overlap between financial research and sustainability discourse [27]. This evolution illustrates a field in transition: from building quantitative tools for measuring market volatility to embracing interdisciplinary frameworks that account for socio-political and environmental volatility. As financial systems become more interlinked with global phenomena, future research is likely to expand further into these areas, integrating risk analytics with real-world systemic concerns.

3. Intensity and Centrality of Research Themes

The heatmap visualization supports the above findings by showing areas of highest research density. Terms such as *financial markets*, *risk management*, *uncertainty*, and *investments* appear as bright yellow hotspots, indicating concentrated scholarly attention. These keywords not only appear frequently in literature but also serve as bridges connecting various subtopics, reinforcing their conceptual centrality. In contrast, terms like *portfolio selection*, *climate change*, and *geopolitical risk* appear slightly cooler in tone but still within visible clusters, suggesting that while they are not yet dominant, they represent significant and emerging areas. Their location on the map further supports their integrative role, connecting established theories with new problem domains. This reinforces the idea that contemporary financial risk research is expanding outward—integrating broader themes while maintaining methodological rigor.

4. Authorial Networks and Thought Leadership

The co-authorship network map reveals how academic collaboration shapes knowledge production in this domain. Several key author clusters were identified, with scholars such as Bloom N., Diebold F.X., and Engle R.F. representing the core of the macroeconomic uncertainty and econometrics community. Their high centrality reflects their foundational contributions and continued influence on the evolution of the field. A notable red cluster features many Chinese scholars such as Wang Y., Zhang Y., and Liu J., highlighting the emergence of China as a powerhouse

in quantitative finance and financial modeling research. These scholars demonstrate dense intra-national collaboration, suggesting strong institutional networks and possibly government-backed research funding. Meanwhile, the green cluster, led by scholars like Gupta R., Bouri E., and Yarovaya L., represents a geographically diverse and well-connected group working on systemic risk, global uncertainty, and emerging market volatility. Their presence points to the field's globalization, with research expanding beyond traditional financial centers to include more voices from emerging economies.

5. Global Collaboration and Research Leadership

The country collaboration map further emphasizes this global dimension. The United States clearly dominates the field, both in terms of publication volume and international partnerships. Its central position and extensive links with Europe, Asia, and Latin America highlight its continued leadership in setting the research agenda and fostering collaboration. China, Germany, India, and Italy also emerge as significant contributors. Notably, China forms a dense regional network with countries such as South Korea, Japan, and Hong Kong, reflecting its growing academic footprint and collaborative capacity. European countries like Germany, Greece, and Switzerland are interconnected within a strong continental cluster, while Spain appears as a node bridging collaboration between Europe and Latin America. Interestingly, countries like Brazil, Iran, and South Africa are also visible on the map, suggesting a broadening of participation in financial risk research. This growing diversity not only enhances the global relevance of the field but also enriches its perspectives by incorporating context-specific risks and regulatory frameworks.

6. Implications and Future Directions

The findings of this bibliometric study offer several implications. First, the convergence of traditional risk modeling with global uncertainty drivers points to a need for more interdisciplinary research. Economists, data scientists, environmental analysts, and political risk experts must collaborate to develop integrated models that capture the multifactorial nature of financial risk. Second, the increasing attention to themes such as *geopolitical risk* and *climate change* suggests the growing importance of non-market risk factors. Financial institutions, regulators, and investors should incorporate these elements into their forecasting tools, asset valuation models, and risk disclosure frameworks. The rise of emerging economies in the authorship and country networks indicates a redistribution of scholarly influence. Future bibliometric studies may explore whether this shift translates into new theoretical contributions or innovations in methodology. Supporting inclusive and cross-border research initiatives will be crucial for enhancing the resilience of global financial systems amid rising uncertainty.

CONCLUSION

This bibliometric study provides a comprehensive overview of the global research landscape on uncertainty and risk in financial markets, revealing both the enduring relevance of foundational themes—such as risk assessment, portfolio optimization, and market forecasting—and the increasing prominence of emerging concerns like geopolitical instability, climate change, and systemic uncertainty. The keyword and temporal analyses highlight a shift toward interdisciplinary and context-driven research, while the author and country collaboration maps underscore the growing globalization and diversification of scholarly contributions in this field. With the United States, China, and several European nations at the forefront of collaboration, and with rising participation from emerging economies, the field continues to evolve toward a more integrated and responsive research agenda. These findings emphasize the need for future studies to bridge quantitative rigor with real-world uncertainty, ensuring that financial theories and tools remain robust in the face of increasingly complex and volatile global conditions.

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