RESEARCH TRENDS IN INSURANCE RISK FROM 2000–2022: A BIBLIOMETRIC ANALYSIS OF THE LITERATURE

Wilaiporn Suwanmalai *, Simon Zaby **

* College of Management, Mahidol University, Bangkok, Thailand
** *Corresponding author*, College of Management, Mahidol University, Bangkok, Thailand
Contact details: College of Management, Mahidol University, 69 Vipawadee Rangsit Rd., Samsennai, Phayathai, 10400 Bangkok, Thailand

OPEN ACCESS

How to cite this paper: Suwanmalai, W., & Zaby, S. (2024). Research trends in insurance risk from 2000–2022: A bibliometric analysis of the literature. *Risk Governance and Control: Financial Markets & Institutions, 14*(3), 29–38. https://doi.org/10.22495/rgcv14i3p3

ISSN Online: 2077-4303
ISSN Print: 2077-429X

Received: 16.02.2024
Accepted: 26.07.2024

JEL Classification: G32, G34, O16, L19
DOI: 10.22495/rgcv14i3p3

Abstract

This paper aims to document and synthesize research trends in the domain of "insurance risk" over the past 20 years through bibliometric analysis (Hallinger, 2019) of 894 Scopus keyword-based reviews. Publications on insurance risk predominately originate from the United States (U.S.) and China. The most co-cited papers over the past 20 years were published in *Insurance: Mathematics and Economics.* The journal co-citation analysis (JCA) map identified three main journal fields: finance and risk management, mathematics and statistics, and actuarial science. The authors' co-citation map reveals the intellectual structure of the insurance risk knowledge base, resulting in three leading "schools of thought": risk management, mathematical and model, and actuarial science. Gerber, H. U. and Tang, Q. are the top scholars in their schools of thought. Recent efforts have focused on processes and technology, as gathering and analyzing a large volume of data requires artificial intelligence-based (AI-based) technologies to support efficient data-driven decisions (Tournas & Bowman, 2021). This helps in developing a robust and faster process for revenue and profit strategies. Considering the structure of the intellectual themes could be beneficial as part of insurance risk businesses and their strategic decisions for future achievements and further improvements.

Keywords: Insurance Risk, Bibliometric Analysis, Actuarial Science Research, Artificial Intelligence, Insurance Business Strategy

Authors' individual contribution: Conceptualization — W.S. and S.Z.; Methodology — W.S. and S.Z.; Software — W.S. and S.Z.; Validation — W.S. and S.Z.; Formal Analysis — W.S. and S.Z.; Writing — Original Draft — W.S. and S.Z.; Writing — Review & Editing — S.Z.; Visualization — W.S. and S.Z.; Supervision — S.Z.; Project Administration — S.Z.

Declaration of conflicting interests: The Authors declare that there is no conflict of interest.

1. INTRODUCTION

Insurance risk is "a threat or peril that the insurance company has agreed to insure against in the policy wordings. These types of risks or perils have the potential to cause financial loss such as property damage or bodily injury if it were to occur" (Insuranceopedia, 2024, para. 1). Holsboer (2000) identifies insurance risk as an actuarial view of risks covering mortality, morbidity, longevity, lapse, interest rates, and miscellaneous risks. Brown and Galitz (1982) highlighted that the successful operation of life insurers relies on how they manage this life insurance risk such that they have "underwriting profit" from premium income minus expenses.

The main concepts in the study of insurance risk apply to insurers' financial challenges (Didenko & Sidelnyk, 2021). Effectively managing insurance risk can help alleviate systemic risks in the insurance industry (Liu, 2019). In the context of life insurance, there have been numerous changes over the past two decades. Some developments in this field have been explicit, for example, moving from mitigating insurance risk via the traditional form of using the reinsurance mechanism to securitizing catastrophic bonds. Frankel and LaPlume (2000) emphasize insurance securitization, which securitizes insurance risks into a more comprehensive form that can be transferred to investors in the capital market. This development in the life insurance business reveals innovations created in addition to the traditional form of viewing insurance risk (Frankel & LaPlume, 2000).

Apart from that, the knowledge base in insurance risk has focused on ruin probabilities and risk models to assess risk (Schmeiser & Wagner, 2015), and asset and liability management as a risk management tool for risk in a low-interest-rate environment (Focarelli, 2015; Alfonsi et. al, 2020). Recent efforts (Nguyen et al., 2024) have focused on artificial intelligence (AI) and sophisticated machine learning (ML), using computer programs to supplement or replace human decision-making. With the uncertainty of known-unknown risks, emerging technologies such as AI or ML often involve gathering and analyzing data that are useful for making accurate decisions (Tournas & Bowman, 2021). Therefore, understanding the most recent changes is important. Understanding the evolution of insurance risk and its future trends would help clarify this important domain in the broad area of insurance business, as well as being beneficial for insurance managers in terms of managing a firm's financial operations.

This paper contributes to the literature by providing a bibliometric review of the literature related to insurance risk. Bibliometric reviews are used to document and analyze broad trends in knowledge production within a body of knowledge. Given its importance as the backbone of insurance business operations, it is important to understand such developmental trends in the insurance risk literature. Prior bibliometric reviews published in the insurance risk-focused domain were specific to particular areas, such as health insurance, namely, Taiwan's National Health Insurance (NHI) claims data (Sung et al., 2020) using PubMed (a database for searching medical literature), and a bibliometric review of the Takaful (Islamic Insurance) literature (Khan et al., 2020). Thus, this review aims to examine the broader insurance risk literature that has evolved over the past two decades. The current bibliometric review addresses the following research questions:

RQ1: What is the volume, growth trajectory, and geographic distribution of publications?

RQ2: What are influential sources or journals in this field?

RQ3: Who are the key contributing authors writing in this field?

RQ4: What is the intellectual structure of the knowledge base?

RQ5: What are key topics and what is the research frontier in this field?

To address these research questions, a keyword-based review of the insurance risk literature was conducted using the Scopus index. This review employed systematic methods to identify 894 articles in Scopus. Bibliometric methods were used to document and analyze key trends in the evolution of insurance risk research published between 2000 and mid-February 2022. Data analyses included descriptive statistics, citation, co-citation, and co-word analyses using VOSviewer.

The review aims not only to assess the current status of insurance risk-related literature but also to establish empirical benchmarks that can be used in charting its progress in the decades to come. Thus, future reviews will be able to document changes in the size, growth trajectory, and geographic distribution of this literature as well as shifts in its underlying intellectual structure and topical orientation.

The structure of this paper is as follows. Section 2 explains in detail the conceptual framework. Section 3 describes the methodology. Section 4 presents the bibliometric results and discusses the main findings of the paper. Section 5 provides the implications of the results (including perspectives for future research) and limitations.

2. LITERATURE REVIEW

Scopus was selected as the document source for this review (Hallinger, 2019), with a timeframe from 2000 to mid-February 2022. PRISMA was used to specify the steps to be reported for the identification of documents in systematic reviews of research (Moher et al., 2009; see Figure 1). This search aimed to identify the full set of documents included in the Scopus search engine with the term "insurance risk". This keyword-based review should be able to identify coherent literature reviews rather than employing journal-based reviews. The database search initially yielded 1,020 documents. Any erratum and non-English versions were screened, leaving a database consisting of 978 documents. An additional 84 documents were excluded because of their publication date (publications before 2000). This left 894 articles and reviews for bibliometric analysis.

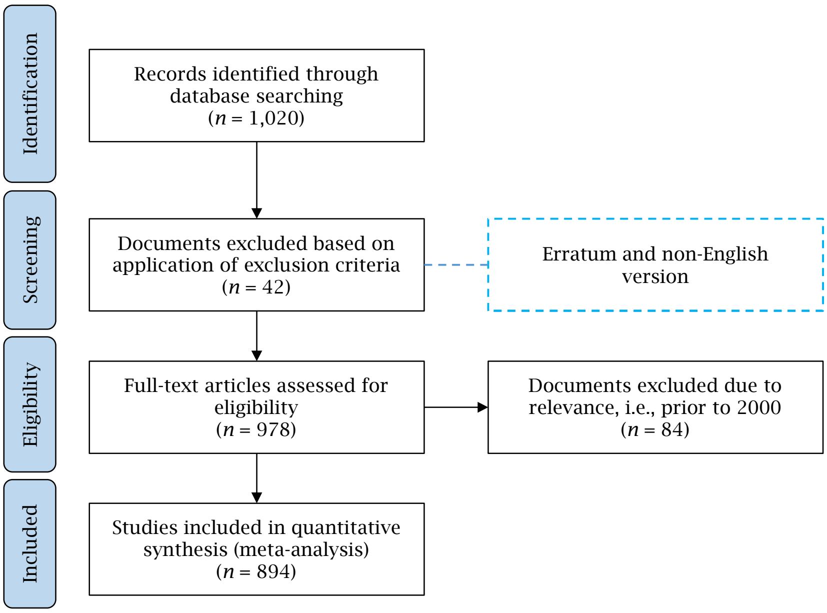
For this keyword-based review, a four-dimensional conceptual model of the "knowledge base" was used. The first dimension of the knowledge base concerns size, as measured by the volume of published studies. While the measurement of size offers no specific insights into quality, knowledge accumulation requires a critical mass of empirical and conceptual research, such as empirical research measuring the relative importance of the insurance business to the financial development of the economy (Outreville, 2013).

The second dimension — time — refers to publication trajectories tracked over a specific period to observe changes in the size of the knowledge base; this bibliometric review spans two decades. Time usually covers more of a certain area depending on the scope of the available literature. For example, the period 1950–2018 covers 81 articles in the *takaful* literature review (Khan et al., 2020).

The third dimension — space — refers to the geographic distribution of documents in the literature. Analysis of the geographic distribution of the number of insurance publications showed that the historical distribution is international in scope. Despite being mainly conducted by researchers from the United States (U.S.), empirical evidence shows economic development in many Asian countries, such as Taiwan, China, South Korea, and Japan (Didenko & Sidelnyk, 2021).

The fourth dimension — composition — refers to the "intellectual structure" of the knowledge base. Understanding the intellectual structure of the field helps identify the themes of insurance articles published in this field. An author co-citation analysis (ACA) network map also serves as the basis for illuminating different schools of thought in terms of the research stream identification process (Khan et al., 2020; Hallinger, 2019).

Figure 1. PRISMA diagram of source identification procedures used in the review of insurance risk



Source: Moher et al. (2009).

3. RESEARCH METHODOLOGY

This review involves a bibliometric analysis using descriptive statistics to document the intellectual insurance risk literature, growth trajectory, and geographical trends.

Bibliographic data (including publication volume, geographic distribution, keywords, and citation data) associated with the Scopus documents were exported to a Microsoft Excel file. Scopus analytical tools and Microsoft Excel were used to analyze the composition, growth, and geographical distribution of insurance risk. A thesaurus file was also created and applied to clean the data for consistency and ensure accurate results (Zaby, 2019).

Data analysis methods, including citation, co-citation, co-word, and network visualization analyses, were conducted using VOSviewer (2009–2020) software. This review employed citation analysis to identify influential journals and authors in the insurance literature. When conducting citation analysis, VOSviewer identifies the number of times that documents and authors in the review database have been cited by other Scopus documents and authors.

ACA of key sources and authors has been used to analyze authors and sources that are frequently cited together. VOSviewer software was also used to create visual representations or "network maps" based on ACA. Such maps have been used to uncover the intellectual structure or research traditions that comprise knowledge bases. For the final research question, we employed keyword co-occurrence analysis or "co-word analysis" to analyze the topical composition of the insurance risk analysis. Temporal co-word analysis extends basic co-word analysis by identifying topics of most recent interest in insurance risk publications.

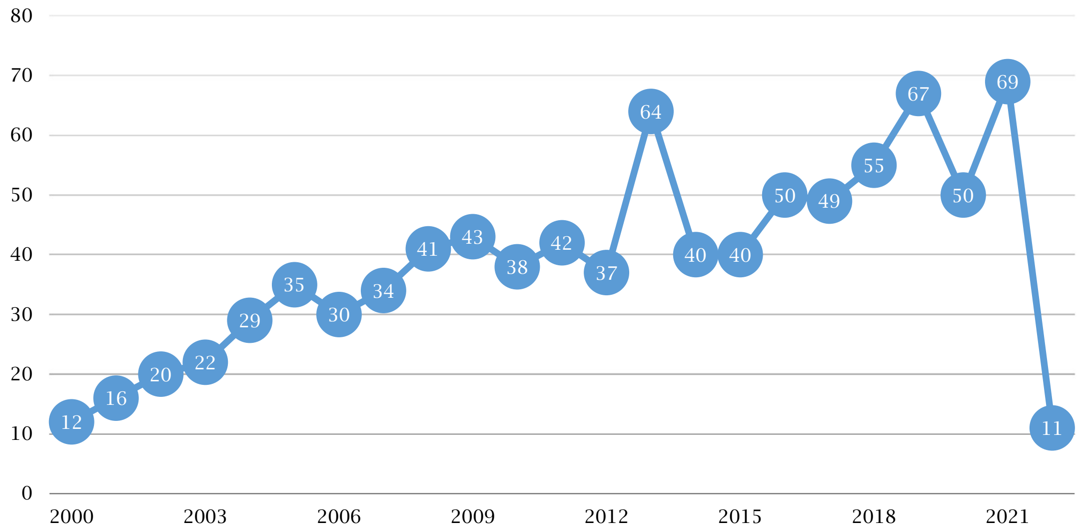
4. RESULTS AND DISCUSSION

The key findings are presented in order of the research questions outlined in the introduction of this paper.

4.1. Volume and geographic distribution of the insurance risk literature

Figure 2 offers insight into the growth trajectory of the insurance risk literature since 2000. An analysis of the database suggests that interest in this field has grown slowly since the beginning of the 21st century. The number of studies on insurance risk grew by over five times during the past two decades.

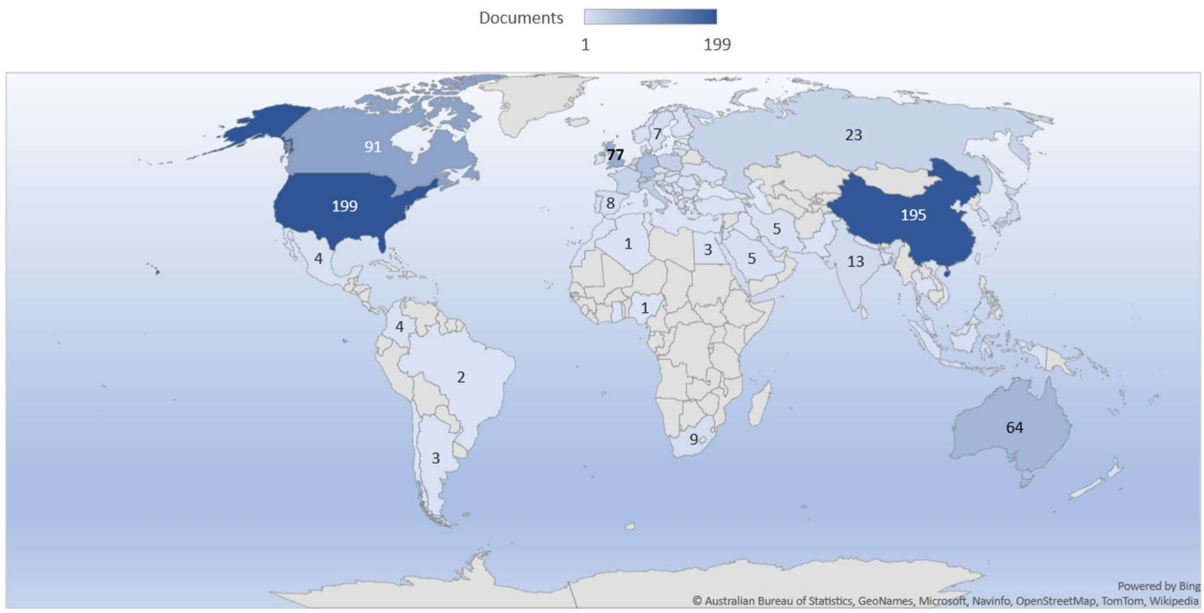
Figure 2. The growth trajectory of insurance risk literature, 2000–2022



Note: n = 894.
Source: Authors' elaboration.

For countries with significant contributions to the insurance risk literature, publications on insurance risk were predominately located (as shown in Figure 3) in the U.S. (199 documents), China (195 documents), Canada (91 documents), the United Kingdom (77 documents), and Australia (64 documents). These five countries cover more than half of the authors' nations. In addition, at least a quarter of the authors came from emerging markets ("Emerging markets", n.d.). However, only 38% of countries worldwide (74 out of a total of 195 countries; Worldometer, n.d.) have contributed to the knowledge base collected for this review.

Figure 3. Geographic distribution of publications on insurance risk, 2000–2022



Note: n = 894.
Source: Authors' elaboration.

4.2. Influential sources in insurance risk literature

Citation analysis was employed to calculate the number of citations of the sources in the document database. This enables us to identify influential sources of insurance risk research. *Journal of Risk and Insurance* is the top-cited source focusing on insurance risk, whereas *Insurance: Mathematics and Economics* has contributed the most papers over the past 20 years. More generally, the top-cited journals are all 1st and 2nd-quartile journals in Scopus, except *Methodology and Computing in Applied Probability* (ranked 9), which is a 3rd-quartile journal.

Table 1. Top 10 cited sources on insurance risk publications, 2000–2022

Rank	*Cited-source*	*Scopus quartile*	*Documents*	*Citations*	*CPD*
1	*Journal of Risk and Insurance*	Q2	7	587	84
2	*Stochastic Processes and Their Applications*	Q1	10	478	48
3	*The Annals of Applied Probability*	Q1	10	314	31
4	*Journal of Applied Probability*	Q2	20	540	27
5	*Astin Bulletin*	Q1	28	555	20
6	*Advances in Applied Probability*	Q2	10	171	17
7	*Stochastic Models*	Q2	6	101	17
8	*Insurance: Mathematics and Economics*	Q1	86	1211	14
9	*Methodology and Computing in Applied Probability*	Q3	12	152	13
10	*Geneva Papers on Risk and Insurance: Issues and Practice*	Q2	14	159	11

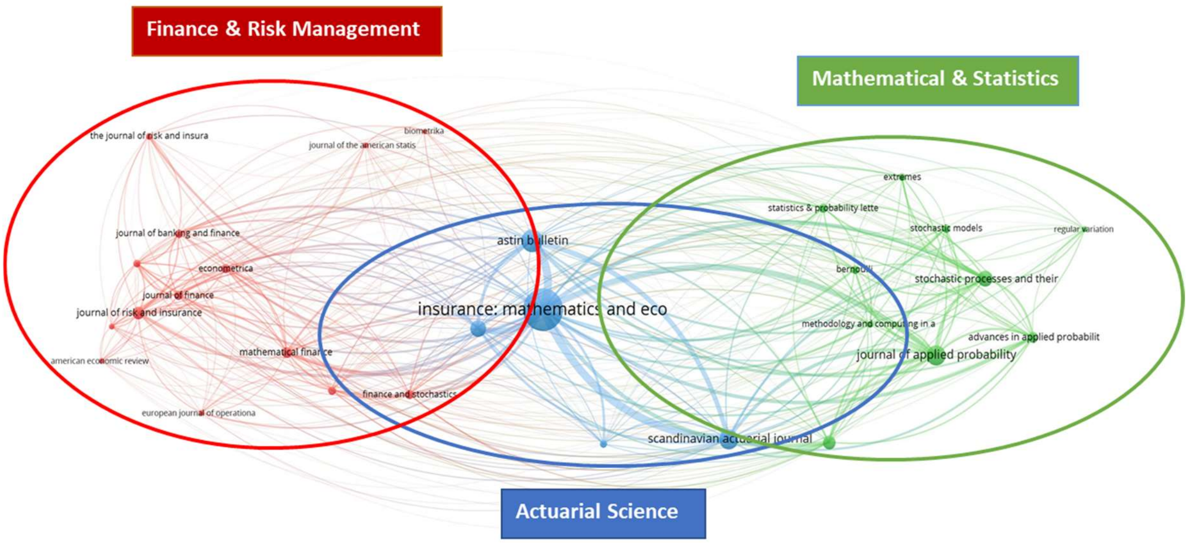
Note: CPD — citations per document.

Journal co-citation analysis (JCA) was used to identify the sources influencing research on insurance risk. JCA indicated that most were 1st-quartile journals in Scopus. *Insurance: Mathematics and Economics* is the most influential (see Table 2). The focus of this journal is primarily actuarial science research, both in terms of pricing (Kaluszka et al., 2012), valuation (Palmowski & Surya, 2020), and solvency and capital management (Wang et al., 2021). This key focus on actuarial matters is similar to the *Astin Bulletin* and *Scandinavian Actuarial Journal*.

Table 2. Top 20 co-cited journals on insurance risk publications, 2000–2022

Rank	*Co-cited source*	*Scopus quartile*	*Co-citations*	*Total link strength*
1	*Insurance: Mathematics and Economics*	Q1	1730	21494
2	*Astin Bulletin*	Q1	549	9535
3	*Journal of Applied Probability*	Q2	456	6443
4	*Scandinavian Actuarial Journal*	Q1	456	8783
5	*North American Actuarial Journal*	Q2	333	5246
6	*Stochastic Processes and Their Applications*	Q1	309	4683
7	*The Annals of Applied Probability*	Q1	223	3230
8	*Journal of Risk and Insurance*	Q2	192	2328
9	*Advances in Applied Probability*	Q1	166	2981
10	*Mathematical Finance*	Q1	160	2623
11	*Finance and Stochastics*	Q1	121	1900
12	*Econometrica*	Q1	120	1689
13	*Journal of Finance*	Q1	117	1748
14	*Statistics & Probability Letters*	Q2	114	1572
15	*Risk Management*	Q3	107	1392
16	*Journal of Banking and Finance*	Q1	105	1572
17	*Stochastic Models*	Q1	94	1283
18	*Bernoulli*	Q1	93	1548
19	*Extremes*	Q1	91	1073
20	*Journal of Financial Economics*	Q1	91	1437

Figure 4. JCA map: Journals that have influenced insurance risk publications, 2000–2022



Note: Minimum 28 co-citations for top 50 journals.
Source: Authors' elaboration.

The JCA map provided in Figure 4 can be categorized into three main journal fields: finance and risk management (25), mathematical and statistics (19), and actuarial science (6). *Insurance: Mathematics and Economics* is the most highly co-cited journal for this knowledge base despite ranking 8th in terms of citations per document. Due to the significant volume of their publications, this journal is the most influential journal for authors of insurance literature, despite belonging to the smallest group of actuarial science journals categorized above.

4.3. Influential authors of the insurance risk knowledge base

Table 3 lists the most influential authors on insurance risk publications ranked by the number of Scopus-indexed citations. Kyprianou, A. E. is the most influential author with a significant impact from his publications with 429 citations and 61 citations per document followed by Zhou, X. with 324 citations and 54 citations per document. Although these authors are from different nations, they both concentrated more on mathematical and statistics, for example, the papers, *Ruin Probabilities and Overshoots for General Lévy Insurance Risk Processes* by Klüppelberg et al. (2004) and *Functional Limit Theorems for a New Class of Non-Stationary Shot Noise Processes* by Pang and Zhou (2018).

Table 3. Ten most highly cited authors with at least five documents in insurance risk publications, 2000–2022

Rank	*Author*	*Nation*	*Affiliations*	*Documents*	*Citations*	*CPD*
1	Kyprianou, A. E.	GBR	University of Bath	7	429	61
2	Zhou, X.	CHN	University of Waterloo	6	324	54
3	Tang, Q.	AUD	University of New South Wales	13	532	41
4	Renaud, J. F.	CAN	University of Waterloo	11	393	36
5	Ahn, S.	KOR	Seoul National University	6	203	34
6	Klüppelberg, C.	GER	Technical University of Munich	6	201	34
7	Landriault, D.	CAN	University of Waterloo	10	204	20
8	Palmowski, Z.	POL	Wroclaw University of Science and Technology	12	205	17
9	Yang, H.	HKG	University of Hong Kong	29	469	16
10	Siu, T. K.	CHN	Macquarie University	12	188	16

Note: CPD — citations per document.

Table 3 also reaffirms the significant contributions of those authors from the top geographic distribution areas, for example, China (Zhou, X. and Siu, T. K.) and Canada (Renaud, J. F. and Landriault, D.). However, none of the U.S. authors were among the top-cited authors.

By setting the thresholds to a minimum of 44 co-citations for the top 100 authors, the top 10 influencers by co-citation were ranked, as shown in Table 4. It was clear that the top influential authors are mainly from two large categories of journals: mathematical and model and risk management.

Gerber, H. U., a Swiss professor, was highly influential in his past co-writing with Bowers, N. L., Hickman, J. C., Jones, D. A., and Nesbitt, C. J. for actuarial mathematics textbooks published by the Society of Actuaries (Bowers et al., 1997). Another highly influential Australian author on insurance risk by co-citation is Tang, Q. He is a professor of actuarial science who emphasizes risk-related articles (e.g., Blanchet et al., 2019).

The top 10 influencers, as shown in Table 4, are predominantly actuarial professionals, and most of them are highly co-cited but not highly cited. Therefore, they are influential in their topical focus and have contributed significantly to the insurance risk field.

Table 4. Top 10 influencers in insurance risk by co-citations, 2000–2022

Rank	*Author*	*Nation*	*Topical area*	*Co-citations*	*Total link strength*
1	Gerber, H. U.	SUI	Actuarial science and mathematical and model	367	6973
2	Tang, Q.	AUD	Actuarial science and risk management	355	5594
3	Asmussen, S.	DEN	Mathematical and model	323	5485
4	Embrechts, P.	SUI	Risk management	280	3843
5	Albrecher, H.	SUI	Actuarial science	265	4926
6	Klüppelberg C.	GER	Risk management	240	3529
7	Kyprianou, A. E.	GBR	Mathematical and model	219	3301
8	Yang, H.	HKG	Actuarial science and risk management	215	3305
9	Willmot, G. E.	CAN	Mathematical and model	172	3171
10	Shiu, E. S. W.	USA	Actuarial science	162	3195

4.4. Intellectual structure of insurance risk

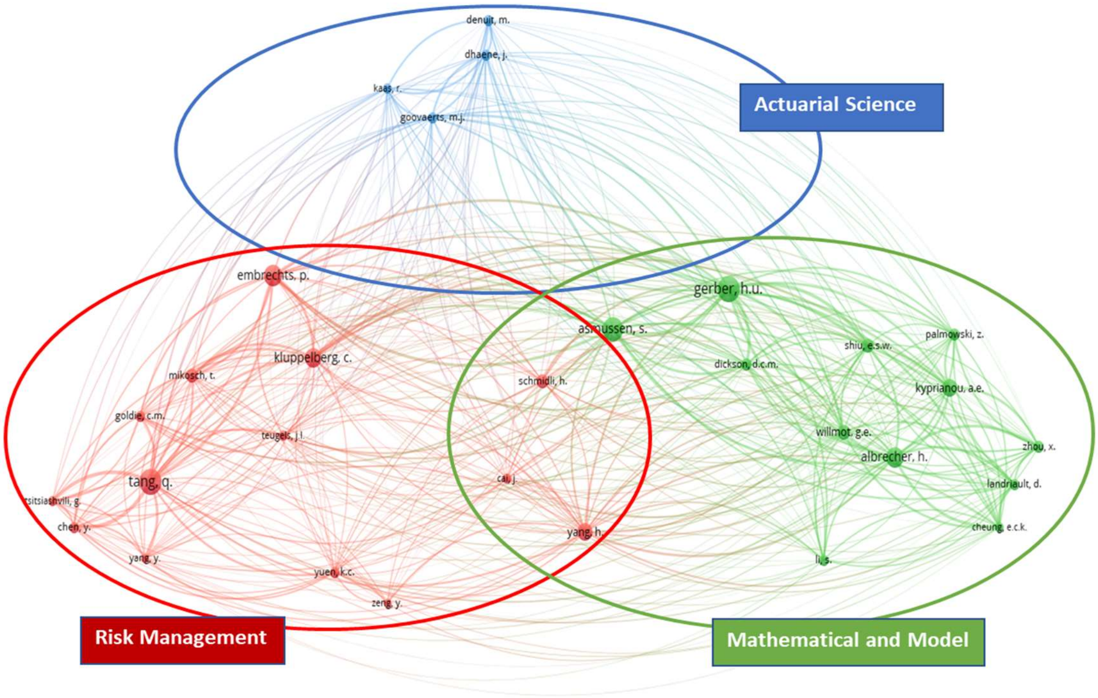
The ACA revealed the structure of the insurance risk knowledge base (see Figure 5). ACA identified three main schools of thought in this field, with the key authors being Gerber, H. U., Tang, Q., Denuit, M., and Dhaene, J., who are highly influential co-cited authors located in the centre of each school of thought.

The first school of thought, in the red cluster, was risk management. Tang, Q., Embrechts, P., and Klüppelberg, C. are the key authors on this theme. Both Tang, Q. and Klüppelberg, C. are highly influential authors and are ranked among the top ten cited authors. Embrechts, despite not being shown on the list of top-cited authors, is a successful influencer based on his textbook co-written with Klüppelberg, C. and Mikosch, T. called *Modelling Extremal Events: For Insurance and Finance* (Embrechts et al., 1997).

The second school of thought, in the green cluster, was mathematical and model, led by Gerber, H. U., who is a key influencer based on his actuarial mathematics textbook published with the Society of Actuaries (Bowers et al., 1997)

Another key author in this mathematical and model cluster, Asmussen, concentrated mainly on probabilities. Two textbooks written by Asmussen are *Applied Probability and Queues* and *Ruin Probabilities* (Asmussen, 2003; Asmussen & Albrecher, 2010).

Figure 5. ACA map: Authors that have influenced insurance risk publications, 2000–2022



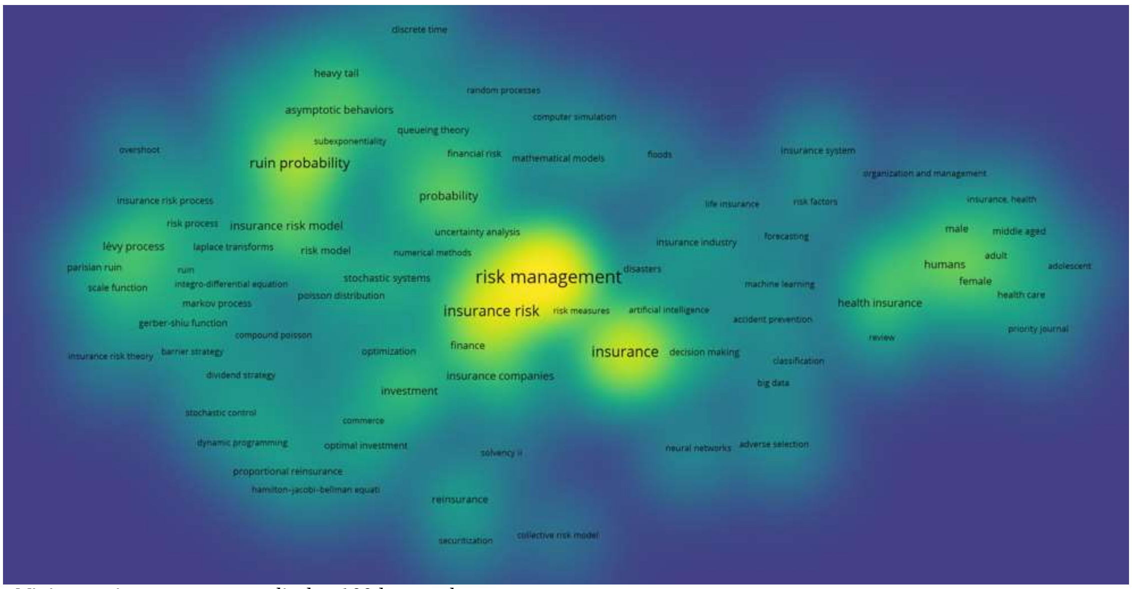
Note: Minimum 90 co-citations, display 30 authors.
Source: Authors' elaboration.

The third school of thought, in the blue cluster, was actuarial science, led by a group of European actuarial science professors. Denuit, M., Dhaene, J., Goovaerts, M. J., and Kaas, R. are co-authors of the textbooks, *Actuarial Theory for Dependent Risks: Measures, Orders, and Models* (Denuit et al., 2006) and *Modern Actuarial Risk Theory: Using R* (Kaas et al., 2008). All these authors have other publications together, for example, *The Concept of Comonotonicity in Actuarial Science and Finance: Theory* (Dhaene et al., 2002b), and *The Concept of Comonotonicity in Actuarial Science and Finance: Applications* (Dhaene et al., 2002a).

4.5. Topical focus of the insurance risk knowledge base

Next, keyword co-occurrence analysis, or co-word analysis, was conducted to identify trends in the topical focus of the insurance field. The author employed VOSviewer to generate a density heat map that "visualizes similarities" in the co-word analysis by setting a threshold of at least six occurrences for a display of 100 keywords (see Figure 6). Keyword co-occurrence analysis lies in its ability to identify emerging research topics both within the subject area itself and directly related areas.

Figure 6. Density heat map: Frequently studied topics in insurance risk, 2000–2022

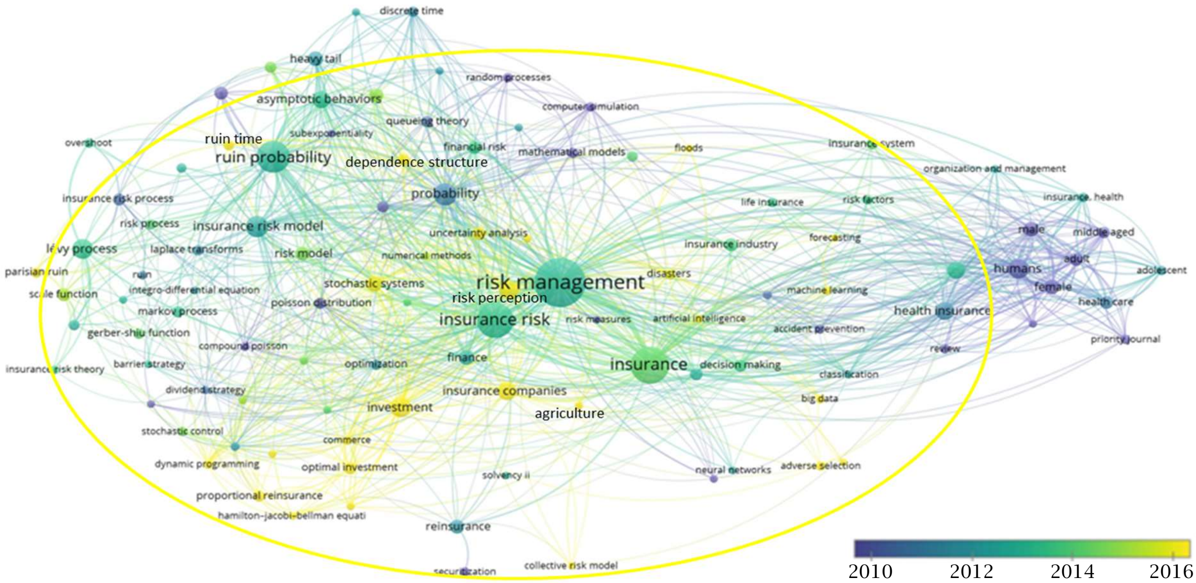


Note: Minimum six occurrences to display 100 keywords.
Source: Authors' elaboration.

The top three keywords in the density heat map are "risk management," as shown *in Dealing With Trend Uncertainty in Empirical Estimates of European Rainfall Climate for Insurance Risk Management* by Jewson et al. (2021), "insurance" from *The Relationship Between Insurance and Economic Development: 85 Empirical Papers for a Review of the Literature* by Outreville (2013), and "ruin probabilities" from *Ruin Probabilities and Overshoots for General Lévy Insurance Risk Processes* by Klüppelberg et al. (2004).

The research frontier in this insurance risk field (see Figure 7) is process and technology — covered by "investment/optimal investment" (López, 2023; Liu et al., 2021), for recent developments in that context), "stochastic process", "artificial intelligence", "machine learning", and "big data." In terms of process, "investment", "optimal investment", and "stochastic process" are interrelated keywords, as shown by time-consistent investment and reinsurance strategies for mean-variance insurers under stochastic interest rates and volatility (Zhu & Li, 2020).

Figure 7. Temporal co-word map: Linkage of 100 keywords to publication years in insurance risk, 2000–2022



Note: Minimum six occurrences to display 100 keywords.
Source: Authors' elaboration.

Recent keywords based on the technology usages are "artificial intelligence", "machine learning", and "big data." The article *AI Insurance: Risk Management 2.0* by Tournas and Bowman (2021) summarizes the risks and concerns of using computer programs such as AI and ML for decision-making.

In addition, this process and technology theme essentially supports the risk management goal of managing insurance risk as an essential risk faced by insurers, as ML can analyze a large volume of data and accurately model risk assessments (Liu, 2019).

5. CONCLUSION

By employing a bibliometric review, this study documents the development of the literature on insurance risk over the past 20 years with its empirical volume, growth trajectory, geographical distribution, influential sources and authors, and intellectual structure of the insurance risk knowledge base. Additionally, the review revealed important themes from three schools of thought. This concluding section discusses the main findings of the paper, the implications of the results (including perspectives for future research), and limitations.

Using data drawn from the Scopus citation database, the authors analyzed 894 articles and reviews published between 2000 and 2022 (see Figure 1). In terms of the growth trajectory of the insurance risk literature, interest in this field has grown slowly since the beginning of the 21st century (see Figure 2). The U.S. and China have been significantly predominant locations for authors who contribute to the insurance risk literature (see Figure 3). At least a quarter of the authors' nationalities came from emerging markets, and only 38% of countries worldwide have contributed to this knowledge base.

The authors used frequency, citations, co-citations, and JCA to identify the most influential journal — *Insurance: Mathematics and Economics.* This journal primarily focuses on actuarial science research (see Tables 1 and 2).

Kyprianou, A. E. is the most influential author on insurance risk, with a significant impact from his publications, followed by Zhou, X. (see Table 3). Results from author citation and co-citation analysis indicated Tang, Q. and Klüppelberg, C. as influential authors, with both high citations and co-citations in insurance risk focusing on risk management as per Tang's co-writing with Blanchet, J. on *Robust Actuarial Risk Analysis* (Blanchet et al., 2019) and *Ruin Probabilities and Overshoots for General Lévy Insurance Risk Processes* (Klüppelberg et al., 2004).

To identify the intellectual structure of insurance risk, three main "schools of thought" were identified as knowledge bases in this field: risk management, mathematical and model, and actuarial science (see Figure 5). The key authors, namely Tang, Q. and Gerber, H. U. are highly influential co-cited authors (see Table 4) located in the centre of each school of thought.

The first school of thought on the risk management theme is represented by Tang, Q. who has extensive studies on risk management (Blanchet et al., 2019). The authors of this paper identify a robust actuarial modelling method for calibrating insurance risk. This method covers baseline and scenario analysis (e.g., worst case, stress test) to develop an optimal solution. Key advantages of this robust performance analysis are its non-parametric nature, which can be applied to various situations, and its computational tractability.

The second school of thought on the mathematical and model theme was revealed by Gerber, H. U. who emphasized actuarial mathematics in a textbook publication with the Society of Actuaries (Bowers et al., 1997). This life actuarial mathematics textbook is a foundation for quantification of life insurance contract risks. Actuaries, especially in the life insurance industry, quantify insurance risks, e.g., mortality and longevity risks of life insurance products, using the actuarial mathematic approach so that product pricing and valuation or reserving can be adequately determined. Actuarial mathematics is an assessment tool that actuaries use to quantify and analyze uncertainty in time and the amount of life insurance risks.

The third school of thought, on the actuarial science theme was led by a small group of European actuarial professors: Denuit, M., Dhaene, J., Goovaerts, M. J., and Kaas, R. They are co-writers of the textbooks *Actuarial Theory for Dependent Risks: Measures, Orders, and Models* (Denuit et al., 2006) and *Modern Actuarial Risk Theory Using R* (Kaas et al., 2008). The unique perspectives and contributions to the field of those textbooks are the contents that bridge theories to practices: foundation setting from random variables, distribution of risk, and extension to risk modelling. The authors captured ground-breaking content ranging from the actuarial foundation of risk distribution to practical stochastic models and R language coding. Those were and are critical milestones for the real-world actuarial profession.

The results of our analysis provide evidence confirming some specific characteristics of the intellectual structure of the field. The knowledge base in insurance risk has focused on risk management by quantifying approaches supplemented by actuarial science and mathematical and model perspectives. Evidence to support this is based on several publications, such as the conditional value-at-risk approach for quantifying optimal risk analysis employed by Tang and his co-authors (Blanchet et al., 2019).

Recent efforts have focused on processes and technologies to gather and analyze large volumes of data that require AI-based technologies to support efficient data-driven decisions (Tournas & Bowman, 2021). This helps to create a robust and faster process for obtaining revenue and profit.

Several implications follow from the findings of this effort to map the literature on insurance risks. Schools of thought that support the intellectual theme structure could be beneficial to consider as part of business strategy decisions for future achievements and further improvements. Using authors and sources as units of analysis can broaden the range of methodological approaches for analyzing citation and co-citation data. Supplementation with a co-word analysis can be used to identify potential trends. Extending this review to future periods might reveal changes in trends and whether there will be similarities or potential changes in this insurance risk knowledge base.

The key limitations of this review are related to the topical scope and sources of the documents. In terms of the identification of sources, while Scopus offers a satisfactory solution to sourcing documents for systematic reviews of research on insurance risk, using a keyword-based approach might make it difficult to identify proper boundaries to enter the field. This could potentially result in the findings of this review differing from those of other prior or future reviews of this knowledge base. A keyword-based review of "insurance risk" may also not cover the majority or whole set of reviews over the period. Relevant research on these topics may be omitted, as it would be difficult to identify boundaries.

Additionally, limitations arose from the delimitation of keyword-based reviews using Scopus. This data extraction methodology led to the omission of non-English versions published in Scopus. Thus, this review could not examine the entire literature on insurance risk.

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