Article

Risk and Bankruptcy Research: Mapping the State of the Art

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Abstract: This article presents a bibliometric study on different types of risk and bankruptcy, aiming to contribute to academic knowledge in this area. We used the bibliometrix tools in R and VOSviewer, following the main laws of bibliometrics (Bradford's law, Lotka's law, and Zipf's law). We analyzed 7163 relevant academic publications retrieved from the WOS database between 1995 and 2023. The characterization of the literature identified trends, importance, and scientific relevance of works, journals, and authors. This allows for promoting collaborations among researchers and provides insights for strategic decision making, advancing knowledge in the field. The most relevant journal was the "Journal of Banking and Finance", with Edward Altman as the prominent author. The United States and China were the most active countries in research. The current research highlights terms such as "board size", "CRS", "responsibility", and "governance", which are commonly found in recent works. The themes of greatest centrality include risk, model, and debt. The bibliometric review revealed gaps in knowledge and research, indicating a growing trend of studies in this area. This article provides valuable information for researchers and managers, supporting decision making in risk management and bankruptcy.

Keywords: risk; bankruptcy; bibliometrix; Lotka's law; Bradford's law

1. Introduction

A bibliometric analysis is a quantitative method of evaluating and analyzing scientific production in a given field of study. It is a technique that uses information and bibliographic data to identify patterns, trends, and relationships between different published academic works. According to Donthu et al. (2021) and Kushairi and Ahmi (2021), it is the application of mathematical and statistical methods to articles and other forms of communication.

It is a method that quantitatively tracks the development of a theme through a body of publications, providing a broad view of the field of study, due to its impartiality and ability to deal with enormous volumes of data (Aria and Coccurullo 2017; Bamel et al. 2022; Li and Xu 2022). In this sense, this work performs a bibliometric analysis of the different types of organizational risk and bankruptcy between 1960 and 31 May 2023.

Bankruptcy and risk are inextricably linked, with the perception of risk as the basis of bankruptcy prediction studies, and playing a crucial role in making business decisions. Risk is understood as a measure of the uncertainty inherent in business activity, that is, the uncertainty about future events that may lead to financial losses, damage to reputation, interruption of operations, or any other undesirable result arising from adverse events (Mikes 2009; Altman 2013).

The impact of risks on organizational failure is significant; risk management and perception play a key role in the financial health and operational continuity of organizations (Kaplan and Mikes 2012; Santos et al. 2022; Lahmiri et al. 2023). In the literature, there are several classifications for the different types of risks, the most commonly found being (i) financial risk, (ii) credit risk, (iii) strategic risk, and (iv) management risk (Altman 2013; Sezer et al. 2020; Jiang et al. 2021; Tavares et al. 2021), and this classification will be used in the work.

Credit risk refers to the probability that a company will not be able to meet its financial obligations; it is directly related to the quality and ability to pay debtors, as well as the efficiency of credit assessment and collection processes (Almeida et al. 2015; Crouhy et al. 2000; Jiang et al. 2021). Financial risk, in turn, is associated with the company's exposure to fluctuations in financial markets, such as interest rate volatility, exchange rate variation, and economic instability (Almeida 2020; Altman 2013; Sezer et al. 2020). Strategic risk refers to the possibility of obstacles arising during the implementation of the business strategy, such as changes in consumer preferences and technological advances, which may lead to a loss of competitiveness (Zhao and Huchzermeier 2015; Tavares et al. 2021). In turn, management risk is related to the ability of managers to make appropriate decisions, define clear objectives, allocate resources efficiently, and mitigate risks, and the lack of management skills can result in strategic errors and operational inefficiencies, increasing the probability of bankruptcy (Sezer et al. 2020; Jiang et al. 2021; Tavares et al. 2021).

This research area has been a concern over time, both for academics and researchers, an idea corroborated by the numerous works published in this research field, among others (Modigliani and Miller 1958; Ivashina and Scharfstein 2010; Zhao and Huchzermeier 2015; Sezer et al. 2020; Jiang et al. 2021). Although it is not a recent issue, a consensual theory of unanimous acceptance has not yet been developed, combined with the consecutive crises experienced in recent years, subprime, COVID-19, and currently the war between Russia and Ukraine, confers relevance and importance to the study.

This bibliometric review contributes to the academic literature in several ways. First, it identifies the main trends and directions in the research area, indicating research opportunities in less explored areas. In addition, it fills a gap in scientific research, as recent works with the same objective and temporal scope were not found.

Another relevant contribution is the assessment of the relevance and impact of research studies, providing insights into the importance of authors and publications. The review also reveals collaborative networks and patterns of joint work in different areas, facilitating partnerships and collaborations between researchers, institutions, and countries.

In addition, following scientific progress allows an understanding of the evolution of research, identifying the most discussed topics and discoveries that contribute to the advancement of knowledge. This information is useful for making strategic decisions, such as defining research priorities, allocating resources, identifying areas of specialization, and evaluating science policies.

Therefore, the contributions of this work serve the primary objective of characterizing the literature by identifying trends, addressing research gaps, evaluating the significance and impact of studies, fostering collaborations among researchers, and providing valuable insights for strategic decision-making.

By employing the fundamental principles of bibliometrics, such as Bradford's law, Lotka's law, and Zipf's law, this study aims to identify patterns, trends, and insights into the current state of knowledge within this specific research field. Bradford's law enables the measurement of scientific journal productivity in the relevant subject area, while Lotka's law measures author productivity based on a size-frequency distribution model. Additionally, Zipf's law assesses the frequency of words in various articles (Aria and Coccurullo 2017; Kushairi and Ahmi 2021).

The work is divided into five sections: the first is the introduction; in the second, a brief description of the state of the art is made; in the third section, the research design is presented, with the presentation of the adopted methodology. In the fourth, the presentation and discussion of the results are made, and, finally, the fifth is reserved for the conclusions of the investigation.

2. Literature Review

Over time, there has been an evolution in the approach to bankruptcy and risk forecasting methods, moving from univariate models based on the analysis of selected indices,

such as the Beaver (1966) model, to the multiple discriminant analysis model of Altman (1968) known as the Z-score model.

For the univariate analysis of the performance of a single variable separately about the prediction of bankruptcy, as an example, we can refer to the model of Beaver (1966), which analyzes selected financial indexes, such as liquidity, debt, and profitability, to predict the bankruptcy of a company.

On the other hand, multiple discriminant analysis models, also known as multivariate models, take into account several accounting variables simultaneously to predict bankruptcy. These models use statistical techniques to identify linear combinations of variables that best separate healthy companies from bankrupt ones. Probably the best-known example is Altman's (1968) Z-score model, which uses five financial variables (liquidity, profitability, leverage, activity, and size) to calculate a Z-score that classifies companies into risk categories of bankruptcy.

Merton (1973) is a renowned author in the field of risk, known for developing models and theories related to financial asset pricing, options, and risk management. His work has significantly contributed to the understanding of this research area. One of his notable findings was the determination of call option value by considering its intrinsic and time value, which greatly improved our understanding of asset pricing and risk management in financial markets. Merton emphasized the significance of risk management and portfolio diversification, considering market uncertainty and volatility when making investment decisions.

Bankruptcy prediction models are subdivided into two main categories: static models, such as the models by Beaver (1966), Altman (1968), and Taffler (1982), and dynamic models, such as Shumway (2001) and Demyanyk and Hasan (2010).

Static models are based on financial information available at a given point in time. They are constructed using historical accounting variables and are focused on assessing a company's current financial situation. These models are useful for making short-term forecasts and providing an instant view of the company's financial health.

On the other hand, dynamic models take into account the temporal evolution of financial variables over some time. They incorporate historical and recent information, allowing for a more comprehensive analysis and identification of trends. These models are useful for making long-term forecasts and capturing changes in financial performance over time.

In the literature on bankruptcy prediction, the most cited models based on accounting variables are the models by Altman (1968), Ohlson (1980), and Zmijewski (1984). Each model uses different explanatory variables and statistical techniques, resulting in different predictive powers. For example, specific studies have shown the effectiveness of these models in predicting failures in different sectors. Altman's Z-score model achieved an accuracy of 80.6%, while Ohlson's model achieved an accuracy capability of 93.8% and Zmijewski's reached 95.3% (Avenhuis 2013; Bărbuță-Mișu and Madaleno 2020).

More recent research recognizes the continuing relevance of Altman's (1968) and Zmijewski (1984) models in predicting financial distress in emerging markets, considering them useful for evaluating organizations and improving their performance. However, new methodologies have been applied, such as factorial analysis in conjunction with other approaches, such as principal component analysis (PCA), fuzzy support vector machines (SVMs), logistic regression, neural networks, and algorithms which have been used to improve prediction models of bankruptcy. Different authors conclude that these approaches allow a better understanding of the underlying variables that influence the risk of bankruptcy and increase the accuracy of forecasts (Kristóf and Virág 2020; Horak et al. 2020; Litvinenkoa and Alvera 2022).

Keasey and Watson (1991) reviewed the usefulness of forecasting models, including the effects of the financial crisis and the limitations of the techniques. The authors concluded that management interest in the development of forecasting models increased

in the 1980s; however, according to the authors this interest was not accompanied by scientific investigation.

Keasey and Watson (1991) describe that the main benefit of statistical (multivariate) techniques is their reliability, with discriminant analysis being the main technique used in investigations in this field of knowledge. However, despite the authors' relevant conclusions, their review work did not advance in aspects related to citations, co-citations, author network, and other bibliometric issues.

Dimitras et al. (1999) highlighted the growing interest in bankruptcy prediction research in the 1990s and the widespread use of discriminant analysis as the most commonly employed technique. The authors conducted a review of 158 studies, although they employed a limited number of methods such as discriminant analysis, linear probability model, probit analysis, logit analysis, recursive partitioning algorithm, survival analysis, univariate analysis, and expert systems.

Daubie and Meskens (2002) examined 150 papers published between 1968 and 2000 and stated that multiple discriminant analysis (logit or probit) and intelligence and multicriteria methods, such as neural networks, are the most commonly applied statistical procedures for bankruptcy prediction. However, their analyses were primarily focused on country, year, financial ratios, and employed techniques, without addressing a broader bibliometric discussion.

Demyanyk and Hasan (2010) reviewed prediction methods applied to financial crises and bank failures, identifying neural networks as the most commonly utilized technique. They emphasized the context of the subprime mortgage crisis in the United States, although their review was not systematic. Murcia et al. (2014) conducted a literature review on credit scoring and found that the majority of studies employ the probit model. However, their review was limited to 50 articles and exclusively focused on credit classification research.

These reviews demonstrate that multivariate data analysis and multiple statistical and computational approaches are essential for supporting empirical research in the field of bankruptcy prediction and risk assessment. However, the limited scope of these reviews in this specific field reveals the most frequent techniques, authors, and articles, as well as the trends between 1968 and 2014, a gap that will be addressed by the present study.

In recent years, technological evolution, including artificial intelligence, has led to sophisticated decision support systems, identifying predictor variables and designing classifiers, which is crucial in risk assessment (Abedin et al. 2018; Ciampi et al. 2021). According to Çallı and Coşkun (2021), with the emergence of social networks and online trading sites, there is an enormous amount of unstructured data available, as well as access to different user profiles, which has led to a change in how traditional indicators are used in risk assessment. Researchers have shifted their focus towards user-generated content, mobile data, social media profiles, blogs, and forums (Rehman et al. 2020; Çallı and Coşkun 2021), acknowledging the increasing importance of these sources in their studies.

The emergence and rapid development of data processing and mining technologies have gained space and importance in investigations for predicting risks and bankruptcy. Authors such as Tounsi et al. (2017), Björkegren and Grissen (2018), and Jiang et al. (2021) add demographic variables and socioeconomic and behavioural factors to the investigation; these have been the object and trend of the most recent research.

3. Methodology and Research Design

This section discusses the techniques used to evaluate the corpus of the current empirical literature, to achieve the objectives that the work proposes.

3.1. Methodology

Hence, the research design employed in this study is bibliometric analysis, which has been established as an effective methodology for quantitatively examining scientific production, as highlighted by Kushairi and Ahmi (2021). It is recognized as the most

suitable approach for analyzing large datasets and tracing their evolution over time (Arslan and Allen 2022).

It is based on the main laws of bibliometrics: (i) Bradford's law, or law of dispersion, which allows the measurement of the productivity of journals, establishing the core and areas of dispersion on a given subject; (ii) Lotka's law, or inverse square law, which measures authors' productivity according to a size-frequency distribution model; (iii) Zipf's law, or law of least effort, which measures the frequency of words in different articles (Aria and Coccurullo 2017; Kushairi and Ahmi 2021).

The productivity of journals and authors is also analyzed through the number of publications, and citations through impact indices, H-index and G-index. The H-index, introduced by Hirsch (2005), measures the academic quality and productivity of a researcher considering the balance between publications and citations. G-index, proposed by Egghe (2006), represents the largest number of publications with a total citation count equal to or greater than g^2. These indicators offer insights into the productivity of researchers and journals as well as scholarly impact.

The analysis was carried out with the support of the bibliometrix package and the BiblioShiny platform of RStudio software and VOSviewer (Aria and Coccurullo 2017; Bhattacharjee et al. 2023). The selection of documents was carried out in the Web Of Science (WOS) database, carried out on 31 May 2023.

In this context, the following research questions were formulated:

RQ. 1—What is the research trend over the years?

RQ. 2—What are the main sources, authors, and most relevant articles in this field of study?

RQ. 3—What kind of collaboration networks exist, and what scientific progress does this field of investigation present?

RQ. 4—What are the most used words and the ones that are most emerging?

3.2. Research Design

In this section, we present the methods adopted to answer the formulated questions and the selection of data following the following research strategy. The great challenge of bibliometric analysis is the formation of the appropriate query; in our work, we kept the query simple enough to group the maximum number of publications. Our work followed the research design shown in Figure 1.
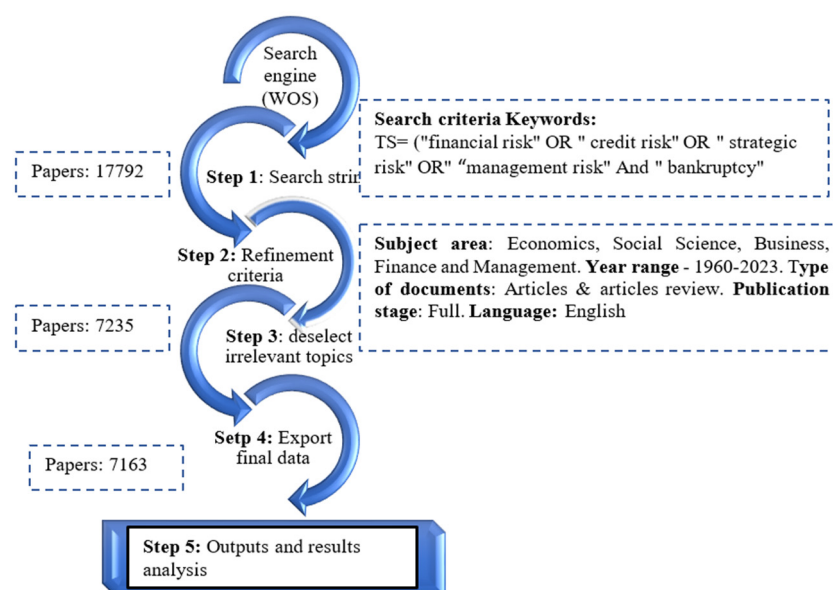

Figure 1. Research design.

4. Presentation and Discussion Results

The general trends of scientific production over time allow for identifying whether production is increasing, decreasing, or remaining constant, providing insights into the dynamics of the research area. They provide information on interest and prominence in research and the academic literature in the area under study. This allows researchers to keep abreast of rapidly growing areas and identify opportunities for future research. Figure 2 shows the trend in the number of publications and the average number of citations per year, over the period under analysis.
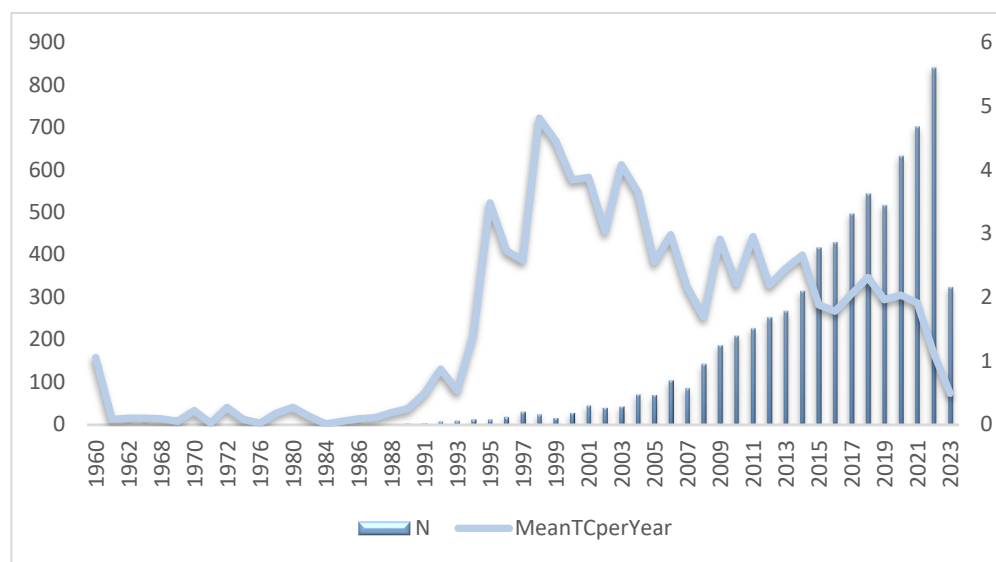
Figure 2. Trend of publications and citations.

There is a growing tendency in the number of publications; until the beginning of the 1990s the publications were very small, showing a growing movement, from 1993 onwards. Research and the number of publications began to increase significantly, with an average growth of 16% per year over the last 20 years. The year 2022 was the year with the highest number of published works: 839. In the first five months of 2023, 38.60% of the number of works from the previous year were published.

When analyzing the average number of annual citations, it appears that these showed an increasing trend between 1992 and 2005, then showed a decreasing average trend, compared to an increase in the number of publications, indicating that the works cited are selected and to a lesser extent number.

The movement of the average number of citations is explained by extensive research in the field of investigation. This growth leads to a decrease in the impact of recent works, resulting in a decline in citations. While some recent publications contribute valuable insights, others may lack originality, rigor, or relevance. Consequently, the number of citations decreases as researchers focus on citing the most impactful and reliable works.

Over time, research trends and interests have evolved, and this decrease in the number of citations reflects a shift in focus within the field, where new research directions and subtopics gain prominence, as discussed further in the evolution of terms. This shift diverts attention from previously published works and results in lower citation rates.

Changes in citation practices over time, such as citation norms and a total number requested by some journals, influence the observed trends and average citation numbers. This analysis allows us to answer the first research question.

Bradford's law, also known as the dispersion law, provides a means to measure journal productivity and identify the core and dispersion areas within a specific subject. It enables the analysis of publication dispersion among the top 20 journals that have published

the most works in the given research area. By examining this dispersion, we can gather evidence to address the second question posed earlier.

Regarding the dispersion of journals, the journals that published work in this field of investigation were 864, with 5 journals accounting for 25% of the 7163 publications, each having more than 100 publications. The Journal of Banking and Finance was the journal that stands out, with over 300 papers published. A second group of journals are responsible for 35% of publications with a total number of publications between 50 and 100 papers. The remaining works are published in a more dispersed number of journals, with fewer than 50 publications each, such as the Journal of Empirical Finance (47), Journal of Finance (41), and the Journal of Financial Intermediation (36); 85.6% of journals published 10 or fewer papers.

Regarding the number and impact of scientific journals, Table 1 shows the 20 journals with the greatest influence and academic impact in this field of research. The relevance and academic impact of each journal were measured by the H-index and G-index, and by the total number of citations (TC) and publications (NP).

Table 1. List of the 20 newspapers with the greatest impact and relevance.

Journal	h_Index	g_Index	TC	NP
Journal of Banking and Finance	75	116	17,479	369
Journal of Financial Economics	40	77	6670	77
European Journal of Op. Research	32	56	3498	106
Journal of Finance	31	41	5669	41
Journal of Financial Stability	29	51	2968	112
Review of Financial Studies	27	48	4712	48
Management Science	23	49	2465	62
Research Intern. Busin. and Finance	22	36	1448	77
Journal of Operational Risk	21	31	1869	282
Energy Economics	20	42	1811	44
Economic Modelling	19	32	1242	83
Insurance Mathematics and Economics	19	30	1137	77
Journal of Financial Intermediation	19	36	1397	36
Journal of the Op. Research Society	19	32	1160	57
Mathematical Finance	19	31	1067	48
Journal of Money Credit and Banking	18	32	1100	43
Quantitative Finance	18	26	1082	113
Journal Internat. Money and Finance	17	32	1060	47
Internat. Review of Financial Analysis	17	31	1202	88
Journal of Empirical Finance	17	27	826	47

The most relevant and prominent journal that publishes works in this area was the Journal of Banking and Finance, having published 369 works, being also the journal that has the greatest academic impact evaluated by the H-index (75) and G-index (116). It was followed by the Journal of Financial Economics, with an H-index of 40 and a G-index of 77, having published 77 papers. The Journal of Empirical Finance is the last in this table, with an H-index of 17 and a G-index of 27 and with 47 papers published in this field of study.

The application of Lotka's law measures the authors' productivity according to a size-frequency distribution model. Similar to the previous analysis, the authors are evaluated

by the H-index and G-index, by the total number of citations in WOS, and the total number of publications in this field of study, as shown in Table 2.

Table 2. List of the 25 authors with the greatest impact and relevance.

Authors'	h_Index	g_Index	TC	NP
Altman	14	20	1399	20
Belas	12	12	402	12
Hammoudeh	12	13	489	13
Lucas	12	18	509	18
Shevchenko	12	18	356	18
Jarrow	11	16	1923	16
Baesens	10	15	726	15
Inekwe	10	17	845	17
Li	10	14	217	16
Muhle-karbe	10	13	224	13
Crook	9	11	388	11
Subrahmanyam	9	13	542	13
Wang	9	10	659	10
Zhu xq	9	11	199	11
Chernobai	8	9	237	9
Giesecke	8	9	471	9
Glasserman	8	10	407	10
Hasan	8	9	236	9
Hassan	8	17	322	21
Inekwe	8	14	243	14
Ivanovski	8	11	564	11
Kim	8	8	241	8
Koopman	8	14	362	14
Lando	8	9	1377	9
Mues c.	8	11	615	11

The author with the greatest academic impact is Altman, with an H-index of 14, a G-index of 20, and 20 publications in this area, also presenting a total of 1399 citations. Altman is followed by a group of four authors with an H-index of 12, with the authors at the bottom of the table, and a group of eight authors, all with an H-index of 8, with several citations between 356 and 509, with Christophe Mues appearing at the end of the list with a G-index of 11 and 615 citations.

Figure 3 presents the total production of scientific articles, which fall within this field of investigation, of the 20 authors with the highest number of publications. This analysis makes it possible to verify which authors are most influential and who have remained active in the investigation of this theme for a longer time, allowing the analysis of the points of continuity and discontinuity of publications by the author.

It appears that it was significantly in the last decade that the authors showed more interest through the concentration of publications. The most active author and for a longer period was Altman; the author presents evidence of publication of works over more than 25 years, having published 20 works. Altman is followed by Jarrow, with evidence of publications for 17 years, between 1995 and 2011. Hassan is the author with the highest number of publications, 21 in total, being concentrated in the last seven years, with 2022 being the year of greatest productivity: the author published 5 papers. The largest number of works and authors are concentrated in the last two decades.

To answer research question 3, Table 3 presents the 15 works with the greatest impact, measured by the citations received. It also presents the DOI (Digital Object Identifier) as an identifier of published texts with a sequence of numbers and letters. In our work, we chose to provide this identifier instead of the title.
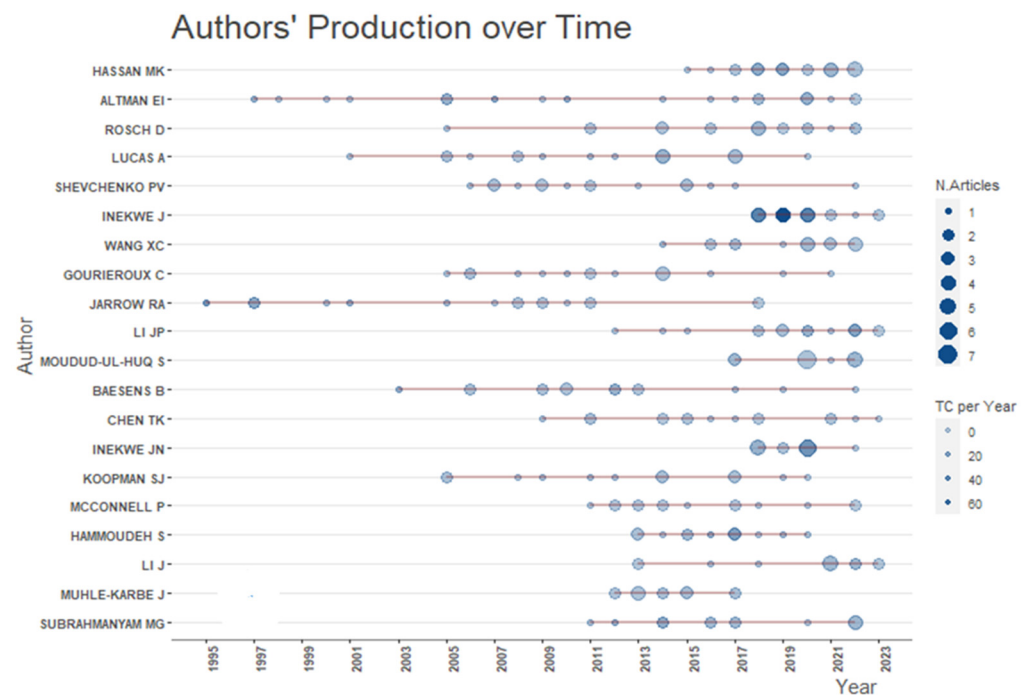
Figure 3. Authors' production over time.

Table 3. List of the 15 most relevant works.

1st Author	DOI	Total Citations	TC per Year
Andersen et al. (2003)	Doi:10.1111/1468-0262.00418	1677	798,571
Diebold (2014)	Doi:10.1016/j.jeconom.2014.04.012	1465	1,465,000
Laeven (2009)	Doi:10.1016/j.jfineco.2008.09.003	1422	948,000
Patton (2006)	Doi:10.1111/j.1468-2354.2006.00387.x	1151	639,444
Duffie (1999)	Doi:10.1093/rfs/12.4.687	902	360,800
Lee (2009)	Doi:10.1016/j.elerap.2008.11.006	845	563,333
Malmendier (2011)	Doi:10.1093/qje/qjq004	824	633,846
Collin (2001)	Doi:10.1111/0022-1082.00402	805	350,000
Jarrow (1995)	Doi:10.2307/2329239	778	268,276
Jianakoplos (1998)	Doi:10.1111/j.1465-7295.1998.tb01740.x	777	298,846
Diebold (1998)	Doi:10.2307/2527342	668	256,923
Eisenberg (2001)	Doi:10.1287/mnsc.47.2.236.9835	585	254,348
Juttner (2011)	Doi:10.1108/13598541111139062	529	406,923
Jarrow (1997)	Doi:10.1093/rfs/10.2.481	514	190,370
Duffie (2001)	Doi:10.1111/1468-0262.00208	494	214,783

Altman (1968) carried out the first study using the multivariate technique (discriminant analysis) to measure credit risk based on financial ratios, discriminant analysis, and corporate bankruptcy prediction articles, and is perhaps the most cited and most relevant article in this field.

Of the 15 works that have the greatest academic impact, a group of four works with more than 1000 citations in WOS is presented. The article with the highest number of citations (1677) and an average of 79.85 citations per year is the article entitled "Modeling and Forecasting Realized Volatility" published in 2003 in the journal Econometrica, by Torben Andersen, Tim Bollerslev, Francis Diebold, and Paul Labys, where the authors test the modeling and prediction of volatility in financial risk management, using intraday data to evaluate the returns of spot exchange rates Deutsche mark/dollar and yen/dollar.

This was followed by the work by Diebold and Yılmaz published in 2014, 11 years after the aforementioned publication, in the journal of Econometrics with the title "On the network topology of variance decompositions: Measuring the connectedness of financial

firms", with 1465 citations and an average of 146.5 citations per year. The authors tested various connectivity measures constructed from variance decomposition.

The next ten papers feature over 500 citations. Finally, there is the article, by Darrell Duffie and David Lando, entitled "Term Structures of Credit Spreads with Incomplete Accounting Information", published in Econometrica journal in 2003, the paper with a total of citations (494) and an average of 214,7 annual citations.

To answer question 4, Figure 4 shows the 18 countries with the highest number of publications, by authors of the same nationality and in collaboration with authors from other countries.
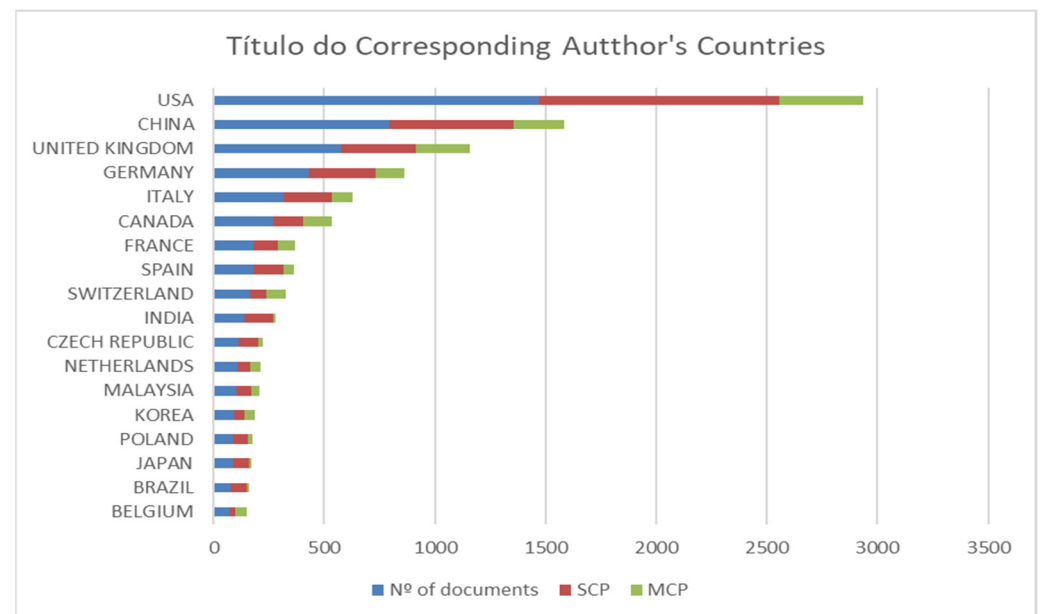

Figure 4. Corresponding author's countries.

Of the countries illustrated in the figure, four continents are represented: America (USA, Canada, and Brazil), the European continent (United Kingdom, Germany, Italy, France, Spain, Switzerland, Czech Republic, Netherlands, Poland, and Belgium); the Asian continent (China, India, Malaysia, Korea, and Japan); and Oceania (Australia), which demonstrate the importance and dissemination of research in this field of study.

The USA is the country with the highest volume of publications (1469), of which 1088 are works resulting from collaboration between North American authors and 381 articles in collaboration with authors from other nationalities. This is followed by China, with 793 publications, 233 of which resulted from the collaboration between authors of different nationalities.

Regarding the collaboration network between authors of different nationalities, Figure 4 shows the collaboration network between countries in the participation of knowledge in this area of study, based on the assumption of a minimum of five works carried out in collaboration with authors of different nationalities. Scientific collaborations were divided into two types: those articles that were published by authors from a single country (independent production) - identified by the acronym SCP (Single Country Publications), represented by the color red, and productions with authors from different countries, joint production, identified by the acronym MCP (Multiple Country Publications), displayed in green.

To answer the last research question, about the most frequent keywords and the evolution of their trend, statistical analysis of the most popular terms was used. This method and results allow for finding evidence about trends, popularity, emerging or declining topics, and gaps in the area under study.
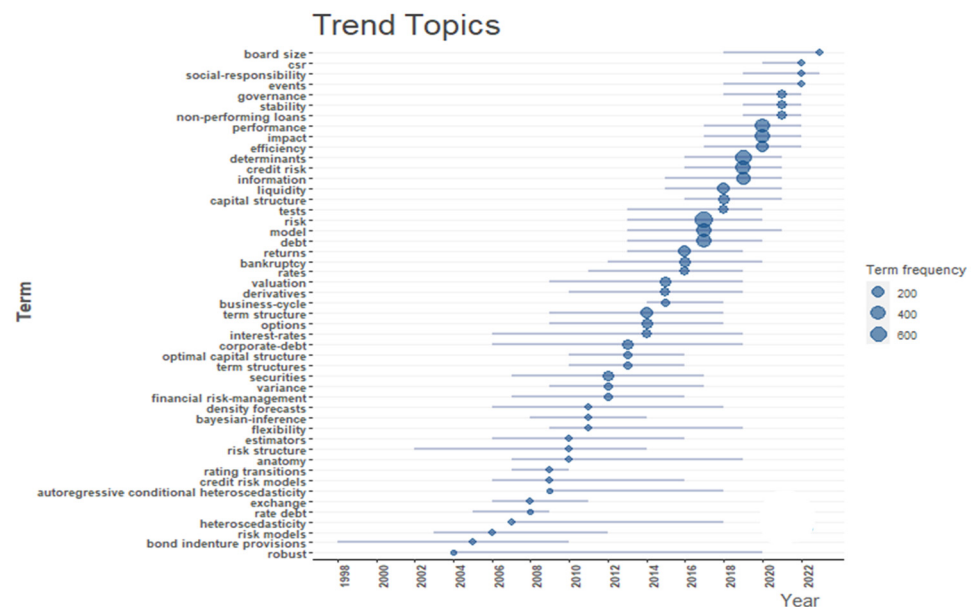
Word clouds (NP) are graphic resources that represent frequencies of words used in a text; they are formed through algorithms that allow the construction of images formed by words. Figure 5 shows the word cloud of the subject under study.

Figure 5. Word cloud.

At the most superficial level of observation, the emphasis on the tendency and popularity of terms such as "determinants", "risk", "performance", and "credit risk" is evident, thus presenting them as the most common terms in the different works under analysis, followed by terms like information, impact, and model debt. These terms are the ones that are used most frequently.

Word co-occurrence analysis is the mapping of concept networks, showing how terms are interconnected. This can reveal conceptual relationships and provide an overview of the structure of knowledge in the specific field.

Figure 6 shows the co-occurrence between words, and identifies related topics that are addressed together in the scientific literature. This visualization facilitates understanding of patterns and interactions between concepts, as well as revealing areas where there is a lack of connections between terms, indicating possible research gaps.

Figure 6. Word co-occurrence map.

Laengle et al. (2017) and Bornmann et al. (2018) argue that the relationship patterns between articles, journals, or authors can be represented and recognized by co-occurrence analysis, as it calculates the most common ones. Figure 7 shows the co-occurrence data map based on "keywords" used in publication titles and abstracts.

Figure 7. Trend topics map.

When mapping the networks of concepts, two clusters are verified, showing the two main areas of investigation; this correlation between the terms is demarcated by the connecting lines between them. The figure allows us to corroborate the evidence of the cloud of words about the central search terms, divided into two clusters, which show the subareas of investigation.

The red cluster, with the use of terms such as risk, models, markets, returns, and volatility, shows that one of the research fields is directed to risk models, financial markets and risks, capital structure, and bankruptcy. The blue cluster highlights an investigation in the field of business performance, the determinants, credit risk, efficiency, behavior, and corporate governance.

Figure 7 shows the evolution of the trend and popularity of the 50 most recurrent terms in the literature, identifying transitional terms over time, and showing changes in word usage, highlighting terms that have emerged or become more relevant.

It was only after 2004 that it was possible to identify the term "robust" as a term frequently used by researchers. As of 2016, the frequency of use of terms such as "risk", "model", and "debt" has been verified in the analyzed documents. By 2020, the frequency of use of terms such as "credit risk", "information", "performance", and "efficiency" were more frequent in works. More recently, authors have used terms such as "board size", "CRS", "responsibility", "events", and "governance". This evolution of topics and change of focus in the field of investigation are indicative of current research areas.

After analyzing the most frequent terms, identifying different groups of words, and exploring their connection and evolution of terms, thematic mapping was performed, as shown in Figure 8. Thematic mapping is an emerging way of mapping the production of scientific knowledge that can give new directions, promoting quality increments in scientific production.

Like Syed and Bawazir (2021), we use the graphical scheme of a thematic map or strategic diagram, where the Cartesian axes represent density (a measure of the network's internal strength) in the ordinate and centrality (a measure of the degree of interaction of a network with other networks) on the abscissa, run in four quadrants (Camón Luis and Celma 2020; Linnenluecke et al. 2020; Syed and Bawazir 2021).

According to the authors, the upper right quadrant represents the main themes, where themes are found that are fully developed and are vital to the research field. In the upper left quadrant, specialized and peripheral themes are described, that is, themes with a

relatively higher density but a lower centrality, are isolated and have a limited influence in the field, despite their distinctive internal development.
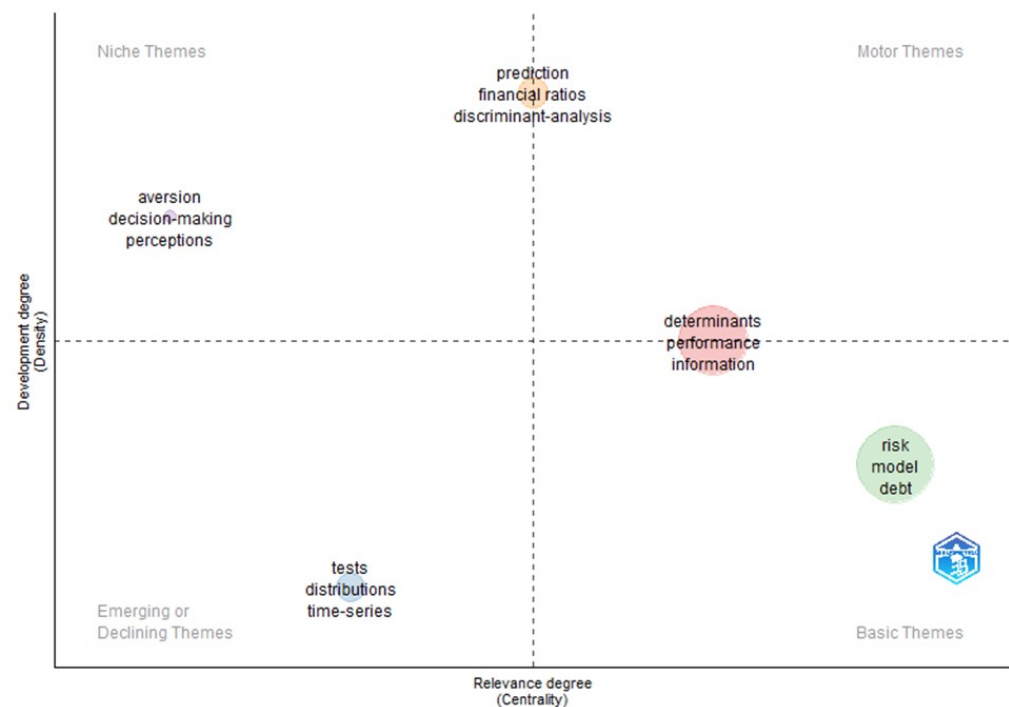

Figure 8. Thematic mapping.

Emerging or declining themes are represented in the lower left quadrant and are underdeveloped and marginal themes in the research field. In the lower right quadrant, basic and comprehensive themes are represented, which are not yet fully developed but have a very important position in the research field.

According to the strategic diagram generated from the authors' keywords, four main themes with different levels of density and centrality can be observed. However, the map does not show major themes or emerging or declining themes.

Within the specialized themes, relatively peripheral and marginal, there are two clusters. The green one contains studies that include the keyword "behavior", "choice", and "aversion", studied by authors such as Grewal et al. (1994), Gorton and Pennacchi (1995), Lee (2009), Malmendier and Nagel (2011), Johnson and Ramirez (2021), Krichen and Chaabouni (2022), and Basu and Swaminathan (2023).

These themes have low centrality, which implies that these research areas have limited influence despite their distinctive internal development. The pink cluster, although in the same quadrant, has greater centrality than the first, which demonstrates greater influence in the research. Some studies present the terms "prediction", "bankruptcy", and "financial ratios", addressed by authors such as Baesens et al. (2003), Acharya et al. (2007), Altman (2013), Peng and Huang (2020), Dumitrescu et al. (2022), Wu et al. (2021), Mushafiq et al. (2023), and Sun et al. (2023).

In addition, there are themes related to risk and debt models. Those in the purple cluster (Andersen et al. 2003; Patton 2006; Jarrow and Turnbull 1995; Jiménez et al. 2014; Roncoroni et al. 2021; Bali et al. 2021; Medina-Olivares et al. 2022; O'Connell 2023), which, despite showing some development in the field of study, have a very important position alongside the blue cluster. This cluster is formed by terms such as "determinates", "performance", and "credit risk" (Laeven and Levine 2009; Jüttner and Maklan 2011; Ding et al. 2021; Alrawad et al. 2023).

Other topics that are not fully developed yet, but have a very important position, are studies that use terms such as "prospective", "scenarios", and "scenario planning"; these themes have greater centrality.

Continuously, Figure 9 presents the diagram of the thematic evolution of the research over the time period under study. Thematic evolution analysis is a way of finding the evolutionary relationships between evolution paths and trends that have evolved over a period. Thematic analysis uses the weight of the inclusion index by occurrence of words with a minimum cluster frequency of 5 while the minimum weight index is 0.1. The width of the connections is proportional to the number of keywords shared by the connected themes and indicates the relevance between them.

Figure 9. Thematic evolution diagram.

The tree fields plot map divides the analysis into three distinct periods: a 40 year period from 1960 to 2000, a 20 year period from 2001 to 2020, and the most recent 3 year period from 2021 to 2023. This map provides an overview of the changes in terms and research topics over time.

During the early period (1960–2000), the research topics were different and studied separately compared to the later periods. However, as the search progressed, there was a gradual shift towards more central themes.

From 2001 onwards, research lines started incorporating topics related to choices, decisions, and demand into the study of behavior. The field of risk research began incorporating terms such as "market", "determinants", "insurance", and "models".

In the latest period, the research field expanded further, as themes from previous time segments merged to form new themes, such as determinants, liquidity, prediction, efficiency, and decision making. Overall, the tree fields plot map highlights the evolving nature of research topics and the incorporation of new themes into the field over time.

5. Conclusions

In this study, we carried out a bibliometric analysis of different types of risk (financial risk, credit risk, and strategic and managed risk) associated with organizational failure, using the Web of Science Core Collection for data collection, between 1995 and May 2023, having analyzed 7163 publications. The global exploration of this study allowed recognition of the contributions and the main contributors in the expansion of knowledge regarding this area of investigation over more than 28 years of research.

The study showed a continuous growth of articles and citations in the domain of the subject, presenting an average annual growth of 16% in the last 20 years. These results are in agreement with the study of Demyanyk and Hasan (2010), who also reported a substantial exponential growth of articles from 1993 to 2010. Our results also indicate that the US is the most productive country in the field of risk and bankruptcy.

The Journal of Banking and Finance proved to be the journal with the greatest impact and relevance in this field of investigation, measured by the H-index, G-index and the number of publications and citations. The author who stood out for relevance and impact was Altman, based on the number of publications and citations and measure of academic impact by the H-index and G-index.

The article that proved to be the most relevant was published in 2003 in the Journal Econometrica, by Torben Andersen, Tim Bollerslev, Francis Diebold, and Paul Labys, entitled "Modeling and Forecasting Realized Volatility", with more than 1500 citations and an annual average of citations from 79.85.

The works that also stood out, with more than 1000 citations in the WOS, were the one by Diebold and Yılmaz published in 2014, published by the Journal of Econometrics with the title "On the network topology of variance decompositions: Measuring the connectedness of financial firms", with 1465 citations, and the article "Bank governance, regulation and risk-taking" by the authors Laeven and Levine, published in 2009, by the Journal of Financial Economics.

In 2006 Patton published the article "Modelling asymmetric exchange rate dependence" in the International Economic Review, a paper that has high relevance and importance in this field of research, evaluated by more than 1000 citations.

Research in this field has prioritized themes such as models, risk, and debt, with those being the themes that have the greatest centrality, meeting the conclusions found by Dimitras et al. (1999), Daubie and Meskens (2002), and Demyanyk and Hasan (2010).

The keywords used by the authors show an evolution over the period under analysis, and it is usual to find terms in the most recent work such as "board size", "CRS", "responsibility", "events", and "governance", indicative of the tendency of recent investigations. The trend of the last two years shows that topics such as determinants, liquidity, prediction, efficiency, and decision making are the priority given by researchers.

Cluster analysis in the articles showed that there are two prominent clusters in this area, risk and determinants. The blue cluster, of determinants, contains several aspects, including performance, information, and credit risk, while the other cluster, of risk, includes debt, markets, models, and default.

We also conclude that over time the forecast models have changed, currently prioritizing methodologies such as factorial analysis in conjunction with other methodologies, principal component analysis (PCA), fuzzy support vector machines (SVMs), logistic regression, neural networks, and algorithms (Horak et al. 2020; Litvinenkoa and Alvera 2022).

Investigating the domain of risk and bankruptcy continues to be an important issue in academic circles as well as in policy-making circles. The study made it possible to show recent trends and the main themes in the domain of risk and organizational failure. We obtained important knowledge that can help to draw a clear picture of this field of research.

Overall, our results show emerging topics and recent trends that are witnessed and evidenced by various research papers in the field of finance, providing insights into the importance of authors and publications, partnerships, and collaborations between researchers, institutions, and countries. They reveal collaboration networks and make it possible to follow scientific progress.

These conclusions are useful for making strategic decisions, whether by researchers or institutions, allowing them to define research priorities, allocate resources, identify areas of specialization, and evaluate scientific policies. For future research, based on our results, further research can be directed towards financial innovation and regulation. The work has limitations, and the information presented in this research is restricted only to the WoS database, not having considered other databases such as Scopus.

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