

A BIBLIOMETRIC STUDY OF BANKRUPTCY PREDICTION FOR CORPORATE FIRMS

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Abstract: *This article focuses on the study of bankruptcy prediction, assessing the progress of explaining research trends through a bibliometric analysis developed by querying as a single database the Web of Science (WoS) platform, as of March 19, 2024. To perform the search in the specialized literature, we used 3 keywords "Financial distress", "Bankruptcy" and "Insolvency" to match exactly the words contained in the titles of the documents, resulting in a number of 2,058 documents.*

Bibliometric analysis is an effective method of conducting a quantitative study, in the form of an inventory of publication activity, of academic results, in order to understand research trends in a certain field of research by analyzing existing documents.

The results indicate that although there is a significant increase in the number of publications since 2008, the collaboration between authors is still weak. The findings also provide a comprehensive view of the interdisciplinarity of bankruptcy modeling research in the fields of economics, business management, and finance.

The authors provide researchers with information on theoretical developments and intellectual frameworks for future research in the field. Furthermore, they aimed to contribute to the theoretical development of bankruptcy prediction modeling by providing useful information and new insights. This information can be critical for policy makers and corporate decision makers.

Keywords: *bankruptcy, financial distress, insolvency.*

JEL Codes: G33

Introduction

Fitzpatrick published a study in 1932 comparing bankrupt firms with successful (non-bankrupt) firms, bankruptcy prediction was a research topic. Altman 1968 discovered the bankruptcy prediction model known as "Altman Z-score", many researchers began to focus on predicting the financial difficulties of companies. A lot of academic studies have been devoted to discovering a more accurate prediction of a company's failure. Authors often distinguish between failed and non-failed companies using "ultimate failure," or bankruptcy.

The results also provide a comprehensive overview of interdisciplinary research on bankruptcy prediction modeling in the fields of finance, corporate governance, and computer science, showing that although the number of publications has increased significantly since the 2008 financial crisis, cooperation among authors is weak including international level.

The exact definition of financial difficulties has not yet been established. From a theoretical analysis point of view, there are several levels of financial distress (Bruynseels and Willekens 2012). Temporary cash flow problems such as insolvency or non-payment are examples of minor

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financial difficulties. Furthermore, the most serious type is bankruptcy or failure of a business (Sun et al. 2014).

The failure of a company causes discontinuity of operations and affects everyone who is connected to the company (shareholders, creditors, suppliers, etc.). Bankruptcy prediction models are important for current corporate firms in establishing failure in trust businesses (Zopounidis and Doumpos 1999).

The bibliometric method helped to explore and describe the current literature on bankruptcy prediction modeling. The reason for this paper is that this field of research has expanded a lot in recent times; it is essential to assess its progress and explain trends through bibliometric analysis and visualization. The bibliometric method helped to explore and describe the current literature on bankruptcy prediction modeling. The research was carried out on 19.03.2024, based on a relevant search in the Web of Science database. To perform a search in the specialized literature, we used 3 keywords, filtered by articles and economics and business finance, resulting in a sample consisting of 2,058 published documents (2,021 documents published between 1975 and 19.03.2024, and for 37 documents published before 1975).

Literature review of bibliometric study and bankruptcy prediction

Otlet used the term bibliometrics for the first time in 1932 defining it as "the measurement of all aspects related to the publication and reading of books and documents". Bibliometrics is a field of study that applies mathematical and statistical methods to quantify information written in scientific publications. Pritchard (1969). Bibliometric methods were used to trace the relationships between scholarly journal citations (Schaer, 2013).

Bibliometric methods can be used in quantitative research to examine trends in a particular field of study by reviewing existing literature such as published articles, books, theses, and reports. Bibliometric studies also aim to find links between researchers, to identify and map the intellectual structure of the studied field, examining a wide range of materials used in different fields (Pinto et al., 2014).

The purpose of the bibliometric study on knowledge in the field of credit risk and bankruptcy prediction was carried out to identify and describe the use of multivariate data analysis techniques, presenting the publication trend of journals, articles, authors and co-citation structures and co -authors (Prado et al. 2016).

Insights and essential elements on bibliometric research trends in early warning systems in the fields of economics, management, business financing and public administration were also provided by (Klopotan et al. 2018).

Considering the growing number of published works related to bankruptcy prediction in various fields in recent years, (Hillegeist et al. 2004), or focused on conducting comparative studies comparing two accounting-based models, Altman's Z-score (1968) and Ohlson's (1980) O score providing an overview of business failure prediction methods The quantitative study of science is aimed at advancing our knowledge, and bibliometric analysis plays an important role in this field of research (Van Raan, 2004).

Bibliometric analysis is the quantitative study of scientific terms, the production, growth, collaboration, and use of scientific publications. In recent times, bibliometric analysis has emerged as an important method for evaluating and analyzing the results of scientists, cooperation between authors and institutes, comparison of results, most cited results, co-citation analysis, etc.

Bibliometric analysis is an essential element of research evaluation methodology, especially in scientific and applied fields (Ellegaard and Wallin 2015). The use of bibliometric analysis for collaboration between industries and universities is explained by (Skute et al. 2019)

Bibliometrics consists of all quantitative features of science studied by statistical and mathematical methods (Broadus, 1987). Bibliometric mapping is a three-dimensional representation of the relationship between disciplines, fields, domains, and publications or individual authors. The

data flow used to perform the bibliometric analysis was centered on data retrieval, then its preprocessing, network extraction, mapping, analysis and finally visualization (Cobo et al., 2011).

Bibliometric analyzes are research methods that quantify scientific publications presented in a database, useful for evaluating the links between key elements of publications (Neptune et al., 2015).

Research design and methodology

For this article, the scientific research was based on bibliometric analysis covering articles from the Web of Science Core Collection database, because this database is characterized by multidisciplinary and a high level of quality in terms of scientific papers published up to 19.03.2024 and the use of scientific data processing procedures with the VOSviewer program.

The literature selection process was carried out by introducing the keywords established by the authors, "Financial distress" OR "Bankruptcy" OR "Insolvency" identified in the title of the document. In terms of language options, no language has been removed, but most of the results are written in English. Later, I also used the filter on articles from the economics and business finance category, resulting in a number of 2,058 international academic papers published up to 19.03.2024. The search results confirm the increased scientific interest in the fields of economics and business finance, with the data contained in WoS having a Hirsch index of 91.

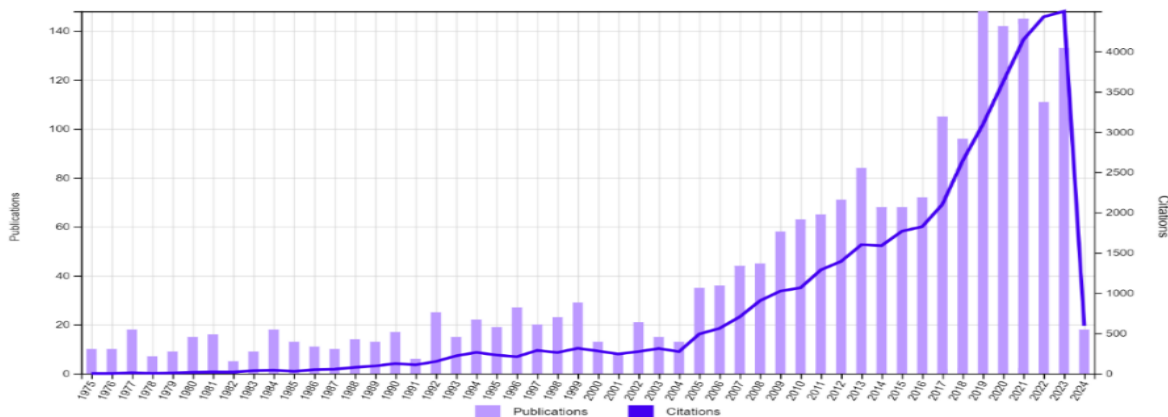
Evolution publication and citations (according to number of publications)

The time distribution of publications and citations can be seen in (table no. 1). Regarding the evolution of publications over time, an increased interest of researchers can be observed especially after the economic crisis of 2008, reaching a peak in 2019 with 138 published articles . In particular, in the period 2009-19.03.2024, the number of publications increased significantly, representing 68.51% (1,410 documents) of the total of 2,058 documents, reflecting the growing interest in this topic in recent years.

The importance of each publication is also given by the number of citations it obtains, the same trend can be observed here as in the case of publications, the peak being reached in 2023, when there were 4,506 citations, representing 10.39% of the total citations for the 2,058 documents. The items in the sample were cited 43,351 times during the entire analyzed period, the average number of citations per article being 21.62. The number of citations in this analysis represents the total number of citations of chlor 2,058 articles selected from the Web of Science database.

Until 2004, fewer articles were published in this field, starting from 2005, the number of published papers and citations began to increase gradually, and from 2008, researchers began to investigate this field of study more, there being a significant increase in scientific publications and interest, which is also seen in the number of citations due to the global financial crisis.

Tableno. 1. Evolution publications and citations



Source : Processing the authors own through via Web of Science

Top most 10 productive international journals and total citations (according to number of publications)

It can be seen in (table no. 2), the International insolvency review magazine is ranked first with the highest number of publications (134 papers) 2.73 times more than the second ranked journal, and the Journal of finance magazine has accumulated the most many citations 6,341 on only 43 publications.

Table no. 2 Top 10 most international journals and total citations

No	Source	Documents	Citations
1	International insolvency review	134	395
2	Banking law journal	49	27
3	Journal of banking & finance	47	1748
4	Journal of finance	45	6341
5	Journal of financial economics	43	4560
6	Financial management	29	1298
7	Review of financial studies	28	8
8	Journal of taxation	26	661
9	International review of law and economics	23	205
10	Journal of risk and insurance	21	247

Source: Processing the authors own through via Web of Science

As can be seen in (table 3), the researcher (Ohlson 1980) with the publication Financial ratios and the probabilistic prediction of bankruptcy from 1980 collected the most citations (2,338), and in second place (Zmijewski 1984) with the publication Methodological issues related to the estimation of financial distress prediction models from 1984, collected only 1,257 citations, 1.86 times less, which also shows the relevance of the publication. Nine of the most cited papers were published between 1977–1996 and only one was published after 2000 in 2004.

Table no. 3. Top 10 international papers source

No	Author's name	Title	Year	Citation
1	OHLSON, JA	Financial ratios and the probabilistic prediction of bankruptcy	1980	2338
2	ZMIJEWSKI, ME	Methodological issues related to the estimation of financial distress prediction models	1984	1257
3	LELAND, HE; TOFT, KB	Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads	1996	758
4	OPLER, TC; TITMAN, S	Financial distress and corporate performance	1994	608
5	GILSON, SC	Bankruptcy, boards, banks, and blockholders - evidence on changes in corporate-ownership and control when firms default	1990	593
6	HILLEGEIST, SA; KEATING, EK; CRAM, DP; LUNDSTEDT, KG	Assessing the probability of bankruptcy	2004	587
7	AUMANN, RJ; MASCHLER, M	Game theoretical analysis of a bankruptcy problem from the Talmud	1985	538
8	HOSHI, T; KASHYAP, A; SCHARFSTEIN, D	The role of banks in reducing the costs of financial distress in Japan	1990	488

9	WARNER, JB	Bankruptcy costs - some evidence	1977	483
10	LANG, LHP; STULZ, RM	Contagion and competitive intraindustry effects of bankruptcy announcements - an empirical analysis	1992	454

Source : Processing the authors own through via Web of Science

Results and discussion

A bibliometric study was conducted using VOSviewer software to analyze academic literature to observe and assess publication trends in this research area. An analysis of the evolution of published works was carried out individually and country co-authorship analysis, reference co-citation analysis, co-citation cited source analysis, co-occurrence analysis to see the association of words in this field For this selection, the Hirsch index (Index H) is 91.

The widely used program VOSviewer provides “visualization techniques that can be used to map the ever-growing, domain structure of scientific disciplines and to support information retrieval and classification” (Borner et al., 2005). It is chosen because it pays special attention to graphical representation, which focuses on displaying large bibliometric maps in a way that is easy to understand and interpret (Waltman et al., 2010).

Working together on research in a certain field is demonstrated by co-author analysis (Liao and colab., 2018). The phrase "coauthor" is used when writing a book, an article, a report, or anything else with one or more people (Cambridge University Press, 2008).

Co-citation occurs when a work that is cited in a list of references is cited in another work. This type of connection between documents is defined as the occurrence of two articles from anterior literature being cited together in subsequent literature (Small, 1973).

Individual and country co-authorship analysis

In this section collaborative power is addressed from the perspective of individuals and countries.

Individual co-authorship analysis

Co-authorship between authors is one of the important analyzes in this study. This traces the network of authors that has formed around the research topic. Using the data exported from the Web of Science database, we performed an analysis with the WOSviewer software, 3,676 authors were identified, but of these only 141 authors published at least 3 articles and the largest set of connected items is formed of 8 items, the graphic representation being the following:

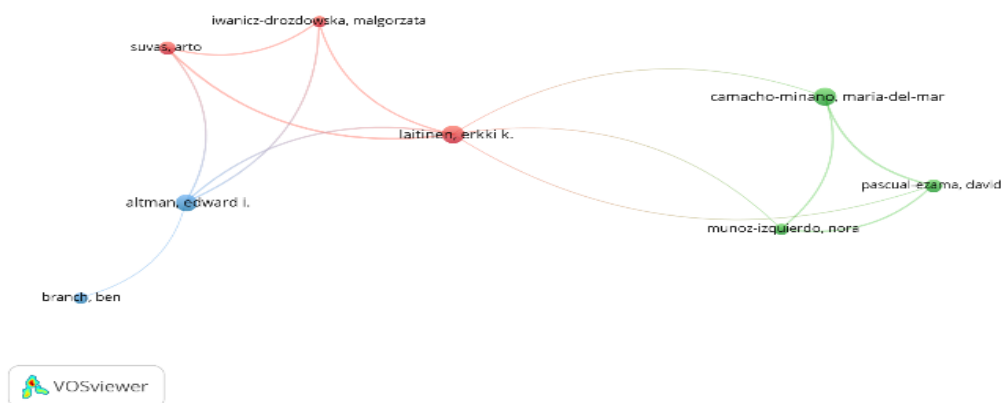


Fig. no 1 Individual co-authorship map
Source : Processing the authors own through via VOSviewer

The VOS-viewer software was used to construct an individual co-author network, which shows the co-author links between researchers, as shown in (fig. no. 1). Each link is significant because it indicates the number of papers that two researchers co-authored (Van Eck and Waltman, 2019). The total connectedness of a node is the sum of the link strengths of this node over all other nodes, and the link strength is a quantitative indicator of the relationship between two elements (Pinto et al., 2014).

The level of collaboration indicates access to research status in a certain field, and co-author research is an important content of bibliometrics study (Reyes et al., 2016).

For data selection and thresholding, the minimum number of documents by an author is set to 3, and the minimum number of citations by an author is set to 0. Among the 3676 identified authors, 141 meet the thresholds, and the largest set of items connected consists of 8 items and their co-author network is shown in (fig. no. 1), where each node represents an author, and the lines and distances reflect the relationship between them. When two nodes are closer to each other, they tend to have a strong relationship because the distance between them indicates the intensity of the relationship. Authors that have a stronger connection, in terms of citations and publications, are represented as larger nodes.

A link is a connection or relationship between two elements, and the stronger the link between two elements, the thicker the line used to display the link in the map view, 3 clusters are identified and two more relevant nodes show a higher strength of collaboration links between authors for Laitinen, Erkki K. (7 documents 432 citation) and Altman, Edward I. (6 documents 551 citation).

From the selection made, it can be seen that the relationship between the authors in terms of research collaboration is not very developed and strong. The most intensive degree of co-authorship is found in the red and green cluster which consists of a number of 3 authors, followed by the blue cluster with 2 authors, the rest of the clusters containing only one author.

Country co-authorship analysis

If we change the unit of analysis, i.e. we focus on co-authorship between countries and not on that between authors, a trend in scientific collaboration between countries is observed.

An important method of analyzing co-autors is analyzing co-autors by country, as this can reveal the communication level between countries and the most influential countries in the research field (Liao et al., 2018).

In the composition of the sample, there are 90 countries concerned with the study of bankruptcy prediction, of which only 55 concentrated their research efforts in the creation of at least 5 documents and were cited at least 13 times in other publications, elaborated and presented in fig . No. 2.

As we can see in (fig. no. 2), the research centers with the largest number of links and the largest number of publications in this field are the USA (628 documents), England (200 documents) and China (136 documents), being also the ones with the largest nodes on the map.

Consequently, the United States of America is seen as the largest node on the map, as it has the greatest connecting power as a whole, allowing for extensive connection and collaboration with numerous nations and re-regions across all continents. England has the largest European hub and has good connections with Spain, Germany and Italy. This observation shows that the cooperative and collaborative relationships of authors in this field of study are stronger when they are in geographical proximity.

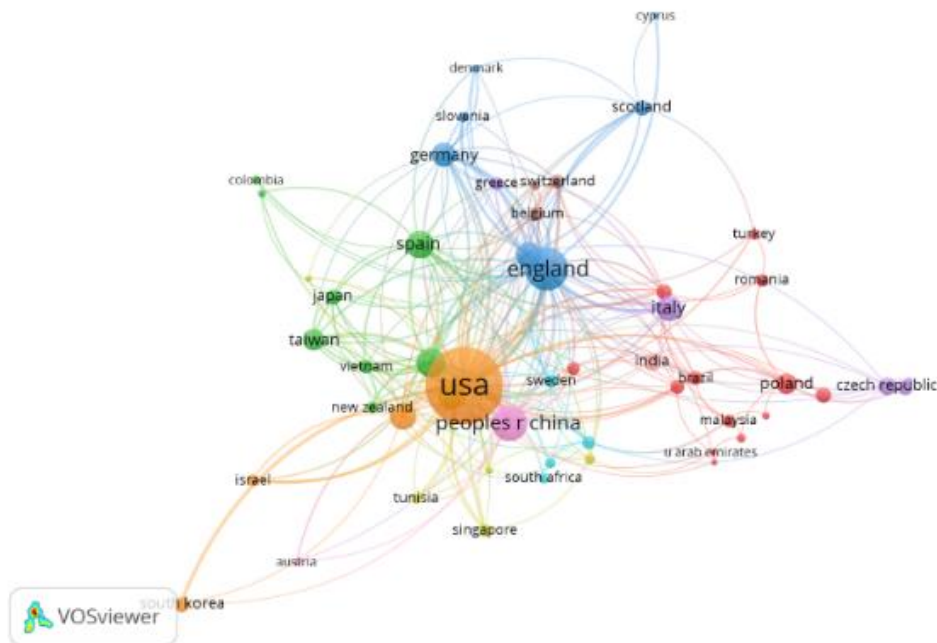


Fig. no 2 Country co-authorship map from the articles select
Source : Processing the authors own through via VOSviewer

Co-occurrence analysis

In order to represent the occurrences of the words used, we chose as the unit of analysis the unit of analysis author keywords and minimum number of occurrences of a keyword 10, resulting of the 3038 keywords, 41 meet the thresholds, and largest set of connected items consists of 40 items , in the 2,058 articles in the selection, the graphic representation being the following:

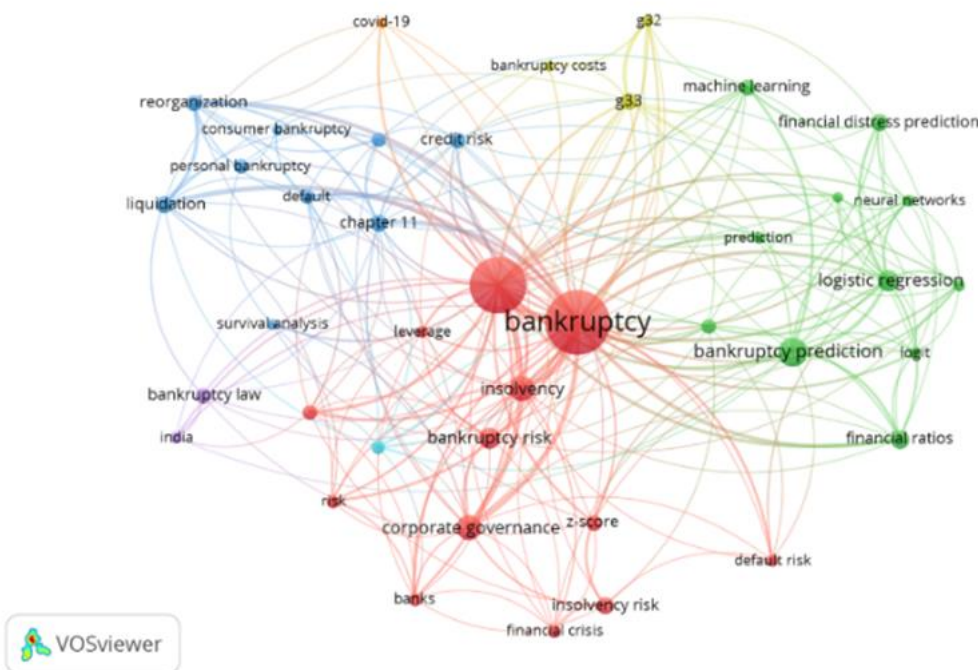


Fig. no, 3 Co-occurrence of key words from articles select
Source : Processing the authors ' own through via VOSviewer

The keyword with the highest occurrence of 335 and total link strength is "bankruptcy", followed by other keywords with a high occurrence such as: "financial distress" (254 occurrences), "bankruptcy prediction" (69 occurrences), "insolvency" (67 occurrences) and "corporate governance" (50 occurrences).

Reference Co-citation analysis

Co-citation is a form of document coupling that is defined as the frequency with which two documents are cited together by other documents (Small, 1973). A co-citation map consists of a set of nodes representing journal articles and a set of edges representing the co-occurrence of nodes and/or articles in the reference list of papers of that map (Fahimnia et al., 2015).

A reference co-citation map based on bibliometric data was created in VOSviewer (fig. no. 4) and the minimum threshold setting for the number of citations by an author was set to 75, a threshold that only 18 of the 48,232 of authors fulfill it.

To represent a reference co-citation map, we chose cited reference as the unit of analysis and the minimum number of citations of an author was chosen at 75, resulting in a threshold that only 18 of the 48,232 cited references.

In (fig. no. 4), the authors find the strongest link is given by the largest node which is by Altman (1968), whose work entitled Financial Ratios, Discriminant Analysis and Prediction of Corporate Bankruptcy first introduced the multivariate analysis known as of Z-score, has 504 co-citations. Ohlson's (1980) study, the second largest node, examined the O-score for predicting bankruptcy, with 329 co-citations, as an alternative to Altman's Z-score. The 1966 Beaver study, which used univariate analysis to examine ratios and assess their predictive ability to classify failed and non-failed firms, included 246 co-citations and ranked third. It can be seen that among the first 18 studies in the ranking, all were published before 2008, which indicates that most of the works published in the last 15 years (after 2008) did not generate a large impact in this research field.

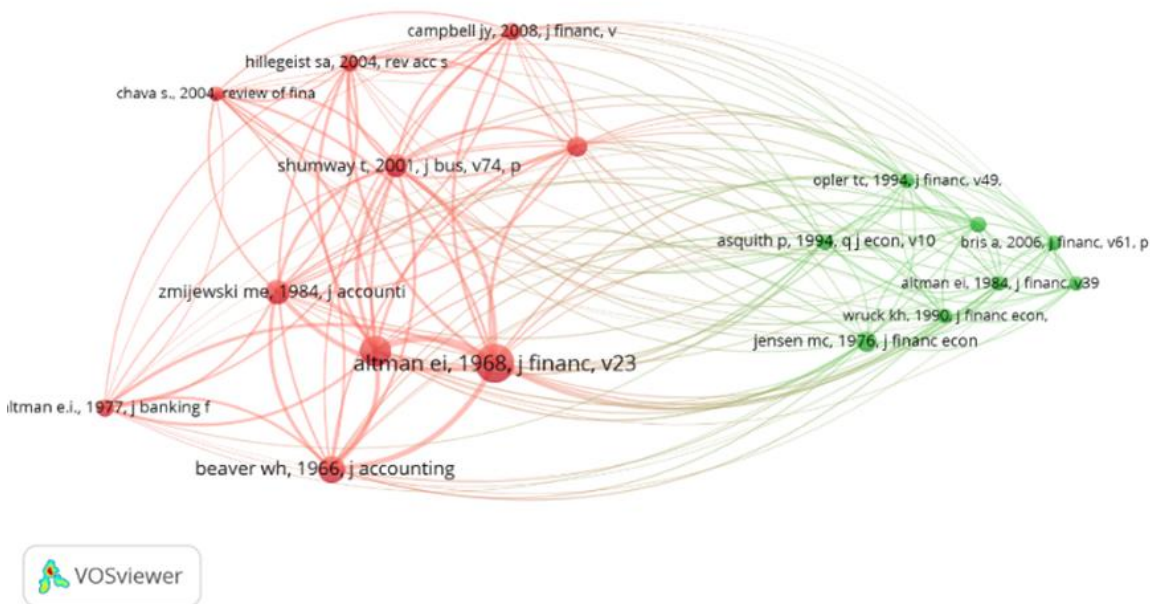


Fig. no. 4 Reference Co-citation map
Source : Processing the authors own through via VOSviewer

Co-citation cited source analysis

Co-citation analysis of journals reveals the overall subject structure and characteristics of journals (Liao et al. 2018). The distance between two journals in a view roughly indicates the relationship between the journals in terms of co-citation links. In general, the closer two magazines are to each other, the stronger the relationship. The strongest co-citation relationships between journals are also represented by lines (Van Eck and Waltman, 2019).

Therefore, the authors performed the co-citation analysis of the sources accordingly with respect to the specialized literature. A source co-citation map based on the data extracted from the Web of Science was created in VOSviewer (fig. no. 5), being selected as the minimum threshold for the number of co-citations of a source at 350 citations, a threshold on which only 18 of the 20,669 sources fulfill it. The size of nodes represents journal activity, and smaller distance between two nodes represents higher co-citation frequency.

The authors find that the most relevant in terms of total link strength and citations is the Journal of finance, closely followed by the Journal of financial economics.

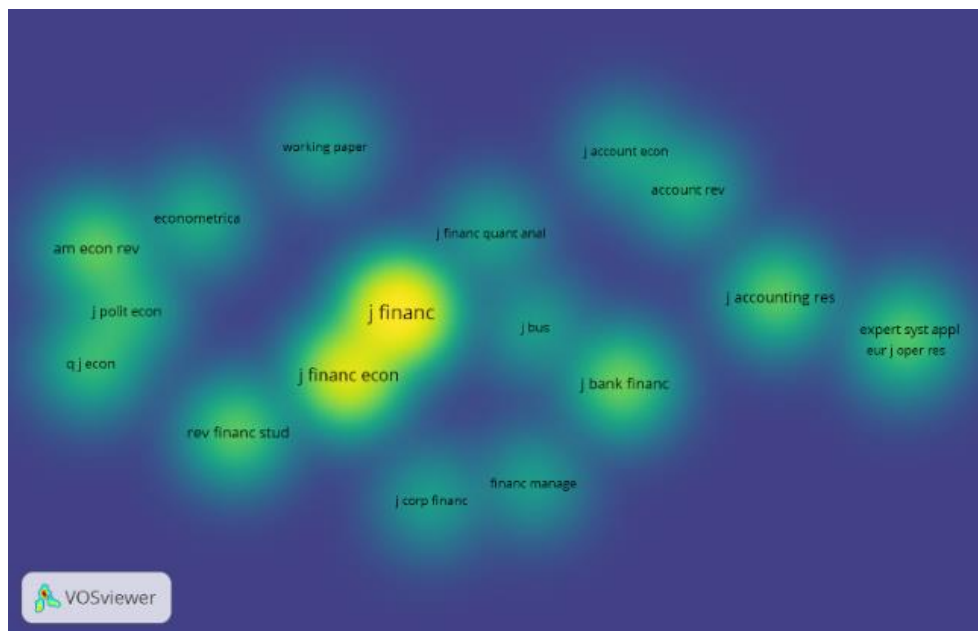


Fig. no. 5 Co-citation cited source density map

Source : Processing the authors ' own through INTERMEDIATE VOSviewer

Conclusions

This bibliometric analysis provides new insights in identifying areas of bankruptcy prediction that have not yet been explored and demonstrates the evolving pattern of existing studies in the literature.

The bibliometric study was carried out using a relevant search on the Web of Science database until 19.03.2024 and analyzed the specialized literature using 3 keywords, resulting in the selection of 2,058 documents (2,021 documents published between 1975 and 19.03 .2024, and for 37 documents published before 1975).

The objectives of the study include the identification and evaluation of research trends in this field, as well as the presentation of the evolution of published works, Individual and country co-authorship analysis, Co-occurrence analysis, reference Co-citation analysis and Co-citation cited source analysis.

The number of publications increased very slowly until 2008 (648 publications), after that an increase in publications can be observed 2009 -19.03.2024 (1,410 publications), the peak being in 2019 with a number of 138 publications, observing an increased interest of researchers after the

economic crisis of 2008. This trend of rapid growth in the number of studies coincided with the economic collapse caused by the financial crisis of 2007-2008 and led to a growing interest from researchers in research on predicting business failure using artificial intelligence or machine learning techniques for data processing on a large scale (do Prado et al. 2016).

At the international level the cooperation between the authors is weak, the strongest collaboration links are identified through the author nodes Laitinen, Erkki K. and Altman, Edward I. (first and second most important authors). The United States, China, and the United Kingdom are the most influential countries and regions in terms of publication volume and country co-authorship, and geographically close countries tend to have relatively higher levels of cooperation and collaboration in this research field.

Co-citation analysis of references shows that the most frequently cited works are Altman (1968), Ohlson (1980), and Beaver (1966). In terms of journal co-citation networks, the Journal of Finance stands out among other journals in terms of overall link strength and number of citations, while International Insolvency Review has the highest number of articles (134 out of 2,058).

The co-occurrence analysis reveals that most of the keywords are related to the topic, and the most frequently used ones are: "bankruptcy", "financial distress", "bankruptcy prediction", "insolvency" and "corporate governance".

The main contribution of this study is to provide new insights and important insights into trends in bankruptcy prediction research and to identify intellectual structures aimed at discovering new niches in this field for future research.

This study provides a comprehensive review of interdisciplinary research on dietary pattern, a topic addressed since 1968.

Indeed, artificial intelligence is becoming increasingly popular as a research tool in many fields, and this gap is leading scientists and professionals to consider the use of intelligent technologies as an alternative in research and decision analysis

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