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Global pension scheme investments: An insightful bibliometric analysis

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Abstract The pension scheme is fundamental for social security systems worldwide and is crucial for people's well-being. Investing in these systems is very important as it helps to improve living standards. When people retire, having a good pension gives them confidence and security, which is good for the economy. It's essential to improve pension schemes to help people with lower incomes have a better living standard. This has led to more academic research being done recently. The goal of this article is to analyze existing research to understand new trends and future research opportunities. The study looked at 547 publications from the Web of Science database from 1995 to 2023, using tools like Biblioshiny, VOSviewer, and Datawrapper to analyze key articles, authors, countries, and institutions in terms of how much they were published and how influential they were. The study also looked at how these different factors related to each other. The research focused on important terms and how they have changed over time. There was also a specific investigation into finance. The results showed that China, the United States, and the United Kingdom are the leading countries in research on pension schemes, and the publications are mainly about economics, corporate finance, business, management, environmental studies, and development studies. Some important trends in the studies included the best investment strategies, income momentum, and risk management.

Keywords: retirement, investments, trends, risk

1. Introduction

In recent years, researchers, government bodies, and individuals have raised worries regarding the future sustainability of existing pension schemes (Alonso-García & Rosado-Cebrian, 2021). The importance of pensions in the socioeconomic context of any society has been acknowledged for a considerable period (Martínez et al., 2021). As individuals grow older, their capacity to generate income diminishes, placing pressure on their families, communities, and society overall. When someone's earning potential is restricted, it can limit their ability to fulfill financial obligations in case of illness or disability. Similarly, the loss of a breadwinner has comparable ramifications for the immediate family, community, and society at large. Throughout history, families, communities, and society have traditionally supported the elderly, disabled, and dependents of deceased individuals. The goal is to establish a stable income, reduce dependency on family support, and ensure social security for individuals. This phenomenon is attributed to an increase in life expectancy coupled with a significant decline in birth rates (González et al., 2021). This has prompted efforts to explore alternative schemes that can ensure their longevity in the future (Martínez et al., 2018). Even though several changes have been implemented recently, they are considered inadequate to guarantee the long-term sustainability of pensions (Alonso-García & Rosado-Cebrian, 2021; Symeonidis et al., 2021). Pension schemes have therefore been established as institutions to manage the reduction or cessation of income resulting from aging, disability, or death.

Germany was among the pioneering nations that established a social pension in 1889 under Chancellor Otto von Bismarck's leadership. This initiative aimed to link regular employees with the newly formed German state, offering a small fixed allowance to every worker who reached the age of 65. Initially, funding for this pension scheme relied on taxes from tobacco monopolies. Germany's mandated state pension arrangements are underpinned by a pay-as-you-go (or redistributive) approach. Following Germany's lead, other countries such as Denmark in 1891, New Zealand in 1898, Australia in 1908, and Sweden in 1913 implemented similar pension schemes. The Government Pension Investment Fund of Japan (GPIF) is the largest globally, boasting assets under management (AUM) totaling $1.4 trillion. It has maintained this top position since 2002. Meanwhile, the sole newcomer to the list of top 20 funds for 2022 was India's Employees' Provident Fund. Contributions from workers and employers to pension funds are not saved or invested but rather used to fulfill existing pension obligations. Additionally, countries like the USA, England, and Australia also introduced pension scheme in the early 1900s. Various nations use different terms or acronyms to refer to their pension scheme, with Germany calling it "retirement insurance" and the United States referring to it as "social security" (Börsch-Supan & Wilke, 2004), In the United Kingdom and Ireland, the term "pension scheme" is commonly used, while in Australia and New Zealand, these plans are referred to as "superannuation

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plans." Social security, on the other hand, encompasses a broader range of programs aimed at providing social welfare to workers and their dependents, to ensure financial support after retirement. Therefore, during times of uncertainty, both social security and pension schemes are crucial for the well-being of retirees.

To comprehend pensions, numerous frameworks have been created. Most studies have utilized interdisciplinary approaches to pensions and retirement schemes. In recent years, the quest for sustainability has led to a burgeoning body of literature on pension funds, exploring topics such as the analysis of various pension models (Wolf et al., 2021), Aging and Social security research globally tends (Martínez et al., 2021), Retirement system and pensions (Owusu et al., 2024), women's retirement (Mohamad et al., 2023), Sustainable investment strategies in Pension fund management (Ikwue et al., 2023), Social Security of elderly (Li et al., 2022), the well-being of older adults (Huang et al., 2022), Aging policies (Nan et al., 2020), and the study of demographic aspects, including age (Lopez et al., 2012; Pan et al., 2021).

While the concept of pension schemes dates back to the 1890s (Wang & Peng, 2016), Interest in the subject increased during the 20th century. Many studies on pensions have centered on addressing issues related to behavioral factors that affect future pension savings (Thaler & Benartzi, 2004); retirement planning and financial literacy (Gallego-Losada et al., 2022), the evolution of pension schemes, the past, present, and future (Börsch-Supan & Wilke, 2004), income inequality and poverty among the elders (Been et al., 2017), reforming the public pension scheme A. H. (Börsch-Supan & Wilke, 2006), the expectation for pension insurance, and the theoretical model (Wolf et al., 2021) level. Quality and life expectancy (Ibragimova et al., 2019), improving the economic security of older persons by the public pension scheme (Narayana, 2023), and health improvement of older adults based on benefit duration in social pension policies (Hwang & Lee, 2022).

1.1. Objective of the study

Due to the significant interest in the National Pension Scheme, a substantial volume of research has emerged on the topic. However, due to the interdisciplinary nature of the subject, comprehensively assessing the scope, trends, and significant findings of this research remains challenging. Bibliometric analysis can facilitate the systematic mapping of the research landscape by revealing patterns in publication output, citation patterns, authorship, and research topics.

The objectives of this bibliometric analysis are to provide a comprehensive overview of the research on the national pension program and its investments. The specific aims of the study include:

1. Identifying the primary research themes and emerging trends within the field.
2. Examining the long-term patterns in publication productivity and citation impact.
3. Investigating the geographical distribution of publications and collaboration patterns in research.
4. Recognizing the most influential authors, institutions, and journals within the field.
5. Exploring the most frequently cited publications and their significant findings.
6. Identifying research gaps and proposing future directions for investigation.

1.2. Study scope

The national pension scheme encompasses a broad spectrum of social security within the financial sector. This research specifically addresses the retirement savings and security system, aiming to promote financial stability and long-term well-being. The bibliometric investigation encompasses scholarly articles sourced from academic journals, conference proceedings, and similar scholarly platforms indexed in prominent databases like Web of Science, Scopus, and Google Scholar. The study period is delimited by data availability and the evolution of the pension scheme, with a primary focus on publications spanning from the early 1990s to the present day. Notably, the analysis excludes books, book chapters, and conference materials.

Moreover, this bibliometric analysis acknowledges the interdisciplinary nature of pension schemes and investment research, spanning disciplines such as economics, corporate finance, management, business studies, environmental studies, and development studies. By examining the intersection of various fields, this study endeavors to provide a comprehensive and nuanced understanding of the research landscape surrounding the national pension scheme.

2. Review of Literature

Pensions are characterized as defined-benefit arrangements. Unlike defined-contribution plans, where the responsibility for planning and investment risk falls on the employee, in defined-benefit plans, it rests with the employer. Benefits from these plans can be distributed in fixed monthly payments, resembling annuities, or as a single lump-sum payout. A pension serves as a form of retirement income that individuals accumulate over their working lives to ensure a source of income during retirement. It represents a long-term investment that grows through regular contributions. Planning for retirement early in life makes it easier to build a substantial retirement fund. Through the social security system, the state offers both contributory and non-contributory retirement pensions (Pak, 2021). These pension schemes operate on a distributive basis, where the pensions of current retirees are funded by the earnings of current workers. When current workers retire, their pensions will be supported by the earnings of the next generation of workers. In essence, each generation's

pensions are financed by the contributions of the following generation, rather than solely by their contributions (Okulicz-Kozaryn & Morawski, 2021; Yasuoka, 2021).

This operational approach requires a balanced ratio between pensioners and workers. However, recent challenges have emerged, as evidenced by governments' struggles to ensure timely payments. Declining birth rates in affluent nations, coupled with extended life expectancies, have led to a significant increase in the number of individuals reaching retirement age (Owadally et al., 2022). Amidst the current search for solutions to the financial downturn triggered by the COVID-19 pandemic, policymakers are moving away from the restrictive notions of pension scheme sustainability prevalent in past decades (Wolf et al., 2021). Pensions led to higher household expenditures and decreased poverty rates, although the impact was lessened in households headed by individuals with low literacy levels, indicating that this particularly disadvantaged group had lower access to pension benefits.

Pensions led to higher household expenditures and decreased poverty rates, although the impact was lessened in households headed by individuals with low literacy levels, indicating that this particularly disadvantaged group had lower access to pension benefits (Kaushal, 2014). In Mexico, the social pension program reduced instances of food scarcity, hunger, and inability to acquire medicine due to financial constraints. Furthermore, it increased formal health service consumption, public health insurance enrolment, and doctor visits while not increasing healthcare costs. Finally, it enhanced cognition, lung function, endurance, and women's frailty while decreasing depressed symptoms but not grip strength (Riumallo-Herl & Aguila, 2019).

In Colombia, the social pension program reduced the probability of individuals rating their health as poor by 5.6% and the probability of hospitalization by 5.4% among men. However, there were no discernible variations in self-reported health issues or medical consultations between genders (Hessel et al., 2018). In Korea, a study found no association between the social pension initiative and household spending (Lee & Jung, 2016). In Costa Rica, the augmentation of social pension disbursements improved the self-assessment of health among elderly individuals, yet it did not influence limitations in Instrumental Activities of Daily Living, depression, blood pressure, cholesterol levels, or hemoglobin levels (Brenes-Camacho, 2011). In South Africa, social pension initiatives were associated with increased rates of outpatient healthcare usage, along with improved awareness of and treatment for hypertension (Lloyd-Sherlock & Agrawal, 2014). Furthermore, the research revealed that raising the social pension benefit led to a decrease in symptoms of depression, although it did not impact grip strength or individuals' self - assessment of health (Pak, 2021).

Additional studies have delved into the realm of pensions and pension schemes within academic discourse, offering theoretical and empirical insights into this field. These publications have concentrated on assessing both theoretical frameworks and practical issues related to pensions and social security (Abel, 2019; Martin, 2001) found that pensions decreased the labor supply within families by augmenting household income and raising reservation wages.

Researchers conducted a bibliometric analysis of literature concerning aging policy in China, utilizing the PKULaw database, which exclusively contained Chinese documents. They scrutinized 226 publications released from 1978 to 2019. The Gephi program was employed to generate a visualization map depicting connections between keywords and agencies. Policy categories encompassed laws, opinions, notices, regulations, administrative orders, decisions, measures, rules, procedures, and sketches. The study explores the progression of China's aging policy (Nan et al., 2020).

The dearth of literature on pensions across disciplines such as Arts & Humanities, Social Sciences, Economics, Business Management, and Accounting, coupled with an upward trajectory in publications, prompted us to explore evolving patterns and themes in the pension domain. To date, only one bibliometric study on pensions, aging, and social security has been documented in academic literature. The authors of this study examined 1,287 publications spanning from 1936 to 2021, utilizing the Scopus database and focusing solely on journal articles in their literature review. Our study adds value to the literature by encompassing a broader spectrum of publications, including books, book chapters, and conference proceedings, alongside journal articles. We believe this comprehensive approach will yield valuable insights into pension research. Additionally, our study examines trends in the wider field of pension research through the analysis of single keywords, addressing a gap in the existing literature (Martínez et al., 2021).

The Web of Science database was used to conduct a bibliometric analysis of literature in the topic of the Subjective well-being of old adults. The literature was limited to reviews or articles published in any language between 2002 and 2021. The number of articles considered for the study is 354 and was obtained from 183 journals. The key areas of study in the subject include psychology, education, health and medicine, medical and clinical. The paper addresses the issue of aging and economic strength (Huang et al., 2022).

The bibliometric analysis concentrated on the geographic dispersion of articles featured in peer-reviewed journals indexed in the Web of Science database. Articles from proceedings, book chapters, working papers, correspondence, and conferences were excluded from the study. The final dataset comprised 242 papers published from 1990 to 2019. The study conducted performance analysis and scientific mapping of the most cited article worldwide in the field of retirement planning and financial literacy (Gallego-Losada et al., 2022).

This research contributes to the existing body of knowledge by conducting a comprehensive examination of pensions and retirement within the realm of accounting studies. Employing bibliometric methodologies, the study scrutinizes a

substantial volume of research articles on pensions and retirement, totaling 6,661 papers, spanning a period of 112 years from 1910 to 2022. Data for the analysis were sourced from the Elsevier Scopus database, encompassing pension and retirement literature from diverse fields including Arts & Humanities, Social Sciences, Economics, Business Management, Accounting, and Economics, given that the documents were exclusively available in English. By employing dual keywords, this study analyzes trends in the broader domain of pension and retirement research, addressing a gap in the existing literature (Owusu et al., 2024).

3. Methodology

3.1. Research framework

This study employs bibliometric analysis methodologies to explore the literature about pension schemes. Bibliometric analysis is a method used to analyze extensive volumes of unstructured data (Donthu et al., 2021). Bibliometric analysis involves assessing scientific papers, books, conference proceedings, and similar publications, along with their citations, utilizing statistical tools and methods. This analytical approach is currently applied across various fields, including mathematics (Martínez et al., 2021), Finance (Koenigsmarck & Geissdoerfer, 2021), accounting (Owusu et al., 2024), financial inclusion in fintech (Afjal, 2023), Policies (Nan et al., 2020) and the sciences (Van Eck & Waltman, 2010). The method is considered essential for recognizing emerging patterns in a research area, encompassing factors such as journal and article performance, collaborative endeavors among authors, geographical patterns in publications, and the research output of institutions in terms of publications, journals, and countries across various areas of existing literature. This study's comprehensive examination entails analyzing trends in publishing, authorship, citations, keywords, country of origin, affiliations, document sources, and other pertinent factors. Bibliometric analysis facilitates the identification and advancement of key research domains, as well as the exploration of theoretical frameworks underpinning those particular subjects (Donthu et al., 2021).

3.2. Data sources, data collection and document type

The information for the research was sourced from the Web of Science repository. The database is a diverse source of abstracts and citations for scientific research. Globally relevant journals cover approximately 9,200 journals in 178 scientific areas and over 21,000 peer-reviewed, high-quality scholarly publications published worldwide. Using the Boolean technique, the study used the search phrase "pension scheme" or "pension" or "old age saving" in the title exclusively from 1985 to 2023 (i.e. 38 years) on December 10, 2023. The original search yielded a total of 4,123 documents. The study's emphasis was narrowed, an additional search key term, "pension" or "investment" in the author keywords and the number of publications was decreased to 1,864. The document type was limited to articles that fit the study's purpose; this reduced the document to 1,338. Following further refinement that confined the search to languages that included English, the document was reduced to 1,124. The study focused on the subject areas of the publications, which were limited to "Economics", "Business Finance", "Management", "Business", "Environmental Studies", and "Development Studies", resulting in a total of 527 documents. Following the screening, the total number of documents was 527, which was exported to the Biblioshiny in R package software for analysis.

3.3. PRISMA statement

Following the application of the search query, the "Preferred Reporting Items for Systematic Reviews and Meta-Analysis" (PRISMA statement) was employed to rigorously refine the search outcomes (Haddaway et al., 2022). Figure 1 illustrates the complete methodology. The rationale behind adopting the PRISMA statement stemmed from its ability to enhance reliability across diverse reviews, its recognition for its thoroughness, and the recent surge in its utilization within numerous bibliometric analyses. Figure 1. depicts a summary of the procedure.

PRISMA flow diagram illustrating the search procedure in the discovery and screening of sources for bibliometric analysis. Preferred Reporting Items for Systematic Reviews and Meta-Analyses under PRISMA.

3.4. Data analysis

The research utilized both Microsoft Excel and the bibliometric analysis tool, bibliometrix®, to conduct a comprehensive examination. The bibliometric analysis comprised descriptive and collaborative network analyses, including co-citation, bibliographic coupling, and co-occurrence testing. Bibliometrix® leverages the biblioshiny interface to offer an extensive evaluation of scientific mapping. Additionally, VOSviewer was employed to handle large datasets, offering advanced mapping functionalities and expanded display options (Donthu et al., 2021). Datawrapper was employed to generate choropleth maps, and Microsoft Excel was utilized to generate descriptive figures and tables. These analyses identify and illustrate crucial aspects such as authors, documents, or countries, providing valuable insights into the evolution of science across various research domains (Moed et al., 1995). This study attempts to demonstrate the evolution observed in the study of pensions, pension schemes, and investment. Similar, to what other authors have done before (Martínez et al., 2021; Nan et al., 2020; Owusu et

al., 2023). This bibliometric investigation adhered to the outlined work plan as follows: Initially, we defined the scope of the research field. Second, we determined the database from which to obtain the necessary information for conducting various analyses. Third, we adjusted the research criteria, specifying parameters such as document types, language, search terms, and document sections to be examined. Fourth, following data acquisition, we extracted the relevant findings from the database. Fifth, the data underwent processing using the aforementioned software, and lastly, the results were scrutinized and discussed.

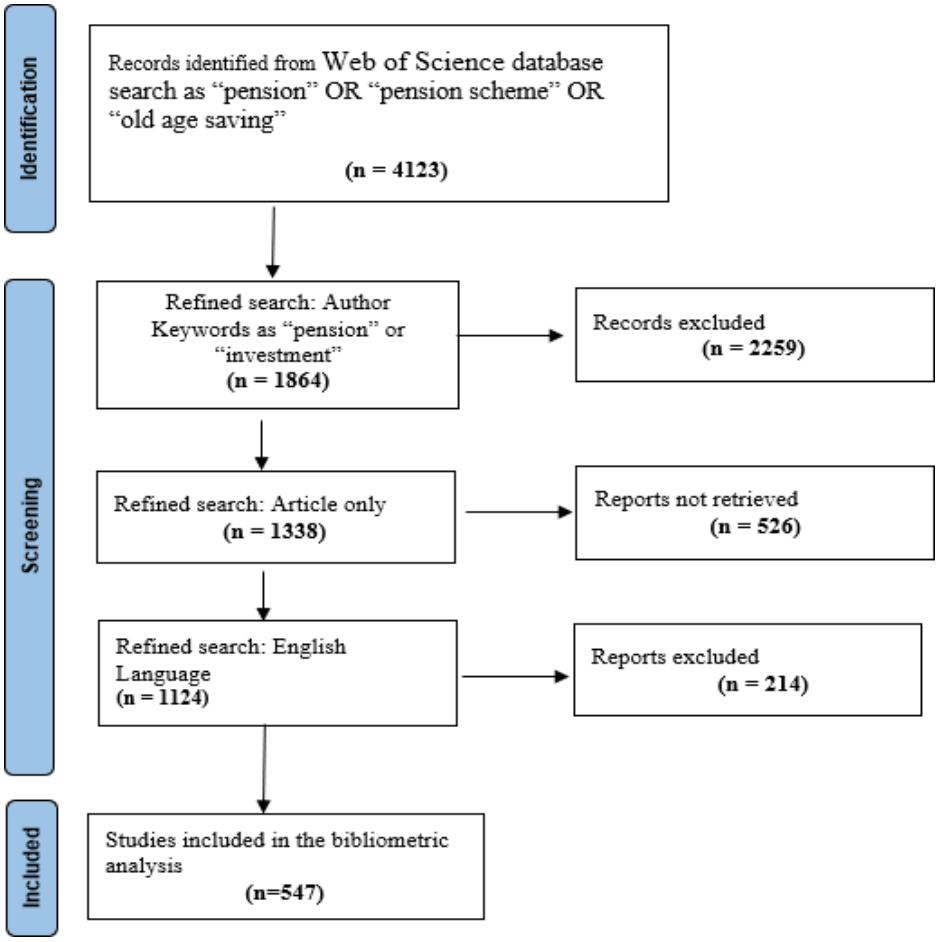

Figure 1 PRISMA flow diagram.

4. Results and Discussion

To conduct the bibliometric analysis, this section provides a synthesis of the significant discoveries spanning three decades of research on pension schemes and investment within the domains of corporate management, finance, and accounting. This was achieved via performance analysis and scientific mapping techniques (Donthu et al., 2021). The objective was to uncover trends in the publication of studies on pension schemes and investments, as well as the intellectual framework of previous research. The subsections encompass trends in publication and authorship, the top-cited countries and journals, as well as co-occurrence and keyword analysis derived from the references within the dataset. Table 1 provides a summary of the data employed in this study.

Table 1 Summary of information regarding research on pension schemes within the Finance domain.

Data	Pension scheme research
Volume of articles	547
Volume of journals	201
Volume of authors	1029
Volume of countries	67
Volume of citations	15130
Average citations/article	7.912
Average citations/ authors	13.86872

4.1. Study quantification

The annual output of articles is consistently rising, indicating a surge in research enthusiasm. Figure 2 illustrates the trends in publication and citation over the sample period, revealing notable expansion. There is a noticeable increase in annual citations and publications, underscoring the significance of the subject and addressing the initial research inquiry. The historical examination reveals a rise in scholarly output, particularly post-2002. The year with the most articles published was 2022, with 54. Particularly, 32 papers were already out there within the first six months of 2023, accounting for over 70% of the publications from 2022 and nearly twice as many as in 2002.

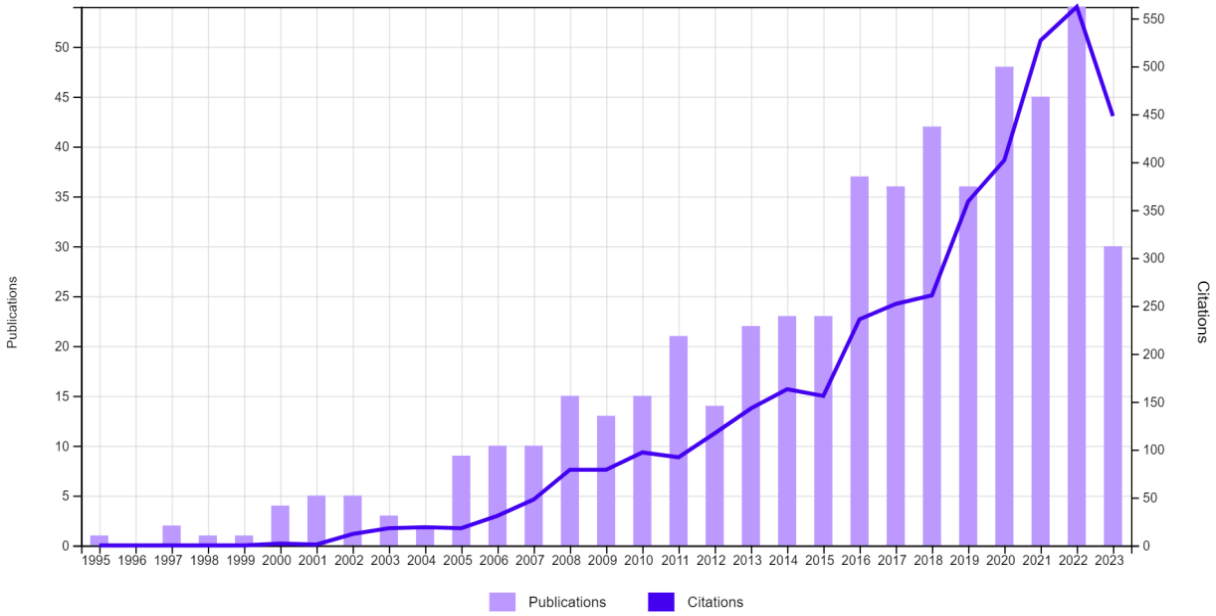

Figure 2 Publication and citation trends. *Sources:* WEB OF SCIENCE

After presenting and analyzing the trends in publication and citation, Table 2 was compiled, showcasing the top ten most cited publications in the Web of Science database.

The article by (Boulier et al., 2001) received the most local citations (144), followed by (Battocchio & Menoncin, 2004), which received 105 citations. The article earned 72 citations (Vigna & Haberman, 2001) while the other papers were cited between 97 and 76 times.

The paper addresses the subject of pension fund management (Boulier et al., 2001). The study focuses on defined-contribution plans with benefits and a stochastic interest rate at maturity. The interest rate model of Vasicek is examined (Battocchio & Menoncin, 2004). The research focuses on the defined contribution pension fund over time. Analyze the portfolio problem in the financial market with two risks: pay risk and inflation risk. Numerical simulation is demonstrated (Sinn, 2000). This study argues that the PAYGO system wastes economic resources. The total of the system's implicit and explicit tax burdens and transition measures. It solves the demographic dilemma and replaces lost human capital with real capital.

Drawing on data from 1993, the study reassesses the impact of the South African social pension on the employment participation of working-age individuals (Posel et al., 2006). As per the findings, rural African women exhibit a notably higher likelihood of engaging in migrant labor. The research explores several potential reasons for the observed influence of pension income (Sethi, 2005) The research delves into the public pension funds of the United States, which possess assets exceeding $1 trillion and are continuously growing. It explores enduring risk concerns such as environmental conservation, sustainability, and ethical corporate practices, alongside the factors influencing a firm's long-term viability. These metrics are commonly known as "socially responsible investing" (SRI), but when applied to businesses, they are termed "socially responsible corporate behavior (SRCB)" and underscore the notion that present risk evaluations rely on current assessments.

According to (Vigna & Haberman, 2001), the study introduces a formula to determine the best investment distribution within a defined contribution pension plan, where the fund is allocated across various assets. It evaluates two investment categories: high-risk and low-risk assets, examining investment distribution concerning the downside risk from retiring members, along with optimal investment strategies. Consequently, probabilities of target shortfall, average deficit, and value at risk were computed. The replacement ratios consider both financial and annuity risks for retirees (Han & Hung, 2012). The study employs a stochastic dynamic programming method to explore the optimal asset allocation for a defined contribution pension plan, incorporating safeguards against stochastic inflation. It outlines the dynamics of the nominal interest rate model and employs the CRRA utility function to derive a closed-form solution. Lastly, a numerical example is presented to illustrate the dynamic nature of the optimal investment strategy (Blake et al., 2003). The research examined participants in defined contribution pension schemes upon retirement. It contrasts the acquisition of a standard life annuity with distribution plans featuring different levels of equity exposure. It found that the ideal age for purchasing an annuity is determined by the fund's

bequest utility and investment performance (Bütler & Teppa, 2007). This study investigates the decision to annuitize at retirement using distinctive microdata sourced from a Swiss employer-sponsored pension scheme. The researchers identified a substantial and consistent influence of a utility-based metric of annuity value on individual annuitization rates. In conclusion, the research presented here shows that there is no apparent supremacy of one pension scheme over another, emphasizing the need to evaluate several systems in pension schemes.

To evaluate the significance and pertinence of the journal in these fields, Figure 3 provides an indicator of the locally most referenced journals to scrutinize their relevance and importance in this domain. As depicted, there are five journals with over 200 citations. Leading the list is the Insurance Mathematics & Economics journal, followed by the Journal of Finance.

Table 2 The most cited articles in the Web of Science database.

Authors	Title	Journal	Global citations	Local citations
(Boulier et al., 2001)	Optimal management under stochastic interest rates: the case of a protected defined contribution pension fund (Boulier et al., 2001)	Insurance mathematics & economics	144	35
(Battocchio & Menoncin, 2004)	Optimal pension management in a stochastic framework (Battocchio & Menoncin, 2004)	Insurance mathematics & economics	105	28
(Sinn, 2000)	Why a funded pension system is needed and why it is not needed (Sinn, 2000)	International tax and public finance	97	4
(Posel et al., 2006)	Labour migration and households: a reconsideration of the effects of the social pension on labour supply in south Africa (Posel et al., 2006)	Economic modelling	96	2
(Sethi, 2005)	Investing in socially responsible companies is a must for public pension funds - because there is no better alternative (Sethi, 2005)	Journal of business ethics	94	4
(Haberman & Vigna, 2002)	Optimal investment strategies and risk measures in defined contribution pension schemes (Haberman & Vigna, 2002)	Insurance mathematics & economics	87	27
(Han & Hung, 2012)	Optimal asset allocation for dc pension plans under inflation (Han & Hung, 2012)	Insurance mathematics & economics	84	21
(Blake et al., 2003; Bütler & Teppa, 2007)	Pension metrics 2: stochastic pension plan design during the distribution phase (Blake et al., 2003; Bütler & Teppa, 2007)	Insurance mathematics & economics	83	8
(Bütler & Teppa, 2007)	The choice between an annuity and a lump sum: results from Swiss pension funds(Bütler & Teppa, 2007)	Journal of Public Economics	76	3
(Vigna & Haberman, 2001)	Optimal investment strategy for defined contribution pension schemes (Vigna & Haberman, 2001)	Insurance mathematics & economics	72	18

Table 3 using Bradford's law of ranking for the top 10 journals, infer the journal's best year of publication. To evaluate scholarly production, performance analysis employs many criteria. The most important measures are the number of articles and citations. Citations measure impact and influence, whereas publications measure output. Two further indicators are the citations per publication and the H-index, which integrates citations and publications to assess performance. The number of articles that have been mentioned at least h times and thus have influence is represented by the h-index (h). The g-index (g) stands for the number of publications that were cited at least g2 times, which indicates influence. These numerous indications provide important information regarding an academic contributor's academic contributions and research relevance. With 81 publications, an h-index of 27, and a g-index of 41, Insurance Mathematics & Economics stands out as the publication with the highest values for contribution, influence, and impact. The selected articles were published in 149 journals, with the top ten journals account for more than 15% of all publications. This concentration shows the importance of a particular journal in the field of research.

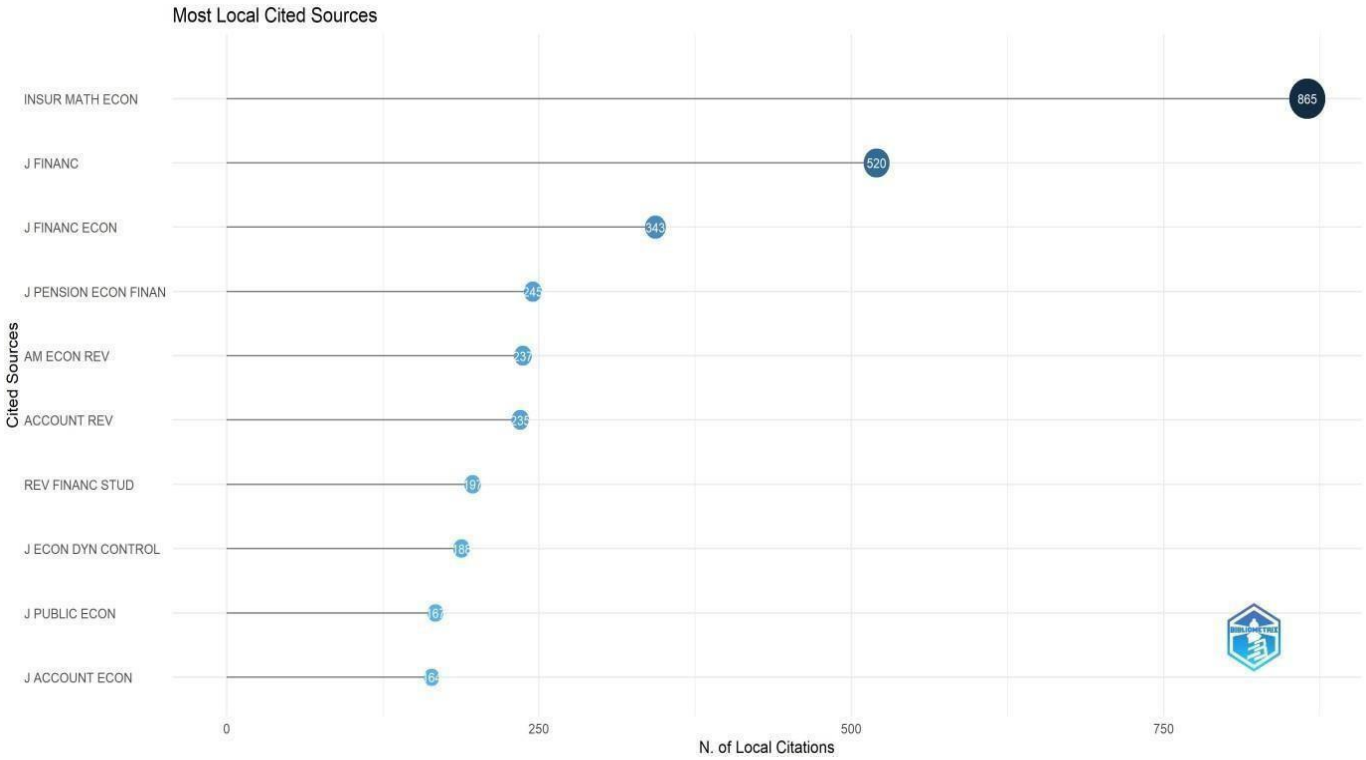

Figure 3 Most locally cited Journal. *Sources:* WEB OF SCIENCE

Figure 4 illustrates an examination of publication performance, showcasing the concentration of publications within particular journals, alongside their h-index and g-index as indicators of performance.

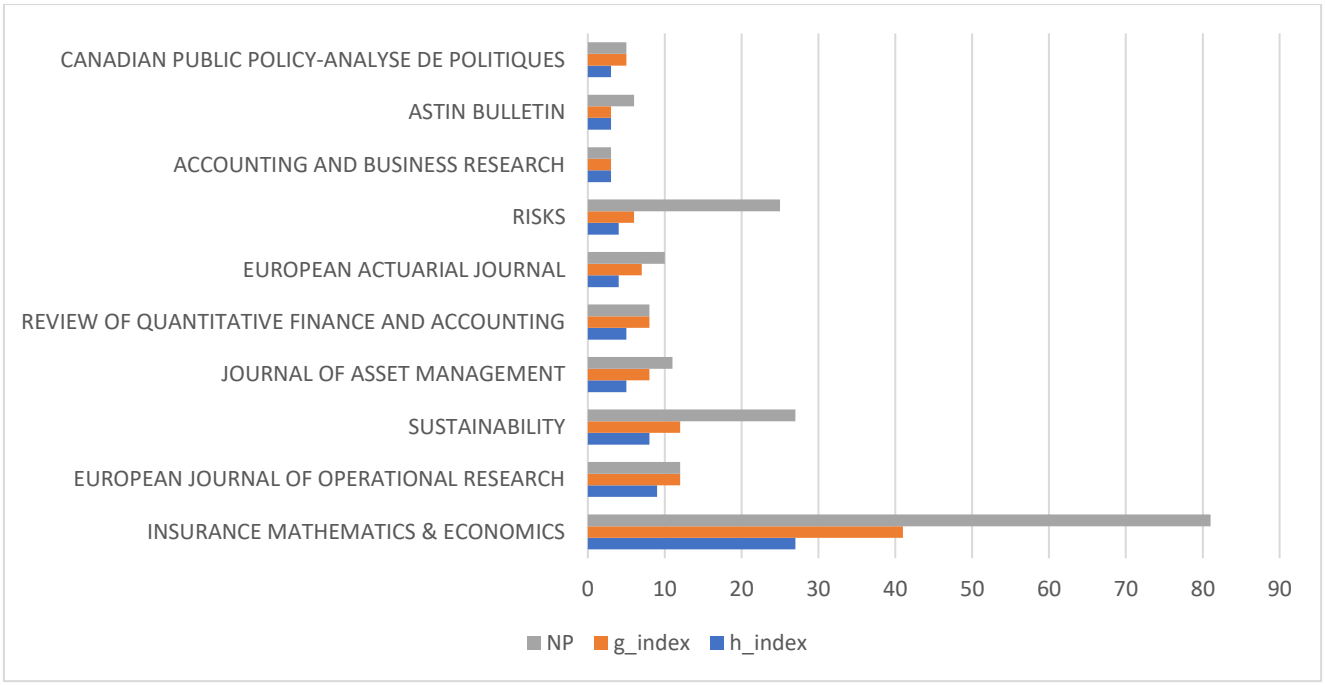

Figure 4 The top 10 journals with the most publications and performance. *Sources:* WEB OF SCIENCE

Figure 5 shows the writers with the most publications and their frequency across the period under consideration. The top ten writers with the most publications in the subject were identified using Lotka's Law, also known as the Inverse Square Law. Josa fombellida. R has the most publications with 11, followed by Liang Zx, who has ten. Three authors, Rincón-Zapatero JP, Guan GH, and Blake D, have shown sustained interest in this topic for more than 20 years, as evidenced by their extensive publications in the past.

Table 3 The top 10 best journals for article publishing.

Journals	A	H_index	G_index	TC	NP	PY_start	Rank
Insurance Mathematics & Economics	865	27	41	1963	81	1997	1
European Journal of Operational Research	160	9	12	207	12	2008	4
Sustainability	69	8	12	169	27	2015	2
Journal of Asset Management	16	5	8	71	11	2005	6
Review of Quantitative Finance and Accounting	34	5	8	74	8	2009	9
European Actuarial Journal	16	4	7	56	10	2011	7
Risks	22	4	6	50	25	2013	3
Accounting and Business Research	37	3	3	65	3	2009	29
Astin Bulletin	68	3	3	17	6	2011	12
Canadian Public Policy - Analysis de Politiques	1	3	5	26	5	2008	15

Sources: Author's first effort.
A: number of articles; H-index: Hirsch in this topic; G-index: author-level metric; TC: total citations; NP: number of publications; PY start: particular year start.

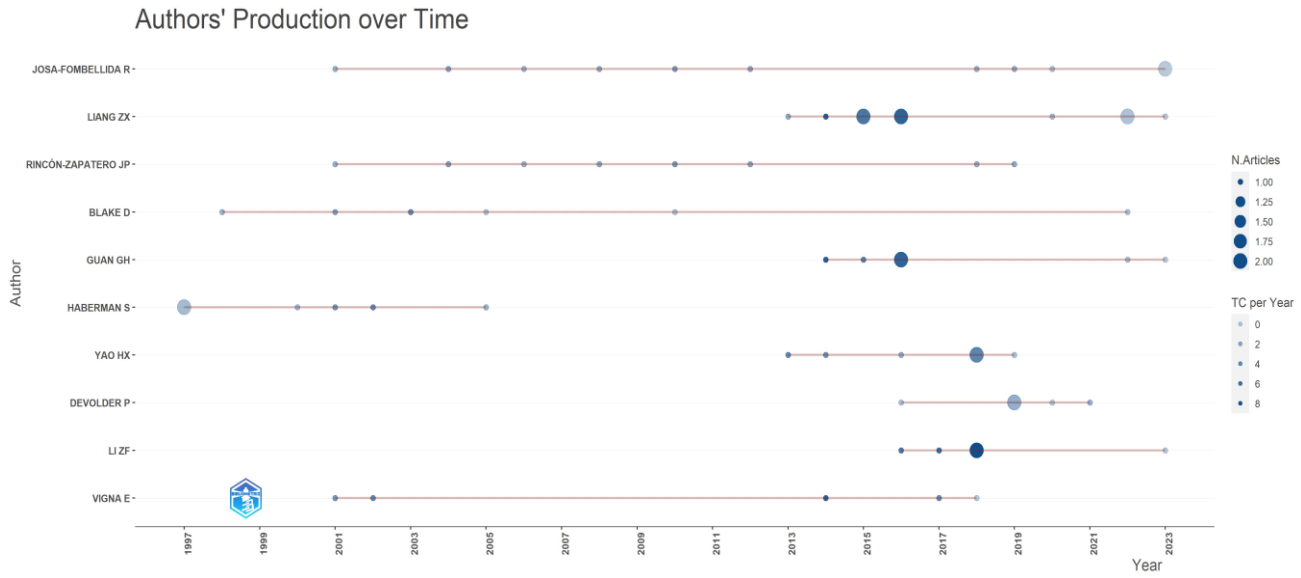

Figure 5 Authors' productions over time. *Sources:* WEB OF SCIENCE

While productivity is one component in determining a researcher's influence, other criteria such as consumption and citation must also be considered. Hirsch (2005) developed the h-index to assess the academic quality and output of a researcher based on the ratio of publications to citations. Egghe (2006) proposed the g-index, which takes into account the largest number of articles with a total number of citations equal to or greater than g^2. These statistics provide information about the productivity and intellectual influence of scientists.

Table 4 summarizes the influence of the top 20 authors in this area. The author with the greatest influence seems to be Josa Fombellida R, who has an h-index of 8 and a g-index of 11, 11 publications, and 220 citations in Web of Science. Rincon-Zapatero JP has an h-index of 8 and a g-index of 8, 8 publications and a total of 218 citations, while the authors with the least influence each have at least two publications in this field and at least two citations.

4.2. Geographic spread

The social and structural links between the many parts of research, scientific production, countries, organizations, and their cooperation are presented and examined here in Figure 6.

Table 5 illustrates the 20 countries with the highest number of papers, with the country identified based on the author's affiliation.The nation with the highest number of publications is China, followed by the United States. Countries from different regions such as North America (with the United States and Canada), Europe (with the United Kingdom, Germany, Ukraine, Spain, Lithuania, Croatia, Poland, France, the Netherlands, Switzerland, Greece and Italy), Asia (with China, Japan and Turkey), Oceania (represented by Australia and Denmark) and South America (especially Brazil) are represented in the top 20 countries with the most publications. These data show a clear disparity in research output between Asian, South American, and African countries.

Table 4 The 20 most important authors from the Web of Science database.

Element	h_index	g_index	TC	NP	PY_start
Josa-Fombellida R	8	11	220	11	2001
Rincón-Zapatero JP	8	8	218	8	2001
Haberman S	6	6	230	6	1997
Liang ZX	6	10	200	10	2013
Yao HX	5	6	117	6	2013
Blake D	4	6	179	6	1998
Cairns AJG	4	4	159	4	2001
Guan GH	4	6	167	6	2014
Li ZF	4	5	134	5	2016
Vigna E	4	5	256	5	2001
Zeng Y	4	5	143	5	2015
Apostolakis G	3	3	44	3	2016
Chen A	3	4	28	4	2011
Devolder P	3	4	16	5	2016
He L	3	4	33	4	2013
Kraanen F	3	3	44	3	2016
Menoncin F	3	3	135	3	2004
Van Dijk G	3	3	44	3	2016
Wang SX	3	4	41	4	2018
Aase KK	2	2	7	2	2015

H-index: Hirsch in this topic; G-index: author-level metric; TC: total citations; NP: number of publications; PY start: particular year start.

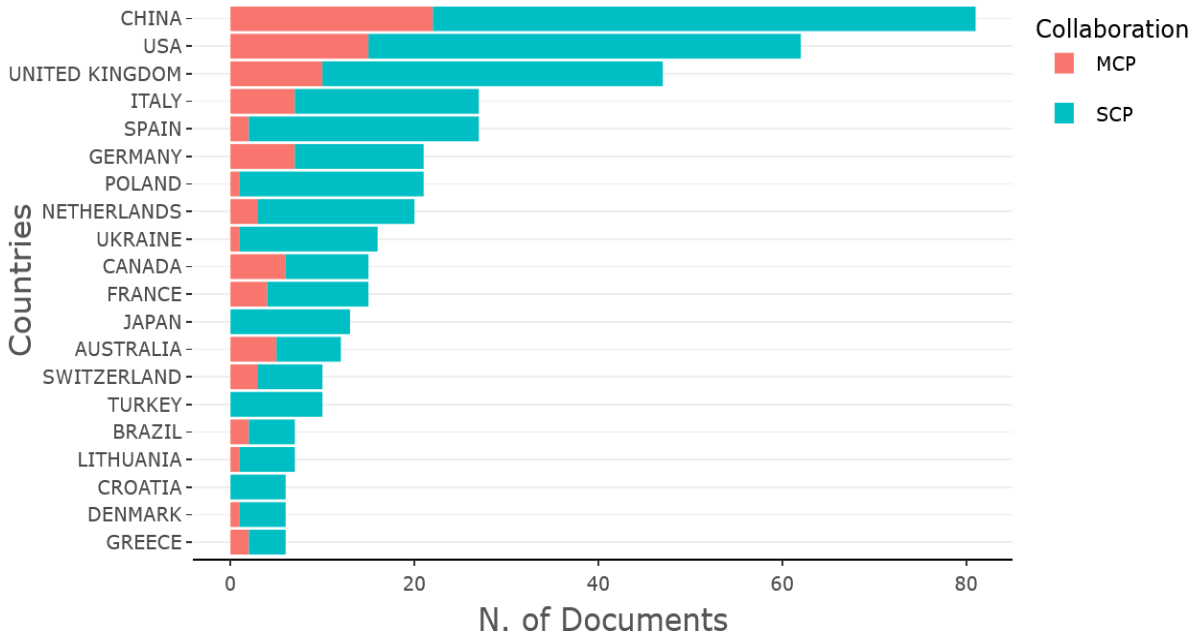

Figure 6 Countries with the highest number of publications. *Sources:* WEB OF SCIENCE

The three-domain diagram serves as a bibliometric analysis tool that illustrates the distribution of publication output, collaboration patterns, and the importance of publications within a particular discipline or scientific community (Koo, 2021). It facilitates the identification of key players in the scientific field and provides valuable insights into authors' collaboration trends and publication practices. Figure 7 shows a three-domain diagram that illustrates the connections between influential authors, prominent countries, and prestigious journals. The data presented in this three-domain diagram can help researchers identify key authors and their countries, coordinate collaborative research efforts, and target noteworthy journals. The author from China who published the most is Liang ZX, while the most prolific author from Spain is Josa-fombellida R, and from the United Kingdom is Blake D. It shows that all the countries' author published their article in the Journal of Insuran ce Mathematics and Economics.

Table 5 List of single and multiple countries' publications.

Country	Articles	SCP	MCP	Freq	MCP_Ratio
China	81	59	22	0.148	0.271
USA	62	47	15	0.113	0.241
United Kingdom	47	37	10	0.085	0.212
Italy	27	20	7	0.049	0.259
Spain	27	25	2	0.049	0.074
Germany	21	14	7	0.038	0.333
Poland	21	20	1	0.038	0.047
Netherlands	20	17	3	0.036	0.15
Ukraine	16	15	1	0.029	0.062
Canada	15	9	6	0.027	0.4
France	15	11	4	0.027	0.266
Japan	13	13	0	0.023	0
Australia	12	7	5	0.021	0.416
Switzerland	10	7	3	0.018	0.3
Turkey	10	10	0	0.018	0
Brazil	7	5	2	0.012	0.285
Lithuania	7	6	1	0.012	0.142
Croatia	6	6	0	0.010	0
Denmark	6	5	1	0.010	0.166
Greece	6	4	2	0.010	0.333

SCP: Single country publication; MCP: Multiple country publication

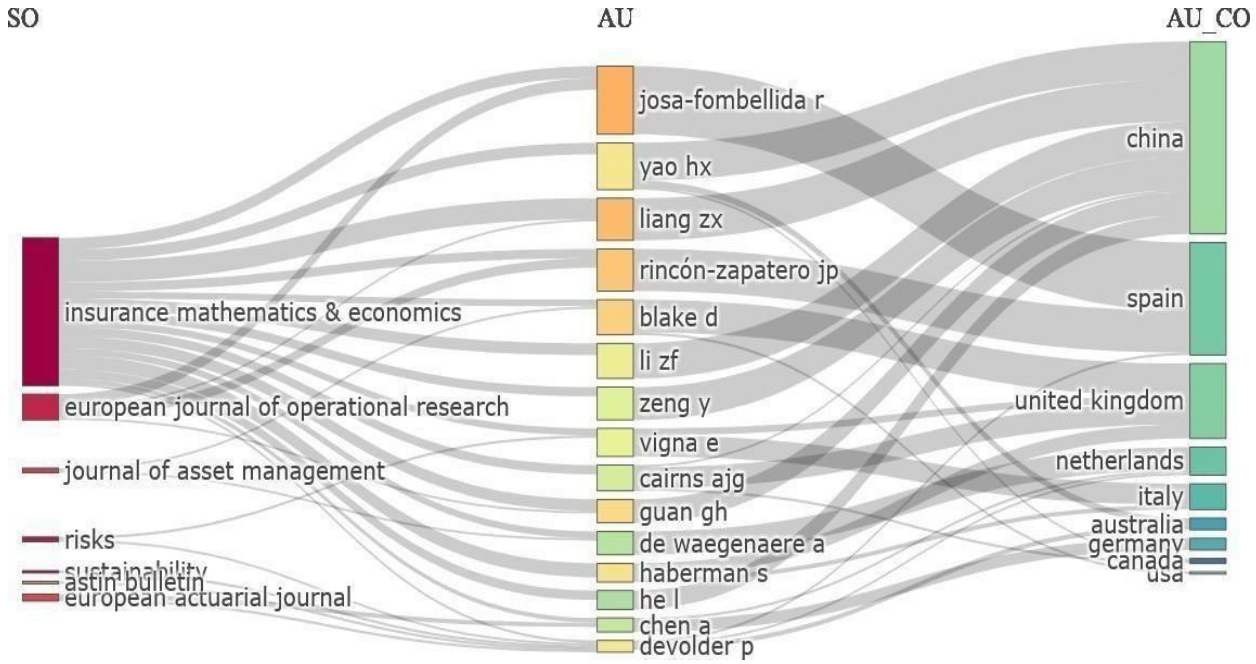

Figure 7 Three-field plots.

In Figure 8 and Table 6, the blue shade shows the publication intensity of each country, reflecting the level of research output. The thickness of the red line represents the frequency of collaboration. Most importantly, partnerships between China and the United States of America should be strengthened. Notably, China has the strongest partnership with the United States (frequency=14), Australia (frequency=8), Canada (frequency=5), and Germany (frequency=4). The United States of America has also increased cooperation with 18 different countries. Similarly, the United Kingdom has increased its engagement with 11 different countries with the least frequency. Italy and Spain have collaborated with 8 different countries with no repeat. Asia and North America have the strongest partnership relationships, followed by Australia.

Figure 9 highlights the linkages and collaboration between institutions. Concerning the geographical distribution and the relevance of this study for the bibliometric analysis. Tilburg University has published 13 papers that have been cited a total of 161 times, with a total link strength of 216. Tsinghua University, on the other hand, has published 12 articles that have a total

of 232 citations and a link strength of 288. The University of Valladolid has contributed 12 papers, with 220 citations and a total link strength of 220. Heriot-Watt University contributed 9 papers with 163 citations and a total link strength of 191. The Renmin University of China has contributed 8 papers with 47 citations and a total link strength of 233.

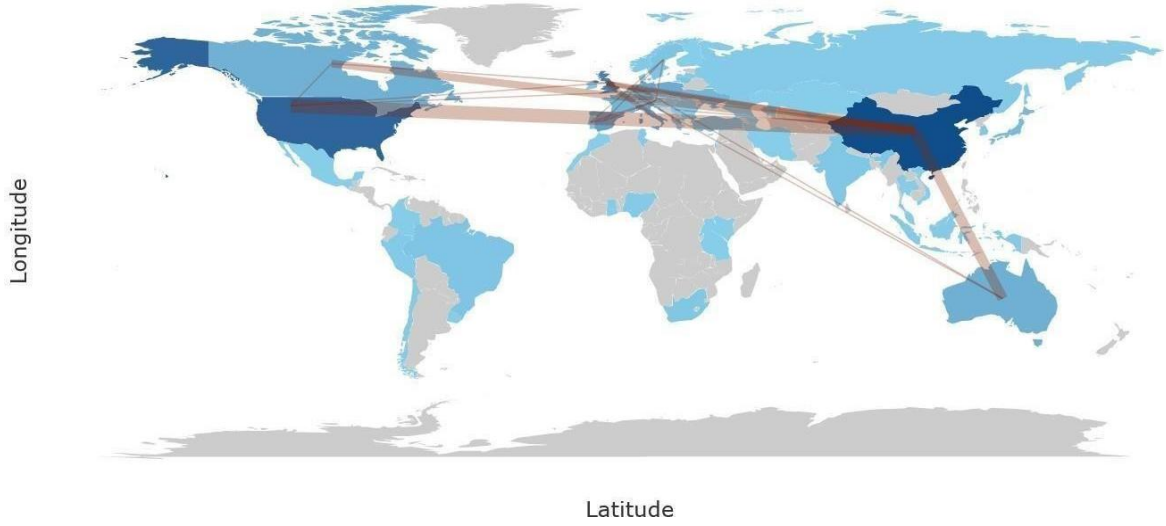

Figure 8 Illustrates international research collaboration in original investigations.

Table 6 Top 10 research collaborations of countries.

From	To	Frequency
China	USA	14
China	Australia	8
China	Canada	5
China	Germany	4
United Kingdom	Germany	3
United Kingdom	Italy	3
China	United Kingdom	3
Australia	Belgium	2
China	Serbia	2
Germany	Australia	2

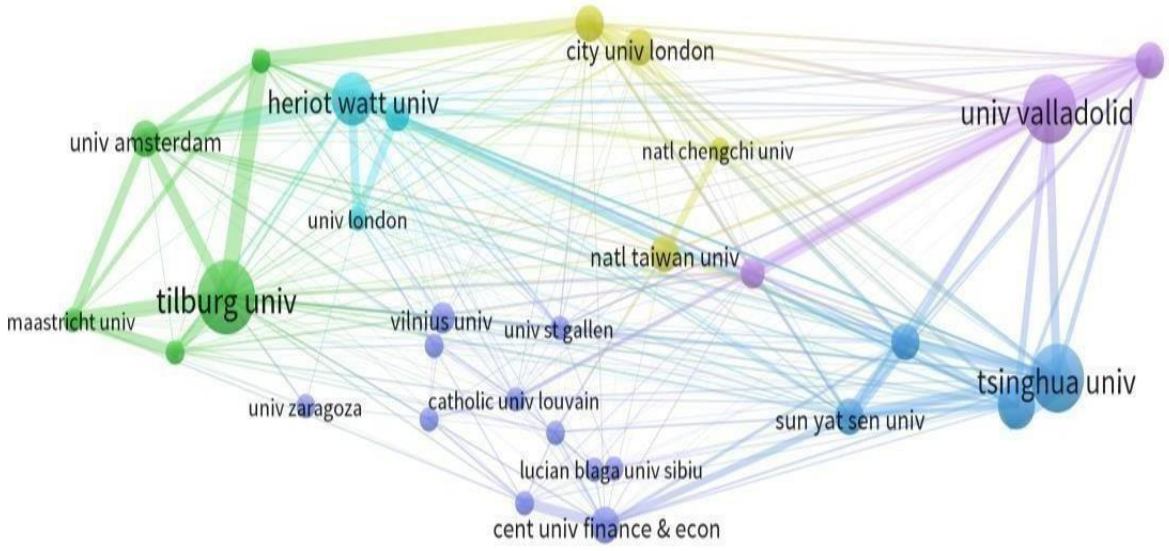

Figure 9 Relevance and collaboration among authors from various universities.

4.3. Scientific mapping based on frequency

The focus of this research is on the intellectual interconnections and structural links with the research topic. This is done with the help of scientific mapping methods such as the analysis of co-quotations, the analysis of co-words, and the analysis of co-authorship. Figure 10 illustrates the 50 most frequently used terms, while.

Figure 10 Word cloud.

Figure 11 shows their co-occurrence with a frequency of five or more, providing valuable insights into the field of research. The word cloud analysis provides an overview of the primary research areas, with "risk" standing out as the most frequently used term, followed by "management"," "social security" and "model" Even though my study term is pension scheme and investment, the pension trends are now referred to as risk. The total number of keywords in the publications is 691, with "risk" being the most important term in recent years of research.

Using VOS viewer, a co-occurrence network analysis was performed on the top 1728 terms plus author keywords derived from the keywords retrieved from 547 documents. The network analysis shows numerous clusters within the network, each marked by different colors, with a frequency of ≥ 5 in keyword clustering. The size of the circular node on the map corresponds to the frequency of occurrence of the author's keyword, while the distance and thickness of the lines connecting the keywords indicate the strength of their relationship. In addition, the total distance between the keywords indicates their correlation, with a shorter distance indicating a stronger connection. The color of the node indicates its affiliation to a particular cluster. Each cluster is linked to a thematic focus, which is described by the keywords and their connections to each other.

The yellow cluster includes terms like pension funds, scheme, definite contribution, corporate governance, performance, private PF, and public PF. The blue cluster is centered on terms like pension reforms, pension policy, sustainability, and retirement. The orange cluster is linked to the terms pension system, social security, and poverty. Pension, financial literacy, annuity, and savings are all part of the green cluster. The red cluster is centered on investment concepts like dynamic programming, stochastic optimum control, and stochastic interest rates. The remaining clusters are made up of phrases used by authors when referring to various pension plans and provisions.

These studies allow scholars to identify key concepts, track trends, and uncover connections within the literature. These observations improve the understanding of key research topics and help to formulate future research approaches (Almeida & Vieira, 2023).

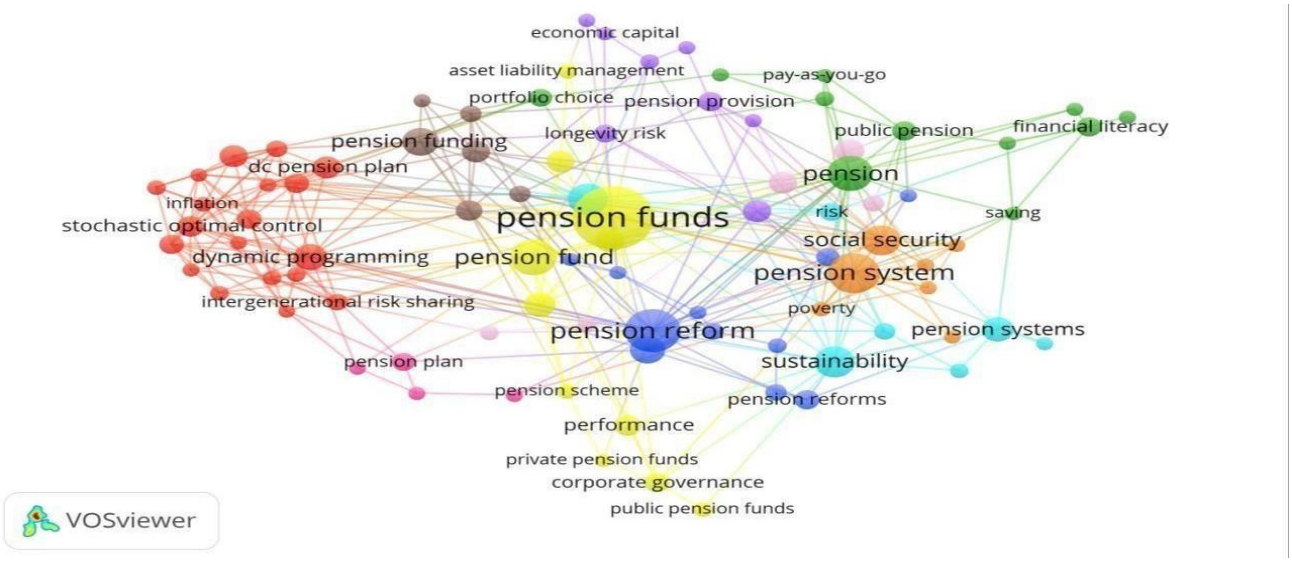

Figure 11 Author keyword co-occurrences.

Figure 12 depicts the progression of term trends over time. From 2003, an extensive collection of earlier articles facilitated the identification of rarely used keywords. In 2018, certain terms began to gain prominence, with concepts such as "risk"," "management" and "model" gaining in importance. In 2017, the predominant terms included "social security'," "consumption" and "asset allocation" From 2021, keywords related to financial management, such as "income'," "rate" and "debt'," are expected to gain popularity. In 2022, the most often used terms, such as "age," "cost," and "liquidity," also became common. In 2023, phrases like "optimal investment" were trendy.

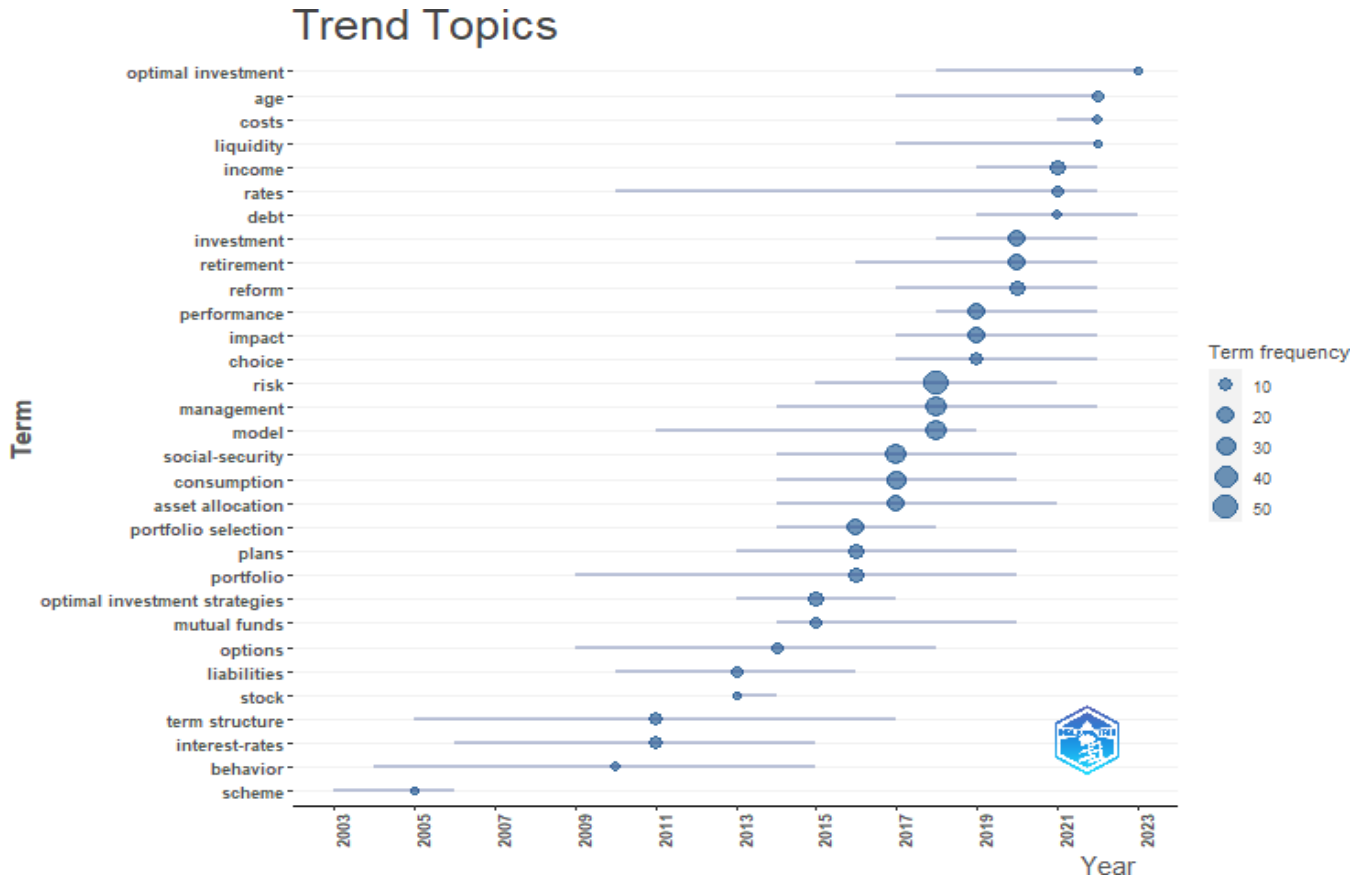

Figure 12 Trend topics. *Source:* WEB OF SCIENCE

Co-citation analysis is a tool for mapping a research field's intellectual structure by identifying papers that are frequently cited together, showing theme commonality. Co-citation analysis reveals underlying themes and provides insights into the field of study by examining how frequently publications appear together in the reference lists of other articles. This analysis not only identifies influential publications but also delineates subject groups within the field (Almeida & Vieira, 2023). Figure 13 represents the co-citation network. Examining the co-citation map provides a comprehensive understanding of the links and associations between the most frequently referenced sources and leads to the identification of four clusters that correlate strongly with each other. These clusters are formed based on a frequency threshold of m ≥ 4 for their construction. The first cluster, with 19 blue nodes, represents the most cited publications and the most prominent writers on the subject of optimal investment strategy and risk measurement of the contribution pension system. The second cluster is orange in color and has 6 nodes where authors on the subject of pension system and reform are cited papers. The third cluster is green, and authors in the field of optimal risk management in pension are cited papers with 6 nodes. The fourth cluster is violet, and authors in the field of pension funds are cited papers with 8 nodes. The fifth cluster is red, and authors in the field of optimal risk management in pension are cited papers with 12 nodes.

Figure 14 and Table 7 show that the countries with the most research, China, the United States of America, and the United Kingdom, were the top countries producing scientific articles, followed by many countries producing. The analysis of Figure 14 reveals that China has the highest scientific production of 173 articles during 28yearsThe United States of America produced 128 articles. The United Kingdom has 92 articles produced, Spain has 60, and the Netherlands has 59, with other countries producing more than 30. The majority of pension scheme investing research is conducted in Asian and North American countries. China has a high life expectancy.

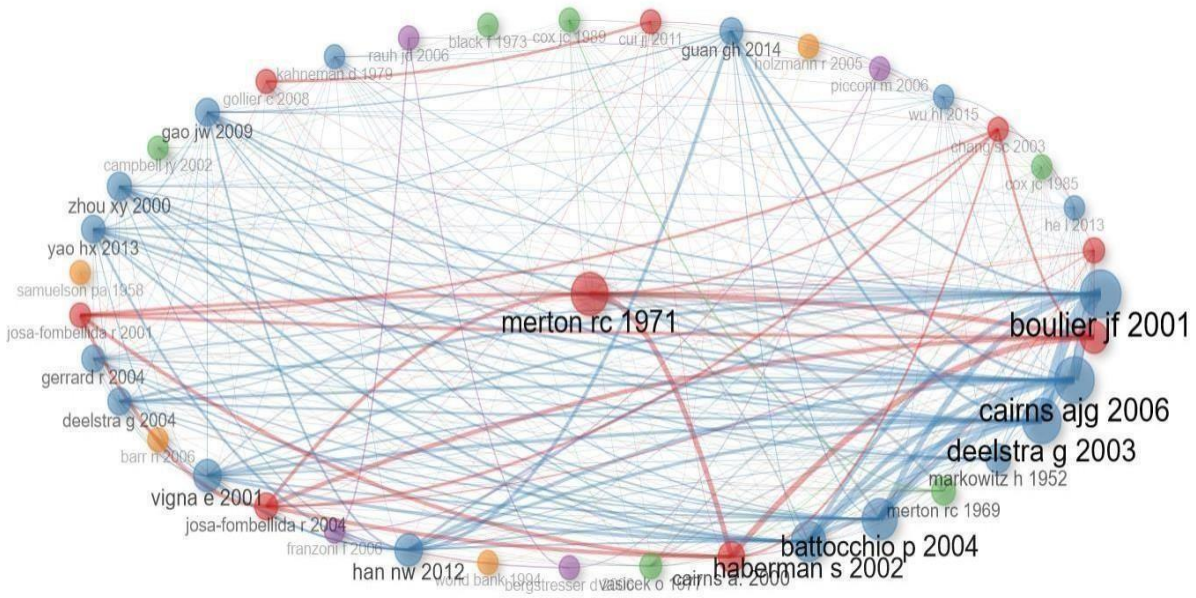

Figure 13 Co-citation network.

Figure 14 and Table 7 show that the countries with the most research, China, the United States of America, and the United Kingdom, were the top countries producing scientific articles, followed by many countries producing. The analysis of Figure 14 reveals that China has the highest scientific production of 173 articles during 28yearsThe United States of America produced 128 articles. The United Kingdom has 92 articles produced, Spain has 60, and the Netherlands has 59, with other countries producing more than 30. The majority of pension scheme investing research is conducted in Asian and North American countries. China has a high life expectancy.

Table 7 The frequency of the country scientific production articles.

Region	Freq
China	173
USA	128
UK	92
Spain	60
Netherlands	59
Italy	48
Germany	40
Australia	33
France	33
Poland	31

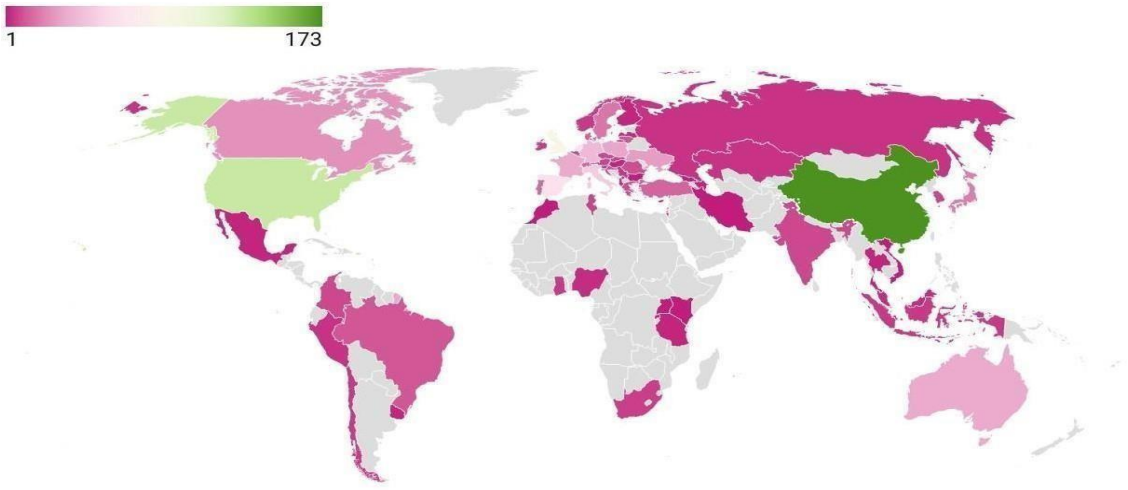

Figure 14 Country scientific production. *Sources:* WEB OF SCIENCE

The research conducted a bibliometric assessment of the existing literature on pension schemes and public investment in the field of behavioral finance. It examined the evolution and intellectual framework of research growth in this field, identified thematic areas to guide future studies, and analyzed how research trends have evolved. The study used a bibliometric literature review approach and analyzed the data to effectively address its objectives.

Various keyword analysis methods were applied to analyze publications, citations, authorship trends, and keyword occurrence, along with an overlay visualization of keyword co-occurrence, using bibliometric data from the Web of Science database, which includes 4,123 publications. In addition, the study identified the most influential annuity publications, citations, authors, institutions, and countries. In addition, the report tracked the development of research in the fields of pensions and investments from 1995 to 2023. By using comparable terms, the analysis also revealed topic areas within the field of pension schemes and investments throughout the study period.

The study discovers that the volume of research in the field of pension schemes and individual investment trends for life security has expanded in the investigated year. They do, however, indicate a fluctuation in annual growth, although this does not affect the development of pension schemes. Evern has been increasing its fellow chart from 2011 till the present. The most papers were published in 2022, with 55 publications, and it has 560 citizens. The analysis also discovered that the overall number of articles cited is 2599, whereas the number of articles cited without self-citation is 2377. The number of times cited is 4328, the number of times cited without self-citation is 3593, and the average per item is 7.01%. J. Boulier and P. Battocchio are the most referenced writers in the optimal pension management research paper, which was published in Insurance Mathematics & Economics.

Based on Bradford's criteria, the top journals in which these articles have been published are Insurance Mathematics & Economics, which has 865 articles with an h-index of 41 and a g-index of 27. The Journal of Finance includes 520 articles but is not included in the index, as is Bradford's law rank list. At the time, the most productive journals were identified to be in the upper quartiles of Web of Science. The top three journals, according to Bradford's law, are the Insurance Mathematics & Economics, Sustainability, and Risks.

The author with the most publications is Josa fombellida R, who has 11 articles in h-index 8, g-index 11, and citations of 220, followed by Liang ZX, who has 10 articles in h-index 6, g-index 10, and citations of 200, and Rincon-Zapatero JP, who has 8 articles in h-index 8, g-index 8, and citations of 218. The findings also reveal the presence of significant collaborative networks among authors with expertise in this topic.

Further to the analysis, China generated 81 products with SCP (Single country publication) 59 and MCP (Multiple country publication) 22, the United States produced 62 articles with SCP 47 and MCP 15, and the United Kingdom produced 47 articles with SCP 37 and MCP 10. These are the nations that produce the most in the globe. The three-field graph then shows a clear perspective of the country, author, and journal production. The highest cluster in this is Chinese author Liang ZX wrote articles in Insurance Mathematics & Economics, followed by Spain author Josa fombellida R published works in Insurance Mathematics & Economics. China has the highest level of collaborative production with the United States at frequency 14, followed by China with Australia at frequency 8, and China with Canada at frequency 5.

The contribution of institutions was also taken into account, with Tilburg University in the Netherlands having 13 papers with 161 citations and Tsinghua University in China having 12 papers with 232 citations, followed by University Valladolid in Spain having 12 papers with 220 citations. Another result shows a word cloud with the most frequent risk term in the text and then the author keyword co-occurrence is pension funds. Finally, an examination of the most recent trends in pension scheme research reveals that one of the most current themes is Optimal Investment.

The poll showed that Boulier is the most frequently mentioned author, followed by Carins AJG and Merton RT. Finally, the scientific production of the countries shows a clear picture of the study, with China producing the most articles (173), the United States producing 128 articles, and the United Kingdom producing 92 papers in the field of pension schemes and their investment-related titles.

5. Conclusion and Direction for Future Research

This study illustrates the different perspectives from which a topical issue such as pension schemes and investments can be explored using relevant bibliometric methods. It has been fascinating to observe how the academic community's interest in pension schemes, which has fluctuated since the first paper was published in 1936, has grown rapidly in recent years. Furthermore, it has been fascinating to observe the evolution of the topic under study, which has evolved from the initial concerns about life expectancy and population aging to the current focus on the long-term sustainability of pension schemes.

This article advances the theoretical framework of pension scheme research by helping scholars identify key research topics and potential areas for further exploration. These areas include pensions for transgender individuals, community-based pension services, household pension arrangements, and insurance provisions for children's pensions.

The integration of three prominent bibliometric tools, namely Datawrapper, VOSviewer, and Biblioshiny, is a remarkable enrichment of this study. This innovative approach to bibliometric analysis, which usually relies on the use of one or two tools, represents a significant added value.

The key contribution of this study is the insights it offers on trends in pension schemes and investment research. Developing new financial systems to ensure the sustainability of pensions is crucial for the aging population. Despite numerous reforms, their implementation and impact are still not well-researched or understood by the public. Therefore, it is important to focus efforts on this area. Addressing these challenges requires reforms, the development of supplementary pension schemes, and the introduction of modern financial instruments such as unit-linked products.

Identifying current trends and topics that no longer captivate academics will facilitate the discovery of new avenues for researching pension schemes and simplify the research process.

This study provides an in-depth examination of researchers' escalating concerns about pension schemes and investments. Consequently, it allows for the review of changing key themes over the period studied. These thematic shifts were closely linked to societal anxieties at each point in time. They ranged from issues such as early retirement or life expectancy at the end of the twentieth century to today's focus on the sustainability of the pension scheme.

This study has limitations that may require further investigation. The exclusive use of the Web of Science database in this study suggests that future research could incorporate additional databases such as Google Scholar or Scopus. Alternatively, a study could integrate data from both the Scopus and Web of Science databases, bearing in mind that a larger database may require refinement of the research focus. Broadening the scope could include examining types of documents other than journal articles, particularly books that contain valuable insights into pension scheme research.

In addition, the scope of this study can be expanded to examine a specific country or to explore research areas such as behavioral science or public administration in greater depth. Focusing on a single keyword, such as "pensions", could also be viable. To identify patterns across the research landscape, it could be beneficial to use multiple keywords such as "optimal investment"," "optimal management" and "optimal strategy" in the analysis.

Ethical Considerations

Not applicable.

Conflict of Interest

The author declares no conflict of interest.

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