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Research Article

Bibliometric Insight into Artificial Intelligence Application in Investment

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Abstract:

This study explores the key trends and ideas around using artificial intelligence in investment. The authors employ the bibliometric approach, using VOS viewer software to analyze 582 academic articles from the SCOPUS database between 2004 and 2023. The findings show that interest in artificial intelligence within investment has grown since 2017, reflecting a delay in its adoption by the investment industry. China, the United States, India, and the United Kingdom were identified as the leading countries researching this topic. The National Research University Higher School of Economics, Russia, and Spiru Haret University, Romania emerged as the most active institution in this area. It highlights the growing adoption of AI across various financial institutions, including banks, hedge funds, and fintech firms, due to its ability to analyze extensive datasets, enhance decision-making, and optimize portfolios. Key AI-driven, cost-effective investment advice. These technologies outperform traditional advisors' inefficiency and objectivity but face challenges in gaining trust among seasonal investors. However, the study has limitations, as it only used articles from the SCOPUS database and focused solely on English–language publications. The future directions emphasize the integration of AI with sustainability and natural language processing, reflecting its potential to address broader societal challenges. The study underlines that extensive regulatory frameworks, improved collaboration, and user-centric AI solutions are required to optimize its influence on investment practices.

1. Introduction

Industries and societies are disrupting and transforming due to the growing application of artificial intelligence (AI) in financial systems [1, 2]. Many financial organizations are investing significantly in acquiring data science and machine learning (ML) capabilities. These firms range from classic hedge fund management firms and investment and retail banks to modern financial technology (FinTech) service providers [2,3]. AI is used extensively in trading, investment management, and portfolio optimization due to its distinct data analysis, decision-making, and risk management capabilities[4]. This paper will examine the opportunities and challenges associated with incorporating AI into the investment arena to show how it can promote innovation and enhance investment performance. Artificial Intelligence (AI) has a significant benefit in investment management because of its capacity to evaluate extensive datasets from many sources, such as financial reports, market trends, and economic indicators. Algorithms driven by AI can see trends, identify abnormalities, and produce data-driven forecasts that help guide investment choices [5]. This may enhance the efficacy and precision of investment tactics, culminating in increased profits and enhanced risk mitigation. Using their financial objectives, risk tolerance, and financial circumstances as a guide, robo-advisors help investors make investment choices. Robo-advisors are intended to function similarly to human advisors, if not better, by utilizing artificial intelligence and mathematical algorithms. Because Robo-Advisors follow certain guidelines, their investing performances are successful and unbiased because they are less emotionally influenced and more objectively driven than human financial advisors [6]. The Robo-Advisors will automatically create an appropriate asset allocation strategy based

on personal investment preferences such as the initial capital and time horizon[7]. To put it briefly, Robo-Advisors use economies of scale to provide investors with more affordable services and sounder advice.

Several asset management firms, including Merrill Lynch, Goldman Sachs, and Charles Schwab, have shifted to offering technology-based investment advice through robot advisors and artificial intelligence (AI) in response to the shifting landscape and technological advancements [8]. According to reports, the global asset management under Robo Advisory was valued at $30 million in 2015. By the end of 2020, it is anticipated to reach $500 million globally. The data clearly shows that Robo advising is stealing market share from competitors in addition to guaranteeing a competitive edge. By increasing a company's income and offering its clients more value, artificial intelligence (AI) presents a huge opportunity for the financial services and asset management industries [9].

Although there are several drawbacks, robo-advising services have certain benefits, such as minimal investment costs and round-the-clock access. However, research indicates that there is a relatively limited uptake of robot advising services [10]. Robo-advising services have replaced the conventional methods of providing financial and asset management services for a small fraction of clients, primarily those who are too young investors [11]. As far as investing through this fintech application is concerned, this very clearly illustrates the lack of trust and confidence among seasoned investors [12]. In light of the above facts, there is enormous space for studies that can help the managers of Robo advisory firms attract potential customers and retain existing ones.

1.1 Artificial Intelligence

Artificial intelligence technology is the ability of computers or computer-controlled robots to do activities relating to entities in general, as opposed to natural intelligence. The technology used to construct these computer-controlled robots mimics human thought and behavior[13]. The term “artificial intelligence” refers to creating technology gadgets with mental skills like perception and communication [14].

According to another definition, artificial intelligence is a machine that uses programming to perform mathematical and logical operations on computer systems. By mimicking human behavior, artificial intelligence technology builds intelligent machines. According to the definition, smart machines are those that act, think, and make decisions similarly to humans. When given a task, artificial intelligence does not require a definition; rather, it is described as a technical machine that generates machines using programming and algorithms that operate independently [14].

1.2 Investment

Investment is a term used to describe the idea of postponed consumption, which is the act of making an asset purchase, extending credit, or holding money in a bank account to earn returns in the future. An investor is a person who, to make a profit, invests in one or more asset classes, including debt securities, real estate, commodities, currency, and derivatives like put and call options. Investment decisions are based on several factors: goals, risk tolerance, and investment type. It has been noted that technical and fundamental analysis is done before investing and that most of the time, investors lose patience since their emotions are usually in the way [15]. Artificial intelligence is one of the most crucial components influencing decision-making [16].

1.3 Research Questions

The two research questions were addressed using bibliometric analysis, and one question was included in the systematic literature review. The study aims to answer the following questions: (1) What are the key themes, co-authorship trends among countries, and frequently used keywords in the context of this topic? (2) what findings emerge from a critical examination of previous studies in this field (3) What are the potential future directions for the " artificial intelligence and investment’’ research field?

The first question was addressed by formulating the following research objectives: analyzing the growth of the artificial intelligence and investment literature (2004–2023); studying the countries that the corresponding author felt were most relevant; identifying the ten most relevant institutions; locating the ten most relevant journals; identifying the most pertinent authors; and analyzing the ten academic articles that were most frequently cited; what is the trend of co-authorship among writers?; the co-authorship network of key authors and the 10 most key authors based on co-authorship were examined and we looked at the top keywords utilized in publications and the co-occurrence networks of those terms. The second question shows what findings emerge from critically examining previous studies in this field. Finally, it makes predictions of the potential future directions

for the " artificial intelligence and investment'' research field.

2. Methods

Financial organizations may now examine and make decisions in areas like risk assessment, trade and investment, credit scoring, and fraud detection thanks to artificial intelligence, which is significant to the financial sector. To achieve the goal of providing the most comprehensive coverage of peer-reviewed artificial intelligence and investment, a literature search was carried out using the SCOPUS database. This study incorporates both systematic review and bibliometric analysis. Our research follows several earlier studies by using a bibliometric (quantitative) approach [17]. The bibliometric technique focuses on two primary objectives: (1) scientific mapping tools to explore the relationships between the research domains, and (2) performance analysis to assess the influence of research domains on the study. Applying bibliometric analysis, according to studies in the literature [18, 19], allows researchers to look into the intellectual framework of a particular field in the literature as well as uncover new patterns in the performance of articles and journals, patterns of collaboration, and research components. Figure 1 shows data refinement and extraction process. Table 1 is the search criteria and article selection.

2.1 Information Extraction Strategies

Key Selection Strategy

The core selection method and refining are the most important steps in the search process.

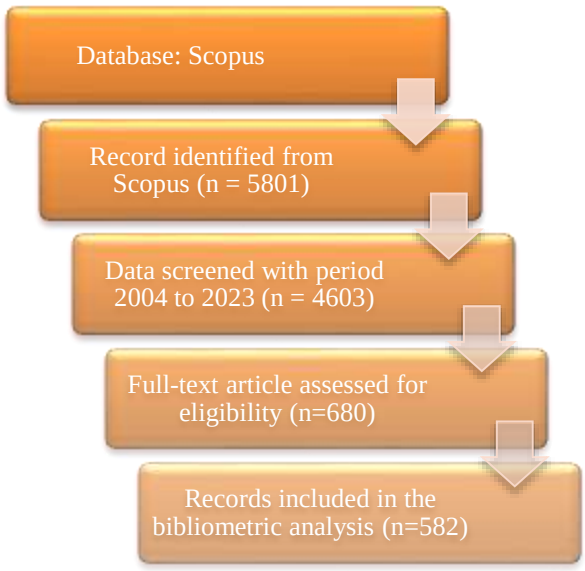

Figure 1. *Data Refinement and Extraction Process.*

Table 1. *Search criteria and article selection*

Filtering criteria	Reject	Accept
Search Criteria		
Search engine: Scopus		
Search term: (''artificial intelligence'' OR ''AI'' OR " Robo advisors " AND " Investment")		5801
Year: 2004 – 2023 (2 decades)	1198	4603
Subject area: ''Business, management and accounting'', ''Economics, econometrics and finance'', ''Social sciences',," psychology" and ''Arts and humanities''	3322	1281
Document type: "Articles" and Reviews"	569	712
Article selection: Language verification: Add only English language documents	32	680
Content filtering: Articles should be included if their "Titles, abstracts, and keywords" demonstrate their applicability to the study's focus (Artificial Intelligence and investment).	98	582

Using a methodology similar to that of Alshater et al. [20], We used the following keywords to look for articles: ''artificial intelligence'' OR ''AI'' OR " Robo advisors " AND " Investment".Using this method, we could categorize the different research streams and potential areas for future research, allowing us to assess the literature on machine learning and finance extensively. The keyword, abstract, and article title boxes were used for the search. Search results showed 5801 articles.

Range Language, Subject Area, and Document Type.

In August 2024, the literature search was completed. We collected articles from 2004 to December 2023, where 4603 research publications were screened and extracted, and 1198 that didn't meet this condition were removed. Further, screening process criteria were taken as a subject area, (''Business, management and accounting'', ''Economics, econometrics and finance'', ''Social sciences," psychology" and ''Arts and humanities''). This filtering resulted in the inclusion of 1281 documents and the exclusion of 3322 studies. We also chose review papers and articles in the fields of the above-mentioned subject areas, including 712, and removed 569. Using languages as the criterion for data filtering, the researchers reduced the number of publications to 680 that were authored in English for the final screening stage. Of these, 32 were not in English.

Data Refinement Process

Since bibliometric data are frequently taken directly from the database, the researcher must clean the data by the study's objective [18]. After screening the data, the extracted research papers were marked for systematic scrutinizing. Data quality improvement was done based on the eligibility standards selected by the researcher. This means articles should be included if their "Titles, abstracts, and keywords" are directly related to Artificial Intelligence and Investment, it consists of 582 documents and removed 98 papers.

Software

This work uses VOS viewer software to create and view bibliometric maps [17]. It is a famous and widely used option for research on bibliometrics [17]. Researchers can use this method to view the dynamics and organization of earlier research on machine learning and financial challenges [21, 18].

3. Results and Discussion

The results of this analysis are covered in this section. It is divided into 3 sub-sections according to the research questions. Section 3.1 presents the key themes in artificial intelligence and investment, trends in co-authorship among countries, and the co-word analysis. Additionally, section 3.2 shows a systematic review of the literature. Finally, section 3.3 predicted potential future directions for the area of research "Artificial intelligence and investment.''

3.1 Key Themes in Artificial Intelligence and Investment

Table 2 displays general information about the input data used in the analysis. Between 2004 and 2023, 582 articles on artificial intelligence and investment subjects were found using our search. There were 1710 authors in total, 104 of whom carried out the study on their own, resulting in an average of 0.34 documents per author. Out of the total, just 6.77% were review articles. Over time, the average number of citations per document has been 20.74, which seems quite high. Because of this, it is expected that as more academics become interested in this field, the total amount of work published and cited about artificial intelligence and investment will increase.

Growth of Artificial Intelligence and Investment Literature

Figure 2 shows the annual growth in published documents from 2004 to 2023. Although artificial intelligence and investment studies have a history

Table 2. *General information*

Description	Result
Period	2004 - 2023
Documents	582
Average citation per document	20.74
Document Average Age	3.34
Document Type	
Article	545
Review	37
Authors	
Authors	1710
Authors of single-authored documents	104
Authors Collaboration	
Single-authored docs	106
Co-Authors per Doc	3.11
International co-authorships %	25.95

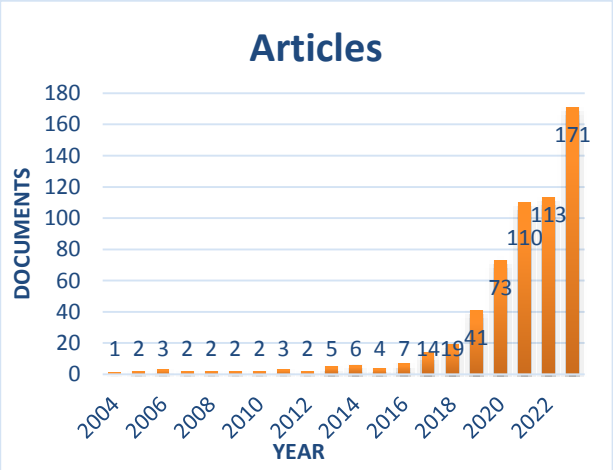

Figure 2. *Document growth per year.*

dating back to the 1950s, a literature review suggests that the distribution of published documents was relatively low before 2017 due to the minimal progress in this field. From 2017 onwards, the study has been the subject of increased investigation.

A revolution in deep learning, leading to unprecedented advancements and massive investments from tech giants and venture capitalists, advances in computing power, and the creation of sophisticated algorithms. A growing demand for data-driven solutions and an increasing interest in artificial intelligence (AI) are projected to fuel the peak annual growth rate of artificial intelligence research in investment in 2023, which displays the maximum amount of around 171 documents in this field.

The Most Relevant Countries by The Corresponding Author

The number of published documents from different countries during the same period is shown in Figure 3. These represent only the countries of the

corresponding authors, not those of the other co-authors. According to Figure 3, China is the largest contributor to artificial intelligence and investment, with the USA and India in second and third place, respectively. UK and Spain hold the fourth and fifth positions. Strong government support, substantial financing, a tech-focused educational system, and a sizable digital environment that provides a huge amount of data are the main causes of China's dominance in AI and investment articles. This study reveals, surprisingly, that research in the field has been growing exponentially in developing countries such as China, India, and South Korea. This indicates that these countries can keep up with its technological advancements, have less stringent data protection laws, and have wide access to a variety of financial data types.

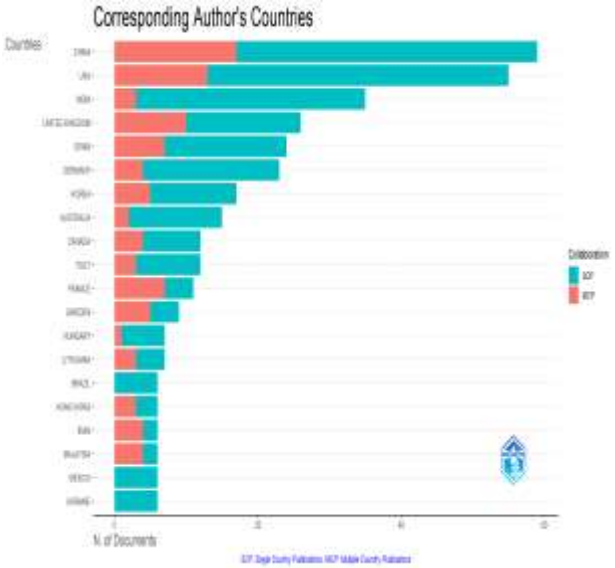

Figure 3. *Most relevant countries by the corresponding author.*

The Five Most Relevant Institutions

Based on the quantity of articles released and the affiliations of the contributing authors, Table 3 enumerates the top five productive institutions. The following institutions are listed along with their countries of origin. National Research University Higher School of Economics (Russia), Spiru Haret University (Romania), Kaunas University of Technology (Lithuania), The University of Manchester (United Kingdom), University of Granada (Spain),

Interestingly, China producing the most prolific contributions in artificial intelligence and finance (Figure 3). But in the first five institutions no one from China. National Research University Higher School of Economics, Russia, contributed the most contribution. Spiru Haret University, Romania held the second position of article contribution. Following, three institutions (the Kaunas University of Technology, The University of Manchester, and the University of Granada,) produced the same number of articles. Table 3 provides academics, business experts, and prospective students with a list of relevant universities with the facilities and experience needed for artificial intelligence and investment in research.

Table 3. *The five most relevant institutions*

NO	Affiliation	Articles
1	National Research University Higher School of Economics, Russia	11
2	Spiru Haret University, Romania	10
3	Kaunas University of Technology, Lithuania	9
4	The University of Manchester, United Kingdom	9
5	University of Granada, Spain	9

Ten Most Relevant Journal

Table 4 lists the most relevant journals that publish works in artificial intelligence and investment. If writers want to publish in this field, they can choose among the journals listed here. John Wiley & Sons Ltd, Springer Netherland, MDPI and Institute of Operations Research, and the Management Sciences publish the top ten journals. Elsevier owns five of the top ten journals, while the Emerald Group owns one. We also observed that the journals published by Elsevier "Technological Forecasting and Social Change", "Decision Support System and Knowledge-Based System", and "Journal of Behavioural and Experimental Finance and Resources Policy", all of which were ranked Q1 in Scopus. Only one Q2 journal was published by Springer Netherland out of ten journals. Also, the highest H- Index on the list is found in these journals. Since 2017, the expanding field of technology has also raised interest in artificial intelligence and investment research for publication prediction. As a result of the search being restricted to specific relevant keywords (artificial intelligence OR AI OR Robo advisors and Investment) and journals limited to Business, management and accounting, Economics, econometrics and finance, social sciences, psychology, and Arts and humanities, it is observed that half of the publications (table 4) were technology-based journals and the remaining were non-technology-based journals. For new scholars in the field, the top ten sources of articles can serve as a guide. Furthermore, it will assist scholars in locating a publisher for their works in related fields. Because it offers a useful examination of the use of artificial intelligence and finance, including investing and predicting, the work can be used as a further reference by other researchers.

Table 4. *The ten most relevant journals.*

Rank	Sources	No of articles	JH-index 2023	SJR 2023	Publisher
1	"Sustainability" (Switzerland)	13	169	Q1 0.67	Multidisciplinary Digital Publishing Institute (MDPI)
2	"Technological Forecasting and Social Change"	14	179	Q1 3.12	Elsevier
3	"Decision Support System"	7	180	Q1 2.21	Elsevier
4	"Knowledge-Based System"	7	169	Q1 2.22	Elsevier
5	"Computational Economics"	6	47	Q2 0.5	Springer Netherland
6	"Journal of Behavioural and Experimental Finance"	6	39	Q1 0.96	Elsevier
7	"Management Science"	5	290	Q1 0.82	Institute for Operations Research and the Management Sciences
8	"Resources Policy"	5	114	Q1 2.06	Elsevier
9	"Strategic Change"	5	42	Q1 0.82	John Wiley & Sons Ltd
10	"International Journal of Bank Marketing"	4	104	Q1 1.33	Emerald Group Publishing.

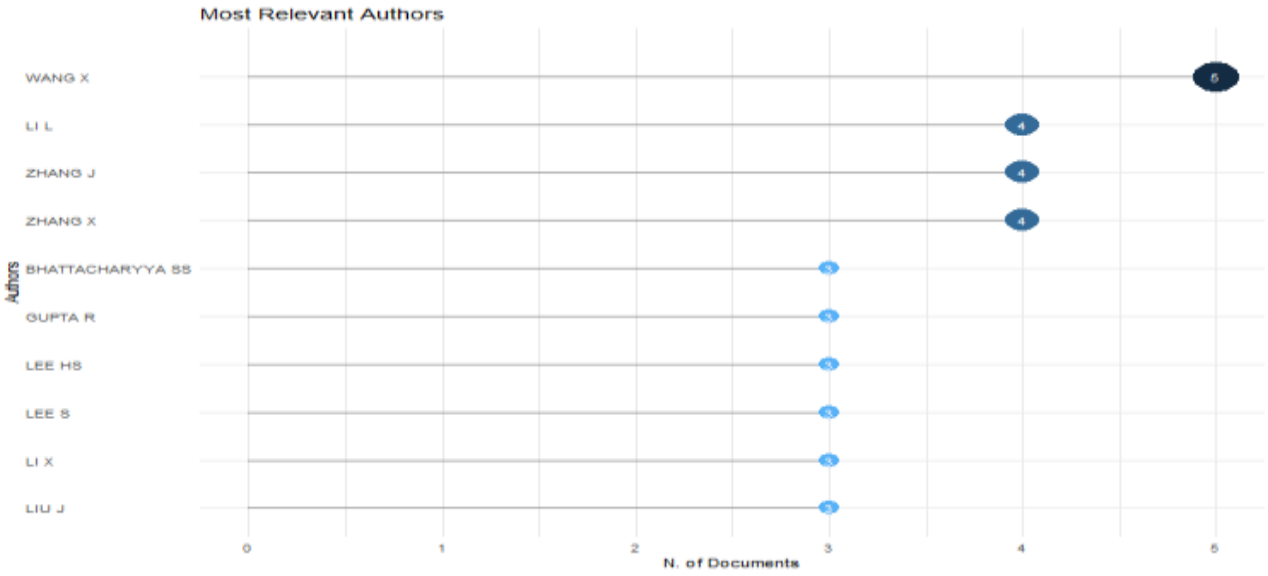

Figure 4. *Most ten relevant authors*

The Most Relevant Authors

Figure 4 displays the most prominent writers who have discussed artificial intelligence and investment. Most authors only produced three articles. This suggests that artificial intelligence and investment in research is still in its early stages. Fintech technologies are expected to be accompanied by significant advancements in artificial intelligence, Rob advisors, machine learning, and investment research in the upcoming years. Moreover, this figure demonstrates the topmost contributors based on the counts of articles produced. The top contributor in this field is Wang X who has published five articles, followed by Li L, Zhang J, and Zhang X they have produced four articles. The remaining six writers out of the top ten, have published three articles by each.

Impact Metrics of Top Ten Authors

To highlight the most prominent authors and evaluate their performance five measures were utilized for analyzing and interpreting the result. In this case, total citations, total publication index, g index, and m index were the metrics that were employed. We may measure the productivity and scholarly work of authors by grouping the h-index, g-index, and m- m-index under the author-level metrics among this group [22]. The volume of research and its level of popularity within the field can be determined by looking at the top citation and publication count.

Table 5. *Impact Metrics of Top Ten Authors.*

Author	h_index	g_index	m_index	TC	NP	PY_start
Li L	4	4	0.364	47	4	2014
Lee Hs	3	3	0.6	48	3	2020
Lee S	3	3	0.429	62	3	2018
Li X	3	3	1.5	24	3	2023
Oh KJ	3	3	0.6	48	3	2020
Park S	3	3	0.5	105	3	2019
Wang L	3	3	0.3	52	3	2015
Wu L	3	3	0.5	208	3	2019
Zhang L	3	3	0.333	36	3	2016
Zhang X	3	4	0.3	41	4	2015

Note: TC= Total citation, PY= Publication year started, NP = Number of publications.

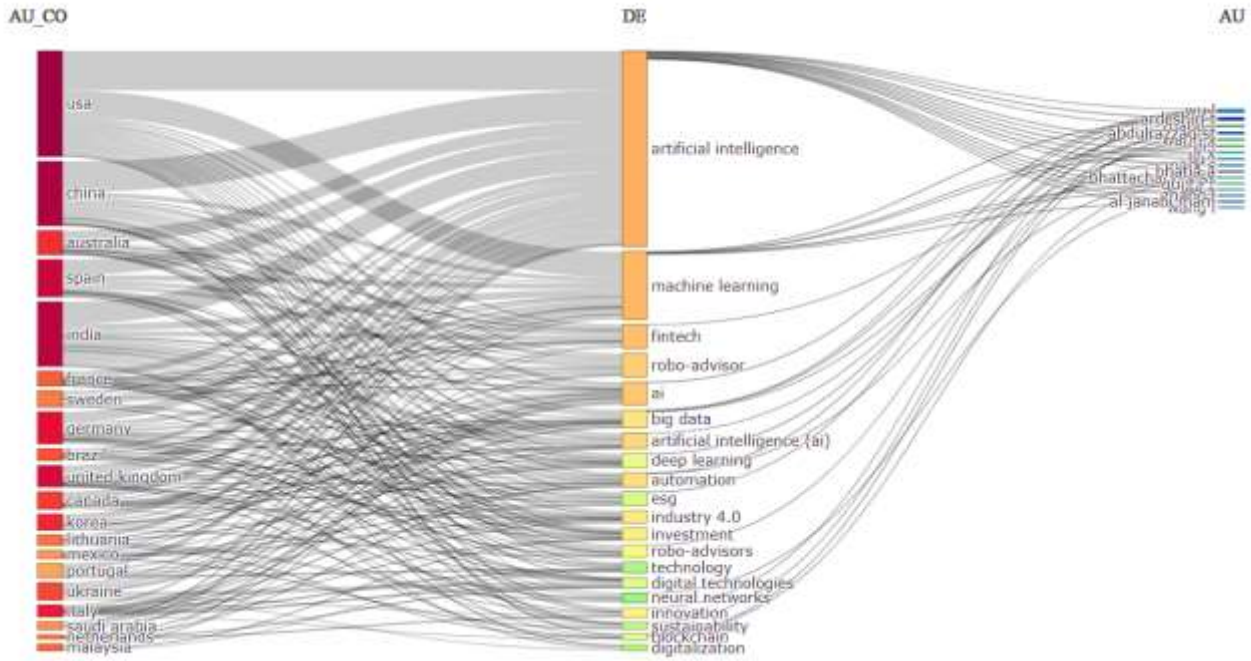

Figure 5. *Three- Field Plots Diagram.*

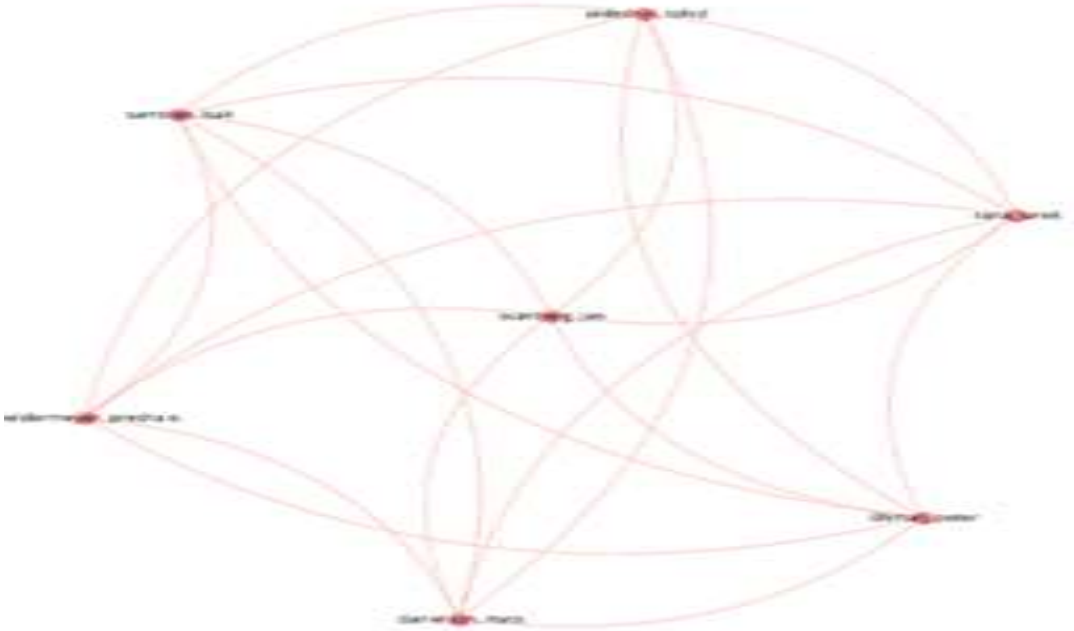

Figure 6. *Co-authorship network of key authors.*

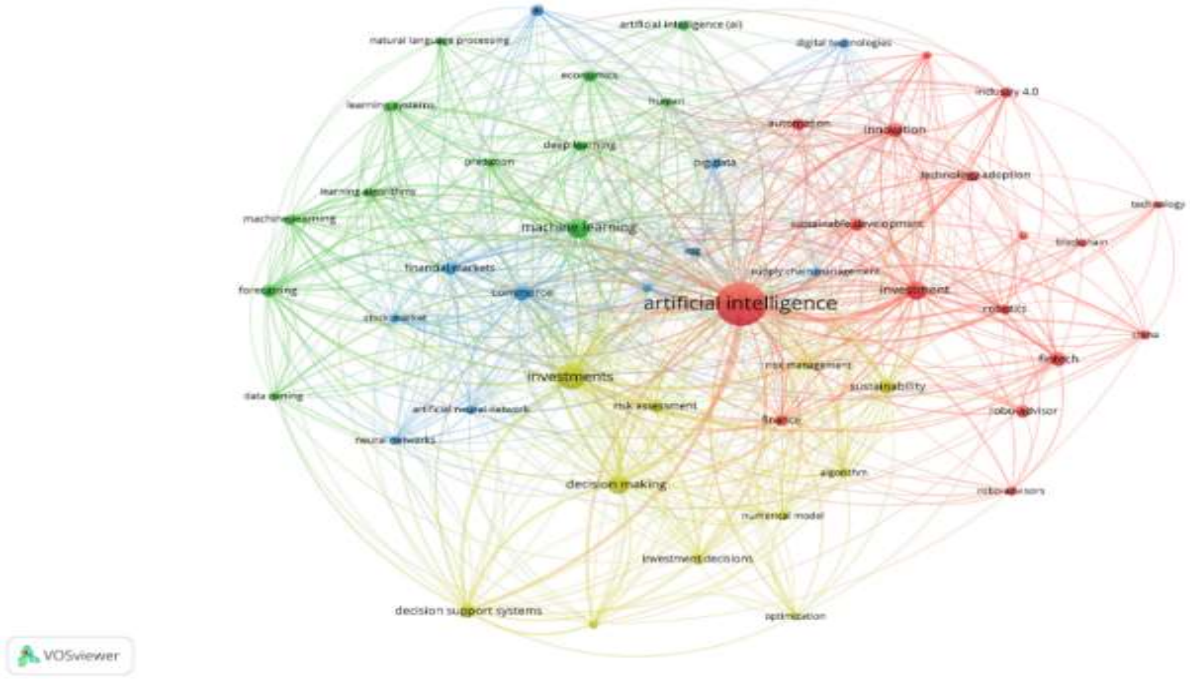

Figure 7. *Co-occurrence network of keywords. The VoS Viewer software is utilized to construct the Co-occurrence network of keywords*

Table 5 shows the ranking of the most significant authors in this discipline based on their h-index and impact factor. Moreover, this table reveals that Li L, the author has four publications in this field with 47 citations. His h-index is 4, pointing out that he is a highly productive author in this field. Further analysis the Table 4 we understand that most of the authors contributed the same number of articles and all the writers have the same h-index. Moreover, Zhang X also contributed four articles, and Wu L has the maximum number of citations, around 208 from this list.

Three- Field Plots

Sankey diagrams represent the interactions between three distinct components; the flow's breadth indicates the nodes' proportional value [23] This three-field plot shows the relationship between the author's countries of origin (AU-CO), Research domains (DE), and individual authors (AU). The author's countries are shown left field, and keywords are middle field, and individual authors are in the right field. For this analysis, the top 20 items were taken, and each of these items has been pointed toward the most significant keywords in this field such as artificial intelligence, machine learning, fintech, and robo-advisor along with countries and authors. Figure 5 shows three- field plots diagram.

Examine this three-field plot, shows that, artificial intelligence studies are the highest, then followed by machine learning, fintech, and robo-advisor. The majority of studies conducted in this field are in the USA followed by China, Australia, and Spain. The graphics show the geographic distribution of contributions as well as the range of study areas. It emphasizes how contributions from different nations and experts are drawn from current topics like AI and finance. Furthermore, the extensive network of connections highlights the global range of developments in AI and related domains by revealing a collaborative and diverse research

Trend of Co-Authorship Among Authors

In this section, we present our analysis of the goal of identifying the intellectual features of the field of artificial intelligence and investment research, along with the key author's co-authorship network and the top ten writers based on co-authorship analysis.

Co-authorship network visualization of key authors

As scholarly collaborations are becoming more common [24] and produce deeper and more distinct understandings [25], our investigation aims to investigate how researchers in the field interact with one another [26, 18, 27]. The minimum number of documents of an author's two of the 1710authors, 47 meet the threshold limit, among them the largest set of connected items consists of seven which is demonstrated in Figure 6.

The Vos Viewer software is utilized to construct the network visualization map.

According to the data, there are very few citations and links between any authors and other scholars in the network. It implies that writers in this field prefer to collaborate with their colleagues at their institutions.

Table 6. *Top ten countries based on co-authorship analysis.*

Rank	Country	Documents	Citations	Total Link Strength
1	united states	118	3470	83
2	United Kingdom	48	1090	50
3	China	65	1183	40
4	India	59	924	27
5	France	20	932	26
6	Australia	26	488	23
7	Germany	39	1049	23
8	Italy	26	765	20
9	South Korea	25	377	19
10	Spain	32	711	19

Key Countries Based on Co-Authorship Analysis

The United States emerges as the leading force in the co-authorship study, which shows a clear hierarchical order in international research collaboration. The US guides the world in research productivity and finance, with 118 publications, 3470 citations, and an 83-link strength. China (65 documents, 1183 citations) and the United Kingdom (48 documents, 1,090 citations) hold the second position in research powerhouses after the US. Both countries reveal substantial international collaboration, as evidenced by their link strengths of 50 and 40 respectively. India ranks fourth with 59 publications, however, there is potential for increased research impact given its low citation count (924).

The analysis also reveals interesting regional variations in research collaboration and efficiency. Despite having fewer publications, European countries such as France and Germany demonstrate exceptional efficiency from just 20 papers, France generated 932 citations, demonstrating high-impact research. Although their citation impacts differ significantly, nations such as Australia, Italy, South Korea, and Spain constitute a group with similar link strength (19- 23), indicating comparable degrees of international collaboration. The data illustrates a worldwide research landscape in which Asian countries (except China) tend to concentrate more on publication volume, whereas Western countries typically exhibit larger citation impacts per document. This suggests that different areas have distinct goals and research tactics.

Co- Word Analysis

The co-occurrence network of keywords and the most often used keywords in publications are the main discussion topics in the co-word analysis conversation. Co-word analysis, according to Donthu et al [18], looks at the true content of a publication. The top ten keywords (table 6), the co-occurrence network of all terms (figure 7), and the map of keyword density in artificial intelligence and investment (Figure 8) are all examined in this study.

Table 7. *The top 10 keywords of publications.*

Rank	Keywords	Frequency	Total Link Strength
1	Artificial Intelligence	289	629
2	Investments	97	410
3	Machine Learning	62	177
4	Investment	50	188
5	Decision Making	49	196
6	Commerce	35	192
7	Fintech	32	75
8	Innovation	30	95
9	Decision Support Systems	29	112
10	Sustainability	26	95

Co-Occurrence Network of Keywords

The minimal occurrence of a keyword is 10, and out of the 582 documents selected for our study, we extracted 3582 keywords, 51 of which meet the threshold. Four clusters in this scientific field are identified by the study based on Figure 7.

Top keywords used in a publication

Table 7 presents the main core keywords associated with the research topic. These keywords were: “artificial intelligence” (289 occurrences and 629 total link strength); “investment” (97 occurrences and 410 total links strength); “machine learning” (62 occurrences and 177 total link strength); “decision making” (49 occurrences and 196 total link strength); “Commerce” (35 occurrences and 192 total link strength); “fintech”(32 occurrences and 75 total link strength); “innovation” (30 occurrences and 95 total link strength); “ Decision support systems” (29 occurrences and 112 total link strength) and “sustainability” (26 occurrence and total link 95)

In Figure 8, we plot the visual density map to visualize the keywords. The graphics help us comprehend that each node has a distinct colour representing the density of the items, ranging from blue to green to yellow. Notably, the keywords highlighted in yellow are more prevalent and have

greater weight. On the other hand, the point's coloration trends to resemble blue with decreasing frequency and weight.

According to the findings displayed in the network visualization of keywords, we determined that the most significant keywords are "artificial intelligence," "investments," "machine learning," "Investment," "decision making" and "commerce", followed by others.

The author's principal term, "artificial intelligence," is demonstrated in Figure 7 and Table 6, corresponding with the primary keywords search performed in this investigation. This work could help future research in this field. Researchers have other options besides "artificial intelligence" such as "machine learning," "fintech" and "decision support systems". To gather additional research on artificial intelligence and investment, the terms "innovation," "commerce" and "sustainability" might be substituted for one another. Furthermore, it is proposed that future studies use machine learning to predict investment concerns based on the keyword density visualization map in Figure 8 [28].

3.2 Systematic review of literature

Overview of previous reviews

Numerous investigations into artificial intelligence have been carried out to examine various viewpoints on the subject from various disciplines. It is evident from Table 8 that most cited review articles discussing AI and investment have been published in the last twenty years. This table shows the author's name, title, year of publication, source, and citation count. Table 9 shows a systematic review of the 20 most cited articles on AI and investment (2004 to 2023).

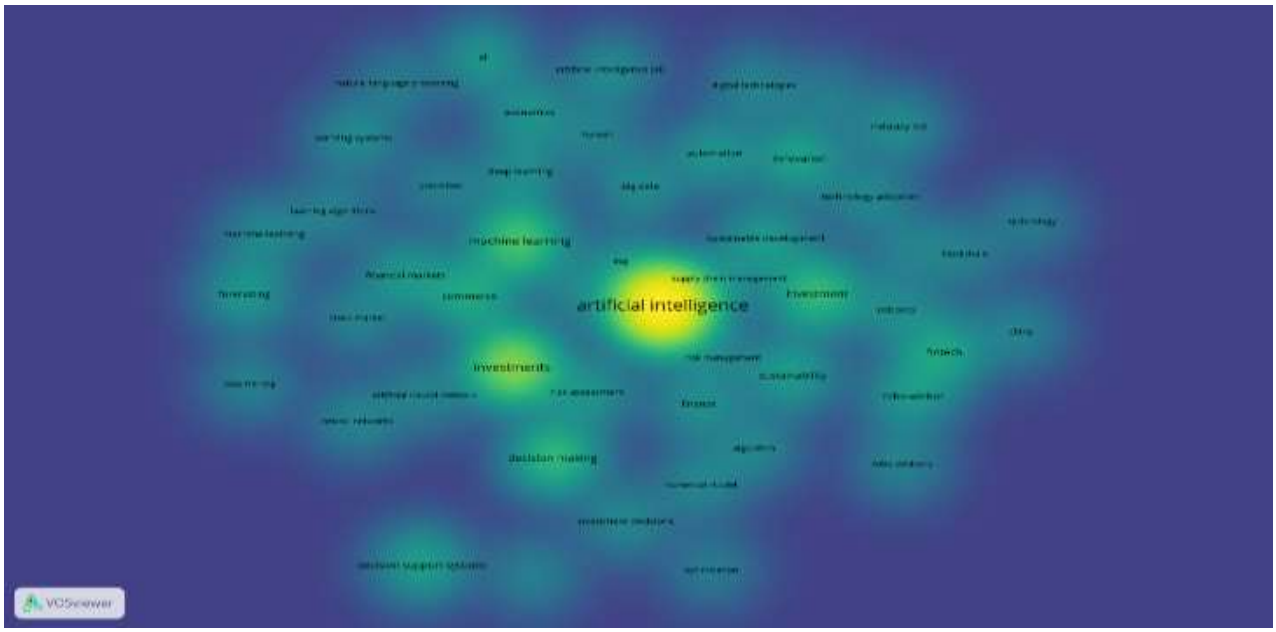

Figure 8. *Keyword density visualization map.The VoS Viewer software is utilized to construct the density visualization map.*

Table 8. *Overview of top 20 cited previous reviews on AI and Investment from 2004 to 2023.*

S. No.	Authors	Title	Year	Sources	Citations
1	Vergara & Agudo, (2021) [29]	"Fintech and sustainability: Do they affect each other?"	2021	"Sustainability" (Switzerland)	133
2	Debrah et al., (2021) [30]	"Green finance gap in green buildings: A scoping review and future research needs"	2022	"Building and Environment"	107
3	Baker & Dellaert,(2020) [21]	"Regulating robo advice across the financial services industry"	2018	"Iowa Law Review"	77
4	Amir & Khan, (2021) [31]	"Assessment of renewable energy: Status, challenges, COVID-19 impacts, opportunities, and sustainable energy solutions in Africa"	2022	"Energy and Built Environment"	59
5	Grennan & Michaely, (2020) [32]	"FinTechs and the Market for Financial Analysis"	2021	"Journal of Financial and Quantitative Analysis"	50

6	Quatrini, (2021) [33]	"Challenges and opportunities to scale up sustainable finance after the COVID-19 crisis: Lessons and promising innovations from science and practice."	2021	"Ecosystem Services"	42
7	Gongane et (al., 2022) [34]	"Detection and moderation of detrimental content on social media platforms: current status and future directions."	2022	"Social Network Analysis and Mining"	35
8	Zhang & He, (2020) [35]	"Smart technologies and urban life: A behavioral and social perspective"	2020	"Sustainable Cities and Society"	32
9	Bottero et al., (2021) [36]	"Evaluating the transition towards post-carbon cities: A literature review".	2021	"Sustainability (Switzerland)"	30
10	Qoronfleh et (al., 2020) [37]	"The future of medicine, healthcare innovation through precision medicine: policy case study of Qatar"	2020	"Life Sciences, Society and Policy"	26
11	Sheth & Shah, (2023) [38]	"Predicting the stock market using machine learning is the best and most accurate way to know future stock prices."	2023	"International Journal of System Assurance Engineering and Management"	24
12	Janabi, (2020)[39]	"Multivariate portfolio optimization under illiquid market prospects: a review of theoretical algorithms and practical techniques for liquidity risk management."	2021	"Journal of Modelling in Management"	23
13	Sonkavde et al., (2023 [40]	"Forecasting Stock Market Prices Using Machine Learning and Deep Learning Models: A Systematic Review, Performance Analysis and Discussion of Implications"	2023	"International Journal of Financial Studies"	21
14	Lăzăroiu et al., (2023) [41]	"Artificial intelligence algorithms and cloud computing technologies in blockchain-based fintech management"	2023	"Oeconomia Copernicana"	20
15	Lin et al., (2023) [42]	"Artificial intelligence in intelligent tutoring systems toward sustainable education: a systematic review"	2023	"Smart Learning Environments"	20
16	Andronie et al., 2023 [43]	"Big data management algorithms in artificial Internet of Things-based fintech"	2023	"Oeconomia Copernicana"	18
17	Shafiullah et al., 2022 [44]	"Review of Smart City Energy Modeling in Southeast Asia''	2023	"Smart Cities"	16
18	Calo, (2018) [45]	'Artificial intelligence policy: A primer and roadmap"	2018	"University of Bologna Law Review"	16
19	Ahmed et al., (2023) [46]	"Optimal design, operational controls, and data-driven machine learning in sustainable borehole heat exchanger coupled heat pumps: Key implementation challenges and advancement opportunities"	2023	"Energy for Sustainable Development"	12
20	Lewis et al., (2021) [47]	"AI vs 'AI': Synthetic Minds or Speech Acts"	2021	"IEEE Technology and Society Magazine"	12

Table 9. *A systematic review of the 20 most cited articles on AI and investment (2004 to 2023).*

S. No.	Title	Authors	Major Findings	Sources	Citations
1.	"Yahoo! for Amazon: Sentiment Extraction from Small Talk on the Web"	Das & Chen, (2007) [48]	The paper develops a methodology for extracting small investor sentiment from stock message boards using a voting scheme of different classifier algorithms. Compared to traditional Bayes classifiers, this scheme achieves lower false positives and higher sentiment accuracy	"Management Science"	873
2.	"Consumers and Artificial Intelligence: An Experiential Perspective"	Puntoni et al., 2020) [49]	The article explores consumer experiences with AI, highlighting feelings of misunderstanding and aversion towards AI classifications, especially in subjective contexts. It emphasizes the influence of sociocultural factors and the interrelationships between different AI experiences, suggesting that consumers' perceptions can significantly affect	"Journal of Marketing"	371

			their interactions with AI systems.		
3.	"Influence of artificial intelligence(AI) on firm performance: thethe business value of AI-basedtransformation projects"	Wamba-Taguimdje et (al.,2020) [50]	The main objective of this article is to analyze the influence of Artificial Intelligence (AI) on firm performance, particularly by exploring the business value derived from AI-based transformation projects. The study aims to provide insights into how AI can enhance organizational and process performance	"Business Process Management Journal"	314
4.	"An agile co-creation process for digital servitization: A micro-serviceinnovation approach"	Sjödin et al., (2020) [51]	The article reveals that agile co-creation in digital servitization enhances value through micro-service innovation. It emphasizes the importance of cross-functional collaboration among teams and iterative development to address the digitalization paradox, ensuring customized and scalable digital service offerings for manufacturing firms.	"Journal of Business Research"	310
5.	"A performance measurement system for Industry 4.0-enabled smart manufacturing system in SMMEs-A review and empirical investigation"	Kamble et al., (2020) [52]	The article identifies performance measures for smart manufacturing systems in SMMEs, emphasizing real-time monitoring, improved productivity, and a structured Smart Manufacturing Performance Measurement System (SMPMS). It highlights the need for gradual implementation and statistical validation of measures to enhance operational performance in the context of Industry 4.0	"International Journal of Production Economics"	229
6	"Influence of artificial intelligence on technological innovation: Evidencefrom the panel data of China's manufacturing sectors"	Liu et al., (2020) [53]	The article finds that artificial intelligence (AI) significantly promotes technological innovation by enhancing knowledge creation, technology spillover, and learning capabilities. The impact of AI varies across sectors, being more pronounced in low-tech industries. Additionally, higher levels of AI correlate with greater technological innovation, emphasizing the importance of R&D investment and talent development.	"Technological Forecasting and Social Change"	226
7	"A systematic review of fundamental and technical analysis stock market predictions"	Nti et al., (2020) [54]	The study reviewed 122 research works on stock market predictions from 2007 to 2018, revealing that 66% focused on technical analysis, 23% on fundamental analysis, and 11% on combined analyses.Support vector machines and artificial neural networks were the most utilized machine learning algorithms A significant gap was identified in incorporating diverse data sources, such as financial news and social media sentiment, into predictive models.	"Artificial Intelligence Review"	200

S. No.	Title	Authors	Major Findings	Sources	Cita-tions
8.	"Project selection in project portfolio management: An artificial neural network model based on critical success factors"	Costantino et al.,2015) [55]	The article presents an artificial neural network model that utilizes critical success factors (CSFs) to enhance project selection in portfolio management. It highlights the ongoing debate about CSFs' effectiveness, the need for better frameworks, and the limitations of current research, emphasizing the importance of empirical analysis and generalizability	"International Journal of Project Management"	154
9	"Intention to use analytical Artificial Intelligence in services. The effect of technology readiness and	Flavián et al., (2022) [56]	The study found that customers' technological optimism increases their intention to use robo-advisors, while feelings of technological discomfort surprisingly also positively influenced adoption. Additionally, service awareness and the financial advisor's name play	"Journal of Service Management"	141

	awareness"		significant roles in consumer acceptance of analytical AI investment services.		
10	"Hybridization of evolutionary Levenberg – Marquardt neural networks and data pre-processing for stock market prediction."	Asadi et al., (2012) [57]	The study introduces a pre-processed evolutionary Levenberg-Marquardt neural networks (PELMNN) model for stock market prediction, effectively combining genetic algorithms and feedforward neural networks with data pre-processing techniques. The findings indicate that integrating various methods enhances prediction accuracy, demonstrating the model's capability to adapt to stock market fluctuations.	"Knowledge - Based Systems"	141
11	"Talking AI into Being:The Narrativesand Imaginariesof National AIStrategies and TheirPerformative Politics"	Bareis & Katzenbach, (2021) [58]	National AI strategies across countries like China, the U.S., France, and Germany show a surprising consistency in narrative, framing AI as an inevitable and disruptive technology. Governments play a dual role, enabling and restricting discourse around AI, which shapes societal integration. The paper highlights the performative politics of these strategies, as they co-produce future technological pathways with significant resources	"Science Technology and Human Values"	134
12.	"Fintech and Sustainability: Do They Affect Each Other?"	Vergara & Agudo, (2021) [29]	The article explores the relationship between Fintech and sustainability, highlighting that Fintech can enhance sustainable finance by promoting green investments. It emphasizes the need for standardized ESG reporting to combat greenwashing and protect consumers. Additionally, it discusses the importance of regulatory frameworks for sustainable Fintech initiatives, focusing on consumer protection and the identification of deceptive practices	**"**Sustainability" (Switzerland)	133
13	"Innovating through digital revolution: The role of soft skills and Big Data in increasing firm performance"	Caputo et al., (2019) [59]	The article reveals strong relationships between human resources' work motivation and firms' revenues, and between organizational behaviours and investment in Big Data. It also highlights the mediated effect of Big Data on economic performance, while noting that not all hypotheses, particularly regarding emotions, were validated	"Management Decision"	121
S. No.	**Title**	**Authors**	**Major Findings**	**Sources**	**Cita-tions**
14	"Automation and artificial intelligence in business logistics systems: human reactions and collaboration requirements"	Klumpp, (2017) [60]	The article identifies critical challenges in human-artificial collaboration within logistics, emphasizing the need for effective training and acceptance strategies. It highlights resistance levels to AI, the potential evolution of truck driving into a technology-oriented profession, and the necessity for strategic management in mixed AI environments.	"International Journal of Logistics Research and Applications"	119
15	"The Productivity J-Curve: How Intangibles Complement General Purpose Technologies"	Brynjolfsson et al., (2021) [61]	The article discusses the Productivity J-curve, highlighting how intangible investments, particularly in software and R&D, significantly impact productivity growth. It reveals that mismeasurement of productivity, especially related to IT and AI investments, leads to substantial underestimations of total factor productivity. The findings suggest that new general-purpose technologies (GPTs) often initially underestimate their productivity effects due to the need for complementary intangible investments.	"American Economic Journal: Macroeconomics"	118

16	"Designing a robo-advisor for risk-averse, low-budget consumers"	Jung et al., (2017) [10]	The study identifies design principles for robo-advisors aimed at risk-averse, low-budget, inexperienced consumers, emphasizing the importance of usability and comprehensibility in user interfaces. It highlights the need for further research to explore how consumer characteristics and design decisions affect trust and perceptions of robo-advisors. The research suggests that future evaluations should occur in real-life settings to enhance external validity.	"Electronic Markets"	115
17	"Early Predictions of Movie Success: The Who, What, and When of Profitability"	Lash & Zhao, (2016) [62]	The study uses historical data to introduce the Movie Investor Assurance System (MIAS) to predict movie profitability.It emphasizes the importance of both actors and directors in determining a film's financial success, challenging previous beliefs that downplayed directors' roles.	"Journal of Management Information Systems"	114
18	"Overcoming the main barriers of circular economy implementation through a new visualization tool for circular business models"	Bianchini et al;(2019) [63]	The article identifies a significant gap between the circular economy (CE) concept and its practical implementation in industries due to barriers like insufficient information on resources and processes. It introduces a new Circular Business Model (CBM) visualization tool that quantifies resource flows and impacts, enhancing decision-making for circular initiatives. The tool can be adapted across various industrial sectors, addressing hidden circular opportunities and improving strategy selection.	"Sustainability" (Switzerland)	113
19	"Applications of Artificial Intelligence in commercial banks "A research agenda for behavioral finance"	Königstorfer & Thalmann, (2020) [64]	The article highlights the limited research on AI applications in commercial banking, particularly in managing deposits and payment processing. It emphasizes the benefits of AI in these areas and suggests further exploration of customer attraction to AI-based services. Additionally, it points out the need for better documentation of AI services for regulatory purposes.	"Journal of Behavioral and Experimental Finance"	110
S. No.	**Title**	**Authors**	**Major Findings**	**Sources**	**Cita-tions**
20	"Green finance gap in green buildings: A scoping review and future research needs"	Debrah et al., (2021) [30]	The article reveals a significant investment deficit in green buildings, emphasizing that green finance (GF-in-GBs) is a largely under-researched area. Most studies focus on content analysis rather than empirical data, with limited academic publications. The research suggests future directions, including the development of green finance rating software and AI-enabled performance assessment tools, to enhance the effectiveness of green finance initiatives in the building sector.	"Building and Environment"	107

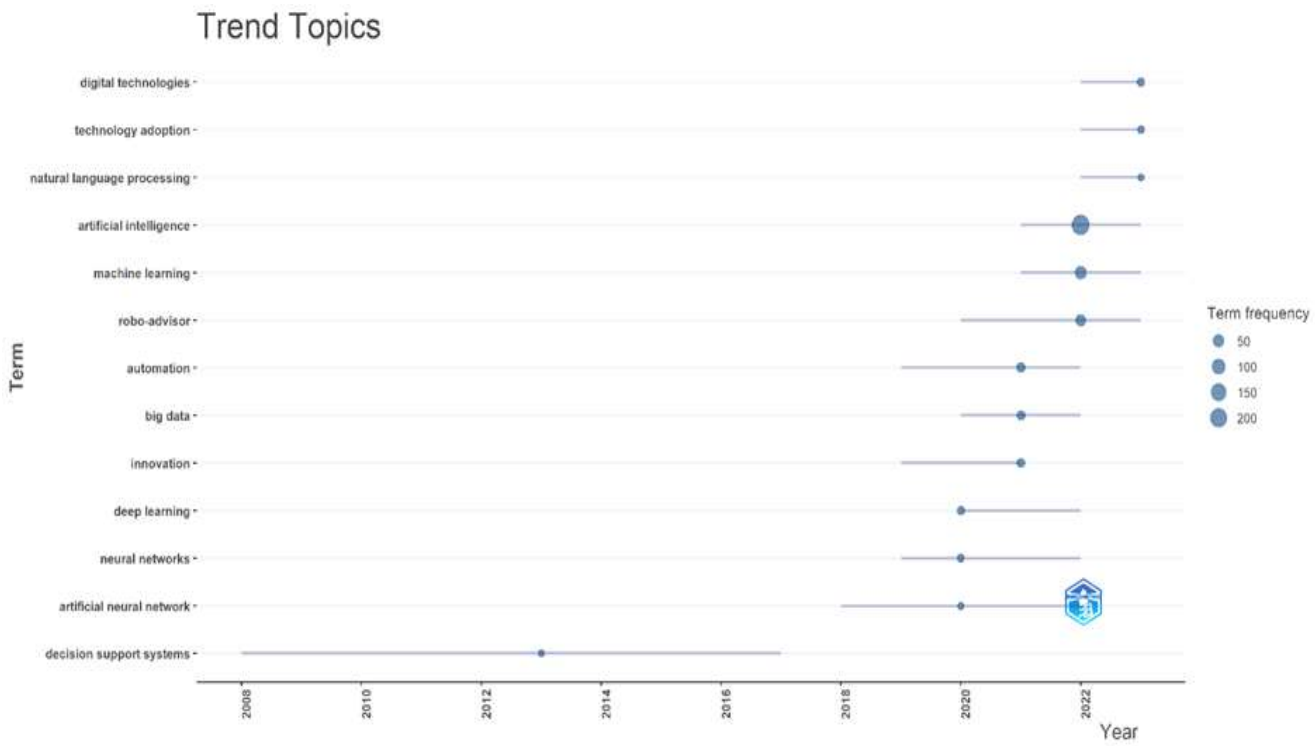

Figure 9. *Trends Across the Ages.*

Critical Evaluation of Artificial Intelligence in Investment

The systematic review of the top 20 cited articles on artificial intelligence and investment from 2004 to 2023 explains a complex and evolving landscape of technological innovation in financial domains. The study significantly improved from the early tendency analysis technique to more complicated, multidimensional approaches that integrate technological, psychological, and strategic considerations.

The influential work by Das and Chen, [48] pioneered sentiment analysis from web sources, laying the foundation for the increasingly sophisticated prediction model. Further studies extended this strategy, such as Nti et al.,[54] which emphasized the significance of combining a variety of data sources, such as sentiment on social media and financial news. The study found that 66% of research was devoted to technical analysis, and the most commonly employed machine learning algorithms were support vector machines and artificial neural networks.

Research from the viewpoint of consumers, especially from Puntoni et al.,[49] and Flavián et al., [56] provides a more complex interpretation of AI adoption. This work revealed complex psychological dynamics, showing that technological optimism and even technological discomfort can influence consumer acceptance of AI-driven financial tools. This human-centric approach indicates an important shift from purely technological considerations to more holistic, user experience-driven research.

The assessment also emphasizes size how AI has the potential to revolutionize a variety of fields. According to Liu et al., [53] artificial intelligence greatly fosters technological innovation by improving knowledge generation and learning capacities, especially in low-tech industries. Similarly to, research on AI applications in commercial banking was conducted by Königstorfer & Thalmann,[64] who noted advantages in deposit administration and payment processing while also pointing out areas that needed more study

The combination of AI and sustainability is a new trend. In their investigation of the connection between fintech and sustainability, Vergara and Agudo.[29] emphasized the necessity of strong regulatory frameworks and AI's potential to encourage green investments. This indicates a wider understanding of AI's potential to solve more significant societal and environmental issues besides financial optimization.

Methodologically, the research shows a trend towards hybrid approaches. Asadi et al. [57] reveal how combining genetic algorithms, neural networks, and complicated data preprocessing can enhance predictive accuracy in stock market analysis. This approach suggests that the future of AI in investment lies not in singular methods but in integrated, adaptive systems. Despite the encouraging results, there are still major study

limitations. Numerous studies stress the need for thorough regulatory norms, improved human-AI collaboration frameworks, and more empirical research. For example, the Brynjolfsson et al. [61] study emphasized the difficulty of quantifying AI's effects on productivity, arguing that conventional measurements might understate technological contributions.

This systematic study shows how AI evolved in investment from simple predictive tools to complex, context-aware systems that consider technological capabilities, human psychology, and broader societal implications. The research suggests that future developments will focus on creating more intuitive, transparent, and user-centric AI solutions that bridge technological innovation with human understanding

3.3 Trend Areas and Future Directions

Trend Areas

This section shows what has been popular over the years. Trending subjects exhibit an upward-sloping paradigm, as seen by the analysis of Figure 9 imported from biblioshiny. With a five-word minimum repetition frequency and a three-word annual word count, the study concentrated on the author-identified keywords to understand the content.

The analysis covers articles published between 2004 and 2023. The decision support system was the focus of this base year's trend, especially for the year 2008. Subsequently, the trends shifted annually in the direction of distinct research areas. Focusing more on the previous four years, in the example, figure 9 shows that in 2020, deep learning, artificial neural networks, and neural networks were highly significant, while in 2021, innovating, big data, and automation were more important. Significant research in the fields of artificial intelligence, machine learning, and robo–advisors was demonstrated in 2022. In 2023, research in artificial intelligence and investment was deemed to be mostly focused on natural language processing, digital technologies, and technology adoption.

Future Direction

Because this bibliometric analysis focused on investment and artificial intelligence. The investigation was restricted to a short period, WoS, and Scopus database. Only two variables are included for evaluation in this study. Investment behavior is a rapidly expanding subject of study, as evidenced by the literature and the outcomes. Additional factors and aspects of artificial intelligence, such as natural language processing, digital technologies, and technology adoption., may be the subject of future research. To find specific results and outcomes, more databases could be investigated. The article also gives the idea that it has analyzed artificial intelligence and investment behaviors collectively and compared them. However, the research was limited to just a few numbers of variables, databases, and periods, which may open up new research directions. Artificial intelligence is popular tools and it was applied in different fields [65-75].

4. Conclusion

This study's systematic literature evaluation offers important new perspectives on how artificial intelligence (AI) applications in investing are developing. The authors carefully reviewed 582 scholarly articles from the SCOPUS database, during the period of the years 2004 – 2023, using bibliometric analysis. The results show that interest in and research output on AI in Investment has significantly increased, especially after 2017. This suggests that the investment business is gradually but steadily implementing AI technologies. The way financial markets function in the digital age changing, and this trend highlights the increasing awareness of artificial intelligence's ability to improve investment strategies and decision-making processes.

With China, the United States, India, and the United Kingdom rising as major players, the study identified the top nations making contributions to this field of study. With the most papers and citations, the US stands out as the country that dominates research output and international collaboration in the fields of AI and finance. According to the geographic distribution of research activities, some nations are leading the way in innovation and knowledge development, even though AI's applications in investment are gaining traction globally.

Additionally, a wide variety of contributors, with many writers only publishing one piece. This observation indicates a possible research gap, indicating that there is a lot of scope for future in-depth investigations and exploration in this area. By offering a framework for assessing the influence and output of particular researchers, the bibliometric metrics used – such as the h-index and citation counts help to improve our comprehension of the academic environment around AI in investment.

This study highlights how crucial institutional ties are in influencing research output. For aspiring researchers looking for advice on where to publish their work and which universities are at the

forefront of this field of study, the list of the top five producing institutions is an invaluable resource. This data is essential for encouraging researcher collaboration and knowledge sharing, which will ultimately progress AI applications in investment.

In summary, this comprehensive literature review not only clarifies the present status of investment AI research but also establishes the framework for further investigation. By offering a thorough summary of publishing patterns. Author contributions, and institutional affiliations, the study give researchers the tools they need to successfully negotiate the complexity of this quickly developing subject. As artificial intelligence continues to transform the investment landscape, it will be crucial to do continuous research to identify novel approaches, uses, and financial industry relevance. The results of this study stimulate more research and encourage academics to examine the relationship between AI and investing in greater detail. This will help us better understand how these technologies can be used to achieve a better understanding of how these technologies can be used to achieve better financial results.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
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