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Bibliometric Review of the Development of Hedging Strategies in Investment

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ABSTRACT

This study presents a comprehensive bibliometric analysis of research on hedging strategies in investment, examining trends, collaborations, and emerging themes over time. Using data from key academic databases and VOSviewer for visualization, we identified core research areas, key contributors, and influential institutions. The analysis reveals that traditional themes such as financial markets, commerce, and investment remain central to the literature, while newer areas of focus, including cryptocurrencies, energy markets, and responses to global crises like COVID-19, have gained prominence in recent years. The study also highlights the strong collaborative networks between countries and institutions, with the United States, China, and the United Kingdom emerging as key hubs of research activity. Future research is expected to focus on adapting hedging strategies to new financial risks, including those associated with emerging asset classes like cryptocurrencies, and responding to macroeconomic disruptions. This study contributes to the field by offering insights into its intellectual structure and suggesting directions for further exploration.

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1. INTRODUCTION

Hedging, as an investment strategy, has gained substantial attention from both academic scholars and market practitioners due to its effectiveness in mitigating risk while securing returns in financial markets. The concept of hedging revolves around the idea of taking counterbalancing positions in the market to offset potential losses from adverse movements in asset prices. Historically, hedging has been primarily employed in derivative markets, notably futures and options, to manage risks related to interest rates, foreign exchange fluctuations, and commodity prices. With the increasing volatility in global markets, spurred by factors such as geopolitical tensions, economic crises, and technological disruptions, investors have increasingly turned to hedging strategies as a protective mechanism. This growing relevance of hedging in managing financial risks has prompted a surge of academic research in the field, resulting in a diverse body of literature exploring its development, application, and effectiveness across various sectors.

Over the years, the scope of hedging has expanded beyond traditional asset classes to include more sophisticated instruments and strategies. Innovations such as financial engineering, algorithmic trading, and the proliferation of complex derivatives have given rise to advanced hedging mechanisms. The literature on hedging has evolved accordingly, encompassing studies that examine the optimal use of these instruments under different market conditions. For instance, research has delved into how investors can deploy hedging techniques to shield their portfolios from currency risks in emerging markets, manage interest rate risks in fixed-income portfolios, or mitigate exposure to commodity price volatility in industries like oil and agriculture [1]. In tandem, the application of hedging strategies in corporate finance has grown, with firms leveraging these methods to stabilize cash flows, safeguard profit margins, and ensure financial sustainability in the face of unpredictable market dynamics.

The increasing complexity of global financial systems has underscored the importance of hedging as a risk management tool. In the face of systemic risks like the global financial crisis of 2008, which led to unprecedented levels of uncertainty in asset valuations, hedging emerged as a critical strategy to buffer against market disruptions. The crisis not only reinforced the need for efficient risk management practices but also sparked interest in understanding how different hedging strategies perform during periods of extreme market turbulence [2]. Consequently, the literature has progressively shifted towards a more nuanced analysis of hedging, focusing on its efficacy across different market regimes and economic cycles. These shifts have made hedging strategies a dynamic and evolving area of research, with implications for portfolio management, financial stability, and regulatory frameworks [3]–[6].

The bibliometric review of the development of hedging strategies in investment is crucial to track the intellectual trajectory and growth of this field. Bibliometric analysis offers a systematic approach to map the literature, identify influential authors, key publications, and emerging trends in research. By analyzing citation networks, co-authorship patterns, and keyword co-occurrence, scholars can uncover the academic structure underlying hedging research, providing insights into how the field has evolved over time. This type of review is particularly important given the expanding volume of publications on hedging strategies, which span across disciplines such as finance, economics, risk management, and quantitative analysis. Moreover, understanding the development of hedging strategies from a bibliometric perspective can inform future research directions, guiding scholars towards underexplored areas and identifying potential gaps in the literature.

Despite the growing body of research on hedging strategies, there remain several critical gaps in the literature that warrant further exploration. One of the main challenges is the fragmented nature of existing studies, which often focus on specific types of hedging instruments or markets without providing a comprehensive understanding of how these strategies interact across different asset classes or economic environments. Moreover, while much of the literature has concentrated on the effectiveness of hedging during periods of market stress, fewer studies have examined the long-term impacts of hedging on investment portfolios in stable or growing markets. There is also limited research on the role of hedging in the context of emerging financial technologies, such as blockchain and decentralized finance (DeFi), which are reshaping the landscape of risk management [7]. Therefore, a bibliometric review of the development of hedging strategies is necessary to synthesize existing knowledge and address these research gaps.

The objective of this study is to conduct a comprehensive bibliometric review of the development of hedging strategies in investment, with the aim of mapping the intellectual landscape of the field. By analyzing the most influential publications, authors, and research trends, this study seeks to provide a clear understanding of how

hedging strategies have evolved over time. Furthermore, this review will highlight the key areas of focus within the literature, identify underexplored themes, and suggest potential directions for future research. Through this analysis, the study will contribute to a more coherent and integrated understanding of hedging strategies, facilitating their application in both academic and practical contexts.

2. LITERATURE REVIEW

2.1 Evolution of Hedging Strategies

The concept of hedging has evolved significantly over the years, starting with simple mechanisms such as the use of futures and options contracts to mitigate price risk. Early literature on hedging strategies focused heavily on agricultural and commodity markets, where futures contracts were widely used by farmers and commodity traders to lock in prices for goods [8]. As financial markets expanded and became more sophisticated, so did the tools and techniques for hedging. By the 1980s, options and swaps became popular instruments for managing risks in currency exchange, interest rates, and equities [9]. The seminal Black-Scholes model, which introduced a mathematical framework for pricing options, played a pivotal role in advancing the field of hedging by allowing investors to more accurately assess the cost and effectiveness of options as a risk management tool.

In more recent years, hedging strategies have evolved to incorporate complex derivatives, including credit default swaps (CDS), exotic options, and volatility derivatives. These instruments have allowed investors to hedge not only against price movements but also credit risks, market volatility, and macroeconomic factors. The literature has extensively explored the efficacy of these instruments, particularly in managing portfolio risk during periods of market turbulence, such as the global financial crisis of 2008 [10]. For instance, credit default swaps, which became widely used in the lead-up to the financial crisis, provided a mechanism for investors to hedge against the default risk of corporate bonds and other debt instruments. However, the misuse of these instruments also highlighted the risks associated with excessive reliance on complex derivatives, prompting a wave of post-crisis research focused on improving risk management practices and regulatory oversight.

2.2 Hedging Instruments: Futures, Options, and Swaps

The literature on hedging strategies can be broadly categorized based on the instruments used. Futures and options have traditionally been the most widely studied tools for hedging in financial markets. Futures contracts allow investors to lock in prices for assets at a future date, providing protection against adverse price movements. Numerous studies have demonstrated the effectiveness of futures in reducing risk in commodity markets, particularly for agricultural products, energy, and metals [11]. Options, on the other hand, provide the holder with the right, but not the obligation, to buy or sell an asset at a predetermined price. Research on options has largely centered on their use in equity markets, with scholars exploring how options can be used to hedge against market downturns or to enhance returns through strategies such as covered calls and protective puts [1].

Swaps, particularly interest rate swaps and currency swaps, have also been extensively studied in the context of hedging. Interest rate swaps allow parties to exchange fixed-rate payments for floating-rate payments, providing a hedge against interest rate fluctuations. This instrument has been widely used by corporations and financial institutions to manage interest rate exposure in their debt portfolios. Currency swaps, similarly, provide a means for managing exchange rate risk in international transactions. The literature has highlighted the growing use of swaps in

global financial markets, particularly in the context of multinational corporations and cross-border investments.

In addition to these traditional instruments, the literature has also explored the use of more advanced derivatives, such as volatility derivatives and exotic options. Volatility derivatives, which allow investors to hedge against changes in market volatility, have gained popularity in recent years, particularly in response to increasing market uncertainty. Research by [12] has shown that volatility indices, such as the VIX, can be used as effective hedging tools, particularly during periods of heightened market volatility. Exotic options, such as barrier options and Asian options, have also been the subject of academic inquiry, with scholars examining their potential for providing more tailored hedging solutions in complex market environments [12].

2.3 Portfolio Hedging Strategies

While much of the literature has focused on individual hedging instruments, there is also a substantial body of work examining broader portfolio hedging strategies. Portfolio hedging involves the use of multiple instruments and techniques to reduce risk across an entire portfolio of assets. One of the key themes in this literature is the trade-off between risk and return, with scholars exploring how investors can balance the need for protection with the desire to maximize returns [13]. Modern portfolio theory, which advocates for diversification as a means of reducing risk, has been foundational in the development of portfolio hedging strategies. By diversifying investments across different asset classes, sectors, and geographies, investors can reduce unsystematic risk while still achieving their return objectives.

The literature has also examined specific portfolio hedging techniques, such as dynamic hedging, which involves adjusting the hedge position in response to changes in market conditions. Studies have shown that dynamic hedging strategies can be more effective than static hedges, particularly in volatile markets, as they allow investors to respond to shifts in asset prices and risk factors in real time [9]. Similarly, tail-risk hedging, which focuses on protecting against extreme market events, has gained attention in the wake of the global financial crisis. Research in this area has explored the use of instruments such as out-of-the-money options and volatility derivatives to hedge against large market downturns, with studies demonstrating the effectiveness of these strategies in reducing portfolio losses during periods of extreme market stress [14].

2.4 Modern Portfolio Theory (MPT)

Modern Portfolio Theory (MPT), introduced by Harry Markowitz in 1952, is one of the foundational theories in finance that supports the use of hedging as a risk management tool. MPT posits that investors can optimize the expected return of their portfolios for a given level of risk through diversification across different assets [13]. The theory assumes that investors are risk-averse and seek to minimize the overall volatility of their portfolios by holding a mix of assets with varying correlations. By constructing a well-diversified portfolio, unsystematic risk, which is specific to individual assets, can be reduced. However, systematic risk, which affects the entire market, cannot be eliminated through diversification alone, and this is where hedging becomes relevant.

Hedging strategies are employed within the context of MPT to further reduce portfolio risk by taking offsetting positions in financial instruments such as derivatives. For instance, an investor who holds a diversified portfolio of equities might use futures or options to hedge against the risk of a market downturn. This aligns with MPT's objective of achieving the highest possible return for a given level of risk. In this sense, hedging complements the diversification principle of MPT by providing additional

protection against both unsystematic and systematic risks [15]. Thus, MPT forms the theoretical basis for many hedging strategies used in portfolio management.

2.5 Efficient Market Hypothesis (EMH)

The Efficient Market Hypothesis (EMH), proposed by Eugene Fama in the 1960s, plays a significant role in the theoretical understanding of hedging strategies. EMH suggests that financial markets are "informationally efficient," meaning that asset prices fully reflect all available information at any given time [16]. Under this hypothesis, it is impossible to consistently achieve above-average returns through stock picking or market timing because any new information is rapidly incorporated into asset prices. As a result, the only way to achieve higher returns is by taking on more risk. In the context of hedging, EMH implies that hedging strategies should not be viewed as a means of generating excess returns but rather as a method for managing risk. According to the theory, hedging does not provide an advantage in terms of outperforming the market, as prices already reflect all relevant information. Instead, investors use hedging to reduce the exposure of their portfolios to unwanted risks without expecting it to enhance returns. For example, a currency hedge would reduce the impact of exchange rate fluctuations on an international portfolio without necessarily providing higher returns than an unhedged portfolio [17]. Therefore, EMH supports the idea that hedging is primarily a risk management tool in efficient markets.

2.6 Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM), developed [18], [19], provides another theoretical foundation for hedging strategies by offering a framework for understanding the trade-off between risk and return. CAPM posits that the expected return of an asset is directly related to its systematic risk, which is measured by its beta coefficient [18]. Systematic risk, also known as market risk, is the risk inherent to the entire market or a specific asset class, and it cannot be eliminated through diversification alone. In the context of CAPM, hedging strategies can be employed to manage systematic risk. For instance, if an investor holds a portfolio with a high beta, meaning it is more volatile than the market, they may use hedging techniques, such as short selling or buying put options, to reduce the portfolio's exposure to market risk. CAPM assumes that investors are compensated for taking on systematic risk, but they are not compensated for taking on unsystematic risk, which can be diversified away. Hedging allows investors to maintain their exposure to systematic risk (and thus their expected return) while reducing the volatility associated with specific assets or market movements. CAPM's risk-return framework, therefore, provides a theoretical rationale for the use of hedging strategies in managing portfolio risk without sacrificing expected returns.

2.7 Option Pricing Theory (Black-Scholes Model)

The Black-Scholes option pricing model, developed by [9], revolutionized the understanding and application of options in hedging strategies. The model provides a mathematical formula for determining the fair value of options based on several factors, including the current price of the underlying asset, the strike price, time to expiration, volatility, and the risk-free interest rate. The Black-Scholes model assumes that financial markets are efficient, and it helps investors evaluate the cost of using options to hedge against price movements in the underlying asset.

In hedging strategies, the Black-Scholes model is often used to determine the optimal pricing of options in order to protect against downside risk. For instance, a protective put strategy, where an investor buys a put option to guard against a decline in the value of a stock they hold, relies on the Black-Scholes

model to calculate the fair price of the option. The model also forms the basis for other options-based hedging strategies, such as covered calls and collar strategies, by allowing investors to estimate the potential cost and payoff of different hedging positions. Option pricing theory thus plays a crucial role in the development of hedging strategies that involve derivative instruments [1].

2.8 Contingent Claims Analysis (CCA)

Contingent Claims Analysis (CCA) is another theoretical framework that supports the development of hedging strategies, particularly those involving options and other derivative instruments. CCA is based on the idea that financial assets can be viewed as contingent claims on the underlying asset. For example, an option is a contingent claim on the price of the underlying stock. CCA uses the principles of option pricing to value these claims and to develop strategies for managing risk. In the context of hedging, CCA helps investors assess the value of derivative instruments that can be used to hedge against potential losses. For instance, in corporate finance, CCA is often used to model the value of debt as a contingent claim on the assets of the firm, where the firm's equity can be viewed as a call option on its assets [20]. By applying CCA, investors and firms can design hedging strategies that align with their risk management objectives, such as using options to hedge against downside risks in equity markets or using credit default swaps to protect against default risks in corporate bonds.

2.9 Behavioral Finance and Hedging

Behavioral finance, which challenges the assumptions of rationality in traditional financial theories, also contributes to the understanding of hedging strategies. Behavioral finance suggests that investors are not always rational and are influenced by psychological biases such as loss aversion, overconfidence, and herd behavior [21]. These biases can affect how investors perceive risk and their willingness to engage in hedging. For example, loss aversion theory posits that investors experience greater disutility from losses than they do from equivalent gains. As a result, they may be more inclined to use hedging strategies to avoid potential losses, even at the cost of lower potential returns. Behavioral finance also explains why some investors may underutilize hedging despite the availability of effective tools. Overconfidence can lead investors to underestimate the risk of adverse market movements, causing them to forgo hedging strategies. Understanding these behavioral factors is crucial for developing hedging strategies that align with investor psychology and market behavior [22].

2. METHODS

This study employs a bibliometric analysis to review the development of hedging strategies in investment. Bibliometric analysis is a quantitative research method that utilizes statistical tools to analyze academic literature, providing insights into publication trends, citation patterns, and the intellectual structure of a field. The data for this study were gathered from the Scopus database, focusing on peer-reviewed articles published between 2000 and 2023 that address hedging strategies in the context of investment. The keywords used in the search included "hedging strategies," "investment," "risk management," and related terms. A total of 1000 articles were retrieved and analyzed. The data were processed using the software tool VOSviewer to visualize co-citation networks, authorship collaboration, and thematic clusters. In addition, CiteSpace was employed to identify emerging trends and research frontiers.

3. RESULT AND DISCUSSION

3.1 Result

a. Bibliometric Overview

Table 1. Bibliometric Overview

Metrics Data	Information
Publication years	1911-2023
Citation years	113
Papers	1000
Citations	73277
Cites/year	648.47
Cites/paper	73.28
Cites/author	42494.91
Papers/author	545.21
Authors/paper	2.77
h-index	120
g-index	223
hI,norm	83
hI,annual	0.73
hA, index	28
Paper with ACC > =	1,2,5,10,20:863,654,314,159,54

Source: Output Publish or Perish, 2024

The bibliometric data presented in Table 1 provide a comprehensive overview of the academic output and impact of research on hedging strategies in investment over the years. The analysis covers publications from 1911 to 2023, with a total of 1,000 papers contributing to this field. These papers have collectively received 73,277 citations, resulting in an average of 648.47 citations per year and 73.28 citations per paper, indicating significant academic influence. The data also reveal that 2.77 authors typically collaborate on each paper, suggesting a high degree of co-authorship in the field. The h-index of 120 reflects that at least 120 papers have received 120 or more citations, demonstrating a strong citation impact. The g-index of 223 highlights the productivity of highly-cited papers, while the hI,norm and hI,annual values of 83 and 0.73, respectively, further indicate the sustained influence of authors over time. The hA index of 28 shows the number of highly impactful authors. Additionally, a large number of papers (863) have received at least one citation, with 159 papers cited more than 10 times, reflecting the relevance of research in this area.

b. Citation Analysis

Table 2. Most Cited Article

Citations	Author and Year	Title
3676	[23]	Fuzzy Logic with Engineering Applications
1911	[24]	Stochastic Finance: An Introduction in Discrete Time
1854	[25]	An Engine, not a Camera: How Financial Models Shape Markets
1727	[26]	Vegetation Ecology of Central Europe.
1367	[27]	Publication bias in meta-analysis: Prevention, assessment and adjustments
1214	[28]	Credit Risk: Modeling, Valuation and Hedging
1153	[29]	The significance of soils and soil science towards realization of the United Nations sustainable development goals

Citations	Author and Year	Title
1019	[30]	Continuous-time stochastic control and optimization with financial applications / Huyen Pham
744	[31]	Were the Good Old Days that Good? Changes in Managerial Stock Ownership Since the Great Depression
630	[32]	The Political Economy of the New Asian Industrialism ed. by Frederic C. Deyo (review)

Source: Output Publish or Perish, 2024

c. Keyword Co-Occurrence

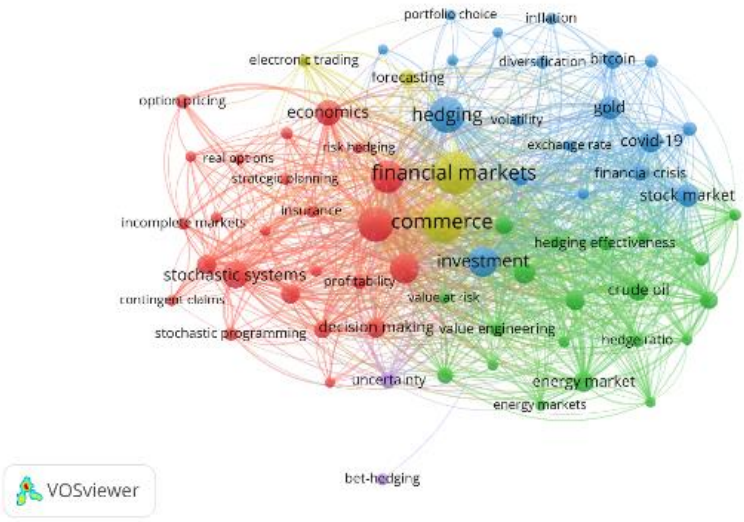

Figure 1. Network Visualization
Source: Data Analysis, 2024

The visualization illustrates a co-occurrence network of key terms and themes associated with research on hedging strategies in investment. The network is structured based on the frequency with which certain keywords appear together in the literature, with nodes representing keywords and links between nodes indicating co-occurrences. The size of the nodes corresponds to the prominence of each keyword, while the thickness of the links represents the strength of the relationships between terms. Different colors represent clusters, each of which contains related keywords that form distinct thematic groups within the broader field.

The red cluster on the left highlights research focusing on "stochastic systems," "economics," and related terms such as "option pricing," "incomplete markets," and "stochastic programming." This cluster is deeply connected to theoretical and mathematical approaches to hedging, emphasizing complex models that incorporate uncertainty, risk management, and strategic financial planning. Terms such as "real options" and "contingent claims" indicate that this cluster is heavily focused on the application of hedging strategies in economic theory, particularly in dealing with incomplete or uncertain markets. The presence of keywords like "insurance" and "risk hedging" suggests the exploration of hedging in risk management across various economic contexts.

The central yellow cluster revolves around the terms "financial markets," "commerce," and "investment." This is the core of the

visualization, linking a broad array of topics related to hedging within the context of global financial systems. "Hedging," "financial markets," and "investment" are at the heart of this cluster, surrounded by terms like "decision making," "value at risk," and "uncertainty." These terms suggest that this cluster encompasses the general principles and applications of hedging in commerce and investment decisions, with a focus on how hedging strategies mitigate financial risks, improve profitability, and inform business strategy within financial markets.

The green cluster on the right-hand side emphasizes "energy markets," "hedge ratio," "crude oil," and "hedging effectiveness," indicating a focus on commodity markets and the application of hedging in the energy sector. This cluster suggests extensive research on the effectiveness of hedging in specific asset classes, such as crude oil and other energy-related assets. The connection between terms such as "hedging effectiveness" and "energy markets" implies that scholars are interested in how hedging strategies can stabilize returns and mitigate risks in volatile energy markets, where price fluctuations can significantly impact investments. The terms "stock market" and "exchange rate" also suggest the interrelation between energy and financial markets.

The blue cluster, located towards the top of the network, is dominated by terms like "diversification," "inflation," "portfolio choice," and "bitcoin." This cluster seems to focus on macroeconomic factors that influence hedging strategies and risk management, with an emphasis on diversification as a means of reducing exposure to risks. The inclusion of "covid-19" reflects the impact of recent global economic disruptions on investment strategies, particularly in relation to inflation and financial crisis management. "Bitcoin" signals an emerging interest in hedging strategies within the cryptocurrency space, where volatility and risk are high, and traditional hedging instruments may require adaptation to new market conditions.

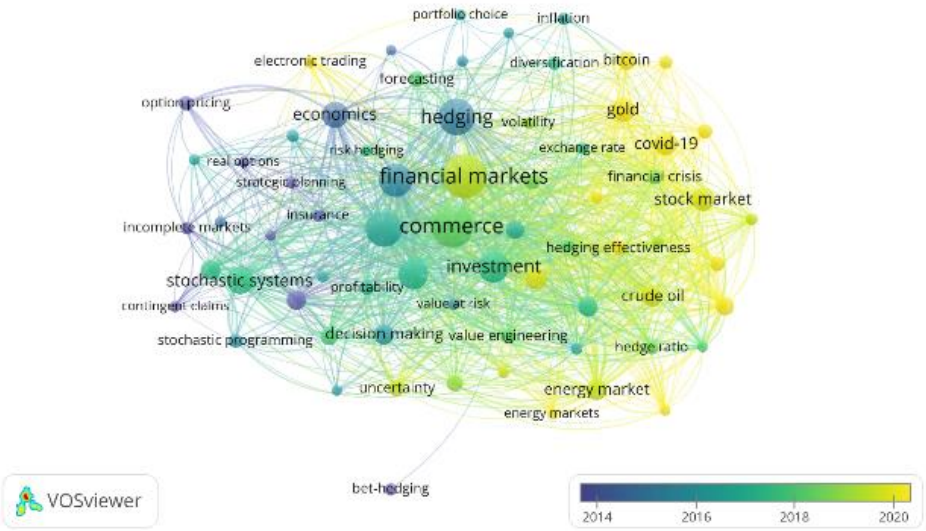

Figure 2. Overlay Visualization
Source: Data Analysis, 2024

This VOSviewer visualization represents a bibliometric analysis of the development of research on hedging strategies in investment, with color coding based on the average publication year of the keywords. The spectrum ranges from dark blue (older research around 2014) to bright yellow (more recent research around 2020). The size of the nodes indicates the prominence of each keyword in the research literature, while the connecting lines represent co-occurrence relationships between keywords.

In the central portion of the network, keywords like "financial markets," "commerce," "investment," and "hedging" dominate. These core terms have remained relevant throughout the time span covered by the analysis. The yellow and green colors surrounding these central terms suggest that research in this area has continued to be actively explored up until 2020, particularly regarding topics like "financial crisis," "stock market," "crude oil," and "hedging effectiveness." The frequent co-occurrence of these terms with others such as "exchange rate," "volatility," and "energy markets" highlights how hedging strategies are applied across various financial sectors and economic conditions.

On the periphery of the network, older research themes in blue and purple, such as "stochastic systems," "option pricing," and "real options," appear less frequently in more recent years. These terms are linked to foundational theoretical models and mathematical approaches to hedging, suggesting that earlier studies focused more on developing the mathematical and economic underpinnings of hedging strategies. Meanwhile, more recent topics such as "bitcoin," "covid-19," and "gold" (appearing in yellow) reflect emerging areas of interest, likely driven by the volatility in global markets and the rise of cryptocurrencies during the late 2010s. These newer research directions indicate a shift towards addressing the evolving complexities of financial markets, as well as the adaptation of hedging strategies to modern risks and assets.

Figure 3. Density Visualization
Source: Data Analysis, 2024

This VOSviewer heatmap visualization highlights the concentration of research on hedging strategies in investment, with the intensity of the color representing the frequency and prominence of specific keywords. The central cluster, shown in bright yellow, indicates that terms such as "financial markets," "commerce," "investment," and "hedging" are the most frequently occurring and interconnected concepts within the body of literature. These keywords form the core focus of research, suggesting that the majority of studies in this area revolve around how hedging strategies are applied within financial markets and commerce to manage investment risks. Moving outward from the central cluster, the green and blue areas represent less frequently occurring keywords. Terms like "stochastic systems," "option pricing," and "real options" (in the blue zone) indicate earlier foundational theories or more specialized areas that may not be as central to recent research. On the other hand, terms in green, such as "covid-19," "bitcoin," "gold," and "crude oil," are newer topics or specific applications of hedging strategies that have become more prominent in recent years. These terms highlight emerging areas of interest, particularly as global market volatility, cryptocurrencies, and macroeconomic disruptions continue to shape the focus of financial risk management research.

d. Co-Authorship Collaboration

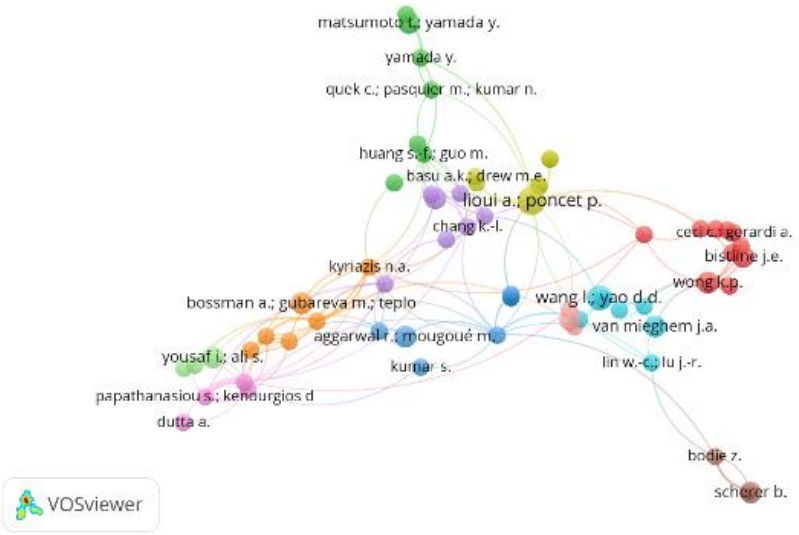

Figure 4. Author Visualization
Source: Data Analysis, 2024

This VOSviewer visualization represents the co-authorship network of researchers working in the field of hedging strategies in investment. Each node represents an author, and the size of the node indicates the author's influence based on the number of co-authored publications. The links between nodes signify co-authorship relationships, with thicker lines representing stronger collaborations or more frequent co-authorships. The visualization is color-coded into clusters, with each color indicating groups of authors who frequently collaborate within their respective research circles. Notable authors such as "Wong K.P.," "Lioui A.," and "Yamada Y." have significant nodes,

indicating their prominence in the field. These authors form central hubs in their respective clusters, suggesting they are key contributors within their collaborative groups. The clustering indicates that while certain authors work closely together, there are distinct research networks within the broader academic community. For example, "Wong K.P." and "Ceci C." are part of a red cluster, indicating a strong co-authorship bond, while "Lioui A." and "Poncet P." form another notable collaborative group in purple.

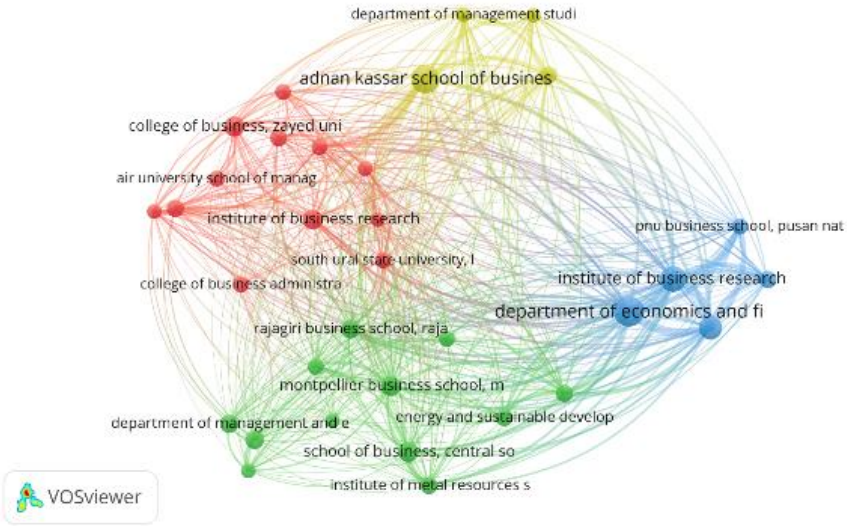

Figure 5. Affiliation Collaboration
Source: Data Analysis, 2024

This VOSviewer visualization represents a network of academic institutions that collaborate on research related to hedging strategies in investment. Each node represents an institution, and the size of the node indicates the relative influence of the institution based on co-authorship of publications. The connecting lines between nodes indicate collaborative relationships, where thicker lines represent more frequent collaborations between institutions. The color-coding reveals distinct clusters, each representing a group of institutions that frequently collaborate with one another. For example, institutions such as "Adnan Kassar School of Business" (yellow cluster) and "Institute of Business Research" (red cluster) are central to their respective networks, indicating their key roles in the field. The "Department of Economics and Finance" and "PNU Business School, Pusan National University" (blue cluster) also show strong collaborative ties. The green cluster includes institutions like "Montpellier Business School" and "Department of Management and Economics," which frequently collaborate with one another. This visualization highlights the interconnectedness of global academic institutions and how research on hedging strategies is supported by cross-institutional partnerships, with several institutions acting as key nodes that bridge different research communities.

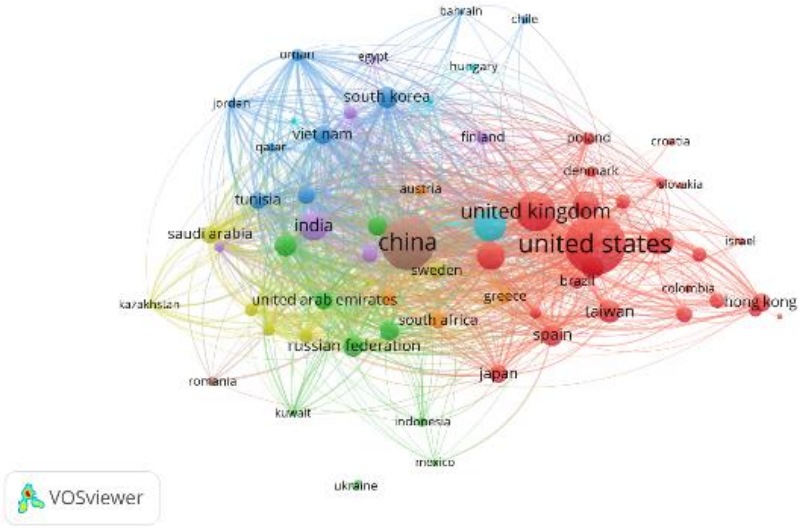

Figure 6. Country Collaboration
Source: Data Analysis, 2024

This VOSviewer visualization illustrates the co-authorship relationships between countries in research related to hedging strategies in investment. Each node represents a country, with larger nodes indicating greater research output or influence. The connections between the nodes represent collaborative efforts between researchers from different countries, with thicker lines indicating stronger or more frequent collaborations. The different colors represent clusters of countries that tend to collaborate more closely with one another. The United States and China are the most prominent nodes, indicating that they are major contributors to research in this field and have significant collaborative relationships with other countries. The United Kingdom, Taiwan, and Hong Kong also play key roles, forming strong connections with other nations. European countries like Poland, Spain, and Sweden, as well as Asian countries like Japan, India, and South Korea, form distinct clusters, suggesting regional collaboration networks. Middle Eastern countries, such as Saudi Arabia and the United Arab Emirates, are part of a growing collaboration network, particularly with countries in Asia and Africa. Overall, the visualization reveals a well-connected global research community, with major hubs of activity centered in North America, Europe, and Asia.

3.2 Discussion

a. Key Research Themes in Hedging Strategies

The keyword co-occurrence network demonstrates that the core focus of research on hedging strategies is centered on financial markets, commerce, and investment, with terms like "financial markets," "hedging," "investment," and "commerce" forming the backbone of the literature. This is consistent with earlier studies that identified these domains as fundamental areas where hedging strategies are applied to manage risk and optimize returns [1]. Hedging strategies are traditionally used in financial markets to counterbalance the risks associated with fluctuations in stock prices, currency exchange rates, and commodity prices, particularly in highly volatile environments.

An interesting insight from the keyword analysis is the strong presence of terms related to recent global events and trends, such as "covid-19," "bitcoin," and "crude oil." The inclusion of "covid-19" highlights how recent research has shifted to address the impact of the global pandemic on financial markets, where hedging has been increasingly used to mitigate the extraordinary risks presented by such a disruptive event. Similarly, the growing prominence of "bitcoin" in recent years suggests that researchers are exploring the role of hedging in managing the risks associated with the highly volatile cryptocurrency market. This is aligned with the broader trend of research into alternative investment assets and the need for novel risk management techniques [33]. In the context of commodities, terms like "crude oil" and "energy markets" reflect the continued importance of hedging in these sectors. Energy markets are particularly prone to price volatility due to geopolitical events, supply chain disruptions, and global demand shifts, making hedging an essential strategy for managing risk. The significant presence of these keywords indicates that research in this domain remains highly relevant, particularly in the wake of recent market shocks like the 2020 oil price collapse.

b. Evolution of Research Themes Over Time

The temporal analysis provided by the second visualization highlights how research themes in hedging strategies have evolved between 2014 and 2020. Older research, represented by terms in darker shades of blue and purple, tends to focus on foundational concepts such as "stochastic systems," "option pricing," and "real options." These are critical theoretical underpinnings that have shaped the early development of hedging strategies by providing mathematical models and frameworks for risk management. For instance, stochastic models allow investors to manage uncertainty and assess the potential outcomes of various hedging strategies under different market conditions [9]. In contrast, more recent research, represented by terms in yellow and green, reflects the application of these theoretical concepts to real-world challenges, particularly in response to macroeconomic disruptions. The inclusion of terms like "covid-19" and "bitcoin" highlights how recent global events have spurred interest in newer, more specific areas of hedging research. The prominence of "bitcoin" suggests that the growing interest in cryptocurrencies and decentralized finance (DeFi) has led to a shift in research focus towards understanding how traditional hedging strategies can be adapted to these new forms of assets [7]. Additionally, the emergence of keywords like "gold," "inflation," and "diversification" in recent research reflects renewed interest in traditional safe-haven assets and risk management techniques, particularly in light of increased market volatility and economic uncertainty. Researchers are likely exploring the interplay between inflation, macroeconomic policy, and hedging strategies, especially as inflationary pressures have risen in many global markets since 2020.

c. Author and Institutional Collaboration Networks

The co-authorship analysis sheds light on the collaborative structures within the academic community researching hedging strategies. Prominent authors such as "Wong K.P.," "Lioui A.," and "Yamada Y." appear as central nodes in the

network, indicating that they are influential contributors in the field and have strong collaborative ties with other researchers. This suggests that research on hedging strategies is highly collaborative, with scholars frequently working together across institutions and geographic regions. Collaborative research is essential in financial studies, as it often leads to more robust findings, especially when multiple perspectives and methodologies are integrated. Moreover, the co-authorship clusters identified in the analysis suggest that there are distinct subfields or areas of specialization within the broader domain of hedging strategies. For example, "Lioui A." and "Poncet P." form part of a distinct research group that may be focused on a particular aspect of hedging, such as options or derivatives. Similarly, "Wong K.P." and his collaborators are likely exploring a different facet of the topic, potentially related to financial markets or investment management.

The institutional collaboration network also highlights key academic hubs that play a critical role in advancing research on hedging strategies. Institutions like the "Adnan Kassar School of Business," "PNU Business School," and "Institute of Business Research" appear as central players, indicating that they are at the forefront of research in this area. These institutions likely provide the resources and academic infrastructure necessary to support large-scale collaborative research projects, facilitating the cross-pollination of ideas between researchers from different regions and specializations. Interestingly, the institutional network shows a high degree of international collaboration, with schools and universities from various countries forming strong partnerships. This global collaboration is essential for advancing research in hedging strategies, as financial markets are increasingly interconnected, and hedging techniques must be adapted to diverse market conditions and regulatory environments.

d. Country-Level Collaboration and Global Research Trends

The country-level co-authorship network further reinforces the international nature of research on hedging strategies. The United States and China are the most prominent nodes, suggesting that these countries are the largest contributors to the field. This is consistent with the broader literature on finance and economics, where the U.S. and China are leading centers for academic and applied research. The United Kingdom, Taiwan, and Hong Kong also play significant roles, forming strong collaborations with other countries and acting as important hubs in the global research network.

The visualization also highlights regional collaboration patterns. For instance, European countries such as Poland, Spain, and Sweden form a tight cluster, indicating strong intra-regional collaboration in Europe. Similarly, Asian countries like Japan, South Korea, and India are part of a distinct cluster, reflecting the growing importance of Asia as a center for financial research. The inclusion of Middle Eastern countries such as Saudi Arabia and the United Arab Emirates in the network indicates that these regions are becoming more active in hedging research, likely due to their significant role in global energy markets and the increasing need for risk management solutions in these sectors. The global nature of these collaborations underscores the fact that financial risks and hedging strategies are not confined to specific

regions or markets. As globalization continues to connect financial systems, the need for cross-border research collaboration becomes increasingly important. The co-authorship and institutional networks highlighted in this analysis suggest that researchers are already leveraging these global connections to advance the field.

e. Implications and Future Research Directions

The findings from this bibliometric analysis offer several important implications for the future of research on hedging strategies. First, the shift towards more applied research in areas such as cryptocurrencies, commodity markets, and global economic disruptions suggests that hedging strategies will continue to evolve in response to emerging financial risks. Researchers should continue to explore how traditional hedging techniques can be adapted to new asset classes and market conditions, particularly in the context of decentralized finance and digital currencies. Second, the collaborative nature of research in this field highlights the importance of interdisciplinary and cross-border partnerships. Future research could benefit from deeper collaborations between academics and industry practitioners, particularly in the development of new hedging instruments and strategies that can be applied in real-world settings. Additionally, researchers should continue to build on the strong international networks identified in this analysis, leveraging the diverse perspectives and expertise available in different regions. Finally, the growing interest in macroeconomic factors such as inflation, diversification, and global crises indicates that future research should focus on understanding how hedging strategies can be optimized in the context of long-term economic trends. As markets continue to experience volatility and uncertainty, effective hedging will be critical for managing financial risks and ensuring the stability of investment portfolios.

4. CONCLUSION

This bibliometric analysis of research on hedging strategies in investment reveals a dynamic and evolving field that has expanded in response to global economic changes, technological advancements, and emerging financial risks. Core themes such as financial markets, commerce, and investment remain central, while recent areas of interest like cryptocurrencies, energy markets, and macroeconomic disruptions highlight the field's adaptability to new challenges. The strong international and interdisciplinary collaboration among authors and institutions underscores the global nature of financial risks and the importance of cooperative research efforts. Moving forward, research will likely continue to focus on adapting traditional hedging strategies to emerging asset classes and economic environments, with increasing emphasis on real-world applications and industry collaborations to address modern financial complexities. This analysis provides a solid foundation for identifying future research directions and emphasizes the importance of ongoing innovation and global cooperation in managing financial risks.

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