Journal of Information Systems Engineering and Management
2025, 10(29s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Mapping The Web Of Knowledge: A Bibliometric Analysis Of Stock Markets Interlinkage

Dr. Ishwar Sharma*, Dr. Meera Bamba, Bhawana Verma***, Bharti Verma*****

*Assistant Professor, Department of Commerce, Indira Gandhi University, Meerpur, Rewari, Haryana, India

**Associate Professor, Department of Commerce, Indira Gandhi University, Meerpur, Rewari, Haryana, India

***Research Scholar, Department of Commerce, Indira Gandhi University, Meerpur, Rewari, Haryana, India

Corresponding Author: Bhawana Verma E-mail Id- vermabhawana436@gmail.com

ARTICLE INFO

Received: 24 Dec 2024

Revised: 18 Feb 2025

Accepted: 27 Feb 2025

ABSTRACT

The current study aims to provide an overview of existing research on stock market interlinkage and recommend further research directions. The study performed a bibliometric analysis of 1537 Scopus-indexed papers published since 2000 using biblioshiny under the bibliometrix R package. It describes the status of publications, publication trend, the top productive contributor, the leading influential contributor, the most frequently used keywords, important themes, research collaboration network, co-citation network, and scope of future research. Overall, this analysis contributes to a better understanding of the linkage between stock markets and provides insights for policymakers, managers, analysts, investors, and researchers in this field. More research needs to be conducted to investigate the connections between various financial markets, including the stock, bond, commodity, and currency markets, using statistical models with machine learning algorithms to understand better how financial market interlinkage can affect diversification opportunities and risk management strategies.

Keywords: Bibliometric analysis, Biblioshiny, Diversification opportunities, Portfolio diversification, Scopus, Stock markets, Stock markets interlinkage

INTRODUCTION

Dynamic linkage in stock markets has been a subject of interest among researchers (Baharumshah et al., 2003; Dhanaraj et al., 2013; Ferli & Husodo, 2013; Sclip et al., 2016; P. Wang & Moore, 2008). Interlinkage between financial markets is crucial in portfolio diversification and risk management (Alqaralleh & Canepa, 2021; Bouri et al., 2021; Doman & Doman, 2013; Narayan et al., 2004). Investors aim to obtain maximum returns while minimising risk, which can be accomplished by efficiently diversifying their portfolio with assets that have low or negative correlations (Markowitz, 1952). International diversification can reduce investment risk substantially (Solnik, 1974). However, with the advent of liberalisation and globalisation, the relationship between countries and their financial markets has intensified (Aggarwal & Raja, 2019), and such an intensified relationship can lead to a

decrease in diversification opportunities. The linkage among the global stock markets become strong during the period of crisis (Jiang, Yu, Hashmi, et al., 2017; Lee & Kim, 1993; Naeem et al., 2023; Omane-Adjepong et al., 2020). This relationship is time-varying (Choi, 2022; Mensi et al., 2021; Shahzad et al., 2021). Therefore, it is imperative to comprehend the linkage among global stock markets.

Scientific innovation is an iterative process that builds upon previous studies to increase understanding in a given field. To analyse the previous research, bibliometric techniques have emerged as widely accepted scientific specialisations, especially in scientific and practical disciplines (Bornmann & Leydesdorff, 2014). This methodology has been commonly used in research papers to quantify the impact of scholarly publications (Bashir, 2022; J. Chen & Yang, 2021; Derviş, 2020; Khan et al., 2022). Some research questions like RQ1: What is the current status of publication? RQ2: What is the publishing and citation trend in recent literature? RQ3: Who are the most productive contributors in terms of writers, countries, and journals? RQ4: Who are the most influential contributors in terms of writers, countries, and journals? RQ5: Which keywords are used the most frequently? RQ6: What is the present status of research collaboration in the literature? RQ7: What is the intellectual framework of literature? RQ8: Which themes are the most important among scholars? RQ9: Which aspects of existing literature need to be explored by further research? The study will address these research questions via bibliometric analysis. The present study examines the existing literature on dynamic linkages in stock markets and identifies the research gaps, methodologies and key findings in the literature.

The study found that the direction and magnitude of these linkages vary across markets over time (Choi, 2022; Mensi et al., 2021; Shahzad et al., 2021). Researchers need to explore the relationships among different financial markets, such as the stock market, commodity market, bonds market, and currency market, to investigate diversification opportunities among different financial markets. The study suggests that a more thorough investigation is needed to understand how dynamic linkage across financial markets can impact risk management and portfolio diversification opportunities.

Several groups will find this study helpful, including researchers, managers, analysts, investors, and portfolio managers. It overviews the present state of research on stock market interlinkage and provides future research direction. Early-stage researchers can benefit by identifying research gaps. It helps policymakers in making policies. The information in this article will be helpful to managers and analysts who want to learn about the current approaches for making diversification strategies. It helps investors and portfolio managers to identify investment opportunities and assess potential risks. As a result, they will be able to manage their portfolios more effectively and make more informed investment decisions.

The remaining work is organised into several sections. The previous studies conducted by the researchers are covered in section 2 (Literature Review). Section 3 (Research Methodology) explains the methods employed to accomplish the study's purpose. In section 4 (Results and Discussion), results are discussed. The last section includes the conclusion.

LITERATURE REVIEW

Several studies (Choi, 2022; Gupta & Guidi, 2012; Mensi et al., 2021; Shahzad et al., 2021) have found that the magnitude of spillover effects and co-integration between markets can change in response to different events such as financial crises, political events, and changes in monetary policy. The impact of the October 1987 crash, the dot com bubble burst (2000), the Lehman crisis (2008), the Eurozone crisis (2013), the COVID-19 and the Russia-Ukraine crisis on the global stock markets became strong during the period of crisis (Jhunjhunwala & Suresh,

2020; Jiang, Yu, & Hashmi, 2017; Lee & Kim, 1993; Omane-Adjepong et al., 2020) but the linkages between stock markets weakened after the crisis (Guo & Ibhagui, 2019; L. Wang, 2014). Global stock markets are significantly influenced by the US stock market (Gunay & Can, 2022).

Previous studies have used different research methods such as Johansen Co-integration, Granger Causality, Wavelet analysis, Time-varying copula approach, TVP VAR, DCC GARCH model, DCDNN model Network analysis, etc. Johansen co-integration is one of the most commonly used techniques for examining the connection between various stock markets. This technique determines the long-term relationships between variables and the short-term adjustment rate in equilibrium (Johansen, 1988). The VAR model is used to determine how variables change over a period of time (In et al., 2002; Masih & Masih, 2001). Many previous studies used Granger causality tests to examine how well one variable predicted another variable (Narayan et al., 2004; Obadiaru et al., 2020; So et al., 2021). Some studies have examined financial market relationships using wavelet analysis (Das et al., 2018; Mohamed Dahir et al., 2018; R. Wang & Li, 2020). The rolling time-varying copula technique has been used to understand better the dynamic behaviour of financial market relations (Charfeddine & Benlagha, 2016). The most popular technique for analysing the correlation between various financial markets is the Dynamic Conditional Correlation (DCC) GARCH model. DCC is a time-varying model used to determine the interaction between variables over time (Engle, 2002). previous studies such as (Kostika & Laopodis, 2019; Marozva, 2017; Yadav et al., 2023) utilised the DCC GARCH model. The machine learning algorithms may increase the estimation accuracy of DCC GARCH models. The estimate of the correlation matrix is one of the primary applications of machine learning in DCC GARCH models. Maximum likelihood estimation, sensitive to outliers and noisy data, is used in conventional DCC GARCH models to estimate the correlation matrix. The connectedness approach (Diebold & Yilmaz, 2009, 2012, 2014) is used to evaluate spillovers. However, in this approach, the connectedness depends on the rolling window's size, which is arbitrarily determined. To overcome this limitation, Antonakakis et al. (2020) have developed another method, i.e., the TVP-VAR approach. Lastrapes & Wiesen (2021) developed the joint spillover index based on the goodness-of-fit measure R^2. However, we cannot calculate the net directional pairwise connectivity in this approach, which is essential for portfolio decision-making. Balcilar et al. (2021) developed the TVP-VAR extended joint connectedness approach to overcome this issue. It integrates the connectedness approach of Antonakakis et al. (2020) and the joint spillover approach of Lastrapes & Wiesen (2021).

The correlation matrix, more resistant to outliers and noisy data, can be calculated using machine learning methods like neural networks. In the previous study by (Ni & Xu, 2023), a hybrid DCDNN (Dynamic Conditional Deep Neural Network) model was developed based on

the DCC-GARCH and RDNN (Recurrent Deep Neural Network) models. The DCC-GARCH model's prediction error is then forecasted using deep learning to increase the stock market correlation prediction accuracy. The DCDNN model's accuracy is noticeably higher than the DCC-GARCH model (Ni and Xu, 2021). The Deep learning model outperformed traditional econometric models in predicting stock market movements (Lee & Yoo, 2020). The network analysis approach is another contemporary tool used to study the dynamic linkage between stock markets (Gong et al., 2023). Network analysis techniques display stock market data as a network, with nodes representing individual stocks and edges showing their relationships. This method has been used to examine the relationships between stocks and pinpoint the major stocks that impact market trends the most. However, it is wrong to say that the modified models consistently outperform the original ones because further experiments are necessary (Drago & Scozzari, 2023). As a result, there are lots of opportunities for further research. In conclusion,

many different approaches are used to study dynamic linkage in stock markets, and each has its benefits and limitations. The selection of the best methodology depends on the research question and data availability.

RESEARCH METHODOLOGY

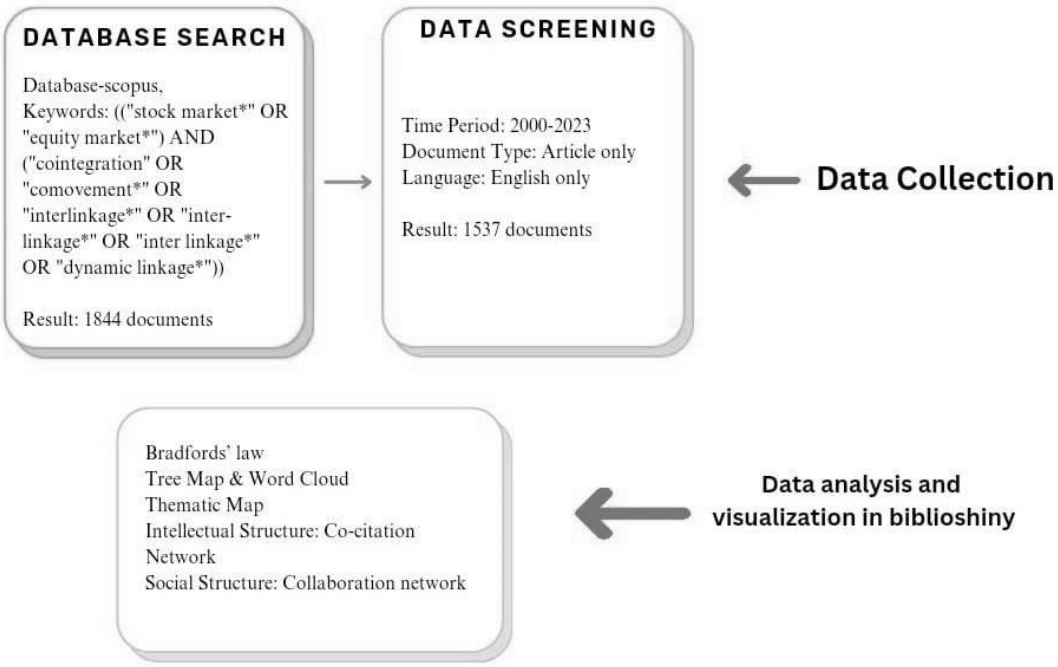


Figure 1: Bibliometric Analysis Procedure

On March 23, 2023, information from the Scopus database was compiled. The study used the Scopus database for bibliometric analysis. The final search query consists of 'TITLE-ABS-KEY' ((“stock market*” OR “equity market*”) AND (“co-integration” OR “comovement*” OR “interlinkage*” OR “inter-linkage*” OR “inter linkage*” OR “dynamic linkage*”)). Initially, 1844 documents in all languages from 1976 to 2023 were discovered on Scopus, comprising articles, books, book chapters, conference papers etc. When only English-language articles between 2000 and 2023 are included, the number of documents drops from 1844 to 1537. Bibliometrix is a software tool for bibliometric analysis using the R programming language. Unlike other software tools such as CiteSpace and VOSviewer, which mainly focus on data visualisation, Bibliometrix places equal emphasis on visualising data and ensuring statistical accuracy (Derviş, 2020). For instance, VOSviewer only offers network visualisation, whereas the bibliometrix R package allows for analysing the collection based on different levels of analysis. These levels of study include the analysis of individual articles, authors, journals, countries, citations and collaboration networks etc. Therefore, by providing different levels of analysis, Bibliometrix allows users to gain a more comprehensive understanding of a research field or topic.

The bibliometric analysis is carried out in the current study using biblioshiny, a component of the Bibliometrix R package (Bashir, 2022). Biblioshiny has unique features compared to other bibliometric software. It is helpful in the acquisition of numerous results through graphs

and tables. Fig. 1 shows the bibliometric analysis procedure.

RESULTS AND DISCUSSION

Status of the publications

Table 1: Descriptive Statistics

Description	Results
Information about Data	
Time	2000:2023
Number of Journals	451
Number of Documents	1537
Annual Growth Rate of Documents (%)	4.89
Average Age of Document	8.73
Average citations per document	21.06
References	51675
Document Contents	
Author's Keywords	2938
Keywords Plus (ID)	1354
Authors' Details	
Authors	2876
Authors (single-authored documents)	279
Authors' Collaboration	
Single-authored documents	320
Co-Authors per Document	2.4
International co-authorships (%)	25.76
Types of Documents	
articles	1537

Source: compiled by author

On March 23, 2023, information from the Scopus database was compiled. Initially, 1844 documents in all languages from 1976 to 2023 were discovered on Scopus, comprising articles, book chapters, conference papers, etc. When only English-language articles between 2000 and 2023 are included, the number of documents drops from 1844 to 1537. Table 1 shows these articles' statistical summaries. Bibliometrix and biblioshiny packages are used for data analysis. The article's description of the stock market interlinkage theme is shown in Table 1. The information was collected from the Scopus database between 2000 and 2023. The Scopus database contains 1537 articles on stock market interlinkage. This topic's annual growth rate is 4.89%. A document receives 21.06 citations on average. On this theme, 2876 authors have contributed.

Publications and citations trend in current literature

Table 2: Annual Average Citation

Year	N	MeanTCper Year	Year	N	MeanTCper Year
2000	11	2.96	2012	75	2.57
2001	17	1.16	2013	82	1.66
2002	29	5.58	2014	81	1.58
2003	37	1.78	2015	79	1.83
2004	28	1.46	2016	77	2.43
2005	40	2.14	2017	90	2.15
2006	35	2.09	2018	96	1.9
2007	39	1.83	2019	84	3.11
2008	53	1.39	2020	102	1.74
2009	77	2.58	2021	109	1.7
2010	61	2.08	2022	140	1.18
2011	62	2.52	2023 (till March 23, 2023)	33	0.61

Source: compiled by author

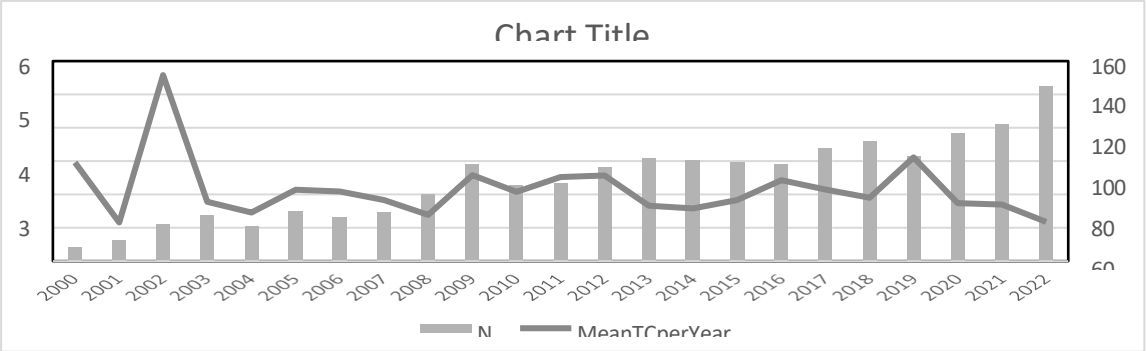


Figure 2: Annual publication and citation trend

Figure 2 displays the number of published papers and their average annual citations. The bars represent the number of papers published, while the grey line shows the average annual citations. The same information is displayed in tabular form in Table 2. Figure 2 is the graphical representation of the number of published documents and the average citation per year. The data used in this analysis was collected from Scopus on March 23, 2023, therefore, Figure 2 depicts the publication trends from 2000 to 2022, excluding the incomplete data for 2023. However, Table 2 shows the data from 2000 to March 23, 2023. It is noteworthy that the publications related to stock market interlinkage demonstrated a positive trend from 2019-2022. The year 2022 experienced the highest number of published documents, with 140 papers. This indicates that more articles on this topic were published in 2022 than in any previous year. The paper with the most citations on a yearly average basis was published in 2002 and received

5.58 citations. It provides a glimpse of publication and citation trends in current literature.

Most productive contributors

Figure 3 show the top 10 most relevant research papers published by each journal. It displays the names of the most famous journals and the number of published documents. The amount and importance of the research themes are indicated by how dark the grey colour appears. Applied Economics is the most productive journal that focuses on stock market interlinkage.

Figure 3: Top 10 Productive sources

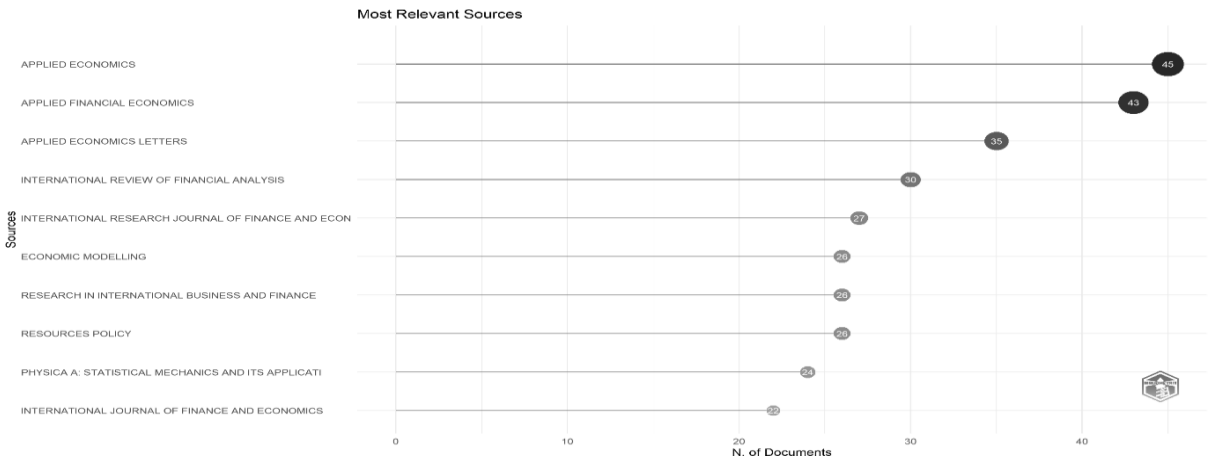


Table 3: Journal rankings according to Bradford's Law

SO	Rank	Freq	cumFreq	Zone
Applied Economics	1	45	45	Zone one
Applied Financial Economics	2	43	88	Zone one
Applied Economics Letters	3	35	123	Zone one
International Review of Financial Analysis	4	30	153	Zone one
International Research Journal of Finance and Economics	5	27	180	Zone one
Economic Modelling	6	26	206	Zone one
Research In International Business and Finance	7	26	232	Zone one
Resources Policy	8	26	258	Zone one
Physica A: Statistical Mechanics and Its Applications	9	24	282	Zone one
International Journal of Finance and Economics	10	22	304	Zone one

Source: compiled by author

Table 3 displays the journal ranking according to Bradford's law, and Figure 4 is a graphical representation of it. Bradford's law is usually used to assess journal productivity (Y.-S. Chen & Leimkuhler, 1987). It is a bibliometric principle that states that scientific literature can be divided into three zones or parts, where the number of articles in each Zone follows a logarithmic distribution. The principle was first proposed by Samuel Bradford in 1934. According to this law, if journals in a research field are arranged according to the number of articles published in them, then the number of articles published in the first set of journals will be greater than in the second. The number in the second set will be greater than in the third set, and so on. This pattern is called the "Bradford distribution" or the "Bradford zone". It helps to identify the core journals in a particular field. Based on their classification under Bradford's law, the Table lists the top 10 research journals. This law classifies scholarly publications into three groups, with Zone 1 being the most significant because it contains key research journals that disseminate works about "stock market linkage". Due to its substantial research contributions, this region is also known as the nuclear Zone. Based on the analysis of 451 research journals, 22 come under Zone 1, 74 under Zone 2, and 355 under Zone 3.

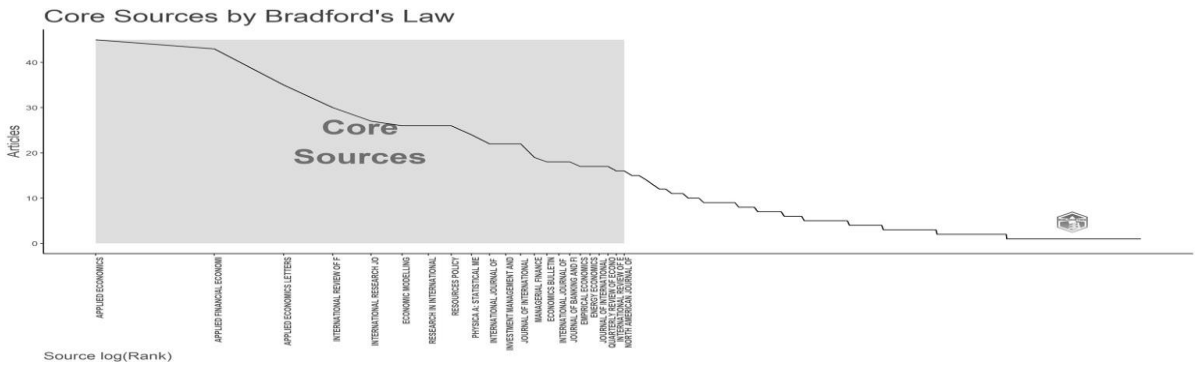


Figure 4 Journal rankings according to Bradford's Law

Figure 5 shows the top 10 authors who have researched stock market interlinkage. Thirteen articles by Chang T have been written on stock market interlinkage. Twelve articles on this topic have been written by Gupta R. Eleven articles on this topic have been written by Laopodis NT. Chang T is the most productive author. Figure 6 shows the top 10 authors' production from 2001 to 2022. Chang T has significantly contributed to the "stock market interlinkage" research topic. He published articles titled "Predicting Stock Market Movements with a Time-Varying Consumption-Aggregate Wealth Ratio" in 2019, with a citation score of 5, in 2014, "International Equity Diversification between the United States and BRICS Countries", having a citation score of 12, and in 2011 "Revisiting Rational Bubbles in the G-7 Stock Market Using the Fourier Unit Root Test and the Non-Parametric Rank Test for Co-integration" having citation score of 11. He published 13 articles from 2001 to 2019. Gupta R published articles titled "Co-integration relationship and time-varying comovements among Indian and Asian developed stock market" in 2012 with a citation score of 94 and "Trade and Investment Linkages and Stock Market Long-Run Relationship" in 2016 with a citation score of 3. He published 12 articles from 2011 to 2019. Laopodis NT published an article, "Dynamic linkages among cryptocurrencies, exchange rates and global equity markets", in 2019 with a citation score of 33. He published 11 articles from 2002 to 2020.

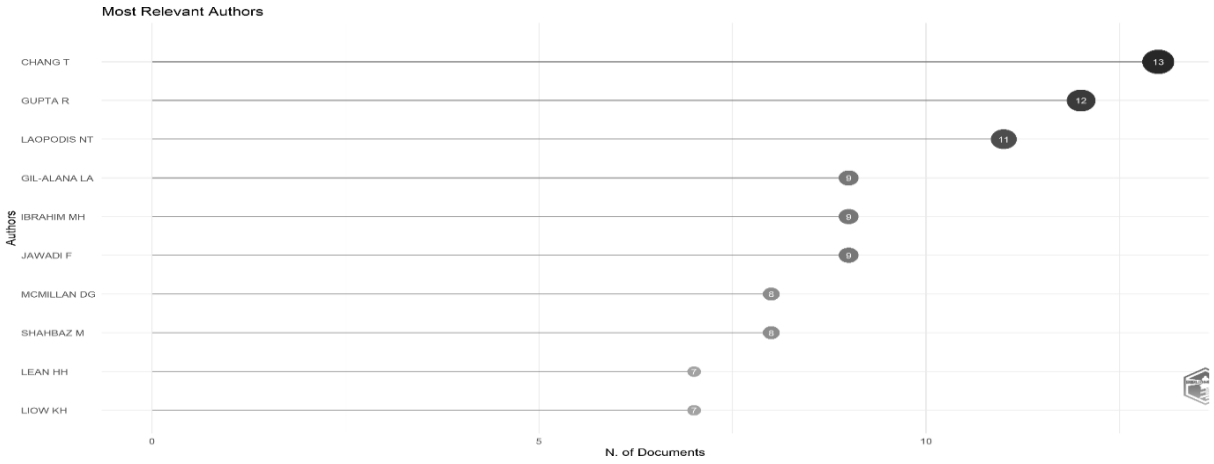


Figure 5: Top 10 Productive Authors

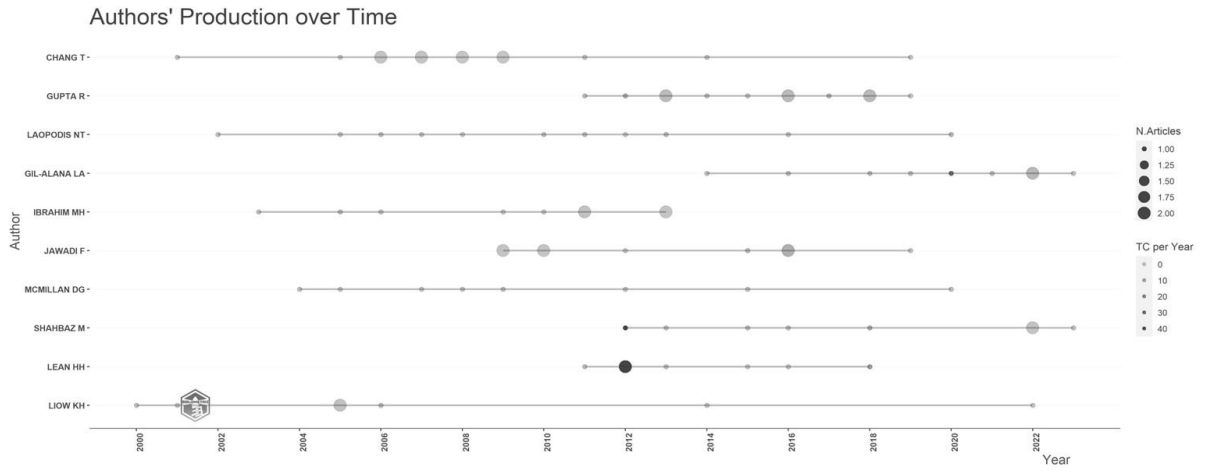


Figure 6 Authors' production over time

Figure 7 shows the top 10 countries concerning SCP and MCP. The red box shows the MCP (Multiple Country Publication), and the blue box shows the SCP (Single Country Publication).

The tabular representation of the same information is given in Table 4. China is ranked first with 147 publications as it has the highest number of authors' correspondence. Out of these 147 publications, 112 are single-country authored publications, and 35 are multiple-country authored publications. The USA is ranked second with 143 articles. Of these 143 articles, 99 are single-country authored publications, and 44 are multiple-country authored publications. India is ranked third with 126 articles. Of these 126 publications, 109 are single-country authored publications, and 17 are multiple-country authored publications. All the countries have more SCP than MCP.

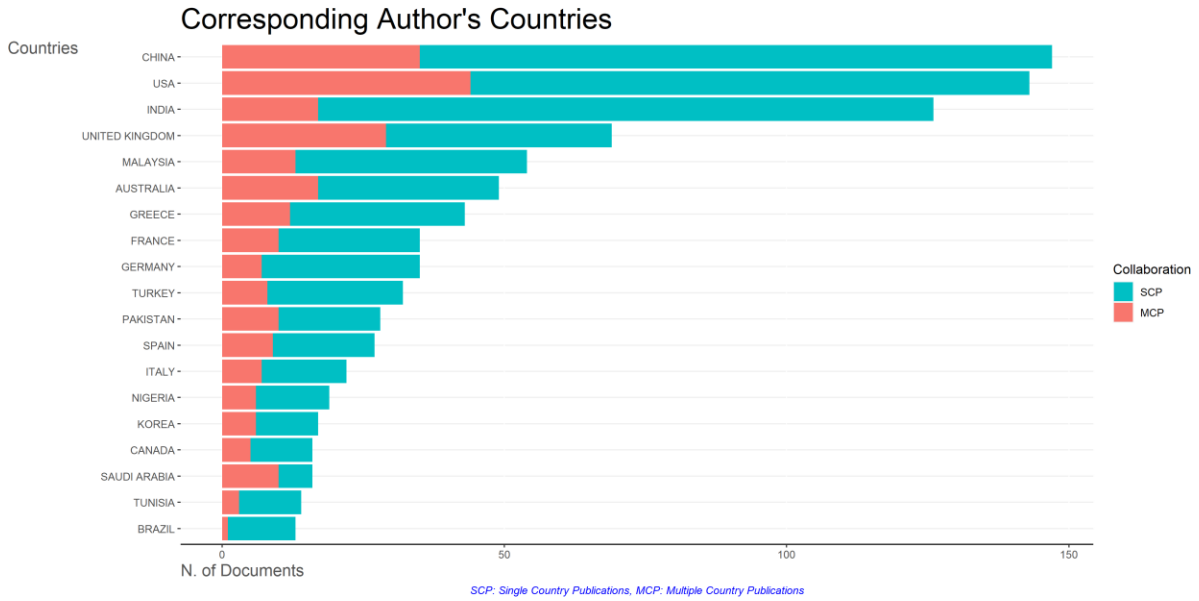


Figure 7: Most Productive Countries Table 4: Top 10 Productive Countries

Country	Articles	SCP	MCP	Freq	MCP_Ratio
China	147	112	35	0.096	0.238
USA	143	99	44	0.093	0.308
India	126	109	17	0.082	0.135
United Kingdom	69	40	29	0.045	0.42
Malaysia	54	41	13	0.035	0.241
Australia	49	32	17	0.032	0.347
Greece	43	31	12	0.028	0.279
France	35	25	10	0.023	0.286
Germany	35	28	7	0.023	0.2
Turkey	32	24	8	0.021	0.25

Source: compiled by author

Most influential contributors

Table 5: Top 10 influential journals

Source	h_index	g_index	TC	NP	PY_start
International Review of Financial Analysis	17	30	1112	30	2000
Applied Economics	15	22	613	45	2001
Journal of Banking and Finance	15	18	1574	18	2000
Physica A: Statistical Mechanics and its Applications	15	23	537	24	2007
Research In International Business and Finance	15	26	782	26	2005
Applied Financial Economics	14	29	880	43	2000
Economic Modelling	14	26	790	26	2005
Journal of International Financial Markets, Institutions and Money	14	22	764	22	2003
Journal of Energy Economics	14	17	1551	17	2001
	13	17	1239	17	2009

Source: compiled by author

Table 5 lists the h-index, g-index, total citations, total publications, and publication starting year. Moreover, the significance of each journal that publishes research on stock market interlinkage is considered by calculating their h-index and g-index, shown in the above Table. The International Review of Financial Analysis holds the top position with an h-index of 17 and a g-index of 30. Applied Economics is the journal with an h-index value of 15 and a g-index of 22, in second place. The Journal of Banking and Finance has an h-index value of 15 and a g-index of 18 in third place.

Table 6: Author's Impact Table

Element	h_index	g_index	m_index	TC	NP	PY_start
Gupta R	10	12	0.769	272	12	2011
Laopodis Nt	9	11	0.409	191	11	2002
Gil-Alana La	6	9	0.6	191	9	2014
Lucey Bm	6	6	0.353	317	6	2007
Mcmillan Dg	6	8	0.3	87	8	2004
Yang J	6	6	0.286	555	6	2003
Chang T	5	7	0.217	61	13	2001
Dajcman S	5	5	0.417	133	5	2012
Hammoudeh S	5	6	0.278	280	6	2006
Jawadi F	5	9	0.333	112	9	2009

Source: compiled by author

In Table 6, each row represents the name of the authors, and the columns represent different metrics used to measure an author's research impact. Gupta R has an h-index of 10, suggesting

he has published at least 10 articles with 10 or more citations each. Additionally, his g-index is 12, indicating he has published a minimum of 12 articles, each with at least 144 (12^2) citations. His m-index is 0.769 and he has a total of 272 citations. Furthermore, He has 12 publications and his first publication was in the year 2000. By these metrics, it's evident that Gupta R. is the most influential author, followed by Laopodis N. and Gil-Alana L. as the next most prominent authors.

Figure 8 shows the total number of citations for research produced by authors from different countries. The Top three countries are the United States, China, and India. The United States has received the highest number of citations, with 5,076. China is the second-highest country in terms of citations, with 3,041 citations, and India comes in third with 589 citations.

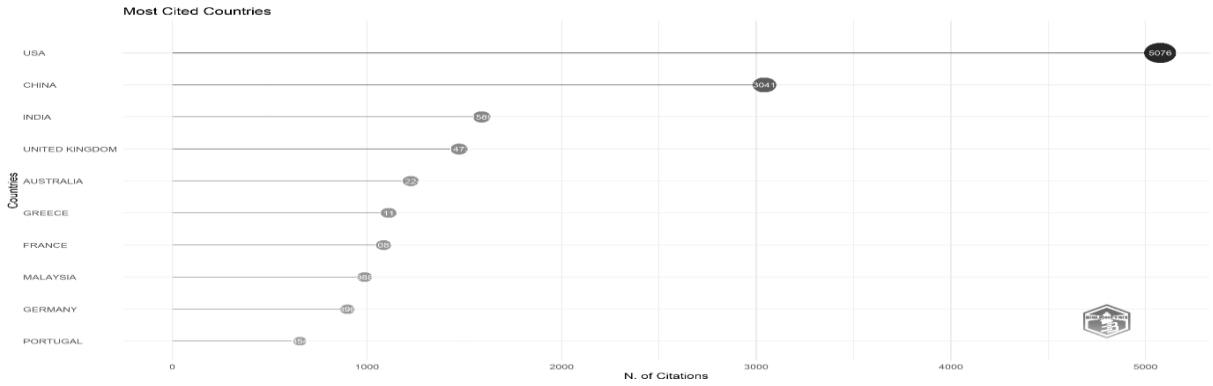


Figure 8: Top 10 cited countries

Most frequent keywords

The word cloud in Figure 9 displays the words that appear most frequently in a collection of papers related to the stock market interlinkage. The most dominant words are positioned in the word cloud's center and represented by larger font sizes. The word cloud clearly shows the word "co-integration", which appears the most frequently in this collection. The term "stock market" is the next most often-used word. When assessing the overall impact of research within a topic, keyword frequency data should be taken into account along with other aspects, including the quality and significance of the study.

Figure 10 shows the Tree Map of keywords. A tree map of keywords is a visual representation of data that shows the relative relevance or frequency of certain words. In a tree map, each keyword is represented by a rectangle, and the size of the rectangle corresponds to the frequency or importance of the keyword. The larger the rectangle, the more frequent or important the keyword. A tree map of keywords related to the field of "stock market interlinkage" shows that the most frequently occurring keyword is "co-integration" (20%), followed by "stock market" (8%).

Figure 9: Word Cloud

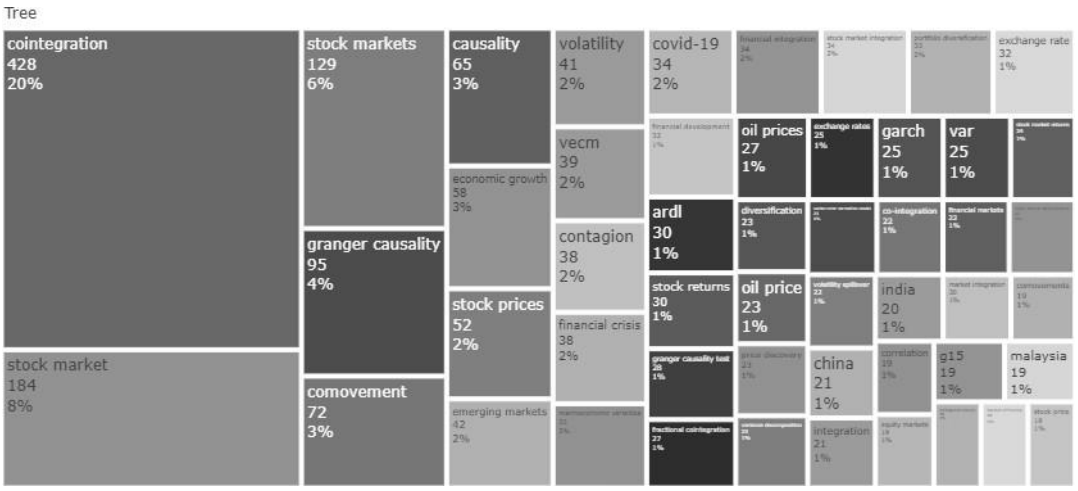
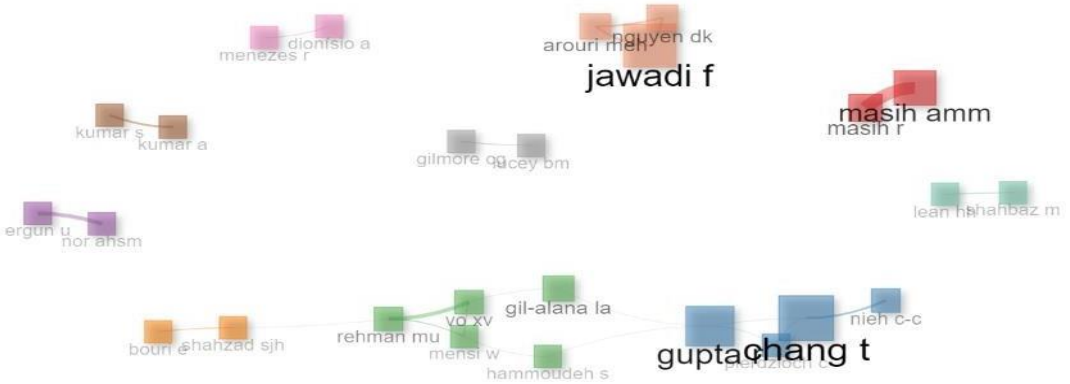


Figure 10: Tree Map

Social structure of papers

Collaboration network analysis is used to map the social structure of a field. Figure 11 shows the research collaboration network of authors. Social structure refers to the patterns of collaboration and interaction between authors in a particular field of study. The co-authorship network reveals groups of authors who have worked closely together on a specific subject or research question. It also pinpoints significant authors who have strong ties to other authors in the network. Figure 11 demonstrates ten clusters of different colours. Each square in the diagram symbolises an individual author, and the colours of the square reflect various clusters or groups of authors who have worked together. Authors in the same cluster are closely related and have worked together. The green cluster shows that Rehman, Vo, Mensi, Gil-Alana, and Hammoudeh are closely related and have worked together.

Figure 11: Authors' Research Collaboration Table 7: Countries' Collaboration



F

From	To	Frequency
China	USA	17
USA	United Kingdom	15
China	Pakistan	14
China	United Kingdom	13
USA	Australia	12
United Kingdom	Australia	11
China	Australia	10
China	Hong Kong	10

Source: compiled by author

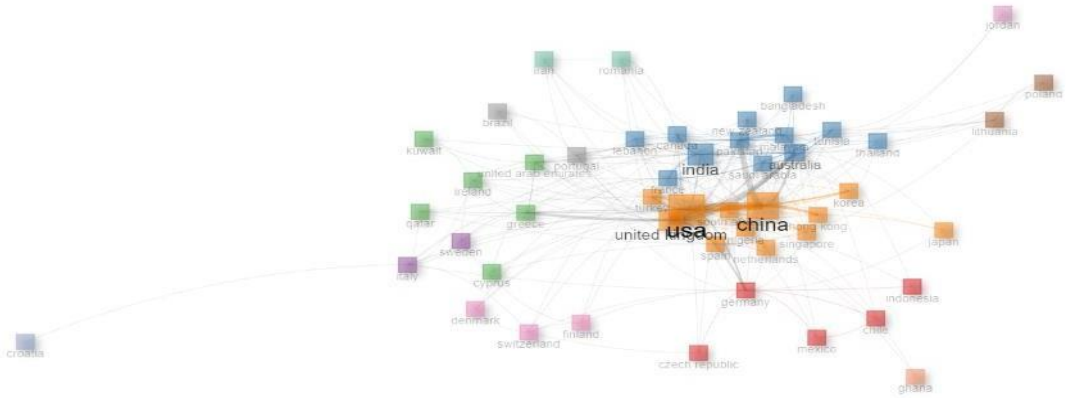


Figure 12: Countries' Research Collaboration

Table 7 displays the level of collaboration between scholars from various nations on research initiatives and publications. China and the USA have the highest number of joint research projects, i.e., 17. The subsequent highest collaborations involve the USA and the United Kingdom, with 15 publications. Figure 12 shows the graphical representation of the research collaboration network of countries. In the diagram, each square represents a country, and the colours of the square represent different clusters or groups of countries that have collaborated. The colours of the square represent several clusters of different colours. The countries which are placed in the same cluster in a collaboration diagram, are closely connected and have engaged in significant collaboration. The Orange cluster shows that countries like the USA,

China, and the United Kingdom have the highest academic and scientific collaboration in scholarly literature. Collaboration between academics from other nations is becoming increasingly crucial since it allows for sharing of knowledge, resources, and ideas and can result in more significant and innovative research. Country collaboration is an essential aspect of modern research and is critical in advancing knowledge and driving innovation. More impactful and comprehensive studies can be developed by fostering greater collaboration between researchers from different countries.

Intellectual structure of papers

Co-citation network analysis is used to map the intellectual structure of a field. Figure 13 shows the co-citation network of articles. The frequency with which two papers are cited is examined using this technique. Researchers can utilise this information to identify the most read publications and collections of related papers, enabling them to understand a particular field better. In Fig. 13, each square represents paper, and the colours of the square represent different clusters or groups of co-cited publications. The diagram's grouping of papers reveals a substantial correlation between co-citations—the colours of the square stand in for the two distinct colour clusters of red and blue. A co-citation network diagram with two clusters is used to visualise and understand co-citation patterns and interactions between publications in a particular field. Some papers such as "Dynamic conditional correlation: A simple class of multivariate generalised autoregressive conditional heteroskedasticity models" (Engle, 2002), "Statistical analysis of co-integration vectors" (Johansen, 1988) and "Estimation and hypothesis testing of co-integration vectors in Gaussian vector autoregressive models" (Johansen, 1991) and "Common stochastic trends in international stock markets" (Kasa, 1992), are present in both the clusters indicating that these papers are influential and serve as key references.

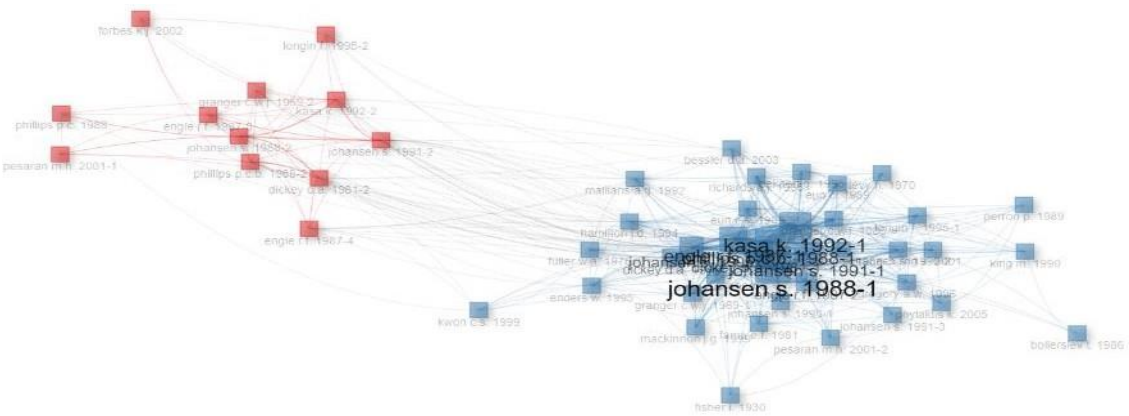


Figure 13: Co-citation network

Significant themes

Table 8: Themes and Keywords' Frequency

Main indicators	Theme	Keywords' frequency

Fractional co-integration, fractional integration, long memory	Motor themes	Fractional co-integration (27), fractional integration (13), long memory (10), stock market volatility (10)
Co-integration, stock market and granger causality	Basic Themes	Co-integration (428), stock market (184), granger causality (95), causality (65), stock prices (52), VECM (39), macroeconomic variables (35), financial integration (34), exchange rate (32), ardl (30)
Economic growth, financial development, stock market development	Basic Themes	Economic growth (58), financial development (32), stock market development (22), panel co-integration (15), emerging economies (9), foreign direct investment (9)
Stock markets, comovement, emerging markets	Basic Themes	Stock markets (128), comovement (72), emerging markets (42), volatility (41), contagion (38), financial crisis (38), covid-19 (34), stock market integration (34), portfolio diversification (33), garch (25)
Integration, g15, c32	Niche Themes	Integration (21), g15 (19), c32 (9), economic integration (9), linkages (9), unit roots (9) and vector autoregression (9)
International portfolio diversification	Niche Themes	International portfolio diversification (9)
Pairs trading		
copula		
Covid-19 pandemic		

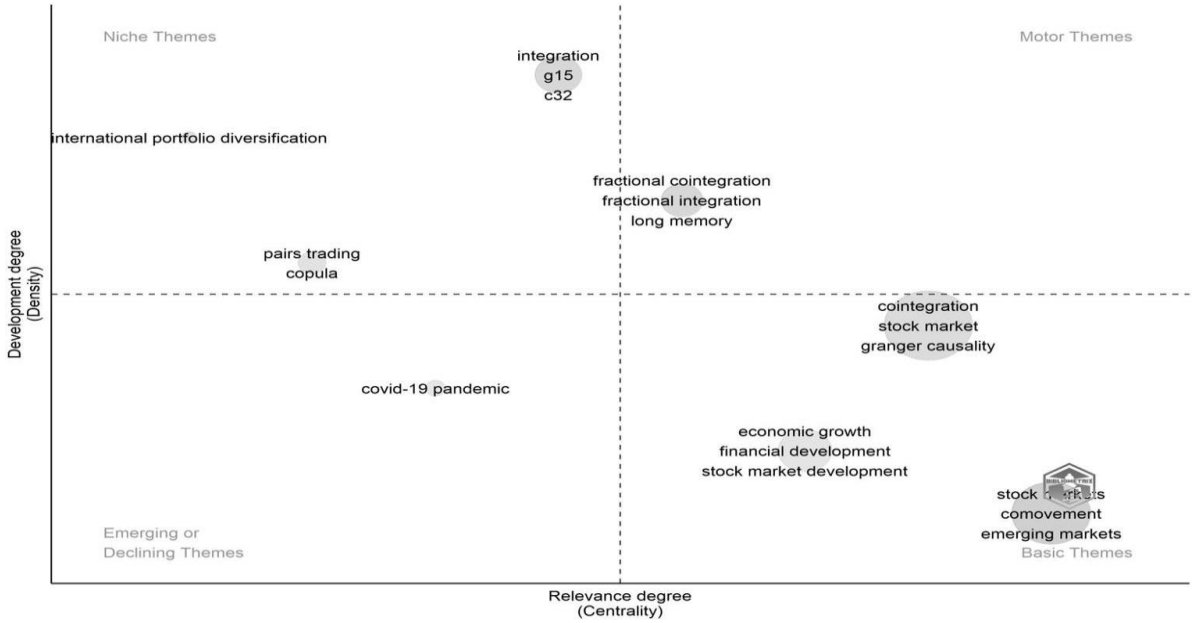
Source: compiled by author

portfolio diversification are isolated yet well-developed.

Figure 14: Basic and declining themes

Future research directions

Every investor wants to maximise their return or minimise their risk, which can be done with the help of portfolio diversification. Understanding the interlinkage between the financial is important for portfolio diversification. Investing in stocks provides limited diversification. Therefore, investments should be diversified across different financial markets. Investors invest in equity and bonds to diversify portfolios as bond and stock returns are inversely and significantly related (Kolluri et al., 2015) however, Inflation negatively affects stock prices (Quayes & Jamal, 2008). This relationship between stock and bond becomes positive during



the high inflationary period (Andersson et al., 2007); therefore, it can be said that a stock-bond portfolio fails to provide diversification benefits during the inflationary period. Over time, this change in the relationship between stocks and bonds may pose a challenge for asset allocation. So, now it's time to add commodities also in the portfolio because commodity futures offer significant diversification benefits to equity investors (Conover et al., 2010), commodity and stock returns show a low correlation during an inflationary period; therefore, commodities act as a hedge against Inflation (Charfeddine & Benlagha, 2016; Purankar & Singh, 2017). Equity-commodity portfolio provides maximum return with minimum risk compared to investment in only commodity and only equity (Perumandla, 2018), but there is some controversy regarding the stock-commodity relationship. Some previous studies found a negative and low relationship between stock and commodity market (Perumandla, 2018), while others showed a positive relationship between stock and commodity (Chen & Lin, 2014; Drake, 2022). All this discussion emphasises the need to explore the relationship between different financial markets, such as the relationship between the stock market, bonds market, commodity market, and currency market, etc. The interconnectedness of these markets means that movements in one market can have a contagion effect on others, which has important implications for investment decisions and risk management. The study stressed the importance of further researching how dynamic linkages between different financial markets can affect portfolio diversification and risk management strategies. This indicates the need for more in-depth analysis to understand

how such linkages impact investment decisions and risk mitigation practices. Understanding connections between different financial markets can help investors, portfolio managers, and policymakers to make informed decisions about investments, policy-making, and risk management. Besides this, other statistical models have been used to examine the linkage between financial markets. The Estimation accuracy of these statistical models may be increased using a machine learning algorithm. Therefore, further research can be done by combining statistical models with machine learning techniques.

This study will be beneficial for researchers, managers, analysts, government agencies, investors and portfolio managers. It helps researchers identify areas that need more investigation. It may be used by researchers in selecting the most valuable and educational information sources. As a result, they may be able to develop new research topics and keep up with the most recent theories. It can help researchers locate possible collaborators and experts in the stock market. Researchers can contact these people and organisations to get their opinions on research initiatives or to collaborate on research projects by identifying the most prominent authors and publications. It offers insightful information to help researchers deepen their knowledge of this field, find new research questions and areas of focus, and possibly work with other researchers and subject matter experts. Government officials can contact these individuals and groups to acquire their thoughts on suggested policies by identifying the most crucial research publications and authors. This study will be beneficial to stock market managers and data analysts. Data analysts may create more reliable models using this information, enabling them to make well-informed investment decisions, and managers can

design effective risk management strategies to lower potential losses. Portfolio managers can make more informed investment decisions, handle risks skilfully, and produce better results for their customers or investors. It provides information to investors and portfolio managers that can help them make better investment and risk management decisions. These insights can help investors create more profitable and efficient portfolios, which could result in higher returns.

CONCLUSION

The current study aims to gain knowledge of the scholarly works on stock market interlinkage to give an overview and pinpoint potential areas for future research. The study used the biblioshiny from the bibliometrix R package to analyse 1537 Scopus-indexed articles published between 2000 and 2023 to identify research patterns in stock market interlinkage. The study found that publications on stock market interlinkage continue to grow from 2019. Applied Economics is the most productive Journal, Chang T is the most productive author, and China is the most productive country. International Review of Financial Analysis is the most influential Journal, Gupta R. is the most influential author, and the United States is the most influential country. Word cloud and tree map highlight that co-integration and stock markets are the most significant keywords in the current literature.

The Collaboration Network of authors shows that the highest research collaboration exists among Gupta R, Chang T, and Jawadi F. The Collaboration Network of countries shows that the USA and the United Kingdom have the highest levels of academic collaboration in the existing literature. Some papers such as “Dynamic conditional correlation: A simple class of multivariate generalised autoregressive conditional heteroskedasticity models”, “Statistical analysis of co-integration vectors” and “Estimation and hypothesis testing of co-integration vectors in Gaussian vector autoregressive models” serve as key references. The fractional co-integration and fractional integration are motor themes. More in-depth analysis is needed to understand how financial market linkages impact diversification strategies. Further investigation of the linkages between various financial markets using a combination of statistical models with machine learning algorithms is needed as it may improve the estimation

accuracy. This study will be beneficial for researchers, policymakers, investors and portfolio managers.

REFERENCES

[1] Aggarwal, S., & Raja, A. (2019). Stock market interlinkages among the BRIC economies.

[2] *International Journal of Ethics and Systems*, *35*(1), 59–74. https://doi.org/10.1108/IJOES-04-2018-0064

[3] Alqaralleh, H., & Canepa, A. (2021). Evidence of Stock Market Contagion during the COVID-19 Pandemic: A Wavelet-Copula-GARCH Approach. *Journal of Risk and Financial Management*, *14*(7). https://doi.org/10.3390/jrfm14070329

[4] Andersson, M., Krylova, E., & Vähämaa, S. (2007). Why does the correlation between stock and bond returns vary over time? *Applied Financial Economics*, *18*(2), 139–151.

[5] https://doi.org/10.1080/09603100601057854

[6] Antonakakis, N., Chatziantoniou, I., & Gabauer, D. (2020). Refined Measures of Dynamic Connectedness based on Time-Varying Parameter Vector Autoregressions. *Journal of Risk and Financial Management*, *13*(4), 1–23. https://doi.org/10.3390/jrfm13040084

[7] Baharumshah, A. Z., Sarmidi, T., & Tan, H. B. (2003). Dynamic linkages of Asian stock markets. *Journal of the Asia Pacific Economy*, *8*(2), 180–209.

[8] https://doi.org/10.1080/1354786032000074730

[9] Balcilar, M., Gabauer, D., & Umar, Z. (2021). Crude Oil futures contracts and commodity markets: New evidence from a TVP-VAR extended joint connectedness approach.

[10] *Resources Policy*, *73*, 1–14. https://doi.org/10.1016/j.resourpol.2021.102219

[11] Bashir, M. F. (2022). Oil price shocks, stock market returns, and volatility spillovers: a bibliometric analysis and its implications. *Environmental Science and Pollution Research*, *29*(16), 22809–22828. https://doi.org/10.1007/s11356-021-18314-4

[12] Bornmann, L., & Leydesdorff, L. (2014). Scientometrics in a changing research landscape.

[13] *EMBO Reports*, *15*(12), 1228–1232. https://doi.org/10.15252/embr.201439608

[14] Bouri, E., Cepni, O., Gabauer, D., & Gupta, R. (2021). Return connectedness across asset

[15] classes around the COVID-19 outbreak. *International Review of Financial Analysis*, *73*. https://doi.org/10.1016/j.irfa.2020.101646

[16] Charfeddine, L., & Benlagha, N. (2016). A time-varying copula approach for modelling dependency: New evidence from commodity and stock markets. *Journal of*

[17] *Multinational Financial Management*, *37–38*, 168–189. https://doi.org/10.1016/j.mulfin.2016.10.003

[18] Chen, A., & Lin, J. W. (2014). The relation between gold and stocks: an analysis of

severe bear markets. *Applied Economics Letters*, *21*(3), 158–170.

[19] https://doi.org/10.1080/13504851.2013.844321

[20] Chen, J., & Yang, L. (2021). A Bibliometric Review of Volatility Spillovers in Financial

[21] Markets: Knowledge Bases and Research Fronts. *Emerging Markets Finance and Trade*, *57*(5), 1358–1379. https://doi.org/10.1080/1540496X.2019.1695119

[22] Chen, Y.-S., & Leimkuhler, F. F. (1987). Bradford's law: An index approach. *Scientometrics*, *11*(3–4), 183–198. https://doi.org/10.1007/BF02016591

[23] Choi, S.-Y. (2022). Volatility spillovers among Northeast Asia and the US: Evidence from the global financial crisis and the COVID-19 pandemic. *Economic Analysis and Policy*, *73*, 179–193. https://doi.org/10.1016/j.eap.2021.11.014

[24] Conover, C. M., Jensen, G. R., Johnson, R. R., & Mercer, J. M. (2010). Is now the time to add commodities to your portfolio? *The Journal of Investing*, *19*(3), 10–19.

[25] https://doi.org/10.3905/joi.2010.19.3.010

[26] Das, D., Kannadhasan, M., Tiwari, A. K., & Al-Yahyaee, K. H. (2018). Has co-movement

[27] dynamics in emerging stock markets changed after global financial crisis? New evidence from wavelet analysis. *Applied Economics Letters*, *25*(20), 1447–1453.

[28] https://doi.org/10.1080/13504851.2018.1430307

[29] Derviş, H. (2020). Bibliometric Analysis using Bibliometrix an R Package. *Journal of Scientometric Research*, *8*(3), 156–160. https://doi.org/10.5530/jscires.8.3.32

[30] Dhanaraj, S., Gopalaswamy, A. K., & Babu M, S. (2013). Dynamic interdependence between US and Asian markets: an empirical study. *Journal of Financial Economic Policy*, *5*(2), 220–237. https://doi.org/10.1108/17576381311329670

[31] Diebold, F. X., & Yilmaz, K. (2009). Measuring Financial Asset Return and Volatility Spillovers, with Application to Global Equity Markets. *The Economic Journal*, *119*(534), 158–171. https://doi.org/10.1111/J.1468-0297.2008.02208.X

[32] Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional

[33] measurement of volatility spillovers. *International Journal of Forecasting*, *28*(1), 57–66. https://doi.org/10.1016/j.ijforecast.2011.02.006

[34] Diebold, F. X., & Yilmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, *182*(1), 119–

[35] 134. https://doi.org/10.1016/j.jeconom.2014.04.012

[36] Doman, M., & Doman, R. (2013). Dynamic linkages between stock markets: the effects of crises and globalization. *Portuguese Economic Journal*, *12*(2), 87–112.

[37] https://doi.org/10.1007/s10258-013-0091-1

[38] Drago, C., & Scozzari, A. (2023). A network-based analysis for evaluating conditional

covariance estimates. *Mathematics*, *11*(2). https://doi.org/10.3390/math11020382

[39] Drake, P. P. (2022). The gold-stock market relationship during COVID-19. *Finance Research Letters*, *44*. https://doi.org/10.1016/j.frl.2021.102111

[40] Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics*, *20*(3), 339–350. https://doi.org/10.1198/073500102288618487

[41] Ferli, O., & Husodo, Z. A. (2013). Dynamic conditional correlation analysis Asia Pacific and Latin America equity market: interdependence and contagion. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2392160

[42] Gong, J., Wang, G.-J., Zhou, Y., Zhu, Y., Xie, C., & Foglia, M. (2023). Spreading of cross- market volatility information: Evidence from multiplex network analysis of volatility spillovers. *Journal of International Financial Markets, Institutions and Money*, *83*.

[43] https://doi.org/10.1016/j.intfin.2023.101733

[44] Gunay, S., & Can, G. (2022). The source of financial contagion and spillovers: An evaluation of the covid-19 pandemic and the global financial crisis. *PLOS ONE*, *17*(1), e0261835. https://doi.org/10.1371/JOURNAL.PONE.0261835

[45] Guo, B., & Ibhagui, O. (2019). China–Africa stock market linkages and the global financial crisis. *Journal of Asset Management*, *20*(4), 301–316. https://doi.org/10.1057/s41260- 019-00122-8

[46] Gupta, R., & Guidi, F. (2012). Cointegration relationship and time varying co-movements among Indian and Asian developed stock markets. *International Review of Financial Analysis*, *21*, 10–22. https://doi.org/10.1016/j.irfa.2011.09.001

[47] In, F., Kim, S., & Yoon, J. H. (2002). International Stock Market Linkages: Evidence from the Asian Financial Crisis. *Journal of Emerging Market Finance*, *1*(1), 1–29.

[48] https://doi.org/10.1177/097265270200100102

[49] Jhunjhunwala, S., & Suresh, S. (2020). Commodity and Stock Market Interlinkages: Opportunities and Challenges for Investors in Indian Market. *Global Business Review*, 1–17. https://doi.org/10.1177/0972150920946413

[50] Jiang, Y., Yu, M., & Hashmi, S. (2017). The financial crisis and co-movement of global stock markets—A case of six major economies. *Sustainability*, *9*(2), 260.

[51] https://doi.org/10.3390/su9020260

[52] Jiang, Y., Yu, M., Hashmi, S. M., Li, X., Zhou, J., Ke, H., & Yang, X. (2017). The Financial Crisis and Co-Movement of Global Stock Markets—A Case of Six Major Economies. *Sustainability*, *9*(2). https://doi.org/10.3390/SU9020260

[53] Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic*

[54] *Dynamics and Control*, *12*, 231–254. https://doi.org/10.1016/0165-1889(88)90041-3

[55] Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. In *Source: Econometrica* (Vol. 59, Issue 6).

[56] Kasa, K. (1992). Common stochastic trends in international stock markets. *Journal of Monetary Economics*, *29*(1), 95-124.

[57] Khan, A., Goodell, J. W., Hassan, M. K., & Paltrinieri, A. (2022). A bibliometric review of finance bibliometric papers. *Finance Research Letters*, *47*.

[58] https://doi.org/10.1016/j.frl.2021.102520

[59] Kolluri, B., Wahab, S., & Wahab, M. (2015). An examination of co-movements of India's stock and government bond markets. *Journal of Asian Economics*, *41*, 39–56.

[60] https://doi.org/10.1016/J.ASIECO.2015.10.001

[61] Kostika, E., & Laopodis, N. T. (2019). Dynamic linkages among cryptocurrencies, exchange rates and global equity markets. *Studies in Economics and Finance*, *37*(2), 243–265.

[62] https://doi.org/10.1108/SEF-01-2019-0032

[63] Lastrapes, W. D., & Wiesen, T. F. P. (2021). The joint spillover index. *Economic Modelling*, *94*, 681–691. https://doi.org/10.1016/J.ECONMOD.2020.02.010

[64] Lee, S. Bin, & Kim, K. J. (1993). DOES THE OCTOBER 1987 CRASH STRENGTHEN THE CO-MOVEMENTS AMONG NATIONAL STOCK MARKETS? *Review of*

[65] *Financial Economics*, *3*(1), 89–102. https://doi.org/10.1002/J.1873-5924.1993.TB00574.X

[66] Lee, S. Il, & Yoo, S. J. (2020). Multimodal deep learning for finance: integrating and forecasting international stock markets. *The Journal of Supercomputing*, *76*(10), 8294– 8312. https://doi.org/10.1007/s11227-019-03101-3

[67] Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, *7*(1). https://doi.org/10.2307/2975974

[68] Marozva, G. (2017). Africa stock markets cross-market linkages: A time-varying Dynamic Conditional Correlations (DCC-GARCH) Approach. *Journal of Applied Business*

[69] *Research (JABR)*, *33*(2), 321–328. https://doi.org/10.19030/jabr.v33i2.9904

[70] Masih, R., & Masih, A. M. M. (2001). Long and short term dynamic causal transmission amongst international stock markets. *Journal of International Money and Finance*, *20*(4), 563–587. https://doi.org/10.1016/S0261-5606(01)00012-2

[71] Mensi, W., Nekhili, R., Vo, X. V., & Kang, S. H. (2021). Good and bad high-frequency volatility spillovers among developed and emerging stock markets. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJOEM-01-2021-0074

[72] Mohamed Dahir, A., Mahat, F., Ab Razak, N. H., & Bany-Ariffin, A. N. (2018). Revisiting

[73] the dynamic relationship between exchange rates and stock prices in BRICS countries: A wavelet analysis. *Borsa Istanbul Review*, *18*(2), 101–113.

[74] https://doi.org/10.1016/j.bir.2017.10.001

[75] Naeem, M., Hamouda, F., & Karim, S. (2023). Return and volatility spillovers among global assets: Comparing health crisis with geopolitical crisis. *International Review of*

[76] *Economics & Finance*, *87*, 557–575.

[77] https://www.sciencedirect.com/science/article/pii/S1059056023001764

[78] Narayan, P., Smyth, R., & Nandha, M. (2004). Interdependence and dynamic linkages

[79] between the emerging stock markets of South Asia. *Accounting and Finance*, *44*(3). https://doi.org/10.1111/j.1467-629x.2004.00113.x

[80] Ni, J., & Xu, Y. (2023). Forecasting the dynamic correlation of stock indices based on deep learning method. *Computational Economics*, *61*(1), 35–55.

[81] https://doi.org/10.1007/s10614-021-10198-3

[82] Obadiaru, E. D., Obasaju, B. O., Omankhanlen, A. E., & Eyiolorunshe, D. T. (2020).

[83] Dynamic links between the Nigerian equity market and those of selected regional and developed countries. *Heliyon*, *6*(9). https://doi.org/10.1016/j.heliyon.2020.e04782

[84] Omane-Adjepong, M., Alagidede, I. P., Dramani, J. B., Omane-Adjepong, M., Alagidede, I. P., & Dramani, J. B. (2020). COVID-19 Outbreak and Co-Movement of Global Markets: Insight from Dynamic Wavelet Correlation Analysis. *Wavelet Theory*.

[85] https://doi.org/10.5772/INTECHOPEN.95098

[86] Perumandla, S. (2018). Time-varying correlations, causality, and volatility linkages of Indian commodity and equity markets: evidence from DCC - GARCH. *Indian Journal of*

[87] *Finance*, *12*(9). https://doi.org/10.17010/ijf/2018/v12i9/131558

[88] Purankar, S. A., & Singh, V. K. (2017). Portfolio co-integration dynamics of metal and energy commodities: evidence from India. *International Journal of Management Practice*, *10*(3), 273–294. https://doi.org/10.1504/IJMP.2017.084951

[89] Quayes, S., & Jamal, A. (2008). Does inflation affect stock prices? *Applied Economics Letters*, *15*(10), 767–769. https://doi.org/10.1080/13504850600770871

[90] Sclip, A., Dreassi, A., Miani, S., & Paltrinieri, A. (2016). Dynamic correlations and volatility linkages between stocks and sukuk: Evidence from international markets. *Review of*

[91] *Financial Economics*, *31*(1), 34–44. https://doi.org/10.1016/j.rfe.2016.06.005

[92] Shahzad, S. J. H., Naeem, M. A., Peng, Z., & Bouri, E. (2021). Asymmetric volatility

[93] spillover among Chinese sectors during COVID-19. *International Review of Financial Analysis*, *75*. https://doi.org/10.1016/j.irfa.2021.101754

[94] So, M. K. P., Chan, L. S. H., & Chu, A. M. Y. (2021). Financial network connectedness and systemic risk during the covid-19 pandemic. *Asia-Pacific Financial Markets*, *28*(4), 649–665. https://doi.org/10.1007/s10690-021-09340-w

[95] Solnik, B. H. (1974). Why Not Diversify Internationally Rather Than Domestically?

[96] *Financial Analysts Journal*, *30*(4), 48–54. https://doi.org/10.2469/FAJ.V30.N4.48

[97] Wang, L. (2014). Who moves East Asian stock markets? The role of the 2007–2009 global

[98] financial crisis. *Journal of International Financial Markets, Institutions and Money*, *28*, 182–203. https://doi.org/10.1016/j.intfin.2013.11.003

[99] Wang, P., & Moore, T. (2008). Stock market integration for the transition economies: Time- varying conditional correlation approach. *The Manchester School*, *76*, 116–133.

[100] https://doi.org/10.1111/j.1467-9957.2008.01083.x

[101] Wang, R., & Li, L. (2020). Dynamic relationship between the stock market and

[102] macroeconomy in China (1995–2018): new evidence from the continuous wavelet analysis. *Economic Research-Ekonomska Istraživanja*, *33*(1), 521–539.

[103] https://doi.org/10.1080/1331677X.2020.1716264

[104] Yadav, M. P., Sharma, S., & Bhardwaj, I. (2023). Volatility spillover between Chinese stock market and selected emerging economies: a dynamic conditional correlation and portfolio optimization perspective. *Asia-Pacific Financial Markets*, *30*(2), 427–444.

[105] https://doi.org/10.1007/s10690-022-09381-9