

ASYMMETRIC VOLATILITY AND LEVERAGE EFFECT IN STOCK MARKET: A BIBLIOMETRIC REVIEW

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ABSTRACT. This paper aims to provide quantitative statistics and a comprehensive review of the key influential and intellectual structure of asymmetric volatility and leverage effect in the stock market. This study reviews 271 articles and review papers published in scientific journals indexed by the Scopus database from 1994 to 2021. VOSviewer and Excel software are used to analyse the collected data and apply the bibliometric tests such as citation analysis of documents, source, authors, institutions and countries, Co-occurrence analysis of author keywords, co-authorship and Bibliographic coupling of authors, source and countries. By analysing the growth in this topic, during the first 10 years, the publication in this topic was considerably less. After that, until 2020, the growth is remarkable. Further, the study identifies the most influential and impactful authors, journals, institutions, and countries to asymmetric volatility and leverage effect in the stock market. To the best of the author's knowledge, this is one of the first papers to address the literature of asymmetric volatility and leverage effect in the stock market from a bibliometric aspect. It helps researchers and other academicians to explore and build a quantitative base regarding the scientific development of asymmetric volatility and leverage effect in the stock market.

1. INTRODUCTION

One key aspect of the stock market that has long attracted much attention in the financial literature is the analysis of the stock returns and their volatility. Volatility is used to measure the market risk of a single instrument or an entire portfolio of instruments. Changes in the level of market volatility can have an important effect on capital investment, consumption, and other business cycle variables (Schwert 1989, 85). Volatility tends to decline as the stock market rises and increases as the market falls (Bhowmik 2013, 2). A growing body of empirical evidence suggests that investor attention fluctuates over time and that will impact assets price. Similarly. The stock return volatility and risk premia increase with attention (Andrei & Hasler 2015, 34-35).

Empirically, contemporaneous returns and conditional return volatility are negatively correlated. This phenomenon is often referred to as asymmetric volatility. It is most apparent during stock market crashes. One of the explanations for this phenomenon proposed by (Black, 1976) is called the leverage effect. He proposed that a negative return increase stock volatility than a positive return of the same magnitude (Goudarzi & Ramanarayanan 2011, 221-222) (Bekaert & Wu, n.d.). (Black, 1976) and (Christie, 1982) were among the first to document the volatility asymmetry, and provide an explanation to this asymmetry based on the leverage hypothesis. This leverage effect has become synonymous with asymmetric volatility (Wang & Mykland

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2014, 197-198). It suggests that a negative return should make the firm more levered, hence riskier and therefore lead to higher volatility. As the asset price decline, companies become mechanically more leveraged (depending on debt) since the relative value of their debt rises relative to that of their equity as a result stocks become riskier and volatile. Further, (Hens & Steude 2009, 83-94) provide clear evidence that indeed the leverage effect is not fully explained by the capital structure of the firm.

The literature agrees that bad news increases volatility but disagree over the impact of good news on the stock market volatility (Malik 2011, 545-546). Since the stock volatility is highly persistent, the news brings higher current volatility and thus increase the future volatility. According to Efficient Market Hypothesis (EMH), the stock prices are expected to adjust to information very quickly and this information is a potential source of much of the volatility. One of the striking empirically observed phenomenon in the stock market is the asymmetric response of volatility to news/information (Blasco et al. 2002, 1227-8). Stock traders in a given market incorporate into their buy and sell decisions not only information generated from the domestic market but also information flow from other markets (Koutmos & Geoffrey Booth 1995, 747).

Conditional heteroskedastic models are the basic econometric tools used to estimate and forecast asset return volatility (Alberg et al. 2008, 1201). Both the ARCH and GARCH models capture volatility clustering and leptokurtosis, but as their distribution is symmetric, they fail to model the asymmetric volatility or leverage effect. To address this gap, non-linear GARCH models including EGARCH (Exponential GARCH) by Nelson, 1991, GJR GARCH (Glosten, et al., 1993) and APGARCH (Asymmetric Power GARCH) by Ding, et al., 1993 were introduced. The Extended Multivariate Exponential Generalised Autoregressive Conditionally Heteroskedastic (EAGRCH) model is best to capture the asymmetric impact of good news (market advances) and bad news (market declines) on volatility transmission (Horpestad et al. 2019, 542). Further, (Karmakar 2007, 100) propose that the GARCH-M model has an advantage over the GARCH specification. The basic GARCH model is based on the implicit assumption that the average risk premium is constant for the sample period. The GARCH-M specification relaxes these restrictions by allowing the velocity feedback effect to become operations. A new measure of asymmetric volatility; the News Impact Curve proposed by (Engle & Ng 1993, 1749-78), measure how new information is incorporated into volatility estimates. The diagnostic tests for volatility models: the Sign Bias Test, the Negative Size Bias Test, and the Positive Size Bias Test extended the scope for estimation of asymmetric volatility.

The main purpose of this paper is to conduct a thorough review of the literature along with identifying the gaps while presenting future research directions. More specifically, we mainly deal with the following research questions:

RQ1: What is the trend or pattern of knowledge development in the area of asymmetric volatility and leverage effect in the stock market?

RQ2: Which are the influential papers of Asymmetric volatility and leverage effect in the stock market?

RQ3: Who are the impactful and influential authors on this topic?

RQ4: Which are the productive institutions and countries on this topic?

RQ4: What are the main gaps and future research directions to further explore asymmetric volatility and leverage effect in the stock market?

These research questions are transformed to following research objectives:

1. To draw out the trend and pattern of publication in asymmetric volatility and leverage effect in the stock market.
2. To elicit influential and impactful authors, documents and sources in asymmetric volatility and leverage effect in the stock market.
3. To identify the most productive institutions and countries in this field of research.
4. To address the gap in this existing literature and to propose the future scope of research in this area.

The remaining part of this paper is structured as follows. The next section presents the background of asymmetric volatility and leverage effect, followed by methodology used in this work. Section 4 shows the analysis result, followed by section 5, which develop a graphical analysis of the bibliometric data in Scopus. The last section concludes the main findings, limitations and scope of future research.

2. BACKGROUND OF ASYMMETRIC VOLATILITY AND LEVERAGE EFFECT

Understanding the relation between stock returns and innovations in expected volatility is a fundamental issue in financial market. The phenomenon that negatives return shocks tends to imply higher future volatility than positive return shock of same magnitude is referred to as Asymmetric Volatility Phenomenon (AVP) (Dennis, Mayhew, and Stivers 2006, 382-384). The financial leverage effect, the volatility feedback effect and behavioral theories are the three main explanations for this (Horpestad et al. 2019, 1). The phenomenon of leverage effect was first documented by "Black, F. 1976 and Christie 1982, evidenced that a drop in the value of the stock increases financial leverage, which make the stock riskier and then increases its volatility. The volatility feedback effect suggests that an increase in volatility requires a higher rate of asset return, which only occurs when there is a drop in the asset price (Horpestad et al. 2019,2) If volatility is priced, an anticipated increase in volatility raises the required return on equity, leading to an immediate stock price decline (Bekaert and Wu 2000, 1-2).

The determinant of asymmetric volatility remains an unsolved question in the finance literature. From 1976, when Black, F. (1976) proposed the phenomenon of leverage effect, many authors have contributed to this literature by investigating and providing divergent empirical evidence to this phenomenon. Some of the researchers has focused on testing its validity in developed markets, were some of them are interested in emerging markets, (Wang, Li, and He 2020,) explores the spill overs between economic policy uncertainty (EPU) and stock market realized volatility (RV). They suggested that good volatility spill overs become larger during periods of stimulated reform, whereas bad volatility spill overs become larger during periods of international disputes. Further documented that the Chinese stock market volatility is sensitive to both U.S. and Chinese EPU and that the spill over is asymmetric in different periods. (Karanasos and Kim 2006, 124-133) use an APARCH model with non-normal error distributions and in drawing out some of the key theoretical properties of the model successfully apply the model to Korea, Japan, Hong Kong, Taiwan and Singapore. Further, (Huang and Lin 2004) use APARCH models to make value at risk calculations for Taiwan, both for the stock index and its associated futures. (Ané and Ureche-Rangau 2006) extend the APARCH model to Japan, Hong Kong, Singapore and Malaysia. (Horpestad et al. 2019, 2-3) provide empirical evidence that large forecast improvements of asymmetric volatility models are larger when the market uncertainty is greater, by incorporating 19 stock market indices from North America, Europe, Asia and Australia using high frequency data. They also assessed the importance of the asymmetric model specification, by comparing the given asymmetric specification with its symmetric counterparts.

ARCH and GARCH models were the popular tools for modelling and forecasting volatility. The family of ARCH (Autoregressive Conditionally Heteroskedastic) models introduced by (Engle 1982). The most interesting feature nor explained by these models is leverage effect (Karmakar 2007, 100). To solve this issue many non-linear extensions of GARCH models have been proposed. The EGARCH (Exponential GARCH) was proposed by (Nelson 1991), TARARCH (Threshold ARCH) model was introduced by (Zakoian 1994) , Asymmetric power ARCH (APARCH) model introduced by (Ding, Granger, and Engle 1993) and GJR GARCH model was suggested by (Glosten, Jagannathan, and Runkle 1993).

Recent years have also seen a surge of interest among researchers and academicians to add literature in asymmetric volatility and leverage effect. Many authors have contributed many empirical and conceptual papers in this field (Baur and Dimpfl 2019), (Luo and Wang 2019), (S. Chen et al. 2020), (Umar et al. n.d.) and (J. Horpestad et al. n.d.). Although, some of

the researchers try to comprehend the literature on asymmetric volatility and leverage effect by undertaking bibliometric and literature review studies (Bhowmik and Wang 2020), (Shin 2018) and (Agarwal, Kumar, and Goel 2019). (Flores-Sosa, Avilés-Ochoa, and Merigó 2022a) contributed a comprehensive evaluation of literature in exchange rate volatility by comparing two databases, namely Scopus and Web of Science and (Aviles-Ochoa, Flores-Sosa, and Merigo 2021, 1998-2000) proposes a bibliometric review of price 56 volatility models in business economics and decision. Furthermore, (J. Chen and Yang 2021) uses the bibliometric method of knowledge mapping analysis to clearly present the knowledge base and research fronts of cross-market volatility spill overs. Even though, no previous studies have addressed the literature of asymmetric volatility and leverage effect in the stock market from a bibliometric aspect. The present study tries to provide quantitative statistics and a comprehensive review of the key influential and intellectual structure of asymmetric volatility and leverage effect in the stock market through bibliometric analysis.

3. METHODOLOGY

In this paper, we adopt a bibliometric methodology, that involves the use of quantitative tools for the analysis of bibliometric and graphic information. Bibliometric analysis can be used for the evaluation of research performance in a topic/area, and the study of science as a system of communication and knowledge generation. In this study, we seek to infer the intellectual formation of asymmetric volatility and leverage effect in the stock market by considering several bibliometric indicators such as citation analysis, co-occurrence of author keywords, and bibliometric coupling. The VOSviewer and excel software has been used to represent graphical information of bibliometric data.

In line with (Flores-Sosa, Avilés-Ochoa, and Merigó 2022, 1420-38), we conduct a performance analysis of review corpus, selecting bibliometric analysis techniques of citation analysis of the document, source, author, institution and country (to know the most impactful and influential document, author, institution and country in asymmetric volatility and leverage effect in the stock market), co-citation analysis, which is effective for the demarcation of fundamental knowledge, and bibliometric coupling, useful for explicating the themes in the body of knowledge, co-occurrence or author keywords.

3.1. Data Collection.

3.1.1. *Source of data collection.* To collect the data, we rely upon the Scopus database. The rationalization of this choice is because, it is the largest multidisciplinary database of peer-reviewed literature in social sciences, and it is among the most esteemed accessible database with the listing of all or most of the reputed journals.

3.1.2. *Structured process of data collection and refinement process.* This methodological section is vital to assure the accuracy of the data collecting process. Our data set from Scopus database was retrieved on 16 December, 2021. We use the keywords “Asymmetric Volatility” OR “Leverage Effect” AND “Stock Market”, which brought the result from 1994 to 2021. Our search is then limited to documents which are published in English language and in the subject area of “Business, management and accounting”, “Economic, econometrics, finance”, “Social science” and “Arts and humanities” and in journals as articles and reviews within the field. These filters leave us with a total of 271 documents on this topic.

We conduct our analysis in the following dimensions:

1. Bibliometric citation analysis
2. Bibliometric Co-occurrence analysis
3. Bibliographic Coupling analysis
4. Bibliometric Co-authorship analysis

To build visualization networks, we use VOS viewer and Excel software. It explains the relevance of objects in terms of distance and size of the node. The longer/shorter the distance between the objects the less/more associated they are.

4. FINDINGS

4.1. Performance analysis of Asymmetric Volatility and Leverage Effect research.

The performance analysis of asymmetric volatility and leverage effect research in the stock market is evaluated through publication activity, top authors, institutions, countries, journals and articles on this field of research.

4.1.1. *Publication activity of Asymmetric volatility and Leverage effect in the stock market.* The publication trends of Asymmetric volatility and Leverage effect research is presented in Figure 1, wherein the total number of article publication is mapped against their respective year of publication from 1994 to 2021. It indicates that the Asymmetric Volatility and Leverage effect is not a new field of research, occurring since 1994. By comparing with 1994, there is a surge in papers that were published in asymmetric volatility and leverage effect. In 1994, only one paper is published by Susmel R., 1994, even though the study is more about measuring the timing of mean and volatility spill overs between New York and London equity markets using ARCH models. In the first 10 years, the publication on this topic was considerably less. After that, until 2020, the growth is remarkable. After the financial crisis of 2008, publication trend of works in this field of research was became significant due to the increased risk and uncertainty in the stock market.

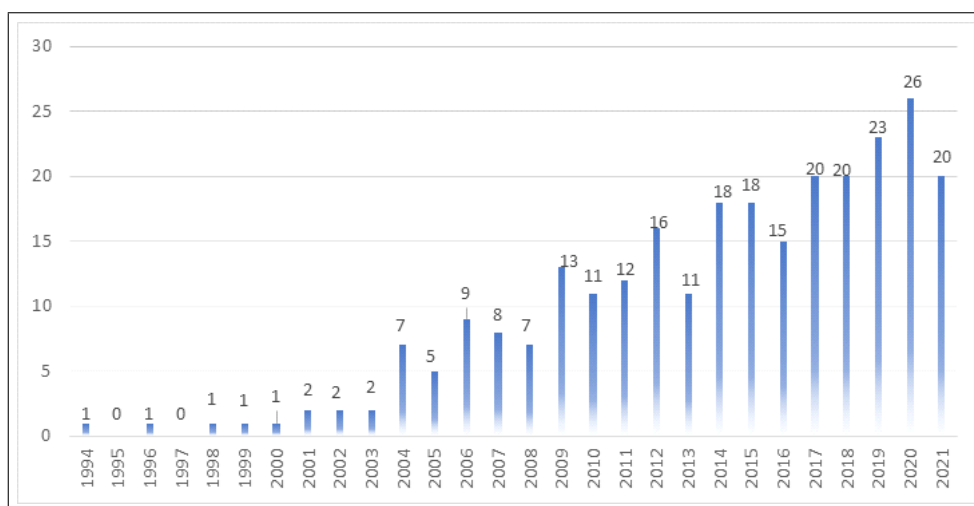


Figure 1: The annual number of papers published in asymmetric volatility and leverage effect in the stock market

4.2. Top authors in Asymmetric volatility and Leverage effect in the stock market.

Table 1 presents the top authors in Asymmetric volatility and Leverage effect in the stock market. Based on the number of citations, the most productive and impactful author on this topic is McAleer M., 2009, who have a total publication of 15 with 315 citations. Followed by Bollerslev T., 2006 with 186 citations. The least influential author in this topic (among Top 11 authors) is Zhang W., 2011 with 3 publications with a citation of 5.

	Author Name	TP	TC
1	Mcaleer M.	15	315
2	Bollerslev T.	3	186
3	Karanasos M.	11	140
4	Asai M.	3	47
5	Fakhfekh M.	4	37
6	Jeribi A.	4	37
7	Chen C.W.S.	3	18
8	Singh A.	3	9
9	Su J.-B.	3	9
10	Zhang W.	3	5

Note: TP= Total Publication, TC= Total Citation

4.3. Leading institutions and countries. Table 2 shows the most productive institutions and countries in Asymmetric volatility and Leverage effect in the stock market. The South China University of Technology is the most productive institution/university on this topic with 84 citations. Followed by the Complutense University of Madrid with 83 citations. The Soka University is another of the most influential and impactful universities on this topic.

Next, let us analyse the countries with the most publication in Asymmetric volatility and Leverage effect in the stock market. From Table 3, it can be interpreted that the United States of America is the most productive country, which published a total of 32 documents on this topic with 2068 citations. Followed by Australia with 437 citations. In terms of productivity, Taiwan follows the United States. India is being in the 7th position with 34 publications with 194 citations. Most of the studies in asymmetric volatility and leverage effect in the stock market were conducted in developed countries. It may due to the fact that capital markets are the important source for mobilising idle savings from the economy. It enhances the production and productivity of the national economy. So, it is important to evaluate the volatility asymmetric and leverage effect in these markets than markets of other economies.

Organisation	TP	TC	Country	TP	TC
South China University of Technology	2	84	United States	32	2068
Complutense University of Madrid	2	83	Australia	27	437
Soka University	4	72	United Kingdom	21	351
Erasmus University Rotterdam	5	43	China	24	322
Erasmus University Rotterdam	3	26	Taiwan	24	274
Complutense University of Madrid	2	20	Spain	17	227
National Tsing Hua University	2	20	India	34	194
Complutense University of Madrid	2	20	Germany	13	192
Wakayama University	2	16	The Netherlands	14	188
Yokohama National University	2	10	Japan	18	186
University of Modern Sciences	2	3	Malaysia	10	23

Note: TP = Total Publication, TC= Total Citation

4.4 Top Journals in Asymmetric Volatility and Leverage Effect in stock Market

Table 3 presents the top journals which publish documents in Asymmetric volatility and Leverage effect in the stock market with top citations. Energy Economics is the highest impactful journal on this topic with 351 citations. Followed by the Journal of Econometric, Journal of Empirical Finance and Econometric Reviews with citations of 261, 242, and 211 respectively. In terms of productivity Energy Economics and the Journal of Empirical Finance are have

the most publications in asymmetric volatility and leverage effect in the stock market with a total publication of 8. Followed by the Journal of Econometrics, Applied Financial Economics and Finance Research Letters with 7 publications. Elsevier and Taylor & Francis are the most productive publishers on this topic.

Table 3: Top journals in asymmetric volatility and leverage effect in stock market		
Source	TP	TC
Energy Economics	8	351
Journal of Econometrics	7	261
Journal of Empirical Finance	8	242
Econometric Reviews	5	211
Applied Financial Economics	7	147
Finance Research Letters	7	99
Journal of International Financial Markets, Institutions and Money	4	97
Journal of Banking and Finance	4	96
Applied Economics	6	77
Journal of Business and Economic Statistics	4	70
Economic Modelling	6	67
International Review of Financial Analysis	5	62
International Journal of Finance and Economics	5	35
Quarterly Review of Economics and Finance	4	29
International Research Journal of Finance and Economics	5	24
Studies in Nonlinear Dynamics and Econometrics	4	22
European Journal of Finance	4	15
Note: TP = Total Publication, TC= Total Citation		

4.5 Top Articles on Asymmetric Volatility and Leverage effect

The top-cited publications on asymmetric volatility and leverage effect research in the stock market are presented in Table 4. The most cited paper in Asymmetric and Leverage effect is by (Bekaert G 2000, 2-38), which have 713 citations. The study is basically aimed at providing a unified framework to simultaneously investigate asymmetric volatility at the firm and the market level and to examine two potential explanations of the asymmetry; leverage effect and volatility feedback. Followed by Asymmetric causality tests with an application (Hatemi 2012, 447-56) with 286 citations. (Wu 2001, 837-859) examined the determinants of asymmetric volatility, and propose both the leverage effect and the volatility feedback effect, are the two popular explanations of asymmetry. (Susmel R 1994, 3-25) examines the timing of mean and volatility between the New York and London equity markets; using the ARCH model including an asymmetric or leverage model and found the evidence of the volatility spill over between these markets.

Further impact of trades on daily volatility was tested by (Avramov D 2006, 1241-1277), (Bollerslev T 2006, 123-150) provide a simple theoretical framework for assessing the empirical linkage between returns and realized and implied volatilities. Other impactful and influential research in the area of asymmetric volatility and leverage effect by (Bowden N 2008, 3186-3197), (McAleer M 2009, 422-440), (Bouri E., 2017), and (Alberg D 2008, 1201-1208) estimated stock market volatility using asymmetric GARCH models, namely asymmetric GJR, APARCH models, and EGARCH. (Liu H 2013, 152-166) applied various Autoregressive Moving Average (ARMA) models with GARCH processes, namely ARMA-GRACH models along with ARMA GARCH in mean (ARMA-GARCH-M).

Further (Koutmos 1998, 277-290), and 1999 widen the scope of asymmetric volatility and leverage effect in international stock markets. Moreover, (Dang V.A 2012, 465-482), (Low 2004, 527-546), (Meddahi N 2004, 355-379), and (Bae J 2007, 41-58) tested different aspects of asymmetric volatility and leverage effect in the stock market.

Table 4: Top cited publications on asymmetric volatility and leverage effect		
Authors	Title	TC
Bekaert G. (2000)	Asymmetric Volatility and Risk in Equity Markets	713
Hatemi-J A. (2012)	Asymmetric causality tests with an application	286
Wu G. (2001)	The determinants of asymmetric volatility	211
Susmel R. (1994)	Hourly volatility spillovers between international equity markets	211
Avramov D. (2006)	The impact of trades on daily volatility	127
Bollerslev T. (2006)	Volatility puzzles: A simple framework for gauging return-volatility regressions	116
Bowden N. (2008)	Short term forecasting of electricity prices for MISO hubs: Evidence from ARIMA-EGARCH models	110
Mcaleer M. (2009)	Structure and asymptotic theory for multivariate asymmetric conditional volatility	108
Bouri E. (2017)	On the return-volatility relationship in the bitcoin market around the price crash of 2013	100
Alberg D. (2008)	Estimating stock market volatility using asymmetric GARCH models	98
Liu H. (2013)	Applying ARMA-GARCH approaches to forecasting short-term electricity prices	94
Koutmos G. (1998)	Asymmetries in the conditional mean and the conditional variance: Evidence from nine stock markets	91
Dang V.A. (2012)	Asymmetric capital structure adjustments: new evidence from dynamic panel threshold models	88
Low C. (2004)	The fear and exuberance from implied volatility of S&P 100 index options	88
Meddahi N. (2004)	Temporal aggregation of volatility models	87
Luo J. (2018)	High-frequency volatility connectedness between the US crude oil market and China's agricultural commodity markets	75
Shehzad K. (2020)	COVID-19's disasters are perilous than Global Financial Crisis: A rumor or fact?	70
Koutmos G. (1999)	Asymmetric price and volatility adjustments in emerging Asian stock markets	64
Bollerslev T. (2012)	Volatility in equilibrium: Asymmetries and dynamic dependencies	63
Bae J. (2007)	Why are stock returns and volatility negatively correlated?	52
Note: TC= Total Citation		

5. NETWORK VISUALIZATION OF ASYMMETRIC VOLATILITY AND LEVERAGE EFFECT IN THE STOCK MARKET

In this section, we analyse the Scopus data set of 271 documents of asymmetric volatility and leverage effect in the stock market using VOSviewer. Graphical analysis is in the index as co-citation, bibliographic coupling and co-occurrence of author keywords with the objective to know the influence and relationship of journals, publications of authors, institutions, countries, and keywords.

Co-citation occurs when two documents published in different journals receive a citation from the same third source. Figures 2 and 3 show the co-citation map of Scopus. It is analysed that

the Journal of Econometrics and Econometrica are the most influential and impactful journals on asymmetric volatility and leverage effect in the stock market. Followed by the Journal of Empirical Finance, and Energy Economics. In terms of cited authors Bollerslev T., 2006, Bae J., 2007 are the influential authors in this topic.

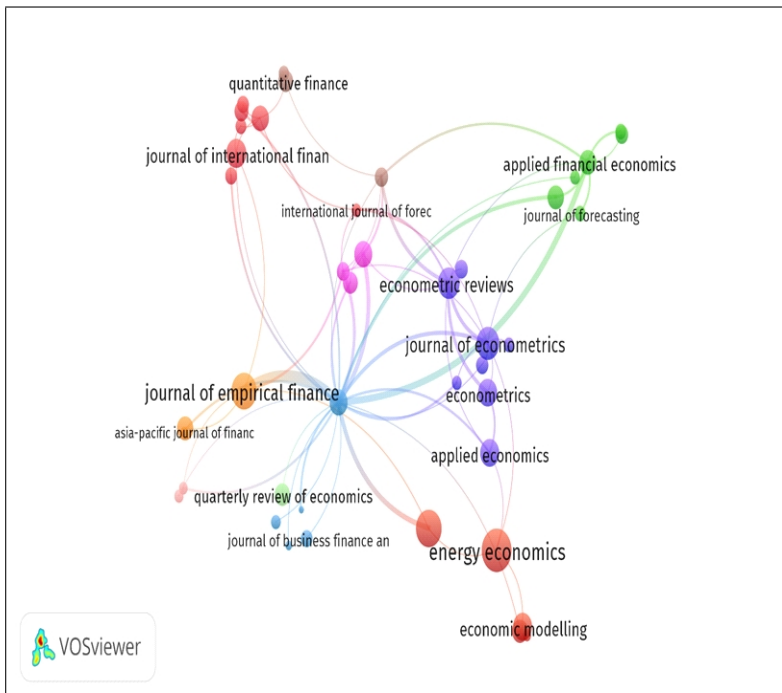


Figure 2: Co-citation of journals regarding asymmetric volatility and leverage effect in stock market

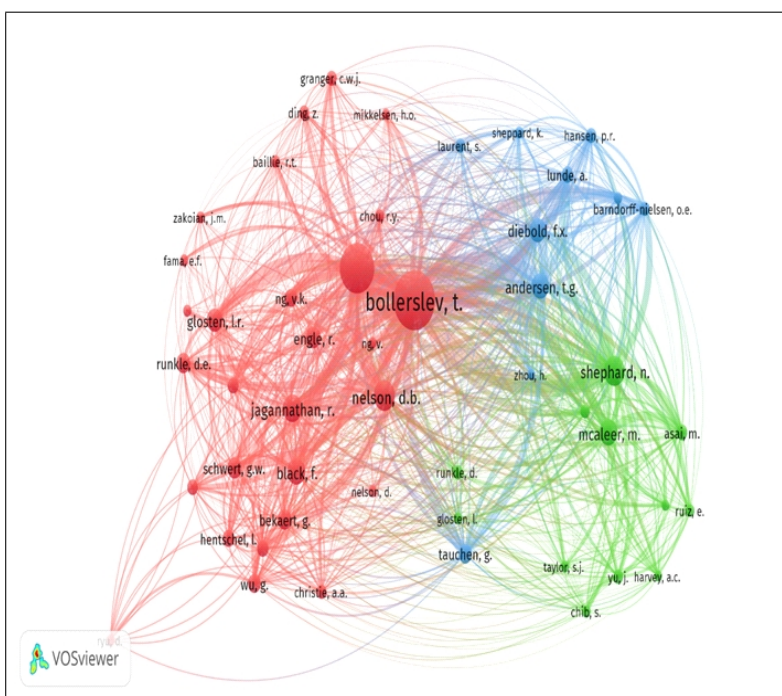


Figure 3: Co-citation of authors in asymmetric volatility and leverage effect in stock market

The bibliographic coupling of authors occurs when the authors of two documents cited the same third document Goudarzi & Ramanarayanan, 2011. By analysing bibliographic coupling of authors of asymmetric volatility and leverage effect in the stock market. Figure 4, interpreted that McAleer M., 2009 and Asai, 2013 are the most influential authors on this topic. Bibliographic coupling of countries analyses the result per country (Figure 5). It proposes that the United States of America is the country with the most publications on this topic. Followed by Australia, the United Kingdom, China, Taiwan and Spain.

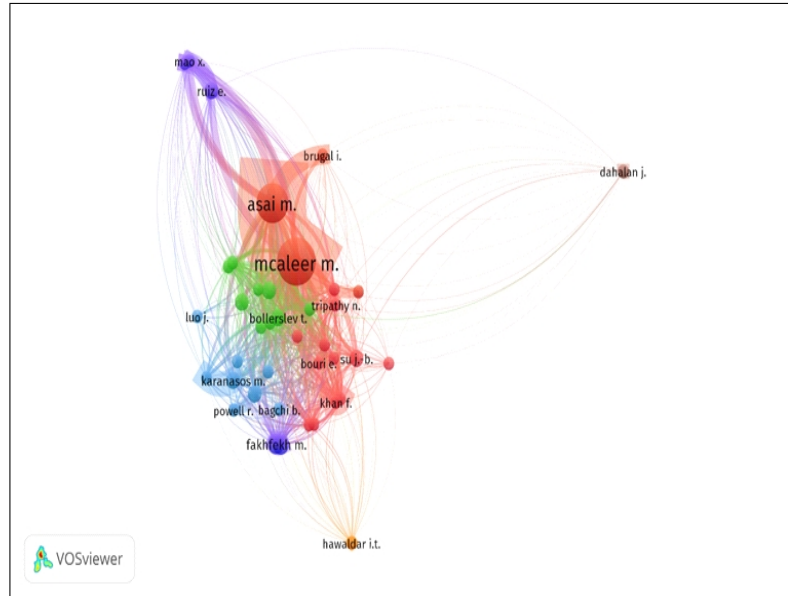


Figure 4: Bibliographic coupling among authors publishing about asymmetric volatility and leverage effect in stock market

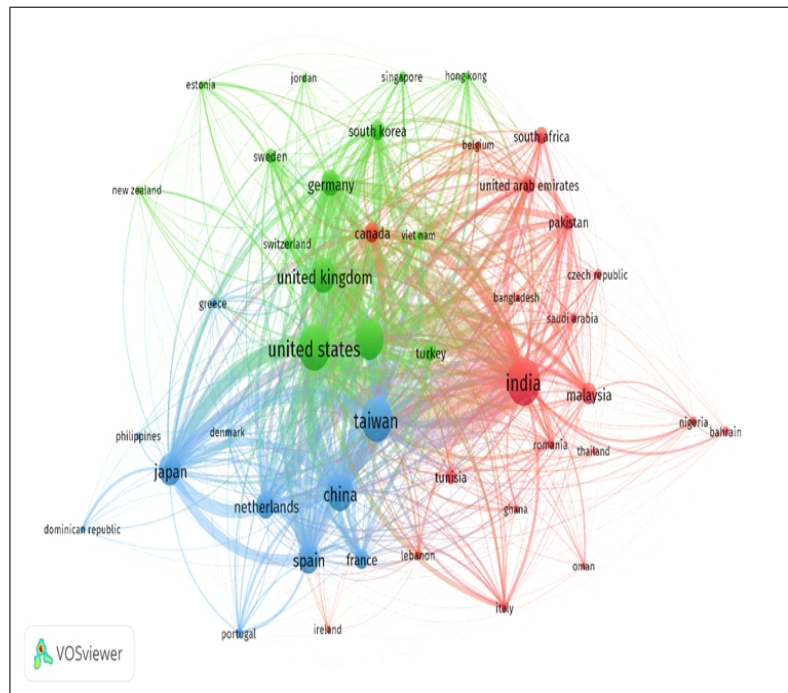


Figure 5: Bibliographic coupling by countries

Co-occurrence of author keywords presented in Figure 6, In addition to leverage effect, other words associated with great influence are volatility, GARCH, Asymmetric Volatility, TGARCH.

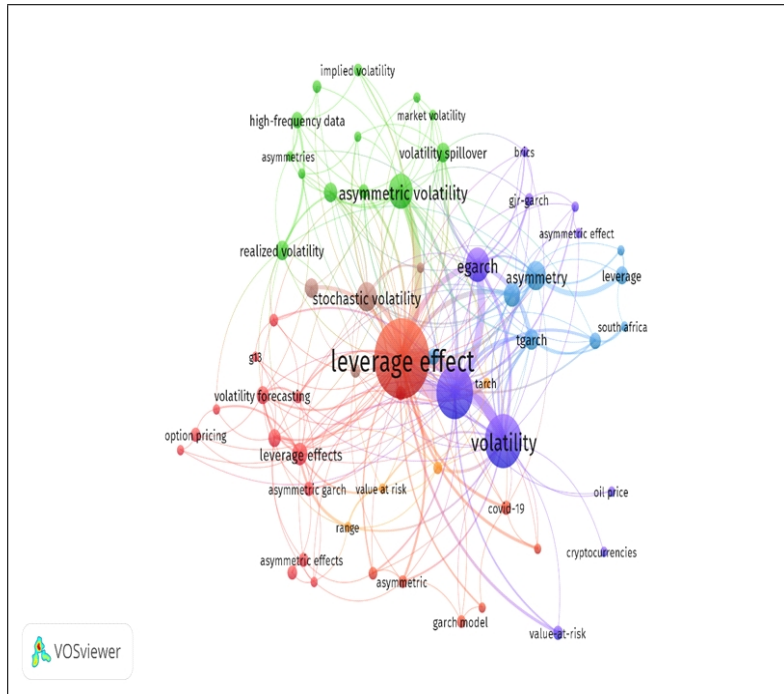


Figure 6: Co-occurrence of author keywords in published documents regarding asymmetric volatility and leverage effect in stock market

5.1. **Co-authorship analysis.** Another important bibliometric analysis is related to the prediction and recommendation of research through co-authorship analysis (Ponomariov and Boardman 2016).

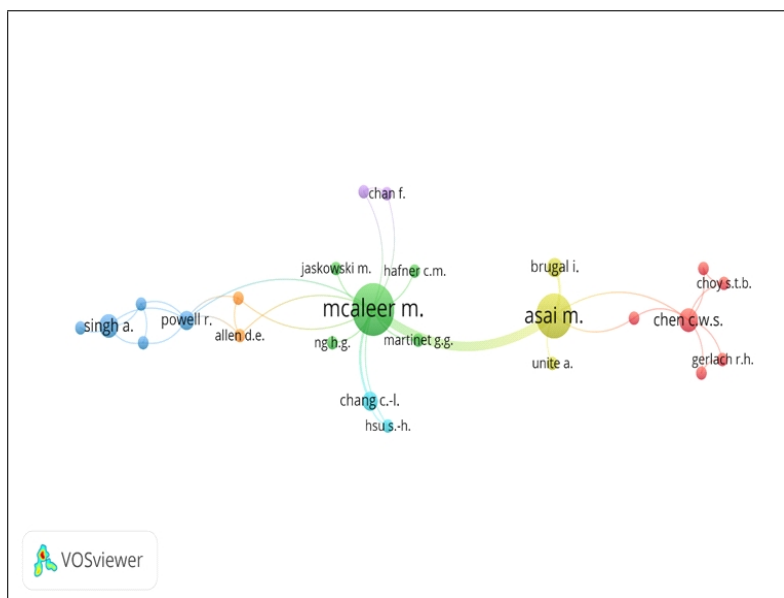


Figure 7: Co-authorship analysis of authors in asymmetric volatility and leverage effect in stock market

This measure reflects the strength of research collaboration of a researcher with his/her co-author (Kumar 2015, 56-67). The evaluation of co-authorship networks reveals the temporal pattern and evolutionary trends in scientific collaboration. In a co-authorship network, nodes represent authors, organisations and countries, which are connected when they share the authorship of a paper (E Fonseca, et al., 2016, 2-8). If a researcher is an isolated node in a co-authorship network, then he/she has not established any research collaboration with other researchers.

6. CONCLUSION

Investigation of causes of asymmetric volatility and leverage effect in the stock market is an emerging and interesting field of research among researchers in finance, as it affects the investment decision, thus leading to capital formation and economic development. Asymmetric volatility is a phenomenon, which proposes that a negative return increase its volatility than a positive return of the same magnitude. One of the explanations for this phenomenon proposed by Black, 1976 is called the leverage effect.

This paper aims to provide quantitative statistics and a comprehensive review of the key influential and intellectual structure of asymmetric volatility and leverage effect in the stock market. For analysing the research questions, such as identification of trend or pattern of knowledge development in the area of asymmetric volatility and leverage effect in the stock market, influential and impactful papers, authors and journals, productive countries in this topic, and a gap in the existing literature, the study reviews 271 articles and review papers published in scientific journals indexed by the Scopus database from 1994 to 2021. VOSviewer and Excel software are used to analyse the collected data. By analysing the growth in this topic, it is found that there is a surge in papers that were published in asymmetric volatility and leverage effect when compared with 1994. In the first 10 years, the publication on this topic was considerably less. After that, until 2020, the growth is remarkable. By conducting bibliometric citation analysis of documents, sources, authors, organisations and countries, we found that McAleer M is the most influential and impactful author in this topic with a total publication of 15 with 315 citations, followed by Bollerslev T with 186 citations. The most productive institution/ university and country in this topic are, The South China University of Technology with 84 citations and the United States of America is the most productive country, which published a total of 32 documents in this topic with 2068 citations, followed by Australia with 437 citations. In terms of publication, Energy Economics is the highest impactful journal on this topic with 351 citations. Followed by the Journal of Econometric, Journal of Empirical Finance and Econometric Reviews with citations of 261, 242, and 211 respectively. The most cited paper in Asymmetric and Leverage effect is by Bekaert G. (2000), which have 713 citations. Followed by Asymmetric causality tests with an application Hatemi J.A 2012 with 286 citations.

Through this quantitative and comprehensive review, it is also found that most of the studies on this topic are undertaken in developed countries like USA and Australia. There is a gap existing in the case of developing and emerging markets, especially in the case of an emerging market like India. More studies on this topic will help the investors and other participants of the financial market to evaluate the risk and uncertainty in the market and to construct a portfolio by including assets that are negatively correlated to perform better in the market.

7. ORIGINALITY AND VALUE

To the best of the author's knowledge, this is one of the first papers to address the literature of asymmetric volatility and leverage effect in the stock market from a bibliometric aspect. Whenever there is assurance that scholars build on high accuracy, it will be easier to recognize genuine research gaps instead of merely conducting the same research again and again, so as to progress better and create more appropriate hypotheses and research questions, and, consequently to raise the standard of research for future generation. It helps researchers and

other academicians to explore and build a quantitative base regarding the scientific development of asymmetric volatility and leverage effect in the stock market. The major contribution of this study is that it consolidates fragmented literature in this area, highlights significant sources, authors and documents in this field of research. The current study also contributes to the scope of further research in the area of volatility asymmetry and leverage effect in the stock market. The content analysis and systematic literature review can be conducted by taking the literature of past few decades to analyse the major themes in this field of research, and major tools used to measure this phenomenon.

8. RESEARCH LIMITATIONS

The current study research is a bibliometric analysis and hence limitations related to such studies are applicable. The data for the study is limited to Scopus database and the study used only some of the important bibliometric analysis like citation analysis, co-occurrence and co-authorship analysis.

REFERENCES

- [1] Agarwal, Shweta, Shailendra Kumar, and Utkarsh Goel. 2019a. "Stock Market Response to Information Diffusion through Internet Sources: A Literature Review." *International Journal of Information Management* 45 (November 2017): 118–31. <https://doi.org/10.1016/j.ijinfomgt.2018.11.002>.
- [2] Alberg, Dima, Haim Shalit, and Rami Yosef. 2008. "Estimating Stock Market Volatility Using Asymmetric GARCH Models." *Applied Financial Economics* 18 (15): 1201–8. <https://doi.org/10.1080/09603100701604225>.
- [3] Andrei, Daniel, and Michael Hasler. 2015. "Investor Attention and Stock Market Volatility." *Review of Financial Studies* 28 (1): 33–72. <https://doi.org/10.1093/rfs/hhu059>.
- [4] Asai, Manabu. 2013. "Heterogeneous Asymmetric Dynamic Conditional Correlation Model with Stock Return and Range." *Journal of Forecasting* 32 (5): 469–80. <https://doi.org/10.1002/for.2252>.
- [5] Avramov, Doron, Tarun Chordia, and Amit Goyal. 2006. "The Impact of Trades on Daily Volatility." *Review of Financial Studies* 19 (4): 1241–77. <https://doi.org/10.1093/rfs/hhj027>.
- [6] Bae, Jinho, Chang Jin Kim, and Charles R. Nelson. 2007. "Why Are Stock Returns and Volatility Negatively Correlated?" *Journal of Empirical Finance* 14 (1): 41–58. <https://doi.org/10.1016/j.jempfin.2006.04.005>.
- [7] Bekaert, Geert, and Guojun Wu. 2000. "Asymmetric Volatility and Risk in Equity Markets." *Review of Financial Studies* 13 (1): 1–42. <https://doi.org/10.1093/RFS/13.1.1>.
- [8] Black, Fisher. (1976) *Studies of Stock Price Volatility Changes*. In *Proceedings of the 1976 Meeting of the Business and Economic Statistics Section, American Statistical Association, Washington DC, 177-181*. - References - Scientific Research Publishing." n.d. Accessed February 24, 2022. [https://www.scirp.org/\(S\(czeh2tfqyw2orz553k1w0r45\)\)/reference/ReferencesPapers.aspx?ReferenceID=1969803](https://www.scirp.org/(S(czeh2tfqyw2orz553k1w0r45))/reference/ReferencesPapers.aspx?ReferenceID=1969803).
- [9] Bollerslev, Tim, and Hao Zhou. 2006. "Volatility Puzzles: A Simple Framework for Gauging Return-Volatility Regressions." *Journal of Econometrics* 131 (1–2): 123–50. <https://doi.org/10.1016/j.jeconom.2005.01.006>.
- [10] Bouri, Elie, Georges Azzi, and Anne Haubo Dyrhberg. 2017. "On the Return-Volatility Relationship in the Bitcoin Market around the Price Crash of 2013." *Economics* 11: 1–17. <https://doi.org/10.5018/economics-ejournal.ja.2017-2>.
- [11] Bowden, Nicholas, and James E. Payne. 2008. "Short Term Forecasting of Electricity Prices for MISO Hubs: Evidence from ARIMA-EGARCH Models." *Energy Economics* 30 (6): 3186–97. <https://doi.org/10.1016/j.eneco.2008.06.003>.
- [12] Chen, Cathy W.S., Mike K.P. So, and Richard H. Gerlach. 2005. "Asymmetric Response and Interaction of U.S. and Local News in Financial Markets." *Applied Stochastic Models in Business and Industry* 21 (3): 273–88. <https://doi.org/10.1002/asmb.600>.
- [13] Christie, Andrew A. 1982a. "The Stochastic Behavior of Common Stock Variances. Value, Leverage and Interest Rate Effects." *Journal of Financial Economics* 10 (4): 407–32. [https://doi.org/10.1016/0304-405X\(82\)90018-6](https://doi.org/10.1016/0304-405X(82)90018-6).
- [14] Dang, Viet Anh, Minjoo Kim, and Yongcheol Shin. 2012. "Asymmetric Capital Structure Adjustments: New Evidence from Dynamic Panel Threshold Models." *Journal of Empirical Finance* 19 (4): 465–82. <https://doi.org/10.1016/j.jempfin.2012.04.004>.
- [15] Ding, Zhuanxin, Clive W.J. Granger, and Robert F. Engle. 1993. "A Long Memory Property of Stock Market Returns and a New Model." *Journal of Empirical Finance* 1 (1): 83–106. [https://doi.org/10.1016/0927-5398\(93\)90006-D](https://doi.org/10.1016/0927-5398(93)90006-D).

- [16] Fonseca E Fonseca, Bruna de Paula, Ricardo Barros Sampaio, Marcus Vinicius de Arajo Fonseca, and Fabio Zicker. 2016. "Co-Authorship Network Analysis in Health Research: Method and Potential Use." *Health Research Policy and Systems* 14 (1): 1–10. <https://doi.org/10.1186/s12961-016-0104-5>.
- [17] Fakhfekh, Mohamed, and Ahmed Jeribi. 2020. "Volatility Dynamics of Crypto-Currencies' Returns: Evidence from Asymmetric and Long Memory GARCH Models." *Research in International Business and Finance* 51: 101075. <https://doi.org/10.1016/j.ribaf.2019.101075>.
- [18] Glosten, Lawrence R., Ravi Jagannathan, And David E. Runkle. 1993. "On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks." *The Journal of Finance* 48 (5): 1779–1801. <https://doi.org/10.1111/J.1540-6261.1993.TB05128.X>.
- [19] Goudarzi, Hojatallah, and C S Ramanarayanan. 2011. "Modeling Asymmetric Volatility in the Indian Stock Market." *International Journal of Business and Management*. Vol. 6. www.ccsenet.org/ijbm.
- [20] Hatemi-J, Abdunnasser. 2012. "Asymmetric Causality Tests with an Application." *Empirical Economics* 43 (1): 447–56. <https://doi.org/10.1007/s00181-011-0484-x>.
- [21] Henry, Olan. 1998. "Modelling the asymmetry of stock market volatility." *Applied Financial Economics* 145-153.
- [22] Jeribi Ahmed, Mohamed Fakhfekh, Anis Jarboui. 2015. "Tunisian revolution and stock market volatility: evidence from FIEGARCH model." *Managerial Finance* 41 (10): 1112-1135.
- [23] Karanasos, Menelaos, and Stavroula Yfanti. 2020. "On the Macro-Drivers of Realized Volatility: The Destabilizing Impact of UK Policy Uncertainty across Europe." *European Journal of Finance* 26 (12): 1146–83. <https://doi.org/10.1080/1351847X.2020.1732437>.
- [24] Karanasos, Menelaos, and Jinki Kim. 2006. "A Re-Examination of the Asymmetric Power ARCH Model." *Journal of Empirical Finance* 13 (1): 113–28. <https://doi.org/10.1016/J.JEMPFIN.2005.05.002>.
- [25] Koutmos, Gregory. 1998. "Asymmetries in the Conditional Mean and the Conditional Variance: Evidence from Nine Stock Markets." *Journal of Economics and Business* 50 (3): 277–90. [https://doi.org/10.1016/S0148-6195\(98\)00004-6](https://doi.org/10.1016/S0148-6195(98)00004-6).
- [26] Koutmos, Gregory. 1999. "Asymmetric price and volatility adjustments in emerging asian stock markets." *Journal of Business Finance and Accounting* 26: 83-101. <https://doi.org/10.1111/1468-5957.00249>
- [27] Kumar, Sameer. 2015a. "Co-Authorship Networks: A Review of the Literature." *Aslib Journal of Information Management* 67 (1): 55–73. <https://doi.org/10.1108/AJIM-09-2014-0116>.
- [28] Liu, Heping, and Jing Shi. 2013. "Applying ARMA-GARCH Approaches to Forecasting Short-Term Electricity Prices." *Energy Economics* 37: 152–66. <https://doi.org/10.1016/j.eneco.2013.02.006>.
- [29] Low, Cheekiat. 2004. "The fear and exuberance from implied volatility of S&P 100 index options." *Journal of Business* 77 (3): 527-546. <https://doi.org/10.1086/386529>.
- [30] Luo, Jiawen, and Qiang Ji. 2018. "High-Frequency Volatility Connectedness between the US Crude Oil Market and China's Agricultural Commodity Markets." *Energy Economics* 76: 424–38. <https://doi.org/10.1016/j.eneco.2018.10.031>.
- [31] Malik, Farooq. 2011. "Estimating the Impact of Good News on Stock Market Volatility." *Applied Financial Economics* 21 (8): 545–54. <https://doi.org/10.1080/09603107.2010.534063>.
- [32] McAleer, Michael, Suhejla Hoti, and Felix Chan. 2009. "Structure and Asymptotic Theory for Multivariate Asymmetric Conditional Volatility." *Econometric Reviews* 28 (5): 422–40. <https://doi.org/10.1080/07474930802467217>.
- [33] Meddahi, Nour, and Eric Renault. 2004. "Temporal Aggregation of Volatility Models." *Journal of Econometrics* 119 (2): 355–79. [https://doi.org/10.1016/S0304-4076\(03\)00200-8](https://doi.org/10.1016/S0304-4076(03)00200-8).
- [34] Shehzad, Khurram, Liu Xiaoxing, and Hayfa Kazouz. 2020. "COVID-19's Disasters Are Perilous than Global Financial Crisis: A Rumor or Fact?" *Finance Research Letters* 36: 101669. <https://doi.org/10.1016/j.frl.2020.101669>.
- [35] Singh, Amanjot. 2017. "Modeling conditional volatility of Indian banking sector's stock market returns." *Scientific Annals of Economics and Business* 64 (3): 325-338.
- [36] Su, Ender, and John F.O. Bilson. 2011. "Trading Asymmetric Trend and Volatility by Leverage Trend GARCH in Taiwan Stock Index." *Applied Economics* 43 (26): 3891–3905. <https://doi.org/10.1080/00036841003742561>.
- [37] Susmel, Raul, and Robert F. Engle. 1994. "Hourly Volatility Spillovers between International Equity Markets." *Journal of International Money and Finance* 13 (1): 3–25. [https://doi.org/10.1016/0261-5606\(94\)90021-3](https://doi.org/10.1016/0261-5606(94)90021-3).
- [38] Bollerslev, Tim, Sizova Natalia, and Tauchen George. 2012. "Volatility in equilibrium: Asymmetries and dynamic dependencies." *Review of Finance* 16 (1): 31-80. <https://doi.org/10.1093/rof/rfr005>.
- [39] Wu, Guojun. 2001. "The determinants of asymmetric volatility." *Review of Financial Studies* 14 (3): 837-859. <https://doi.org/10.1093/rfs/14.3.837>.
- [40] Zhang, Wenyuan, and Yunyue Wang. 2011. "Notice of Retraction: GARCH Family Model Based on the Shanghai Stock Market Shorting Mechanism Analysis." 2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce, AIMSEC 2011 - Proceedings, 5046–49. <https://doi.org/10.1109/AIMSEC.2011.6011093>.