FINANCIAL CONTAGION AND VOLATILITY SPILLOVER: AN ANALYSIS OF GLOBAL STOCK MARKETS

Thesis Submitted for the Award of the Degree of

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in

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By

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2025

DECLARATION

I, hereby declared that the presented work in the thesis entitled Financial Contagion and Volatility Spillover: An Analysis of Global Stock Markets" in fulfilment of degree of **Doctor of Philosophy (Ph. D.)** is outcome of research work carried out by me under the supervision of Dr. Rupinder Katoch , working asProfessor, in theMittal School of Businessof Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.

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CERTIFICATE

This is to certify that the work reported in the Ph. D. thesis entitled Financial Contagion and Volatility Spillover: An Analysis of Global Stock Markets” submitted in fulfillment of the requirement for the award of degree of **Doctor of Philosophy (Ph.D.)** in the Mittal School of Business, Lovely Professional University, is a research work carried out by Shubham Kakran (12020346), is bonafide record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

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ABSTRACT

The interconnectedness of the stock markets offers valuable insights into the broader dynamics of global financial markets. Over the last two decades, the interest of the ordinary person has raised in the different stock markets (Kumbur et al., 2022), as it is not surprising every day, billions of dollars in assets are traded on stock exchanges (Hoseinzade and Haratizadeh, 2019).In general, the last few decades have seen a rise in political and economic openness, which an increase has often followed in financial integration (Kakran et al., 2023a). The financial and economic crises of the last several decades have demonstrated that interdependence in the actual economy is frequently insufficient to explain contagion. Financial distress can cause contagion, which has far-reaching implications. The transmission mechanisms in financial markets have been stated to be relatively constant over time (Rigobon, 2003; Bracker et al., 1999), but this assertion has been challenged (Corsetti et al., 2005). According to studies on co-movement factors, the structural closeness of the nations' economies explains just a portion of the amount of co-movement in the financial markets. This sparked a debate concerning the impact of global sectoral determinants (Bekaert et al., 2009; Dutt and Mihov, 2013).

The study attempts to examine the relationship among the stock markets of the developed, emerging, and frontier countries from the early years of the establishment (2004)up to the recent Russia-Ukraine crises (June 2023). Such relationships seek to understand the effectiveness of the stock markets with high market capitalization. The latest TVP-VAR methodologyis employed to unveil the interconnectedness and volatility spillover during and before six major crises, i.e. GFC, EDC, Brexit, the Chinese burst bubble,COVID-19, and Russia-Ukraine crises.This TVP-VAR is developed by Antonakakis et al. (2021) asan influence connectedness technique, which is based on Diebold and Yılmaz(2014) (a better version of Diebold and Yılmaz's (2012)[1]and TVP-VAR model (Koop and Korobilis, 2014). Unlike typical

[1] Diebold and Yilmaz (2012) make a substantial contribution by expanding on Pesaran and Shin's (1998) generalised identification. In the generalised identification context, unlike Cholesky factor identification, variable ordering is not a concern. Diebold and Yilmaz (2012) consider both "total" and "directional" features, implying that *i→j* connection does not always correspond to *j→i* connectedness. Diebold and Yilmaz (2014) is a generalised identification and directional viewpoint with a network framework which offer some rudimentary network visuals with connectedness approach.

static models employed in prior research, TVP-VAR models capture the time-varying nature.

In order to study the severity of the crises or contagion effect as per ForbesandRigobon (2002), widely known as financial contagion. This study employed the DCC-GJR-GARCH approach,based on Engle (2002) technique, to test for contagion. This approach, which compensates for heteroskedasticity by estimating correlations of standardized residuals, is commonly used in contagion literature to reflect the changing nature of correlations and structural alterations in data over time (Akhtaruzzaman et al., 2021). For testing contagion, we have taken the Crises origin country for the regression of DCC-GARCH on the rest of the selected country, taking crises one and the rest of the period as zero.

This study also attempted to capture the co-movement in all the periods, which provides a more detailed understanding of the different stock markets with the most highly market-capitalised country, i.e. by taking the US[2] as the base country, using the latest wavelet coherence, cross-wavelet transform, and wavelet correlation technique.

Need of the study

Based on the systematic literature review, it is evident that a few emerging country's financial markets have often been studied, taking the reference of developed economies like the US and European countries. Most researcharticles based on research work on the financial stock market are concentrated on the US, Chinese, and Australian stock markets. However, there is still more space to shift study in the context of emerging and frontier markets. In the past available papers, frontier markets are ignored because of the prominent research gap. Ukraine's crisis and COVID-19 impacted emerging and frontier markets, which must be explored. Research on volatility spillover in emerging and frontier markets is limited, but studies suggest significant volatility spillover between emerging and developed markets. However, the direction of spillover is not always unidirectional, and the

[2] US is highly market capitalized country (2020 rankings) and acted as the major crises are epicenter.

impact of spillover on emerging and frontier markets can be different from the impact on developed markets.

Additionally, there is a limited study on the volatility spillover, financial contagion, and co-movements between frontier markets. Frontier markets are defined as less developed and less accessible than emerging markets and have different characteristics, such as small market capitalization, trade volume, low liquidity, and high volatility. Due to these characteristics, volatility spillover in frontier markets may have other features and impacts than in emerging markets. Given the increasing significance of emerging and frontier markets in the global economy, studying the volatility spillover in these markets is essential to understand the potential risks and opportunities better. This study used risk aversion theory and efficient market hypothesis as theoretical lenses.

1. **Research Gap-**It is the first study to explore the stock market integration based on market capitalization tounveil the six major crises, i.e., GFC, EDC, Chinese Burst bubble, Brexit, COVID-19, andRussia-Ukraine crises, which cover the significant sample period from 2004 to 2023 (June).Research on volatility spillover in emerging and frontier markets is limited, but globalresearch focuses on the volatility spillover between emerging and developed markets. However, the direction of spillover is not always unidirectional, and the impact ofspillover on emerging and frontier markets can differ from the impact on developedmarkets (Kakran et al., 2023b;Kaur et al., 2023). Additionally, there is a limited study on thevolatility spillover and financial contagion between frontier markets. Frontier markets are defined as less developed and less accessible than emerging markets and have differentcharacteristics, such as small market capitalization, trade volume, low liquidity, and highvolatility. Due to these characteristics, volatility spillover in frontier markets may have otherfeatures and impacts than in emerging markets. Given the increasing significance of emergingand frontier markets in the global economy, it is essential to study the volatility spillover inthese markets to understand the potential risks and opportunities better.

2. **Reference material-** Their disparity in the different regionsimpacts directly in the short term (volatility spillover) or indirectly in the long-term during crises (financial contagion) the global stock markets based on the different regional and economic blocs or perspectives which influence the international investments and trading. Over the period, due to various reasons, i.e. economic openness,financial situations, trade pacts, and domestic macro or fiscal policies have also triggered the investments and market capitalizations in Europe, the US, and other continents,which generally firstly impacted other stock markets have had a significant impact. As a result, the source or reference information used to construct and evaluate hypotheses has inherent limits. Thus, unveiling the relationship between developed, emerging, and frontier countries is crucial.

3. **Holistic approach-** Over the previous three to four decades, the history, culture, technology, and economics of emerging and frontier nations have experienced substantial transformation. Studying such developments'impacts on the stock markets will give us a more comprehensive approach to global investors.

4. **Regional Similarity -**Despite the coverage of the global stock markets, this study also focuses on the different regions classified by Morgan Stanley Capital International (MSCI) as America region, Europe, Middle East and Africa (EMEA), Asia Pacific region(APAC) region, which helps to understand the similar challenges and remedies in terms of size, population, geographical diversity, and the resources.

5. **Stakeholders-** After considering the potential that some trading entities (individuals and others) may have netted off their gains against prior losses, the maximum number of trading entities (individuals and others) was 2.014 million. It represents less than half of the 4.288 [3]million active investors the exchange recorded for the year. Thus, for the global investor's hedging perspective in regular trading (based on the interconnectedness of volatility spillover or co-movements) andin the crisis period (to understand the path of the contagion), it has the potential to understand the severity of impacts and the least impacted country.

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[3] https://choiceindia.com/blog/how-much-percentage-of-indian-population-investing-in-stock-market.

6. Other reasons- Regardingthe regionalstock market (such as APEC), a comparison may be sufficient and have limited implications for only the bloc partner countries. Chronological study of the different crises opens the doors for the behaviour of the stock market in the chronologicallysignificant crises.The fund manager should consider diversifying the portfolio across various regions to minimize regional risks and dependencies. The analysis provides insights into the spillover effects between markets in other countries or regions. The portfolio can benefit from reduced concentration risk by diversifying across geographically diverse markets. A fund manager seeking greater market independence and lower interdependencies may consider investing in markets with higher diagonal values (own shock impact) and lower off-diagonal values (transmitter and recipient of shocks). Moreover, the study of these thirty countries would help to understand the price changes and market integration, co-moment, frequency of change, volatilityspillover or financial contagion effects.

Objectives of the Study

1) To assess volatility spillover in the selected stock markets during global crises.

2) To examine financial contagion across the selected stock markets during global crises.

3) To explore time-frequency co-movement between the selected stock markets during the crises.

Research Design Methodology

Table 1 summarises the different stock market indices, source of data, ranking of the various market capitalizations, and differentiation of the global stock market in different market capitalizations, i.e. developed, emerging, and frontier countries.

Table 1 Classification of counties based on (MSCI) and shortlisted based on ranking in equity inflows released by the International Monetary Fund (IMF).

Developed Countries (10)							
Americas					**Asia-Pacific (APAC)**		
S.no.	**Country**	**Market Capitalization Ranking**	**Exchange (Bloomberg Tikker)**	**S.no.**	**Country**	**Market Capitalization Ranking**	**Exchange Bloomberg ticker**
1	US	01	SandP 500 (SPX)	6	Japan	03	Tokyo Stock Exchange (Nikkei 225)
2	Canada	03	Canadian stock market (SPTSX)	7	Hong-Kong	04	Hang Seng Index (HIS: IND)
Europe Middle East Africa (EMEA)				08	Australia	11	Australia Stock Market (AS51: IND)
3	Germany	08	Frankfurt Stock Exchange (DAX)	09	Russia	16	Moscow Stock Indices (IMOEX)
4	Switzerland	10	Swiss Market Index (SMI: IND)	10	Singapore	17	Straits Times Index (STI)
5	Spain	15	Spanish Stock Exchange (IBEX 35)				
Emerging Country (10)							
Americas				**APAC**			
11	Brazil	14	Ibovespa Brasil Sao Paulo Stock Exchange Index (IBOVESPA)	15	China	02	Shanghai Stock Excahnge (SHCOMP Index)
12	Mexico	21	Mexican IPC index (Indice de Precios y Cotizaciones) (MEXBOL)	16	India	06	Bombay Stock Exchange (BSE)
EMEA				17	South Korea	09	Korea Composite Stock Price Index (KOSPI Index)

13	Saudi Arabia	07	Tadawul All Share Index (TASI: Index)	18	Thailand	18	Stock Exchange of Thailand (SET Index)
14	South Africa	13	Johannesburg Stock Exchange (JALSH/ FTSE/JSE)	19	Indonesia	19	Jakarta Stock Exchange Composite Index (JSCI)
				20	Malaysia	20	Kuala Lumpur Composite Index (FBMKLCI Index)
Frontier Countries							
EMEA							
21	Morocco	36	(MCSINDEX: IND)	27	Kenya	47	Nairobi Stock Exchange (KNSMIDX Index)
22	Nigeria	37	(NGX: IND)	28	Jordon	48	Jordon Stock Exchange (JOSMGNFF Index)
23	Kazakhstan	40	Kazakhstan Stock Exchange (KZKAK)	29	Bulgaria	49	Bulgaria Stock Exchange - Sofia (129225Z:BU)
24	Romania	44	Bucharest Stock Exchange Trading Index (BET: IND)				
25	Bahrain	45	Bahrain Bourse All Share Index (BHSEASI)	**APAC**			
26	Croatia	46	Croatia Zagreb Stock Exchange Crobex Index (CRO: IND)	**30**	Vietnam	26	Vietnam Stock Exchange (VNINDEX Index)

Major Findings

➢ **Major findings from the volatility spillover among the global stock markets**

❖ Before or Pre-GFC, 73.68% volatility spillover was generated; Brazil (47.28 %), Switzerland (42.67 %), Brazil (47.28 %), Switzerland (42.67 %), and Mexico (31.15%) were significant transmitters; Croatia (-25.69 %), Spain (-26.02 %),and Jordon (-21.83 %) were substantial net receptors of the volatility spillover and weak integration identified during this period, which indicates it as stable period.Intresntgly During GFC, 84.37% volatility spillover was generated, suggesting a turbulent period. During this period, the US, Mexico, and Canada were identified as the primary transmitters; Australia, Spain, and Nigeria were identified as the significant receptors of the spillover. Moreover, minor impact in short period frequency (8.13%) and medium (72.77%), but a substantial impact in entire period (80.91%) frequencies.

❖ During Pre-EDC, this study identified high volatility spillover, i.e. 83.54%, whichindicates PIIGS, Morocco, and Saudi Arabia as significantreceptors, Kenya, Spain and the US as primary transmitters of the spillover. During EDC, 76.47% volatility spillover was generated in the US, and Germany was the primarytransmitter; PIIGS and Kenya were the significant receptors of the volatility spillover. It indicates the US remains the epicentre of the spillover among all these countries. Less volatility spillover was generated during this period, possibly due to the pre-EDC period overlapping the GFC period, as EDC isa simulation crisis.

❖ During a pre-Chinese crash, 81.29% volatility spillover was generated in which the US (33.25%), Canada (25.1%), and Kenya (24.44%) were identified as the significant net transmitters of the spillover. On analyzing developed countries, the US (33.24%), Canada (25.1%), and Russia (6.20%) were identified as significant transmitters, and on the other side, Spain (-19.21%), Singapore (-15.94%), Japan (-7.66%) were identified as primary net volatility spillover receiver.

❖ During the Chinese Crash, 91.45% volatility spillover was generated in which Canada (72.81%), Saudi Arabia (69.08%), and Nigeria (32.79%) are identified as the significant transmitter; Singapore (-48.70%), Indonesia (-45.89%), Spain (-45.63%)

are identified as the primary receptor of the volatility spillover. Chinese crash generated 37.10% volatility spillover in short frequency, medium frequency generated 51.93%, and 89.03% in the entire period as generated volatility spillover.

- ❖ During Pre-Brexit 92.94% volatility spillover and the reason may be due to oil crises; among developed countries, this study (indicated Japan (31.66%), Germany (30.90%), Hong Kong (20.97%) were the primary net transmitter, and Australia (-47.92%), Spain (-39.47%), Switzerland (-36.56%) as primary net receiver of the volatility spillover.

- ❖ During Brexit volatility spillover, 89.50% generated UK (35.44%), Switzerland (24.35%), Singapore (22.46%) were net transmitter; Canada (-41.29%), Hong-Kong (-6.34%), Singapore (-5.97) was significant net receptor.

- ❖ During pre-COVID-19, no such interconnectedness was identified as it acted as a regular period, but it still generated an 84.64% volatility spillover among the selected stock market. South Africa (30.35%), Germany (28.22%), and Hong Kong (25.39%) were the significant transmitters; Romania (-43.30%), Morocco (-34.93%), and Russia (-26.83%) were substantial receptor of the spillover.

- ❖ During COVID-19, 88.63% volatility spillover generated by the US (54.42%), Switzerland (33.40%), and Mexico (48.66%) were significant transmitters; Kenya (-36.79%), Nigeria (-36.02%), and Japan (-34.68%) were substantial receptor of the spillover. On testing, different frequencies also showed low impact (35.73%), as compared to the medium (52.22%) and entire period (87.95%).

- ❖ During the Russia-Ukraine crises, volatility spillover among the developed countries indicates Russia (54.4%), Germany (49.09%), Spain (48.41%) as a significant net transmitter; Singapore (-53.90%), Hong Kong (-52.87%), Japan (-52.60%) identified as the significant net receiver.

- ❖ On analyzing significant net volatility spillover during Russia-Ukraine crises Germany (39.74%), Switzerland (29.52%), Japan (8.16%) among developed countries are central transmitter; India (31.89%), South Africa (30.66%), Thailand (22.24%) among emerging countries; Bahrain (33.65%), Romania (31.82%), Croatia (20.25%)

among frontier countries. On analyzing the volatility spillover on the different frequency domains, this study found short frequency (27.49%), high spillover in just starting, medium frequency (56.11%), and total frequency (83.60%). TVP-VAR-BK Model results indicated that in just four days, 27.49% volatility spillover was generated, 56.11% in the medium term, and 83.60% in the longer term.

➢ **Major findings from the financial contagion among global stock markets –**

❖ During global financial crises (GFC-2007 to 2009), Russia, Switzerland, Germany, Singapore, and Canada among developed countries; Mexico, Brazil, Thailand, South Africa, Indonesia, and Malaysia among emerging countries; and Croatia and Romania among frontier countries reported significant contagion effect among all the frontier countries on taking the US as the origin of crises during GFC. On analyzing correlation (developed markets have a strong connection with the US, whereas emerging and frontier markets have a low correlation) among all the countries taking the US as crises origin (using DCC-GJR-GARCH results) indicated Brazil, Mexico, Canada as highly integrated countries, in which India acted as connected contagion channel among all the countries, although due to different factors such as financial stability, financial innovation, and irrational behaviour (different sentiments) of investors may impact these contagion channels.

❖ Similarly, during EDC (May 2010- June 2013), Russia, Spain, Australia, Hong Kong, and Singapore among developed countries; Brazil, China, Saudi Arabia, South Korea, and Thailand among emerging countries; Croatia, Romania, Vietnam were identified as significantly impacted from financial contagion This might be owing to the U.S. losing economic supremacy because of the crisis, as well as China emerging as an economic powerhouse and improving trade and economic relations with other markets.

❖ Chinese burst bubble (June 2015 to Dec 2015) Singapore, Hong Kong, Australia, Japan, US, Germany, and Canada among developed countries; South Africa, Thailand, South Korea, Indonesia, India, Saudi Arabia, Malaysia, and Brazil among emerging countries; Vietnam, Croatia, Jordon, Bahrain, Romania, Morocco, and Kazakhstan among frontier countries.

❖ During the BREXIT (June 2016 to Sept. 2017) event, emerging countries didn't show any contagion, but only Spain, Hong Kong, and Australia among developed countries; Vietnam, Bulgaria, and Nigeria among frontier countries had significant contagion.

❖ During the world health crisis, i.e. COVID-19 (Jan 2020 to April 2021), only Spain and Russia were among the developed countries; Bulgaria, Nigeria, and Kenya, among frontier countries, didn’t show significant contagion. The rest of the countries show substantial contagion.

❖ In geopolitical crises, i.e., the Russia-Ukraine crises (Feb 2022 to Feb 2023), all selected developed and emerging countries showed no contagion impact. Still, some volatility may occur among countries or economic blocs during this period. Among all the frontier countries except Bulgaria, Kenya, and Romania, the rest of the countries were impacted due to contagion, which indicates frontier countries showed more contagious effects than other countries.

➢ **Major findings from the co-movementamong the global stock markets –**

❖ During GFC (807 to 1431 observation) among developed countries, Japan, Australia (lower to top), the UK, Canada, and Switzerland are strong Germany Singapore in-fluctuations (medium, top level). Spain, Hong Kong, Russia, Australia, Brazil, and Mexico seem to have the least impact (lower to medium). Among emerging countries, Brazil, Mexico, and South Korea are strongly connected (low to high), Saudi Arabia, South Africa, India, Indonesia (medium to high), China, Malaysia, and Thailand are also the least impacted, and among frontier countries, Vietnam, Bulgaria, Croatia, and Romania positively correlated. However, higher co-moments were identified in the extended period, with Morocco, Nigeria, Bahrain, Kenya, Jordan, and Kazakhstan as the least impacted.

❖ During the European debt crises (EDC) (1518 to 2328 observation) among developed countries, Russia (low to medium), the UK (low to high) in the longer term positively Switzerland, Germany, least impacted (medium to longer), Spain, Japan, Singapore (medium), Hong-Kong, Canada, Australia, less impacts. Among emerging countries, Brazil and Saudi Arabia showed some low and high-frequency co-moment, Mexico (at low-level period), South Africa (low to high), China and India least impacted, South Korea, Malaysia medium level, Thailand medium to high, Indonesia low to high. Among frontier countries, Morocco showed positive and negative significant impacts on the medium level, Kazakhstan at the upper medium scale, Bahrain at the top level, Romania at the all level, Nigeria, Kenya, Jordon as at the least impacted, Croatia (low and high level), Vietnam, (higher at low level), and Bulgaria (in more extended period).

❖ During the Chinese crash (2852 to 2996 observations), among developed countries, Japan (low to high), Hong Kong (low to medium), Australia, Canada (Medium), Russia were the least impacted, Singapore, Spain, Germany, Switzerland, UK on the lower level. Among frontier countries, Bulgaria, Vietnam, Morocco, and Kenya are least affected by Nigeria (in starting a few days), Kazakhstan scattered not linear moment, Romania (low to high), Bharain (low to middle), Croatia (low level) and Jordon (medium level) shown co-moment. Among emerging countries, South Korea, Brazil, Mexico, Saudi Arabia, Thailand, Indonesia, Malaysia, and China are the least impacted. However, up to certain limits, South Africa and India have shown co-moment.

❖ During the Brexit crisis (3122 to 3453 observations), among developed countries, Singapore, Germany, and Switzerland made minor comments at a low level, Australia on the top level, Russia, Japan, Hong Kong, Spain, the UK, and Canada were least impacted. Indonesia, Malaysia, Thailand, Brazil, Mexico, Saudi Arabia, South Africa, China, and India were the least affected among emerging countries. South Korea indicated that co-movement went from a low to medium level. Among frontier countries, Vietnam, Bulgaria, Morocco, Nigeria, Kazakhstan, Romania, Bahrain, Croatia, and Kenya have slight co-movementat a low level and are the least impacted. Jordon indicated that co-movement went from medium to high levels.

❖ During the COVID-19 crisis (4601 to 4963 observations), strong positive co-movements were identified with the US among all the countries. Among developed countriesare the UK, Spain (medium to high), Canada, Germany, Switzerland, Japan, Hong Kong, Australia, and Singapore (low to high). Among emerging countries are Mexico, Saudi Arabia, South Korea, Thailand, India, South Africa (low to high), Indonesia, Thailand, Malaysia, and Brazil (low to medium). Among the frontier countries, Kazakhstan, Nigeria, Morocco, Kenya, and Jordon showed the least co-moment, but Bahrain (medium period), Romania, Croatia (medium to long), Vietnam and Bulgaria (low to above medium period) had positive co-moment.

❖ During the Russia-Ukraine crisis (4601 to 4963 observations)among developed countries, the UK, Canada, and Spain (low to medium period), another strong co-movementwas identified. In the emerging nations of South Africa and Malaysia, up to some limit, South Korea and India (medium) have shown positive co-movementwith the US. In the frontier, countries were less co-movementwith the US in all the crises than in developed and emerging countries.

Conclusion

Different results indicated that significant changes were established in the selected stock markets during all the crises based on the time frame and origin of the crises. As on analyzing the volatility spillover among all the selected countries, Pre-Brexit (92.94%)(as in the same time frame oil crash also occurred), Pre Russia-Ukraine crises (91.62%) (as still in the more extended period COVID-19 impacts are observed), Chinese crash (91.45%), Brexit (89.50%), Covid -19 (88.64%), Russia-Ukraine crises (85.80%), Pre-Covid (84.64%), GFC (84.37%), Pre-EDC (83.54%), Pre-Chinese (81.29), Pre-GFC Crises (73.68%), EDC Crises (76.47%), were the major impacted crises among all the selected countries.

In analyzing financial contagion during GFC and COVID-19, this study found thatsignificant countries generated financial contagion.Among all the crises, different levels of co-movementwere identified with the selected stock market in the US based on the various intensities of the crises. However, during GFC and COVID-19, high co-movementidentified among all these countries, especially developed and emerging countries, showed a higher level of co-movement but a low levelidentified among the frontier countries, which can act as for the hedging perspective. Moreover, these wavelet coherence results are further robustly explored by wavelet correlation and cross-wavelet transform models.

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INTRODUCTION

CHAPTER -1

INTRODUCTION

Economic globalization's rapid development leads to the financial crisis's growing scale, intensity, and speed. Global financial, economic, political, health and other crises may cause interconnectedness among the different markets as turmoil through financial contagion or spillover; when the primary risk management models do not operate or fail to identify a well-diversified portfolio, fund allocation becomes a severe challenge for fund managers, policymakers, and individual investors. The spreading of financial crises increases the risk of doing business at macro and microeconomic levels. The financial crisis appeared for a long time, naturally creating contagion in financial crises. The diversification behaviour of international investors is significantly influenced by four factors: liberalised government regulations, increased investor awareness of the benefits of cross-border diversification, the growing number of new Multinational Companies (MNCs), and advanced computer technology that facilitates rapid information dissemination and enhance flexibility in global trading. The geographic nature of risk communities and their market composition heterogeneity, with core structures coinciding with Asia-Pacific, Europe, the Americas, and other regions having different market classifications, i.e. developed, emerging, and frontier economies.

1.1 Stock Market

According to SEBI (Securities Exchange Board of India), the stock market is a platform related to the trading of publicly listed companies in shares. Stock markets have different functions (Fig.1) for the economy's growth, and stock market liquidity is an essential fundamental factor. Financial risk is the highest risk to the company, risk manager, and Investors. A stock market is a reliable barometer for measuring the economic condition of a country. Every significant change in a country and economy is reflected in the prices of the shares. The rise or fall in the share price indicates the boom or recession cycle of the economy. Stock exchange is also known as a pulse of the economy or economic mirror, which reflects the financial conditions of a country. The stock markets help to value the securities based on demand and supply factors. The securities of profitable and growth-oriented companies are valued higher as there is more demand for such securities. The stock exchange permits healthy securities speculations to ensure liquidity and demand for the supply of securities.

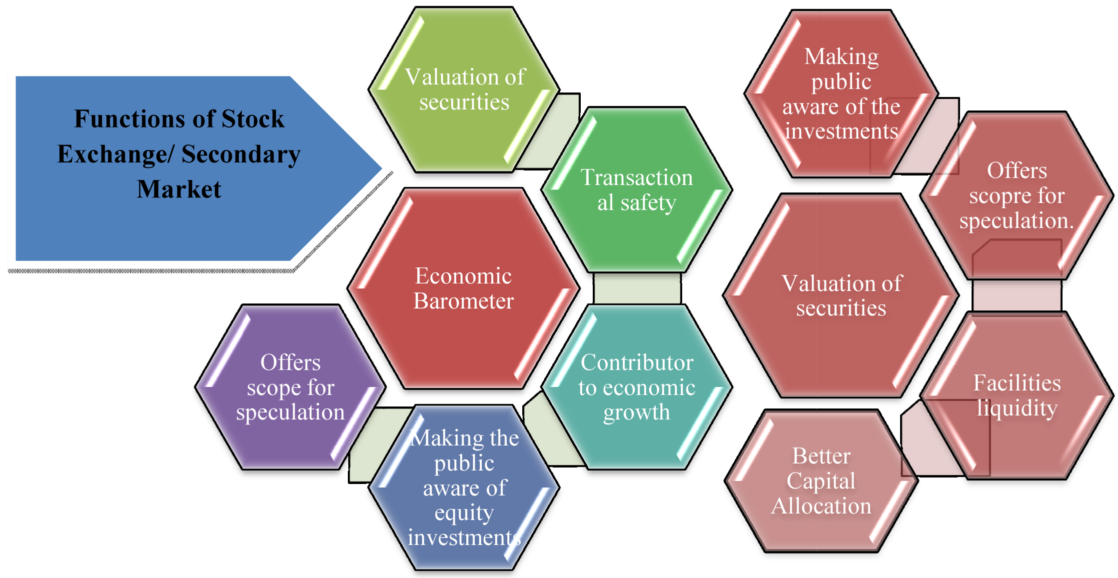

Fig.1.1: Different functions of the stock markets (Information Source: https://www.sebi.gov.in). Source: Author using MS Word.

1.2 Contagion and Volatility Spillover

Over the years, the global markets have been impacted directly or indirectly due to several (internal or external) economic factors. Globalization, privatization, and liberalization of the world's economic policies have opened the doors for trading and different investments in the global economy. The "spillover effect" describes how even a minor disruption in one market may have a noticeable impact on other markets due to the interconnected nature of the world's marketplaces, which has resulted from globalization. Different crises transmitted shocks, beginning from a shocked country and spreading around global markets despite no ties or direct relations among those countries.

Paskaleva et al. (2021) stated that financial crises are a sharp phenomenon in developed and emerging markets. Bodart and Candelon (2009) indicated that contagion could occur between the foreign stock market and the shock market. There is a lot of disagreement on the definition of contagion and on appropriate testing techniques on whether contagion is observed or not to a large extent (Baele et al., 2010; Bodart and Candelon, 2009; Bekaert and Harvey, 2003; Billio and Pelizzon, 2003; Fijorek et al., 2020). The past 30 years are a series of several financial crises in both emerging and developed economies as the 1992 ERM Attack in 1994, the Tequila crisis in 1997, Mexican Peso East Asian Crisis in 1998, then the Russian collapse in 1998, LTCM(Long Term Capital Management) Crisis, 1999, Brazilin Crisis, 2000, Technological crisis, 2007-09, Global Financial Crisis (GFC), European Debt Crisis (EDC), Chinese Brust Bubble, BREXIT, COVID-19 (2019 novel coronavirus) and recently Russia-Ukraine (2022) war crisis (Bae et al., 2003; Billio and Pelizzon, 2003; Wang et al., 2020; Kakran et al., 2023b; Kakran et al., 2024). The daily closing price among the selected developed (Fig. 1.2), emerging (Fig. 1.3), and frontier (Fig. 1.4) indicated similar patterns (fluctuations) in the selected period of study, which stated that a significant crisis has impacts on the global stock market. A common feature is that these crises can spread quickly from one market to another. This financial character is mainly called "financial contagion," which threatens economic stability. For example, the GFC emanated in the US subprime debt market, spread rapidly across global financial markets on an uncertain scale, caused global financial disasters, and resulted in financial system collapse and social unrest. Financial contagion appears to prevail in financial markets, and the standard research stream stressed the contagion mechanism of the financial crisis.

Many authors (Forbes and Rigobon, 2001; 2002; 2004; Bodart and Candelon, 2009; Baele et al., 2010) also pointed to contagion as a significant rise in cross-market linkage after a shock to one country and also stated that contagion as excess correlation expected from the economic fundamental. As the 1997 HongKong crisis shifted or transferred contagion to Brazil, Canada, Germany, and South African stock markets (Bekaert and Harvey, 2003; Baele et al., 2010; Bond et al., 2006; Baur, 2003; Baig et al.,1998) said that due to various more biased above definitions were failed as by comparing tranquil period and crisis period no longer find any evidence for contagion during three important 1990's crises namely Mexican crisis 1994, Hong-Kong crisis 1997, Tequila crisis 1997 as to adjust volatility does not continuously represent the correct correlation. However, Brière et al. (2012) stated that contagion is shown by increased correlation in the equity market during turmoil. Pericoli and Sbracia (2003) discussed many definitions of contagion. In beginning clusters of currency crises, contagion is a significant rise in the probability of a crisis in one country, conditional on a crisis in another. In works mainly focusing on asset prices, contagion is sometimes termed a volatility spillover from the country that originated the crisis to other countries' financial markets. In models stressing multiple equilibria and herding, contagion is called spillovers that cannot be explained in fundamentals. The definition of an underlying focused test is a structural break in cross-market links. Brière et al. (2012) stated that contagion is often confused with globalisation as both have the supremacy to increase correlation. Still, contagion and globalisation are not mutually exclusive; theyare tricky and complicated to separate economically. When a risk manager indicates a single way, a causal relationship between a particular market's current and past volatility shocks is called volatility spillover. This studyembraces the definition of Forbes and Rigobon (2002) as contagion, which is the significant rise of cross-market correlation due to inter-market connectedness after a disturbance in one country or a group of countries. This concept offers a straightforward method for assessing the contagion effect by analysing the connections between the genesis of a crisis and secondary markets before and during the crisis.

Additionally, it offers valuable information on the efficacy of policy intervention. This concept provides a straightforward method for assessing the contagion effect by analyzing the connections between the genesis of a crisis and subsequent markets before and during the crisis. Additionally, it offers valuable information on the efficacy of policy intervention.

The empirical literature on contagion examines four often-referenced approaches for studying financial contagion and the interconnectedness of markets: 1) Analysis of cross-market correlation coefficients (King and Wadhwani, 1990); 2) Utilisation of time-varying correlation approaches such as the DCC-GARCH approach (Engle, 2002); 3) Implementation of the cointegration methodology (Kakran et al., 2024a); and 4) Adoption of the transmission mechanism approach (Eichengreen et al., 1996). The initial three strategies prioritise the robustness of connections across markets, as seen in this study, but the last strategy determines the channels via which financial contagion occurs. The cross-market correlation analysis is the foundation of the contagion test, which was developed and popularized by Forbes and Rigobon(2002). Nevertheless, the test needs calibration to account for the influence of heteroscedasticity bias, as it relies on variations in static correlation coefficients across markets before and during a crisis. The cointegration process examines alterations in the cointegrating vector between markets over an extended period, which means that the test may encounter difficulties when dealing with brief contagion events or limited market data.

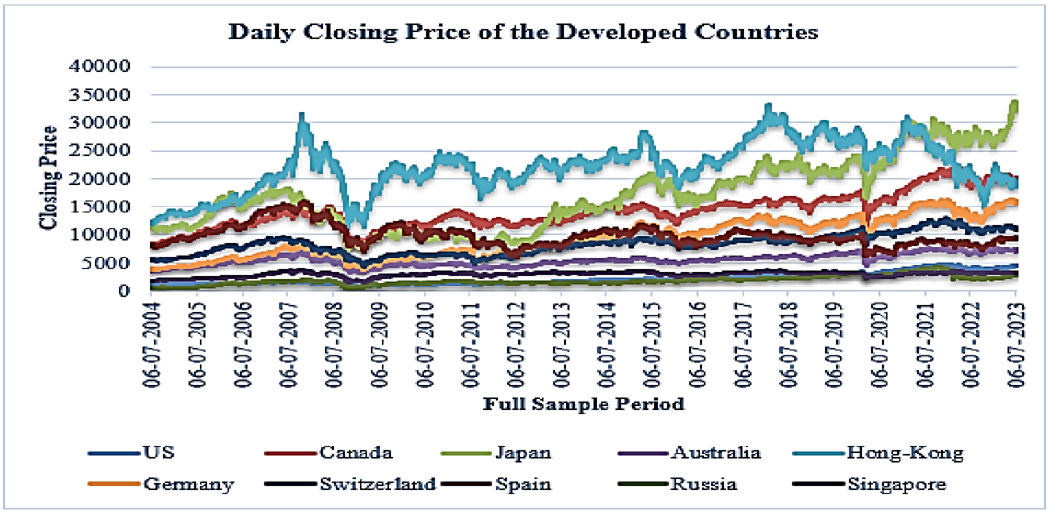

Fig. 1.2: Daily closing stock prices of the selected developed countries.

Source: Author using MS Word.

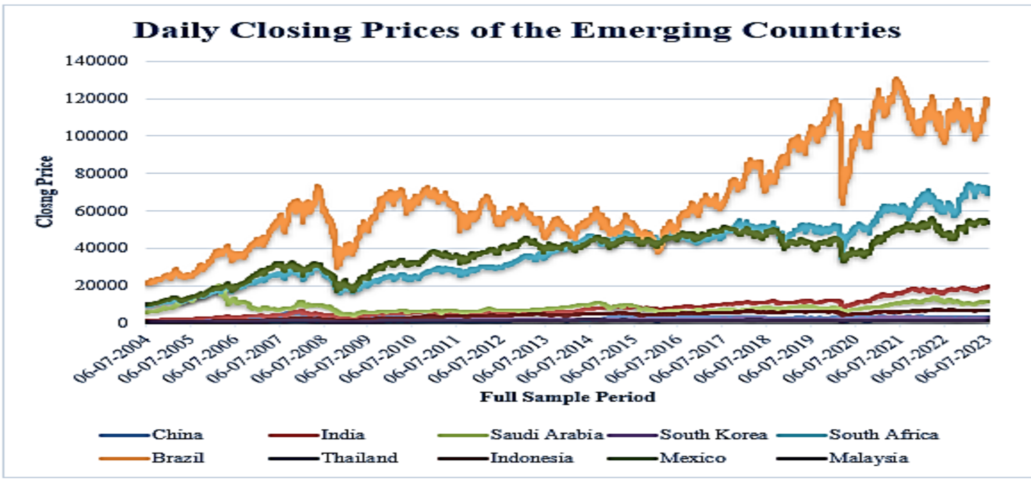

Fig. 1.3: Daily closing stock prices of the selected emerging countries.

Source: Author using MS Word.

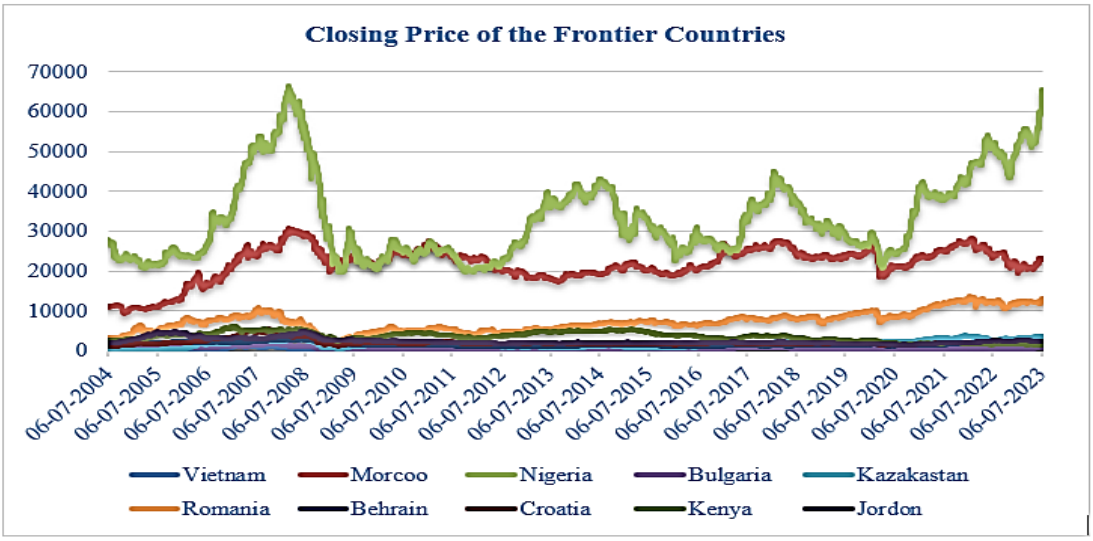

Fig. 1.4: Daily closing stock prices of the selected frontier countries.

Source: Author using MS Word.

1.3 Time-Frequency Co-Movement

Time-frequency co-movement research might entail examining how the correlations between various equities or market indexes change across different periods and frequency components in the stock market. This sort of study can be beneficial for understanding the dynamics of financial markets, mainly how asset correlations and co-movements develop over time. Time-frequency co-movement research might entail examining how the correlations between various equities or market indexes change across different periods and frequency components in the stock market. This sort of study can be beneficial for understanding the dynamics of financial markets, mainly how asset correlations and co-movements develop over time.

There are several factors contributing to co-movement -

➢ The Stock Exchange's Co-movement

The propensity of stock prices to move in the same direction simultaneously is called co-movement in the stock market (Qabhobho et al., 2023). This phenomenon may be seen in individual stocks, industries, and whole markets. Co-movement can be caused by a multiple of reasons, including:

- ❖ Macroeconomic factors: Economic events such as interest rate changes, inflation, and GDP growth can have a broad influence on all equities, leading them to move in the same direction (Schäfer et al., 2024).
- ❖ Sectoral factors: Stocks in the same sector are frequently influenced by industry-specific events such as changes in commodity pricing, legislation, or consumer demand (Younis et al., 2024).
- ❖ Investor sentiment: When investors grow more optimistic or pessimistic about the market, they may buy or sell equities across all sectors, resulting in co-movement (Lohan et al., 2023).
- ❖ Sharing of information: News and events can circulate swiftly through the market, leading investors to respond similarly and move prices in the same direction (Hirshleifer et al., 2024).

The degree of co-movement might vary based on the circumstances. In periods of extreme market volatility, for example, stocks may move more closely together as investors focus on broader market trends rather than specific business performance. For investors, co-movement can have both beneficial and dire consequences. On the one hand, it can make adequate portfolio diversification difficult because all companies may be heading in the same direction. On the other hand, it can allow investors to profit from market trends by holding companies expected to move in the same direction as the broader market.

This study attempted to unveil the co-movement based on the technique, which is critical in understanding the intricate time-sensitive relationships that underpin these markets, particularly during periods of increased volatility and uncertainty. It provides a new viewpoint on the temporal changes of market dynamics by categorising interactions into short, medium, and long-term cycles and exposing how these markets respond differently across time frames. This finding emphasises how stock markets are subject to financial, economic shocks and geopolitical catastrophes. One market component that has not garnered attention is the relationship between border-rising countries. By concentrating on how these intricate relationships become more apparent during periods of global instability, the study provides a more complete picture of market interaction. Third, our findings may help investors, policymakers, and traders build portfolios.

1.4 Different classifications of the market and stock crises from boom to bust as a rollercoaster ride through the history of stock market crises.

Morgan Stanley Capital International (MSCI) market classification is globally used as it balances economic developments and provides greater accessibility to the international investment community while preserving index stability[1]. Market categorization is an essential factor in index creation. MSCI assists investors in understanding and comparing various markets by categorising markets based on standard features. Furthermore, MSCI's market classification includes a market accessibility evaluation, which aims to represent investors' real-world experience in accessing and transacting in each market and a complete and extensive study of current regulatory frameworks.The annual market classification review is intended to verify that MSCI indexes effectively organise the stock markets they measure, allowing investors to compare markets and aggregate markets appropriately into regions and other combinations. MSCI classified different markets in different factors –

- Economic Development

  Considers the sustainability of economic progress; exclusively used to classify established markets.

- Size and liquidity requirements

  Determines which equities fulfil the MSCI Global Standard Indexes' minimal instability criterion.

- Market accessibility

  Based on five market accessibility criteria, this index seeks to represent worldwide institutional investment experiences in a specific equities market.

[1] https://www.msci.com/our-solutions/indexes/market-classification.

Focusing on the three significant factors above, MSCI announced four markets: developed, emerging, frontier, and standalone. MSCI categorises countries according to their economic development and how easily investors can access their capital. Investors may better grasp the risks and rewards of investing in different nations with the aid of this categorization system. The following is an explanation of each grouping:

a) Developed markets:

International investment hinges on developed markets. For investors looking to diversify their portfolios internationally, the developed markets opportunity set is an excellent place to start as they venture outside their home markets. The economic systems, infrastructure, capital markets, and general quality of life of industrialized countries are far superior. In addition to adding stability, transparency, and liquidity to portfolios, they may also be a good fit for developing market investments. These economies have advanced to a point where their capital markets are as robust and easily accessible as the US, Japan, Germany, and the UK. While developing and frontier markets tend to be more volatile, developed markets are more stable and have slower growth rates.

b) Frontier Markets:

If a nation is too small, has too much inherent risk, or lacks sufficient liquidity to be classified as an emerging market, it is regarded as a frontier market instead. It is more established than the least developed countries (LDCs) but not as established as the emerging markets. The generic term for frontier markets is pre-emerging markets. Investors hesitate to invest in these economies because of their size and lack of development. Bangladesh, Kenya, Vietnam, and Morocco are among the examples. Political unpredictability, currency restrictions, and illiquid markets are just a few reasons frontier markets are both very profitable and extremely risky. Although their financial markets are not as established as those in more developed nations, these economies are seeing fast economic growth and development in South Africa, China, India, and Brazil. The risks and rewards of investing in emerging economies are more significant because of political unpredictability and currency changes.

c) Standalone Markets:

Standalone markets[2] have distinct features that don't seem to belong anywhere else. These markets can have just opened to the public or are newly accessible, previously inaccessible, or have unique features, e.g., Argentina, Jamaica, Panama, etc. Further, MSCI's standalone markets are divided into two categories: i) some newly eligible markets may be new markets not previously covered by MSCI or markets closed to a specified group(s) of investors. ii) Markets historically classed as Developed, Emerging, or Frontier Markets.

The financial markets are severely disrupted during financial crises, which cause asset prices to plummet, banks to fail, and people to lose faith in the financial system. Economic activity, employment, and social well-being can all take a hit when these things happen. Over the period, different crises occurred due to several reasons as in last two decades are as follows –

❖ The US subprime crisis or Global Financial Crisis (GFC)

The Global Financial Crisis (GFC) began in August 2007, but it reached its height in mid-September 2008 following the failure of a major US financial institution (Bernanke, 2018). The US subprime crisis may be traced (spanning from 2007 to 2009) to the US mortgage bubble. It was caused by the bankruptcy of Lehman Brothers, the country's largest bankrupt company to that point, and had far-reaching consequences. Following this, the Eurozone sovereign debt crisis erupted as Greece's government stated that its public deficit had reached 12.7% of domestic GDP, four times the permissible limit. Because of their global repercussions, several researchers interested in financial contagion have evaluated these two crises. US subprime crises decline in correlation levels of different stock markets in the context of the US.

The primary factors behind the crash are as follows -

A) Housing Bubble: Using complicated financial instruments like mortgage-backed securities (MBS) and cheap financing, the housing market saw an unsustainable

[2] A reclassification to Standalone status may occur if market accessibility, size, or liquidity deteriorate significantly.

price increase, leading to a gigantic bubble. The boom broke, and investors and financial institutions lost much money when borrowers stopped paying back their subprime mortgages.

B) Excessive Leverage: When the housing bubble burst, financial institutions and investors might have lost much more money since they took on so much debt to buy riskier assets like mortgage-backed securities (MBS).

C) Regulatory Failures: The financial system became susceptible to risks due to lax supervision and insufficient restrictions, which enabled excessive risk-taking.

D) Globalization: The rapid globalization of the crisis and its effects on economies worldwide result from the linked nature of the world's financial markets.

❖ Eurozone Sovereign Debt Crisis

At the tail end of the first quarter of 2010, after the Great Financial Crisis (GFC), ESDC again began to wreak havoc on the economies of the Eurozone nations. The Eurozone is a monetary union, as all its members use the same currency (Bhatia and Tuteja, 2024). The other side is that all nations' tax and spending systems are unique in their fiscal structures. A deterioration of the sovereign credit rating, a political imbalance, and serious budgetary challenges acted as the main components of ESDC. The financial and debt crises of 2008 and 2010 exposed the Eurozone's flaws, inefficiencies, and imbalances. It wasn't challenging for the stock markets of the union's core member states to rebound.

In contrast, PIIGS's periphery stock markets[3]saw a drastic drop in value because of the troubled attempts to revive their economies. The two crises separated the Eurozone stock markets into core and peripheral categories, which slowed their integration. Investors inside the monetary union are becoming increasingly wary when investing in the stock market. Eurozone member states' bond and stock market cycles were discordant because of the impact of the 2008 and 2010 financial crises. According to the researchers, the Greek crisis appears to have less impact on the

[3] Acronym PIIGS indicates the most vulnerable economies in the Eurozone i.e. Portugal, Ireland, Italy, Greece, and Spain.

connection between the Greek stock market and the seven indexes evaluated. The contagion effects of the Eurozone crisis on stock markets in seven Eurozone and six non-Eurozone countries were assessed.

❖ Chinese Brust Bubble[4]

The Shanghai Composite Index lost over two-thirds of its value in just two months during the Chinese stock market meltdown of 2015 and 2016 (Tang et al., 2024). There were several causes for this occurrence, but the most important ones may be grouped into three broad classes.

A) The Excessive Growth of the Market:

Bubble Formation: The Chinese stock market had a spectacular ascent before the catastrophe, driven by retail investor zeal, speculation, and inexpensive loans. As a result, many firms' values were inflated beyond their true profitability.

Leverage: Investors, both retail and institutional, used high levels of influence to profit from the rising market, which significantly increased the severity of their losses when the market crashed.

B) Challenging Decisions:

The Chinese government intervened by slowing the market's rise by increasing interest rates and limiting margin trading. However, investors were confused because they thought these efforts weren't constant.

The Chinese government's unpredictable devaluation of the Yuan in August 2015 stoked fears of sluggish economic development and financial instability. The panic selling that followed only served to deepen the market's fall.

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4 Collapse- Imagine a bridge with weak foundations and watch it collapse. The whole structure gives way to the appearance of cracks as time passes. The market has collapsed on a systemic level.Crash -Let your mind wander to a rollercoaster tumbling down a steep slope. Although terrifying, it does manage to descend to the base and then ascend back up. This is a sharp and unexpected drop in the market, however it will not last forever.Burst Bubble- To visualize a burst bubble, picture a growing soap bubble that, when it explodes, releases a cloud of sudsy water. This shows how inflated pricing may quickly be corrected to a more reasonable level.

C) Difficulties with the Economy at Large:

A slowdown in China's economic development at the time cast doubt on the sustainability of further market gains. Fears over corporate governance and a general lack of openness by many Chinese firms have contributed to a steep decline in investor faith in the country's economy.

❖ BREXIT

The first reaction from the market identified that with 52% of the vote, the UK chose to exit the European Union (EU) on June 23, 2016.Ganderson., (2024). There was instantaneous fear in the financial markets due to this unexpected outcome. The next day, during the early hours of trade, the UK's benchmark stock index, the FTSE 100, fell by more than 8%[5].

The tremors reverberated throughout international markets, sending key indices down in the United States, Europe, and Asia.

Reasons for the Market Recession:

A) Uncertainty: The UK's economic and political future in connection to Europe is now shrouded in mystery following the decision to exit the EU. Fearing for their capital, investors dumped their UK and European assets due to the lack of certainty.

B) Currency Depreciation: A rapid depreciation of the British pound was another consequence of the Brexit decision. As a result, British exports became more competitively priced, while imports became more costly for British businesses, which might affect their bottom line.

C) Risk Aversion: When markets are volatile, investors flee to safer investments like government bonds because they don't want to take any chances. This exacerbated the fall in stock prices.

❖ COVID-19

The worldwide stock market collapsed in February and March of 2020 due to the COVID-19 epidemic (Karan et al., 2023). As a result of generalized anxiety and

[5] https://www.theguardian.com/business/2020/mar/16/markets-hit-by-further-losses-despite-us-interest-rate-cut-willie-walsh-ba-coronavirus

panic, it fell at one of the sharpest and quickest rates in recorded history. In January 2020, initial fears about the virus's spread affected Asian markets (Radulescu et al., 2024). Anxieties and market instability soar as cases soar worldwide in a short period. US markets saw steep declines on February 24-27, 2020, leading to a 10% Dow Jones Industrial Average collapse. A selling panic led to record-low sales from March 9 to the 12th, 2020. The Dow Jones had its worst-ever single-day loss of 30%[6]. By April 2020, markets had levelled off slightly but were still lower than before the catastrophe. The core reasons behind the collapse of the different stocks due to this period are as follows-

A) Disruptions to the economy: Companies and sectors were hit hard by the pandemic's travel restrictions and mandatory shutdowns. As a result, many started to worry about a recession, job losses, and falling company earnings.

   Fear and uncertainty caused by the fast spread of the virus and the absence of control mechanisms caused investors to liquidate their equities in large numbers, causing panic.

B) Problems with market liquidity: As panic spread, many investors attempted to unload their assets simultaneously, making it harder to find buyers and sending prices falling even further.

C) Interconnected on a global scale: The interdependence of world financial markets allowed the catastrophe to span international boundaries swiftly.

❖ Russia-Ukraine war

   Russia invaded Ukraine on February 24, 2022 (Kakran et al., 2024). The war has triggered instability and reductions in the global financial market but has not created a full-blown meltdown. Significant impacts on the stock markets:

A) Sudden Dismay: Major indexes like the SandP 500 and the Dow Jones Industrial Average fell by around 5% following the invasion, indicating a sizeable first market reaction[7].

[6] https://edition.cnn.com/business/live-news/stock-market-news-today-030920/index.html

[7] https://www.investopedia.com/ask/answers/difference-between-dow-jones-industrial-average-and-sp-500/

B) Increased market volatility and price changes resulted from the general unease investors felt due to the conflict. This volatility is still present but not as extreme as before the shock.

C) Sectoral Impact: Major price fluctuations occurred in sectors immediately impacted by the conflict, including oil, defence, and airlines. Energy costs have levelled out after originally skyrocketing.

D) Impact on a Global Scale: The war's effects extended well beyond the USand Europe. Even developing nations' stock markets were not immune to the repercussions, especially those with stronger links to Russia or Ukraine.

1.5 A tapestry of motivations behind the research drivers

The stock market is a reliable barometer for measuring the economic condition of a country. Every significant change in a country and economy is reflected in the prices of the shares. The comprehensive statistical and systematic literature review (Chapter-2) also indicated global investors' interest in studying the stock markets, focusing on financial contagion and spillover as globalisation[8] fostered increased trade and technology interconnectedness and interdependence among nations. Globalization encompasses the economic and societal transformations that have occurred consequently. Over the period, different crises impacted the global economy, from the shock market to other stock markets. The available literature pointed out that significant studies have worked with ten to fifteen sample sizes, predominantly focusing on developed countries or small regional blocs, where emerging and frontier countries' dynamics have not been explored with a large sample size. Only a few studies have examined the financial contagion and volatility spillover, where interconnectedness (time-frequency co-movement). Thus, it motivated as an essential driver for this study to unveil the interconnectedness, volatility spillover, co-movement and financial contagion among the top ten developed, emerging, and

[8] The notion of "old globalisation" primarily involved the movement of physical commodities and basic services over national boundaries. In contrast, "new globalisation" refers to the swift economic integration fostered by digital exchanges, technological advancements, innovation, and the dissemination of ideas and information on a worldwide scale.

frontier countries as market capitalizations[9] (with the MSCI classification of the countries) in the six significant crises (i.e. Global Financial Crisis (GFC) (2007-2009), European Debt Crisis (EDC) (2010-2013), Chinese Brust Bubble (2015), BREXIT (2016), COVID-19 (2020), and recently Russia-Ukraine (2022) war crisis) with pre-during of each crises in (12 panels) subperiods. This study unveils not only the global scenario but also Still; it is also helpful to understand the deep dynamics among the emerging frontier countries and sub-parts of the different regional and economic blocs such as BRICS, G-20, APEC, etc. Rigobon (2019) indicated that there is no suitable model that can be used to perfectly identify "the effect and structure of contagion transmission" because all models suffer from "endogeneity and omitting variable problem," which can be avoided partially by using quantile regression model in terms of conditional volatility. In this study, the presence of contagion is identified using the DCC-GJR-GARCH model (based on the methodology introduced by Engle (2002)) to examine the presence of contagion. This model, which incorporates the estimation of correlations between standardised residuals to account for heteroskedasticity, has been extensively employed in the contagion literature to accurately represent the dynamic changes in correlations and structural alterations in data over time. Moreover, well-established advanced TVP-VAR methodology (to study volatility spillover) and wavelet approach (to explore interconnectedness or co-movements) were implemented. It is based on the latest co-movement model, i.e. wavelet coherence, cross-wavelet transform, and wavelet correlation.

1.6 Charting landscape with the encompassing agenda with limitations

The scope of this study focuses on one of the mirrors of the economy, i.e., the stock market. This study analyses the volatility spillover, financial contagion effects, and interconnectedness or co-movements among global stock markets during six significant crises. In the foreground is a large body of knowledge on financial contagion and volatility spillover across multiple financial asset markets and techniques. The researchers have examined several categories of financial markets, including stocks, bonds, real estate, and money markets. However, this study

[9] Market capitalization quantifies the value of a firm in the open market, considering the market's assessment of its future potential, as it represents the price investors are prepared to pay for its shares.

specifically focuses on stock markets alone. This study is limited to evaluating econometric model findings and excludes regulatory or behavioural issues.

1.7 Novelty of the thesis.

The literature review (chapter 2) indicated that a few studies were conducted on the combined effect of financial contagion and volatility spillover in the global stock market, focusing on the market classification developed, frontier, and emerging markets. According to the previous literature (Refer to Chapter 2), relatively few studies were undertaken on the combined effect of contagion and spillover (volatility and leverage) froman international viewpoint. The current study may differ from past studies in the following ways: in previous studies, a relatively small sampler was used to conduct research, which may not provide a good image of global markets. As a result, the current analysis is based on the most developed and rising nations worldwide. This study addresses a gap in the literature by examining volatility spillover across regional and worldwide stock markets. The report includes thorough analytical research on volatility and contagion impact in a broad market setting for the last fifteen years. This study examined the conceptual and empirical link between contagion and volatility spillover before, during, and after the crisis. This study's novelty is as follows –

- This thesis is focused on the large sample size of 30 countries.
- The study contains extensive analytical data over large sample sizes from 2004 to 2023 to unveil the impact of volatility and contagion in a broad market context.
- It investigated the conceptual and empirical relationship between contagion and volatility spillover during the six significant crises that act as a "black swan."
- This study unveils the time-frequency co-movement between selected stock markets.
- It addresses the gap by examining volatility spillover across developed, emerging, and frontier economies sub-parts of the regional and worldwide stock markets.

- This study fills a gap in the literature by investigating volatility spillover across regional and global stock markets.
- This study opens the door to global investors for their decision marking for portfolio hedging strategies, which can act as a "haven" for foreign and domestic portfolio diversification.

1.8 Structure of the thesis.

This thesis is divided intoseven chapters as follows -

Chapter 1: Introduction

The primary output of this chapter is to outline the current research agenda by discussing the relationship among the different variables in the heading of volatility spillover and financial contagion effects. It also presents this study's novelty anda detailed thesis structure to present the conclusion.

Chapter 2: Review of Literature

This chapter covers the theoretical and empirical framework that resulted from the two approaches, i.e., systematic literature review and statistical review approaches. In the SLR approach, this study focused on the stock markets and identified no detailed study conducted to unveil the relationship between developed emerging and frontier countries.

It stated that the results of various studies were done to find the linkage between two or more markets using long-run relationships, short-run relationships, and volatility linkages. In the later part, a research gap has been identified to help frame objectives for further study.

Chapter 3: Conceptual Framework and Data and Methodology.

This chapter starts with the conceptual framework of the present research, followed by research questions, objectives and hypothesis. It also reports the rationality of crisis period selection, as well as the source and size of the sample selected. A brief discussion of the econometric tools used in this research to answer the research question and the model diagnostic procedures are followed by the conclusion of this chapter. In this chapter, the methodologies used during the study have been detailed. It also includes the need for the study, objectives of the study, source of data collection, methodologies for data tabulation, the period of research and econometric tools used.

Chapter 4: Volatility Spillovers andInterconnectedness Among the Selected Developed, Emerging, And Frontier Stock Markets During Global Turmoil.

This chapter presents the analytical findings of financial contagion and volatility spillover in the selected stock markets employing the TVP-VAR Model.

Chapter 5: Financial Contagion among selected stock markets during several turmoil.

This chapter is divided into three sub-sections, which cover six major crises to unveil the three core objectives (to assess financial contagion using the DCC-GJR-Grach Model.

Chapter 6: Explore Time-Frequency Co-Movement between Selected Stock Markets.

This part uses the wavelet model to focus on the Time frequency co-movement among the selected stock market. This section discusses the results of several crises and concludesthe chapter.

Chapter 7: Conclusion, Limitations, Implication, and future research agenda.

The last chapter of the thesis sprucesthe summary of the thesis, highlighting the scope of the thesis as limitations. This chapter also highlights the potential implications and future research agenda.

1.9 Conclusion

The roadmap of the thesis is covered in this chapter, focusing on the meaning and understanding of the volatility spillover and financial contagion. In the six significant crises (Global Financial Crisis (GFC), European Debt Crisis (EDC), Chinese Brust

Bubble, BREXIT, COVID-19 (2019 novel coronavirus) and Russia-Ukraine war(2022)) war) in the twelve panels (pre-post of each crisis). This chapter also discussed the thesis's novelty concerning the literature of finance, followed by a summary. The theory of financial contagion and volatility spillover is addressed in the classification of prior literature as presented in the next chapter, Chapter 2.

CHAPTER -2

REVIEW OF LITERATURE

CHAPTER -2

REVIEW OF LITERATURE

Over the last four decades, global financial markets have been on a rollercoaster ride, exacerbated by several financial, currency, political, economic, health, and other crises. When a significant crisis occurs in one nation (the shocked country) and spreads to other countries, this is referred to as “financial contagion” (Kakran et al., 2023b).Financial crises are seldom isolated phenomena, and their tentacles regularly span borders, causing regional and worldwide havoc. In essence, "financial contagion" occurs when a significant crisis emerges in one nation and radiates outward across contagion economies. Financial contagion, in which crises spread across borders, wreaking havoc on interconnected markets, has long sparked intense debate. Thus, to understand the background of volatility and financial contagion, Section 2.1 delves deeper into the complexities, examining the slight differences and unexpected parallels between contagion and the seemingly more straightforward concept of spillover.

On the other hand, finding a single, universally accepted phrase for this conundrum is excruciatingly difficult. Instead, the idea of contagion is danced to the music of individual researchers, who are guided by the specific melody of their selected data and the precise insights they seek to reveal. Section 2.2 digs into this kaleidoscope of perspectives, illustrating the numerous definitions that have emerged from the vast and frequently rich fabric of prior research. After that, Section 2.3 sets the theories related to the causes and channels of contagion, expertly analyzing the different ideas presented to explain the "why" and "how" of infection. It investigates the intricate interplay between its potential causes of investor panic, interconnected financial systems, or the domino effect of collapsing assets – and the various channels through which it wreaks havoc, ranging from trade links and information transmission to coordinated policy responses. Section 2.4 covers the practical domain of empirical studies, examining quantitative research that has sought to quantify and comprehend contagion. The massive corpus of literature is thoroughly classified here, exhibiting noticeable trends based on various characteristics, including the approach used, publication dates, geographical emphasis, and specific market types researched. Finally, section 2.5 looks at previous studies, sifting through acquired data to find critical research gaps and unresolved concerns. This exercise serves as the foundation for section 2.6, which masterfully concludes the chapter by highlighting the broad environment ripe for the ever-changing field of financial contagion.

2.1 Theoretical framework development

Global financial markets are the ones from the core stock markets, which directly or indirectly affect different markets, as well as the economy of a country. For three decades, the financial markets faced financial and currency shocks or crises that originated from a particular country, commonly named a shock market, and transmitted shocks rapidly to other markets or geographical regions (Bae et al., 2003; Billio and Pelizzon, 2003; Wang and Zong, 2020). Financial, economic, and other factors constantly influence financial markets, such as currency, stock, commodity, etc. These include fundamental interconnections between countries, trade connections, the international financial system, and geographical vicinity, spread rapidly across global financial markets on an uncertain scale, caused global financial disasters, and macro similarities resulted in financial system collapse and social unrest (Rigobon, 2019).The shifting of crises indicates the relationship between investors and shocks, as investors always try to reduce the risk of shocks by investing in different investment baskets. Similarly, the appropriation of risk aversion theory has been revised.

2.1.1 Beyond shock waves: unveiling the theory and understanding of volatility spillover and financial contagion.

The concepts of contagion and spillover came into the limelight during the 1990s, and the different crises of that decade created the importance of understanding contagion and volatility spillover. After that, in the last ten to fifteen years, a lot of research was conducted, which depicted an unprecedented amount of research and analysis. Over the period, different definitions of contagion have been covered (Fig. 2.1).

Random measurement of the price of an asset is termed volatility. Volatility spillover is the market's volatility returns, which impact the other’s market spillover. Good or bad (negative) information (news) always affects volatility, and this impact is transferred to another market through the channel if there is any relationship between the two markets. In the literature, daily risk transmission across stock markets is usually believed to be symmetric, with negative and positive intraday price changes transferred across markets in the same way (Hamao et al. 1990; King and Wadhwani, 1990; King et al., 1994; Karolyi, 1995; Awartani et al., 2013; Maghyereh et al., 2015; Yarayova et al., 2017; Jiang and Fan, 2018; Sewraj et al., 2018; Kang et al., 2019; Su, 2020; Hou and Li, 2020).

A realistic outcome of a financial crisis is significant disruption in the originating financial market, as well as volatility shock waves in other financial markets (Akhtaruzzaman et al., 2021a; Allen and Gale, 1999; Baig and Goldfajin 1998; Corbet et al., 2021; Celık, 2012; Diebold and Yilmaz, 2012; Mohti et al., 2019). This form of transmission or comovement across financial markets across different geographies is known as contagion. There is a lot of disagreement on the definition of contagion and on appropriate testing techniques on whether contagion is observed or not to a large extent (Baele et al., 2010; Bodart and Candelon, 2009; Bekaert and Harvey, 2003; Billio and Pelizzon, 2003; Fijorek et al., 2020). Pericoli and Sbracia (2000) indicated five distinct definitions of contagion, demonstrating the diversity of these concepts as there will be a surge in the likelihood of a crisis in one country if another country is experiencing one; the financial markets of other countries will be affected by the volatility of the crisis-stricken country; there will be a surge in the number and size of co-movements across markets if one or more of those markets experiences a crisis; the channels that transmit shocks across markets will change; and there will be an excess of co-movements that fundamental economics cannot explain. Dornbusch et al. (2000), Dungey et al. (2006), and Pesaran and Pick (2007)separated contagion from interdependence as it is a significant focus of academic contagion studies, as several indicated by the elevation of literature over the periods. Masson (1999) stated the three distinct groups focus on the interdependence of the country's macroeconomic factors. The first grouping, "monsoonal effects," implies that financial crises spread like wildfire.

The second group pointed out that when one country's financial crisis hits another, it may have a domino effect on other nations via external ties like trade. These two groups show interdependence. According to the third group based on pure contagion, a crisis in one nation might trigger another without changing the underlying economic conditions between the two countries. On the other hand, the World Bank provides three different ways to describe contagion: loosely, somewhat, and severely. When shocks go from one nation to another, or when economic shocks broadly impact economies worldwide, this phenomenon is known as contagion. Even in prosperous times, contagion may strike. A connection to crises is unnecessary for contagion to occur in these situations. It often causes widespread panic, confidence loss, or systemic danger, affecting the financial system. The quick and sometimes illogical sale of assets across marketplaces is a hallmark of this phenomenon. World Bank report indicated that “Contagion refers to the spread of market disturbances mostly on the downside from one country to the other, a process observed through co-movements in exchange rates, stock prices, sovereign spreads, and capital flows.” The Basel Committee's reports indicated problems with global financial system risk management, capital sufficiency, and banking supervision are common themes.

Beyond shared shocks and any essential ties between nations, the transmission of shocks to other countries or the correlation between countries is the narrow definition of contagion. Commonly attributed to herding behaviour, this is typically known as excessive co-movement. For the most stringent definition, contagion happens when correlations between countries are higher during crises than when things are calm. This definition may be seen as the transmission mechanism failing during instability, also known as shift-contagion.

The study's definition of contagion is consistent with Forbes and Rigobon's (2002) analysis of the cited literature, but it is comparable to the World Bank's "extremely restrictive" definition. By this definition, contagion occurs when there is a change in the pattern of correlation between the returns of stock market indexes of various nations during times of financial crisis and calm. Wang et al. (2021a)stated that in most studies, contagion channels are divided into two different categories: “Fundamental induced channel” such as FDI (Foreign Direct Investment) and international trade and “Investor induced channel.” Investor-induced contagion is caused by wealth constraints covering the emerging stock market and the rebalancing behaviour of portfolios in developed markets. During a crisis, internationally diversified speculators (investors) could become wealth-constrained and use portfolio-rebalancing tactics to compensate for their loss in the crisis country by selling their positions in other countries, triggering a negative market movement in these regions (Calvo and Reinhart, 2004; Kaminsky and Reinhart, 1998; Karolyi, 2003; Kyle and Xiong, 2001; Rijckeghem and Mauro, 2001; Yuan, 2005). Bodart et al. (2009) and Wang et al. (2021a)indicated that contagion is sometimes termed ‘Shift Contagion’ as economic fundamentals drive financial contagion (significant temporary and short-term linkage), which is created on multiple equilibria based on endogenous liquidity. Investor psychology, such shocks lead to portfolio reshuffling and changes in the regime of exchange rates. When a risk manager indicates a single way, a causal relationship between current volatility and past volatility shocks of a particular market is called volatility spillover. Dewandaru et al. (2016) and Dornbusch et al. (2000) stated that a financial crisis had proven either financial contagion or interdependence, precisely as specified two different characteristics between fundamental-based and pure contagion. An expansion in cross-market comovements during a financial crisis is not proof of contagion but rather a continuation of high market interdependence (Forbes and Rigobon, 2002; Bae et al., 2003; Corsetti et al., 2005; Campos-martin et al., 2022). In moments of crisis, contagion is defined as a structural shift in interdependence. Pure contagion is an excessive transmission of shocks in the country where the crash originated. The sentiment shift is non-economic fundamental and may lead to the reversal of crisis and funds (He et al., 2019). The macroeconomic factors strengthen the interdependence magnitude connection between futures markets and financial contagion, which affects investors' sentiments.

There are two theories for the spread of crises i.e., according to the first theory of contagion, the presence of real and financial connections emerging from macroeconomic factors, such as changes in trade linkages, interest rates, currency rates, in addition to oil prices, (Mohti et al., 2019), contributes to the spread of a financial crisis across nations (Fig. 2.1). The second implies that a crisis might spread because of portfolio rebalancing techniques and investor reaction to unfavourable conditions in the economy that caused the crisis.

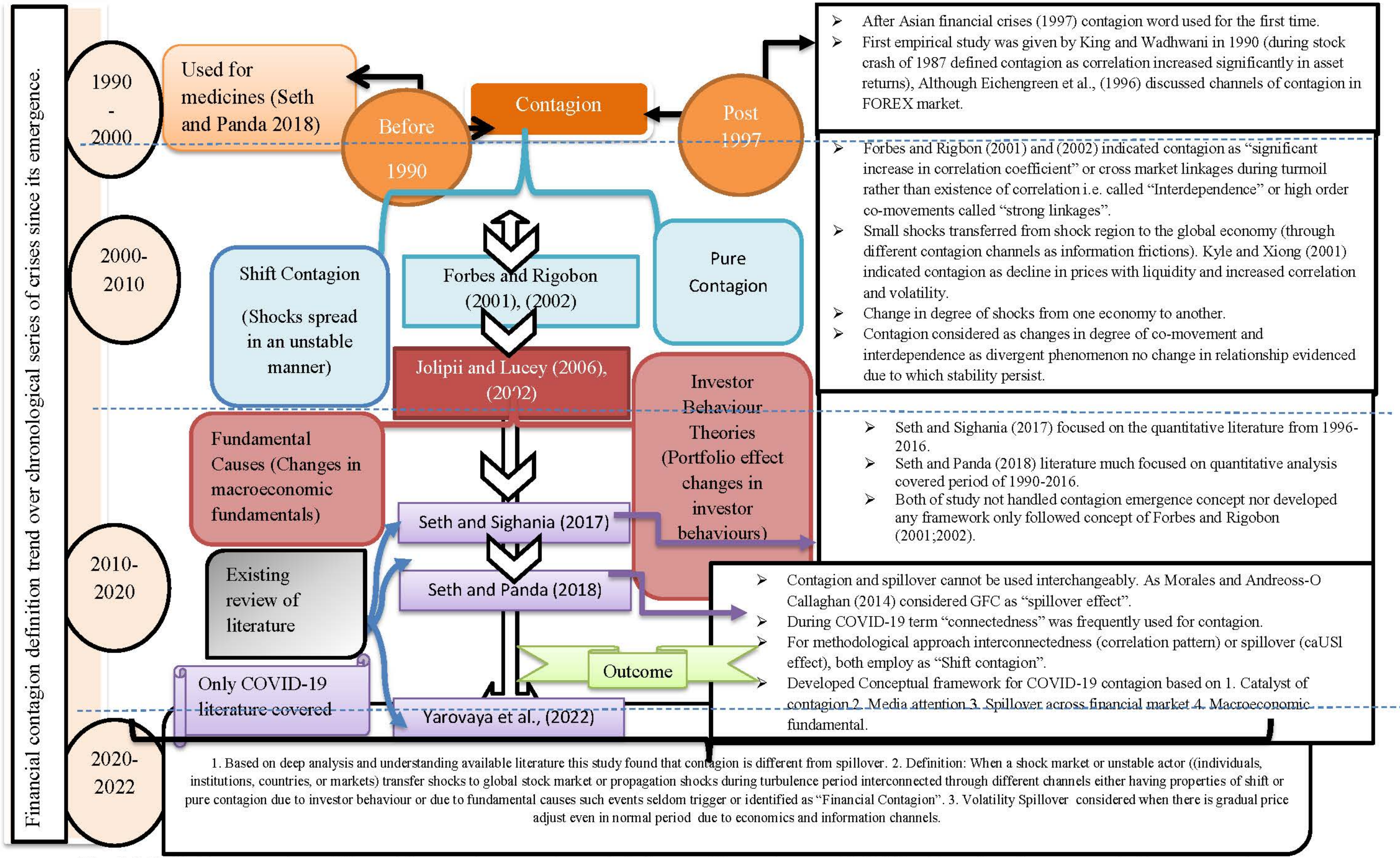


Fig. 2.1: Definition overview of financial contagion over the period. Source: The author used MS Word based on the systematic literature review.

2.4 Classification of the past literature

This thesis classified literature reviews in two different ways: a) statistical review approach (Section 2.4.1) and b) systematic literature review (SLR) approach with bibliometric literature review (Section 2.4.2).

2.4.1 Statistical Review Approach

The primary goal of this research is to formulate and organize the literature on financial contagion and volatility spillovers by systematically reviewing previous literature to understand the phenomenon better, along with the current research gap in existing literature based on different published papers. Globalization opens the doors for trading on an international level under the regulations of the World Trade Organization (WTO). Globalization has allowed investing globally as investors had the potential to support globally. Risks are hedging against the different types of financial risks, and to maximize profits, investors and portfolio managers invest in international cross-border markets, and their funds are differentiated. If the cross-border financial market follows the efficient market hypothesis (EMH) theory, then other market investments will fail and will not provide profits. Portfolio managers investigate the financial contagion and volatility spillover in the market between the shock and foreign markets to resolve such issues and identify the current actual position of financial markets.

Although some studies show contagion and spillover in the context of some financial crises, some have found zero evidence. Therefore, the present study is based on a review of literature conducted to know the researcher's research undertaken based on the global financial stock market and to frame such analysis into an easy access and detailed understanding.

2.4.1.1 Data and Methodology

This section presents data and methodology on financial contagion and volatility spillover in the financial stock market. For the review of past literature, initially, a few keywords were searched, such as financial contagion, volatility spillover, and stock market. Based on the requirement, 185 research papers have been filtered to fulfil the objectives. Seth and Sidhu (2020) used a similar framework for their study to select, refine, and analyse the documents. A similar methodology is used to review the empirical literature related to commodity markets by Seth and Sidhu (2020). The research papers have been collected from different academic research journals based on the Google Scholar search engine, and the number of citations belongs to other databases such as Scopus, Web of Sciences, ABDC-listed journals, and core relevant journals with the study's objective. These journals represent the period between 1969-2022 (March) (Fig. 2.2).

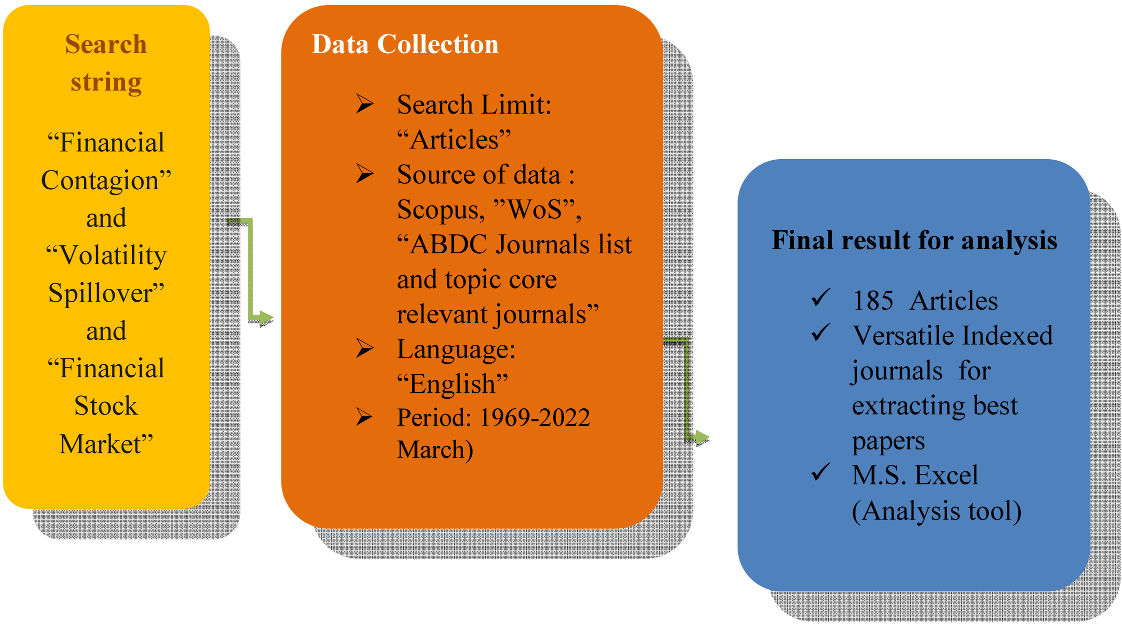


Fig. 2.2: Eye bird view of data collection and methodology.Source: Author using MS Word.

The statistical analysis of the literature review has been done based on followed systematic categorization:

1. Econometric tools used in sample research papers.
2. The classification of studies according to the year of publication (from 1969 to 2022).
3. The classification of studies was based on the country (where research was conducted).
4. The number of years used to collect data samples.
5. The number of stocks, indices, or variables sampled as a representation.

2.4.1.2 Statistical literature review on financial contagion and volatility spillover

This section shows the results of the literature review. Fig. 2.3 shows the leading groups in that literature review.

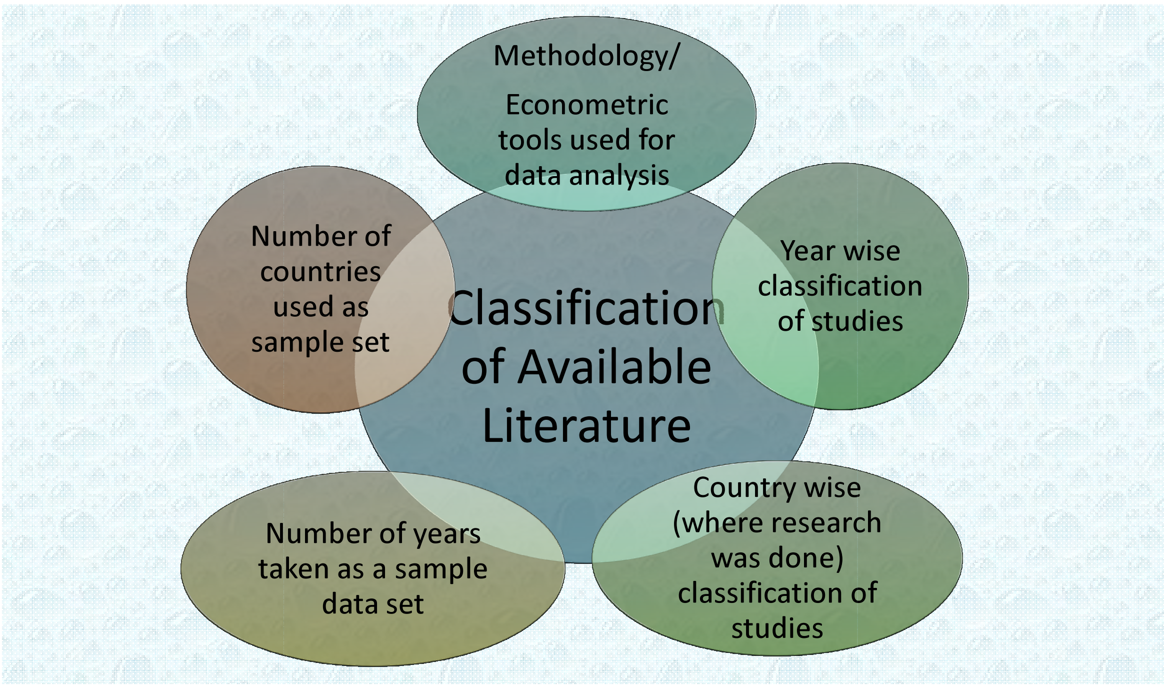


Fig. 2.3: The Core base for classification of past literature.Source: Author using MS Word.

2.4.1.3Econometric tools used in sample research papers

Various authors have used abundant methods in different documents to provide detailed results. Table 2.1 (Fig. 2.4) exhibits the prevalence of used econometrics tools implemented for data analysis. It was found that most of the researchers (40%) used different types of models individually. DCC GARCH/ ADCC GARCH model is widely used in the (26%) study to check the financial contagion and volatility spillover along with a combination of specific other models. Arora and Kaur (2019) used Granger (1969) causality to study short-term capital co-movement to explore market interdependence. Kaur and Arora (2018) used empirical investigation and statistical tools, such as Kaur and Arora (2019), to investigate the long-term relationships between the variables, as the cointegration tests were carried out using e-views. Kakran (2022) indicated the conflict's origins in the Russian invasion of

Ukraine, using a theoretical perspective by exploring the opportunities and threats in the context of India.

The concepts of contagion and spillover came into the limelight during the 1990s, and various crises of that decade created importance for understanding contagion and volatility spillover. After the last ten to fifteen years, much research has been conducted, which has depicted unprecedented study and analysis. During a review of the current literature on the financial stock market, it was estimated that previous research was based on univariate and bivariate generalized autoregressive conditional heteroscedasticity (GARCH) models as an econometric tool for analyzing data such as (Akhtaruzzaman et al., 2021a; Zouari et al., 2014). Along with this, different GARCH models have been used in other papers as Diebold–Yilmaz model, DCC GARCH, asymmetric DCC-GARCH (ADCC) model, VAR, used by (Akhtaruzzaman et al., 2021b), MS-GJR-GARCH model used by (Mwamba et al., 2021), Markov-Switching GARCH model used by (Ghorbel and Jeribi, 2021), DCC-GARCH model used by (Paskaleva and Stoykova, 2021), Arma Garch (Gomez-Gonzalez and Rojas-Espinosa, 2019)DCC-MGARCH used by (Roy et al., 2017), Multivariate DECO-GJR-GARCH model used by (McIver et al., 2020), Asymmetric DCC GARCH model (ADCC) used by (Kocaarslan et al., 2019a; Banerjee and Feinstein, 2021). By measuring variance, volatility spillover is calculated, which is indirectly analyzed and shown as a significant drawback of these family models (Fijorek et al., 2021). A heterogeneous autoregressive distributed lag (HAR-DL) structural break was used to investigate the volatility transfer of the crisis between Hong Kong and the US from 2000 to 2001 (Maderitsch, 2015).

As per Wang and Feng (2020), GARCH family models cannot perform the tail behaviour of the marginal distribution. However, Copula family models are competent. Stock connections, derivative price correlations, and investor sentiment are complex networks widely applied in financial markets. (Menezes and Oliveira, 2015; Lee et al., 2018; Fang et al., 2019; Gaffeo et al., 2019; Jeong et al., 2019; León et al., 2019; Wen et al., 2019; Wang and Feng, 2020; Chen et al., 2021a; Chen et al., 2021b). Scholars are increasingly focusing on the unusual networking structure during volatile times (Haley and Sigler, 1996; Zhou et al., 2016; Chouliaras et al., 2017; Lee et al., 2018; Huang and Wang, 2020) demonstrating that different national stock markets hold common patterns across multiple crises, while there are more heterogeneities among developed and developing countries. In addition, financial copula modelling is concerned with recognizing time series within data, and there are standard categories of multivariate models for economic time series. Akhtaruzzaman et al. (2021b; 2021c; 2021d) studied financial contagion during COVID-19 for different purposes (as a source of contagion (DCC and ADCC model), hedging strategies (DCC Garch model), which is followed in various studies. However,COVID-19 studies have started using Copula modelling as it has become a prominent method for studying variable relationships. Copula modelling enables the study of the tail dependencies, which is helpful in risk and survival studies.

Table 2.1: Econometric tools or methodology used for data analysis.

Econometric tools	**Frequency of applied**
DCC GARCH/ ADCC GARCH	49
AG-DCC	3
ARMA GARCH	5
E-GARCH	5
ARCH model	2
Multi-horizon wavelet transformation	2
Co-Integration/DCC-Co-Integration	3
Bivariate correlation analysis/ CPS correlation analysis	2
Latent Factor Model (LFM)/Factor Model	3
COVAR Approach	4
VAR Framework/ VAR Model	17
DSDM (Dynamic Spatial Durbin Model)	2
Discrete wavelet	2
Wavelet Model/ Wavelet	6
Copula	5
DMC-EVT Copula	1
Other[10][11]	74

Source: The author used MS Word based on the extracted database.

[10] Other test includes Correlation test, Structural break, Johension’s cointegration, Granger causlity test, Chow test, Likelihood function, Optimum hedge ratio, etc.

[11] It also includes unit root testing used for checking stationarity.

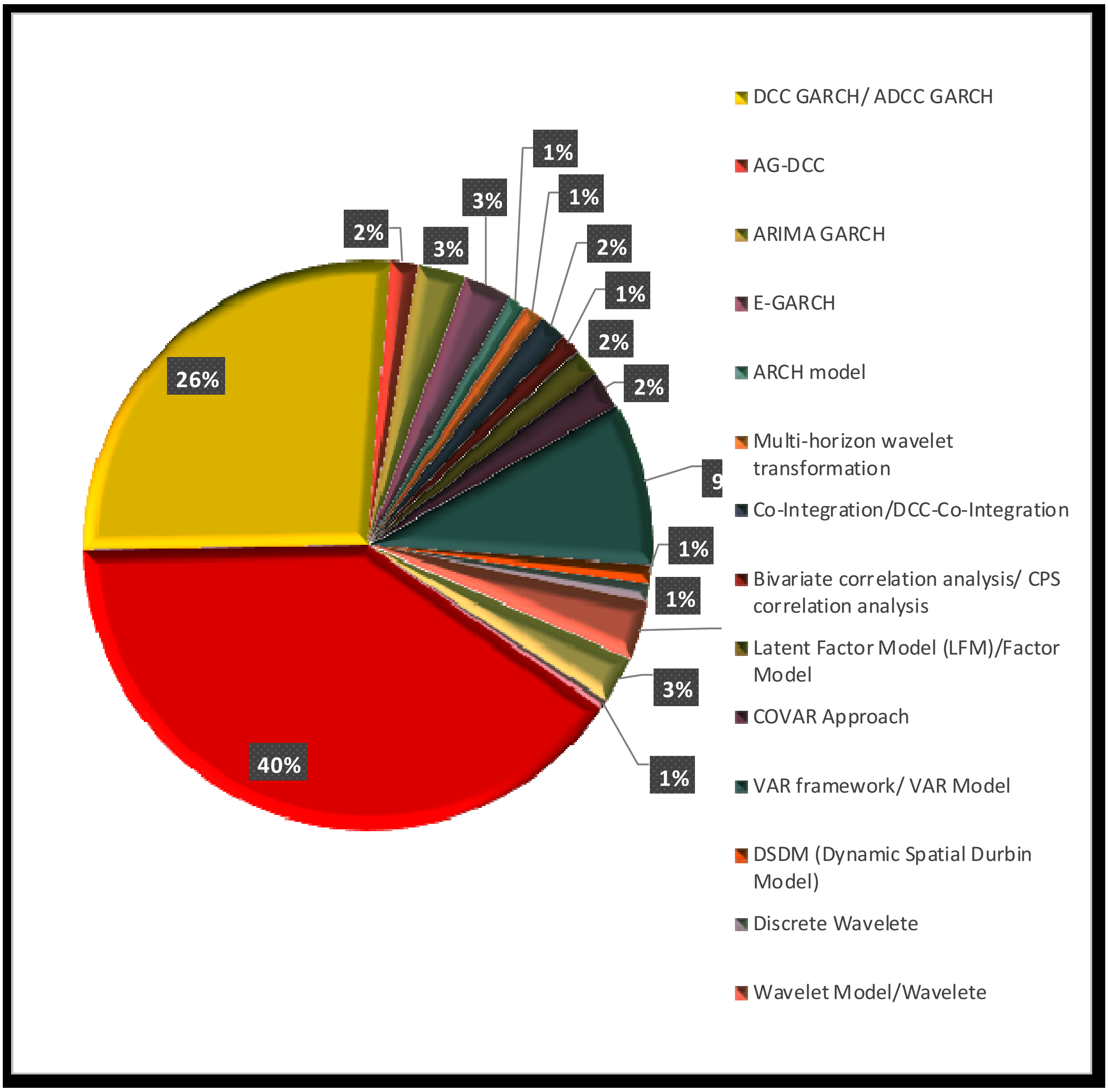


Fig. 2.4: Methodology adopted in sample papers for data analysis.Source: Author using MS Word.

2.4.1.4Classification of studies based on year of publication

Table 2.2 and Fig. 2.5 depict the data collection for the study. The first paper in the context of the financial stock market was published in 1969; later, in the 1990s, publication in the stock market field was flooded as people started focusing on economic crises. This type of research gained popularity firstly on an international platform. But, in India, it started gaining popularity after the year 2000. In this study, most papers are taken from 2019, 2020, 2021, and 2022. To show the present research condition in this field along with the remaining loopholes and research gap. Based on the deep analysis, we found that after 2017, the study started shifting towards commodity markets, but COVID-19 created whiff-off fresh air in the financial stock market, and again, groundbreaking research started.

Table 2.2 Collection of studies based on year of publication.Source: Author using MS Word.

Years	No of papers	Years	No of papers
1969	1	2009	4
1986	1	2010	2
1994	1	2011	4
1996	1	2012	6
1998	1	2013	8
1999	2	2014	7
2000	2	2015	6
2001	3	2016	3
2002	2	2017	4
2003	7	2018	5
2005	5	2019	13
2006	4	2020	33
2007	1	2021	29
2008	2	2022	28

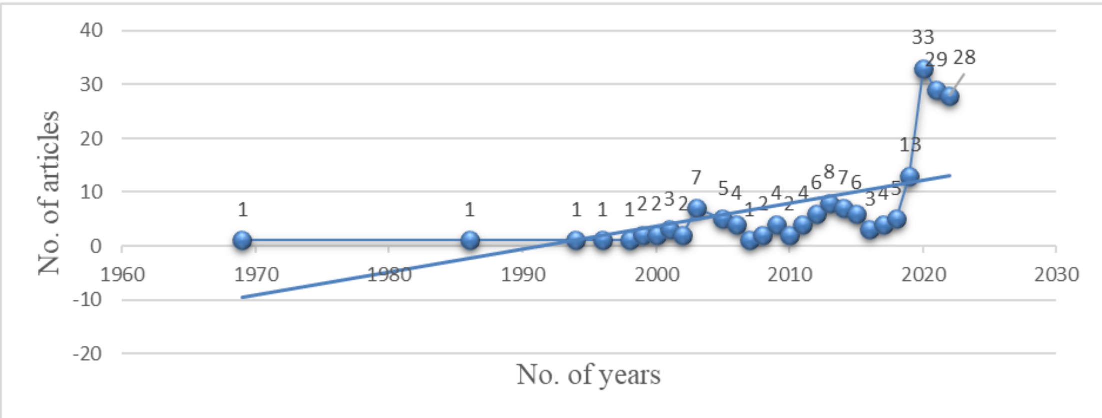


Fig. 2.5: Study collection organized by year of publication.Source: Author using MS Word.

2.4.1.5Country-wise (first author's country) the classification of studies.

Table 2.3 and Fig. 2.6 represent research paper summaries of financial contagion and volatility spillover in the context of the financial stock market based on country-wise classification. It is Examine that most of the study was conducted in the US, China, and Australia. A few authors of emerging (except China) and frontier markets have conducted a study in the context of financial contagion and volatility spillover.

Table 2.3: Country-wise (Author's country) classification of studies.Source: Author using MS Word.

Country	Frequency	Country	Frequency	Country	Frequency	Country	Frequency
Africa	1	Estonia	1	Korea	2	Spain	2
Austin	1	France	2	Lithuania	1	Switzerland	2
Australia	13	Germany	5	Malaysia	4	Vietnam	1
Bangladesh	1	Greece	9	Mexico	1	Taiwan	2
Belgium	2	India	8	Mongolia	1	Thailand	1
Brazil	4	Indonesia	1	Morocco	1	Japan	3
British	1	Ireland	2	Netherlands	1	Tunisia	2
Bulgaria	1	Israel	1	New Zealand	1	Turkey	3
Canada	2	Istanbul	1	Pakistan	1	UAE	4
China	30	Italy	8	Philippines	1	UK	2
Colombia	3			Poland	2	US	14
Ecuador	1	Jordon	1	Romania	3	Venice	1
Egypt	1	Kabul	1	Slovenia	1	Saudi Arabia	2
Sweden	2	Finland	1	Kuwait	2		

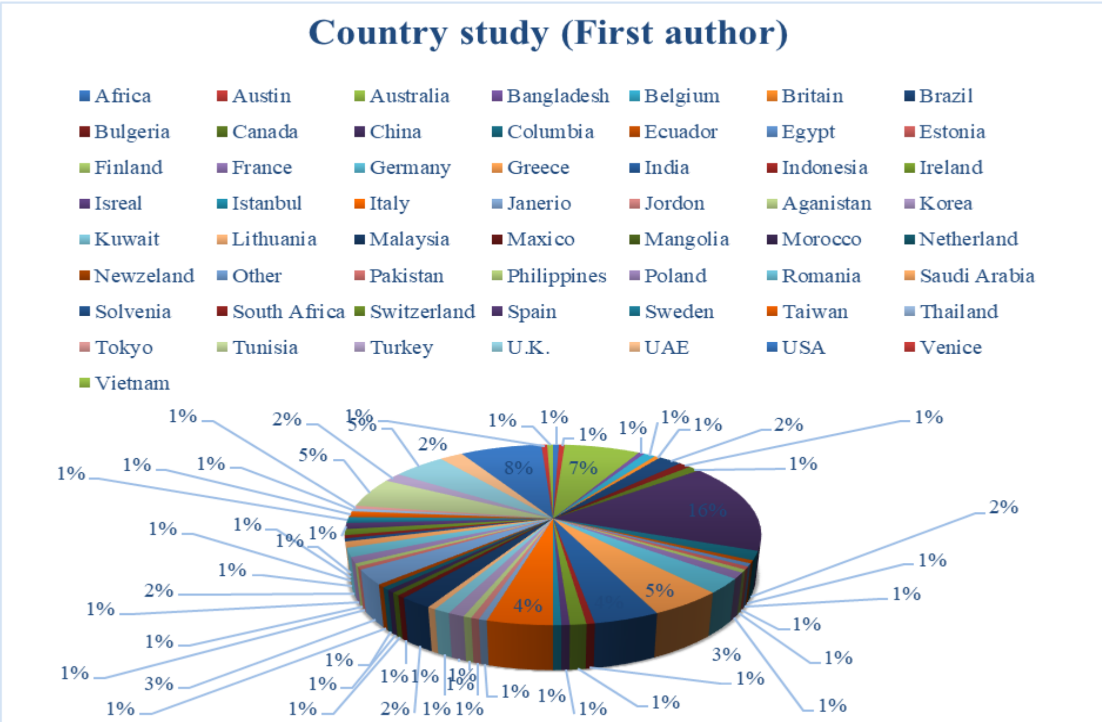


Fig. 2.6: Study classification based on first author's country (author's calculations).Source: Author using MS Word.

2.4.1.6Yearly data of the countries

Fig. 2.7 (Table 2.4) shows the different numbers of years used in the form of data for analysis. About 40 research documents took 6-11 years of data as part of their study, followed by 38 pieces (12-17 years) and 24 papers (18-23 years). Most of the authors focused on a lesser number of years as they focused on the particular period of the event (crises) (Campos-Martins and Amado, 2022; Maghyereh and Abdoh, 2022; Nsour et al., 2022)).

Table 2.4 Number of years period in countries used as the sample set.

Number of years	Number of countries	Number of years	Number of countries
1	14	12-17	38
2	17	18-23	24
3	4	24-29	10
4	7	30-35	6
5	6	36-41	2
6	40	42-47	1

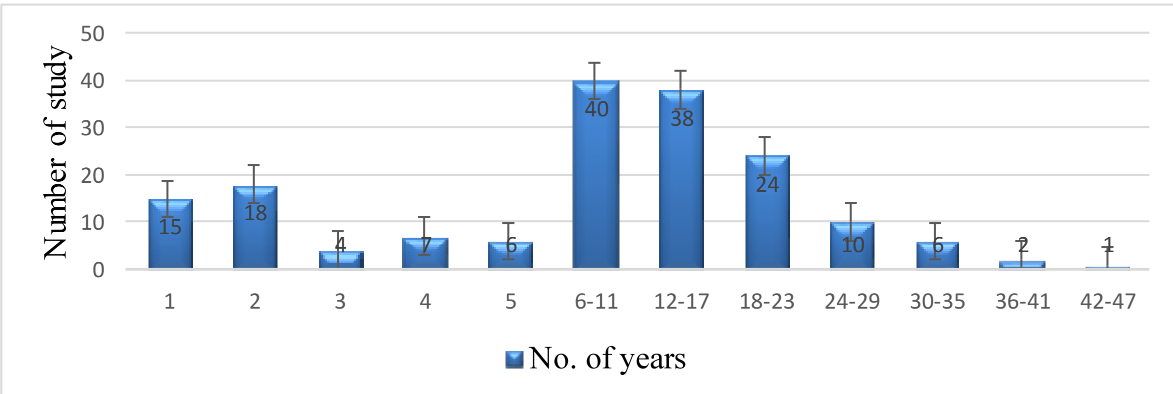


Fig. 2.7: Number of years used as sample data.Source: Author using MS Word.

2.4.1.7The number of countries plotted in research as sample datasets in various research papers.

Fig[12]. 2.8 represents the number of countries used out of 185 papers; 50 studies considered 6-10 countries, meaning the standard average as most authors used these countries. Only one author (Liu and Jiang, 2020) used 71 countries in their papers,

[12] 16 papers are theoretical based, so number of countries (period) data is not available.

representing the top countries for analysis through comparison. More countries as sample data create the opportunity for comparative study and make the learning opportunity. However, it sometimes reaches typical situations for comparative research of channels of contagion and volatility spillover in financial stock markets. Most national and international published journals used datasets from 8-10 countries, showing the authors' feasibility for analysis and presentation.

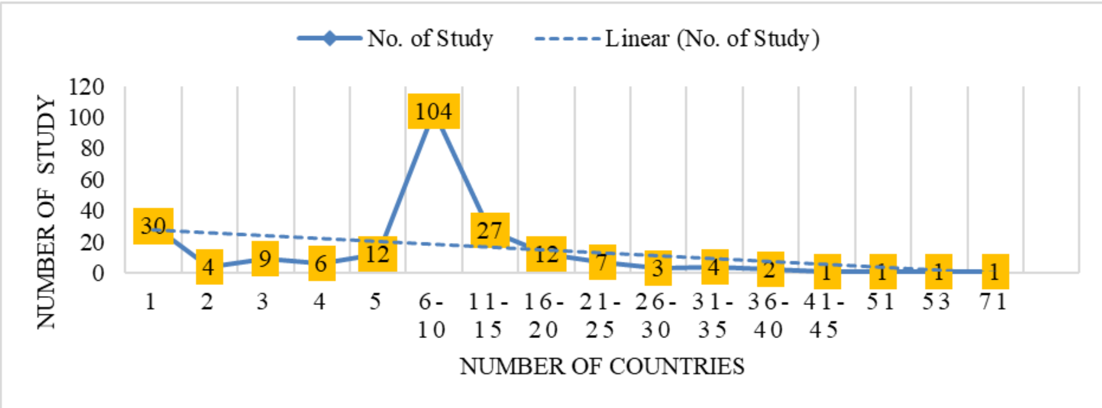


Fig. 2.8: Number of countries used to collect the data. Source: Author using MS Word.

➢ Limelight on the health crises (COVID-19) and financial stock market

During the COVID-19 crisis, researchers discovered many financial contagions as several economies and their stock markets were simultaneously affected. According to (Ding et al., 2021), many major stock indexes plunged more than 30% in the first quarter of 2020. Investors throughout the globe experience fear as a result of market collapses (Jiang et al., 2022; Su, 2021). On the one hand, relatively immature mainland investors, primarily individual investors, tend to overreact to market collapses (Corbet, 2014; Corbet et al., 2018; Corbet and Gurdgiev, 2019). Risk spillovers between stock markets and oil to stock markets from European and American stock markets increase significantly after the start of the COVID-19 pandemic, but those from Asian markets decline(Fu and Qiao, 2021; Liu et al., 2022b; Liu et al., 2021a). Uddin et al. (2022) stated that a strong and positive dependence had been found among the investigated markets (Hongkong, China, Japan, and Korea) due to the outbreak of COVID-19.

In the Asian market, the Indonesian stock market was severely affected by COVID-19 (Mugiarni *et al.*, 2021). Nsour et al. (2022) investigated the impact of the COVID-19 pandemic on Shanghai Stock Exchange (SSE) index returns and volatility. They discovered that both the COVID-19 epidemic and the 2008 financial crisis harmed market returns, with the impact on volatility greater during the pandemic. Lin and Hung (2021) demonstrated that the number of daily COVID-19-confirmed cases in Vietnam has a negative impact on listed company market stock returns. Liu et al. (2020) reviewed the time series on the Nifty and Sensex in India and discovered that the stock market in India was volatile during the epidemic era. When they compared the performance of the COVID-19 period to that of the pre-COVID-19 period, they discovered evidence that stock returns decreased during the COVID-19 period. Chopra and Mehta (2022)stated that the spreading COVID-19 outbreak has already sent shocks across global stock markets. Kumar and Dhiman (2020a) studied the impact of COVID-19 by focusing on containments as its measures, with a thematic review showing that fake news also results in volatility.

2.4.1.8Results of statistical review with the practical implications

This study shows the literature review of past published research papers in the context of financial contagion and volatility spillover in the financial stock market. This paper focuses on the core elements of previously published articles. A study has used 185 research papers from different databases from 1969 to 2022 and refined them based on compatibility to fulfil the core objectives of this paper as to systematically discouragement. Several factors are examined for data analysis, such as the number of nations utilized as sample data, the technique employed by the researchers, the entire period considered for data analysis, and each country's contribution to the study. Most of the studies focused on the stock market before COVID-19, but since 2019, research in the context of the financial stock market has decreased as the researcher has focused on the spot and commodity markets. In the latest available study, different researchers have shown different results. However, most of them showed contagion and shifted in contagion during the financial crises from the three acute crises of 1990, i.e., the Mexican crisis of 1994, the Hong Kong crisis of 1997, and the Tequila crisis of 1997. In the context of GFC, the contagion channel was presented concerning some countries, as Corsetti et al. (2005) and Fry et al. (2008) mentioned.

Most papers based on research on the financial stock market concentrated prominently on the US, Chinese, and Australian stock markets. However, there is still more space to shift study in the context of emerging and frontier markets. In the past available papers, frontier markets are ignored because of the prominent research gap. Ukraine crisis and COVID-19 impacted emerging and frontier markets, which still need to be explored. The current study will help future researchers, academics, policymakers, practitioners, and relevant stockholders create a direction for future research work related to a specific focus in the same subject area for further research in the context of financial crises, as well as a lead for contributing data in a resourceful manner.

Research on volatility spillover in emerging and frontier markets is limited, but studies suggest significant volatility spillover between emerging and developed markets. However, the direction of spillover is not always unidirectional, and the impact of spillover on emerging and frontier markets can be different from the impact on developed markets. Additionally, there is a limited study on the volatility spillover between frontier markets. Frontier markets are defined as less developed and less accessible than emerging markets and have different characteristics, such as small market capitalization, trade volume, low liquidity, and high volatility. Due to these characteristics, volatility spillover in frontier markets may have other features and impacts than in emerging markets. Given the increasing significance of emerging and frontier markets in the global economy, studying the volatility spillover in these markets is essential to understand the potential risks and opportunities better.

Further study may be undertaken by concentrating on developed, emerging, and frontier markets and employing dynamic methods. However, this study is comprehensive and includes the different databases on the relativity and objectivity of this article. A comparative regional study can be conducted in the upcoming articles, although this study covers almost all contributing global economies or regions.

2.4.2 Systematic Literature Review (SLR) Approach

In the previous three decades, a sharp phenomenon of financial crises has been witnessed, directly or indirectly affecting financial stock markets through financial contagion and volatility spillover. In the era of highly connected globalized world a black swan from a country (shock market) tremendously impacts other countries (stable stock markets) (Forbes and Rigobon, 2002; Lucey et al., 2022; Akhtaruzzaman et al., 2021a; Corbet et al., 2021; Goodell et al., 2020; Yarovaya et al., 2022; Akhtaruzzaman et al., 2022).

Thus, this study focuses on the systematic literature review to unveil the current status or agenda of this study (Fig. 2.9). To address the knowledge gaps, this study seeks to synthesize the corpus of literature with asystematic approach (as an independent study covering parameters, i.e. necessity, importance, relevance, urgency, and contribution) concentrating on financial contagion and volatility spillover.

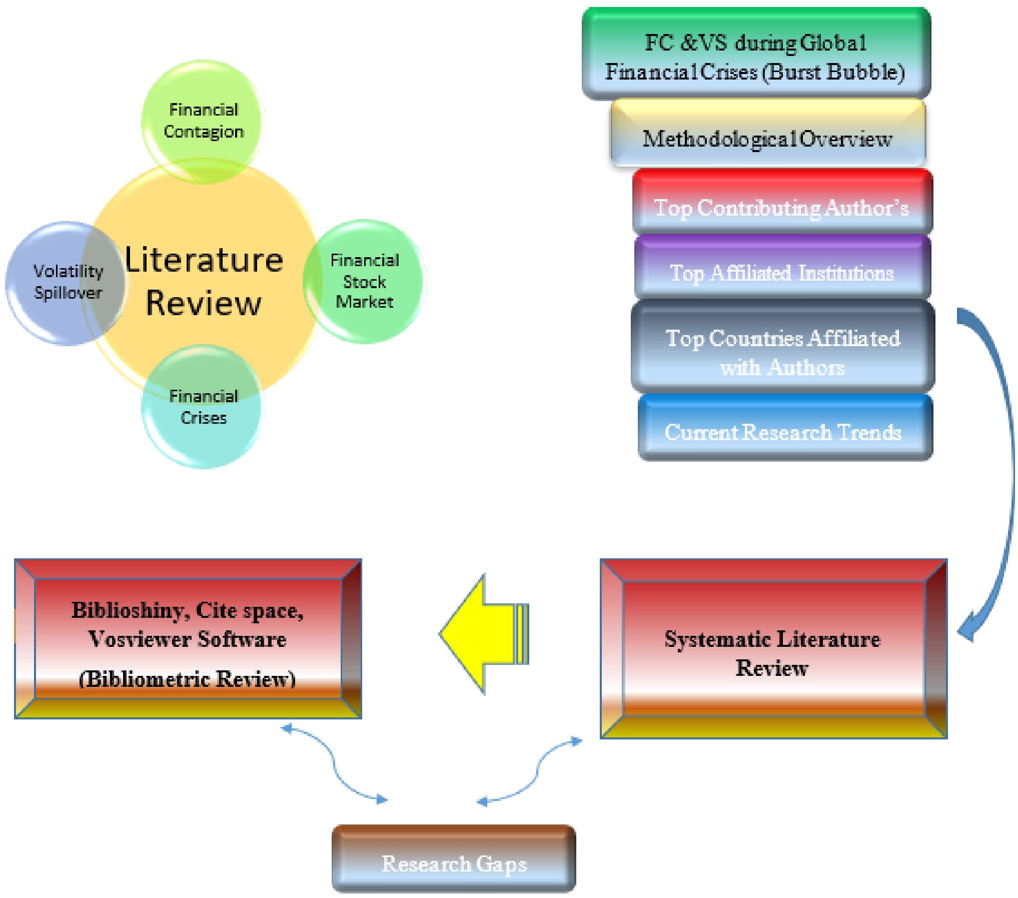


Fig. 2.9 : Quick overview of the SLR strategy.Source: Author using MS Word.

This study contends that bringing the literature together will provide a more sophisticated view of the progress in FC/VS research in the context of financial crises in the financial stock market with the understanding, which is currently lacking, will help to improve practical decision-making by bringing together the significant antecedents and consequences of the global financial market. A systematic review of the turbulent proposed topic can also highlight the various thematic areas of prior research, delineate the research profile of the existing literature, identify various research gaps, project possible avenues for future research, and develop a guiding research framework on this timely topic. It is an urgent need for portfolio investors and researchers to synthesize or have a bird's eye view for understanding the chronological series of crises from 1990, which shows the contagion effect so that similar crises' impact can be neutralized through different hedging strategies in the future. These valuable findings will, therefore, benefit other researchers and practitioners interested in the field of FC/VS.

2.4.2.1 Echoes of Knowledge: Unravelling insights from historical literature reviews

In context of appropriate definition different practitioners and academician engaged in debates from long period of time (Akhtaruzzaman et al., 2022a; Ballester et al., 2019; Boubaker et al.,2022; Seth and Panda, 2018; Seth and Sighania, 2017; Yarovaya et al., 2022) as well as on different aspects of financial contagion and volatility spillover that's creates an urgent need of study with a systematic approach (Fig. 2.10). Although in the existing literature three review articles identified as Seth and Sighania, (2017) focused on methodology, econometric tools, year wise classifications, issues in the area with search string "financial market contagion" (biased search string[13]) identified 104 articles (84 article from 47 journals and 20 article from working papers) from different sources (not clearly mentioned database source or indexing of articles) for the period 1996 – 2016; Seth and Panda (2018) also focused on previous literature identified 151 articles (124 articles from 66 journals, 12 working documents, 3 conference papers, and 12 other[14]articles) with search string "financial contagion, financial market contagion or international stock market contagion and spillover" (biased search string[1]) on various sources (not clearly

[13] As per the guidelines of systematic approach three factors (completeness, rigor, and exposition) are missing out of seven factors (i.e. novelty, importance, value, timelines, exposition, rigor and completeness) which states the weak search strings (Donthu et al., 2021).

[14] Others indicates working, seminar, discussion, and lecture notes.

mentioned database or indexing of articles) for the period 1990-2015 explored similar aspects as methodology, econometric tools, year wise classifications, different available studies on different financial crises; Ballester et al., (2019) conducted review on sovereign connectedness focusing emerging economies with the search strings [(“contagion” AND “emerging market” AND “crisis” or “contagion” AND “emerging market” AND “crisis” or “contagion” AND “emerging market” AND “sovereign”)] focused on banking and sovereign sector only for drawing literature in emerging market; Yarovaya et al., (2022) synthesized the literature by giving an overview over definition ambiguities and conceptual framework targeted for only COVID-19 period. From the preceding summary of the existing review, investigator understood that specific questions and updated insights are still missing in the above reviews (as referred to the objectives of this study), which would be accomplished by the current research with a robust systematic approach to getting more insightful results. This study does not present an understanding of the financial market integration, financial market linkages, and stock market co-moments, although a detailed study was conducted by Patel et al.. It does not cover theory, channels, and causes of contagion. This study is limited to the articles available for the finance domain (as per the listing of the ABDC (Code-3502)) and covers RQ 1 to RQ5.

This above literature review focuses on five pertinent questions (RQs):

RQ1. What is the current state of literature addressing financial contagion and volatility spillover?

RQ2. What is the current research profiling of top journals, articles, authors, countries, institutions, and publication trends for financial contagion and volatility spillover research?

RQ3. What are the knowledge clusters in the intellectual structure of financial contagion and volatility spillover?

RQ4. What are the future research opportunities, the limitations of recent research and promising avenues for future investigation of financial contagion and volatility spillover?

RQ5. Can a comprehensive conceptual framework be synthesized from the extant literature to help academics, practitioners, and other relevant stakeholders?

This study emphasizes the chronological core relativity theory of hedging strategies to deal with the different types of crises in the financial stock market; almost no existing literature is available that directly shows interconnectedness for reducing the impact of the particular crisis by employing hedging strategies. But this is the only study that emphasized the scientometrics, SLR post-COVID-19, which directly with such crucial issues as how the earlier pandemics affected the stock market interconnected, information transmission mechanism or how that spark of instability causes crisis changed to the spillover/contagion in the global stock market.

2.4.2.2 Data Collection and Research Methodology:

The literature is mainly based on bibliometric analysis, knowledge mapping, and cluster visualization with VOS viewer software (1.6.17) andthe Biblioshiny app from R software. For SLR, the data is extracted from the official Scopus database (scopus.com) using the search strings -

(TITLE-ABS-KEY ("Financial Cris?s" OR "Finan* Crash*" OR "Black Swan" AND "Contagion Channel*" OR "Financial Contagion Channel*" OR "Financial Contagion" OR "International Finan* Contagion" OR "Financial Risk Contagion" AND "Finan* Stock* Market*" OR "Equit* Market*" OR "Finan* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*") OR TITLE-ABS-KEY ("Financial Cris?s" OR "Finan* Crash*" OR "Black Swan" AND "Contagion Channel*" OR "Financial Contagion Channel*" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion") OR TITLE-ABS-KEY ("Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Finan* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*") OR TITLE-ABS-KEY ("Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover"

AND "Contagion Channel*" OR "Financial Contagion Channel*" "Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion" AND "Financ* Stock* Market*" OR "Equit* Market*" OR "Finan* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*") OR TITLE-ABS-KEY ("Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Contagion Channel*" OR "Financial Contagion Channel*" "Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion") OR TITLE-ABS-KEY ("Financial Cris?s" OR "Financial Crash*" OR "Black Swan" AND "Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover") OR TITLE-ABS-KEY ("Financial Cris?s" OR "Financial Crash*" OR "Black Swan" AND "Contagion Channel*" OR "Financial Contagion Channel*") OR TITLE-ABS-KEY ("Financial Cris?s" OR "Financial Crash*" OR "Black Swan" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*") OR TITLE-ABS-KEY ("Contagion Channel*" OR "Financial Contagion Channel*" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*") OR TITLE-ABS-KEY ("Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*") OR TITLE-ABS-KEY ("Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion" OR "Contagion Channel*" OR "Financial Contagion Channel*" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market*" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*" OR "international stock market* contagion and spillover")) AND PUBYEAR > 1988 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTSRCTITLE , "International Review Of Financial Analysis") OR

LIMIT-TO (EXACTSRCTITLE , "Finance Research Letters") OR LIMIT-TO (EXACTSRCTITLE , "International Review Of Economics And Finance") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of International Financial Markets Institutions And Money") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of International Money And Finance") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Banking And Finance") OR LIMIT-TO (EXACTSRCTITLE , "Pacific Basin Finance Journal") OR LIMIT-TO (EXACTSRCTITLE , "Emerging Markets Review") OR LIMIT-TO (EXACTSRCTITLE , "Global Finance Journal") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Empirical Finance") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Financial Economics") OR LIMIT-TO (EXACTSRCTITLE , "International Journal Of Managerial Finance") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Financial Markets") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Financial Research") OR LIMIT-TO (EXACTSRCTITLE , "International Review Of Finance") OR LIMIT-TO (EXACTSRCTITLE , "Financial Review") OR LIMIT-TO (EXACTSRCTITLE , "European Financial Management") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Behavioral And Experimental Finance") OR LIMIT-TO (EXACTSRCTITLE , "Quantitative Finance") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Portfolio Management") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Futures Markets") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Fixed Income") OR LIMIT-TO (EXACTSRCTITLE , "Journal Of Finance") OR LIMIT-TO (EXACTSRCTITLE , "European Journal Of Finance")).

This study employed two-fold review technology, i.e., Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol, backed by three primary stages, i.e., assembling, arranging, and assessing of articles(Paul et al., 2021) and bibliometric review approach (Donthu et al., 2021). A systematic literature review is bounded by a set of review protocols for which rules and regulations are employed with replicability and transparency to reduce bias and offer accurate decision findings. A literature review is required to build the foundation for creating a new conceptual model or theory and to assist in chronicling the evolution of a specific topic across time. The list of SPAR-4-SLR is illustrated in Fig. 2.10. Both approaches enabled us to develop a fine-grained and nuanced understanding of the prior literature on financial contagion and volatility spillover-related research specific to the financial stock market. According to experts, the SLR is a sophisticated and well-liked research methodology for identifying, reviewing, and analyzing historical publications on a particular issue or subject (Paul et al., 2021). This study employed a strong and well-defined strategy to carry out this SLR, which started with defining the study's goals and outlining the search strategy. The academic community has adequately recognized systematic review's importance, and exclusive publications special issues for systematic literature reviews exist. There are four kinds of systematic reviews: domain-based reviews, theory-based reviews, and method-based reviews, including meta-analytic reviews (Donthu et al., 2021). Previously, systematic literature reviews relied on review protocols from the science fields (e.g., the PRISMA protocol). Still, the notable proliferation of systematic literature reviews in the social sciences, where entrepreneurialism and corporate reside, has resulted in the creation of new review protocols for business and management research by business researchers, such as the Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR).

In summary, the SPAR-4-SLR protocol states that systematic literature review, as a technique, comprises three phases that include the gathering, organising, and evaluating (i.e., 3 As) of academic literature (Paul et al., 2021). Unlike the PRISMA protocol, the SPAR-4-SLR protocol includes publication inclusion and exclusion rules, increasing the clarity of the scientific reasoning behind review process choices (Paul et al., 2021). There are numerous types of systematic literature reviews (e.g., bibliometric, theme, framework, theory, and method reviews), with the bibliometric variant arguably being the most objective because bibliometric reviews typically acquire big data and engage in quantitative and statistical techniques using technology (e.g., online scientific database, software technology) to consolidate and report the performance and scientific knowledge of scholarly literature in the field (don't because bibliometric reviews are driven by technology, they can handle and analyze a vast corpus of articles in a way that other review types, which often depend on human coding and analysis, cannot. The vast corpus of articles included and reviewed in this technology-enabled systematic literature review also indicates that the bibliometric variation is more informative than equivalents with a generally smaller corpus.

Bibliometric analysis is a method of scientifically and statistically assessing bibliographic data from a body of literature (Linnenluecke et al., 2020). Several studies employ bibliometric techniques to glean insightful information from the existing literature and provide new recommendations. The method is becoming more frequently used to examine the intellectual structure of study topics (Boubaker et al., 2023; Donthu et al., 2021; Paul et al., 2021). Bibliometric analysis is divided into two categories: performance analysis and science mapping. Performance analysis is also popular in SLRs despite its descriptive form, as it gives an up-to-date assessment of the advancement of the study subject (Linnenluecke et al., 2020). It also provides insights into which journal (or source) or authors publish extensively on the topic and who are often referenced by the scientific community, improving publication quality tracking. This study focuses on the content of articles and scientifically maps links between articles using citations and keywords as an exploration of intellectual structure and a significant component of the bibliometric evaluation.

Steps followed for (SPAR-4-SLR) protocol as follows:

- **Assembling**

To assemble the corpus of study on financial contagion and volatility spillover in the financial stock market. It is the most crucial step that builds the foundation of a study. So, this literature review study was constructed and followed two steps. First, it identified its search strings relating to FC/VS from a preliminary review of relevant literature. After that, in step two consulted with eight experts to determine the suitability of those keywords as representations of financial contagion. This procedure of assembling generated resulted in a list of 15 different search strings (see Fig. 2.10).

After identifying search terms, this study executed a Scopus database search to identify search terms in each article's "article title, abstract, and keywords"to extract the data (for results). Scopus, the broadest high-quality scientific database of academic papers, was selected (Lohan et al., 2023) above Web of Science, which includes fewer articles for evaluation than Scopus (Paul et al., 2021). Several 13,887 articles were extracted with different combinations of the search strings to achieve the RQ of the study with crystal results.

- **Arranging**

To arrange the corpus of 13,887 articles returned from the assembling stage, this study used the category (code) function in the Scopus database to review the search results according to year, subject area, document type, publication stage, source type, and language, wherein search results were filtered and limited to "2020", "business, management, and accounting," "article and review paper," "final," "journal," and "English" in those categories, respectively. These filters were imposed in line with the recommendations of Paul et al. (2021) because 1962-2023 represented the full-year run. These filtration were put in place in accordance with Paul et al. (2021) recommendations covering the origin year to 2022; financial contagion occurs in the fields of business, management, and accounting; non-articles like editorials and notes might not have undergone peer review; including reviews may produce double-barreled insights; in-press articles were excluded because they had not yet been finalized; and non-journal sources like books, book chapters, and conference proceedings.

- **Assessing**

This study uses a bibliometric analytic technique for assessment to evaluate the final corpus, which includes 936 articles on sustainable finance and is pretty significant. A bibliometric analysis, in essence, employs quantitative methods to assess the scientific content of academic works (Donthu et al., 2021a). It is noteworthy that systematic reviews using bibliometrics are now commonplace, with business in general (Donthu et al., 2021) and finance in particular (Linnenluecke et al., 2018) taking advantage of bibliometric analysis (Donthu et al., 2021a) similar to the situation with this review (i.e., 936 articles). Following previous reviews (Donthu et al., 2020), this study conducts a bibliometric analysis applying a performance analysis to determine the publication pattern, the top documents, most contributing journals, authors, institutions, and economies, with methodological choices and research contextual factors, as well as a science mapping through a temporal analysis employing word clouds (Vaneck and Waltman,2017) and using keyword co-occurrence network analysis (Donthu et al., 2021) in VOSviewer (Vaneck and Waltman, 2017). This analysis curates a future research agenda based on self-reading the papers and considering existing gaps under each central theme to develop insights into the area. Moreover, the top journals are identified in Table 2.5.

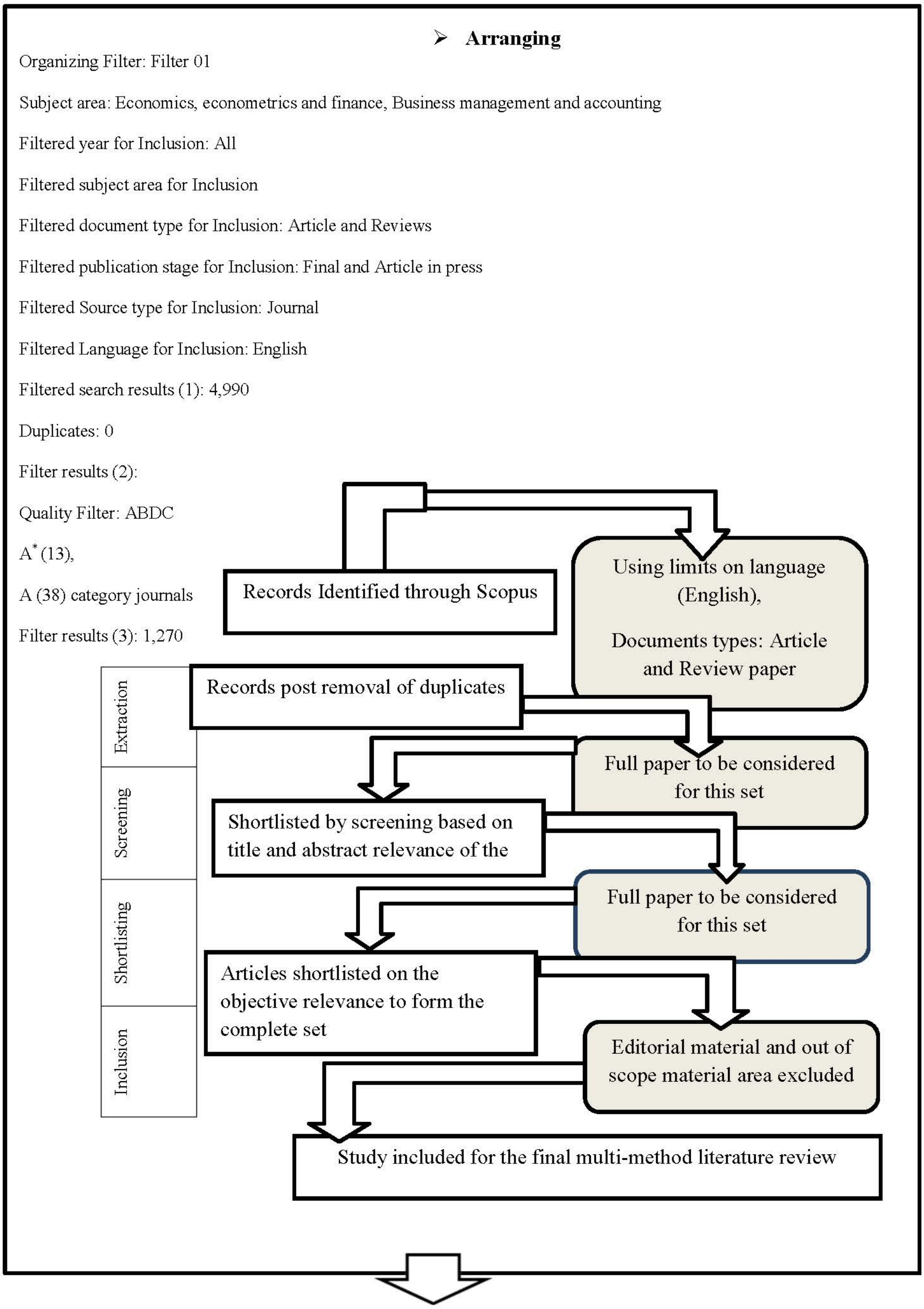
➢ **Assembling**

Search database: Scopus

S.No.	Search strings: TITLE-ABS-KEY	Original Results	Filtration at level 1
1.	"Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion" OR "Contagion Channel*" OR "Financial Contagion Channel*" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market*" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*" OR "international stock market* contagion and spillover"	1762	1380
2.	"Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*"	3398	2778
3.	"Contagion Channel*" OR "Financial Contagion Channel*" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Financ* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*"	4	4
4.	"Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Contagion Channel*" OR "Financial Contagion Channel*" "Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion"	15	12
5.	"Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Contagion Channel*" OR "Financial Contagion Channel*" "Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion" AND "Financ* Stock* Market*" OR "Equit* Market*" OR "Finan* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*"	04	3
6.	"Volatility Spillover" OR "Spillover" OR "Finan* Spillover*" OR "Spillover Effect" OR "Volatility Transmission*" OR "Return Spillover" AND "Contagion" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion" AND "Financial Stock* Market*" OR "Equit* Market*" OR "Finan* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*"	438	370
7.	"Financial Cris?s" OR "Finan* Crash*" OR "Black Swan" AND "Contagion Channel*" OR "Financial Contagion Channel*" OR "Financial Contagion" OR "International Financial Contagion" OR "Financial Risk Contagion"	341	276
8.	"Financial Cris?s" OR "Finan* Crash*" OR "Black Swan" AND "Contagion Channel*" OR "Financial Contagion Channel*" OR "Financial Contagion" OR "International Finan* Contagion" OR "Financial Risk Contagion" AND "Finan* Stock* Market*" OR "Equit* Market*" OR "Finan* Market" OR "Global Equit* Market*" OR "Stock* Market*" OR "Global Financial Market*"	195	167
	Total Results	6,157	4,990

Note: In search string * states different combination of word as finan* states finance, financial in similar way crisis as crisis, and crises, this combination improved quality of search for better and more results.

2. DATA AND RESEARCH METHODOLOGY



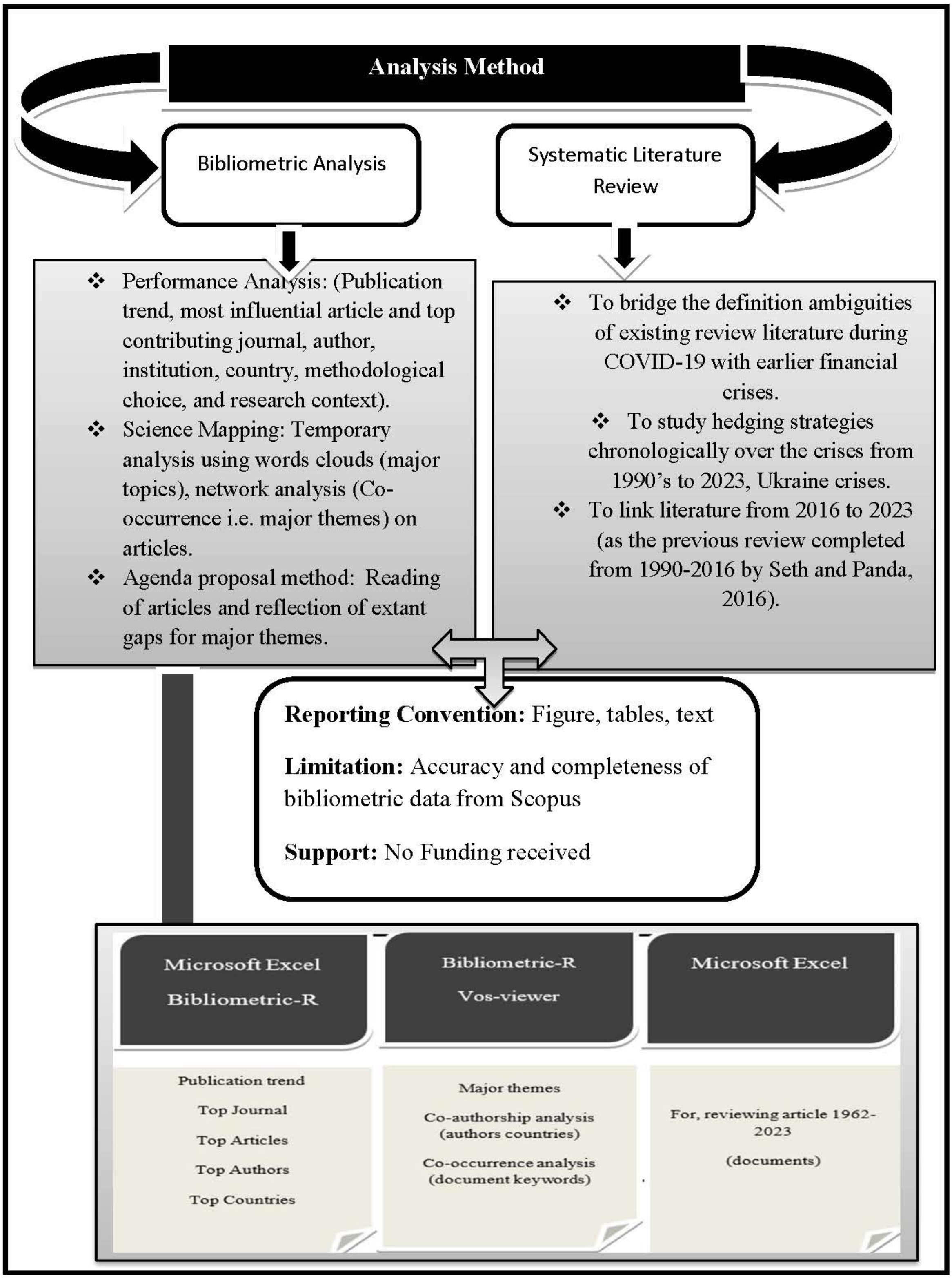


Fig. 2.10: Detailed systematic review procedure based on SPAR-4-SLR approach.Source: Author using MS Word.

Table 2.5: List of the selected journals and No. of publications.Source: Author using MS Word.

Title	Publisher	Field of Research	Rati ng	No. of Publication
Journal of Behavioural and Experimental Finance	Elsevier	3502	A	10
Journal of Corporate Finance	Elsevier	3502	A*	10
The Journal of Fixed Income	Pageant Media	3502	A	11
The Journal of Portfolio Management	Pageant Media	3502	A	11
Financial Review (US)	Wiley-Blackwell Publishing	3502	A	12
International Review of Finance	Wiley-Blackwell Publishing	3502	A	12
Journal of Financial Markets	Elsevier	3502	A*	12
Journal of Financial Research	Wiley-Blackwell Publishing	3502	A	12
The Journal of Finance	American Finance Association	3502	A*	12
European Financial Management	Wiley-Blackwell Publishing	3502	A	15
Journal of Commodity Markets	Elsevier	3502	A	17
International Journal of Managerial Finance	Emerald Group Publishing	3502	A	18
Journal of Financial Economics	Elsevier	3502	A*	23
The Journal of Futures Markets	Wiley-Blackwell Publishing	3502	A	23
Quantitative Finance	Taylor and Francis Online	3502	A	27
Journal of Empirical Finance	Elsevier	3502	A	35
The European Journal of Finance	Taylor and Francis Online	3502	A	47
Global Finance Journal	Elsevier	3502	A	50
Emerging Markets Review	Elsevier	3502	A	62
Pacific-Basin Finance Journal	Elsevier	3502	A	80
Journal of Banking and Finance	Elsevier	3502	A*	106
Journal of International Financial Markets, Institutions and Money	Elsevier	3502	A	120
Journal of International Money and Finance	Elsevier	3502	A	122
International Review of Economics and Finance	Elsevier	3502	A	124
Finance Research Letters	Elsevier	3502	A	165
International Review of Financial Analysis	Elsevier	3502	A	184

In response to RQ1, the current state of literature addressing financial contagion and volatility spillover –

Based on the available literature, in the global context, most of the research in the context of financial contagion and spillover was done in the US and China as part of the developed and emerging economy. Glick et al. (1999) used a maximum of 161 countries, followed by Liu et al. (2020) with 124 countries as for sample data. Dewandaru et al. (2016) used a maximum period of 42 years to study contagion co-moment, followed by Flores-Sosa et al. (2020) used 39 years of data based on exchange rate and volatility for a bibliometric study.

Jiang et al. (2022) stated that global financial crises are highly contagious; even Chopra et al. (2022) found that the US subprime crisis was most contagious, especially in the Asian stock market. In addition, cross-country contagion seems more likely to occur through trade and financial channels for economically grouped nations, according to research concentrating on regional contagion. Samitas et al.(2022) stated that COVID-19 and lockdown resulted in financial contagion. Liu et al. (2022a). The pandemic enhances European and American market spillover contributions while decreasing those in most Asian economies, and the pandemic's risk contagion across worldwide stock markets can last for 6 to 8 months. The empirical study can find Sovereign transmission of shocks (for instance, Campos-Martin et al., 2022). US and Germany unveil in case regime and trend changes are accounted for, as supported by (Gulzar et al., 2019). The adverse effects of crisis-induced shocks spreading to other countries throughout the post-crisis period, influencing investor behaviour and financial and macroeconomic stability, have led to increased research on financial contagion, particularly after the 2008 Financial Crisis. Islam et al. (2013) examined financial contagion and volatility spillovers between 15 Asian and European nations from 1997 to 2013. Their findings show significant volatility spillover for the Asia-top Pacific economies (India, Japan, China, South Korea, Taiwan, Malaysia, Singapore, and Australia), as well as financial contagion for European markets (Austria, France, Germany, Greece, Holland, Italy, and the UK).

This study focused on almost every crisis related to the survey keywords. In most studies, the US is the epicentre of research, and there are some crises. This study will help explore the available literature on crisis in the context of the US.

In response to the RQ2, the current research profiling top journals, articles, authors, countries, institutions, and publication trends for financial contagion and volatility spillover research are as follows-

Over the years, finalized articles (Table 2.6, Fig. 2.11) indicated that over the period, literature on the contagion and volatility spillover incrementally increased as from the 1990s till 2023 (December), numerous crises impacted the stock market, which given thrust to the stock market-related articles as the stock markets are susceptible to any crises which further impacts other macro variables.

Table 2.6: Yearly articles of the selected journal with inclusion and exclusion criteria.(Source: Author using R software.)

Year	Articles	Year	Articles
1990	0	2007	19
1991	2	2008	18
1992	0	2009	28
1993	2	2010	24
1994	4	2011	28
1995	4	2012	45
1996	2	2013	69
1997	3	2014	76
1998	4	2015	62
1999	6	2016	85
2000	5	2017	72
2001	11	2018	80
2002	9	2019	72
2003	11	2020	83
2004	16	2021	121
2005	15	2022	126
2006	13	2023	154

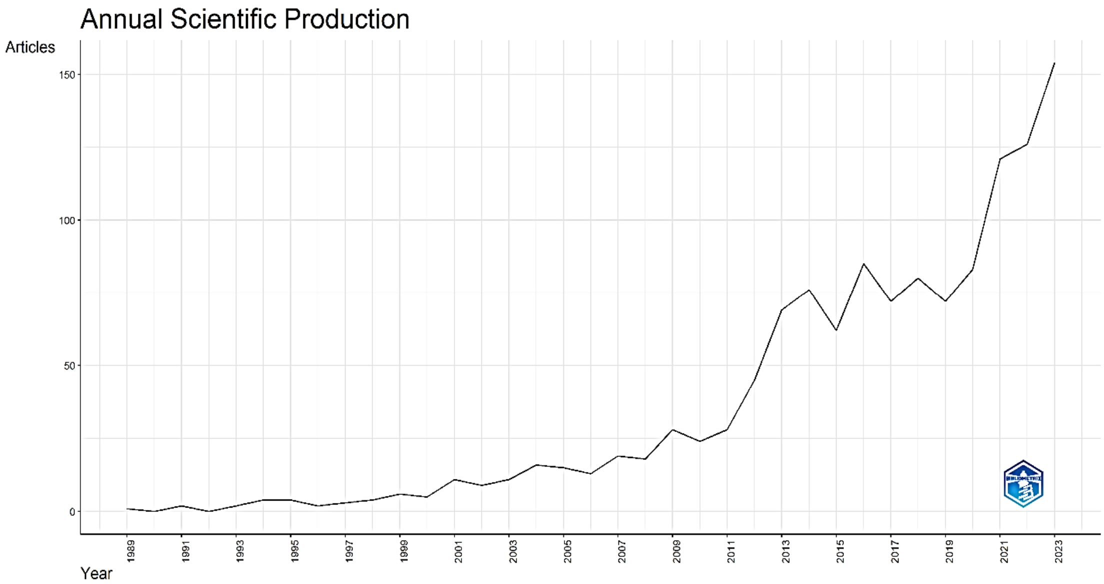


Fig. 2.11: Annual production of the publications from 1989 to 2023 (Source: Author using R software).

However, on analysis, this study identified that the average citation per year increased during a specific period (2001-2003) only, which is due to articles of Forbes and Ribobon (2001; 2002), which are highly cited due to the contagion definition provided by these articles (Fig. 2.12). Forbes and Rigbon (2002), cited by 2442, followed by Baur (2012) 1031, and Johnson (2000) by 941 indicate this above article got as much high indexing. However, during the crisis period, the average citation score increased as the publication of the number of articles increased during specific crisis periods, i.e., GFC-2008, EDC, Chinese burst bubble, BREXIT, COVID-19, and recent Russia-Ukraine crises (2022).

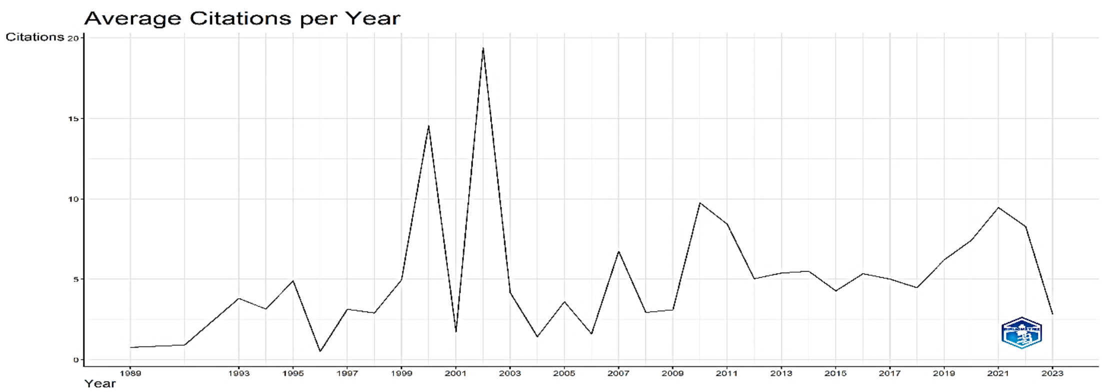


Fig. 2.12: Average citations per year from 1989 to 2023. (Source: Author using R software.)

During the three-fold observation, the yearly occurrence (AB_TM) of the keywords, financial stock or equity market, contagion, or crisis period, are the core keywords that follow the strings of the analysis. In-country affiliation suggests that China, the US, and followed by Australia are the top contributing countries in the selected area. On the other hand, emerging markets are also trending and identified as a current theme during the different crises for framing the monetary policies (indicated by author's keywords (DE)) (Fig. 2.13).

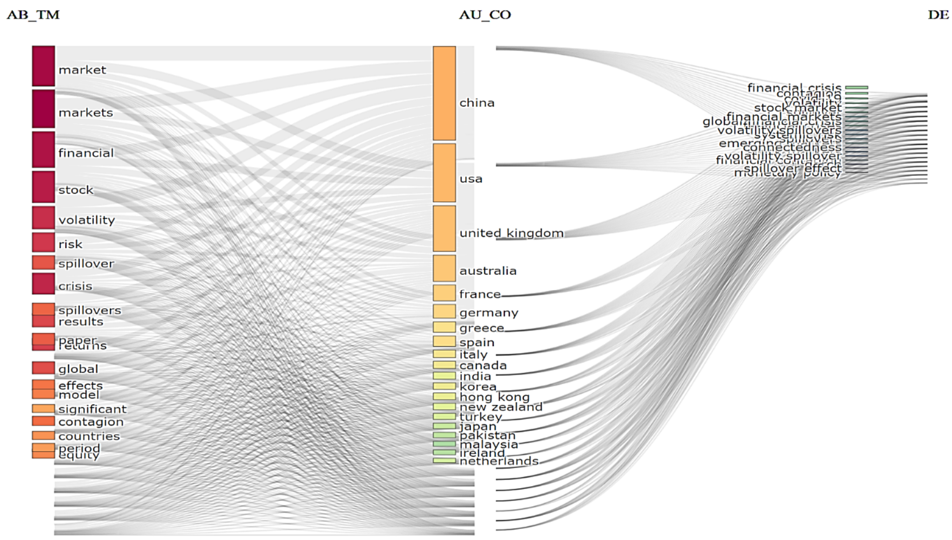


Fig. 2.13: Three-fold graph of the study yearly occurrence (AB_TM), country affiliation (AU_CO), and Author's keywords (DE).(Source: Author using R software.)

In identifying the most purifying articles, results (Table 2.7 and Fig. 2.14) indicated International Review of Financial Analysis (articles)(180), Finance Research Letters (161), Journal of International Financial Markets Institution and Money (120) as a most relevant journal which covers the core studies of different crises.

Table 2.7 Themost relevant journal to study the volatility spillover and financial contagion.(Source: Author using R software.)

Articles	Rank	Freq	CumFreq	Zone
International Review Of Financial Analysis	1	180	180	Zone 1
Finance Research Letters	2	161	341	Zone 1
Journal of International Financial Markets, Institutions And Money	3	120	461	Zone 1
Journal of International Money and Finance	4	120	581	Zone 2
International Review of Economics and Finance	5	111	692	Zone 2
Journal of Banking And Finance	6	106	798	Zone 2
Pacific Basin Finance Journal	7	77	875	Zone 2
Emerging Markets Review	8	62	937	Zone 3
Global Finance Journal	9	50	987	Zone 3
European Journal of Finance	10	47	1034	Zone 3
Journal of Empirical Finance	11	35	1069	Zone 3
Quantitative Finance	12	27	1096	Zone 3
Journal of Financial Economics	13	23	1119	Zone 3
Journal of Futures Markets	14	23	1142	Zone 3
International Journal of Managerial Finance	15	18	1160	Zone 3
European Financial Management	16	15	1175	Zone 3
Financial Review	17	12	1187	Zone 3
International Review of Finance	18	12	1199	Zone 3
Journal of Finance	19	12	1211	Zone 3
Journal of Financial Markets	20	12	1223	Zone 3
Journal of Financial Research	21	12	1235	Zone 3
Journal of Fixed Income	22	11	1246	Zone 3
Journal of Portfolio Management	23	11	1257	Zone 3
Journal of Behavioral And Experimental Finance	24	10	1267	Zone 3
Pacific-Basin Finance Journal	25	3	1270	Zone 3

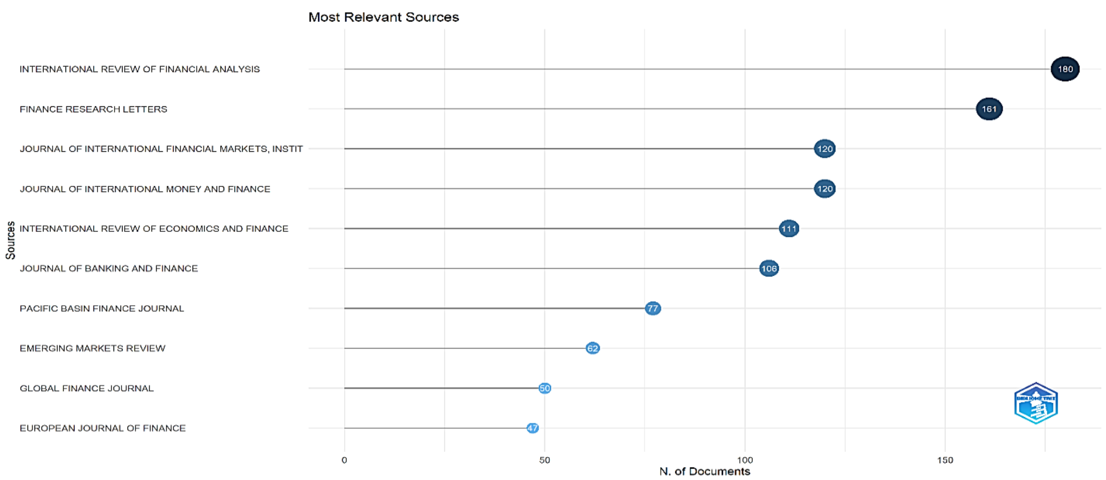


Fig. 2.14: The most relevant source in volatility spillover and financial contagion.(Source: Author using R software.)

Moreover, on the yearly production of the journals, the Finance Research Letter (FRL) International Review of Economics and Finance is identified as a leading journal (Fig. 2.15).

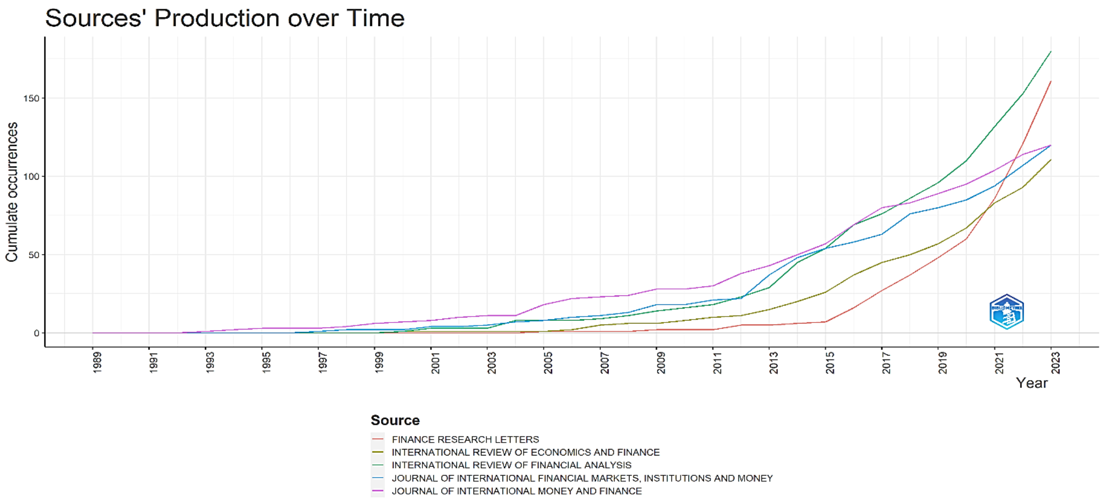


Fig. 2.15: Yearly (1989-2023) journal growth (Source: Author using R software).

Based on the source local impact by the H index (journal performance measure that aids in identifying a journal's significance) International Review of Financial Analysis, Journal of Banking and Finance, Journal of International Financial Markets, Institutions and Money (Fig. 2.16).

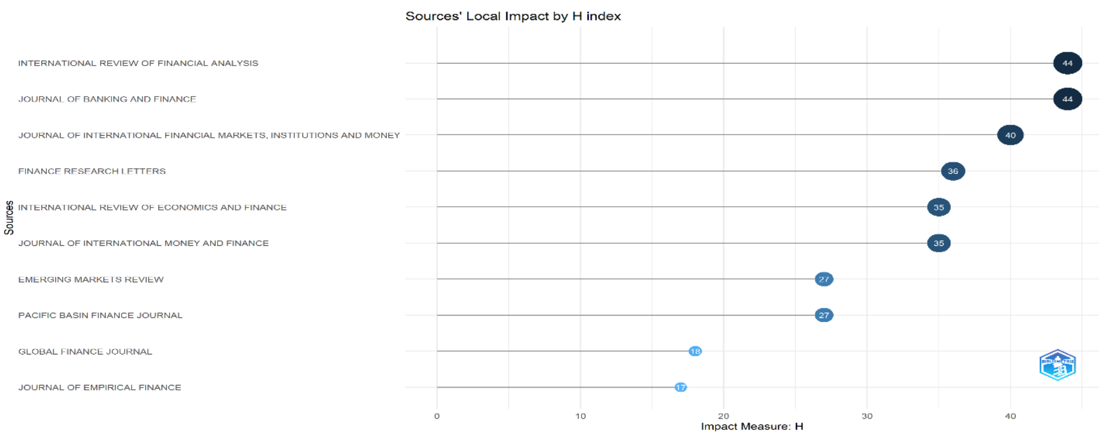


Fig. 2.16: Source local impacts of the journal by H index. (Source: Author using R software).

In terms of affiliation, Hunan University (China), Not reported (not mentioned in the database), Central South University (China), Beshang University (Las Vegas US), Monash University (Australia), University of Economic Ho Chi Minh City (Vietnam), Deakin University (Australia) identified as the most contributing countries (Fig. 2.17).

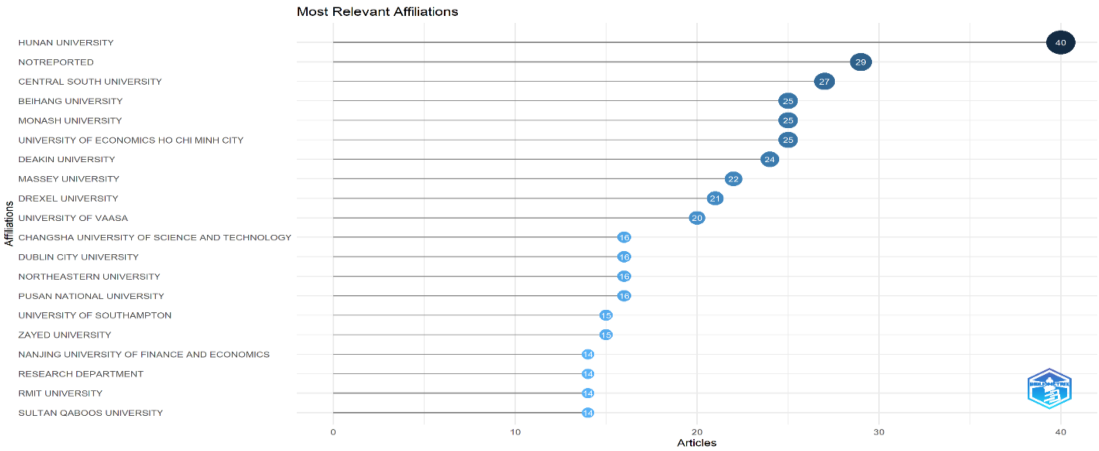


Fig. 2.17: Most relevant affiliation in the area of financial contagion and volatility spillover(Source: Author using R software).

Regarding the country's scientific production, the US, among developed countries, and China are the emerging countries identified as the dominant countries. Moreover, on the other side, it is determined that the least production is from the major emerging and frontier countries, indicating a lack of literature from these countries (Fig. 2.18).

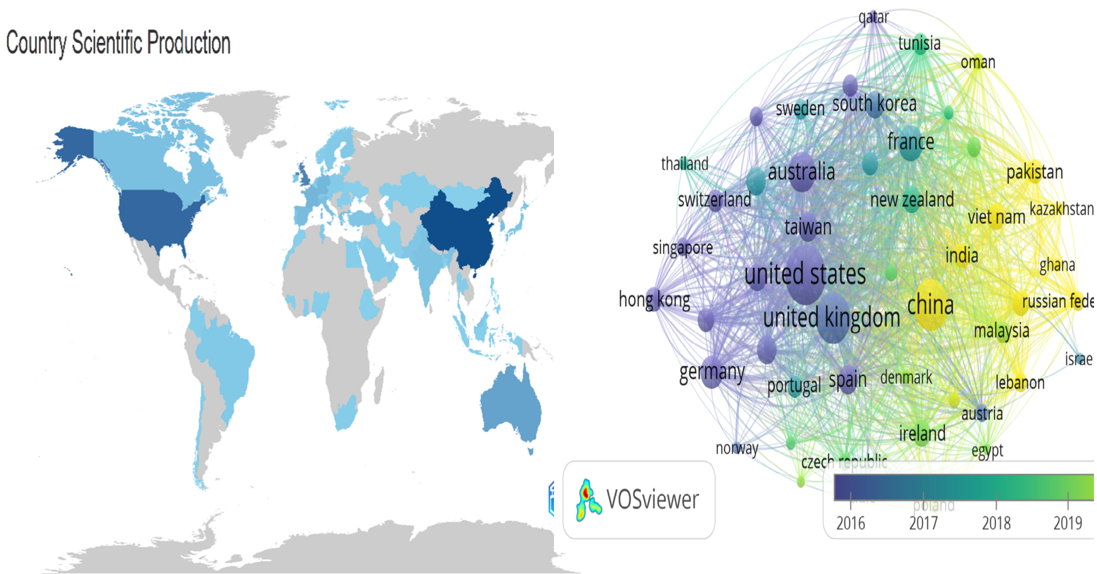


Fig. 2.18: Most contributing countries in the area of financial contagion and spillover(Source: Author using R software).

On analyzing the collaboration among the countries, it is identified that China and the US are also highly influential countries, and across the globe, different collaborations increased over the period.

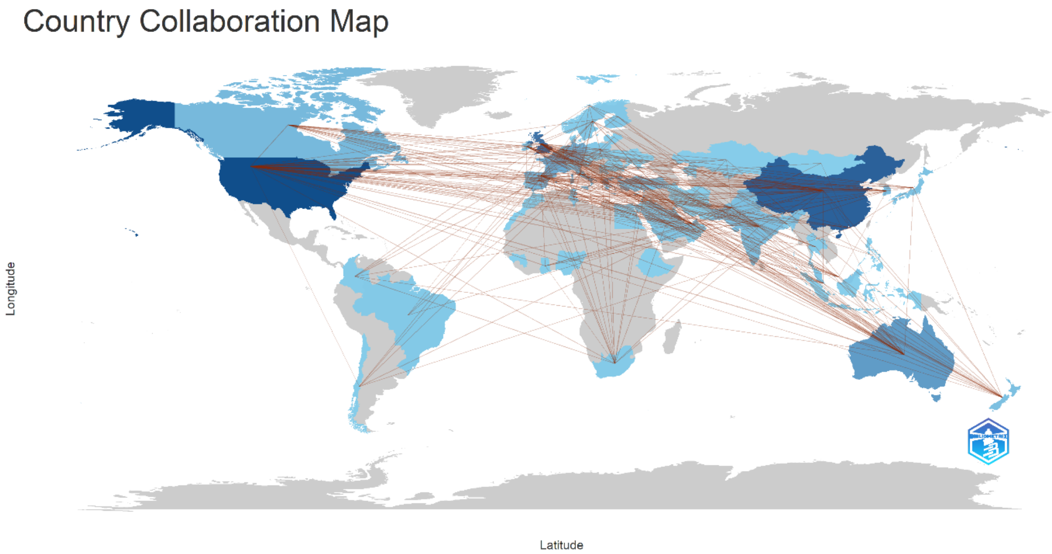
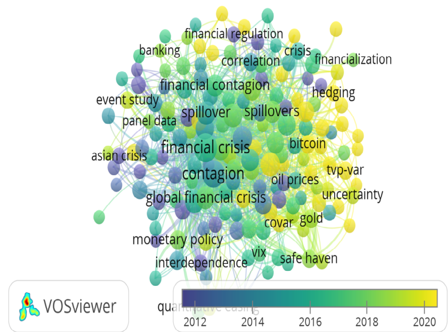


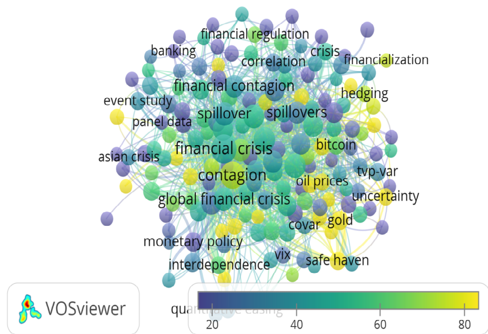
Fig. 2.19: Most collaborative countries in the selected area. (Source: Author using R software).

2.4.2.3 Thematic review of the literature

On analyzing the (RQ-3) different intellectual structures and significant themes of co-occurrence (Fig. 2.20, Fig. 2.21). Based on the co-occurrence with the minimum number of five documents out of 2899 sets of keywords, 167 meet the threshold. Based on co-occurrence, this study identified some significant themes from the 14 clusters shown over the literature's movement. In the early period of 2000 or during the 1990s, literature focused on the Asian financial crises, with the asset pricing models, and during the Chinese stock crash of early 2000, tested the co-integration approaches. On analyzing the significant clusters, studies have shown the financial contagions spillover during the GFC period, which started with the developed countries and shifted to the emerging markets, then during EDC, shifted to systemic risk and volatility. Later on, the study focused on the Chinese stock market crash and the oil market crash; during the period, the Grach model and structural break modelling were utilized quite a lot. After that, the literature shifted with the Brexit event, during which different stock indices were tested, taking different macro variables with credit swaps and risk. As the era of COVID-19 started, the literature diverted with the keywords the bitcoin, COVID-19, financial markets, gold, haven, and Spillover index with variance decomposition or Diebold Yilmaz technique was identified as intensively utilized, later copula approach also intensively utilized. After that, the EPU, emerging market, equity market, event study, exchange rate, financial stability, diversification, Granger causality, herding, high frequency, investor sentiments, liquidity, market efficiency, market integration, multivariate Grach. During the period of the recent Russia-Ukraine crisis, literature tested the Oil prices and price discovery heavily to identify the Correlation, interdependence, financial integration, volatility transmission, Uncertainty, spillover effects, realized volatility, Market integration using the Vix, Var, Co-var, TVP-VAR, network analysis, multivariate Grach, quantile regression, models (as highly identified in Fig. 2.20)with the quantitative easing market efficiency and black swan as the theory.Table- 2.8 unveils the crucial past literatureon the financial contagion and volatility spillover.



a) Yearly co-occurrence of the keywords.



b) Co-occurrence of the keywords in frequency.

c) Overall effective co-occurrence of the keywords.

Fig. 2.20: Based on the connectedness or co-occurrence of keywords, different major clusters were identified. (Source: Author using Vos-Viewer software).

Table 2.8: List of the past literature review (Source: Author).

Authors	Title	Methods/Research Theme	Findings	Limitation and theory direction
Girard and Rahman, (2002)	The Effect of the Asian Financial Crisis on Stock Returns, Volatility and Market Integration in the Region	The data used in this study consists of daily closing prices (5 days a week) for Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand and US market indexes. Comparing correlations of VAR residuals and squared residuals in pre-crisis versus crisis periods	This paper examines the change in cross-market linkages between nine Asian capital markets and the US due to the Asian financial crisis. This study uses price levels to find a significant increase in market integration in the region since the financial crisis started.	N/A
Yang and Tim,(2004)	Crisis, contagion, and East Asian stock markets	The 1997 financial crisis in East Asia caused the issue of contagion to resurface. Contagion is often associated with high-frequency events; hence, it has been measured on stock market returns, interest rates, the exchange rate, or their linear combinations.	This paper tests for evidence of contagion between selected East Asian stock markets, thereby exploring the importance of the linkages between stock markets as a transmission channel during the crisis.	N/A
Wilson and Zurbruegg, (2004)	Contagion or interdependence? Evidence from co-movements in Asia-Pacific securitised real estate markets during the 1997 crisis.	The 1997 real estate market crash in Thailand had a domino effect on property markets around the Asia-Pacific region. This study used DataStream International to compile daily securitized property market price indices for Singapore, Malaysia, Hong Kong, Australia, and Thailand.	This article focuses on the impact of Thailand's real estate market collapse on other Asia-Pacific property markets. You may look at the 1997 financial crisis as a single event if you include the depreciation of the Thai baht up until December 1997, the downward spiral in Tokyo during the same time that the U.S. dollar depreciated against the yen in 1994–1995 and the fact that Korea was likely on the verge of a recession. Most analysts agreed that this was when the crisis had the most noticeable effect. Assuming this time frame alone, insufficient evidence suggests that Thailand's real estate market collapse caused any epidemic.	The crisisera began when the Thai market experienced depreciation and ended with the stock market disaster in Hong Kong. In contrast to prior claims, this shorter period clearly showed that international markets followed the lead of the Thai market, which had detrimental effects on domestic property scope.

Białkowski and Serwa, (2005)	Financial contagion, spillovers and causality in the Markov switching framework	Apply copula functions that capture several dependence structures.	This paper investigates the dependence structure between daily oil price changes and stock market returns in six GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) from June 1, 2005, to February 11, 2013.	The empirical results indicate a significant change in the dependence structure. For all countries, the copula parameters and tail dependence coefficients are more substantial during the financial period than tranquil, implying a contagion effect.
Mighri and Mansouri (2024)	Modeling international stock market contagion using multivariate fractionally integrated APARCH approach	This study explores whether the plunging stock market in the US in the aftermath of the global financial crisis (2007–2009) exerts contagion effects on emerging stock markets.	This article aims to examine how the dynamics of correlations between two emerging countries (Brazil and Mexico) and the US evolved from January 2003 to December 2013	The empirical analysis shows a contagion effect for Brazil and Mexico during the early stages of the global financial crisis, indicating signs of "recoupling." Nevertheless, linkages show a general pattern of "decoupling" after the Lehman Brothers collapse.
Seth and Sighania (2017)	Financial market contagion: selective review of reviews	Several resources were looked at to review the past literature, and out of hundreds of papers, 104 research papers were used to form the sample for the present study. These 104 research papers are further classified based on various variables to know the status of research done on the topic	This article aims to review and organize the status of research on financial market contagion to provide easy access to future researchers. This study classifies the available literature, provides a complete bibliography on the subject, and analyses the findings of the studies considered for review.	This paper classifies the past research on financial market contagion and finds that the research work in this field has increased significantly recently, particularly between 2011 and 2015. Apart from the above findings, many other findings were revealed by the studies used for this paper.
Massad and Andersen, (2018)	Three different ways synchronization can cause contagion in financial markets	The methodologies used are agent-based modelling, models of integrate-and-fire oscillators, and communication models of human decision-making.	The dynamics of three different pathways, in which the synchronization of human decision-making could lead to turbulent periods and contagion phenomena in financial markets.	The model is introduced in which financial market performance impacts decision-making through communication between people. Conversely, the sentiment created via communication affects financial market performance.
Soylu and Güloğlu, (2019)	Financial contagion and flight to quality between emerging markets and U.S. bond	Examining causality from the left tail of one distribution to the right tail of another distribution, and vice versa.	Focusing on eight emerging markets from South Asia to South America, this paper analyzes three risk spillovers	The findings suggest that Chen's test results outperform the others in terms of robustness and reveal

	markets.		flight to quality, flight from quality and financial contagion – between emerging market stocks and U.S. bonds.	that the U.S. monetary policy could influence investors willing to park their money in emerging markets.
Delle Foglie and Panetta, (2020)	Islamic stock market versus conventional: Are Islamic investing a 'Safe Haven' for investors? A systematic literature review	A systematic literature review of articles published in academic journals from 2009 to 2019 shows a lack of consensus on the answers. Until today (i.e. 2019), most contributions have focused on the contraposition of the two systems, trying to verify the presence of decoupling, contagion, interdependence, or relationship between these two realities.	This paper tries to answer the following questions: "Are Islamic indexes a 'Safe Haven' for investors?" and "Does Islamic equity investment provide diversification benefits to Conventional investors?".	Finding results can be used to define a better financial system (in the stock market component), which is more resilient to unexpected financial shocks and supports the inception of a sustainable economic system.
Kuchler and Stroebel, (2021)	Social Finance	There are significant peer effects in mortgage refinancing decisions, and individuals' beliefs about the attractiveness of housing market investments are affected by their friends' recent house price experiences.	This study reviewed empirical literature that studies the role of social interactions in driving economic and financial decision-making.	This study of social interactions in finance, including the Social Connectedness Index, measures the frequency of Facebook friendship links across geographies. This study concludes by outlining several promising directions for further research in social finance.
Lamba and Jain, (2023)	A review on the unprecedented influence of COVID-19 on the stock market: what communities should know?	A systematic literature review and bibliometric approach were used in the study, covering 585 selected articles published in journals of high repute from January 2020 to January 2022.	This paper aims to show the pragmatic studies that examine whether novel COVID-19 affects the national and international stock markets and reinforces the existing literature by highlighting the factors that result from COVID-19.	It was concluded that short-term studies have been undertaken, which cannot determine the long-term implications of COVID-19. Over time, besides COVID-19, various other factors have started impacting the stock market, so it has become difficult to examine the influence of COVID-19 on the stock market in isolation.
Adeabah et al., (2023)	How far have we come, and where should we go after 30+ years of research on Africa's emerging financial markets? A systematic review and a	There has been a consistent expansion of financial markets research in Africa over the past 30 years, indicating a growing interest and dedication to this field of study.	Perform a systematic literature review and a bibliometric network analysis of studies on Africa's financial markets from 1992 to 2021	Identify seven principal domains of inquiry derived from the theme network and content analysis, as follows: (i) asset valuation, (ii) financial interconnectedness, (iii)

	bibliometric network analysis			contagion, herd behaviour, and extreme global occurrences, (iv) efficiency and predictability of equity returns, (v) market interdependencies origins and pathways, (vi) portfolio diversification and risk mitigation strategies, and (vii) influence of economic and financial information.

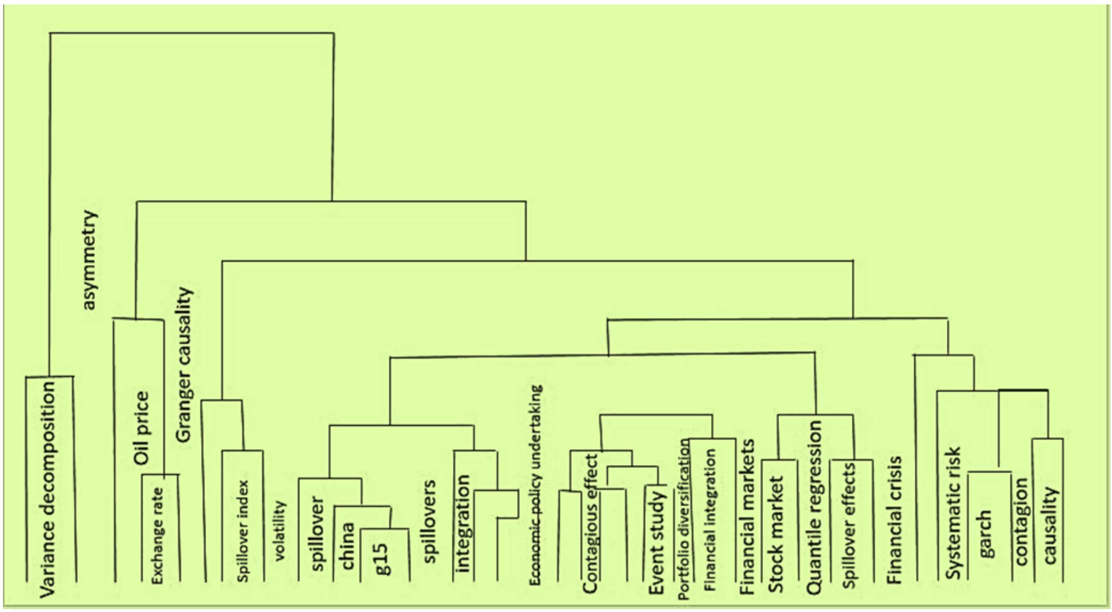


Fig. 2.21: Different major clusters were identified based on the connectedness or co-occurrence of keywords. (Source: Author using R software).

❖ **Research Gap**

➢ COVID-19, given the opportunity to include more emerging markets in the new studies, should be explored more intensively. Given that the COVID-19 outbreak originated in China and subsequently spread worldwide, affecting equally the developed and emerging markets, this specific situation also creates new possibilities to contribute to the emerging markets literature.-Yarovaya, (2022)

➢ Most studies related to financial contagion have been found to be carried out in the context of financial markets of developed countries rather than emerging or developing countries. - Kaur, 2023

➢ Research on volatility spillover in emerging and frontier markets is limited, but global research is majorly focused on the volatility spillover between emerging and developed markets. However, the direction of spillover is not always unidirectional, and the impact of spillover on emerging and frontier markets can be different from the impact on developed markets.

Frontier markets are defined as less developed and less accessible than emerging markets and have different characteristics, such as small market capitalization, trade volume, low liquidity, and high volatility. Due to these characteristics, volatility spillover in frontier markets may have other features and impacts than in emerging markets. Given the increasing significance of emerging and frontier markets in the global economy, studying the volatility spillover in these markets is essential to understand the potential risks and opportunities better. -Kakran et al., (2023b)

❖ Future research agenda for the financial contagion and volatility spillover -

Contagion is defined differently in the financial literature. For example, Allen and Gale (2000) described it as the straightforward transmission of shocks between countries, but Bekaert et al. (2014) defined it as the transmission strength. Furthermore, Forbes and Rigobon (2002) described it as a significant rise in cross-market contacts following a shock to a single nation or group of countries. Since then, it has gained widespread recognition as an essential research topic in finance. This point of view is aligned with the increasing number of research articles in studies examining the literature and assessing the evolution of the research issue. The literature for this study was retrieved only using the Scopus database, as stated in the second sub-part of the second section. As a result, future research investigations may involve using various databases. The study will allow portfolio managers, traders, and other investors to better understand the behaviour and interconnection of financial markets, particularly during difficult periods. The findings have various implications for the current state of the literature on financial contagion, including study gaps and potential future research efforts (as RQ-4 for the future research agenda).

First, previous academic research on financial contagion has relied chiefly on low-frequency data, such as daily, monthly, quarterly, or yearly data, primarily among emerging and developed countries. Still, the frontier is lopsided, and there is a lack of literature on high-frequency or intraday data across all global stock markets. Second, the idea of financial contagion is mainly studied in the context of the developed stock market; however, there is little literature on other markets, such as the debt market, currency market, and commodity market. Third, most studies on the selected issue have been conducted in the context of developed-country financial markets rather than emerging or developing countries. As a result, future research studies should take note of this and solve these concerns.

- Conceptual Framework of the study –

On analyzing the study's conceptual framework (RQ5), Fig. 2.22 shows the proposed framework for evolving future research works. Instead of treating social aspects as independent constructs, investigations must assume parameters with a mediator impact while also assuming a bigger scale of market stock prediction models. Given the scarcity of empirical studies in this field, such an approach has novel implications for policymakers and industry practitioners alike. This methodology requires that three postulated relations be empirically validated. Furthermore, the research gap has previously been discovered, indicating an absence of studies in frontier nations.

Proposition 1 (P1): Various independent variables, such as financial, economic, and monetary considerations, can have a significant positive or negative impact on a particular sector/industry/economy/region of the global stock exchange. Despite much research on this link, many questions remain unresolved. Regional variances, local economic issues perpetuated in media or news, and a shortage of literature on developed, emerging, and frontier countries all contribute to the complexity of comprehension.

Proposition 2 (P2): Based on the different mediating and moderating factors, i.e., social indicators, information transmission mechanism, and other significant indicators. Different countries have different impacts on the country of origin of the crisis. Still, due to these transmission channels through moderation, it might be possible some countries may be impacted in the short term, i.e., volatility spillover, and may have an impact in the long term, i.e., financial contagion. Social variables moderate or mediate the relationship between economic conditions and a specific sector/industry in a country's stock exchange. This concept is quite valuable in bringing about changes in the marketplace. Thus, it becomes crucial to understand the market dynamic during different crises among the developed, emerging, and frontier economies.

Proposition 3 (P3): The stock market fluctuations in a specific industry have an observable impact on the other sectors as well, with different levels of severity. Thus, it can also be further studied using the fixed effect model to determine whether the crashes in the stock market impact the other sectors by taking the different macro variables of developed, emerging, and frontier countries.

Moreover, this study underpins the Market Efficiency Theory (MET), which indicates that from a market efficiency standpoint, some markets absorb information better (earlier) than others (Dimson and Mussavian, 1998). Also, such a delay in price discovery invites an opportunity for profit should a trader be able to predict the direction and speed of information flow consistently.

On the other side,this study underpins the Modern Portfolio Theory (MPT), formulated by Harry Markowitz in 1952, indicated that MPT is based on the idea that an investor can build a portfolio of multiple assets or indices that will maximize returns for a given level of risk or, conversely, minimize risk for a given level of expected return. Elton, 1997 also discussed this theory in detail.

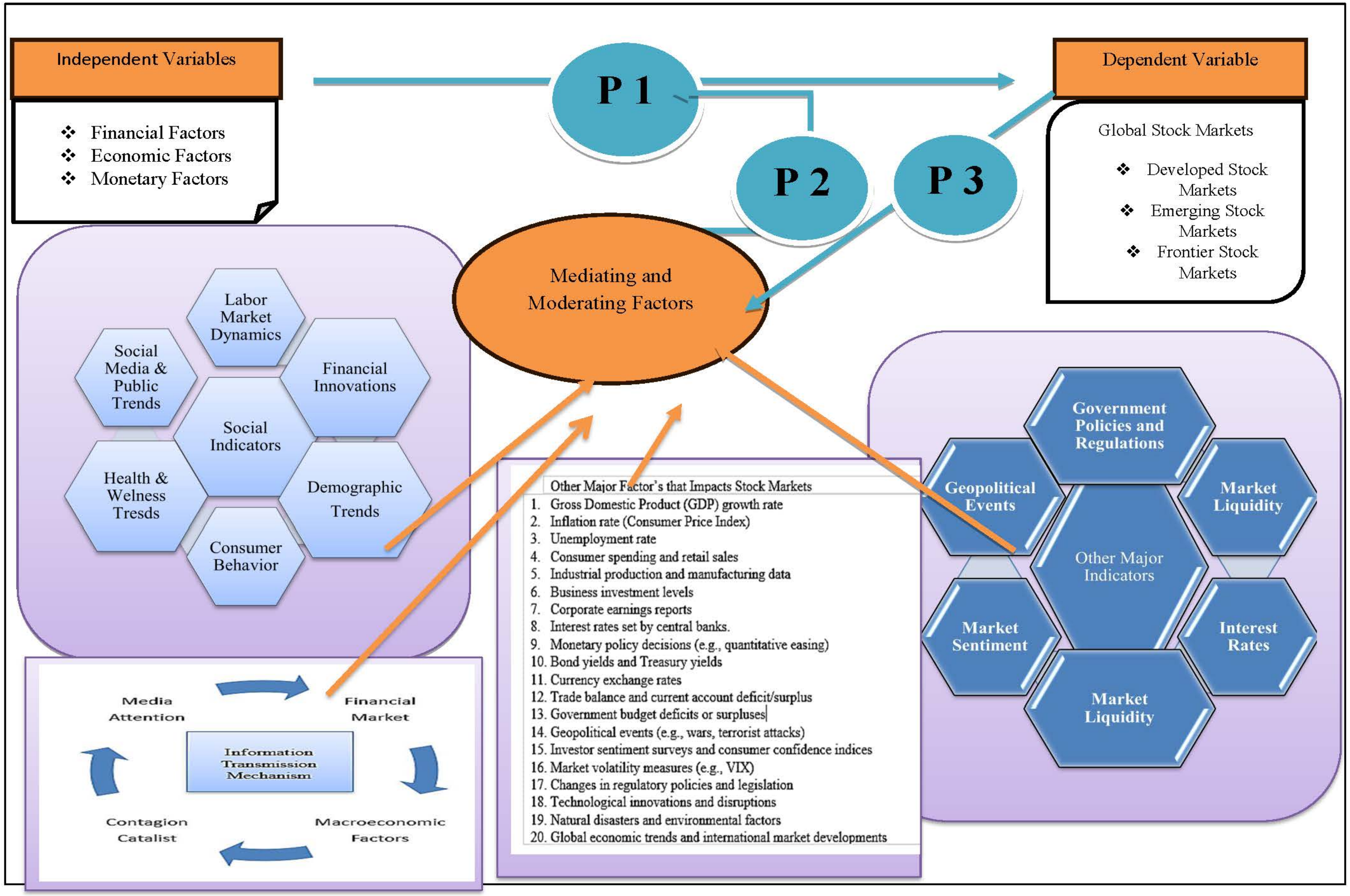


Fig. 2.22 Conceptual Framework for understanding the volatility spillover or contagion effects.

2.4.2.4 Conclusion

The current study seeks insight into key work in financial contagion in four different methods across 1270 publications extracted from Scopus between 1962 and 2023. First, the study uses trend analysis (yearly occurrence) to identify yearly patterns in financial contagion publications across 25 years. The data demonstrates that scholars' interest in financial contagion has grown, particularly in the last 14 years, and the power trend is the best-fitting trend line. Second, country and affiliation data suggest that research on the selected theme predominantly focuses on the United States, followed by other industrialized countries. It also provides the opportunity to study financial contagion in emerging economies. Third, author statistics show that Percioli's four articles on the selected issue acquired the most citations (784), but in terms of volume, Kenourgios has the most publications on financial contagion. Thus, there is ample opportunity for Indian scholars to work in this field. Therefore, the above-detailed discussion revealed limited research on volatility spillover and contagion in emerging and frontier markets. Still,the literature indicated significant volatility spillover between frontier, emerging and developed markets. However, the direction of spillover is not always unidirectional, and the impact of spillover on emerging and frontier markets can be different from the impact on developed markets.

Additionally, there is a limited study on the volatility spillover between frontier markets. Frontier markets are defined as less developed and less accessible than emerging markets and have different characteristics, such as small market capitalization, trade volume, low liquidity, and high volatility. Due to these characteristics, volatility spillover in frontier markets may have other features and impacts than in emerging markets. Given the increasing significance of emerging and frontier markets in the global economy, studying the volatility spillover in these markets is essential to understand the potential risks and opportunities better. Further study may be undertaken by concentrating on developed, emerging, and frontier markets and employing dynamic methods. In the future, a review study over a particular database (Web of Sciences, Scopus, Google Scholar) research on the above keywords can be conducted with a more systematic approach as in other areas (sugarcane bibliometrics) conducted by Kumar et al. (2022). However, this study is comprehensive and includesthe different databases on the relativity and objectivity of this article. A comparative regional study can be conducted in the upcoming articles, although this study covers almost all contributing global economies or regions.

Furthermore, the article citation counts show that Allen and Gale's study paper 'Financial Contagion' from 2000 was the most popular among researchers working on the emphasized issue. Fourth, bibliographic coupling figures disclose five thematic clusters that categorize subthemes, and concerning them, the topic of financial contagion has been explored, such as the credit crisis, global financial crisis, currency crisis, eurozone crisis, and pandemic (2019 onwards). The notion of financial contagion is primarily examined concerning stock markets; however, a few studies have considered other sectors, such as the real estate market, commodities market, and debt market. It's essential to investigate financial contagion across many markets during a crisis.

CHAPTER -3

RESEARCH METHODOLOGY

CHAPTER -3

RESEARCH METHODOLOGY

Chapter 2 examined the theoretical framework and previous empirical studies conducted on financial contagion and the impact of volatility spillover on global financial contagion in the international financial stock market. This chapterexplores the different methods employed by the researcher to examine the volatility spillover, financial contagion, and co-movementamong the stock market that impacts the country where the crisis originated in global markets. The chapter is segmented into different significant sections. In the first section, the theoretical framework for studying volatility spillover and financial contagion effects among the global financial markets is presented (Fig. 3.1). Section 3.1 outlines and examines the conceptual underpinning of the approach for studying volatility spillover and financial contagion. The research objectives and hypotheses are outlined (in sections 3.2 and 3.3). Section 3.4 summarises the research issues generated by the identified research gaps. Section 3.5 describes the sources of data obtained and the sample characteristics chosen for this study. The second half (section 3.6 finishes with a chapter summary.

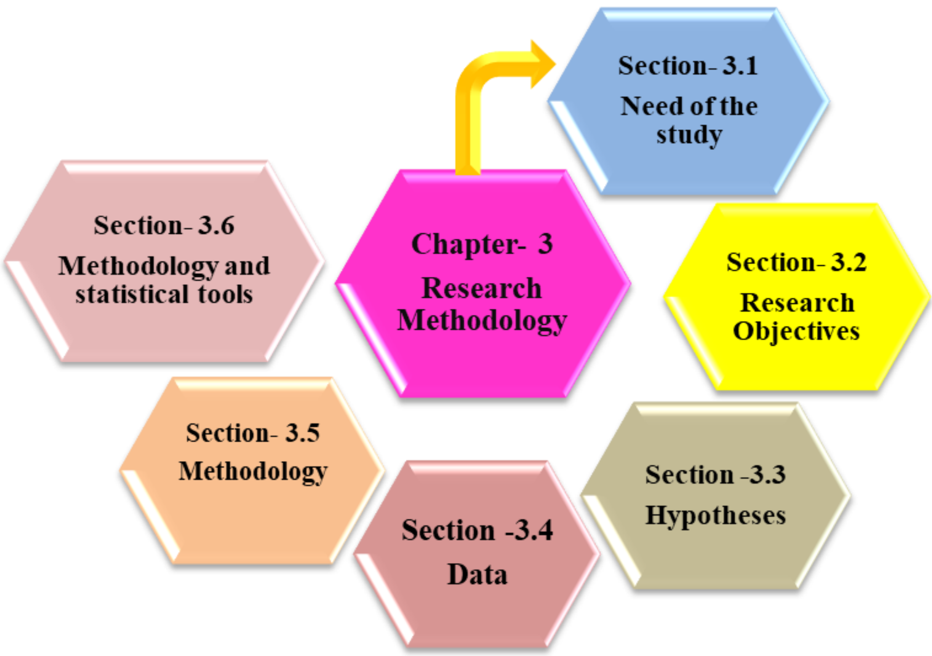


Fig. 3.1: Eye Bird view of Chapter 3 in different sections.(Source: Author using MS Word).

3.1 Need of the study

The above statistical literature and systematic literature review approach indicated a significant research gap for the in-depth study of the stock market. This chapter focuses on the methodological framework for this study to unveil volatility spillover, financial contagion, and the co-movementamong the developed, emerging, and frontier stock markets. The methodological framework aids the researcher by establishing hypotheses and conducting a practical analysis of the study's objectives (Fig. 3.2).

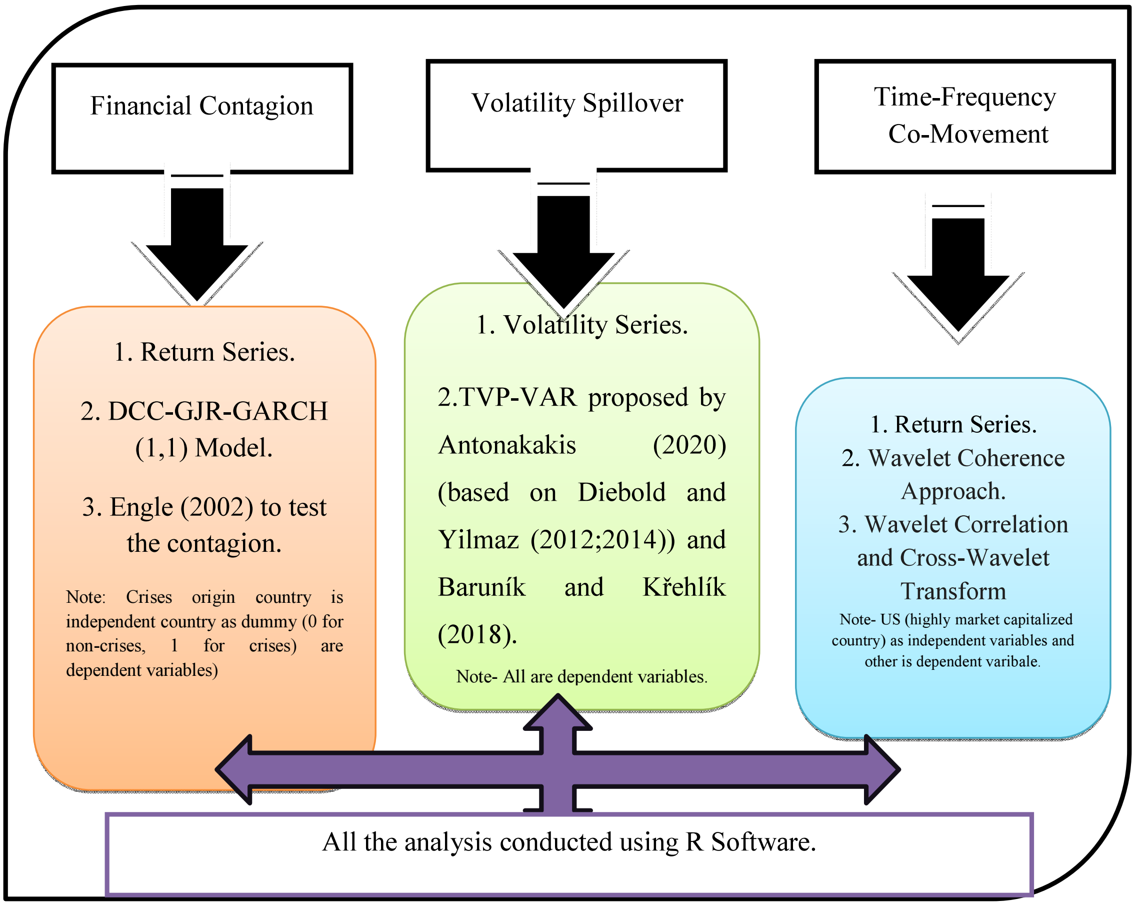


Fig. 3.2: Methodological framework for this thesis.(Source: Author using MS Word).

3.2 Research Objectives

1. To Assess volatility spillovers in selected stock markets during global events.
2. To Examine Financial Contagion Across Selected Markets in Financial Crises.
3. To Explore Time-Frequency Co-Movement between Selected Stock Markets.

3.3 Research Hypothesisand Questions

➢ Research Hypothesis

Research Objective	Hypothesis	References
To assess volatility spillover in the selected stock markets during global crises.	$H_{01} =$ There is an impact of volatility spillover in the selected stock markets during global crises.	Fang et al., 2023; Lan et al., 2023; Kakran et al., 2023a; Kakran et al., 2023b; Kakran et al., 2024a; Kakran et al., 2024b; Fang and Shao et al., (2022).
To examine financial contagion across the selected stock markets during global crises.	$H_{02} =$ There is financial contagion across the selected stock markets during global crises.	Iwanicz-Drozdowska, (2021); Fu et al., (2021a); Paskaleva and Stoykova, (2021); Gunay and Can, (2022)
To explore time-frequency co-movement between the selected stock markets during the crises.	$H_{03} =$There is time-frequency co-movement between the selected stock markets during the crises.	Matar et al., (2021); Rubbaniy et al., (2023).

➢ **Research question.**

RQ1. Is financial contagion existing among theselected global stock market?

RQ2. Does the selected global stock market interconnect and generate volatility spillover?

RQ3. Is there any relationship as co-movementbetween the US and the global markets after the outbreak in the selected stock market?

3.4 Data and Summary Statistics

This study is based on the secondary data (Table 3.1).This study covers the six significant crises, i.e. GFC- 2007-2009, EDC, Chinese Crash, Brexit, COVID-19, and Russia-Ukraine crises. Although study objective 1, this study focused on the pre-during crises period to unveil the understanding of volatility spillover in the stable and crisis periods. However, to study objective -2 (financial contagion), this study focused on the crises, and to research objective -3 (time-frequency co-movement), it covers the entire sample period. This study is based on a secondary source of data. The daily closing price of the whole period covered for this study from 08 July 2004 to 17 July

2023, sourced from Bloomberg. The Morgan Stanley Capital Index (MSCI)[15] global market classification is used to help pick the list of developed and emerging markets. Appendix 1 (return series) and Appendix 2 (volatility series) show the descriptive statistics of the entire sample period.

In the return series,Saudi Arabia, Morocco, Bulgaria, Thailand, and Russia have shown highlydamagingSkewness[16], and Kazakhstan, Kenya and Nigeria have shown highly positive skewness.Morocco, Croatia, and Russia have shown high positive skewness[17].

In the volatility series, Japan, Brazil, and Russia showed high skewness, and Vietnam, China, and Jordon showed low skewness; in the context of kurtosis, Brazil, Russia, and Japan showed high value of kurtosis, and Vietnam, China, and Jordon shown low value of kurtosis.

This study has nine global geographical regions (Developed Americas, Developed Europe, Middle East Africa (EMEA), Developed Asia-Pacific (APAC), Emerging America, Emerging EMEA, Emerging APAC, Frontier EMEA, and Frontier APAC). To identify the top 10 high market-capitalized countries among developed, emerging, and frontier countries (Stock market capitalization, in dollars - Country rankings)[18].

To mitigate the effects of external factors, a brief period of crisis management is strategically selected. There is a lot of disagreement in the literature over the precise start date of the GFC (Belhassine, 2020). Some claim it began in 2007, while others claim it started on September 15, 2008, with the collapse of Lehman Brothers (Johnson and Mamun, 2012). This study indicated pre-GFC period from July 8th, 2004 (initial data based on the availability of all the sample data indices) to August 8th, 2007 (as noted in the previous Quoreshi et al., 2019; Bello et al., 2022 studies), while

15 https://www.msci.com/our-solutions/indexes/market-classification

16 A distribution's degree of asymmetry is gauged by its skewness. When a distribution's left and right sides are not mirror reflections, it is said to be asymmetrical. There are three types of skewness in distributions: zero, left (or negative), or right (or positive).

17 Kurtosis is a crucial concept for investors to comprehend tail risk, or the frequency with which "infrequent" occurrences transpire, based on their assumptions regarding the distribution of price returns. A statistical measure called kurtosis is used to characterise how observed data are distributed around the mean.

18 https://www.theglobaleconomy.com/rankings/stock_market_capitalization_dollars/

the GFC crisis period runs from August 9th, 2007 (Quoreshi et al., 2016; Bello et al., 2022 studies) to December 31st, 2009[19] (Bello et al., 2022, indicated thereafter stabilization and tentative sign of recovery). The analysed time frame for EDC encompasses significant economic occurrences spanning from Pre EDC 1 Jan 2009 to 30 April 2010, and during EDC, the time frame (covers referendum vote results in declaration up to the revocation of Article 50) and EDC is from 03 May 2010 (From this date Greek Following this day, Greece's Prime Minister said that the austerity package was insufficient and demanded a rescue proposal from the Eurozone and the IMF. The crisis expanded to other European markets, causing the Eurozone to implode, supported by Kenourgios et al., 2016) to 10 June 2013 as per Mollah et al. (2016).

The Chinese burst bubble crashed from 11 June 2013 to 11 June 2015, (the Chinese stock market turbulence started on June 12, 2015 (Wildau, 2015) with the burst of the stock market bubble and concluded in early February 2016. Within one month of the occurrence, one-third of the value of A-shares on the Shanghai Stock Exchange was lost. Significant aftershocks occurred around the "Black Monday" events of July 27 and August 24. By the 8th and 9th of July 2015, the Shanghai stock exchange had dropped 30% in three weeks as 1,400 businesses, or more than half of those listed, requested a trading stop to avoid further losses)[20].

Aristeidis and Elias (2018) studied pre-Brexit from January 1st, 2016, to June 23rd, 2016, and during Brexit from June 24th, 2016, to September 30th, 2017. To study the global health crisis, i.e. COVID-19,this study adopted a sample period from Okorie and Lin (2021) and Bello et al. (2022) as the Pre-crisis era October 1st, 2019, to December 31st, 2019, and during COVID-19 from January 1st, 2020 (Kakran et al., 2023) to April 15, 2021(Banerjee et al., 2022). For the Pre Russia-16 April 2021 to 23 Feb 2022 (Kakran et al., 2023a) and during Russia-Ukraine crises 24 Feb 2022 to 17 July2023 (Kakran et al., 2023a).

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[19] For GFC period 31 March 2009 (Kakran et al., 2024; Panda and Seth, 2018) can also be taken as the last date, but to check the contagion effect (as occurred in longer period) we have choose 31 December 2009.

[20] https://archive.org/stream/Alchemist53To77/Alchemist%2053%20to%2077_djvu.txt

Table 3.1: Classification of counties based on (MSCI) and shortlisted based on ranking in equity inflows released by the International Monetary Fund (IMF) (Source: Author).

Developed Countries (10)							
Americas					**Asia-Pacific (APAC)**		
S.no.	**Country**	**Market Capitalization Ranking**	**Exchange (Bloomberg Tikker)**	**S.no.**	**Country**	**Market Capitalization Ranking**	**Exchange Bloomberg ticker**
1	US	01	SandP 500 (SPX)	6	Japan	03	Tokyo Stock Exchange (Nikkei 225)
2	Canada	03	Canadian stock market (SPTSX)	7	Hong-Kong	04	Hang Seng Index (HIS: IND)
Europe Middle East Africa (EMEA)				08	Australia	11	Australia Stock Market (AS51: IND)
3	Germany	08	Frankfurt Stock Exchange (DAX)	09	Russia	16	Moscow Stock Indices (IMOEX)
4	Switzerland	10	Swiss Market Index (SMI: IND)	10	Singapore	17	Straits Times Index (STI)
5	Spain	15	Spanish Stock Exchange (IBEX 35)				
Emerging Country (10)							
Americas				**APAC**			
11	Brazil	14	Ibovespa Brasil Sao Paulo Stock Exchange Index (IBOVESPA)	15	China	02	Shanghai Stock Exchange (SHCOMP Index)
12	Mexico	21	Mexican IPC index (Indice de Precios y Cotizaciones*)* (MEXBOL)	16	India	06	Bombay Stock Exchange (BSE)
EMEA				17	South Korea	09	Korea Composite Stock Price Index (KOSPI Index)
13	Saudi Arabia	07	Tadawul All Share Index (TASI: Index)	18	Thailand	18	Stock Exchange of Thailand (SET Index)
14	South Africa	13	Johannesburg Stock Exchange (JALSH/ FTSE/JSE)	19	Indonesia	19	Jakarta Stock Exchange Composite Index (JSCI)
				20	Malaysia	20	Kuala Lumpur Composite Index (FBMKLCI Index)
Frontier Countries (10)							

EMEA							
21	Morocco	36	(MCSINDEX: IND)	**27**	Kenya	47	Nairobi Stock Exchange (KNSMIDX Index)
22	Nigeria	37	(NGX: IND)	**28**	Jordon	48	Jordon Stock Exchange (JOSMGNFF Index)
23	Kazakhstan	40	Kazakhstan Stock Exchange (KZKAK)	**29**	Bulgaria	49	Bulgaria Stock Exchange - Sofia (129225Z: BU)
24	Romania	44	Bucharest Stock Exchange Trading Index (BET: IND)				
25	Bahrain	45	Bahrain Bourse All Share Index (BHSEASI)	**APAC**			
26	Croatia	46	Croatia Zagreb Stock Exchange Crobex Index (CRO: IND)	**30**	Vietnam	26	Vietnam Stock Exchange (VNINDEX Index)

3.5 Methodology

This study is based on the developed, emerging and frontier countries, and for evaluating the contagion effect, it focuses on the crisis's origin country and assessing the time-frequency it has taken US (as it is highly listed in Table -3.2. Focusing on the context of ESDC, the developed European markets are again divided into two sub-parts, i.e., GIPSI (Greece, Ireland, Portugal, Spain, and Italy) and the other developed European markets.

Table 3.2: Classification of different panels (with crisis origin country) with and date selection pre-during crises criteria. (Source: Author).

S. No.	Panel	Start Date	Reason	End Date	Reason	Crisis Origin
Panel-1	Pre-GFC	08 July, 2004	Availability of data	08 August, 2007	-	
Panel -2	GFC	09 August, 2007	On this day, BNP Paribas, France's largest bank, halted withdrawals from three investment funds. This decision was due to the inability to fairly value the holdings of subprime mortgage-related securities after the U.S. housing market began to deteriorate. BNP Paribas cited a "complete evaporation of liquidity" in the market for such securities, which made it impossible to value these complex financial instruments. (Quoreshi et al., 2016; Bello et al., 2022)	31 March, 2009	Bello et al. (2022), Panda and Seth (2018), and Kakran et al. (2024) also indicated thereafter stabilization and tentative signs of recovery.	US
Panel -3	Pre-EDC	01 April, 2009	-	30 April, 2010	-	
Panel -4	EDC	02 May. 2010	Following this day (i.e. 02 May 2010), Greece's Prime Minister said that the austerity package was insufficient and demanded a rescue proposal from the Eurozone and the IMF. The crisis expanded to other European markets, causing the Eurozone to implode, supported by Kenourgios et al. (2016) and Bello et al. (2022)	09 June, 2013	Mollah et al., (2016) and Bello et al., (2022)	PIIGS
Panel -5	Pre-Chinese crash	11 June, 2013	-	11 June, 2015	-	
Panel -6	Chinese Crash	12 June, 2015	The Chinese stock market turbulence started on June 12, 2015 (Wildau, 2015), with the stock market bubble burst and concluded in early February 2016. Within one month of the occurrence, one-third of the value of A-shares on the Shanghai Stock Exchange was lost. Significant aftershocks occurred around the "Black Monday" events of July 27 and August 24. By the 8th and 9th of July 2015, the Shanghai stock exchange had dropped 30% in three weeks as 1,400 businesses, or more than half of those listed, requested a trading stop to avoid further losses (Zhao et al., 2019).	31 Dec, 2015	The SSEC index has suffered a more than 43% drop from the peak on June 12, 2015, to the bottom on August 26, 2015, and the SZSC index has lost 45% over the same period.	China

S. No.	Panel	Start Date	Reason	End Date	Reason	Crisis Origin
Panel -7	Pre-Brexit	01 Jan, 2016	-	23 June, 2016	-	
Panel -8	Brexit	24 June, 2016	On Thursday, 23 June 2016, the British electorate voted to leave the European Union with a vote of 52% to 48%. Just over nine months later, on 29 March 2017, Prime Minister Theresa May triggered Article 50, marking the start of two years of negotiations to thrash out Britain's deal for its exit from the EU.	30 September, 2017	Bello et al., (2022)	UK
Panel -9	Pre-COVID-19	01 Jan, 2019	-	31 Dec, 2019	-	
Panel -10	COVID-19	01 Jan, 2020	January 1, 2020, Chinese health authorities and the WHO were examining a cluster of pneumonia-like episodes in Wuhan, Hubei Province. After investigation, SARS-CoV-2 was shown to have caused these instances. Wuhan Huanan Seafood Wholesale Market, suspected of being a virus source or amplifier, was closed and disinfected today. One of the first significant outbreak public health responses. WHO released its first Disease Outbreak News on the new virus on January 5, 2020, about Wuhan's cluster of 'viral pneumonia of unknown cause' cases. Bello et al. (2022) also supported this date.	15 April, 2021	Banerjee et al. (2021) The vaccination drive started around the world in early 2021.	China
Panel -11	Pre-Russia-Ukraine Crisis	16 April, 2021	-	23 Feb, 2022	-	
Panel -12	Russia-Ukraine crisis	24 Feb, 2022	Russia Invaded on Ukraine	17 July, 2023	Till date	Russia

In general, three approaches have been applied in the past literature to handle the missing values (arise due to the national/ local holidays or any other reason): replace the previous one, delete the data from all the series concerning the missing data, and replace by moving average as the data is taken from Bloomberg no missing data identified in any observation.To overcome the different time zone problems for the international stock markets, this study uses two two-day moving average returns for the analysis (Bello et al., 2022).

3.5.1 Stochastic Time Series: ADF Test for Non-stationarity

Theoretically, a time series is a collection of random variables where each item is linked to a certain point in time. A stochastic process is collecting these random variables in chronological order. Stochastic comes from the Greek word'stochos', which means 'a target or belonging to chance' (30). The stochastic process can be characterized using the joint distribution of the variable X_t. The paper focuses on stationary time series required to run any econometric model. Stationary time series are those where the joint distribution of variables does not vary over time, while non-stationary time series do. Econometric models often use stable data series with constant mean, variance, and autocorrelation throughout time (Jebb and Tay, 2017). The stationarity of the time series can be verified using the unit root formula (Dickey and Fuller, 1979; Dickey et al., 1986). This study examines the stationarity of stock market indices' log closing prices using the unit root model developed by Dickey and Fuller (1981) as the Augmented Dickey-Fuller (ADF) test and Phillips and Perron (1988) as the Phillips-Perron (PP) test. Non-stationary time series are defined as follows:

$$X_t = X_{(t-1)} + \mu_t \tag{3.1}$$

$$X_t = X_{(t-1)} + \mu_t;\ \mu_t IIDN\ (0, \delta^2) \tag{3.2}$$

Where μt a weakly stationary series, the above equation is defined as a random walk model without drift. Here,X_t is non-stationary, but its first difference (i.e., $Xt - (t-1)$ = ΔXt = μt) is a stationary time series. The above equation can be written as follows:

$$X_t = \rho X_{(t-1)} + \mu_t\ , \quad -1 \leq \rho \leq 1 \tag{3.2.1}$$

Equation (3.2) is a Markov first-order autoregressive model. If $\rho \geq 1$, an investigator can face a unit-root problem in series X_t, which identifies a non-stationary situation, and if $|\rho| < 1$, then the time series X_t is stationary. The equation (3.2) can be written again as follows by subtracting X_{t-1} from both the sides:

$$X_t = \rho X_{(t-1)} + \mu_t$$

$$X_t - X_{(t-1)} = \rho X_{(t-1)} + \mu_t - X_{(t-1)} + \mu_t$$

$$\Delta X_t = (\rho - 1)X_{(t-1)} + \mu_t$$

$$\Delta X_t = \delta X_{(t-1)} + \mu_t; \tag{3.3}$$

$$\delta = (\rho - 1);\ \Delta = first\ difference\ operator$$

If δ = 0; ρ = 1, which indicates the unit root in Xt series and again if δ = 0, then ΔXt = μt and μt is a white noise error term, thus, a random walk time series can become stationarity time series by using first difference. On the other hand, a time series can be stationary only if the value of $\delta$is negative. The test of DF assumes that the error term μt was uncorrelated. But if μt is correlated, Augmented Dickey-Fuller (ADF) is a more robust test than the DF test. It tests the stationarity of the time series by eliminating the assumption of uncorrelated error terms by adding a lagged difference term to the right-hand side of equation (3.3) and is defined as:

$$\Delta X_t = \delta X_{(t-1)} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-1} + \epsilon_t\ without\ drift \tag{3.4}$$

$$\Delta X_t = \beta_1 + \delta X_{(t-1)} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-1} + \epsilon_t\ with\ drift \tag{3.5}$$

$$\Delta X_t = \beta_1 + \beta_2 t + \delta X_{(t-1)} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-1} + \epsilon_t\ with\ drift\ \ and\ trend \tag{3.6}$$

Where ϵt is a pure white noise error term, the hypothesis and critical value for ADF arethe same as the DF test. The lag order for ΔXt is selected based on statistical methods. The null hypothesis for the test of unit root set is δ = 0 (i.e., the series having unit root),whereas the alternative one is δ< 0 (i.e., series follow stationarity).

PP test is generally a non-parametric statistical tool to test the unit root by focusing on autocorrelation in the error terms without adding lagged differenced terms (Gujarati, 2002). The test statistics and critical value of the PP test are also the same as the ADF test statistic. The regression equation for PP analysis is $A(1)$ process:

$$\Delta X_{(t-1)} = \alpha_1 + \beta X_{t-1} + \epsilon_t \tag{3.7}$$

Here,$Xt{-}1$ is an exploratory variable, and β is an autoregressive $A(1)$ coefficient. The null hypothesis of stationarity (or $\Delta Xt{-}1$) can be tested against β = 1:

H_o: $\beta = 1\ (unit\ root\ and\ non-staionarity)$

H_a: $\beta < 1\ (staionarity)$

If $\beta \geq 1$, indicates the series $\Delta Xt{-}1$ is non-stationary; if $\beta = 1$, suggests the series $\Delta Xt{-}1$ contains a unit root and non-stationary, and if $\beta < 1$, suggests the series $\Delta Xt{-}1$ follows stationarity.[21]

For calculating the return series, refer to Eq. 3.8

$$R_t = ln\left(\frac{P_t}{P_{t-1}}\right) \tag{3.8}$$

For calculating the volatility series, refer to Eq. 3.9

Daily volatility = $\sqrt{(\sum (P_{av} - P_i)^2 / n)}$ (3.9), Where the daily stock price on the i^{th} day is $P_{i,}$ and the mean price is Pav. Next, calculate the difference between each day's stock price and the mean price, P_i - P. Next, calculate the square of all deviations, i.e. $(P_{av} - P_i)^2$. Calculate the sum of all squared deviations $\sum (Pav - P_i)^2$. Divide the total of squared variances by the number of daily stock prices (n). This is referred to as stock price variance, i.e. Variance = $\sum(P_{av} - P_i)^2 / n$. Next, calculate the daily volatility or standard deviation by taking the square root of the stock's variation.

21 In current study ADF test employed for checking stationarity.

3.5.2 TVP-VAR connectedness approach proposed by Antonakakis et al. (2020).

3.5.2.1 Diebold Yilmaz (2012) Model

The present study analysed adverse shocks' effects on the volatility transmission across APEC foreign exchange (FOREX) markets. The study employed the Diebold and Yilmaz (2012) methodology. Diebold and Yilmaz (2012) proposed a metric within a Global Vector Autoregression (GVAR) model to measure the extent of volatility spillovers across various markets, assets, and firms. The methodology employed, Generalized Factor Error Vector Decomposition (GFEVD), considers the sequential arrangement of variables, thereby enabling the occurrence of simultaneous disturbances to each variable and preceding variable. This unchanging attribute guarantees a thorough evaluation of the effects of shock. This invariant property implies an exhaustive examination of shock effects. Variance decompositions (VDs) can be conducted using an *N*-variable VAR(q) process, as demonstrated in *Eq. (1),* which can be represented in an infinite moving average (MA) form, as depicted in Eq. (2).

$$Y_t = \sum_{i=1}^{q} \Phi_i Y_{t-i} + \varepsilon_t \tag{3.10}$$

$$Y_t = \sum_{i=0}^{\infty} \mathrm{A}_i \varepsilon_{t-i} \tag{3.11}$$

In Eq. (2), $A_i = \sum \Phi_i A_{i-j} is\ a\ N \times N$ coefficient matrix. A_0 is $N \times N$ is the identity matrix, while $A_i = 0$ for $i < 0$. Evaluating the interrelationships among variables by utilising numerous MA coefficients can present challenges and complexities. The utilization of MA coefficients requires the implementation of specific transformations, which can be achieved through either the Impulse Response Function or Variance Decomposition methodologies. These approaches provide valuable insights into the dynamics of the system. Variance decompositions (VDs) play a crucial role in determining the extent to which various shocks contribute to the forecast error variance (FEV) of individual variables. The quantification of the forced expiratory volume (FEV) proportion that can be attributed to shocks originating from one market and affecting another provides valuable insights into the interdependencies between variables. This analysis is facilitated using vector autoregressive models (VDs), which serve as a valuable tool in comprehending these relationships, $\forall\, j \neq i$, for each i:

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' A_h \sum e_i)^2}{\sum_{h=0}^{H-1} (e_i' A_h \sum A_h'\, e_i)^2} \tag{3.12}$$

The of the error or shock vector covariance matrix indicated by the $\sum$, σ_{jj} signifies the standard deviation of the error term for the jth equation during the selection vector e_j It takes a value of 1 for the jth element and 0 for others. $A_h$indicated the coefficient matrix as the infinite MA representation. The Generalised Forecast Error Variance Decomposition (GFEVD) method integrates the consideration of correlated shocks instead of the conventional practice of orthogonalizing shocks to each variable. As a result, it can be observed from the variance decomposition matrix that the summation of the elements in each row does not necessarily equate to one, indicating that the contributions of the jth market (represented in the column) to the ith market may vary. To tackle this issue, Diebold and Yilmaz (2012) suggest normalising every element within the VD matrix by dividing it by the sum of its respective rows, as depicted in Equation (4).

$$\breve{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)} \tag{3.13}$$

By design, the sum of the elements in each column of the variance decomposition (VD) matrix equals one, i.e., $\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H) = N$. Using the stated definition, volatility spillovers may be considered the estimated stock market volatility "i," which can be attributed to shocks originating from the stock market "j." Further, the Total spillover index (TSI) can be expressed mathematically using Eq. (5).

$$S^{g}(H) = \frac{\sum_{i,j=1, i\neq j}^{N} \tilde{\theta}_{ij}^{g}\,(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}\,(H)} \times 100 \tag{3.14}$$

Furthermore, Eq. (3.15) illustrates the directional volatility spillovers market "i" receives from all other markets "j," whereas Eq. (3.16) depicts the volatility spillovers market "i" transmits to all other markets "j." The difference between Eq. (3.15) and Eq. (3.16) is what investigatorscall the net directional volatility spillovers, and it is reflected in Eq. (3.17). The extent to which a given stock market contributes to or absorbs shocks may be inferred from its net spillovers.

From others to the market *i*:

$$S_{i.}^{g}(H) = \frac{\sum_{j=1,i\neq j}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \times 100 \quad (3.15)$$

To others from the market, i:

$$S_{.j}^{g}(H) = \frac{\sum_{j=1,j\neq i}^{N} \tilde{\theta}_{ji}^{g}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ji}^{g}(H)} \times 100 \quad (3.16)$$

Net Volatility Spillover:

$$NS_{i}^{g}(H) = S_{.j}^{g}(H) - S_{i.}^{g}(H) \quad (3.17)$$

Further, it intends to test whether or not the findings are consistent across different frequency domains, and it does so by adapting and expanding the method DY (2012) developed, which is very useful for analyzing spillover effects in the time domain. The coefficients of the moving average process with hysteresis order h (h) were transformed using the Fourier approach described by Baruník and Křehlík (2018). Equation (3.18) shows that a frequency response function is erected.

The approach DY (2012) introduced holds significant value in examining spillover effects within the time domain; this study aims to determine if the findings demonstrate consistency across various frequency domains. Following the methodology outlined by Baruník and Křehlík (2018), Fourier transforms were applied to the coefficients of the moving average process with hysteresis order h (ψh). Subsequently, a frequency response function is constructed, as illustrated in Equation (3.18):

$$\psi(e^{-ih\omega}) = \sum_{h=0}^{\infty} e^{-ih\omega} \psi_h \quad (3.18)$$

The method for obtaining the generalized forecast error variance decomposition for a given frequency ω is provided by Equation (3.19).

$$\theta_{ij}(\omega) = \frac{\sigma_{jj}^{-1}\sum_{h=0}^{\infty}\left(\psi(e^{-ih\omega})\Sigma\right)^{2}_{ij}}{\sum_{h=0}^{H}(\psi_h \Sigma \psi_h)_{ii}} \tag{3.19}$$

The variable $\theta_{ij}(\omega)$ is defined as the segment of the range of the i^{th} variable at the frequency ω caused by the perturbations in the j^{th} variable. The normalized form of $\theta_{ij}(\omega)$ is represented by Equation (3.20).

$$\tilde{\theta}_{ij}(\omega) = \frac{\theta_{ij}(\omega)}{\sum_{h=1}^{n}\theta_{ij}(\omega)} \tag{3.20}$$

The study focuses, rather than on the connectedness of a single frequency of a person, on the interconnection of distinct, descriptive frequencies that pertain to different time scales. As shown in Equation (3.20), it is crucial to calculate the cumulative connectivity within a specific frequency range, represented by $d = (d_1, d_2)$:

$$\tilde{\theta}_{ij}(d) = \int_{d_1}^{d_2}\tilde{\theta}_{ij}(\omega)d\omega \tag{3.21}$$

The expression in Equation (3.22) represents the level of connectedness in frequency band *d*.

$$C^{d} = \frac{\sum_{i=1, i\neq j}^{n}\tilde{\theta}_{ij}(d)}{\sum_{ij}\tilde{\theta}_{ij}(d)} = 1 - \frac{\sum_{i=1}^{n}\tilde{\theta}_{ii}(d)}{\sum_{ij}\tilde{\theta}_{ij}(d)} \tag{3.22}$$

The directional spillover indices within spectrum d encompass the FROM and TO connectedness.

$$C_{i\rightarrow}^{d} = \sum_{j=1, i\neq j}^{n}\tilde{\theta}_{ji}(d) \tag{3.23}$$

$$C_{i\leftarrow}^{d} = \sum_{j=1, i\neq j}^{n}\tilde{\theta}_{ji}(d) \tag{3.24}$$

Furthermore, in the frequency band *d*, it is possible to compute the net directional spillover, as mentioned in Equation (3.22):

$$C^d_{i,net} = C^d_{i\rightarrow} - C^d_{i\leftarrow} \tag{3.25}$$

At last, within spectrum *d*, the computation of the net pairwise connectedness is executed in the following way:

$$C^d_{ij} = \tilde{\theta}_{ji}(d) - \tilde{\theta}_{ij}(d) \tag{3.26}$$

3.5.2.2 Influenced connectedness approach proposed by Antonakakis et al. (2020) based on the TVP-VAR model, Diebold and Yılmaz (2014) with a TVP-VAR.

This study utilized the TVP-VAR-based approach of Antonakakis et al. (2020) influence connectedness technique, which is based on Diebold and Yılmaz's (2014) TVP-VAR model (Koop and Korobilis, 2014). Unlike typical static models employed in prior studies, TVP-VAR models capture the time-varying nature of the connection, resulting in a more realistic portrayal of the variables' shifting dynamics. This method increases knowledge of the interconnectedness and transmission channels, allowing for a more nuanced and thorough examination.

The TVP -VAR*(p)* model can be expressed as follows:

$$x_t = \Phi_{1t}x_{t-1} + \Phi_{2t}x_{t-2} + \cdots + \Phi_{pt}x_{t-p} + \epsilon_t \epsilon_t \sim N(0, \Sigma_t) \tag{3.27}$$

Where x_t, x_{t-1}, and $\epsilon_t$are $N\times N$ dimensional matrices? The first one represents the time-varying variance-co-variance matrix, which acts as the time-varying VAR coefficient. This study utilized $N\times N$ matrix lag-polynomials $\Phi.(L) = [I_N - \Phi_{1t}L - \cdots - \Phi_{pt}L^p]$ with I_N identity matrix. Thus, the model can be written as $\Phi(\mathrm{L})x_t = \epsilon_t$.

As long as the TV-VAR process is stationary, it can be written as a TVP-VMA (∞) using the wold representation theorem: $x_t = \Psi(L)\epsilon_t$, where $\Psi(L)$ matrix of infinite lag polynomials can be computed recursively from $\Phi(\mathrm{L}) = [\Psi(L)]^{-1}$. However, as

$\Psi(L)$ includes an infinite number of lags, it is approximated by $\Psi_h$computed at *h =1,…,H* horizons.

The TVP-VMA coefficients, Ψ_h, are required to compute the generalized forecast error variance decomposition (GFEVD) (see Koop et al., 1996; Pesaran and Shin, 1998), which lies at the focus of the connectedness approach. Investigator prefer the GFEVD over its orthogonal counterpart as the retrieved results are completely invariant with the variable ordering. Additionally, Wiesen et al. (2018) stress that the GFEVD should be employed if no theoretical framework - which would allow the identificationof the error structure is available. The GFEVD can be interpreted as the effect a shock in variable *j* has on variable *i* in terms of its forecast error variance and can be written in the following form:

$$\theta_{ijt}(H) = \frac{(\Sigma_t)_{jj}^{-1}\Sigma_{h=0}^{H}(\Psi_h\Sigma_t)_{ijt})^2}{\Sigma_{h=0}^{H}(\Psi_h\Sigma_t\Psi'_h)_{ii}} \tag{3.28}$$

$$\breve{\theta}_{ijt}(H) = \frac{\theta_{ijt}(H)}{\Sigma_{k=1}^{N}\theta_{ijt}(H)} \tag{3.29}$$

Where $\breve{\theta}_{ijt}(H)$denotes the contribution of the j^{th} variables to the variance of the forecast error of the i^{th}variable at horizon *H*. As the rows of $\breve{\theta}_{ijt}(H)$ do not sum up to one, the Investigator need to normalize them, which results in $\breve{\theta}_{ijt}$. Through the normalization, the investigator gets the following identities $\Sigma_{k=1}^{N}\breve{\theta}_{ijt}(H) = 1$ and $\Sigma_{i=1}^{N}\Sigma_{i=1}^{N}\breve{\theta}_{ijt}\,(H) = N$. In the next step, all connectedness measures can be computed. Investigators start with the net pairwise connectedness, which is calculated as follows,

$$NPDC_{ijt}(H) = \breve{\theta}_{ijt}(H) - \breve{\theta}_{jit}(H) \tag{3.30}$$

If $NPDC_{ijt}(H) > 0$ $(NPDC_{ijt}(H) < 0$ means that variable *j* influences variable *i* more (less) than vice versa.

The total directional connectedness *TO others* measures how much of a shock in the variable *i* is transmitted to all other variables*j:*

$$\mathrm{TO}_{it}(H) = \sum_{i=1, i\neq j}^{N} \breve{\theta}_{jit}(H) \tag{3.31}$$

The total directional connectedness *FROM* others measures how much variable i is receiving from shocks in all other variables *j*:

$$FROM_{it}(H) = \sum_{i=1, i\neq j}^{N} \breve{\theta}_{jit}(H) \tag{3.32}$$

The net total directional connectedness is the difference between total directional connectivity TO and FROM others, indicating the effect of variable *i* on the network under analysis.

$$NET_{it}(H) = TO_{it}(H) - FROM_{it}(H) \tag{3.33}$$

If the $NET_{it} > 0$ ($NET_{it} < 0$) variable *i* influences all others *j* more (less) than being influenced by them. Thus, it is considered a net transmitter (receiver) of shocks.

The total connectedness index (TCI) that measures the degree of network interconnectedness can be calculated by:

$$TCI_t(H) = N^{-1} \sum_{i=1}^{N} TO_{it}(H) = N^{-1} \sum_{i=1}^{N} FROM_{it}(H) \tag{3.34}$$

This statistic represents the average impact of a shock in one variable on all others. The market risk increases when this value rises, and vice versa. So far, this study has concentrated on measuring connectivity in the temporal domain using the above formula. Similarly, the investigation continued the connectivity examination in the frequency domain. Using Stiassny's (1996) spectral decomposition approach, we may investigate connectivity in the frequency domain. Firstly, the frequency response function responded.

$\Psi\left(e^{-iw}\right) = \sum_{h=0}^{\infty} e^{-iw}\Psi_h$ $, where\ i = \sqrt{-1}\ and\ \omega$ denotes of $(x_{t)}$ at frequency ω to continue with the spectral density of x_tAt frequency w, which can be defined as Fourier transformation of the TVP-VMA (∞):

$$S_x(\omega) = \sum_{h=-\infty}^{\infty} \mathrm{E}(x_t x_{t-h}{}')e^{-wh} = \Psi\left(e^{-iwh}\right)\Psi'\left(e^{+iw}\right) \tag{3.35}$$

The frequency GFEVD is the combination of the spectral density and the GFEVD. As in the time domain case,the investigator needs to normalize the frequency GFEVD, which can be formulated as follows,

$$\theta_{ijt}(\omega) = \frac{(\Sigma_t)_{jj}^{-1} |\sum_{h=0}^{\infty}(\Psi\left(e^{-iwh}\right)\Sigma_t)_{ijt}|^2}{\sum_{k=1}^{N} \theta_{ijt}\,(\omega)} \tag{3.36}$$

Where $\breve{\theta}_{ijt}(\omega)$ represent the portion of the spectrum of the i^{th}variable at a given frequency w that can be attributed to a shock in the j^{th}variable. It can be interpreted as a within-frequency indicator.

To assess short-term and long-term connectedness rather than connectedness at a single frequency, theaggregateof all frequencies within a specific range, d = (a,b): a,b ϵ (-π, π), a$< b$:

$$\breve{\theta}_{ijt}(d) = \int_a^b \tilde{\theta}_{ijt}(\omega)d\omega \tag{3.37}$$

Range d:

$$NPDC_{ijt}(d) = \tilde{\theta}_{ijt}(d) - \tilde{\theta}_{ijt}(d) \tag{3.38}$$

$$TO_{it}(d) = \Sigma_{i\neq,1,i\neq j}^{N}$$

$$FROM_{it}(d) = \sum_{i=1,i\neq j}^{N} \tilde{\theta}_{ijt}\,(d) \tag{3.39}$$

$$NET_{it}(d) = TO_{it}(d) - FROM_{it}(d) \tag{3.40}$$

$$TCI_t(d) = N^{-1}\sum_{i=1}^{N} TO_{it}(d) = N^{-1}\sum_{i=1}^{N} FROM_{it}(d) \quad (3.41)$$

All measurements give information about a particular range but not the overall impact. According toBaruník and Křehlík (2018), each frequency band's contribution metrics should be weighed against the entire system by $\Gamma.(d) = \sum_{i,j=1}^{N} \tilde{\theta}_{ijt}\frac{d}{N}$.

$$\widetilde{NPDC}_{ijt}(d) = \Gamma(d).NPDC_{ijt}(d) \quad (3.42)$$

$$\widetilde{TO}_{it}(d) = \Gamma(d).TO_{it}(d) \quad (3.43)$$

$$\widetilde{FROM}_{it}(d) = \Gamma(d).FROM_{it}(d) \quad (3.34)$$

$$\widetilde{NET}_{t}(d) = \Gamma(d).NET_{it}(d) \quad (3.35)$$

$$\widetilde{TCI}_{t}(d) = \Gamma(d).TCI_{t}(d) \quad (3.36)$$

Lastly, this study demonstrates how the frequency-domain measurements of Baruník and Křehlík (2018) relate to the time-domain measurements of Diebold and Yılmaz (2012, 2014):

$$NPDC_{ijt}(H) = \sum_{d} NPDC_{ijt}(d) \quad (3.37)$$

$$TO_{ijt}(H) = \sum_{d} TO_{ijt}(d) \quad (3.38)$$

$$FROM_{ijt}(H) = \sum_{d} FROM_{ijt}(d) \quad (3.39)$$

$$NET_{ijt}(H) = \sum_{d} NET_{ijt}(d) \quad (3.40)$$

$$TCI_t(H) = \sum_{d} TCI_t(d) \quad (3.41)$$

3.5.3 DCC-GJR-GARCH (1,1) Model.

To study financial contagion, this study starts with the analysis by calculating the basic returns from all indices for the entire period, which are derived as follows:

$$R_t = ln\left(\frac{P_t}{P_{t-1}}\right) \tag{3.42}$$

where P_t and $P_t - 1$ are the daily closing prices of the market index at time t and $t - 1$, respectively, and Rt is the return of a stock market index. This study used two-day rolling returns averages to account for exchange opening times and an unrestricted vector autoregressive (VAR) model with five lags to control for serial correlations and intra-week variations in trading patterns, according to Forbes and Rigobon's (2002) methodology. The unrestricted VAR includes all variables, including the return series of both markets (r_{it} andr_{ij}), with a maximum lag of five. The VAR framework. This methodology was also used by Bello et al. (2022) to unveil contagion among the global stock market, which indicates it is a trending study.

$$r_{it} = \mu_i + \sum_{k=1}^{5} \alpha_k r_{it} - k + \sum_{k=1}^{5} \beta_k r_{jt-k} + \epsilon_{it} \tag{3.43}$$

The symbol r denotes returns, with r_{it} representing the crisis market and r_{jt} representing the return of a second market, specifically the global stock market. To extract time-varying variances from VAR residuals, the GARCH (1,1) and GJR-GARCH (1,1) models of Glosten et al. (1993) are used. These models account for volatility's potential asymmetric responses to positive and negative shocks. The related variance formulae are listed below:

$$\sigma_{kt}^2 = \alpha_{k0} + \alpha k1\varepsilon_{kt-1}^2 + \beta_{k1}\sigma_{kt-1}^2 \tag{3.44}$$

$$\sigma_{kt}^2 = \alpha_{k0} + \alpha k1\varepsilon_{kt-1}^2 + \beta_{k1}\sigma_{kt-1}^2 + g\varepsilon_{kt-1}^2 I_{kt-1} \tag{3.45}$$

In this equation, σ_t^2represents the conditional variance, α_0 is the intercept, $\varepsilon_t$is the standardised residual, α1 is the ARCH parameter, and $\beta_1$is the GARCH parameter.

The subscript k represents the crisis market, while j represents the selected stock market. In the GJR - GARCH model (Eq. 3.42), I_{t-1} is a dummy variable representing adverse shocks' impact. It takes the value *1* if $\varepsilon_t - 1 < 0$, and *0* otherwise. This model contains three non-negative scalars: α_0, α_1, and β. A positive and statistically significant g suggests that adverse shocks will have a greater impact on conditional variance. GARCH models measure volatility clustering in data using the persistence parameter. Persistence is calculated as $\alpha_{k1} + \beta_{k1}$ for GARCH and$\alpha_{k1} + \beta_{k1} + Kg$ for GJR-GARCH.It evaluates volatility persistence and decay rate across time. Thereafter, the GJR - GARCH (1,1) model is employed to account for asymmetries in correlation dynamics, which are present in the global and crisis stockmarkets. We estimate conditional variance and conditional covariance terms as follows:

$$H_t = D_t^{1/2} R_t D_t^{1/2} \tag{3.46}$$

$$D_t = diag(\sigma_{it}^2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. \ \sigma_{Nt}^2 \tag{3.47}$$

$$R_t = diag\left(q_{ii,t}^{-\frac{1}{2}} \dots\dots\dots\dots\dots\dots\dots\dots. q_{NN,t}^{-\frac{1}{2}}\right) Q_t \ \ diag\,(q_{ii,t}^{-\frac{1}{2}}, \dots\dots\dots, q_{NN,t}^{-\frac{1}{2}}) \tag{3.48}$$

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha v_{t-1} v'_{t-1} + \beta Q_{t-1} \tag{3.49}$$

where $D_t$is the diagonal matrix containing square roots of the conditional variance obtained by the GARCH (1,1) model, and H_t is the conditional covariance matrix of the residuals. The DCC equation's significant α coefficient value suggests that correlation will change noticeably over time. Models mean-revert because α and β are non-negative scalars that satisfy the condition $\alpha + \beta < 1$. The covariance matrix is represented byQ_t= $[q_{ij,t}]$and the residuals are represented by v_t, which is the residuals standardized by their conditional standard deviation. The matrix of v_t unconditional *NxN* variance/covariance is called $\bar{Q}$. The estimations of conditional correlation are then obtained from the covariance matrix as follows:

$$\rho_{ij,t} = \frac{\text{Conditional Covariance}_{\text{ij,t}}}{\sqrt{conditional\ variance_{it} conditional\ variance}} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{ij,t}}} \tag{3.50}$$

When i denotes a crisis country and j represents a selected country. The DCC coefficient represents the average of conditional correlation ($\rho_{ij,t}$). To analyse financial contagion, we regress the time-varying correlation against dummy variables from the GFC, EDC, Chinese crash, Brexit, COVID-19, and Russia-Ukraine crises, as shown below.

$$\rho_{ij,t} = \gamma_1 + \gamma_2 Crisis + v_{ij,t} \tag{3.51}$$

$\rho_{ij,t}$Is the conditional correlation between the crisis market and a global stock market at time t. The crisis value is *1* for the GFC, EDC, Chinese crash, Brexit, COVID-19, and Russia-Ukraine crises, and *0* otherwise. A positive and statistically significant dummy variable parameter in a one-tailed test suggests contagion during the crisis.

3.5.4 Wavelet Coherence Model

Wavelet techniques offer a unified framework for analysing connections between variables throughout time and at various frequencies (Nepal et al., 2024). These strategies allow you to examine the relationship between variables over different time intervals. Gaurene et al. (2018) found that this strategy improved their understanding of the dynamic relationship between variables.

The wavelet coherence of two-time series x and y is calculated as follows:

$$\mathrm{R}^2 = \frac{\left|\mathrm{S}(\mathrm{s}^{-1}\mathrm{W}_{\mathrm{xy}}(\mathrm{u,s}))\right|^2}{\mathrm{S}(\mathrm{s}^{-1}|\mathrm{W}_{\mathrm{x}}(\mathrm{u,s})|^2)\mathrm{S}(\mathrm{s}^{-1}\left|\mathrm{W}_{\mathrm{y}}(\mathrm{u,s})\right|^2)} \tag{3.52}$$

Where S is the smoothing operator with $0 \leq R^2(u,s) \leq 1$ with value 1 showing strong co-movement between time-series and vice-versa. The wavelet-squared coherence analysis only takes into account positive values. As a result, there is no distinction between positive and negative directions in the relationship between the time series. The amount of the squared wavelet coherence coefficient ranges from *0* to *1*. A value close to zero indicates a lack of correlation, whereas a value close to unity denotes a high association. The Monte Carlo'sspecific power changes across the underlying variables are captured by wavelet analysis. Wavelet coherence, cross-wavelet transforms, and continuous wavelet analysis are the three main components of wavelet analysis. The wavelet coherence technique is imperative in enhancing the dynamic connections or spillovers across various time intervals. The co-movement between data series in the time-frequency domain is examined through wavelet coherence. It aids in discovering the lead-lag association between variables, emphasising the spectrum and periods (Torrence and Webster, 1999). Wavelet techniques offer a unified framework for evaluating correlations between variables throughout time and at various frequencies (Yadav et al., 2022). These strategies make analyzing the link between the variables across different time scales feasible. This approach improves understanding of the dynamic interaction between variables. When wavelet transforms are applied to time series, the original time series data is broken up into several series, and messages are generated at different frequencies. Each decomposed time series represents characteristics unique to a particular time range. The link between frequency and scale may be ascertained using wavelet analysis.The frequency-scale relationship is defined as mentioned in Eq. 2, where *Fc* is the wavelet's centre frequency, a is the scale parameter, and $F_a$is the frequency associated with the scale *"a"*. The wavelet becomes much more spread out as the time window increases (high scale), resulting in a lower frequency.

$$Fa = Fc/a \tag{3.53}$$

Wavelet analysis may be broadly divided into three categories: coherence, cross wavelet, and continuous wavelet. The provided time series is analysed at all frequencies using the Continuous Wavelet Transformation. One method for simultaneously evaluating two signals in the frequency and temporal domains is cross-wavelet analysis (Rua and Nunes, 2009; Shahzad et al., 2020). Cross-wavelet analysis's primary benefit is its capacity to examine the evolution of spectral characteristics across time. The connection between two signals is measured using wavelet coherence. The frequency domain link between time-series variables is the primary focus of this kind of wavelet analysis. Over a specific period, it may be used to ascertain if one variable is ahead of or behind the other. According to Torrence and Webster (1999), two-time series, *a(t)* and *b(t)*, make up the cross-wavelet transformation. The wavelet coherence of two-time series *x* and *y* is calculated as follows:

One can analyse the localised correlation coefficients and phase relationships between two nonstationary time series at varying frequencies using a method known as wavelet transform coherence (WTC). Moreover, the WTC assists in discerning the connection and dependency between two series, *x* and *y*, and is defined as follows:

$$R_{xy}(\tau, s) = \frac{\left|S(\mathrm{W}_{xy})(\tau, s)\right|}{\sqrt{S(|\mathrm{W}_x(\tau, s)|^2).S(|\mathrm{W}_x(\tau, s)|^2)}} \tag{3.54}$$

In the above equation, *S* is the smoothing operator for both the time and frequency domain. *Rxy* is the wavelet correlation with a value range between *0* and *1*; a higher value indicates a stronger correlation between the series.

The wavelet coherence analyses the dependence structure between the x and y series and determines the lead-lag relationship. As the CWT is complex, it is therefore segregated into imaginary and real parts based on the mother wavelet and is defined as:

$$\phi_{x_y} = tan^{-1}\left[\frac{lm\{\mathrm{W}_{xn}\exists_n\}}{Re\{W_{xn-n-}\}}\right], \phi_{x_y}\, \epsilon \mid -\pi, \pi \mid \tag{3.55}$$

In Eq. (3.55), the imaginary and real part is represented by *lm* and *Re*, respectively. Eight phase angles explain the results of the wavelet coherence plot. The arrows pointing towards the right (left) indicate a 0 (180) phase difference, suggesting both series have a positive (negative) correlation at the given time-frequency domain and thus have an in (out) phase relationship. Similarly, up (down) ward-directed arrows suggest that the second (first) series leads the first (second) series.Consequently, it does not distinguish between the positive and negative directions of the time series connection. The squared wavelet coherence coefficient has a value between *0* and *1.*

In contrast, a number near unity signifies a substantial relationship, whereas a value around *0* suggests no link. The fictitious wavelet allocation is analysed using the Monte Carlo simulation approach.

According to Tiwari et al. (2016), the wavelet transform is an effective technique for signal processing that uses a zero-mean function that is localised at both time (Δ_t) and frequency ($\Delta\omega$). In keeping with (Lee et al., 2021), the daughter wavelet is defined as:

$$\widetilde{\psi}_{\tau,s}(t) = \frac{1}{\sqrt{|s|}}\psi\left(\frac{t-\tau}{s}\right), s, \tau \in \mathbb{R}, s \neq 0 \tag{3.56}$$

In this context, $\tilde{\psi}$ represents the daughter wavelet, which is derived from the scale parameters (s), spot, and the mother wavelet (ψ). The mother wavelet collects frequency information with varying dilation across different frequencies in the time series, while the scale parameters account for the degree of dilation, and the placement specifies the wavelet's position within the time series. Moreover, the mother wavelet is defined as:

$$\psi^{Morelet}(t) = \frac{1}{\pi^{1/4}} e^{\mathrm{i}t\omega_0} e^{-t^{2/2}} \tag{3.57}$$

In this context, t and ω_0 denote the normalised time and frequency, respectively. In accordance with the literature (Saiti et al., 2016), we have employed ω_0=6 to achieve an equilibrium between temporal and frequency localisation of the wavelet. The Morlet wavelet also offers insights into wave amplitude and phase, crucial for analysing the synchronisation between the NSI's movement and the ESG indices (Aloui et al., 2015).

The continuous wavelet transform (CWT) offers insight into temporal and spectral resolution across many frequencies. Maintaining phase information is essential for analysing signal properties, providing adaptive frequency resolution for improved analysis of complex signals, and being effective with non-stationary data (Tiwari et al., 2015). Its ability to preserve phase information and adaptive frequency resolution also characterises it. The Continuous Wavelet Transform (CWT) for the time series x is defined as:

$$W_x(\tau, s) = \int_{-\infty}^{\infty} x(t)\widetilde{\Psi}_{\tau,s}^{*}(t)dt, s, \tau \in \mathbb{R}, s /= 0 \quad (3.58)$$

Where, $\widetilde{\Psi}^{*}$ is the complex conjugate of the daughter wavelet (Ψ)defined in Eq.(3.52), and s is the scaling parameter.

The primary purpose of the present study is to investigate the relationship between the news sentiment index and ESG stock indices; therefore, it isessential to study the cross-wavelet. The primary purpose of the present study is to investigate the relationship between the news sentiment index and ESG stock indices; therefore, it isessential to study the cross-wavelet transform as it examines the relationship between two variables.

The cross-wavelet transform extends the capabilities of wavelet analysis to examine relationships between two-time series in the time-frequency domain. This powerful tool determines the power and phase difference between two signals, providing a nuanced understanding of their interactions. The XWT utilizes covariances to explain the relationship between time series, offering a mathematical framework for quantifying their associations. Therefore, following Yu and Lin (2015), XWT between can be explained by utilizing their covariances, which are as follows:

$$w_{xy}(\tau, s) = wx(\tau, s)w_y^{*}(\tau, s) \quad (3.59)$$

Here, W_{xy}Denotes the wavelet transform between two-time series x(wx)and y(wy), and $w{*}y$ is the complex conjugate of the wy. The cross-wavelet power and the local variance of a time series are both represented by the wavelet power spectrum, which is denoted by the $|wxy|$, and the local covariance between two time series is defined by $|wxy|$.

3.6 Conclusion of the chapter

In the above sections, this study unveils the different methodologies used in the analysis of this study, as the DCC-GJR-GARCH (1,1) Model utilized to reveal the financial contagion, the TVP-VAR Model with the TVP-VAR-BK model used to demonstrate the volatility spillover and interconnectedness among the selected markets. At last, the waveletcoherence model, cross-wavelet-transform, and wavelet correlationare utilized to unveil the time-domain frequency among the selected stock markets.

CHAPTER -4

VOLATILITY SPILLOVERS AND INTERCONNECTEDNESS AMONG THE SELECTED DEVELOPED, EMERGING, AND FRONTIER STOCK MARKETS DURING GLOBAL TURMOIL

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VOLATILITY SPILLOVERS AND INTERCONNECTEDNESS AMONG THE SELECTED DEVELOPED, EMERGING, AND FRONTIER STOCK MARKETS DURING GLOBAL TURMOIL

This chapter unveils the volatility spillover and interconnectedness during several crises. Further, this chapter is separated into four sections: 4.1 covers the importance of interconnectedness and volatility spillover to show the relevance of this chapter, Section 4.2 covers the results of the chapter (in twelve sub-sections as Section 4.2.1-Pre-GFC, Section 4.2.2 - During GFC, Section 4.2.3 - Pre-EDC, Section 4.2.4 – During EDC, Section 4.2.5 show Pre-Chinese burst bubble, Section 4.2.6 represent during Chinese burst bubble, Section – 4.2.7 show Pre-BREXIT, Section – 4.2.8 show during BREXIT, Section 4.2.9 represent Pre- COVID-19, Section 4.2.10 cover during COVID-19, Section 4.2.11 cover during Pre-Russia-Ukraine crises, Section 4.2.12 cover during Russia-Ukraine war), Section 4.3 includes APEC stock market as a case study, and in the last Section 4.4 conclusion of the chapter.

4.1 Importance and understanding of interconnectedness during turmoil.

The notion of volatility spillover originated from market integration. By investigating the impact of critical global events on risk transmission as volatility spillover, this study can potentially reveal insights into financial market dynamics that go beyond the usual Efficient Market Hypothesis (EMH) paradigm. Since the late 1980s, regional economic integrations have formed worldwide because of economic activity's rapid regionalization and financial market liberalization (Yamazawa,1992; Oman,1996; Yeung, 2000).

The economic interconnectedness of global equities markets has grown steadily since the turn of the century, owing to extraordinary technological advancements and more significant financial flows across borders. As a result, investors, policymakers, and scholars are increasingly interested in the dynamic relationships between global stock markets. Notably, the spectacular collapse of the US housing market and the breakdown of the US mortgage bubble in the summer of 2007 directly contributed to a catastrophic financial crisis in 2008, which began in the US stock markets and other financial sectors and quickly spread. This crisis spread to neighbouring countries, escalating local crises into global ones. This occurrence reminded investors to research the spillover effects between different financial markets to decrease linkage risk. Understanding return and volatility spillovers across financial markets can provide investors with helpful information regarding hedging techniques, portfolio diversification, and risk management. In financial markets, returns are traditionally used to quantify the overall level of the market.

In contrast, volatilities are used to measure risk, which is aligned with the Investment theory, which estimates the risk-return trade-off using the mean (first moment) and variance (second moment). Lower moments (returns and volatility) are frequently discussed because many classic financial econometrics models rely on standard conditional distribution assumptions for their returns. Under this premise, conditional higher moments like skewness and excess kurtosis must be zero.

Nonetheless, the presence and time fluctuation of conditional higher moments in the returns of various financial assets, especially stock returns, results in volatility spillover. Meanwhile, newer option-valuation, value-at-risk, asset-pricing, and portfolio-choice models have emphasized the need to model fat tails and return asymmetry. More significant moments, such as skewness and kurtosis, represent these qualities. Skewness and kurtosis in returns can significantly impact asset and derivative pricing, risk management, and portfolio allocation. According to Patton (2004), for investors who do not have short-sale constraints, recognizing the higher conditional moments and asymmetric reliance is beneficial to achieving considerable economic and statistical portfolio returns. To include these higher moments in models, Hansen (1994) introduced a parametric model called Autoregressive Conditional Density (ACD), which allows for dynamic conditional skewness and kurtosis. This model remains within the tractable Generalized Autoregressive Conditional Heteroskedasticity (GARCH) framework while addressing the limitations of GARCH models, which typically cannot explain the observed wide fluctuations in security prices, even when accounting for skewness and tail-fatness using highly parameterized distributions.

Furthermore, information spreads throughout financial markets through returns, volatility, and skewness. As a result, like return and volatility spillover, integrating time-varying skewness in spillover analysis is critical for investor decision-making. A positively skewed return distribution indicates frequent modest losses and a few significant wins. On the other hand, a negatively skewed return distributionsuggests that there will be many tiny profits and a few significant losses. Kraus and Litzenberger (1976) found that investors prefer positively skewed portfolios. Considering this knowledge, examining skewness spillovers should help investors comprehend how markets are linked by the asymmetry of their return distributions, which is directly related to extreme risk or downside (upside) risk. As a result, skewness spillover may reveal informational efficiency regarding the ability to absorb cross-border information on the downside (upside) risk between financial markets. Del Brio et al. (2017) also argue that tounderstand better the connectivity and, hence, the effects of globalization inside financial markets;investigators should examine the interdependence of financial markets through a study of higher moments such as skewness rather than just volatility. This study provides new insights into the time-frequency dynamics of more significantmovement(skewness) spillovers among highly market capitalization markets (focusing on a combination of developed, emerging, and frontier countries).

Meanwhile, skewness and volatility spillover are compared to distinguish between the transmission of downside (up) and volatility risks. The Diebold-Yilmaz (2012;2014) approach and the Baruník and Křehlík (2018) methodology are new empirical methodologies for assessing spillover effects in the time and frequency domains. In the time domain, we use the Diebold-Yilmaz approach proposed by Diebold and Yilmaz (2009, 2012, 2014), which quantifies the strength and direction of spillover effects in a fixed investment horizon using the variance decomposition of forecast errors. Because of the variations between numerous economic actors participating in financial markets, investors cannot focus solely on a set investment horizon while implementing risk management plans or making investment decisions. More specifically, investors operate in the market at various investment horizons (expressed by frequency) ranging from seconds to several years due to variances in investor preferences, beliefs, risk tolerances, goals, and levels of information assimilation. Market shocks cause varying frequency responses and links with different degrees of persistence (Baruník and Křehlík, 2018). To acquire skewness spillovers in various frequencies, this study implemented the Baruník and Křehlík methodology, which is considered an extension of the Diebold-Yilmaz (2012).

The significant contributions of this research are as follows. First, to the best of my knowledge (refer to Chapter -2), this is the first study to investigate the high movementspillover effects across global stock markets using empirical approaches in both the time and frequency domains. Indeed, using the same methodology (the Diebold and Yilmaz technique), Diebold and Yilmaz (2009) explored the spillover effects of return and volatility across global equities markets. However, the skewness of returns is considered a measure of excessive risk in difficult times and unfavourable scenarios in financial markets. This study utilized TVP-VAR (Time-varying parameter-vector auto-regression) (a connectedness technique developed by Gabauer (2021)), based on Diebold and Yılmaz (2014)'s TVP-VAR model (Koop and Korobilis, 2014) model as since global stock markets are interlinked with the numerous trading partnership, this has grown in importance because of the global financial crisis. As a result, price and risk information transmitters and receivers start to show up in the market. In contrast to the conventional static models employed in earlier research, TVP-VAR models capture the time-varying character of the interconnectedness and offer a more accurate depiction of the shifting dynamics between the variables (see Chapter 3 for a detailed understanding of the model). This methodology enhances comprehension of the interdependencies and pathways of transmission between monetary policy determinations and energy market dynamics, enabling a more intricate and thorough examination.

Interconnectedness creates the understanding of the risk transmission mechanism across markets (from a risk management standpoint) among the global stock market to assess the spillover impacts of downside (upside) risk and volatility risk. To better understand the differences in the behaviour of the stock market, this study focused on the two forms (time domain and frequency domain) of dynamic spillover effects. One of the takeaways from the research on financial market spillovers is that major changes to the environment in which a stock market functions affect the strength of spillovers from other markets into that market. Thus, dynamic analysis is required to identify how skewness spillover varies over time. Furthermore, because situations and difficulties might differ significantly between short- and long-term investors, a study of spillover should be undertaken at various frequencies to acquire relevant and valuable information for those frequencies.

4.2.1 Panel 1- Pre-GFC (2004 - 2007)

The pre-GFC period covers July 08, 2004, to August 08, 2007. This period indicates the behaviour of the financial stock market during the standard period (compared to the GFC period). Fig. 4.1 indicates the interconnectedness among the developed, emerging, and frontier economies, as the US and Brazil, identified as significant volatility transmitters, show a high level of connectedness.

Small spikes identified in the total period Fig. 4.2 emerged as early as subprime mortgages, which were given to people with bad credit histories, causing housing prices to skyrocket to unsustainable levels. The “TO” row shows the time to which the volatility of other markets affects each market’s volatility. The Net return spillover to each market is computed by subtracting the values in the “FROM” column from those in the “TO” row. On the top of Table 4.1, the Total Spillover Index (TSI) is shown, representing the proportion of the total cross-variance spillovers relative to the overall total (i.e., 100 per market) “total” row showcases the impact of a market shock attributable to its shock and the shocks from other markets. During the pre-GFC period, different crises significantly impacted the 2001 US recession, and the 2006 tequila crisis impacted the developed, emerging, and frontier countries, due to which high volatility spillover generated, i.e., 73.68%. Pre-GFC analysis revealed that Brazil (47.28%), Switzerland (42.67%), Mexico (31.15%), and Canada (30.93%) were identified as the significant net transmitters during the overall Pre-crises period (Table 4.1). Spain (-26.02%), Croatia (-25.70%), Jordan (-21.80%), and Morocco (18%) are identified as primary net receivers among all the selected countries.

In the overall selected period and countries fronter, countries such as Croatia (-25.70%), Jordon (-21.80%), and Morocco (-18%) are identified as the primary receptor of the volatility spillover. This indicates that each of the three nations had bilateral trade agreements with one another and was actively engaged in global commerce.

Among developed countries (*"TO"* single side transmitter of the spillover), Switzerland (121.70%), Canada (108.8%), and the US (104.20%) were identified as significant volatility spillover; the US was recognised as the foremost global economy, the Group of Eight (G8), which included substantial industrialized nations and Russia, but during that period to get massive moreover North American Free Trade Agreement (NAFTA) also facilitated trade and economic cooperation with Canada. On the other side, Switzerland, having bilateral ties with the EU, impacted South Africa and acted as a transmitter to Germany and Croatia, indicating it has the potential to impact developed, emerging, and frontier countries. Among emerging countries (*"TO"* single side transmitter of the spillover), Brazil (125.60%), Mexico (108.70%), and India (91.04%) may be due to the economic bloc, i.e., BRIC, which open trading among these countries. Mexico influences the economy due to interconnectedness among the US, which Mexico, as a burgeoning market, is responsive to worldwide economic circumstances. Events or policy changes in Mexico's economy might operate as indications for broader patterns that might affect other developing countries. Among frontier countries (*"TO"* single side transmitter of the spillover), Bahrain (62.30%), Nigeria (62.26%), and Vietnam (55.91%) were identified as the significant transmitters among selected stock market, which may be due to the strong ties of Vietnam with US, China, and ASEAN countries. Moreover, Bahrain acted as a transmitter, possibly due to trade links with neighbouring GCC countries and key trading partners such as India and China.

Although among developed countries (*"FROM"* single side receptor of spillover), Spain (87.09%), Australia (82.37%), and Hong Kong (80.93%) are significant receptors of the spillover among the selected developed countries, indicated that Australia's economy is primarily dependent on the exportation of natural resources such as iron ore, coal, and liquefied natural gas (LNG). This renders it vulnerable to swings in global commodity prices, which external causes like economic downturns or alterations in energy regulations can instigate. Australia's financial system has a high level of integration with international markets, namely those in Europe and Asia. This makes it vulnerable to financial shocks and susceptible to the transfer of risks from other locations. Australia's economic system is highly interconnected with global markets in Europe and Asia. This makes it vulnerable to financial shocks and susceptible to the transfer of risks from other locations. Australia's currency rate is not fixed like Singapore's; instead, it freely fluctuates. While this feature allows for some adaptability in absorbing external disturbances, it can also intensify instability in the event of a sudden decline in value caused by external forces.

Among emerging (FROM single side receptor of spillover), South Africa (79.23%), South Korea (78.67%), and Mexico (77.51%) are significant receptors of the spillover in the emerging countries may be due to the 2007 Chinese stock market bubble, and partially increase of the interest rate in the US which indicated high volatility. Nevertheless, India's economy has shown notable resilience in the face of these foreign shocks. The cause of this may be attributed to a confluence of circumstances, such as vigorous domestic expansion, a malleable currency exchange rate, and a resilient banking sector. In the context of South Korea’s economy, the Asian financial crisis (1997-1998) had a significant negative impact, and it swiftly recuperated and embarked on a phase of robust expansion in the early 2000s. South Korea's financial system saw increased integration with the global economic system throughout this era. This increased the country's susceptibility to external shocks, such as the 2008 Global Financial Crisis (GFC).

Nevertheless, South Korea saw a milder impact from the Global Financial Crisis (GFC) than other developing nations. This may be attributed to several causes, such as the nation's robust budgetary situation and aggressive policy response. Mexico has acted as the receptor.

On the other side, Croatia (71.05%), Bahrain (68.77%), and Romania (68.77%) (*“FROM*” single side receptor of spillover) are primary receptors among the frontier countries. Croatia is a prominent international hub for finance (with a highly open economy that is heavily resilient to trade flows and economic activity), with a particular focus on services such as wealth management, investment funds, and private banking. This makes it vulnerable to variations in worldwide (especially among the frontier countries) prosperity and asset values, which might result in cash outflow or decreased investment during periods of financial upheaval. Croatia possesses a comparatively substantial public debt load, rendering it more vulnerable to escalating interest rates or fiscal contraction measures in periods of global economic strain. The Romanian economy strongly depends on foreign direct investment (FDI), with a particular emphasis on manufacturing and services. This can render it vulnerable to fluctuations in global investment sentiment or economic downturns in crucial investor nations.

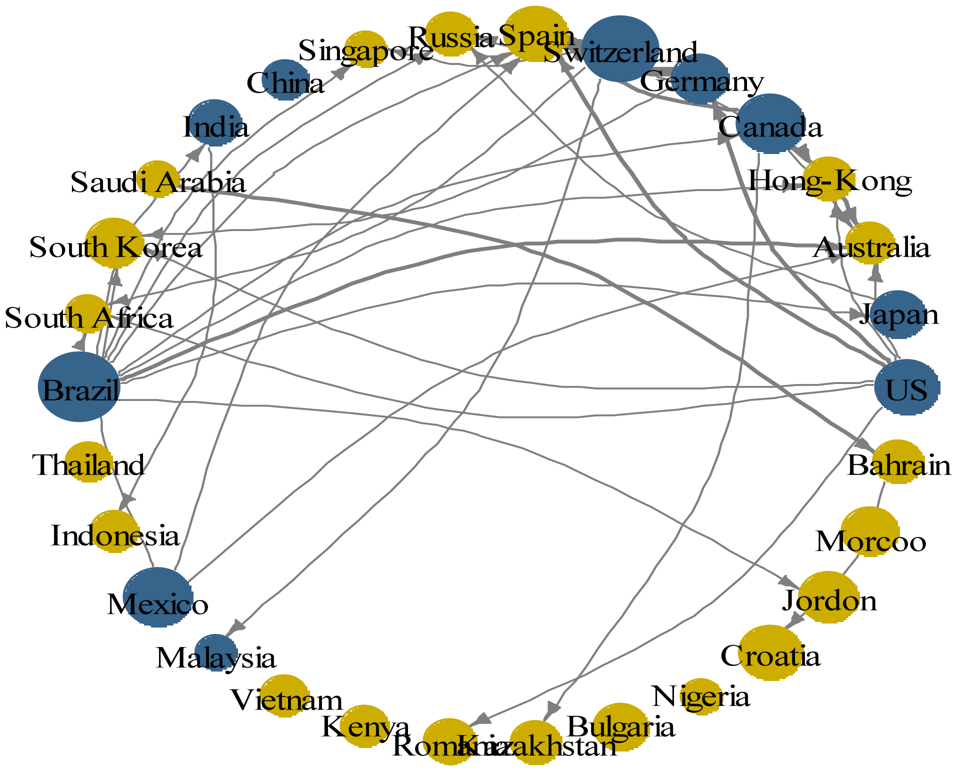


Fig. 4.1: Pre-GFC period interconnectedness among the developed, emerging, and frontier economies.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Thus, the *"TO"* (Transmitter) and *"FROM" (*receiver) of the volatility spillover and the above discussion indicated that during Pre-GFC, it also spillover created among the selected countries through several reasons in which different countries acted as transmitters with varying behaviours due to investors sentiments, the behaviour of the markets and economic blocs. Mohit et al. (2019) indicated that Croatian and Romanian markets were the only ones to show statistically significant signs of contagion in the European area, which suggests these countries were the primary receivers of the spillover.

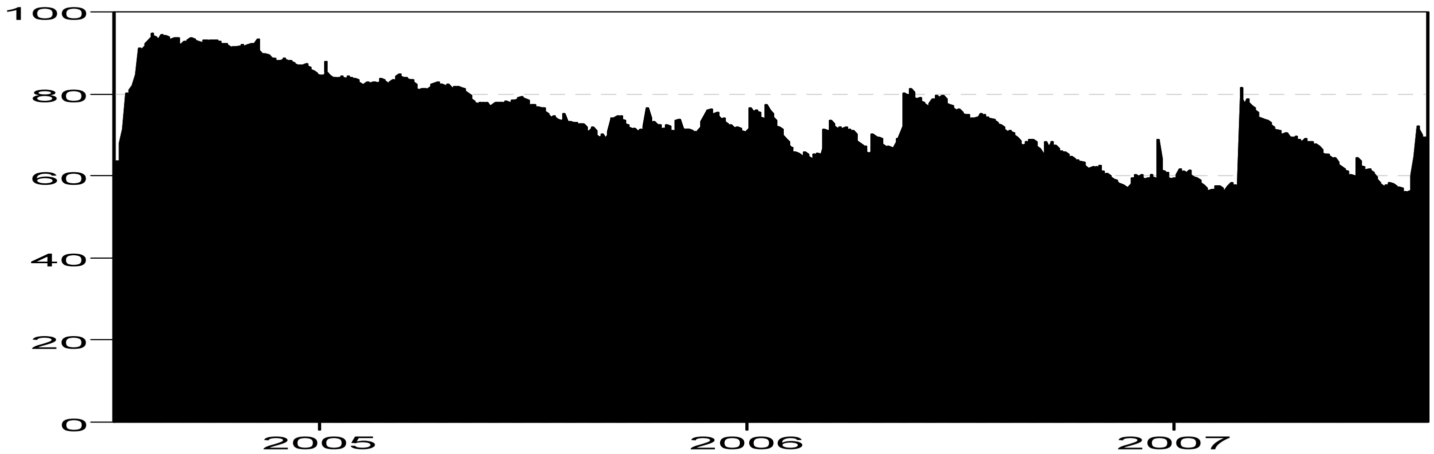
Table 4.1.0: Results of Volatility spillover during the Pre-GFC period.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**23.8**	2.4	2.3	2.6	7.1	5.4	6.3	1.8	2.1	2.2	2.3	3.0	1.7	1.5	2.0	6.4	2.4	1.3	6.2	2.0	1.7	1.2	1.5	1.4	1.7	2.0	1.6	1.3	1.0	1.8	76.2
JN	3.3	**20.3**	3.8	2.3	3.5	4.3	5.9	2.7	1.7	3.3	3.3	4.6	3.1	2.1	3.3	5.6	2.0	1.5	5.0	2.6	2.2	1.8	1.3	1.2	1.2	1.5	1.0	2.0	1.1	2.6	79.7
AA	4.5	4.4	**17.6**	2.9	6.9	3.8	5.3	1.8	1.7	4.5	2.1	3.3	1.9	2.5	4.5	6.8	1.9	2.3	4.6	2.9	1.4	1.2	1.1	1.4	1.5	2.2	1.3	1.0	1.0	1.7	82.4
HG	5.5	3.7	3.9	**19.1**	5.0	2.4	4.2	2.0	2.6	4.6	2.3	4.4	2.2	2.0	2.6	5.2	2.5	3.0	3.6	3.4	1.2	1.2	2.3	1.5	1.6	1.5	1.9	1.2	1.3	2.4	80.9
CAA	5.7	3.3	3.3	2.6	**22.2**	3.2	4.4	1.7	1.9	2.8	2.9	3.9	2.3	2.0	3.9	7.8	2.3	1.8	5.7	2.5	1.5	0.9	1.9	1.2	1.3	2.1	1.2	0.9	0.9	2.1	77.8
GY	9.3	3.8	2.4	2.0	4.5	**21.0**	10.2	2.2	1.8	2.6	2.4	3.1	1.9	1.9	2.5	4.4	1.9	1.9	4.4	2.2	1.3	1.7	1.1	1.2	1.5	2.5	1.1	1.1	0.9	1.4	79.1
SD	5.4	4.2	2.9	2.2	3.7	8.8	**21.0**	2.1	2.2	2.5	2.7	3.2	2.4	2.2	2.7	5.1	2.0	1.4	4.4	2.2	1.9	2.2	1.2	1.0	1.4	2.5	1.0	1.7	1.2	2.4	79.0
SN	6.3	3.6	3.0	2.3	5.1	10.5	9.2	**12.9**	1.8	2.7	2.1	2.9	1.7	1.7	2.3	3.9	3.1	1.9	5.2	2.5	1.2	1.6	1.8	1.9	1.4	2.5	1.2	1.1	1.4	1.6	87.1
RUS	2.5	3.7	2.1	2.4	2.5	3.3	4.6	2.4	**25.8**	2.3	2.8	2.7	2.3	2.0	3.1	5.1	2.1	3.6	2.8	1.9	2.2	1.7	2.3	1.9	1.6	2.8	1.7	2.0	1.8	2.3	74.2
SA	2.9	4.2	4.1	4.5	4.0	3.7	4.9	1.7	1.9	**19.8**	4.0	3.8	2.2	2.2	3.1	5.0	1.9	3.6	4.1	4.0	1.6	1.2	1.3	1.4	1.2	1.8	1.3	1.3	1.2	2.0	80.2
CA	2.5	3.6	2.4	1.8	3.8	2.0	3.0	2.0	2.4	2.5	**24.7**	3.9	3.3	2.0	2.6	5.3	2.1	2.8	3.5	2.9	3.0	2.1	1.8	2.5	1.7	2.3	1.6	1.8	1.5	2.5	75.3
IA	3.5	4.2	2.4	2.5	4.2	2.7	5.2	2.3	1.7	2.4	3.8	**23.4**	2.4	1.8	2.5	5.4	1.6	1.7	4.6	2.6	3.7	1.9	2.5	1.0	1.2	2.7	1.3	1.4	1.1	2.3	76.6
SAA	2.3	4.0	2.6	2.0	3.3	2.3	3.8	2.9	1.4	2.2	3.6	2.7	**29.1**	1.6	1.8	3.9	1.8	2.2	3.6	2.4	2.1	3.9	1.4	1.6	1.3	2.7	1.6	3.2	1.3	1.8	70.9
SK	3.6	4.1	2.9	3.9	3.9	4.3	3.6	1.7	3.8	3.1	3.2	3.5	1.6	**21.3**	3.6	3.1	2.4	3.5	3.5	2.5	2.0	1.7	1.6	1.4	1.7	1.6	1.1	1.6	2.6	1.6	78.7
SA	4.2	2.7	2.5	2.6	5.5	3.5	5.4	1.9	3.2	2.9	3.1	3.2	1.9	2.2	**20.8**	6.2	2.3	1.9	4.5	1.9	3.0	1.2	1.7	2.2	1.5	1.9	1.2	1.7	1.2	2.0	79.2
BL	5.3	3.4	2.3	1.9	4.6	3.3	5.2	1.4	2.7	2.3	3.5	3.3	2.6	2.1	3.6	**21.7**	1.5	2.2	6.3	2.5	1.4	2.7	1.5	1.7	2.2	1.9	1.1	2.0	1.4	2.5	78.3
TD	3.0	2.5	2.2	3.1	3.7	2.2	2.7	2.8	2.1	3.0	2.7	3.5	2.1	1.8	1.9	3.0	**29.3**	3.5	3.4	3.7	1.3	2.2	2.1	1.5	1.7	2.0	1.4	1.2	2.3	2.2	70.8
IA	2.0	3.0	3.1	3.6	2.8	2.9	2.0	1.9	3.2	4.5	2.6	4.0	2.0	2.5	2.8	3.5	2.4	**27.0**	1.9	3.5	1.5	1.8	2.6	1.8	2.0	1.7	2.3	1.1	2.0	1.9	73.1
MO	6.7	4.3	2.0	2.4	5.6	3.3	4.4	2.1	2.1	2.3	2.8	3.9	2.0	1.4	2.5	8.1	2.5	1.9	**22.5**	2.0	1.7	2.1	1.4	1.2	1.3	1.5	1.4	1.2	1.3	2.4	77.5
MA	2.4	3.5	2.9	2.8	3.0	2.9	4.7	2.0	2.3	4.2	4.0	4.0	1.9	2.5	2.1	3.2	2.4	2.8	2.7	**26.4**	1.7	1.3	2.4	1.3	1.6	3.3	1.3	1.2	1.6	1.9	73.6
VN	2.1	2.6	2.2	1.8	2.7	3.0	4.0	2.2	1.6	1.7	3.4	1.8	3.2	1.9	2.5	2.5	1.5	2.1	3.0	2.3	**36.5**	2.1	1.0	2.1	1.6	2.0	1.3	2.2	1.5	1.7	63.5
KA	2.0	2.7	2.3	1.6	2.3	3.1	3.1	2.4	1.7	2.0	2.6	2.6	1.9	2.2	2.1	2.7	2.8	1.9	3.5	1.9	2.0	**35.5**	1.4	1.7	1.7	2.4	1.8	1.8	2.3	2.4	64.5
RA	4.1	1.8	1.4	2.3	3.5	2.2	2.6	2.3	2.6	1.8	3.0	2.6	3.1	2.6	2.3	3.0	2.1	1.9	3.4	3.0	2.2	2.0	**31.2**	1.7	2.1	2.0	2.1	1.2	1.8	2.2	68.8
KN	2.4	2.1	2.8	1.7	3.5	1.7	1.9	1.7	2.0	2.0	1.7	1.7	2.2	2.1	1.7	3.6	1.9	2.2	2.7	1.8	1.8	1.7	2.5	**38.2**	2.2	2.4	2.3	2.1	1.5	1.9	61.8

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
BA	2.3	2.1	2.1	1.9	2.2	2.3	2.4	1.6	2.1	1.9	2.7	2.3	2.0	2.8	1.8	2.1	1.9	1.7	2.2	2.7	1.8	2.6	2.9	2.0	**36.8**	1.9	3.2	1.6	2.2	2.1	63.2
NA	2.3	3.1	2.0	1.8	2.7	2.4	3.2	3.3	2.1	1.6	2.0	2.6	3.1	1.8	1.3	2.3	2.4	1.4	2.8	2.5	2.9	2.4	2.2	2.3	1.4	**36.1**	2.0	1.2	1.4	1.7	63.9
CA	2.4	2.1	1.8	3.0	2.5	2.3	2.5	2.4	2.0	2.6	2.2	2.7	3.4	2.3	2.0	2.3	3.0	2.2	2.7	3.0	2.3	2.1	2.8	1.8	2.7	2.5	**29.0**	1.7	1.9	4.0	71.1
JON	2.0	3.1	2.2	2.2	2.4	2.1	2.5	1.6	1.9	2.5	2.7	2.6	2.8	2.5	2.3	4.5	1.9	2.0	2.3	2.1	1.9	2.1	2.0	2.7	2.0	2.0	1.8	**32.5**	2.0	2.9	67.5
MO	1.4	2.5	1.8	2.0	2.1	1.4	2.0	2.1	2.8	2.5	1.8	2.0	1.3	2.0	2.7	2.5	2.8	1.7	3.0	2.8	1.4	2.1	3.2	2.5	2.0	2.6	1.9	1.9	**37.3**	2.1	62.7
BH	2.3	4.3	2.2	2.0	2.4	1.7	2.8	2.1	1.7	3.1	2.9	3.3	6.3	2.1	2.9	3.2	2.0	2.2	3.1	1.8	2.2	2.3	2.6	2.6	1.8	1.5	1.7	2.0	1.9	**27.2**	72.9
TO	104.2	95.0	74.0	70.6	108.8	97.1	121.7	61.1	62.9	78.8	80.9	91.0	70.5	60.0	75.1	125.6	63.2	63.9	108.7	73.8	55.9	54.9	55.4	49.4	47.8	62.3	45.4	45.7	44.8	62.3	2210.3
Inc.Own	127.9	115.3	91.6	89.7	130.9	118.0	142.7	74.0	88.7	98.6	105.6	114.4	99.6	81.3	95.9	147.3	92.5	90.9	131.2	100.2	92.4	90.4	86.6	87.6	84.6	98.4	74.3	78.2	82.0	89.5	
NET	27.9	15.3	-8.4	-10.3	30.9	18.0	42.7	-26.0	-11.3	-1.4	5.6	14.4	-0.4	-18.7	-4.2	47.3	-7.5	-9.1	31.2	0.2	-7.6	-9.6	-13.4	-12.4	-15.4	-1.6	-25.7	-21.8	-18.0	-10.6	**73.7**

Note: US stands for United States of America, JN – Japan, AA- Australia, HG-Hong-Kong, CAA-Canada, GY-Germany, SD-Switzerland, SN-Spain, RUS-Russia, SA- Singapore, CA-China, IA-India, SAA- Saudi Arabia, SK-South Korea, SA-South Africa, BL-Brazil, TD-Thailand, IA-Indonesia, MO- Mexico, MA-Malaysia, VN-Vietnam, KA-Kenya, RA-Romania, KN-Kazakhastan, BA-Bulgaria, NA-Nigeria, CA-Croatia, JON-Jordon, Morocco- MO, Bahrain- BH (In the above Table from left to right).

Total Volatility spillover during the Pre-GFC crisis period.



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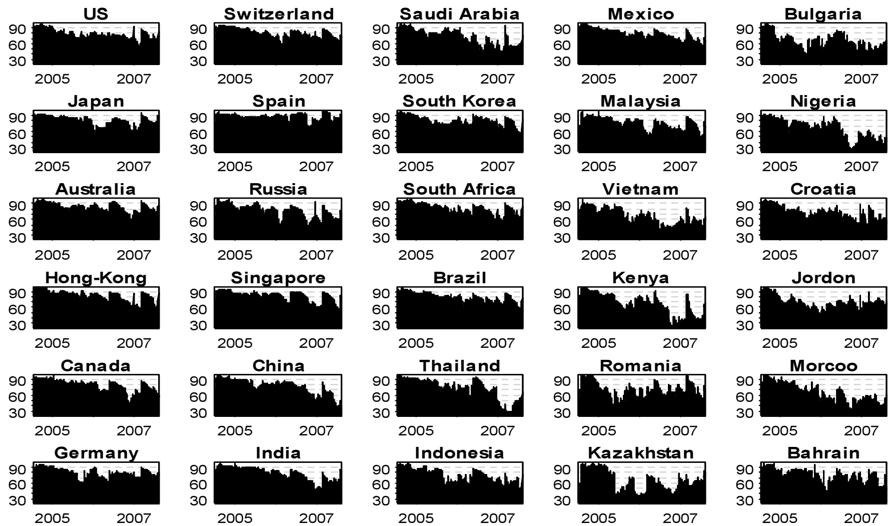

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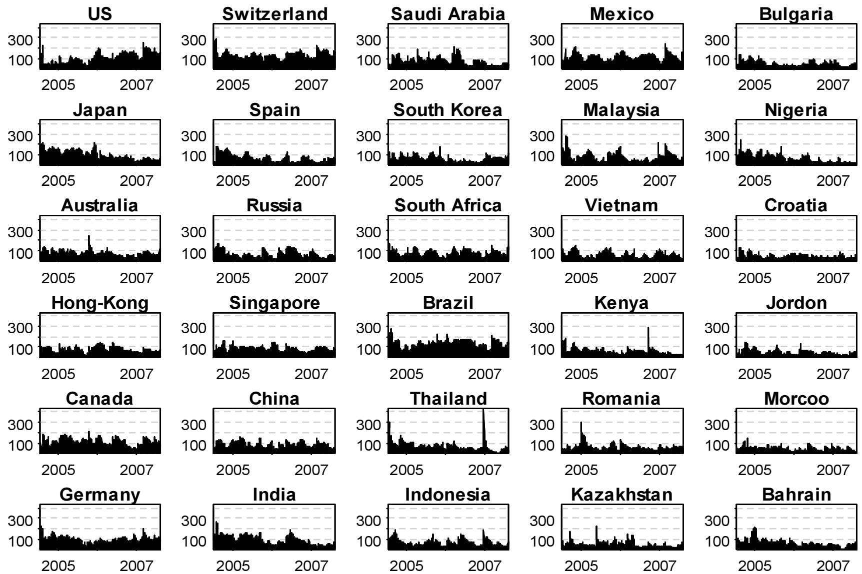


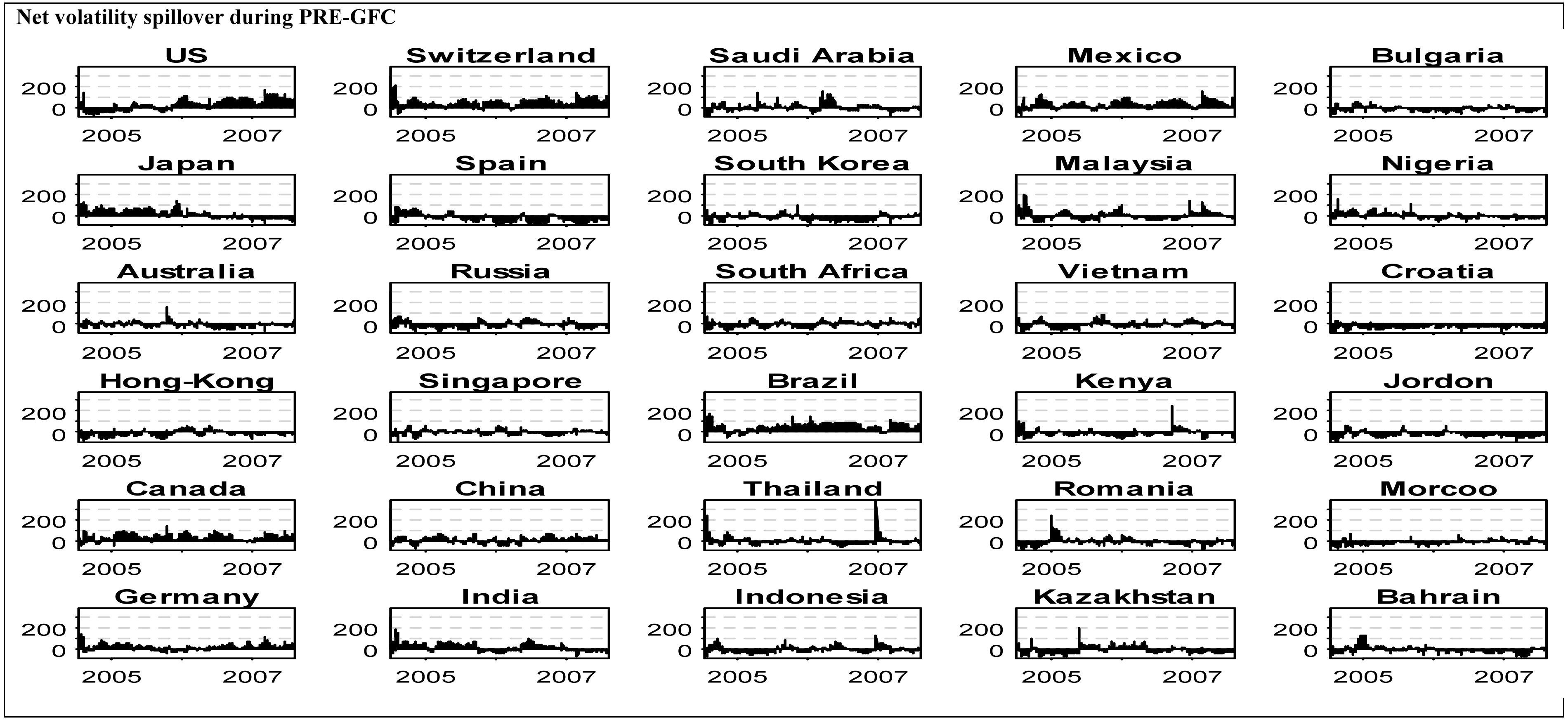


Fig. 4.2: Volatility spillover among developed, emerging, and frontier countries during the pre-GFC period (Source: Author using R software).

➢ **PRE-GFC Robustness**

Pre-GFC (Panel - 1) robustness of the model test on the different window sizes, i.e., 150, 200, 250 among emerging, frontier, and developed. As preliminary results from previous analysis, via a rolling width of 200, a prediction10 days horizon, and a lag duration of 1 day (Fig. 4.3). Again, the robustness findings for the dynamic spillovers index for various rolling window and forecast horizon values for selected countries indicated that once the rolling window is enlarged from 150 to 250 days, the spillover plot for overall selected nations becomes smoother. However, the pattern stays consistent, implying that our preliminary results resist the alternative rolling window option.

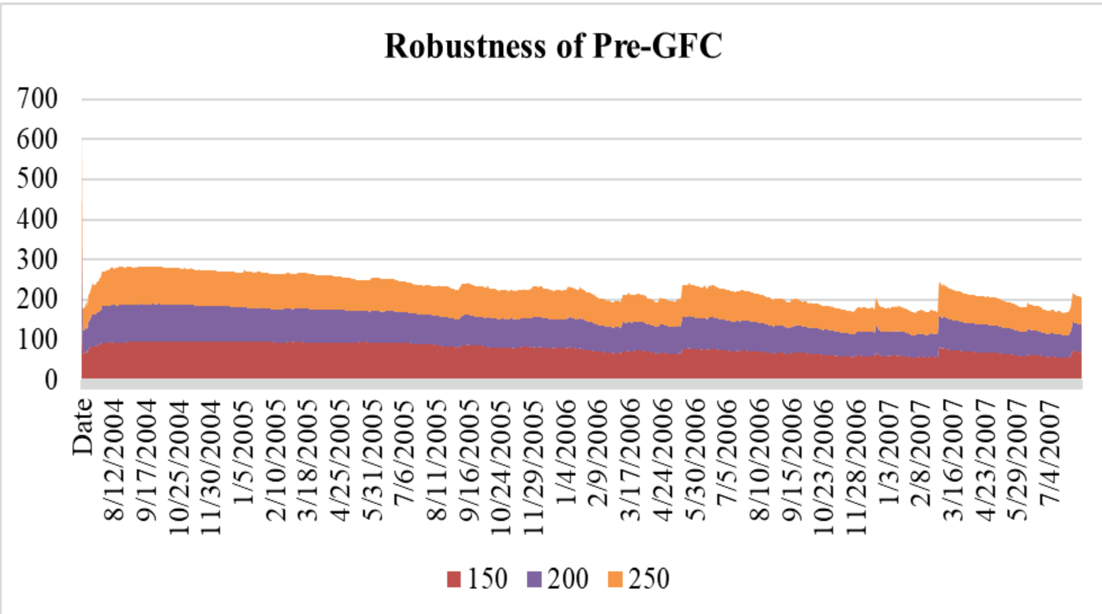


Fig. 4.3: Panel- 1 Pre-GFC robustness on different window sizes among the developed, emerging, and frontier economies (Source: Author using R software).

Note: In the above figure theRed colour shows 150 window size, purple shows 200 window size, and orange shows 250 window size.

4.2.2 Results of Panel 2 - Global Financial Crises (GFC) (2007 to 2009).

Among developed countries, the US (76.34 %), Canada (44.48%), and Mexico (50.03 %) were identified as the significant net volatility transmitters among the developed countries during the GFC crises. This indicates that these three countries highly influenced the other countries. However, the US experienced significant economic repercussions during the GFC because of its heavy dependence on oil exports and international investment (Fig. 4.4). The sharp decline in oil prices resulted in a significant decrease in government income and was detrimental to energy corporations. The crisis was worsened by capital flight, which refers to the withdrawal of funds by investors, which resulted in an economic crisis (2009), with a significant 8% shrinking in its GDP (also resulting in a steep depreciation of the ruble with a substantial increase in unemployment). To intervene, the Russian government implemented fiscal and monetary stimulus measures, such as bank bailouts and infrastructure expenditures.

Nevertheless, apprehensions over corruption and inadequate enforcement of legal principles constrained the efficacy of these actions. Russia saw a relatively swift recovery, driven mainly by the increase in oil prices during the early 2010s. However, its long-term economic expansion continued to be slow. The US, Canada, Japan, and Australia have the GDP response to same-size shocks during turmoil (Park, 2019). The above results are aligned with Park (2019) and Kakran (2024), as the US was the primary transmitter.

Australia (- 29.35%), Spain (- 27.98%), and Nigeria (- 29.55%) were identified as the significant net receptor of the volatility spillover among the selected countries in the GFC countries. Due to vulnerabilities in Spain's banking system and housing market revealed by the GFC, there was a severe recession and a national debt crisis.

Among the emerging countries, Mexico (50.03%), Brazil (30.41 %), and India (21.79%) were identified as the significant net transmitters. On the other hand, this study identified China (-22.51%), Malaysia (-17.97%), and Thailand (-9.98 %) as the primary receptor of the volatility spillover. Due to several reasons, primarily due to non-tariff barriers, it indicates thorough coverage for trade in goods; streamlined and consolidated rights and obligations; complete tariff reduction schedules; streamlined clauses about trade remedies and concession modifications; non-tariff measures; trade repository; trade facilitation and associated chapters.

Among the frontier economies, this study identified Jordon (7.84%) and Kazakhstan (7.8%) as primary net transmitters of the volatility spillover among the selected frontier countries.

Nigeria (-29.55%), Vietnam (-25.39%), and Croatia (-24.96%) are the significant net receptors of the volatility spillover among the selected frontier countries.

But with the government's fast stimulus package and emphasis on diversification, the economy soon recovered and became stronger. On analyzing "*To Other*" among developed countries US (160.39%), Canada (129.48%), and Russia (107.89%) were identified as significant transmitters; among the emerging countries, Mexico (132.90%), Brazil (116.55%), India (105.49), and among frontier countries Kazakhstan (92.27%), Jordon (88.88%), Morocco (64.85%) (Fig. 4.5). Among developed countries *("From Other")* Spain (91.94%), Hong-Kong (91.47%), Japan (90.87), among emerging countries Thailand (90.2%), South Korea (89.69%), Indonesia (87.49%), and among frontier countries Kazakhstan (84.46%), Morocco (84.8%), Bahrain (81.69%) (Fig. 4.5).

In analyzing "From Other," Spain (91.94%), Hong Kong (91.47%), and Japan (90.87%) were identified as significant transmitters among the developed countries. Among emerging countries, Thailand (90.20%), South Korea (89.69%), Indonesia (87.49%), and among frontier countries, Kazakhstan (86.69%), Morocco (81.80%), Bahrain (81.69%) were identified as the primary transmitter.Due to geopolitical concerns, literature also revealed high return spillover during the GFC. Irshad et al. (2021) also found correlations that show a significant association between the US stock market and the stock exchanges in Brazil, Mexico, and Russia. According to Ozdemir (2020), there were bidirectional volatility spillovers between trading volume and stock price before and after the crisis, and there was a unidirectional volatility spillover from stock prices to trading volume during a crisis.

Thus, the inferencefrom studying this panel revealedthat the US, Canada, and Mexico stock markets dominated during the GFC period, which showed high connectedness with other countries.

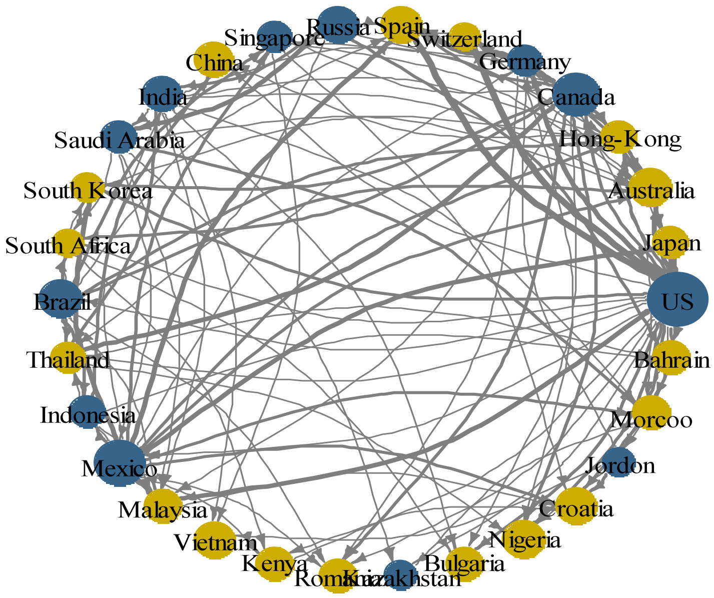


Fig. 4.4: During GFCPlot network among developed, emerging, and frontier economies.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

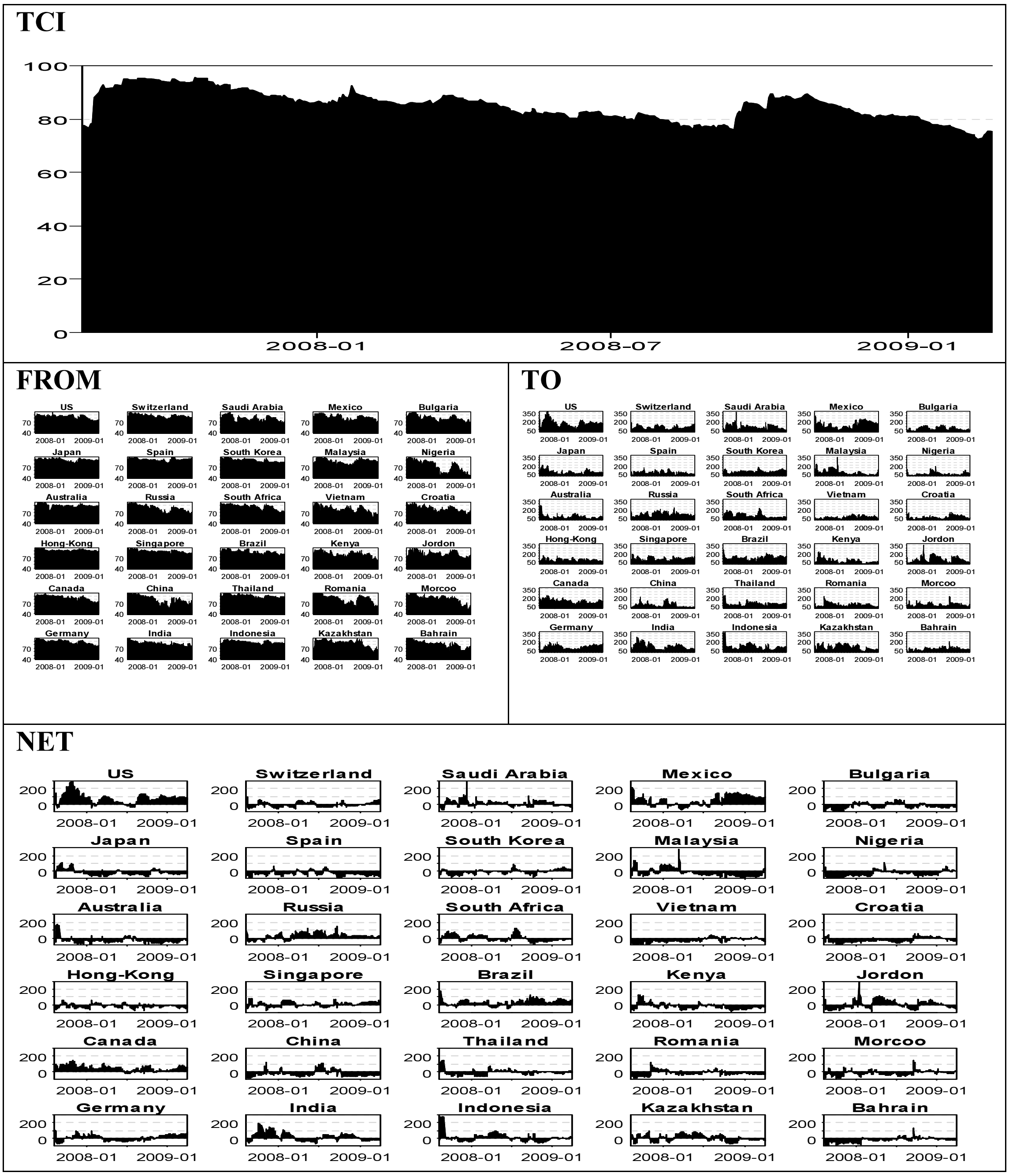


Fig. 4.5: During GFC "To", "From", and "NET" Volatility spillover of the developed, emerging, and frontier countries. (Source: Author using R software).

Table 4.2.0: During GFC volatility spillover (using the TVP VAR) among the developed, emerging, and frontier countries.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**16.0**	2.6	1.5	2.3	6.5	4.3	3.5	1.9	3.8	3.1	1.6	3.4	3.6	2.1	3.0	3.2	2.2	3.3	5.1	2.8	1.9	1.9	1.9	3.9	2.4	1.0	2.4	3.8	2.2	3.1	84.1
JN	8.8	**9.1**	2.5	2.9	5.1	4.6	3.7	2.1	2.7	3.1	2.3	3.4	3.9	3.2	2.8	2.6	3.1	3.3	6.6	3.0	1.9	1.6	2.3	3.6	2.1	1.1	1.8	2.8	2.1	2.0	90.9
AA	5.6	2.9	**10.5**	3.2	5.1	5.1	3.6	2.1	3.7	5.2	1.7	4.8	4.0	3.3	3.4	5.4	2.5	4.1	5.0	1.8	1.2	1.7	1.6	3.3	2.0	1.2	1.2	1.8	1.4	1.6	89.5
HG	4.9	2.7	2.9	**8.5**	4.3	2.8	2.8	2.6	3.8	6.1	2.1	4.7	3.0	5.4	2.7	6.0	3.2	4.3	5.3	1.7	1.6	1.9	2.0	3.9	1.9	1.2	1.5	2.3	2.2	1.7	91.5
CAA	9.5	2.5	1.5	1.9	**15.0**	3.4	2.9	1.7	5.2	2.1	2.1	3.6	3.9	2.1	2.5	5.9	1.5	2.4	5.3	2.5	2.1	2.1	1.9	3.0	2.4	1.1	1.8	3.8	2.1	2.3	85.0
GY	9.2	2.8	1.8	1.9	5.9	**12.0**	6.0	2.3	4.6	2.3	2.1	4.0	3.1	2.1	2.6	4.1	2.0	2.2	5.7	2.6	1.4	1.6	1.8	2.7	2.2	1.1	2.8	3.5	2.2	1.7	88.0
SD	9.2	3.6	2.1	2.3	4.7	8.8	**12.7**	2.4	2.6	3.3	1.4	3.0	2.5	2.8	2.2	3.3	3.3	2.9	4.4	2.2	1.8	1.3	1.8	2.7	2.2	1.2	2.6	2.8	2.2	1.6	87.3
SN	7.4	2.6	2.0	2.2	4.7	7.4	4.9	**8.1**	4.0	3.2	1.9	3.4	2.4	2.9	3.1	4.4	1.9	2.9	6.2	2.4	1.7	1.9	1.5	2.6	2.3	1.2	2.4	3.6	3.0	2.0	91.9
RUS	4.4	2.7	1.8	2.9	3.9	3.2	3.2	1.9	**18.2**	2.7	2.7	2.7	2.7	2.7	2.9	4.4	2.0	2.9	5.6	2.8	2.0	1.8	2.0	2.8	2.2	1.3	2.8	5.4	2.2	1.5	81.8
SA	4.6	2.3	3.0	4.2	4.1	2.7	2.8	2.1	2.2	**11.8**	1.4	4.2	1.9	4.8	3.6	6.2	3.3	5.7	5.2	1.6	1.6	2.1	2.5	4.4	2.0	1.3	1.6	2.6	2.4	1.9	88.3
CA	3.8	2.5	2.6	3.8	3.4	2.3	2.0	1.8	3.4	2.8	**20.4**	3.3	3.4	2.4	2.3	3.5	2.4	4.1	2.4	3.5	1.8	2.9	3.1	2.9	1.9	2.8	1.6	2.4	1.8	2.7	79.6
IA	4.3	2.4	2.9	2.9	4.8	2.5	2.3	3.1	5.8	4.1	1.9	**16.3**	3.7	4.6	2.9	5.0	1.7	2.6	5.1	1.8	1.8	2.6	2.5	2.7	2.0	1.4	1.3	2.6	0.9	1.4	83.7
SAA	3.8	2.6	2.2	2.3	3.6	3.0	3.1	2.3	6.4	1.8	2.6	5.3	**20.6**	1.8	1.9	2.7	3.5	2.5	2.2	2.0	1.8	1.9	2.6	3.4	2.4	1.4	1.6	3.7	2.0	3.3	79.4
SK	5.0	2.8	2.7	3.2	4.8	3.1	2.9	2.9	4.2	4.6	1.7	4.2	1.9	**10.3**	3.5	6.1	2.9	4.2	6.4	2.2	1.7	2.0	2.1	3.5	1.6	1.4	1.8	2.6	2.1	1.8	89.7
SA	5.0	2.7	2.1	2.2	5.2	3.2	2.4	2.5	4.3	3.5	1.4	3.3	3.5	2.7	**14.3**	5.8	3.3	4.2	3.5	1.7	1.4	2.0	2.2	4.6	2.2	1.1	2.3	2.8	2.2	2.4	85.7
BL	5.3	2.0	2.3	3.2	6.4	3.0	3.1	2.3	5.6	3.0	2.3	4.1	3.1	3.7	2.8	**13.9**	2.2	3.0	6.8	1.8	1.9	1.8	1.8	2.3	2.5	1.3	2.0	3.3	2.3	1.4	86.1
TD	4.5	3.3	2.0	3.0	6.3	3.0	3.9	2.5	3.6	4.0	1.3	4.3	3.1	4.4	3.5	5.4	**9.8**	4.5	4.5	2.1	2.1	1.8	2.8	3.7	1.8	1.4	1.6	2.5	1.6	1.9	90.2
IA	4.0	2.8	2.5	3.1	3.8	2.7	2.7	1.9	2.1	6.7	1.0	3.0	2.8	4.0	3.2	6.0	4.4	**12.5**	6.1	2.5	2.4	2.0	2.4	3.0	1.5	2.2	1.6	2.9	2.1	2.1	87.5
MO	7.4	2.3	1.6	2.7	5.8	3.8	3.2	2.2	4.4	2.3	1.8	3.4	3.9	2.6	2.5	5.4	2.4	2.7	**17.1**	2.1	1.8	1.5	2.7	2.8	1.9	1.4	2.0	2.7	2.3	1.4	82.9
MA	6.6	3.3	2.1	2.4	4.3	3.5	2.4	1.3	2.6	3.1	2.8	3.6	3.7	3.0	2.3	4.0	2.7	4.3	7.5	**13.1**	2.8	2.0	2.4	2.5	1.8	1.7	1.3	2.9	2.4	1.7	86.9
VN	3.1	2.9	2.1	2.6	3.1	2.6	3.0	2.5	2.9	3.8	2.8	3.7	2.4	2.9	2.5	2.6	3.3	2.9	2.3	2.2	**21.2**	2.4	2.1	2.5	2.7	2.0	2.2	3.5	2.8	2.7	78.8
KA	3.9	1.9	1.7	2.9	3.6	3.1	1.8	2.2	1.9	3.0	3.5	3.6	3.1	3.0	4.2	2.3	2.7	3.5	3.8	2.6	1.8	**20.8**	2.5	3.2	3.4	2.1	1.1	2.2	2.5	2.1	79.2
RA	3.9	2.5	1.6	2.4	4.5	3.4	2.6	1.5	3.1	3.3	2.0	3.8	3.6	2.5	3.0	3.4	3.9	3.7	5.0	2.5	2.0	1.7	**18.8**	3.5	1.9	1.1	3.0	2.1	2.3	1.7	81.2
KN	5.9	2.6	1.8	2.7	3.7	1.6	2.1	1.9	3.8	3.7	1.8	3.8	5.3	2.2	3.7	2.4	3.0	4.4	2.8	2.4	1.8	4.5	3.1	**15.5**	2.2	1.5	1.0	2.7	2.8	3.4	84.5

BA	5.0	2.9	2.2	2.6	4.3	3.2	3.0	2.2	3.1	3.1	1.7	3.7	3.7	2.4	4.1	3.2	2.9	3.0	2.7	1.7	1.9	2.3	2.0	3.4	**19.0**	1.4	2.2	2.8	2.3	2.3	81.0
NA	4.2	2.6	1.9	2.2	3.8	2.6	2.2	2.0	2.6	2.4	1.9	2.9	2.3	2.6	2.5	2.3	3.1	3.4	2.2	2.7	1.5	2.3	2.1	2.5	1.2	**28.0**	1.8	2.6	2.2	3.5	72.0
CA	5.5	1.7	1.7	1.8	3.0	3.8	3.2	1.7	3.3	3.3	1.8	2.7	2.8	2.1	2.2	3.0	2.4	3.1	4.9	2.9	2.2	2.7	2.8	1.8	2.7	1.8	**19.8**	4.3	3.5	1.3	80.2
JON	5.5	2.0	1.2	2.6	4.7	1.8	1.9	2.5	4.9	2.7	1.5	4.1	3.4	2.2	2.5	2.8	2.0	3.7	2.8	4.2	1.7	3.0	2.1	3.5	1.8	1.7	1.7	**19.0**	2.4	4.4	81.0
MO	5.6	1.9	2.1	3.0	3.8	2.4	2.0	2.8	2.7	2.6	2.0	2.8	4.5	1.6	3.5	3.1	2.2	2.5	4.9	3.1	2.0	2.3	2.4	4.6	2.7	1.4	2.5	2.2	**18.2**	2.5	81.8
BH	4.7	3.2	1.7	2.7	2.6	1.9	2.5	2.9	5.0	3.4	2.1	2.7	4.4	2.4	2.8	2.0	4.1	4.1	2.4	1.7	1.9	1.6	1.9	3.1	2.1	1.9	1.7	5.6	2.6	**18.3**	81.7
TO	160.4	75.3	60.1	77.8	129.5	98.7	85.5	64.0	107.9	98.3	57.1	105.5	95.5	84.3	84.3	116.6	80.2	100.4	132.9	68.9	53.4	61.0	64.7	92.3	62.0	42.5	55.2	88.9	64.9	63.3	2531.2
Inc.Own	176.3	84.4	70.7	86.3	144.5	110.6	98.2	72.0	126.1	110.0	77.5	121.8	116.2	94.6	98.6	130.4	90.0	112.9	150.0	82.0	74.6	81.9	83.5	107.8	81.0	70.5	75.0	107.8	83.1	81.6	
NET	76.3	-15.6	-29.4	-13.7	44.5	10.6	-1.8	-28.0	26.1	10.0	-22.5	21.8	16.2	-5.4	-1.4	30.4	-10.0	12.9	50.0	-18.0	-25.4	-18.1	-16.5	7.8	-19.0	-29.6	-25.0	7.8	-17.0	-18.4	**84.4**

- **Robustness of the GFC**

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Examining the spillover curves illustrated in Fig. 4.6 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

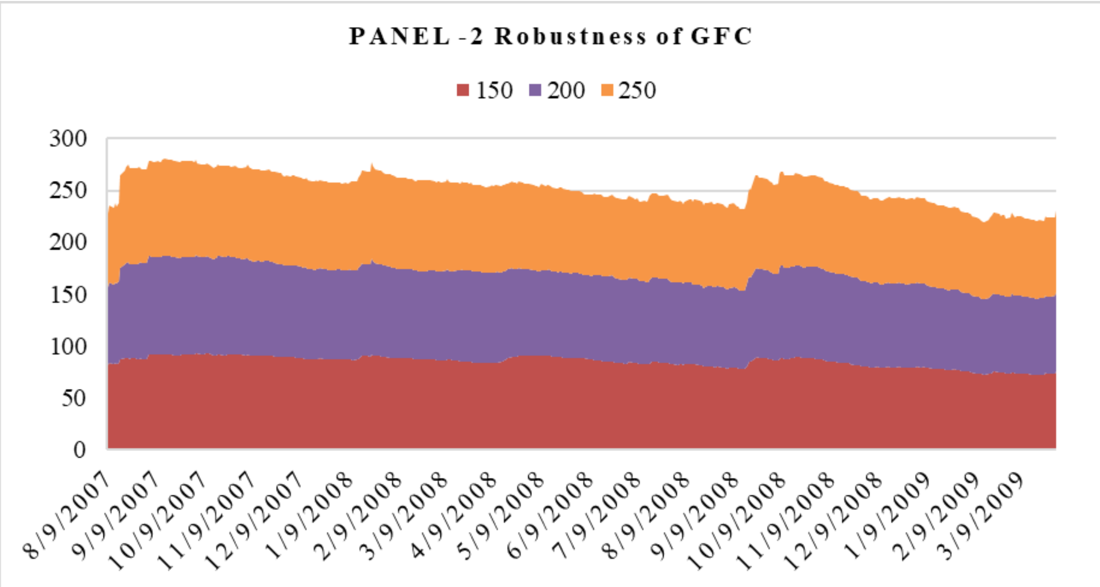


Fig. 4.6: During GFC Volatility spillover among the developed, emerging, and frontier countries on different window sizes: 150, 200, 250.

Note: In the above figure thered colour shows 150 window size, purple shows 200 window size, and orange shows 250 window size. (Source: Author).

4.2.2.1 Results of frequency domain analysis (TVP-VAR-BK Model) during the GFC crises.

Frequency domain analysis (TVP-VAR-BK Model) unveils the high interconnectedness among the stock markets in different periods. In the short period, small interconnected incurred, i.e., 8.13% (Fig. 4.7 and Table 4.3.0), long term is 72.77% (Fig. 4.7 and Table 4.3.1), and the entire period indicates 80.91% (Fig. 4.7 and Table 4.3.2). Thus, it is affirmed that during the GFC, all the developed, emerging, and frontier countries showed high interconnectedness in the long term and transmitted high spillover. Moreover, Fig. 4.8 indicates the frequency spillover based on Baruník - Křehlík (TVP-VAR-BK) during GFC in Short term (1–5), Long term (Above five days), and entire period (total period represented by black, pink colour means 1–4 days, and green colour, above four days) (Panel −1).

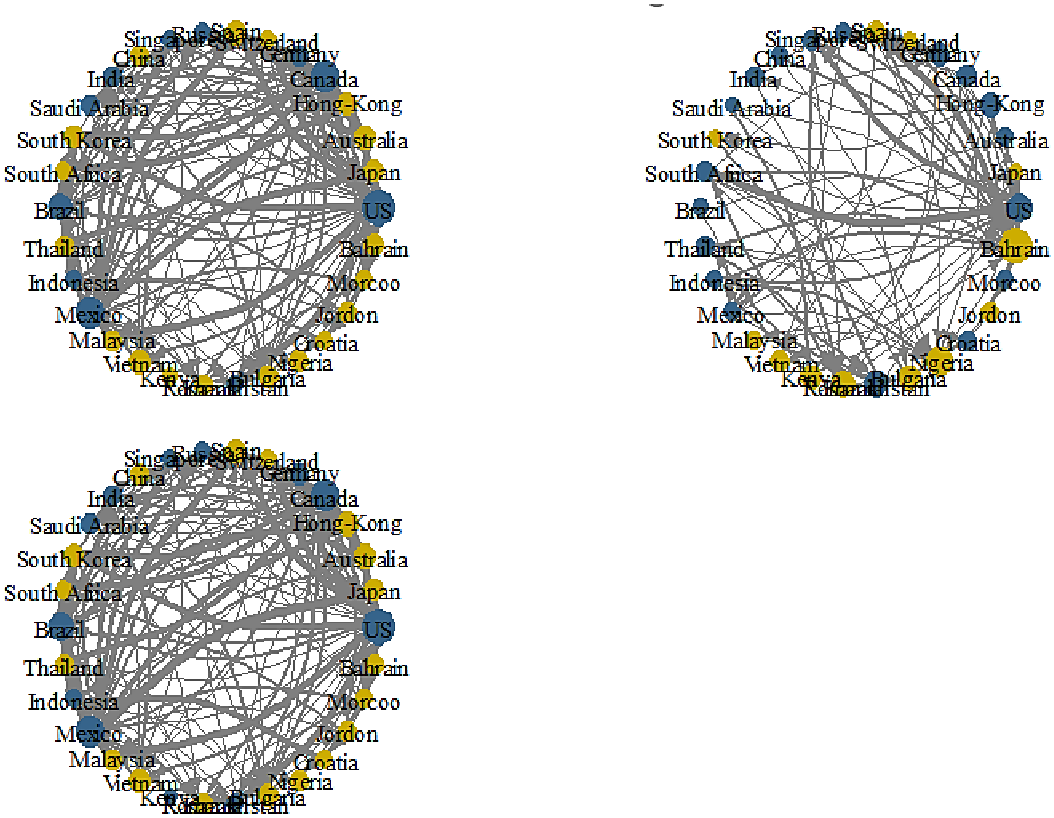


Fig. 4.7: Connectedness during GFC in three different frequencies, i.e., Panel A (0-4 days), Panel B (4 – Inf. days), and Panel C (total days) among developed, emerging, and frontier economies.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Table 4.3.0: Volatility spillover in the short period (Panel A) during GFC among developed, emerging, and frontier economies.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**2.8**	0.1	0.1	0.1	1.0	0.7	0.7	0.2	0.1	0.2	0.2	0.3	0.1	0.1	0.2	0.7	0.1	0.2	0.6	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	0.2	7.1
JN	0.9	**3.1**	0.5	0.6	0.4	0.5	0.4	0.2	0.2	0.5	0.2	0.2	0.1	0.6	0.5	0.2	0.2	0.6	0.7	0.1	0.1	0.1	0.2	0.4	0.1	0.1	0.2	0.1	0.1	0.2	9.0
AA	0.5	0.4	**2.2**	0.7	0.2	0.2	0.1	0.2	0.1	0.5	0.3	0.1	0.2	0.2	0.4	0.2	0.3	0.5	0.4	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.2	6.9
HG	0.5	0.5	0.6	**1.8**	0.1	0.1	0.1	0.1	0.1	0.6	0.5	0.1	0.1	0.3	0.3	0.1	0.3	0.5	0.2	0.0	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.0	0.1	0.2	6.2
CAA	0.7	0.2	0.2	0.2	**2.2**	0.6	0.6	0.1	0.2	0.3	0.2	0.5	0.2	0.2	0.2	0.8	0.1	0.1	0.4	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	7.0
GY	0.4	0.3	0.3	0.4	0.3	**2.7**	1.6	0.2	0.5	0.5	0.1	0.4	0.2	0.2	0.5	0.4	0.3	0.3	0.3	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.3	0.1	0.1	0.2	8.4
SD	0.5	0.5	0.3	0.3	0.5	2.3	**5.4**	0.6	0.6	0.4	0.2	0.4	0.2	0.3	0.3	0.5	0.5	0.3	0.4	0.1	0.1	0.1	0.3	0.3	0.3	0.1	0.3	0.2	0.4	0.3	11.4
SN	0.8	0.3	0.2	0.2	0.5	1.4	1.4	**2.7**	0.4	0.5	0.2	0.4	0.3	0.2	0.6	0.4	0.2	0.4	0.5	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.1	0.1	0.2	10.2
RUS	0.2	0.2	0.2	0.3	0.2	0.4	0.5	0.2	**1.4**	0.3	0.3	0.2	0.1	0.2	0.3	0.2	0.3	0.3	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.1	0.1	0.1	5.9
SA	0.9	0.5	0.6	1.0	0.2	0.2	0.1	0.2	0.2	**3.3**	0.1	0.4	0.2	0.6	1.3	0.1	0.5	1.6	0.2	0.1	0.2	0.1	0.2	0.7	0.1	0.1	0.3	0.1	0.1	0.1	10.9
CA	0.3	0.2	0.4	0.6	0.2	0.3	0.2	0.2	0.2	0.3	**5.1**	0.2	0.7	0.1	0.2	0.1	0.3	0.4	0.4	0.3	0.2	0.3	0.3	0.2	0.3	0.4	0.3	0.2	0.2	0.8	8.6
IA	0.2	0.1	0.2	0.5	0.3	0.4	0.2	0.1	0.2	0.4	0.3	**2.1**	0.3	0.2	0.2	0.2	0.1	0.3	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.2	5.5
SAA	0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.8	0.3	**3.0**	0.1	0.3	0.1	0.4	0.4	0.2	0.1	0.2	0.2	0.2	0.1	0.3	0.2	0.1	0.3	0.2	0.5	7.4
SK	0.5	0.7	0.4	0.7	0.2	0.1	0.1	0.1	0.2	0.7	0.3	0.2	0.2	**2.0**	0.5	0.1	0.3	0.6	0.2	0.1	0.1	0.1	0.2	0.3	0.1	0.1	0.2	0.1	0.1	0.1	7.6
SA	1.3	0.5	0.2	0.4	0.5	0.2	0.1	0.3	0.2	1.3	0.2	0.2	0.3	0.4	**4.4**	0.2	0.5	1.2	0.3	0.1	0.1	0.1	0.2	0.7	0.1	0.2	0.5	0.1	0.1	0.2	10.7
BL	0.3	0.2	0.2	0.3	0.6	0.6	0.4	0.2	0.3	0.2	0.2	0.4	0.1	0.3	0.3	**1.5**	0.1	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.1	6.4
TD	0.6	0.5	0.2	0.4	0.4	0.3	0.3	0.1	0.2	0.5	0.2	0.3	0.2	0.3	0.4	0.2	**2.8**	0.9	0.2	0.3	0.1	0.1	0.3	0.7	0.1	0.1	0.2	0.1	0.1	0.3	8.7
IA	0.8	0.4	0.5	0.7	0.4	0.2	0.2	0.3	0.2	1.7	0.3	0.3	0.2	0.6	1.4	0.2	1.0	**3.6**	0.2	0.3	0.1	0.1	0.3	0.7	0.1	0.2	0.5	0.2	0.1	0.3	12.1
MO	0.7	0.2	0.1	0.2	0.5	0.8	0.6	0.2	0.5	0.2	0.2	0.3	0.2	0.3	0.4	0.7	0.4	0.4	**3.2**	0.1	0.1	0.2	0.3	0.2	0.1	0.2	0.3	0.1	0.1	0.2	8.3
MA	0.4	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.4	0.2	0.2	0.4	0.2	**1.6**	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	4.2
VN	0.5	0.2	0.2	0.2	0.2	0.3	0.3	0.5	0.2	0.5	0.3	0.3	0.2	0.1	0.4	0.2	0.4	0.3	0.2	0.1	**5.0**	0.2	0.2	0.1	0.1	0.1	0.3	0.2	0.1	0.3	6.9
KA	0.5	0.2	0.2	0.1	0.4	0.3	0.3	0.1	0.3	0.2	0.5	0.2	0.7	0.2	0.4	0.4	0.2	0.3	0.5	0.2	0.3	**9.2**	0.1	0.5	0.4	0.2	0.3	0.1	0.3	0.2	8.5
RA	0.3	0.6	0.3	0.6	0.4	0.5	0.4	0.1	0.3	0.5	0.4	0.7	0.2	0.7	0.6	0.2	0.8	0.4	0.5	0.1	0.2	0.2	**6.4**	0.4	0.1	0.3	0.4	0.1	0.2	0.3	10.9
KN	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.1	**1.3**	0.1	0.1	0.1	0.0	0.1	0.1	3.0
BA	0.3	0.2	0.3	0.2	0.2	0.2	0.4	0.2	0.2	0.3	0.6	0.2	0.3	0.2	0.5	0.1	0.3	0.4	0.3	0.1	0.1	0.4	0.3	0.4	**4.7**	0.2	0.3	0.1	0.4	0.4	8.1
NA	0.4	0.5	0.2	0.4	0.4	0.3	0.3	0.4	0.3	0.2	0.7	0.3	0.5	0.4	0.6	0.3	0.6	0.7	0.6	0.4	0.1	0.5	0.4	0.3	0.2	**8.9**	0.2	0.2	0.5	1.0	11.7
CA	0.3	0.1	0.1	0.1	0.2	0.3	0.2	0.0	0.3	0.3	0.1	0.1	0.2	0.1	0.4	0.1	0.2	0.3	0.1	0.0	0.1	0.2	0.1	0.2	0.0	0.0	**1.4**	0.1	0.1	0.1	4.5
JON	0.4	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.2	0.3	0.1	0.3	0.1	0.3	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.2	0.2	**1.4**	0.2	0.2	5.6
MO	0.2	0.1	0.1	0.1	0.3	0.2	0.2	0.3	0.1	0.2	0.1	0.1	0.2	0.1	0.3	0.1	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.1	**2.7**	0.4	4.5
BH	0.5	0.6	0.3	0.6	0.4	0.5	0.9	1.2	0.7	0.7	1.3	0.4	0.8	0.3	0.8	0.3	1.0	0.8	0.7	0.4	0.4	0.3	0.5	0.5	0.4	0.9	0.3	0.4	1.3	**6.6**	18.1
TO	14.1	8.8	7.3	10.3	9.7	12.1	11.2	7.0	6.8	12.9	9.6	7.7	7.5	7.4	13.0	7.2	10.2	13.2	9.5	3.7	3.5	4.5	5.9	8.9	4.2	4.5	7.0	3.3	5.7	7.4	243.9
Inc.Own	16.9	11.8	9.5	12.1	11.9	14.8	16.6	9.7	8.1	16.1	14.6	9.8	10.6	9.4	17.4	8.7	12.9	16.8	12.6	5.3	8.5	13.7	12.3	10.2	8.9	13.4	8.5	4.8	8.4	14.0	
NET	7.0	-0.2	0.4	4.1	2.7	3.7	-0.2	-3.1	0.9	2.0	1.0	2.2	0.1	-0.1	2.3	0.8	1.5	1.1	1.2	-0.5	-3.4	-3.9	-5.0	5.9	-3.8	-7.2	2.5	-2.2	1.2	-10.6	**8.1**

Table 4.3.1: Volatility spillover in the medium period (Panel B) during GFC among developed, emerging, and frontier economies.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**19.3**	2.4	0.8	1.2	9.8	2.9	3.1	0.5	2.7	2.8	1.0	2.8	3.2	0.6	2.8	5.2	2.2	2.2	7.0	1.4	0.7	2.0	0.9	4.1	1.8	0.5	1.9	1.8	1.5	1.3	70.8
JN	10.7	**6.5**	1.0	1.6	7.7	4.3	2.2	0.6	2.2	1.9	1.1	2.8	4.1	1.5	2.3	4.7	2.4	2.1	10.1	2.1	0.6	1.7	1.7	2.9	0.9	0.8	2.4	1.5	2.7	0.9	81.5
AA	7.4	1.7	**7.6**	2.4	8.7	6.7	4.1	0.7	2.8	3.5	0.9	5.8	5.7	1.2	1.8	6.0	1.4	2.5	5.8	2.5	0.4	1.5	1.0	2.4	1.0	0.5	1.7	1.9	1.0	0.6	83.4
HG	6.2	1.7	1.5	**6.5**	7.0	4.7	2.6	1.4	2.7	5.3	1.0	6.0	3.8	4.1	1.8	6.9	1.9	3.6	7.5	1.8	0.6	1.4	1.6	3.3	0.7	0.6	2.4	1.0	2.0	0.5	85.6
CAA	11.1	1.9	0.9	0.9	**16.5**	3.3	2.5	0.6	3.7	1.6	1.3	2.7	2.8	1.0	2.0	8.6	1.2	1.3	7.2	2.2	1.0	2.0	1.3	3.7	1.9	0.6	1.7	2.5	2.1	1.0	74.4
GY	9.7	1.8	0.6	0.9	8.4	**9.8**	3.7	0.6	3.6	1.4	1.3	5.1	4.4	1.0	1.5	5.3	2.0	1.4	7.8	2.1	0.4	1.2	2.0	2.7	1.0	0.7	2.8	2.2	2.6	1.1	79.0
SD	10.1	2.1	0.7	0.8	6.7	7.5	**10.6**	0.6	2.2	1.8	1.0	3.1	2.9	1.3	1.3	3.9	2.6	1.7	5.8	1.5	0.5	1.5	1.2	1.7	1.1	0.7	3.4	2.1	2.2	0.6	72.6
SN	7.7	1.4	0.9	1.2	6.6	7.2	2.8	**4.5**	2.8	2.7	1.3	4.0	2.5	1.7	1.9	5.5	1.9	2.4	8.9	2.2	0.4	1.8	1.7	2.9	0.6	0.7	2.2	2.4	3.3	1.4	82.6
RUS	5.3	1.6	0.7	1.6	6.2	2.6	1.4	1.1	**17.6**	2.6	1.8	2.6	2.3	1.4	2.5	8.1	1.2	2.1	9.0	2.6	1.1	1.5	1.4	3.3	1.1	0.6	2.3	3.2	2.5	1.6	75.2
SA	5.8	1.1	1.6	2.1	6.2	4.6	2.2	1.3	1.7	**10.3**	1.6	3.8	2.5	2.8	2.2	6.8	1.6	4.6	7.1	1.8	0.6	1.4	1.2	2.9	0.6	0.8	2.7	1.2	2.2	0.6	75.6
CA	4.1	1.4	1.5	2.7	3.9	2.9	1.6	1.0	5.3	3.6	**19.7**	4.1	3.1	0.9	2.3	3.1	1.9	3.6	2.4	3.4	1.7	2.3	1.2	2.3	1.1	1.0	1.2	1.3	1.1	1.0	66.7
IA	6.0	1.5	1.8	1.8	7.2	4.9	2.6	1.0	3.0	3.7	1.6	**18.1**	2.8	3.9	1.5	5.8	0.9	1.7	6.7	1.6	0.6	2.0	2.6	2.4	0.5	0.6	1.7	1.5	0.9	1.6	74.3
SAA	4.8	1.4	1.4	1.7	6.2	5.4	2.5	0.8	4.6	1.3	1.0	6.4	**21.0**	1.0	1.3	4.2	1.5	1.4	3.5	1.5	0.6	2.4	1.5	2.3	1.2	0.7	1.4	3.3	1.8	1.8	68.6
SK	7.2	1.6	1.2	1.3	6.8	4.1	2.0	2.1	2.6	3.6	1.6	4.4	2.2	**10.1**	2.3	8.5	1.6	2.7	8.5	1.3	0.5	1.8	1.7	3.8	0.5	0.5	2.5	0.7	1.9	1.0	80.4
SA	6.3	0.9	1.6	1.0	7.9	4.1	1.7	1.6	3.0	2.4	0.9	2.6	3.4	1.4	**11.7**	9.4	1.3	2.2	5.0	1.7	0.7	1.9	0.9	4.0	1.0	0.9	1.5	1.9	1.5	0.8	73.2
BL	9.9	1.6	1.0	1.4	10.4	2.5	2.2	0.9	4.6	2.3	1.4	2.1	2.3	1.1	2.0	**16.3**	1.5	1.8	9.3	1.6	0.8	1.9	0.8	3.5	1.3	0.4	2.6	1.7	2.4	0.6	75.8
TD	5.0	2.0	1.2	1.7	7.0	3.2	2.0	1.5	2.9	2.9	1.2	4.1	2.9	4.1	2.5	6.0	**10.7**	4.3	6.8	1.1	0.7	1.7	3.5	2.4	1.0	0.7	2.0	0.8	1.5	1.2	77.9
IA	4.0	1.6	1.8	1.9	4.5	2.6	1.1	1.2	1.6	6.1	0.9	2.1	2.4	2.0	1.9	6.7	3.7	**13.1**	8.3	2.9	0.6	1.8	1.2	2.3	0.8	1.6	1.5	1.5	1.9	0.9	71.2
MO	9.2	1.5	0.7	1.4	9.3	3.4	1.7	0.7	3.1	1.5	0.7	2.9	4.5	1.5	1.7	8.5	1.7	1.5	**15.9**	1.3	0.4	1.7	1.8	3.1	0.7	0.9	2.4	1.1	3.0	0.9	72.6
MA	9.1	2.2	1.0	1.2	6.0	2.7	1.4	0.5	1.3	2.7	2.3	3.7	2.5	1.1	3.2	4.4	1.5	4.1	8.9	**19.7**	2.0	2.2	1.4	2.5	0.6	1.6	1.0	0.9	1.6	0.8	74.5
VN	4.5	2.7	1.2	1.1	2.8	3.6	2.6	1.6	3.1	2.8	1.6	4.9	3.8	1.5	2.1	1.9	1.7	2.4	3.2	1.9	**20.6**	2.1	2.4	1.9	1.7	1.5	1.4	2.4	1.6	1.6	67.5
KA	4.5	1.3	0.7	1.4	2.1	1.8	1.4	1.0	2.5	2.8	2.0	1.8	2.3	1.5	3.6	2.4	1.2	4.0	6.3	1.0	1.3	**24.4**	1.4	2.4	1.9	1.2	1.1	1.1	1.4	0.9	58.0
RA	3.7	1.1	0.9	0.9	5.1	3.2	2.2	0.6	2.2	2.5	1.4	4.1	3.9	1.7	1.5	3.6	3.8	3.9	5.5	1.2	0.8	1.8	**14.8**	2.4	0.9	1.1	3.5	1.0	2.5	0.9	67.9
KN	11.7	1.5	0.8	0.9	7.1	2.2	1.1	0.7	3.0	2.5	2.1	4.0	3.4	1.0	3.4	3.7	1.7	2.1	5.6	1.3	0.9	4.7	1.9	**22.6**	0.6	0.7	1.2	0.9	1.7	0.8	73.1
BA	5.2	1.5	1.0	1.3	5.8	3.7	4.2	0.7	1.9	3.0	1.1	4.8	4.5	1.6	2.6	2.4	3.4	3.2	2.4	0.9	0.7	1.9	2.8	2.6	**16.2**	0.6	1.8	2.1	1.6	1.8	71.1
NA	3.1	2.0	1.0	1.7	2.1	1.2	1.8	1.7	1.4	2.7	1.3	2.2	1.7	1.8	1.5	1.3	1.9	2.6	2.3	1.0	0.4	2.8	1.6	2.3	1.0	**26.6**	1.7	0.9	2.1	3.6	52.9
CA	5.4	1.2	1.2	1.1	3.0	2.0	2.7	1.5	2.8	4.4	2.0	1.3	2.7	1.1	2.4	2.7	3.6	6.9	4.2	2.4	1.4	2.4	1.0	1.6	2.2	1.2	**20.8**	2.4	5.7	1.1	73.2
JON	5.7	1.2	0.6	1.0	6.1	2.4	1.8	2.1	3.4	1.4	1.2	3.5	3.2	1.8	3.7	5.9	1.2	1.7	4.4	2.5	1.7	2.6	2.2	3.7	1.9	1.2	1.4	**19.5**	2.3	1.7	73.5
MO	7.5	1.4	0.9	1.8	7.2	2.4	1.5	1.0	2.5	2.8	1.0	3.0	4.0	0.5	2.6	4.5	1.3	2.0	7.3	2.1	0.7	1.8	1.4	5.6	0.8	1.2	3.2	0.8	**18.5**	1.7	74.3
BH	4.3	2.2	1.7	2.2	2.1	1.1	2.4	1.5	1.6	1.9	1.6	1.9	3.1	0.6	1.2	2.1	3.1	2.5	2.5	0.6	0.8	2.2	1.8	2.5	1.6	1.4	0.9	1.8	3.0	**19.3**	56.1
TO	194.9	47.3	31.9	42.0	179.7	102.9	65.1	30.9	80.6	80.4	39.3	102.8	92.8	46.8	63.3	148.1	56.7	78.6	179.1	51.4	23.3	58.0	47.0	83.2	31.7	25.4	57.1	47.7	61.3	34.1	2183.2
Inc.Own	214.1	53.8	39.4	48.4	196.2	112.7	75.7	35.4	98.2	90.6	59.0	120.8	113.8	56.9	75.0	164.4	67.4	91.7	195.1	71.1	44.0	82.4	61.8	105.8	47.9	52.0	78.0	67.2	79.8	53.4	
NET	124.1	-34.2	-51.5	-43.6	105.4	23.9	-7.5	-51.8	5.4	4.8	-27.4	28.5	24.2	-33.6	-9.9	72.3	-21.2	7.4	106.5	-23.1	-44.2	0.1	-21.0	10.1	-39.3	-27.5	-16.1	-25.8	-13.0	-21.9	**72.8**

Table 4.3.2: Volatility spillover in the Full period (Panel C) during GFC among developed, emerging, and frontier economies.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**22.1**	2.5	0.9	1.2	10.8	3.6	3.8	0.7	2.8	2.9	1.1	3.1	3.3	0.7	3.0	5.8	2.3	2.4	7.6	1.5	0.8	2.1	1.0	4.5	2.0	0.5	2.0	1.9	1.6	1.5	77.9
JN	11.6	**9.5**	1.5	2.2	8.1	4.8	2.6	0.8	2.4	2.5	1.4	3.1	4.2	2.1	2.7	4.9	2.7	2.7	10.7	2.2	0.6	1.9	1.8	3.3	0.9	0.9	2.7	1.5	2.8	1.1	90.5
AA	7.9	2.1	**9.8**	3.0	8.9	6.9	4.2	0.9	2.9	4.0	1.2	5.9	5.8	1.5	2.2	6.2	1.6	2.9	6.2	2.6	0.4	1.6	1.1	2.7	1.2	0.6	1.9	2.0	1.1	0.8	90.2
HG	6.7	2.2	2.1	**8.2**	7.1	4.8	2.7	1.4	2.8	5.9	1.5	6.2	3.9	4.5	2.1	7.0	2.2	4.1	7.7	1.8	0.6	1.5	1.8	3.5	0.8	0.7	2.5	1.0	2.1	0.7	91.8
CAA	11.8	2.0	1.1	1.2	**18.7**	3.9	3.0	0.8	3.8	1.8	1.5	3.2	3.0	1.2	2.2	9.4	1.3	1.4	7.6	2.2	1.1	2.1	1.5	3.9	2.1	0.6	1.8	2.6	2.1	1.1	81.3
GY	10.1	2.1	1.0	1.3	8.7	**12.6**	5.2	0.8	4.0	1.9	1.5	5.6	4.6	1.2	2.0	5.7	2.3	1.7	8.1	2.1	0.4	1.3	2.1	2.8	1.1	0.8	3.1	2.2	2.7	1.3	87.5
SD	10.6	2.6	1.0	1.1	7.2	9.8	**16.0**	1.2	2.8	2.2	1.2	3.5	3.1	1.6	1.6	4.4	3.1	2.1	6.2	1.6	0.6	1.6	1.4	2.1	1.3	0.8	3.7	2.3	2.6	0.9	84.1
SN	8.5	1.7	1.1	1.4	7.1	8.6	4.1	**7.2**	3.2	3.1	1.5	4.4	2.8	1.9	2.5	5.8	2.1	2.8	9.4	2.2	0.5	1.9	1.9	3.0	0.8	0.7	2.4	2.5	3.5	1.6	92.8
RUS	5.5	1.8	0.9	1.9	6.4	3.0	1.9	1.3	**18.9**	2.9	2.1	2.8	2.4	1.6	2.9	8.3	1.5	2.3	9.1	2.7	1.2	1.5	1.6	3.5	1.2	0.7	2.6	3.3	2.6	1.7	81.1
SA	6.7	1.6	2.2	3.1	6.4	4.8	2.4	1.5	1.9	**13.6**	1.7	4.1	2.6	3.4	3.5	7.0	2.1	6.2	7.3	1.9	0.8	1.5	1.4	3.7	0.7	0.9	3.0	1.2	2.3	0.8	86.5
CA	4.4	1.7	1.9	3.2	4.0	3.1	1.8	1.2	5.4	3.9	**24.8**	4.3	3.8	1.1	2.5	3.2	2.2	4.0	2.9	3.7	1.8	2.6	1.5	2.4	1.3	1.4	1.5	1.5	1.3	1.7	75.3
IA	6.2	1.6	2.0	2.3	7.4	5.3	2.8	1.1	3.2	4.1	1.9	**20.2**	3.1	4.1	1.7	6.1	1.0	2.0	6.8	1.7	0.7	2.1	2.8	2.6	0.7	0.6	1.7	1.6	0.9	1.8	79.8
SAA	5.1	1.6	1.7	1.9	6.4	5.6	2.8	1.1	4.8	1.5	1.8	6.7	**24.0**	1.0	1.6	4.2	1.9	1.8	3.7	1.6	0.8	2.5	1.7	2.4	1.5	0.9	1.5	3.7	2.0	2.3	76.0
SK	7.6	2.3	1.6	2.0	6.9	4.3	2.1	2.2	2.8	4.3	1.9	4.6	2.3	**12.1**	2.8	8.6	1.9	3.3	8.7	1.5	0.7	1.9	1.9	4.1	0.6	0.6	2.7	0.7	2.0	1.1	87.9
SA	7.5	1.4	1.8	1.4	8.4	4.3	1.8	1.9	3.2	3.7	1.1	2.8	3.7	1.9	**16.1**	9.6	1.8	3.4	5.3	1.8	0.8	2.0	1.1	4.7	1.1	1.0	2.0	2.0	1.6	1.0	83.9
BL	10.2	1.8	1.2	1.7	10.9	3.1	2.6	1.0	4.9	2.5	1.6	2.5	2.4	1.4	2.3	**17.8**	1.7	2.0	9.7	1.6	0.9	2.0	1.0	3.6	1.4	0.5	2.7	1.7	2.5	0.6	82.2
TD	5.6	2.5	1.4	2.2	7.4	3.5	2.3	1.6	3.1	3.5	1.4	4.4	3.1	4.4	2.9	6.3	**13.5**	5.2	7.1	1.3	0.8	1.8	3.8	3.0	1.1	0.8	2.3	0.9	1.6	1.4	86.6
IA	4.8	2.0	2.3	2.5	4.9	2.8	1.3	1.5	1.7	7.8	1.2	2.3	2.6	2.6	3.2	6.9	4.7	**16.6**	8.5	3.2	0.7	1.9	1.5	3.0	0.9	1.8	1.9	1.7	2.0	1.1	83.4
MO	9.9	1.7	0.7	1.5	9.8	4.1	2.4	1.0	3.5	1.7	0.9	3.2	4.7	1.7	2.1	9.2	2.1	1.9	**19.1**	1.4	0.5	1.8	2.1	3.3	0.8	1.1	2.6	1.2	3.1	1.1	80.9
MA	9.5	2.3	1.1	1.3	6.2	2.8	1.5	0.6	1.5	2.9	2.4	3.8	2.7	1.2	3.6	4.6	1.6	4.5	9.1	**21.4**	2.1	2.3	1.4	2.7	0.7	1.7	1.1	1.0	1.7	0.9	78.6
VN	5.0	2.9	1.4	1.3	3.0	3.9	3.0	2.0	3.2	3.4	1.9	5.2	4.1	1.6	2.5	2.1	2.0	2.7	3.4	1.9	**25.6**	2.3	2.7	2.0	1.8	1.6	1.6	2.6	1.7	1.8	74.4
KA	5.0	1.4	0.9	1.5	2.5	2.0	1.7	1.1	2.8	3.0	2.5	2.0	3.0	1.6	4.0	2.7	1.4	4.2	6.8	1.1	1.6	**33.6**	1.5	2.9	2.3	1.4	1.4	1.2	1.7	1.1	66.5
RA	3.9	1.7	1.2	1.5	5.5	3.7	2.7	0.7	2.5	3.0	1.8	4.8	4.1	2.4	2.1	3.9	4.6	4.4	6.0	1.3	1.0	2.0	**21.2**	2.7	1.0	1.4	3.9	1.0	2.8	1.3	78.8
KN	11.8	1.6	0.9	1.0	7.3	2.3	1.2	0.8	3.0	2.6	2.3	4.1	3.5	1.1	3.6	3.8	1.9	2.3	5.7	1.4	0.9	4.9	2.0	**23.9**	0.6	0.7	1.2	0.9	1.8	0.9	76.1
BA	5.5	1.6	1.3	1.6	6.0	3.9	4.7	0.9	2.0	3.4	1.8	5.0	4.9	1.8	3.0	2.5	3.7	3.6	2.7	1.0	0.8	2.3	3.1	3.0	**20.9**	0.8	2.1	2.2	2.0	2.2	79.1
NA	3.5	2.4	1.3	2.1	2.5	1.6	2.1	2.1	1.7	2.9	2.0	2.5	2.2	2.1	2.1	1.6	2.5	3.3	3.0	1.4	0.5	3.2	2.1	2.6	1.2	**35.4**	1.9	1.1	2.5	4.6	64.6
CA	5.7	1.3	1.3	1.2	3.2	2.4	2.9	1.6	3.1	4.7	2.1	1.4	2.9	1.1	2.9	2.8	3.8	7.2	4.2	2.5	1.5	2.5	1.1	1.7	2.2	1.2	**22.3**	2.5	5.8	1.1	77.7
JON	6.1	1.3	0.8	1.1	6.4	2.5	2.0	2.3	3.4	1.6	1.5	3.6	3.5	1.9	4.0	6.1	1.4	1.9	4.8	2.8	1.7	2.9	2.4	3.9	2.1	1.4	1.6	**21.0**	2.5	1.9	79.1
MO	7.7	1.5	0.9	1.9	7.4	2.6	1.7	1.3	2.6	3.0	1.2	3.1	4.2	0.5	2.9	4.6	1.5	2.3	7.5	2.2	0.8	2.0	1.5	5.8	0.9	1.3	3.4	0.8	**21.2**	2.1	78.8
BH	4.8	2.7	2.0	2.8	2.6	1.5	3.4	2.7	2.2	2.6	2.9	2.3	3.9	0.9	2.0	2.3	4.0	3.3	3.2	1.0	1.2	2.6	2.3	3.0	1.9	2.3	1.2	2.3	4.4	**25.9**	74.1
TO	208.9	56.1	39.1	52.3	189.4	115.0	76.3	37.9	87.4	93.2	48.8	110.5	100.3	54.2	76.3	155.3	66.9	91.8	188.6	55.0	26.8	62.6	52.8	92.2	36.0	29.9	64.2	51.0	67.0	41.6	2427.2
Inc.Own	231.1	65.6	48.9	60.5	208.1	127.5	92.3	45.1	106.3	106.8	73.6	130.7	124.3	66.3	92.4	173.1	80.3	108.4	207.7	76.4	52.4	96.1	74.0	116.0	56.8	65.3	86.4	72.0	88.2	67.5	
NET	131.1	-34.4	-51.1	-39.5	108.1	27.5	-7.7	-54.9	6.3	6.8	-26.4	30.7	24.3	-33.7	-7.6	73.1	-19.7	8.4	107.7	-23.6	-47.6	-3.9	-26.0	16.0	-43.2	-34.7	-13.6	-28.0	-11.8	-32.6	**80.9**

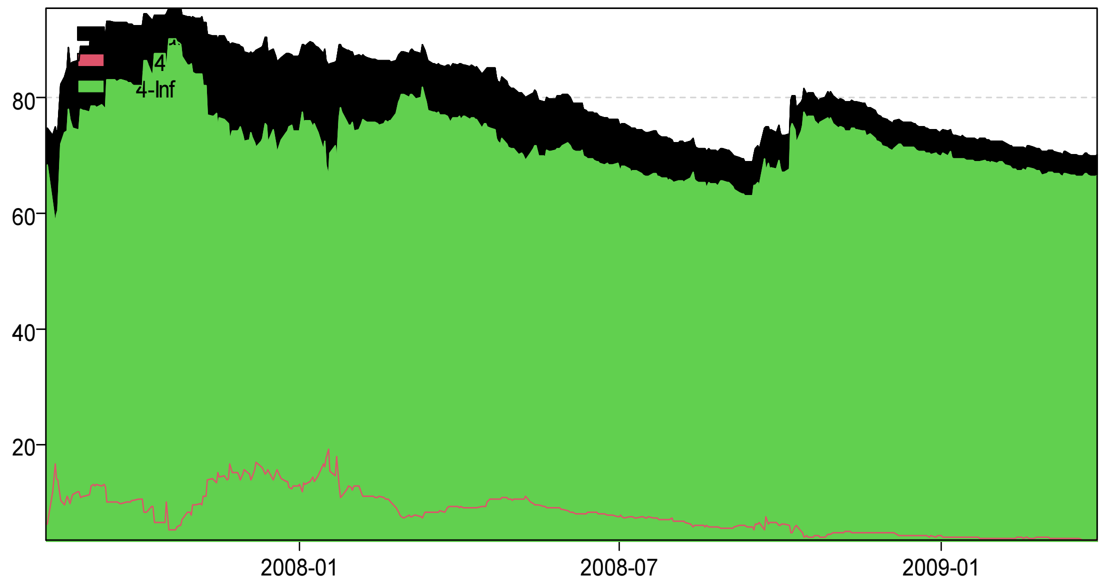


Fig. 4.8: DuringGFC (Panel-1) on the different frequency volatility series using the TVP-VAR-BK Model. Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf Days, green colour), and total frequency (black colour) (Source: Author's using R software).

4.3 TVP-VAR and TVP-VAR-BK Model results during the pre-EDC among developed, emerging, and frontier countries.

During Pre-EDC, this study identified Kenya (43.20%), Spain (32.12%), and the US (26.71%) as the significant net transmitter and Saudi-Arabia (-36.32%), Bulgaria (-32.47%) as the significant net receptor (Fig. 4.9). Kenya (high financial instability; small shocks can have outsized spillover effects in frontier markets). Spain, US developed economies, etc., with globalised markets whose breakage is transmitted through trade, investment, and capital flows.

On the other side, this panel Saudi Arabia (-36.32%), Bulgaria (-33.47%), and PIIGS (-27.14%) are identified as the significant net receptor in the developed countries, and Russia (26.47%), and Germany (11.27%) were identified as the significant net transmitter (Fig. 4.10) (Table 4.4.0).

Among the emerging countries, South Korea (25.90%), Brazil (19.08%), and Thailand (15.53%) are the significant transmitters; on the other side, Saudi Arabia (-36.32%), India (-20.07%), China (-16.02%) were identified as the transmitter.

Among the frontier countries, Kenya (43.20%), Romania (16.27%), and Croatia (7.67%) were identified as the significant transmitters, and Morocco (-25.76%), Bulgaria (-33.47%), Kazakhstan (-27.17%) were identified as the net central receiver of the volatility spillover.

Kenya (43.20%), Spain (32.12%), and the US (26.71%) as these countries were found to be major sources of volatility in the Pre-EDC period, possibly because among the emerging economies, South Korea (25.90%) and Brazil (19.08%) and Thailand (15.53%) were the significant transmitters. This can be linked to South Korea's export-driven economy, which is sensitive to global demand shifts. Kenya (43.20%), Romania (16.27%), and Croatia (7.67%) emerged as frontier/marginal markets exhibiting transmittal behaviour (probably owing to their augmented susceptibility to external financial forces and merger market depth). Saudi Arabia's dependency on oil prices/public sales made it sensitive to global energy market dynamics. Bulgaria and PIIGS' relationship with the weak financial systems and vulnerability to external shocks leads them to absorb spillovers (not transmit them). Among developed markets where volatility was transmitted were Russia (26.47%) and Germany (11.27%) , while countries like Bulgaria (-33.47%) and PIIGS (-27.14%) were hosts absorbing that pollution. Germany'sstrong industrial base and financial sector combined tied it into global markets, maximizing its function as a transmitter. Moreover,Russia's dependence on energy exports and geopolitical risk made it a transmitter of volatility in this case. India (-20.07%) and China (-16.02%) were key recipients among emerging markets. Their overall size and reliance on growth may have absorbed shocks elsewhere. For frontier markets, Morocco (-25.76%), Bulgaria (-33.47%) and Kazakhstan (-27.17%) all took the brunt of the volatility on the back of relatively stronger financial systems and greater access to external financial markets. The countries' net transmitters or net receptacles are configured by their market maturity; as in advanced economies with embedded market economies (e.g., US, Germany), volatility is more likely to be transmitted, while limited financial systems lead to absorption in emerging and frontier markets. Commodity production Nations with abundant resources, such as Saudi Arabia and Russia, are influenced by commodity price fluctuations. Highly globalized economies (like Spain and South Korea) play an essential role in transmitting volatility.

Thus, this panel indicated that theUS, Kenya, and Spain stock markets hadbeen impacted by several as theprimary transmitters in the scenario of the pre-EDC period.

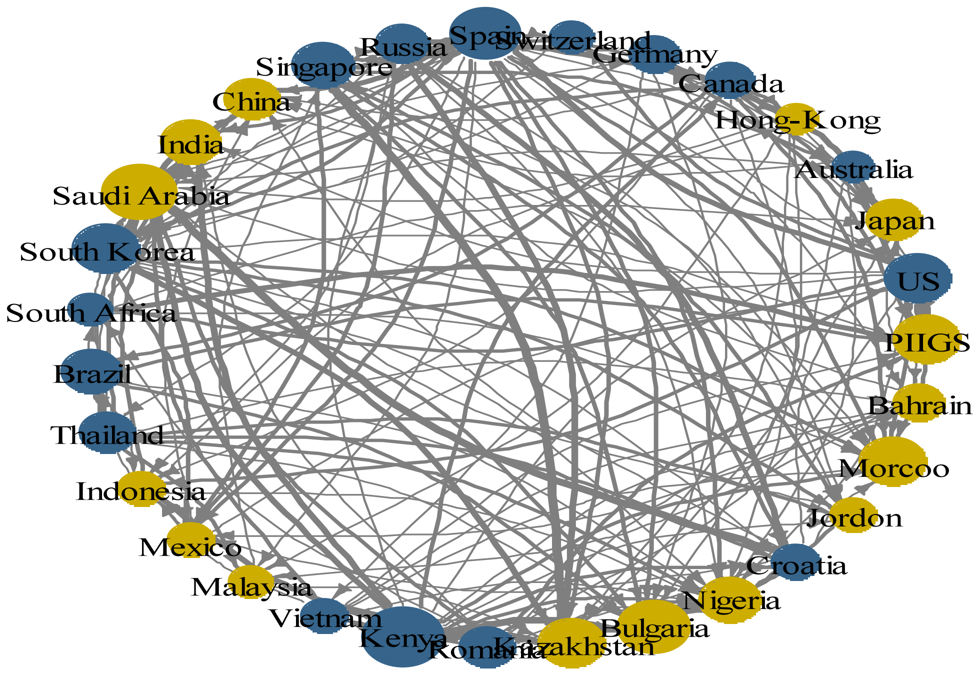
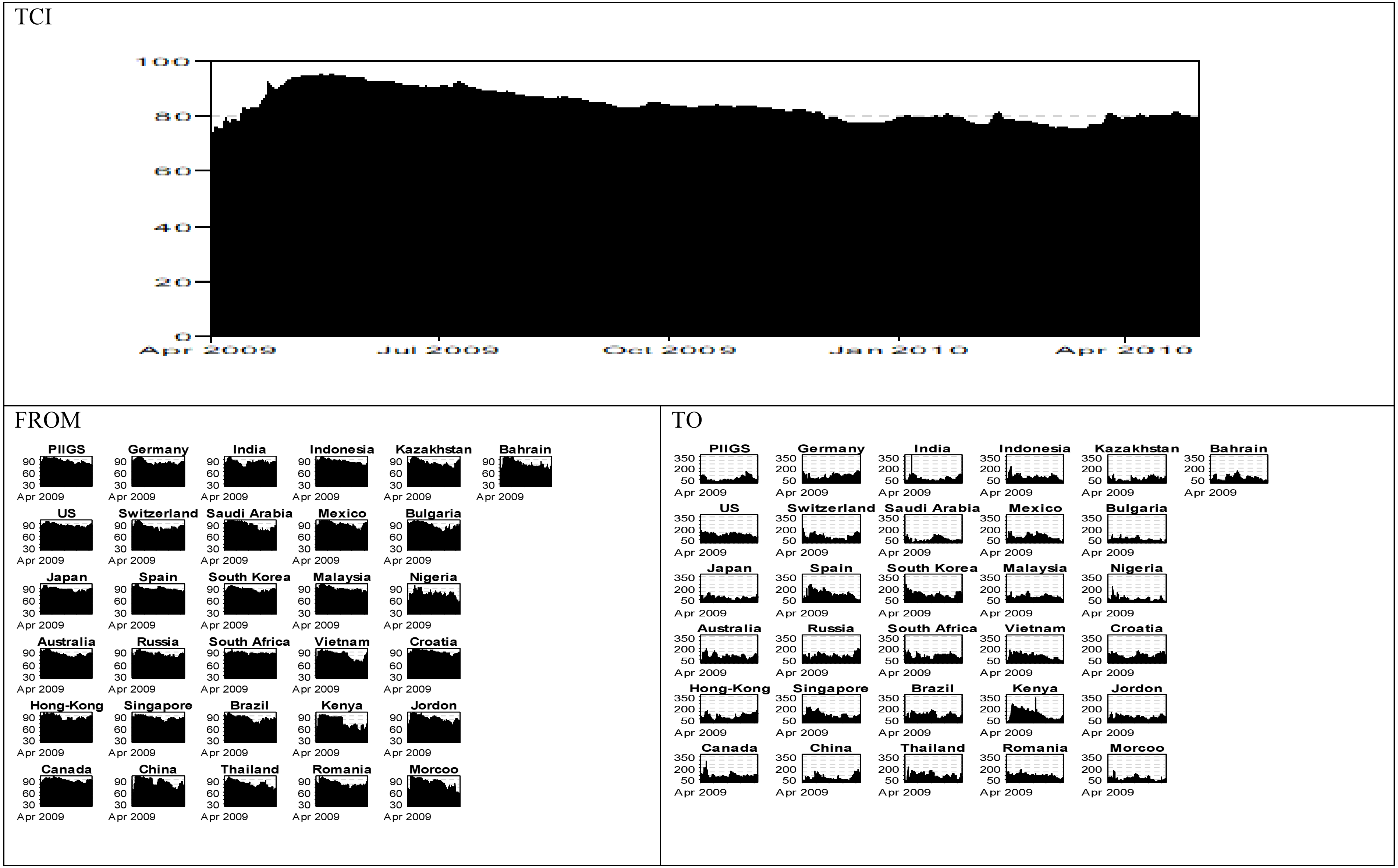


Fig. 4.9: During Pre-EDC, interconnectedness among the developed, emerging, and frontier countries.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).


TCI
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Bahrain
US
Switzerland
Saudi Arabia
Mexico
Bulgaria
Japan
Spain
South Korea
Malaysia
Nigeria
Australia
Russia
South Africa
Vietnam
Croatia
Hong-Kong
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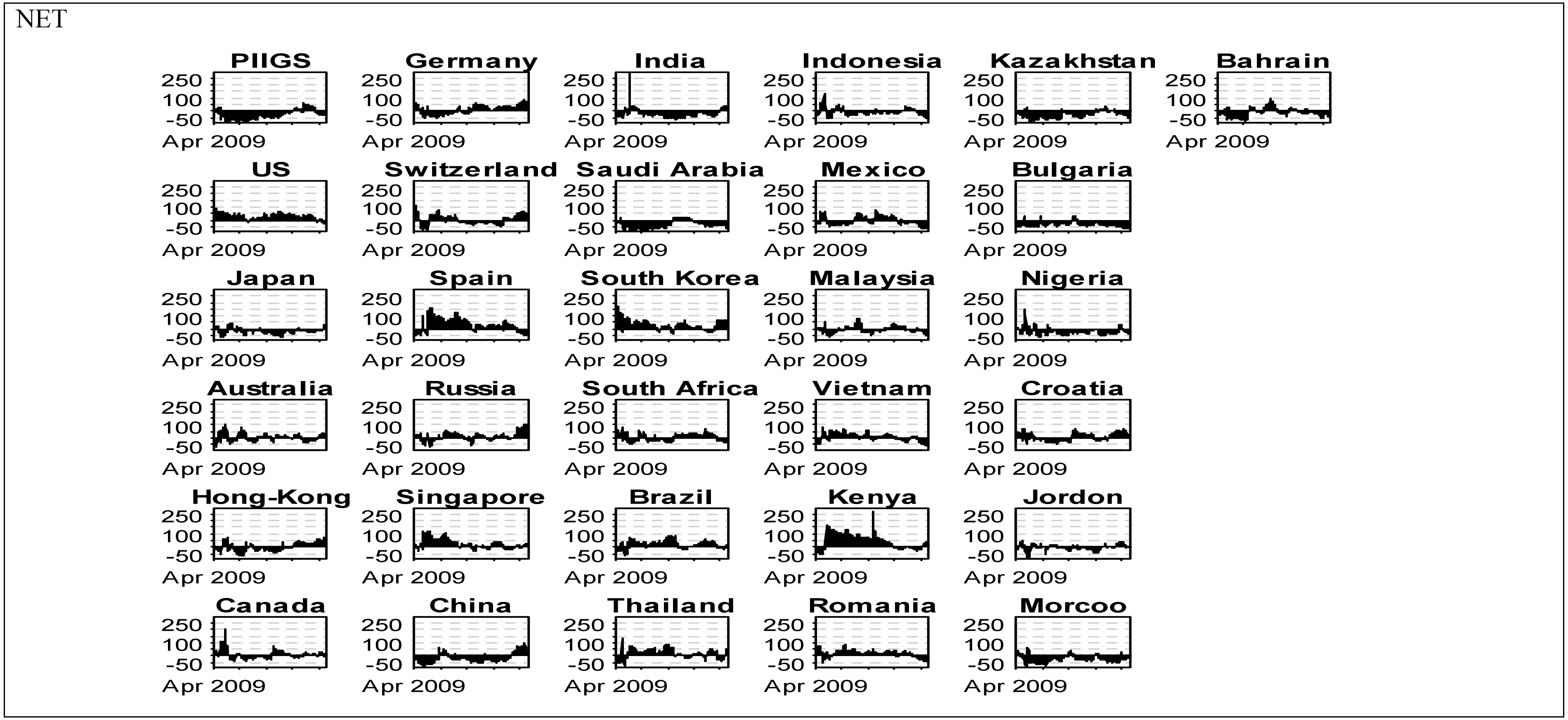


Fig. 4.10: During Pre-EDC, interconnectedness among the developed, emerging, and frontier countries.

Note: In the below tables, the interpretation of different countries are as follows –PIG-PIIGS, US-US, UK-United Kingdom, JN-Japan, AA- Australia, HG-Hong-Kong, CAA-Canada, GY-Germany, SD-Switzerland, SN-Spain, RUS-Russia, SA-Singapore, CA- China, IA- India, SAA-Saudi Arabia, SK- South Korea, SA- South Africa, BL-Brazil, TD-Thailand, IA-Indonesia, MO-Mexico, VN-Vietnam, Kenya-KA, RA-Romania, KN-Kazakhastan, BA-Bulgaria, NA-Nigeria, CA-Croatia, JON-Jordon, MO-Morocco, BH-Bharain, FM-From, TO-To Other, NET-Net spillover.

Table 4.4.0: Volatility spillover in Pre-EDC among developed, emerging, and frontier economies. (Source: Author using R software)

	PIG	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
PIG	**13.5**	7.2	2.0	2.0	2.0	4.0	6.1	3.3	3.9	2.1	2.3	1.9	1.4	1.4	2.4	6.5	4.9	2.5	3.6	3.0	1.8	2.6	2.7	4.8	2.7	1.8	1.1	2.5	2.0	1.3	1.0	86.5
US	2.3	**13.4**	1.6	2.6	1.7	5.9	6.6	2.2	2.8	3.1	2.8	2.0	1.5	1.5	2.7	5.5	5.8	3.2	2.1	5.4	2.1	3.4	3.5	3.9	1.7	1.5	1.2	3.0	2.3	1.4	1.3	86.6
JN	1.9	2.4	**14.3**	2.6	4.3	5.2	3.2	3.2	4.6	2.1	2.8	2.3	2.2	1.7	5.9	2.8	3.1	1.8	3.4	2.2	1.9	2.2	3.8	2.4	1.6	3.3	1.3	3.5	3.8	1.6	2.8	85.7
AA	2.3	3.6	2.9	**15.8**	3.8	3.6	2.7	3.1	3.2	3.9	6.4	1.8	3.0	1.8	7.4	2.1	2.5	2.0	2.3	2.1	1.7	4.7	3.5	1.6	1.5	2.0	0.9	3.0	2.3	1.4	1.1	84.2
HG	2.4	2.8	3.9	2.9	**13.8**	3.8	3.5	3.1	4.2	2.3	3.8	2.9	3.8	1.0	5.7	3.5	3.4	2.2	4.1	3.3	3.0	1.5	2.6	2.8	2.0	1.1	2.1	2.1	2.5	1.7	2.4	86.2
CAA	1.9	5.0	2.0	3.8	1.7	**11.3**	3.8	3.4	4.7	4.8	5.6	1.8	2.2	1.5	4.6	3.6	2.9	2.6	1.7	4.9	2.9	3.1	4.6	2.3	2.4	1.9	1.5	2.3	1.8	1.2	2.3	88.7
GY	3.2	8.0	1.8	2.4	2.7	4.0	**16.7**	5.4	3.4	3.5	2.5	1.0	2.9	1.4	3.5	4.0	4.5	3.5	2.8	2.9	1.6	1.4	2.2	3.4	1.7	0.7	2.1	2.3	1.9	1.8	1.0	83.4
SD	2.5	4.3	2.5	2.6	2.3	2.7	6.0	**18.4**	5.0	2.8	3.1	1.5	3.0	2.1	3.9	2.8	3.6	2.9	2.3	2.1	2.4	3.4	3.0	2.3	1.2	1.4	2.7	2.0	2.4	1.6	1.4	81.6
SN	4.9	6.2	2.9	2.0	2.4	4.1	4.3	2.8	**12.3**	2.0	2.8	0.9	1.4	1.7	2.6	4.9	5.1	2.7	3.5	2.4	2.1	3.4	4.0	5.8	1.4	1.9	1.8	2.9	2.3	1.5	1.2	87.7
RUS	1.9	2.6	2.4	3.7	2.0	2.8	3.7	4.2	4.0	**16.5**	5.8	1.9	2.2	1.2	4.4	2.9	3.4	3.5	1.8	2.2	3.5	1.9	3.9	2.3	1.5	2.6	1.5	1.8	2.1	2.5	3.1	83.5
SA	1.6	2.4	2.4	3.6	4.8	1.8	1.9	4.2	5.0	4.2	**15.8**	2.3	4.1	1.3	5.1	1.9	3.4	2.5	2.5	2.0	6.1	2.3	3.8	1.9	1.7	1.1	1.3	2.4	1.5	1.7	3.7	84.2
CA	1.1	2.6	3.1	3.3	3.8	3.5	1.7	2.2	4.0	3.1	3.1	**16.6**	2.3	1.4	5.3	2.3	2.1	2.5	2.6	4.6	2.8	3.0	3.7	2.4	2.2	2.7	1.7	4.1	3.0	1.2	2.3	83.4
IA	1.3	3.0	2.1	3.5	3.2	2.2	3.7	3.5	4.2	2.5	4.1	1.9	**17.2**	1.7	3.9	2.3	4.4	4.8	3.1	1.7	2.1	2.6	4.7	2.4	1.2	1.3	1.9	3.0	2.6	2.1	1.8	82.8
SAA	1.6	3.4	2.0	2.4	2.5	2.3	3.3	1.8	3.3	2.6	2.2	2.9	1.7	**14.5**	2.8	3.2	2.5	3.6	2.6	2.7	2.7	4.5	4.5	4.0	2.3	1.5	2.2	6.9	3.9	1.7	2.1	85.5
SK	1.1	1.9	5.0	5.8	5.6	2.4	1.9	5.3	4.7	3.6	6.2	2.3	4.4	1.4	**14.5**	1.8	1.7	2.1	2.9	2.0	3.0	3.6	4.3	1.5	1.3	1.2	1.5	2.2	1.6	1.5	1.7	85.5
SA	3.3	7.6	1.3	1.6	2.8	4.3	4.9	2.6	2.9	3.1	2.6	2.0	1.8	2.4	2.7	**13.8**	4.5	3.9	3.2	4.2	2.8	2.8	2.2	4.0	1.4	0.9	1.5	3.1	2.4	1.9	1.8	86.2
BL	2.6	5.2	2.2	1.7	3.4	5.2	4.9	3.3	4.6	3.9	3.5	1.5	2.6	0.9	2.0	3.6	**16.5**	2.5	2.7	4.7	2.6	2.6	2.6	3.7	1.4	1.3	1.4	2.4	2.0	1.2	1.6	83.5
TD	1.7	4.0	1.7	1.7	2.7	2.8	3.0	2.2	4.4	2.6	2.2	1.9	2.0	2.0	2.8	2.3	6.7	**20.4**	2.9	2.8	2.2	3.2	3.5	4.5	2.1	1.2	2.2	2.6	1.5	1.9	2.7	79.6
IA	2.5	4.2	2.7	2.8	2.9	3.5	1.7	1.9	4.2	3.1	2.3	2.1	1.1	1.6	2.6	4.3	4.0	3.8	**14.4**	3.4	3.8	4.1	3.2	6.6	1.5	1.7	1.4	3.0	2.2	1.5	2.0	85.6
MO	1.9	4.1	1.9	2.6	2.5	5.1	2.7	2.8	5.0	4.5	4.3	2.7	1.7	2.3	4.7	3.5	2.9	2.5	2.6	**11.5**	3.8	2.4	4.0	2.2	1.4	2.0	2.2	3.0	2.0	1.2	4.0	88.5
MA	1.7	2.9	2.0	1.6	4.6	2.4	1.8	2.9	3.8	3.9	4.8	2.9	2.5	1.7	3.4	3.2	2.7	4.4	3.5	2.6	**12.7**	2.7	2.5	4.0	1.7	1.2	2.2	3.1	2.9	2.5	5.3	87.4
VN	1.3	4.3	1.7	4.2	2.2	2.3	2.7	2.3	2.7	2.6	3.1	2.4	1.5	2.5	3.5	2.1	3.7	3.1	2.3	2.4	1.6	**18.8**	4.4	5.2	2.8	1.5	1.3	5.6	3.6	1.2	1.3	81.2
KA	1.9	2.8	2.4	3.3	1.6	1.9	1.1	2.7	4.3	2.3	3.6	2.6	1.3	1.3	3.2	2.1	2.6	3.0	2.6	2.9	2.7	4.4	**27.1**	2.3	1.0	2.8	1.6	2.9	2.5	1.2	2.6	72.9
RA	2.5	5.5	2.5	1.6	2.3	2.5	2.8	1.9	5.2	2.4	2.1	2.9	1.1	1.2	2.2	2.6	4.6	3.5	3.6	2.2	2.9	4.0	3.7	**19.6**	2.5	1.4	1.6	3.6	1.8	2.2	1.5	80.4
KN	2.2	2.0	2.3	2.8	3.6	2.1	2.8	2.0	3.9	5.0	5.7	3.2	1.6	1.5	4.4	1.8	1.7	2.9	1.7	2.0	2.9	1.8	5.7	2.8	**18.2**	1.8	1.3	3.9	3.0	1.2	2.4	81.8
BA	1.2	1.8	3.8	3.0	2.7	2.3	2.2	2.4	4.4	2.3	3.5	3.7	1.7	1.7	3.5	1.9	3.7	3.1	2.3	1.7	2.4	2.4	7.6	2.7	1.9	**15.7**	1.8	4.7	4.4	1.7	2.2	84.3
NA	1.5	2.5	1.7	2.4	1.6	2.8	1.9	2.4	4.2	2.9	2.1	2.0	1.0	1.5	3.0	2.3	3.0	4.3	2.7	2.2	2.4	2.6	3.9	3.1	1.4	1.8	**27.2**	2.4	2.1	3.1	2.3	72.9
CA	1.4	3.2	2.0	2.9	2.1	2.0	3.3	2.0	3.7	5.4	4.5	2.2	1.9	2.5	3.7	2.6	2.6	4.7	2.1	1.7	4.0	3.7	5.6	2.9	3.4	2.0	1.4	**11.1**	5.1	2.0	2.4	88.9
JON	0.9	2.2	2.6	3.0	2.6	2.2	2.7	2.0	3.6	4.0	4.1	2.5	1.9	1.9	3.8	1.6	2.3	3.7	1.8	2.0	3.7	2.6	4.3	2.5	2.6	2.3	1.8	6.0	**17.7**	2.1	3.2	82.3
MO	1.5	3.6	1.4	4.1	2.3	3.4	2.4	2.0	3.5	2.9	3.0	2.8	1.7	1.9	3.6	3.3	2.1	3.1	1.9	2.3	2.0	2.9	4.0	3.4	1.8	1.8	2.1	3.8	1.5	**19.6**	4.6	80.4
BH	1.0	2.3	1.2	2.6	3.4	3.4	1.6	1.6	2.6	2.6	2.3	2.8	1.1	1.7	2.5	2.9	2.4	4.5	2.4	2.7	3.7	2.8	4.4	3.1	1.5	1.5	2.2	2.4	3.8	5.8	**21.3**	78.7
TO	59.3	113.3	69.6	85.2	85.9	96.3	94.7	84.6	119.8	96.1	107.1	67.4	62.7	49.2	111.4	89.8	102.6	95.1	79.8	82.9	83.0	88.1	116.1	96.7	54.7	50.9	50.9	96.5	76.6	54.7	68.9	2589.9
Inc.Own	72.9	126.7	83.9	101.0	99.7	107.6	111.4	103.0	132.1	112.6	122.9	84.0	79.9	63.7	125.9	103.6	119.1	115.5	94.2	94.4	95.7	107.0	143.2	116.3	72.8	66.5	78.0	107.7	94.3	74.2	90.2	
NET	-27.1	26.7	-16.1	1.0	-0.3	7.6	11.4	3.0	32.1	12.6	22.9	-16.0	-20.1	-36.3	25.9	3.6	19.1	15.5	-5.8	-5.6	-4.3	7.0	43.2	16.3	-27.2	-33.5	-22.0	7.7	-5.7	-25.8	-9.8	**83.5**

➢ **Pre-Robustness**

To assess the robustness of the above findings, I performed a sensitivity analysis on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Examining the spillover curves illustrated in Fig. 4.11 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

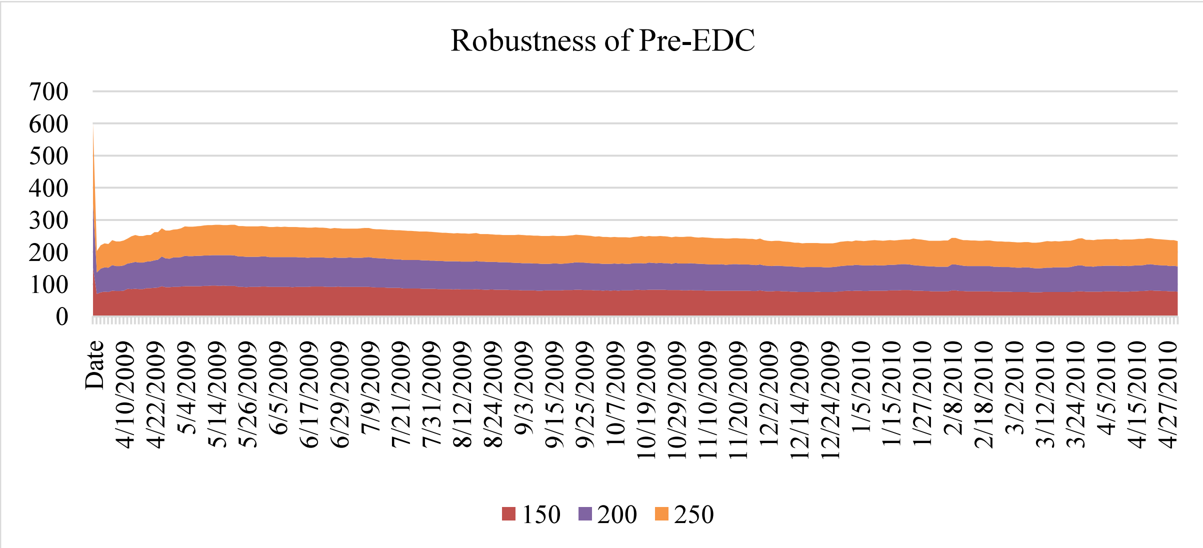


Fig. 4.11: During Pre-EDC, volatility spillover on different window-size among the developed, emerging, and frontier countries.

Note:In the above figure the Redshows 150 window sizes, Purple shows 200, and Orange shows 250.

4.4 Results of the volatility spillover among the developed, emerging, and frontier countries during the EDC crash (2010-2013).

The European debt crisis hit Southern European countries, which acted as a chain reaction to financial problems. More study of specific areas is required to grasp their complexities fully, especially in understanding the behaviour of Global Financial Crises (2008). The enormous economic crisis and loss of investor confidence hit the European economies particularly hard. Several nations in Southern Europe were already heavily indebted when the crisis hit, leaving them more susceptible to economic downturns. The European Central Bank's (ECB) interest rate strategy was flawed because it was one size fits all and failed to consider the different requirements of member states, leaving economies struggling under the weight of increased debt. Portugal, Ireland, Italy, Greece, and Spain were among the nations that had trouble servicing their loans during the sovereign debt crisis, which prompted bailouts and austerity policies. Due to the several uncertainties inside the Eurozone, the crisis cast doubt on the future of the Eurozone and sparked discussions about its organizational framework. Economic and social problems: countries that had to implement austerity measures to control their debt had fewer public services, more unemployment, and social discontent. In the long run, the more significant economic gaps within the area result from certain European economies' recoveries and others' continued struggles. The political climate in Europe changed because of the crisis, which increased Euroskepticism and populism in some nations. Improvements in fiscal discipline, banking rules, and crisis management procedures within the Eurozone were all prompted by the crisis, which prompted reforms and reinforced institutions. During EDC, a total volatility spillover of 76.47% was generated. Still, during Pre-EDC (83.54%), more volatility spillover was generated as the GFC indicated a substantial economic slowdown, which impacted global economies in the long term.

The US (41.35%) and Germany (42.16%) were the primary net transmitters despite their substantial involvement in the European debt crisis (EDC). Germany's favourable financial situation and cheap interest rates attracted European capital, which affected the cost of borrowing for other nations in the eurozone. This might mean taking on more debt for economies that aren't as strong. Germany promoted severe austerity measures as part of rescue packages for crisis-stricken nations, claiming they were essential for restoring fiscal discipline and paying off debt. Critics said that this strategy, which stabilized finances, made things worse for Southern Europeans in terms of unemployment and social suffering. Increased risk aversion and stricter loan restrictions resulted from the 2008 global financial crisis, which began in the USand sent shockwaves throughout European economies. The massive quantitative easing programs launched by the US Federal Reserve to stimulate the US economy indirectly affected Europe via investment injection into global markets. This could affect bond rates and risk perception. The USand Germany weren't just concerned with the European crisis; they had to deal with their own political and economic issues. There was a tangled web of interrelated causes in the European debt crisis, including weak points at home, systemic problems in the Eurozone, and worldwide economic uncertainty. It is too simplistic to pin the blame on individual actors. Germany's participation in European stability institutions and financial aid to bailouts were also beneficial contributions. The USalso contributed to the liquidity pool through international cooperation initiatives.

During EDC in overall countries (including proxy, i.e., PIIGS), PIIGS (-30.40%) and Kenya (-31.13%) were identified as the primary receptor, and the US (41.35%), Germany (42.16%) were identified as the primary transmitter of the volatility spillover, and these countries has shown high interconnectedness (Fig. 4.12). PIIGS (-30.40%) indicates that these countries absorbed the majority of volatility transmitted during the EDC (EDC). Their economies were already at risk from high debt levels, fiscal deficits and weak banking systems, making them more vulnerable to external shocks.As an emerging economy, Kenyahas a volatile absorption, demonstrating its financial markets' susceptibility to global economic disturbances. The effects may have been compounded by limited financial diversification and dependence on external trade and investment. As the US(41.35%), the world’s largest economy with a deep financial market, the US served as a significant channel through which volatility was transmitted. The impact on the world would have been more significant, given US financial institutions are at the centre of interconnected global markets.During Germany (42.16%),as the largest and most stable economy in the EU, Germany took on two roles during the crisis. Its central place in the EU financial system and heavy trade connections with other countries transmitted volatility.The results indicate a high level of interconnectedness among all these countries during the emergence of the EDC. This reflects the ripple effects of the globalized character of financial and moneyed interaction, where economic and financial shocks in large economies are transmitted to smaller and more vulnerable ones.This was a systemic risk crisis, where a shock in one part of the world (for example, in Europe, during the euro-area debt crisis) got transmitted globally through trade, investment, and financial links.The economic and financial integration indicated that the role of the US and Germany as significant transmitters reflects the dominant position of both economies in the global financial system. The bilateral economic interactions affect both countries' international capital flows, trade networks, and investment patterns.As receptors, this suggests that economic integration is asymmetric; the smaller or weaker economies absorb the economic shocks disproportionately (the PIIGS and Kenya).PIIGS countries may also have displayed characteristics such as high debt-to-GDP ratios, dependence on external funding, and sluggish economic growth that made them structurally vulnerable and heightened their sensitivity to volatility.Kenya remained vulnerable to external fluctuations as an emerging market heavily reliant on foreign investment, and the price of global commodities had higher spillover effects due to uncertainty and risk aversion during EDC. Investors withdrew funds from more volatile areas (such as PIIGS, Kenya) and flocked to more stable regions (for example, US and German assets), enhancing the volatility transmission.

During EDC, it transmits significant volatility to other markets: India (15.89%), Brazil (18.78%), and Mexico (25.60%). This means that shocks originating in these economies are transmitted to a wide range of other economies, having a systematic impact at the global level as Mexico is a significant exporter with close links to the U.S. economy through trade and investment flows. During downturns, when U.S. volatility can heighten Mexico's role as a transmitter, the impact of U.S. downturns has this amplification as a function of Mexico's economic exposure. Brazil is a heavy commodity exporter, so its market mirrors global risk sentiment. Brazil is an essential transmitter during economic downturns when volatility in commodity prices can affect other countries dramatically. India is an emerging economy that is opening up to global trading markets more intensely every year, which leads to its volatility affecting others. Its influence during EDC is also due to its position as a regional leader within South Asia. Saudi Arabia (-19.44%), Malaysia (-13.34%) and South Korea (-11.27%) as these countries in are primary receptors of volatility spillovers, which means their financial markets are more sensitive to shocks from other economies during margins of emerging disturbance, rather than other economies being sensitive to their shocks. As a major oil exporter, Saudi Arabiais heavily reliant on oil prices and, as such, is sensitive to external shocks in the energy market. Its negative percentage indicates its position as a net absorber of global volatility. Malaysia is a trade-dependent economy with the most exposure to global supply chain disruptions and fluctuations in commodity prices due to economic downturns. As an extremely export-reliant economy, South Korea is highly sensitive to upturns and global trade downturns, making it a receptor of external shocks in EDC. Countries acting as transmitters tend to be larger or more united economically, have sizeable financial connections or rely more on commodities. Receptor countries tend to have smaller, trade-oriented economies with less capacity to transmit shocks externally. When economies are closely integrated, they hold the potential to serve as amplifiers, spreading volatility across borders. Investment strategies indicate that investors could seek to diversify portfolios by reducing exposure to transmitter countries during downturns and exploring opportunities in receptor countries that may benefit from potential external stabilization measures.

Among frontier countries, Romania (11.40%) and Croatia (10.88%) were identified as the significant transmitters; on the other side Kazakhstan (-22.54%), Nigeria (-19.47%), and Bulgaria (-17.11%) were identified as the primary receptor of the volatility spillover.Romania (11.40%) and Croatia (10.88%) were the significant transmitters, implying that these markets were actively transmitting volatility to other markets during the crisis.It could be because they are economically linked to European markets or because they have systemic vulnerabilities that, for various reasons, made them a channel for amplifying and exporting market stress. Kazakhstan (-22.54%), Nigeria (-19.47%), and Bulgaria (-17.11%) were the primary receptors, absorbing incoming volatility but playing a minor role in seeding it could be as these economies may have been more insulated from external shocks either through structural dependencies (e.g. oil prices, trade relations) or weaker financial systems absorbing volatility from more interconnected markets.Geopolitical and Economic Integration: Romania and Croatia were more geographically and economically proximate to the European Union, implying more substantial trade and financial links and making them natural transmitters.

Kazakhstan and Nigeria's reliance on oil and endowments may help elucidate their receptor roles, as global market shocks disproportionately impact these economies.The maturity of the market: Frontier markets like Bulgaria can show receptor anatomy due to low liquidity and investor confidence, which makes them more susceptible to contagion.

Among developed countries, Germany (42.16%), the US (41.35%), and Australia (12.97%) were identified as primary net transmitters, and Spain (-31.13), Japan (-7.11%), Australia (-4.17%) as the major net receptor of the volatility spillover. Germany, the biggest economy of Europe and a central component of the Eurozone, was a major transmitter of volatilities.The European financial system’s reliance on them and their robust trade with Europe enhanced their clout during the crisis.The US, whose financial markets were dominant globally, imported volatility to other nations.Its role as a transmitter was aided by the interlinkages between US financial institutions and the rest of the world’s dependency on the US dollar.Australia’s close linkages with global commodities markets and globalised financial systems helped transmit this volatility, particularly in economies in the East-Asia Pacific.Being one of the epicentres of the European Debt Crisis, Spain experiencedsignificant volatility due to its banking sector's exposure and fiscal instability.Its economic woes mirrored the broader woes of the eurozone’s periphery.Due partly to its safe-haven status that attracted capital flows in times of uncertainty, Japan was a receptor, not a transmitter.Although it is a net transmitter overall, Australia's role as a receptor suggests this can be both ways; it is a volatility sink, but it also feeds, depending on the market.

Moreover, among all countries, Germany (124.32%), the US (121.90%), and Mexico (103.97%) were identified as the significant transmitter (“To other”), and Spain (86.01%), Australia (84.69%) (“From Other”) (Fig. 4.13) (Table 4.5.0).

Liow (2015) also revealed that the Lehman turbulence and the EDC have influenced the interdependence of volatility and spillover dynamics, demonstrating varied directions and co-movement patterns. Ultimately, the Southern European sovereign debt crisis has not exacerbated the volatility spillover effects beyond the levels observed after the Lehman Brothers collapse. During the EDC crisis, Leung (2020) revealed a general increase in the spillover between the exchange rate and equity markets. Second, the increased spillover from the exchange rate markets to the DJI during the euro debt crisis and from the FTSE 100, N225 to the DJI during the global financial crisis can be explained by both pure contagion (caused by irrational investor behaviour) and fundamental contagion (assessed by macroeconomic fundamentals). Leung et al. (2017) also observed that during times of crisis, there is more spillover between the exchange rate and equity markets. Second, the increased spillover between the FTSE 100 and N225 to the DJI during the global financial crisis and from the exchange rate markets to the DJI during the euro debt crisis can be explained by both pure contagion (linked to the actions of irrational investors) and fundamental contagion (measured by macroeconomic fundamentals). Guru and Yadav (2023) also revealed high interconnectedness among the Asia-Pacific region stock market. Thus, this panel inferred that during such banking crises,the US, Germany, and Mexico stock markets were dominant; even PIIGS countries indicated high interconnectedness as return spillover receivers from the other stock markets.

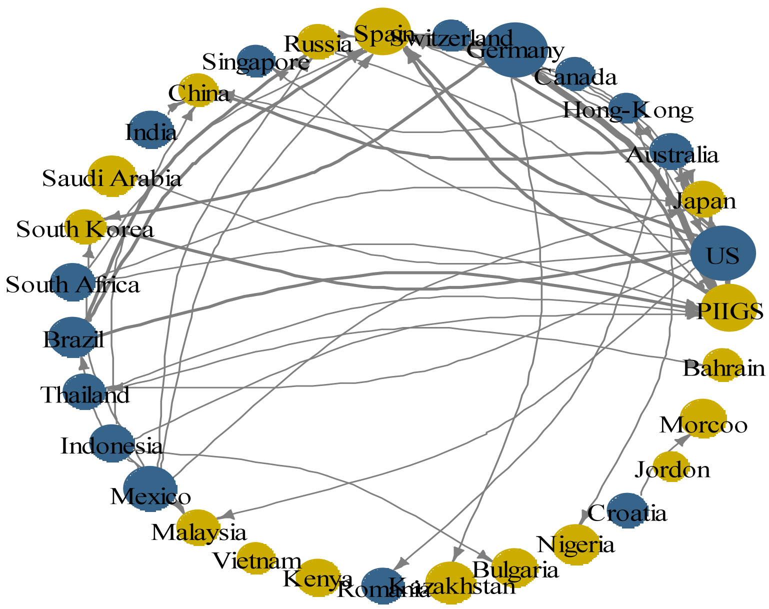
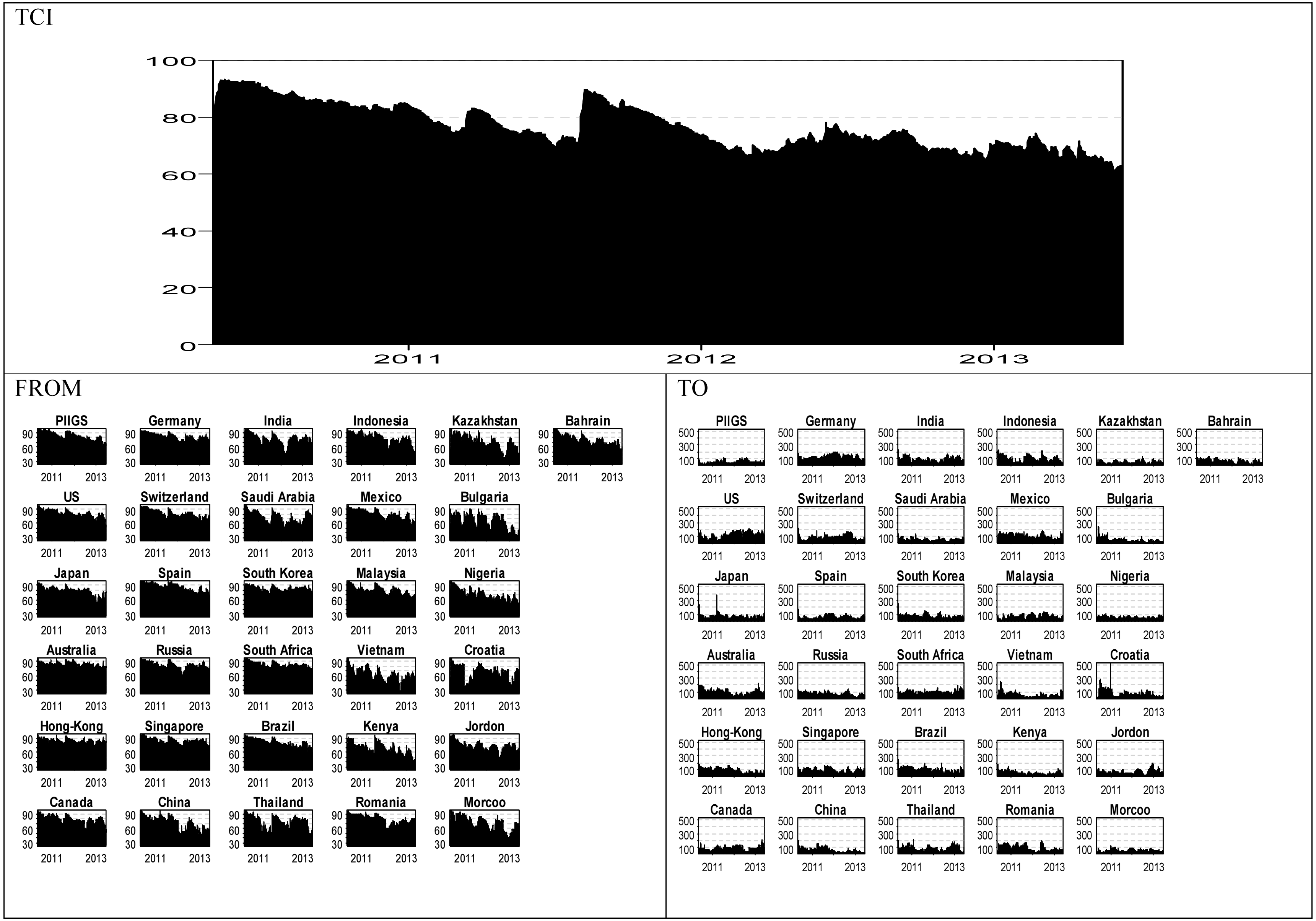


Fig. 4.12: During EDC, interconnectedness among the developed, emerging, and frontier countries.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).



TCI
FROM
TO
PIIGS
Germany
India
Indonesia
Kazakhstan
Bahrain
US
Switzerland
Saudi Arabia
Mexico
Bulgaria
Japan
Spain
South Korea
Malaysia
Nigeria
Australia
Russia
South Africa
Vietnam
Croatia
Hong-Kong
Singapore
Brazil
Kenya
Jordon
Canada
China
Thailand
Romania
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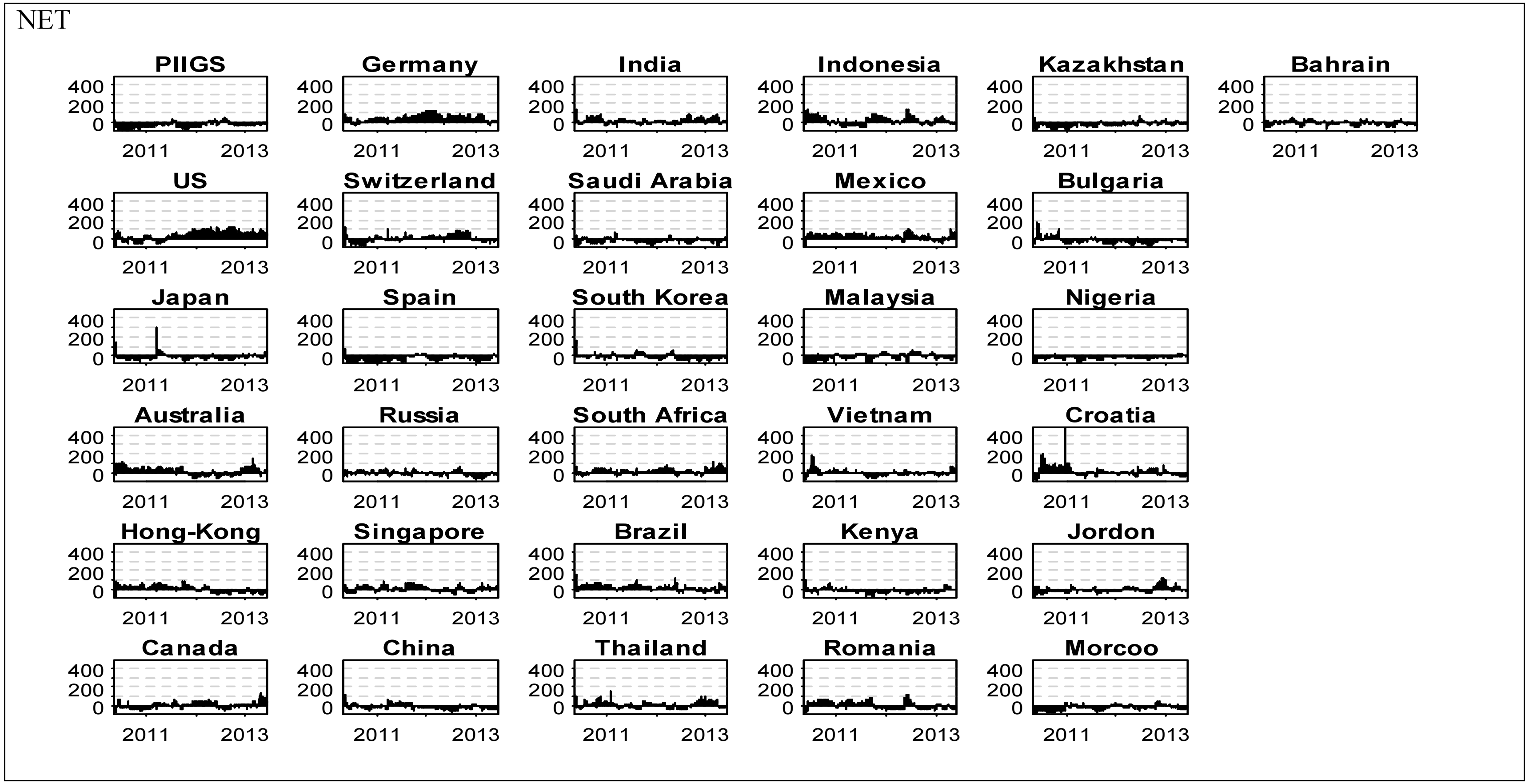


Fig. 4.13: During EDC,"TO", "FROM", and "NET" spillover among the developed, emerging, and frontier countries.

Table 4.5.0: During EDC, interconnectedness among the developed, emerging, and frontier countries TVP-VAR in the EDC. (Source: Author using R software).

	PIG	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
PIG	**17.0**	5.2	2.1	2.5	2.9	2.7	8.4	5.7	6.2	3.4	2.9	1.5	2.4	0.8	1.3	3.9	4.9	2.8	2.8	2.9	1.8	1.2	1.7	2.8	1.7	1.0	1.4	1.9	1.8	1.4	1.3	83.1
US	2.2	**19.5**	2.0	2.6	2.4	7.1	8.2	4.7	1.3	2.5	2.8	1.5	2.2	1.5	2.4	4.5	5.0	1.8	2.5	4.9	2.0	2.1	1.3	2.3	1.4	1.2	1.2	2.5	1.5	1.4	1.7	80.6
JN	1.7	5.3	**22.1**	5.4	4.0	4.1	3.6	2.4	1.8	1.7	2.4	3.3	2.4	2.6	2.7	4.1	1.9	1.3	2.0	3.5	2.8	2.1	1.7	3.0	1.2	1.8	1.6	1.6	2.2	1.4	2.4	77.9
AA	1.3	5.8	3.1	**15.3**	5.6	5.0	5.5	2.8	1.6	2.4	3.2	3.0	2.4	1.9	3.6	3.9	3.0	2.4	2.5	5.5	1.8	1.6	1.2	3.4	1.5	1.0	1.1	2.6	2.7	1.2	2.4	84.7
HG	1.6	4.9	2.5	5.4	**16.2**	4.0	3.9	1.7	1.5	2.4	5.3	3.0	3.9	2.6	4.4	3.1	3.7	3.4	3.0	3.8	1.5	1.4	1.2	3.9	1.2	1.3	1.2	2.4	1.7	2.2	1.8	83.8
CAA	1.6	7.7	1.5	3.4	2.8	**21.3**	5.3	2.8	1.2	3.6	3.5	1.8	2.9	1.4	3.3	3.6	5.4	3.1	2.6	6.0	1.2	1.4	1.2	2.6	0.9	1.0	1.3	2.1	1.5	0.8	1.5	78.7
GY	2.3	6.4	1.7	3.4	2.6	4.3	**17.8**	7.9	1.6	3.2	3.8	1.9	2.8	0.7	2.1	5.5	4.7	2.0	2.6	4.1	1.9	1.9	1.7	3.2	1.2	1.0	1.2	2.2	1.7	1.1	1.7	82.2
SD	2.0	5.6	2.0	2.8	1.5	2.6	10.3	**19.8**	1.2	2.6	3.5	1.4	2.5	0.9	1.8	6.9	4.4	1.9	2.6	4.0	2.0	2.1	1.7	3.1	1.4	1.0	1.4	2.4	1.7	1.4	1.7	80.2
SN	9.4	4.5	1.8	2.4	2.3	3.0	8.2	5.1	**14.0**	3.4	3.3	1.5	2.5	0.9	1.4	3.8	4.8	2.9	2.6	3.1	2.1	1.2	1.7	2.8	1.9	1.1	1.7	2.0	1.8	1.5	1.7	86.0
RUS	1.6	4.0	1.8	3.4	3.2	4.7	4.9	3.0	1.4	**17.9**	3.2	1.9	4.4	1.3	2.3	5.1	5.7	3.0	3.3	4.5	1.5	2.1	2.1	3.5	0.9	1.4	1.0	2.4	1.9	1.4	1.6	82.1
SA	1.3	4.8	1.9	4.8	4.8	3.2	4.3	2.6	1.8	2.3	**16.2**	1.5	4.6	1.8	3.2	3.4	4.3	4.4	4.4	3.6	1.8	1.7	1.7	3.1	1.0	1.5	1.5	2.9	1.8	2.1	2.0	83.8
CA	1.4	1.7	3.6	5.7	5.5	1.8	1.8	1.4	1.9	1.4	1.7	**29.2**	3.3	2.1	2.3	1.7	1.6	2.4	3.1	3.1	2.7	1.5	1.8	3.9	2.1	1.5	1.9	2.4	2.1	1.3	2.1	70.8
IA	1.1	3.7	2.3	3.1	2.9	2.6	2.9	2.4	1.6	3.6	4.1	1.4	**23.6**	1.2	2.3	3.7	3.7	4.1	4.2	3.2	2.2	1.5	1.4	3.1	1.5	1.5	1.5	2.8	2.7	1.7	2.5	76.4
SAA	1.4	4.0	2.5	2.0	2.3	2.5	1.9	1.9	1.3	2.0	2.4	3.4	2.5	**28.4**	1.3	2.2	2.6	2.6	1.9	2.1	2.3	2.2	2.0	3.0	1.9	3.0	1.5	2.3	2.6	4.3	3.9	71.6
SK	1.5	5.9	2.3	4.5	4.5	4.0	5.0	2.6	1.4	2.3	4.2	2.0	3.4	1.0	**17.7**	3.5	4.8	2.9	3.1	4.6	1.7	1.7	1.9	2.6	1.2	1.1	1.6	2.5	1.8	0.9	1.9	82.3
SA	1.3	4.9	1.5	3.3	2.1	3.8	5.8	5.7	1.5	4.2	3.3	1.3	4.7	1.4	2.0	**16.4**	4.4	2.8	3.3	5.2	2.4	2.5	1.7	2.7	1.8	0.9	1.4	2.2	2.3	1.3	2.2	83.7
BL	2.2	5.3	1.8	3.0	2.7	5.0	4.8	2.9	1.6	3.0	3.0	2.0	2.5	0.9	3.3	3.9	**20.5**	2.6	2.5	6.6	1.3	1.9	2.1	4.0	1.1	1.1	1.2	2.7	1.4	1.2	1.9	79.5
TD	1.0	4.3	1.9	3.0	3.2	2.1	2.9	2.5	2.2	1.9	3.5	2.0	3.7	1.4	2.0	2.5	1.7	**26.0**	6.8	2.7	2.6	1.4	1.0	2.4	1.4	1.6	2.0	3.4	3.0	1.8	2.2	74.0
IA	1.1	3.3	2.1	3.0	2.9	1.9	3.3	2.8	1.7	2.5	3.8	1.5	4.1	1.3	2.8	3.1	2.3	5.3	**21.5**	2.5	2.6	1.6	2.5	3.0	1.7	2.0	3.4	3.8	3.0	2.1	1.7	78.5
MO	1.4	5.3	1.8	3.9	3.2	4.5	4.0	2.7	1.0	2.4	2.5	2.5	3.4	1.7	2.9	3.6	4.9	2.4	2.9	**21.6**	1.8	1.8	1.6	4.1	1.6	1.2	1.1	2.8	1.7	1.7	2.3	78.4
MA	1.2	4.0	2.7	2.8	2.6	1.6	3.2	2.5	2.7	1.9	2.7	2.1	3.5	2.3	2.4	3.1	2.4	3.7	4.3	2.6	**21.3**	2.1	1.1	3.4	2.0	1.9	1.7	3.1	3.4	2.3	3.4	78.7
VN	1.4	1.9	2.2	2.2	2.4	1.7	2.4	2.1	1.3	1.7	1.5	2.1	1.7	2.2	2.2	2.8	2.7	1.5	2.5	2.5	2.1	**39.5**	1.8	2.3	1.4	2.1	2.3	2.0	1.9	1.8	1.9	60.5
KA	1.3	2.8	2.3	2.1	2.0	1.9	3.3	2.3	2.2	2.3	3.0	2.2	2.3	3.0	2.7	2.3	2.0	2.2	3.4	2.3	1.6	1.8	**34.2**	2.1	1.4	1.7	2.5	1.7	1.5	1.6	2.1	65.8
RA	1.7	2.2	2.7	5.2	3.6	2.1	2.7	2.2	1.6	2.6	3.2	3.0	3.7	2.3	2.2	2.3	3.1	4.0	3.4	4.3	2.6	1.2	1.5	**21.3**	1.4	1.9	1.9	3.5	2.3	1.6	2.6	78.7
KN	1.5	2.9	1.9	2.1	2.6	2.0	3.5	2.1	1.8	1.7	1.9	2.1	2.3	1.7	2.1	1.9	1.9	2.5	3.1	2.5	2.6	2.6	2.3	2.0	**29.7**	3.2	2.0	2.6	3.8	3.4	1.9	70.4
BA	1.3	2.5	2.5	1.9	1.9	1.7	2.0	1.7	1.9	1.9	1.9	2.0	2.3	2.2	2.1	1.4	1.4	2.2	3.9	2.6	2.3	1.6	3.0	3.5	2.1	**34.9**	2.2	2.5	1.7	3.0	2.1	65.1
NA	1.6	2.2	2.2	3.1	2.3	2.0	2.3	1.9	2.5	2.1	3.1	2.3	2.8	1.4	2.9	2.6	1.9	2.9	2.5	2.4	2.5	2.1	2.0	3.1	1.5	2.4	**30.9**	2.7	2.3	2.0	1.8	69.1
CA	1.1	3.0	1.5	2.8	1.8	1.3	2.7	1.9	1.5	2.0	2.8	2.2	3.7	1.6	1.6	2.2	2.7	2.4	4.3	2.1	2.3	3.3	1.9	2.9	1.9	1.4	1.3	**33.0**	3.0	1.5	2.4	67.0
JON	1.5	2.5	2.0	2.9	2.0	1.6	2.2	1.9	2.0	2.2	1.8	2.2	3.9	2.3	2.0	2.7	1.4	3.4	3.6	1.7	3.4	2.0	1.5	2.6	3.4	1.7	2.3	3.5	**27.8**	1.6	4.6	72.2
MO	1.6	2.8	2.2	2.0	2.1	1.1	2.3	2.0	1.7	2.1	2.8	2.0	2.8	2.7	1.7	2.3	2.4	2.7	1.9	2.7	2.9	2.1	1.8	2.5	2.6	3.2	2.3	3.5	2.4	**29.9**	3.1	70.1
BH	0.9	2.6	3.0	3.1	2.0	1.8	2.7	2.0	1.9	1.8	2.9	2.2	3.0	3.3	2.0	2.6	2.5	4.6	2.8	2.4	3.2	1.9	1.5	3.4	1.8	1.7	1.3	2.7	4.5	2.9	**25.3**	74.7
TO	52.7	121.9	65.2	97.7	86.4	87.5	124.3	85.8	54.9	72.6	90.0	62.7	92.3	52.2	71.0	98.0	98.3	86.0	94.1	104.0	65.3	55.2	51.1	90.1	47.8	48.0	49.7	77.9	67.7	54.1	66.1	2370.4
Inc.Own	69.6	141.4	87.2	113.0	102.6	108.8	142.2	105.6	68.9	90.5	106.2	91.9	115.9	80.6	88.7	114.4	118.8	112.0	115.6	125.6	86.7	94.8	85.3	111.4	77.5	82.9	80.5	110.9	95.5	84.0	91.4	
NET	-30.4	41.4	-12.8	13.0	2.6	8.8	42.2	5.6	-31.1	-9.5	6.2	-8.1	15.9	-19.4	-11.3	14.4	18.8	12.0	15.6	25.6	-13.3	-5.3	-14.7	11.4	-22.5	-17.1	-19.5	10.9	-4.5	-16.0	-8.6	**76.5**

➢ Robustness during EDC

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Examining the spillover curves illustrated in Fig. 4.14 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

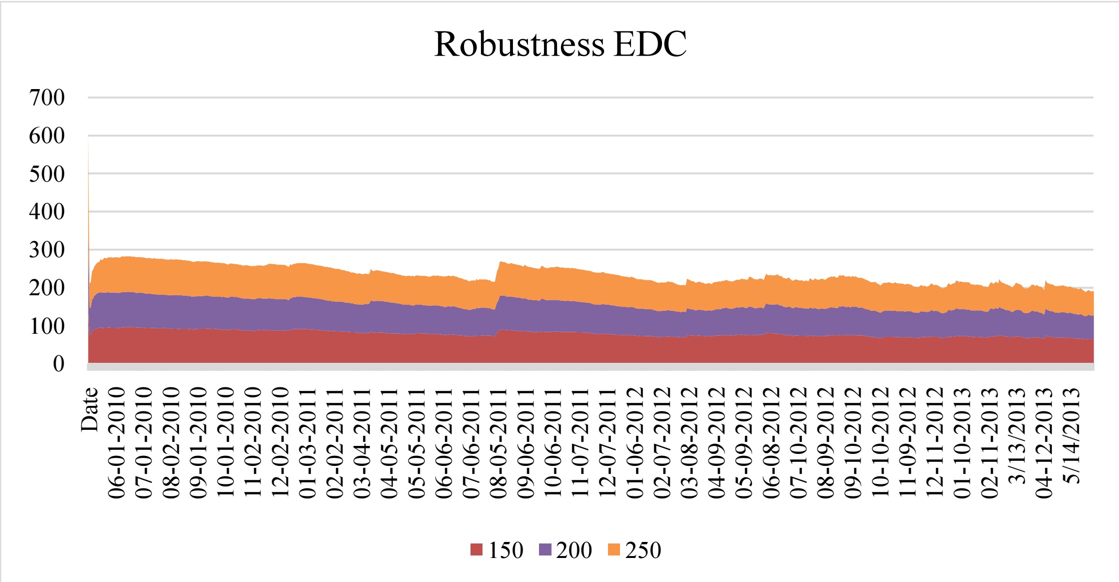


Fig. 4.14: During EDC, interconnectedness among the developed, emerging, and frontier countries.

Note: Red colour shows 150 window size, purple shows 200 window size, and orange shows 250 window size

➢ TVP-VAR-BK Framework (2018)

During European debt crises (EDC), Fig. 4.15 indicated interconnectedness among the stock market in three periods, i.e., Short (1-4 Days), Medium (4 - Inf.), and Total period. TVP-VAR-BK Model indicated short connectedness (7.2 %) (Table - 4.6.0), medium connectedness (67.18 %) (Table- 4.6.1), and total connectedness 74.38% (Table- 4.6.2). Thus, it indicates that EDC was not impacted as much in the short period, even in the pre-period. Moreover, Fig. 4.16 indicates the volatility spillover and interconnectedness in the EDC, which indicates fluctuation reduced as a series of crises GFC and Pre-EDC period highly influenced the stock markets of the selected country.

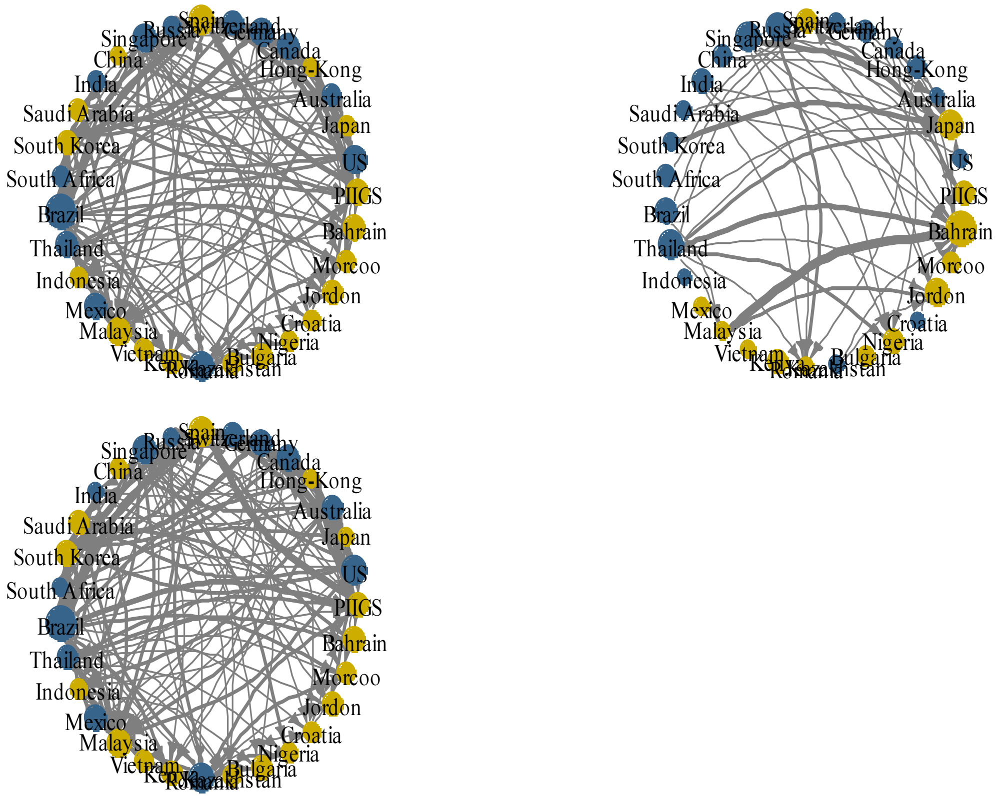


Fig. 4.15: During EDC, interconnectedness among the developed, emerging, and frontier countries.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Table 4.6.0: Short period (Panel A) using TVP-VAR-BK Model during EDC in the selected developed, emerging, and frontier countries.(Source: Author using R software)

	PIG	**US**	**JN**	**AA**	**HG**	**CAA**	**GY**	**SD**	**SN**	**RUS**	**SA**	**CA**	**IA**	**SAA**	**SK**	**SA**	**BL**	**TD**	**IA**	**MO**	**MA**	**VN**	**KA**	**RA**	**KN**	**BA**	**NA**	**CA**	**JON**	**MO**	**BH**	**FM**
PIG	**4.1**	0.6	0.4	0.6	0.4	0.4	1.0	0.6	1.9	0.5	0.4	0.3	0.3	0.3	0.2	0.3	0.4	0.4	0.2	0.3	0.1	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.1	0.1	10.8
US	0.4	**3.2**	0.3	0.4	0.2	0.6	0.9	0.5	0.1	0.3	0.3	0.3	0.2	0.1	0.2	0.3	0.5	0.4	0.2	0.4	0.1	0.1	0.1	0.4	0.1	0.1	0.1	0.2	0.1	0.1	0.1	7.9
JN	0.4	0.7	**7.7**	1.8	0.7	0.5	0.6	0.4	0.4	0.3	1.0	1.3	0.4	0.9	1.3	0.2	0.5	0.7	0.4	0.2	0.4	0.2	0.3	0.5	0.2	0.2	0.8	0.3	0.3	0.2	0.4	16.2
AA	0.2	0.5	1.3	**3.1**	0.7	0.3	0.4	0.1	0.4	0.2	0.7	0.9	0.2	0.5	0.9	0.1	0.3	0.6	0.3	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.4	0.1	0.2	0.1	0.1	10.5
HG	0.2	0.2	0.3	0.5	**1.5**	0.3	0.3	0.1	0.2	0.3	0.4	0.3	0.2	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.1	0.0	0.1	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.1	5.8
CAA	0.2	0.5	0.1	0.2	0.2	**2.4**	0.4	0.2	0.1	0.4	0.5	0.2	0.3	0.1	0.1	0.3	0.6	0.4	0.2	0.5	0.1	0.1	0.1	0.4	0.1	0.1	0.3	0.1	0.1	0.1	0.1	6.9
GY	0.7	0.9	0.2	0.3	0.2	0.4	**2.8**	1.2	0.2	0.5	0.3	0.1	0.2	0.1	0.2	0.6	0.3	0.2	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	8.0
SD	0.5	0.5	0.2	0.3	0.2	0.2	1.2	**2.5**	0.1	0.3	0.2	0.1	0.2	0.1	0.2	0.5	0.3	0.2	0.1	0.2	0.1	0.1	0.1	0.3	0.1	0.0	0.1	0.1	0.1	0.1	0.1	6.4
SN	1.1	0.5	0.3	0.4	0.2	0.4	1.2	0.7	**3.6**	0.5	0.5	0.3	0.3	0.3	0.1	0.5	0.6	0.5	0.2	0.3	0.2	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.2	0.1	0.1	10.3
RUS	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	**1.6**	0.2	0.1	0.2	0.1	0.1	0.3	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.0	3.6
SA	0.2	0.1	0.2	0.2	0.3	0.3	0.3	0.1	0.1	0.4	**1.6**	0.2	0.3	0.1	0.1	0.2	0.3	0.5	0.1	0.2	0.1	0.1	0.0	0.4	0.1	0.1	0.3	0.1	0.1	0.1	0.1	5.6
CA	0.1	0.2	0.7	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.5	**3.4**	0.1	0.4	0.3	0.1	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.4	0.1	0.2	0.1	0.1	5.6
IA	0.1	0.1	0.1	0.2	0.3	0.1	0.1	0.1	0.1	0.3	0.3	0.1	**2.0**	0.1	0.1	0.1	0.1	0.3	0.2	0.1	0.0	0.1	0.0	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.1	3.7
SAA	0.1	0.2	0.4	0.4	0.5	0.2	0.4	0.2	0.3	0.2	0.3	0.4	0.1	**3.4**	0.2	0.2	0.1	0.2	0.3	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.3	0.1	0.2	0.1	0.1	6.4
SK	0.1	0.3	0.5	0.6	0.3	0.3	0.2	0.1	0.1	0.2	0.3	0.4	0.1	0.2	**1.5**	0.1	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	5.8
SA	0.2	0.2	0.1	0.2	0.2	0.2	0.4	0.3	0.1	0.4	0.2	0.1	0.2	0.1	0.1	**1.6**	0.2	0.2	0.1	0.3	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	4.0
BL	0.1	0.2	0.1	0.1	0.2	0.4	0.2	0.1	0.1	0.4	0.4	0.1	0.3	0.0	0.1	0.3	**1.4**	0.3	0.1	0.3	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.1	4.7
TD	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.4	0.1	0.3	0.1	0.1	0.1	0.2	**1.9**	0.1	0.2	0.1	0.1	0.1	0.4	0.1	0.1	0.2	0.1	0.1	0.0	0.1	4.2
IA	0.1	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.1	0.2	0.3	**2.5**	0.1	0.2	0.1	0.1	0.2	0.1	0.2	0.3	0.1	0.1	0.1	0.1	5.4
MO	0.2	0.5	0.1	0.2	0.4	0.7	0.5	0.2	0.1	0.5	0.3	0.1	0.3	0.1	0.1	0.5	0.6	0.3	0.2	**3.2**	0.1	0.1	0.1	0.4	0.1	0.1	0.2	0.1	0.1	0.1	0.1	7.2
MA	0.1	0.1	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.4	0.3	0.2	0.2	0.2	0.1	0.4	0.4	0.4	0.2	**8.5**	0.1	0.1	0.3	0.2	0.2	0.3	0.2	0.9	0.1	1.0	8.3
VN	0.2	0.2	0.3	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	**6.2**	0.1	0.3	0.1	0.2	0.1	0.1	0.1	0.1	0.1	4.1
KA	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.4	0.2	0.4	0.3	0.1	0.3	0.1	0.1	**11.6**	0.4	0.1	0.2	0.3	0.2	0.2	0.2	0.2	7.2
RA	0.4	0.2	0.2	0.3	0.6	0.5	0.4	0.3	0.2	0.8	0.8	0.2	0.7	0.2	0.1	0.3	0.5	0.8	0.2	0.4	0.1	0.1	0.1	**4.4**	0.1	0.1	0.4	0.3	0.1	0.1	0.1	9.6
KN	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.2	0.3	0.1	0.2	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.0	0.1	0.3	**1.9**	0.1	0.2	0.1	0.1	0.1	0.1	3.4
BA	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1	**5.0**	0.3	0.1	0.1	0.2	0.1	4.7
NA	0.2	0.2	0.8	0.4	0.2	0.6	0.3	0.2	0.3	0.4	0.8	0.6	0.5	0.6	0.2	0.2	0.5	0.9	0.3	0.2	0.2	0.1	0.2	0.7	0.3	0.2	**11.4**	0.2	0.2	0.1	0.1	10.8
CA	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.3	0.1	0.1	0.2	**3.1**	0.1	0.1	0.1	4.0
JON	0.1	0.2	0.4	0.5	0.3	0.2	0.3	0.2	0.2	0.5	0.6	0.4	0.2	0.3	0.3	0.2	0.4	0.7	0.2	0.2	1.7	0.1	0.3	0.2	0.4	0.2	0.4	0.3	**19.7**	0.2	1.6	11.7
MO	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.3	0.4	0.2	0.2	0.3	0.1	0.2	0.3	0.3	0.1	0.2	0.1	0.2	0.1	0.4	0.1	0.2	0.2	0.1	0.1	**3.7**	0.2	5.5
BH	0.3	0.4	0.5	0.3	0.4	0.5	0.5	0.4	0.3	0.3	0.4	0.4	0.5	0.6	0.2	0.2	0.4	1.0	0.2	0.2	2.4	0.3	0.3	0.4	0.4	0.3	0.3	0.4	1.6	0.8	**20.6**	15.0
TO	6.7	8.5	8.9	10.5	8.5	9.0	11.1	7.1	6.8	9.5	12.2	8.6	7.5	6.8	6.5	6.6	9.5	11.6	5.5	6.4	7.4	3.1	3.1	9.1	3.9	3.2	7.2	4.1	5.7	3.7	5.2	223.1
Inc.Own	10.8	11.6	16.6	13.6	9.9	11.4	13.9	9.7	10.5	11.1	13.8	12.0	9.4	10.1	8.0	8.2	10.9	13.6	8.0	9.5	15.9	9.3	14.7	13.5	5.8	8.2	18.6	7.2	25.4	7.4	25.8	
NET	-4.1	0.6	-7.3	0.0	2.7	2.1	3.1	0.8	-3.5	5.9	6.7	3.0	3.8	0.4	0.7	2.6	4.8	7.4	0.0	-0.9	-0.9	-1.0	-4.1	-0.6	0.5	-1.5	-3.6	0.1	-6.0	-1.9	-9.8	**7.2**

Table 4.6.1: Medium period (Panel B) using the TVP-VAR-BK Model in the selected developed, emerging, and frontier countries.(Source: Author using R software)

	PIG	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
PIG	**10.4**	4.9	1.4	2.4	1.5	3.4	8.7	7.6	2.3	3.3	3.9	1.5	2.8	0.7	0.6	3.2	6.6	4.0	1.0	3.3	0.4	0.5	0.4	5.3	1.2	0.5	1.2	0.7	0.8	0.6	0.2	74.7
US	2.3	**18.1**	1.6	3.4	2.0	7.0	8.4	5.6	0.6	2.5	2.4	1.6	1.6	0.7	2.2	4.1	5.4	2.2	1.4	5.9	0.6	1.0	0.7	2.1	1.2	0.8	0.8	1.5	0.7	0.5	0.3	70.8
JN	1.2	5.6	**19.2**	5.0	1.9	2.8	5.3	3.9	0.4	1.1	2.3	2.3	1.0	1.0	1.7	4.3	2.5	1.5	1.3	2.8	0.7	1.4	0.7	1.4	0.3	0.7	1.3	1.0	0.6	0.4	0.7	56.9
AA	1.8	7.7	1.7	**12.5**	3.5	5.7	6.7	5.1	0.6	2.8	3.3	1.6	2.0	0.6	2.4	4.5	5.1	2.4	1.4	5.4	0.7	0.9	1.0	2.9	0.5	0.7	0.6	1.3	0.6	0.3	0.3	74.0
HG	1.4	5.7	1.5	4.3	**12.2**	6.3	5.0	3.1	0.5	4.1	6.7	1.2	3.7	0.8	2.0	3.2	7.0	3.6	3.1	5.1	0.7	0.7	0.7	4.5	0.2	1.1	0.7	2.1	0.5	0.8	0.3	80.6
CAA	1.2	8.4	1.3	2.9	2.1	**16.8**	5.1	3.6	0.5	4.8	5.2	1.2	3.0	0.6	1.1	3.7	7.3	3.9	1.9	6.3	0.4	0.5	0.6	4.0	0.7	0.5	1.2	1.0	0.5	0.4	0.2	74.0
GY	2.0	6.6	1.4	3.0	1.9	5.5	**14.6**	8.6	0.9	4.0	4.4	0.9	2.8	0.6	1.0	4.8	6.2	3.3	1.4	4.5	0.5	0.8	0.7	4.1	1.0	0.4	0.8	1.0	0.6	0.6	0.4	74.6
SD	1.9	6.1	1.8	4.0	1.5	4.4	9.2	**17.6**	0.6	2.7	4.4	0.9	2.4	0.4	0.9	6.1	6.2	3.5	1.5	4.8	0.5	0.7	0.6	4.3	0.8	0.4	0.9	0.9	0.8	0.4	0.3	73.5
SN	8.5	3.8	1.2	2.2	1.3	3.7	8.6	6.9	**7.9**	3.0	3.5	1.4	2.6	0.5	0.6	3.1	7.3	3.9	0.7	3.3	0.4	0.6	0.8	4.8	1.3	0.5	1.2	0.7	1.0	0.5	0.2	78.1
RUS	1.1	4.3	0.9	3.1	3.8	6.0	4.1	3.2	0.6	**13.8**	5.3	1.2	5.6	0.5	1.2	5.2	9.2	4.8	2.8	5.4	0.6	0.5	0.6	6.2	0.5	0.5	0.7	1.6	0.7	0.6	0.3	81.0
SA	0.9	4.9	1.6	6.0	4.0	5.2	4.5	3.4	0.6	3.7	**15.1**	1.6	4.1	0.9	1.5	3.2	7.1	5.2	2.6	4.4	0.7	0.6	0.4	4.9	0.4	0.8	0.9	1.8	0.7	1.0	0.2	77.8
CA	1.3	2.7	2.5	6.2	3.8	1.5	1.6	1.0	1.0	2.0	2.9	**33.8**	1.6	1.4	2.9	0.8	2.4	2.7	2.0	3.1	1.0	0.8	0.7	2.3	1.1	1.2	1.9	1.9	1.6	1.0	0.6	57.2
IA	1.1	4.2	1.3	4.4	3.6	4.9	2.7	2.4	0.6	5.5	6.3	1.7	**20.0**	0.6	1.3	2.9	6.8	4.6	3.3	3.6	0.7	0.5	0.8	4.2	0.4	1.0	1.4	1.5	0.7	1.1	0.3	74.3
SAA	0.5	4.1	4.0	2.3	2.2	2.8	2.1	2.3	0.8	2.0	4.1	3.1	1.9	**28.6**	1.7	2.4	2.7	2.2	1.5	1.4	0.6	0.8	1.0	4.7	0.6	1.5	2.0	2.0	1.3	1.5	1.5	61.6
SK	1.2	6.6	1.5	4.0	2.6	5.6	6.4	5.4	0.9	4.4	4.9	1.1	3.2	0.4	**10.1**	3.3	7.5	4.4	2.9	6.5	0.6	0.9	0.7	3.5	0.8	0.5	1.0	1.1	0.5	0.3	0.2	82.7
SA	1.0	4.8	1.2	3.8	2.5	5.5	4.9	6.4	0.5	5.4	4.3	1.2	4.8	0.5	1.5	**14.4**	7.5	4.3	1.6	6.8	0.6	0.8	1.0	4.1	1.0	0.8	1.0	0.7	0.6	0.9	0.3	80.0
BL	1.8	5.4	1.0	3.1	2.9	5.9	4.9	4.3	0.9	3.9	4.4	1.2	2.9	0.5	1.4	4.1	**18.9**	5.1	1.3	6.5	0.5	0.7	0.6	6.6	0.8	0.8	0.8	1.3	0.8	0.5	0.3	75.0
TD	0.6	4.0	1.6	4.8	3.4	4.4	1.9	2.2	0.6	4.7	6.7	1.8	4.9	0.7	1.4	2.9	5.3	**19.2**	6.2	4.3	0.6	0.4	0.6	5.0	0.3	1.0	1.3	1.2	1.0	0.5	0.4	74.6
IA	0.8	4.2	1.7	4.6	3.1	4.2	3.1	2.9	0.5	3.4	5.9	1.7	4.6	0.7	1.4	2.3	4.9	6.2	**15.5**	3.4	0.8	0.4	1.1	6.3	0.5	0.8	2.5	2.3	1.0	0.9	0.4	76.6
MO	1.3	6.1	1.1	3.7	2.6	5.4	5.0	4.6	0.5	3.0	3.6	1.3	3.0	0.6	1.8	3.8	7.4	3.5	1.4	**18.7**	0.6	0.7	0.9	4.1	0.9	0.8	0.6	1.4	0.5	0.6	0.2	70.9
MA	0.7	3.8	1.2	4.1	3.8	2.6	2.8	2.0	0.9	3.8	5.1	2.2	4.0	0.9	2.7	2.6	5.9	5.1	3.6	4.4	**7.7**	0.5	0.5	3.7	1.8	1.1	1.2	2.2	1.0	0.6	0.9	75.6
VN	1.0	1.2	1.2	1.7	1.6	1.8	1.5	1.8	1.0	1.9	2.3	2.0	2.0	1.4	1.2	2.5	2.5	2.9	0.9	1.6	0.7	**42.6**	0.7	4.4	0.6	1.2	1.5	1.0	0.9	1.1	1.2	47.2
KA	0.7	2.5	1.5	2.6	2.0	3.1	3.2	2.0	1.0	1.5	3.3	1.3	1.7	2.7	1.6	1.9	4.2	2.6	1.4	2.8	0.6	0.6	**24.6**	4.8	0.5	1.1	1.3	1.8	0.7	1.1	0.7	56.6
RA	1.2	2.8	1.2	3.1	3.3	3.1	3.2	4.0	0.6	3.9	6.8	1.3	3.4	0.8	1.0	3.4	5.1	4.8	2.0	3.5	0.5	0.5	0.7	**20.7**	0.3	0.6	1.1	1.9	0.4	0.7	0.3	65.2
KN	0.8	1.3	1.0	1.4	1.9	0.9	1.5	1.4	1.3	2.5	2.8	1.3	1.4	2.1	0.9	1.9	3.0	2.6	1.9	1.2	2.5	0.9	1.4	1.9	**46.7**	0.9	2.2	1.0	1.9	1.8	0.7	48.0
BA	0.8	1.9	2.5	2.6	2.3	1.2	1.5	2.9	1.2	1.4	2.9	1.3	1.6	1.9	2.0	1.3	2.2	2.7	3.1	2.0	0.7	0.9	1.1	4.2	0.7	**34.9**	1.1	2.2	0.5	3.8	1.0	55.5
NA	0.5	1.9	2.4	1.9	2.1	1.8	1.0	1.0	0.9	1.6	5.0	1.8	2.3	1.6	2.4	1.1	2.5	3.3	2.4	1.7	0.5	0.5	1.4	5.1	0.8	1.6	**25.9**	1.3	0.6	0.7	0.5	52.0
CA	1.2	3.0	1.3	3.6	2.1	2.4	2.9	2.0	0.5	1.7	4.1	1.7	2.1	1.1	1.0	2.1	4.0	1.4	2.4	2.2	1.0	1.4	0.5	4.7	0.9	1.0	1.0	**37.4**	1.1	0.7	0.3	55.5
JON	0.5	1.8	2.2	3.9	1.1	1.6	0.7	0.9	1.0	1.7	3.2	2.3	3.3	3.0	0.8	2.2	2.7	3.3	1.2	1.3	1.7	1.3	0.4	2.7	1.3	0.9	1.5	2.4	**15.1**	1.1	1.9	53.4
MO	0.9	2.3	1.2	2.8	2.2	1.6	1.3	1.7	1.1	1.7	3.6	1.9	2.7	0.8	0.8	1.2	4.4	3.5	1.1	1.7	0.5	1.5	0.9	3.9	1.1	1.6	1.7	1.6	0.8	**38.4**	0.7	52.4
BH	0.5	1.2	3.4	2.0	1.3	1.5	1.1	1.4	0.6	1.9	1.9	1.2	1.6	5.3	1.3	1.6	2.6	3.9	2.3	1.5	2.2	0.8	0.7	2.1	0.7	1.7	0.9	1.2	1.7	2.3	**11.9**	52.5
TO	40.6	123.9	49.0	102.7	73.7	111.8	118.7	103.5	24.0	89.5	125.6	46.7	84.8	33.8	44.5	89.8	153.2	107.2	61.2	110.2	23.0	22.8	22.8	122.8	23.0	27.0	35.8	43.4	24.9	27.1	15.8	2082.7
Inc.Own	51.0	142.0	68.2	115.2	85.9	128.6	133.3	121.0	32.0	103.3	140.7	80.5	104.8	62.4	54.5	104.2	172.1	126.5	76.7	129.0	30.6	65.4	47.4	143.5	69.7	61.9	61.7	80.7	40.1	65.5	27.7	
NET	-34.1	53.1	-7.8	28.7	-6.9	37.8	44.1	29.9	-54.1	8.5	47.8	-10.5	10.5	-27.8	-38.2	9.7	78.3	32.6	-15.4	39.3	-52.6	-24.3	-33.9	57.5	-25.0	-28.4	-16.1	-12.2	-28.5	-25.3	-36.7	**67.2**

Table 4.6.2: Full period (Panel C) using TVP-VAR-BK Model in the selected developed, emerging, and frontier countries.(Source: Author using R software)

	PIG	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
PIG	**14.5**	5.5	1.8	2.9	1.9	3.7	9.6	8.1	4.2	3.8	4.4	1.8	3.1	1.0	0.8	3.4	7.0	4.4	1.2	3.5	0.5	0.6	0.5	5.6	1.4	0.6	1.5	0.8	0.9	0.7	0.3	85.5
US	2.6	**21.3**	1.8	3.8	2.2	7.6	9.3	6.0	0.7	2.8	2.7	1.8	1.8	0.8	2.3	4.4	5.9	2.6	1.6	6.3	0.8	1.1	0.8	2.5	1.3	0.9	0.9	1.6	0.8	0.6	0.4	78.7
JN	1.5	6.3	**26.9**	6.8	2.6	3.3	5.8	4.3	0.9	1.4	3.4	3.5	1.4	1.9	3.0	4.6	3.0	2.2	1.7	3.1	1.0	1.6	1.0	1.9	0.5	0.8	2.1	1.2	0.9	0.6	1.0	73.1
AA	2.0	8.2	2.9	**15.6**	4.2	6.0	7.0	5.2	1.0	3.0	4.0	2.4	2.2	1.0	3.3	4.6	5.4	3.0	1.7	5.6	0.9	1.0	1.1	3.1	0.7	0.8	0.9	1.5	0.9	0.4	0.4	84.5
HG	1.6	5.9	1.8	4.8	**13.6**	6.6	5.3	3.2	0.7	4.4	7.0	1.5	3.9	1.0	2.2	3.4	7.2	3.9	3.3	5.4	0.9	0.7	0.7	4.7	0.3	1.2	0.9	2.2	0.6	0.9	0.4	86.4
CAA	1.4	8.9	1.5	3.2	2.3	**19.2**	5.5	3.8	0.6	5.2	5.7	1.3	3.3	0.7	1.2	4.1	7.8	4.2	2.1	6.7	0.5	0.5	0.6	4.4	0.9	0.6	1.4	1.1	0.5	0.5	0.3	80.8
GY	2.7	7.5	1.6	3.3	2.2	5.9	**17.4**	9.9	1.1	4.5	4.7	1.0	3.0	0.7	1.2	5.4	6.5	3.5	1.6	4.7	0.6	0.9	0.8	4.4	1.1	0.4	0.9	1.2	0.7	0.7	0.5	82.6
SD	2.4	6.6	1.9	4.3	1.6	4.6	10.4	**20.1**	0.7	3.0	4.6	0.9	2.6	0.5	1.1	6.6	6.5	3.7	1.6	5.0	0.6	0.8	0.6	4.5	0.9	0.4	0.9	1.0	0.8	0.5	0.4	79.9
SN	9.6	4.3	1.5	2.6	1.4	4.1	9.8	7.6	**11.5**	3.5	4.0	1.8	2.9	0.8	0.7	3.5	8.0	4.4	0.9	3.6	0.6	0.7	0.8	5.1	1.4	0.6	1.5	0.8	1.2	0.6	0.2	88.5
RUS	1.3	4.3	1.0	3.3	4.0	6.2	4.4	3.3	0.7	**15.4**	5.5	1.4	5.8	0.6	1.4	5.5	9.3	4.9	2.9	5.5	0.6	0.6	0.7	6.4	0.5	0.6	0.8	1.6	0.8	0.7	0.3	84.6
SA	1.0	5.0	1.8	6.2	4.3	5.5	4.7	3.5	0.7	4.0	**16.6**	1.9	4.4	1.0	1.6	3.4	7.4	5.8	2.8	4.6	0.8	0.7	0.5	5.3	0.5	0.9	1.2	1.9	0.8	1.1	0.3	83.4
CA	1.3	2.9	3.2	6.6	4.0	1.5	1.7	1.1	1.1	2.1	3.3	**37.3**	1.7	1.8	3.2	0.9	2.6	3.0	2.1	3.1	1.1	0.8	0.7	2.5	1.2	1.3	2.3	2.0	1.8	1.0	0.7	62.7
IA	1.2	4.3	1.4	4.5	3.9	5.1	2.8	2.4	0.7	5.7	6.5	1.8	**22.0**	0.6	1.4	3.0	6.9	4.9	3.4	3.7	0.7	0.6	0.9	4.5	0.5	1.0	1.6	1.6	0.8	1.2	0.4	78.0
SAA	0.6	4.4	4.4	2.6	2.7	3.0	2.4	2.4	1.2	2.1	4.4	3.4	2.1	**32.0**	1.8	2.6	2.8	2.4	1.8	1.4	0.9	0.9	1.1	4.9	0.8	1.7	2.3	2.1	1.5	1.6	1.6	68.0
SK	1.3	6.8	1.9	4.6	2.9	5.9	6.6	5.5	1.0	4.6	5.2	1.5	3.3	0.6	**11.5**	3.4	7.7	4.7	3.1	6.7	0.7	1.0	0.8	3.7	0.9	0.6	1.1	1.2	0.7	0.4	0.3	88.5
SA	1.2	4.9	1.3	4.0	2.7	5.7	5.2	6.7	0.6	5.7	4.5	1.3	5.0	0.5	1.6	16.0	7.7	4.4	1.6	7.1	0.6	0.8	1.1	4.2	1.0	0.9	1.0	0.8	0.7	0.9	0.4	84.0
BL	1.9	5.6	1.1	3.2	3.1	6.3	5.1	4.5	1.0	4.3	4.7	1.2	3.2	0.5	1.5	**4.4**	20.3	5.4	1.4	6.8	0.5	0.7	0.7	6.9	0.9	0.8	0.9	1.4	0.9	0.5	0.3	79.7
TD	0.7	4.2	1.7	4.9	3.5	4.6	2.1	2.3	0.7	4.9	7.1	1.9	5.2	0.7	1.5	3.0	**5.6**	21.2	6.2	4.5	0.7	0.5	0.7	5.3	0.4	1.1	1.5	1.3	1.1	0.6	0.5	78.9
IA	0.9	4.3	1.9	4.9	3.4	4.4	3.2	3.0	0.7	3.7	6.2	2.0	4.8	1.0	1.7	2.4	5.1	**6.6**	18.0	3.5	0.9	0.5	1.2	6.5	0.6	1.0	2.8	2.4	1.1	1.0	0.5	82.0
MO	1.6	6.6	1.2	3.9	3.0	6.1	5.4	4.8	0.6	3.4	3.9	1.4	3.3	0.7	2.0	4.3	8.0	3.8	**1.6**	21.9	0.7	0.8	1.0	4.6	1.0	0.8	0.8	1.5	0.5	0.7	0.3	78.1
MA	0.9	3.9	1.5	4.4	4.0	2.9	3.1	2.2	1.1	4.0	5.5	2.5	4.2	1.1	2.9	2.7	6.4	5.6	3.9	**4.5**	16.1	0.6	0.6	4.0	2.0	1.3	1.4	2.4	1.9	0.7	1.8	83.9
VN	1.2	1.4	1.4	1.9	1.8	1.8	1.7	1.9	1.2	2.1	2.5	2.2	2.2	1.5	1.3	2.7	2.6	3.1	1.0	1.6	**0.8**	48.7	0.8	4.7	0.6	1.3	1.6	1.1	1.0	1.2	1.3	51.3
KA	0.9	2.8	1.8	3.0	2.2	3.4	3.4	2.1	1.2	1.7	3.7	1.5	1.9	3.0	2.0	2.1	4.6	2.9	1.5	3.1	0.7	**0.7**	36.2	5.2	0.6	1.3	1.5	2.0	0.9	1.3	0.9	63.8
RA	1.6	3.0	1.4	3.4	3.9	3.6	3.6	4.3	0.9	4.7	7.6	1.5	4.1	1.0	1.1	3.7	5.7	5.6	2.2	3.9	0.6	0.6	**0.7**	25.2	0.5	0.7	1.4	2.2	0.5	0.8	0.4	74.9
KN	0.8	1.4	1.1	1.5	2.1	1.0	1.6	1.5	1.4	2.6	3.1	1.4	1.6	2.2	1.0	2.0	3.1	2.8	2.0	1.2	2.6	1.0	1.4	**2.2**	48.7	1.0	2.4	1.1	1.9	1.9	0.7	51.4
BA	0.9	2.0	2.6	2.8	2.4	1.4	1.6	3.1	1.3	1.6	3.2	1.5	1.9	2.1	2.1	1.4	2.4	3.0	3.2	2.1	0.7	1.0	1.2	4.5	**0.8**	39.8	1.3	2.3	0.6	3.9	1.2	60.2
NA	0.7	2.1	3.1	2.3	2.3	2.4	1.3	1.2	1.2	2.0	5.8	2.4	2.8	2.1	2.6	1.4	3.0	4.2	2.7	1.9	0.7	0.6	1.6	5.8	1.1	**1.8**	37.2	1.4	0.8	0.9	0.7	62.8
CA	1.3	3.1	1.5	3.8	2.3	2.7	3.0	2.1	0.6	1.9	4.3	1.9	2.3	1.2	1.1	2.3	4.2	1.6	2.5	2.4	1.0	1.5	0.5	5.1	1.0	1.1	**1.1**	40.5	1.2	0.8	0.4	59.5
JON	0.6	2.0	2.6	4.4	1.4	1.8	1.0	1.1	1.3	2.2	3.8	2.7	3.5	3.3	1.0	2.3	3.1	3.9	1.4	1.5	3.4	1.4	0.7	2.9	1.7	1.0	1.9	**2.7**	34.9	1.3	3.5	65.1
MO	1.0	2.4	1.4	3.0	2.3	1.8	1.5	1.8	1.2	2.0	4.0	2.1	2.9	1.0	0.8	1.4	4.6	3.8	1.2	1.9	0.6	1.7	1.0	4.3	1.2	1.8	1.9	1.7	**0.9**	42.1	0.9	57.9
BH	0.8	1.7	3.9	2.4	1.7	2.0	1.6	1.8	0.9	2.2	2.3	1.7	2.1	5.9	1.5	1.8	2.9	4.8	2.5	1.7	4.6	1.1	1.0	2.5	1.1	2.0	1.3	1.7	3.3	**3.1**	32.5	67.5
TO	47.3	132.3	57.9	113.2	82.2	120.8	129.8	110.6	30.9	99.0	137.8	55.2	92.2	40.6	51.0	96.4	162.7	118.9	66.7	116.6	30.4	25.9	25.9	131.8	26.9	30.2	43.1	47.5	30.6	30.8	**21.0**	2305.9
Inc.Own	61.8	153.6	84.8	128.7	95.8	139.9	147.2	130.7	42.4	114.4	154.4	92.5	114.2	72.6	62.5	112.4	183.0	140.0	84.7	138.5	46.5	74.6	62.0	157.0	75.5	70.1	80.3	87.9	65.5	72.8	53.5	
NET	-38.2	53.6	-15.2	28.7	-4.2	39.9	47.2	30.7	-57.6	14.4	54.4	-7.5	14.2	-27.5	-37.5	12.4	83.0	40.0	-15.3	38.5	-53.5	-25.4	-38.0	57.0	-24.5	-29.9	-19.7	-12.1	-34.5	-27.2	-46.5	74.4

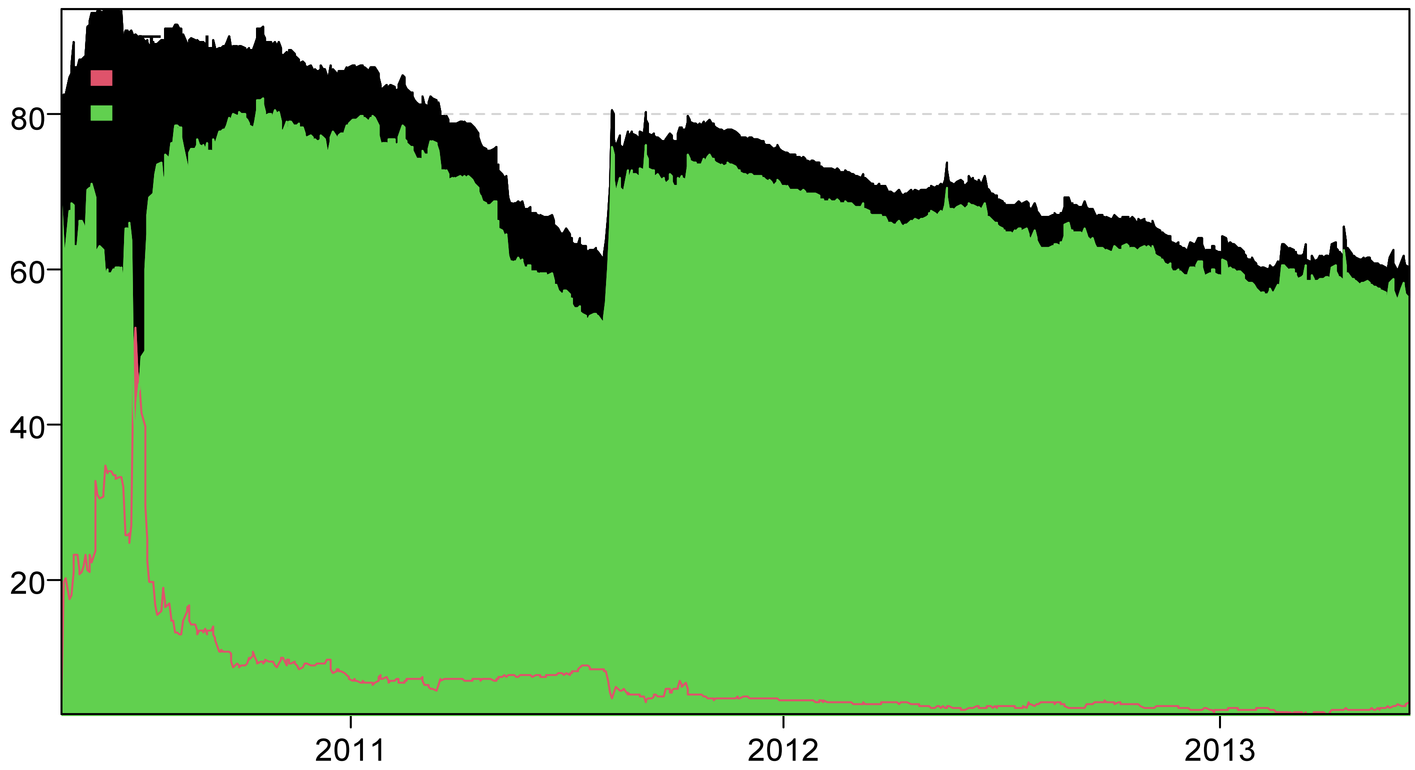


Fig. 4.16: During EDC, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR-BK models.

Note: Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf. Days, Green colour), and total frequency (black colour) (Source: Author using R software).

4.5 Results of the volatility spillover among the developed, emerging, and frontier countries during the Pre-Chinese crash (2013-2015).

This period covers the period from June 11, 2013, to June 11, 2015, to understand the behaviour of the stock market in the selected countries during this period. Fig. 4.17 also indicates that the US and Morocco are identified as the primary transmitters of the volatility spillover. Fig. 4.18 covers the *"TCI," "From other,"* and *"To Other"* volatility spillover among the selected stock market. During the pre-Chinese crisis, a high volatility spillover was also identified, i.e. 81.29 % (Table 4.7.0), due to tension between Russia and Ukraine. In early 2014, protests in Euromaidan toppled pro-Russian president Viktor Yanukovych and ushered in the Dignity Revolution. Pro-Russian demonstrations broke out in southern and eastern Ukraine shortly after that. At the same time, unidentified Russian forces invaded the Crimean Peninsula of Ukraine and seized administration buildings, key locations, and infrastructure.

The annexation of Crimea by Russia followed a contentious referendum. Ukrainian government facilities in the eastern Donbas area were captured by separatist troops supported by Russia in April 2014. The Donbas conflict sparked the subsequent proclamation of independence by the Donetsk People's Republic (DPR) and the Luhansk People's Republic (LPR). Russian covert backing for the separatists was substantial, and Ukrainian efforts to recapture territory entirely from the separatists were unsuccessful. Despite Russia's denials, Russian forces were seen engaging in combat. Despite signing the Minsk II accords in February 2015, the two sides never fully executed them in the years that followed. Ukraine, Russia, and separatist forces in the Donbas war have been locked in a brutal but unchanging battle, with several short-lived ceasefires but no permanent peace and little shifts in territory control. Secondly, concerns about potential interest rate increases and market liquidity decrease arose after the US Federal Reserve began progressively winding down its asset purchase program (QE) in December 2013.

Nevertheless, the market was largely unaffected by the tapering because of its gradual and transparent pace. Concerns about potential interest rate increases and market liquidity decreases arose after the US Federal Reserve began progressively winding down its asset purchase program (QE) in December 2013. During the pre-Chinese crash, theUS (33.25%), Canada (25.1%), and Kenya (24.44%) were identified as the major net transmitters of the spillover, and Vietnam (-21.37%), Thailand (-28.32%), Spain (-19.21%) major receiver.

On analyzing developed countries, the US (33.24%), Canada (25.1%), and Russia (6.20%) were identified as major transmitters, and on the other side, Spain (-19.21%), Singapore (-15.94%), Japan (-7.66%) were identified as major net volatility spillover receiver. Among emerging countries, South Africa (16.13%), Malaysia (9.43%), Brazil (3.38%), major net volatility spillover transmitter and Thailand (-28.32%), South Korea (-18.49%), and Saudi Arabia (-13.52%) were identified as significant receiver. On the other side, Kenya (24.44%), Morocco (30.31%), Nigeria (11.1%) were identified as major transmitters, and Vietnam (-21.37%), Croatia (-15.95%), and Jordon (-8.8%). On analyzing *"To Other"* (transmitters) among developed countries, the US (116.42%), Canada (110.37%), and Hong Kong (86.24%) were identified as the significant volatility spillover. In the emerging countries, South Africa (103.79%), Malaysia (95.21%), and Mexico (86.07%) were identified as major spillover transmitters. On the other hand, Morocco (110.74%), Kenya (107.71), and Nigeria (91.33%) were identified as the major transmitters. Nevertheless, the market was largely unaffected by the tapering because of its gradual and transparent pace.According to the World Economic Forum's African Competitiveness Report (2014–2015), Morocco has the most competitive economy in North Africa. There is much room for the outside world to enter the country's economic system.

Thus, from this panel, during the pre-Chinese crash, the US (33.25%), Canada (25.1%), and Kenya (24.44%) were identified as in the dominant position.

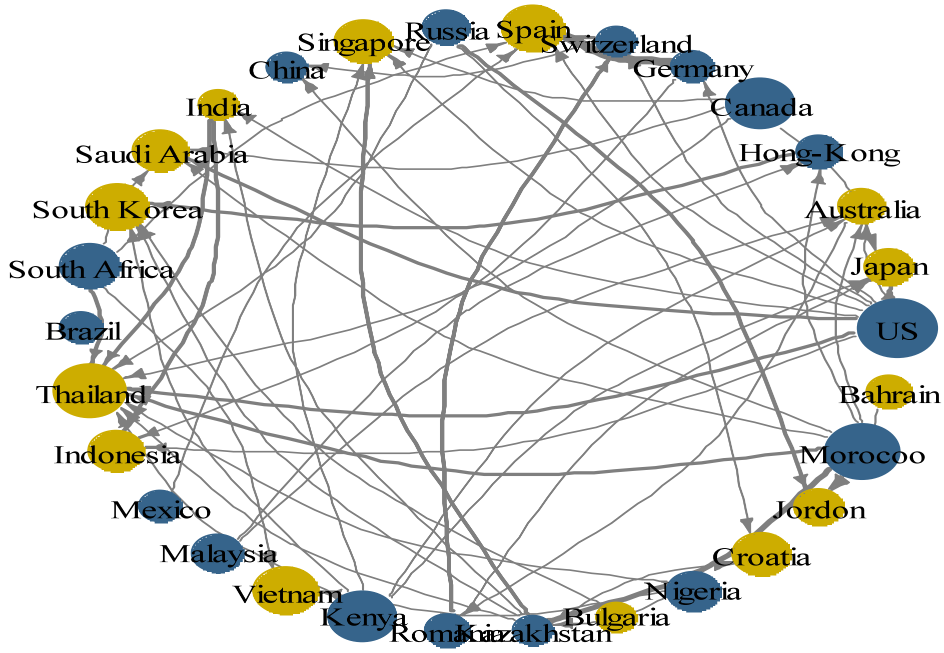
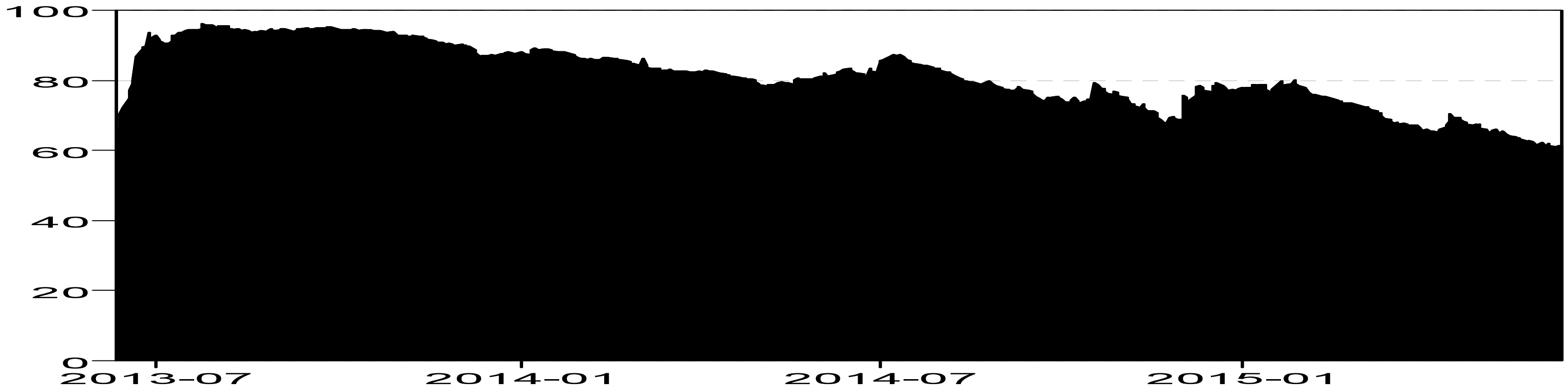
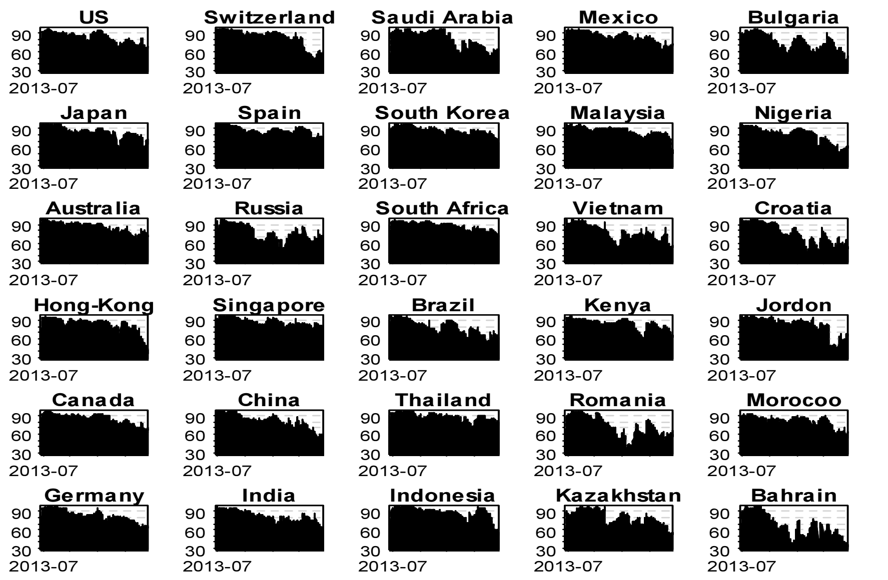


Fig. 4.17: Interconnectedness during the Pre-Chinese among the developed, emerging, and frontier countries using the TVP-VAR model.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software)

TCI	
	
FROM	TO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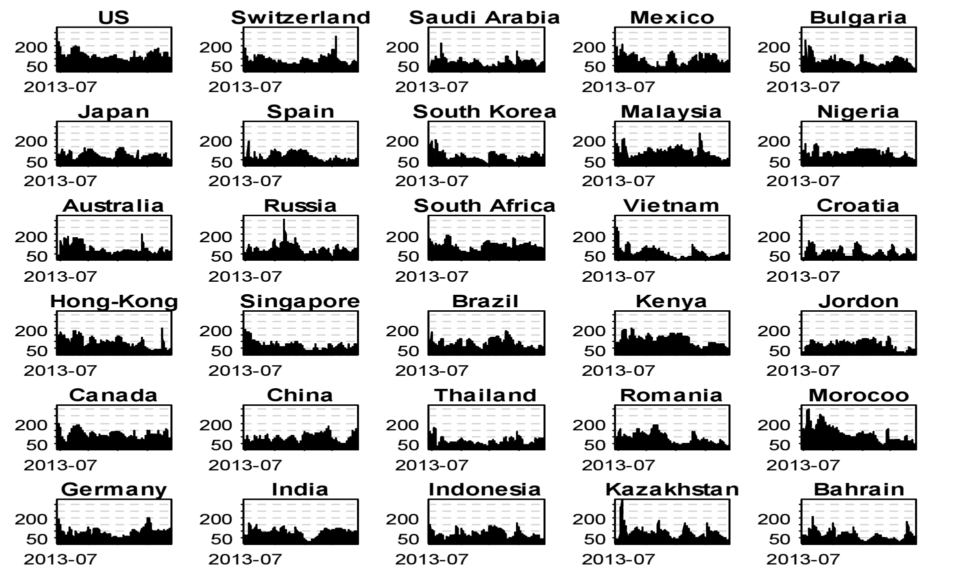
Switzerland
Saudi Arabia
Mexico
Bulgaria
Japan
Spain
South Korea
Malaysia
Nigeria
Australia
Russia
South Africa
Vietnam
Croatia
Hong-Kong
Singapore
Brazil
Kenya
Jordon
Canada
China
Thailand
Romania
Morocoo
Germany
India
Indonesia
Kazakhstan
Bahrain
90
60
30
2013-07


US
Switzerland
Saudi Arabia
Mexico
Bulgaria
Japan
Spain
South Korea
Malaysia
Nigeria
Australia
Russia
South Africa
Vietnam
Croatia
Hong-Kong
Singapore
Brazil
Kenya
Jordon
Canada
China
Thailand
Romania
Morocoo
Germany
India
Indonesia
Kazakhstan
Bahrain
200
50
2013-07

NET

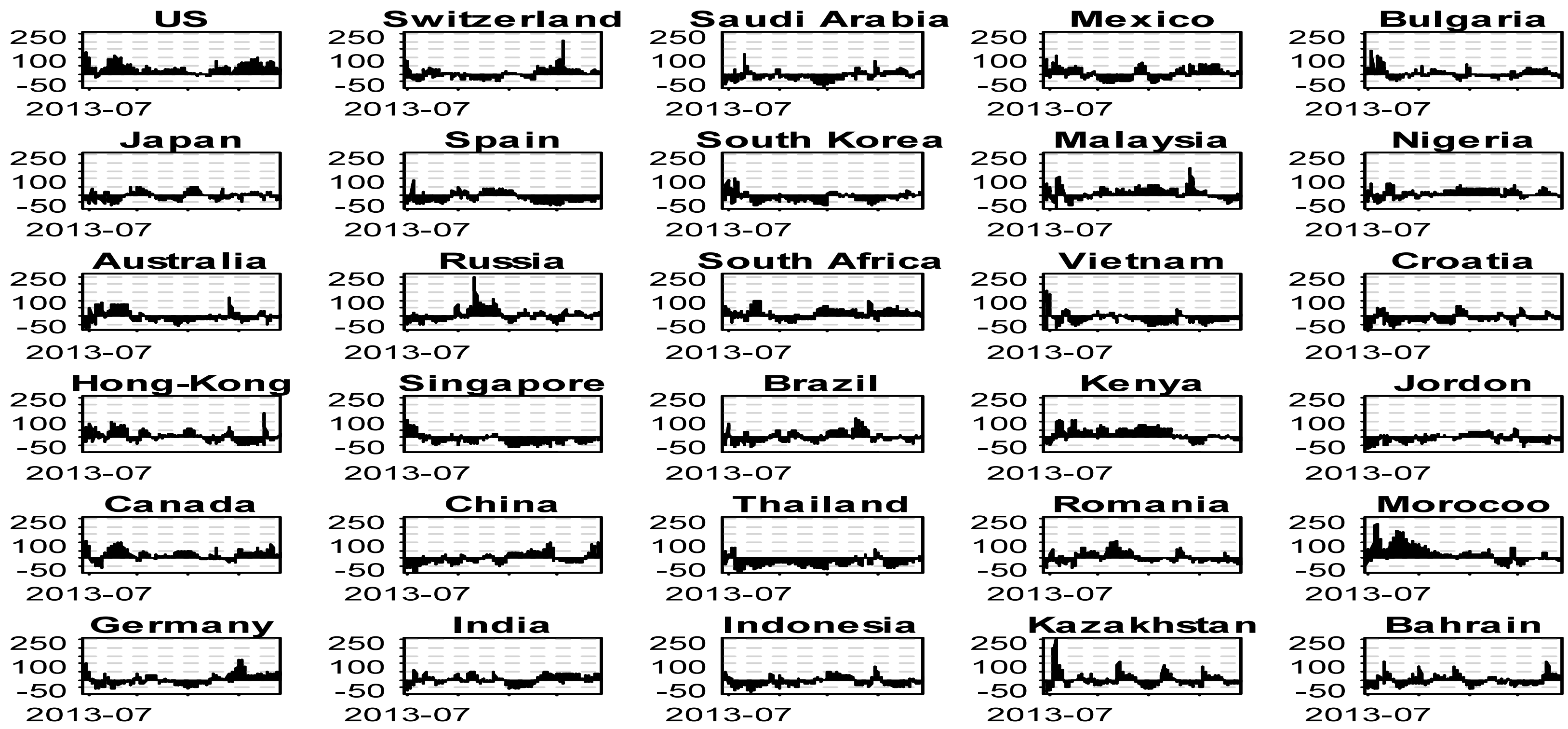


Fig. 4.18 During Pre-Chinese interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software).

Table 4.7.0: During Pre-Chinese interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**16.8**	2.1	2.3	2.4	8.3	3.3	3.4	2.1	2.1	2.6	2.4	1.7	2.0	1.8	5.5	3.6	1.8	2.2	5.1	3.1	1.4	3.6	3.6	2.6	2.1	2.9	1.6	2.5	3.4	1.7	83.2
JN	4.9	**16.0**	3.5	3.1	4.4	2.0	2.4	2.4	2.9	3.1	2.1	3.3	2.4	4.0	3.5	2.7	2.3	2.7	2.3	4.1	1.4	4.4	3.6	2.0	3.3	2.3	1.8	2.6	3.3	1.4	84.0
AA	4.3	2.9	**14.4**	4.1	4.7	2.9	2.3	2.0	2.5	2.2	3.4	3.1	3.3	1.9	3.3	2.2	2.0	2.9	2.2	5.5	1.8	4.6	1.5	2.7	2.5	3.4	1.8	2.4	4.7	2.9	85.6
HG	2.4	3.0	2.6	**18.0**	2.9	2.1	1.9	3.1	2.2	3.0	5.5	2.7	2.4	2.8	2.6	2.5	2.0	3.2	1.8	4.6	1.6	4.4	1.8	4.0	3.2	3.7	1.9	1.9	5.0	1.4	82.0
CAA	9.2	2.2	3.0	2.3	**14.7**	4.5	3.6	2.1	2.5	1.7	2.4	1.9	1.6	1.7	5.8	3.2	2.0	2.7	4.1	3.5	1.2	3.8	3.0	1.8	1.8	3.1	1.8	3.0	3.9	1.7	85.3
GY	5.6	1.6	2.8	3.0	3.8	**17.1**	6.8	2.0	3.1	2.2	2.6	1.9	2.5	2.0	4.4	2.8	1.9	1.6	4.1	2.4	1.5	2.9	4.2	2.2	2.5	3.0	2.3	2.6	2.8	2.2	82.9
SD	5.4	1.7	2.2	3.0	4.5	8.0	**17.5**	2.3	1.9	1.9	2.6	1.4	1.3	1.5	4.3	2.8	1.6	1.7	3.1	3.0	1.2	3.2	5.9	2.9	1.8	3.4	1.9	2.6	3.4	2.2	82.5
SN	4.0	1.9	1.9	3.7	3.3	8.8	5.4	**12.7**	2.3	2.1	3.0	2.3	1.5	2.4	4.9	2.7	2.0	2.2	3.7	3.1	1.8	3.7	2.2	2.2	2.8	3.5	2.2	2.4	4.1	1.6	87.4
RUS	2.1	2.3	2.0	2.0	2.8	2.0	2.3	3.3	24.2	2.4	3.7	4.2	2.5	2.1	3.5	2.6	2.0	1.6	3.0	2.6	2.9	3.1	3.7	2.6	3.0	2.7	2.4	1.7	3.0	1.7	75.8
SA	4.7	3.9	2.4	4.2	3.9	1.9	2.1	3.3	2.2	**13.5**	3.1	4.9	2.4	3.0	2.8	2.3	2.4	3.4	3.1	3.6	1.6	3.9	2.5	4.7	2.4	2.3	2.1	2.0	3.6	2.0	86.5
CA	3.3	2.1	3.0	4.9	3.5	2.5	4.4	2.5	2.0	2.0	**19.1**	2.6	3.3	2.2	3.0	2.5	2.0	2.0	2.5	3.5	1.9	3.8	1.7	2.4	2.2	3.4	1.9	2.4	5.3	2.4	80.9
IA	3.6	3.2	2.1	1.8	3.2	2.5	2.4	2.1	3.8	4.8	3.2	**19.0**	3.0	2.9	2.8	2.9	2.6	1.7	2.8	2.4	3.0	3.1	3.7	4.0	3.0	1.8	2.0	1.7	2.9	2.2	81.0
SAA	6.0	2.1	2.6	2.4	3.9	1.8	1.6	1.6	2.5	3.3	2.8	2.6	**20.0**	2.2	3.4	3.4	2.3	2.2	3.4	3.4	2.7	3.1	2.2	2.2	2.6	2.4	1.7	3.5	3.4	2.8	80.0
SK	2.6	3.9	2.9	6.8	3.4	2.4	1.9	2.5	2.8	3.3	3.5	2.8	2.3	**12.8**	2.8	2.2	3.6	3.3	2.2	3.7	1.8	4.4	2.9	4.0	4.5	2.5	1.4	1.9	3.6	1.4	87.3
SA	6.5	2.4	2.5	2.8	6.3	4.8	4.2	2.2	3.4	2.2	2.1	2.6	1.6	2.0	**12.3**	3.0	1.6	2.2	5.8	3.5	1.6	3.9	3.4	1.6	2.5	3.1	1.8	2.3	4.2	1.8	87.7
BL	3.0	2.7	3.1	2.5	2.9	2.6	1.9	1.7	3.2	1.7	2.7	2.5	2.8	2.6	2.9	**22.5**	2.8	2.0	3.4	3.3	3.0	3.1	2.8	2.5	2.8	2.5	2.6	3.5	2.7	1.9	77.5
TD	5.1	2.4	3.4	2.1	4.7	2.0	2.7	1.8	4.1	3.6	2.8	5.6	2.4	3.1	4.4	2.5	**12.1**	3.0	2.8	2.2	1.7	4.0	2.7	3.2	2.9	3.5	1.8	2.2	4.0	1.7	87.9
IA	4.3	4.3	2.5	3.0	3.1	3.6	2.0	2.7	2.9	4.5	1.9	4.9	2.4	3.3	2.9	2.7	3.3	**12.5**	2.3	4.2	2.1	3.3	2.1	4.2	3.0	2.7	2.2	2.7	2.7	1.6	87.5
MO	5.3	2.8	2.2	2.8	4.9	2.4	2.8	1.8	2.9	3.2	2.5	3.0	1.9	2.3	6.0	3.4	1.9	2.6	**16.1**	4.0	1.5	4.4	2.2	2.0	2.8	2.9	2.0	1.9	3.8	1.8	83.9
MA	4.6	4.8	2.7	2.5	3.8	2.5	2.0	2.7	2.5	2.8	2.2	3.3	3.1	2.4	3.3	4.0	3.0	4.6	3.0	**14.2**	1.4	4.4	1.9	2.8	2.0	3.3	2.2	2.4	3.9	1.9	85.8
VN	2.3	2.0	2.6	2.5	2.4	1.8	2.0	2.3	3.5	2.2	3.6	3.1	2.4	3.2	3.3	3.8	2.2	2.3	1.8	2.0	**24.1**	2.8	3.1	1.9	2.6	4.3	2.8	2.0	3.6	1.7	75.9
KA	3.7	2.6	2.8	3.3	3.8	1.7	2.8	2.9	2.9	1.8	3.0	2.4	2.4	2.6	4.5	2.2	1.4	4.1	3.2	4.1	1.9	**16.7**	1.6	3.1	2.4	4.8	1.5	3.1	5.4	1.2	83.3
RA	4.0	1.8	4.1	2.7	3.4	2.6	2.8	1.8	2.5	2.0	1.9	2.5	2.6	1.7	2.5	2.6	2.2	1.4	2.6	1.6	2.0	2.4	**28.8**	3.1	2.3	2.2	1.8	2.2	2.9	3.3	71.2
KN	2.8	2.6	2.1	3.7	3.0	2.3	4.3	3.4	2.9	1.4	3.7	1.6	1.9	2.1	3.1	1.7	1.2	2.7	1.9	3.6	1.7	3.9	1.7	**21.7**	1.8	4.9	1.6	2.5	6.5	2.0	78.3
BA	2.4	2.9	3.4	2.5	3.0	2.5	2.3	2.4	2.8	1.8	2.2	3.3	2.7	2.8	2.7	3.0	2.6	1.8	2.1	2.1	2.1	3.8	2.0	1.7	**25.8**	2.6	1.8	4.1	3.0	1.9	74.2
NA	3.0	1.9	2.4	2.6	4.0	2.4	3.1	3.1	2.4	1.7	3.3	2.0	1.5	2.2	4.3	2.9	1.5	3.7	3.4	3.9	2.3	5.0	2.4	2.5	2.0	**19.8**	1.8	2.5	4.8	1.9	80.2
CA	2.6	1.8	3.0	2.3	2.5	2.9	2.2	1.6	4.3	2.0	2.3	2.7	3.2	2.3	2.5	2.2	1.7	2.2	3.3	2.7	2.4	2.9	1.8	3.9	2.4	3.0	**25.2**	2.6	3.1	2.6	74.9
JON	2.9	3.3	2.7	2.4	3.8	2.7	2.8	2.5	4.7	1.5	2.4	2.0	2.0	1.7	2.8	3.2	1.5	3.2	2.7	3.0	1.9	4.8	1.6	1.8	2.5	2.9	2.7	**18.7**	4.5	5.0	81.3
MO	3.0	3.1	2.8	3.2	3.5	3.1	3.0	2.9	2.7	2.0	2.8	2.1	1.5	2.2	3.9	2.9	1.0	3.0	2.8	4.0	2.0	5.0	1.7	1.7	1.7	5.8	2.5	2.7	**19.6**	2.0	80.4
BH	2.8	2.0	3.2	1.8	2.8	1.6	1.8	1.5	1.7	1.8	2.0	2.0	2.2	2.0	2.4	2.7	1.3	2.1	1.8	2.5	1.4	2.5	3.3	2.4	1.6	2.5	2.9	2.4	3.5	**35.6**	64.4
TO	116.4	76.3	79.0	86.2	110.4	85.9	83.0	68.1	82.0	70.5	81.5	80.9	66.5	68.8	103.8	80.9	59.6	74.0	86.1	95.2	54.5	107.7	76.4	78.4	73.0	91.3	58.9	72.5	110.7	59.8	2438.6
Inc.Own	133.2	92.3	93.3	104.3	125.1	103.1	100.5	80.8	106.2	84.1	100.6	99.9	86.5	81.5	116.1	103.4	71.7	86.6	102.2	109.4	78.6	124.4	105.2	100.1	98.7	111.1	84.1	91.2	130.3	95.4	
NET	33.2	-7.7	-6.7	4.3	25.1	3.1	0.5	-19.2	6.2	-15.9	0.6	-0.1	-13.5	-18.5	16.1	3.4	-28.3	-13.4	2.2	9.4	-21.4	24.4	5.2	0.1	-1.3	11.1	-16.0	-8.8	30.3	-4.6	81.3

➢ **ROBUSTNESS –**

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Examining the spillover curves illustrated in Fig. 4.19 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

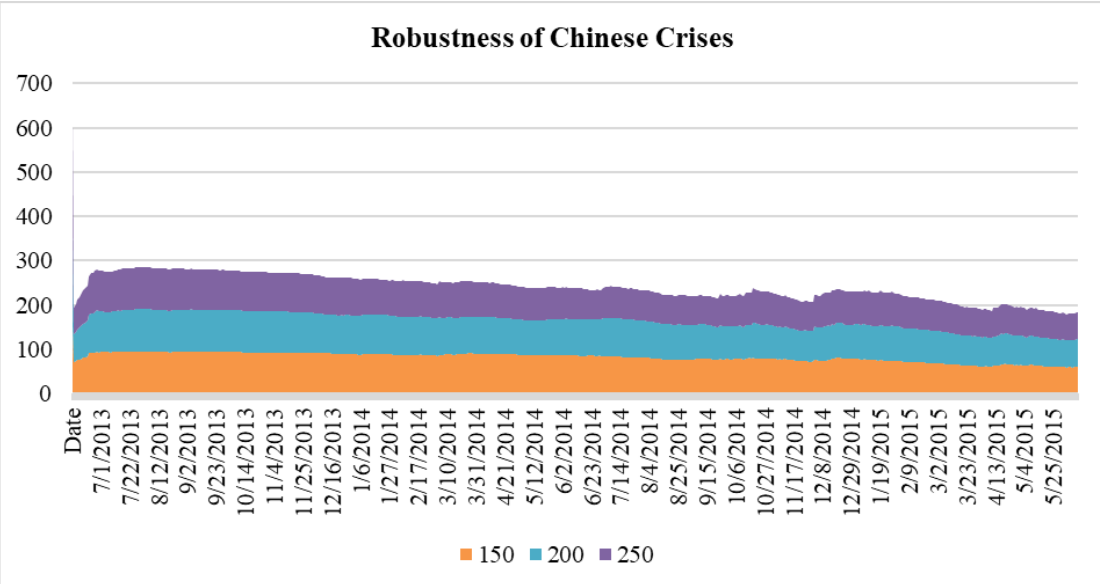


Fig. 4.19: Robustness of Pre-Chinese crises (Panel-3) on window sizes (W) 150, 200, and 250.

Note: In the above figure the orange colour shows 150 window size, blue shows 200 window size, and orange shows 250 window size. (Source: Author using R software).

4.6 Results of the volatility spillover among the developed, emerging, and frontier countries during the Chinese crash (2015-2016).

A stock market bubble burst on June 12, 2015 (Sornette et al., 2015; Ahmed and Rao, 2019), marking the beginning of the 2015–2016 Chinese stock market turmoil that would last until early February 2016. Within 30 days after the incident, A-shares on the Shanghai Stock Exchange lost one-third of their value. There were significant earthquakes around 27 July and "Black Monday" on 24 August. More than half of the 1,400 businesses listed on the Shanghai Stock Exchange requested a trading suspension between July 8 and 9, 2015, after the market had dropped 30% in three weeks; the third effort by the Chinese government to stem the decline in stock market values was in vain. Following three weeks of relatively constant performance, the Shanghai index had its worst daily decline since 2007, August 24th, 8.48% (Bethany Allen-Ebrahimian, 2015).

During the 2015 International Monetary Fund (IMF) annual conference in Peru, which central bankers and finance ministers attended from 188 member countries, questions over whether "China's economic downturn triggered a new financial crisis" were a common topic of discussion.

Although it was much lower than its highs on June 12th, China's stock market had recovered from the shocks by the end of 2015 and beaten the SandP 500 for the year. The Shanghai Composite Index gained 12.6% at the end of 2015. On January 4 and 7, 2016, the Chinese stock market plunged 7%, with the latter happening within 30 minutes of opening, causing trade to be suspended. This was all part of the sharp sell-off that occurred in January 2016. In early 2016, a worldwide rout was triggered by the market crash.

Table 4.8.0 indicates a 91.45% net volatility spillover during the Chinese crash, more than the pre-crisis period, i.e., 81.29%. The global financial market is becoming more interdependent and correlated because of the growing globalization of finance (Mitra and Bhattacharjee, 2015). Because of how interconnected the world's financial markets are, the volatility of one country's markets may delay the volatility of other nations' markets, a phenomenon known as the spillover effect. Several financial markets have the characteristic of volatility spillovers. Researching the volatility spillover effect across various financial markets is becoming more critical as global financial integration strengthens the case for this impact's existence. Monitoring and mitigating risk transmission across financial markets, ensuring the safe functioning of financial systems, and fostering economic growth all need research into the risk spillover impact of China's stock market and global stock markets (Baele, 2005). During the Chinese crash, Canada (72.81%), Saudi Arabia (69.08%), and Nigeria (32.79%) were identified as the primary transmitters of the spillover. In this scenario

(Chinese crash), during a selected period, Canada was recognised as the centre of the trading; Bitumen and heavy oil are standard terms for the oil Canada produces, especially from its oil sands. Compared to lighter crude oils, this is more expensive to extract and needs more processing. The Canadian oil sector saw the effects of the steep drop in oil prices, which affected the viability of heavy oil production.

On the other side of the Chinese crash, Saudi Arabia highly identified volatility as Oil prices plummeted for all these reasons, and by early 2016, crude oil had fallen to levels not seen in years. The steep fall in the Brent and WTI crude oil benchmarks hit the global economy and energy-related sectors hard during this time. The oil market crisis had far-reaching consequences that affected the energy industry, financial markets, and the dynamics of the global economy. The oil and gas industry accounts for a significant chunk of Canada's GDP, and the nation is well-known for its oil exports. A large amount of the country's export income is generated by oil extracted from the country's enormous oil sand deposits in Alberta.

Among developed countries, Canada (72.81%), the US (31.52%), and Switzerland (17.16%) were identified as the significant net transmitters (Fig. 4.20); on the other side Singapore (-48.70%),Spain (-45.63%), Russia (-32.83%) are identified as the significant net receiver of the spillover.

Among emerging countries, Saudi Arabia (69.08%), India (29.08%), and Malaysia (24.79%) were identified as the significant net transmitters; on the other side, Indonesia (-45.89%), Brazil (-45.07%), South Korea (-22.49%) were identified as the major net receiver of the spillover.

Among frontier countries, Nigeria (32.79%), Croatia (22.63%), and Kenya (14.67%) were major net transmitters; on the other side, Kazakhstan (-30.84%), Romania (-18.3%), Bulgaria (-11.41%) were the major net receiver of the volatility spillover.

On analyzing "From Spillover" (Fig. 4.21) among developed countries Spain (95.83%), Singapore (94.95%), Japan (91.40%), among emerging countries Indonesia (95.67%), South Korea (94.52%), Brazil (93.41%) and among frontier countries, Jordon (93.69%), Romania (93.35%), and Croatia (91.72%) were identified as major receiver.

On analyzing "To Other" (Fig. 4.21) Canada (160.88%), US (119.71%), Switzerland (106.45%) among developed, Saudi Arabia (157.97%), India (120.27%), Malaysia (114.78%) among emerging, and Nigeria (123.12%), Croatia (114.35%), Kenya (105.15%) among frontier countries were identified most contributor.

Some stock markets may not have reacted as Pan et al. (2021) revealed that only the shareholdings of professional institutional investors are adversely correlated with businesses' stock price collapse sensitivity. As the influence of professional institutional investors on crash sensitivity is affected by stock liquidity and media sentiment, when the liquidity of listed companies is high, or media sentiment is positive, the detrimental effect of professional institutional investors on crash sensitivity is correspondingly significant. During this crisis, Chen et al. (2017) revealed that the adverse correlation between internal control and crash risk is markedly intensified in firms exhibiting deficient internal and external governance (e.g., audited by non-Big Four auditors, situated in regions with limited market development and displaying less conservative accounting practices) and possessing inadequate capacity to mitigate the effects of extreme negative occurrences (e.g., non-state-owned enterprises).

Zhao et al. (2021) also find the direction of contagion is from stock to oil market for the first bubble and from oil to stock for the second. Liow et al. (2018) revealed that overseas spillovers account for the majority of financial market stress and policy uncertainty, as there is some evidence that policy uncertainty spillovers contribute to financial market stress spillovers in a multi-country setting. Therefore, shifts in the uncertainty spillovers of international economic policy could be a short-term indicator of shifts in the risk spillovers of global financial markets.

Thus, from the detailed discussion of the Chinese burst bubble, we got the core results showing that the Canadian, Saudi Arabia, and Nigerian stock markets dominate. Interestingly, Canada also acted as a highly interconnected stock market with the rest of the stock markets.

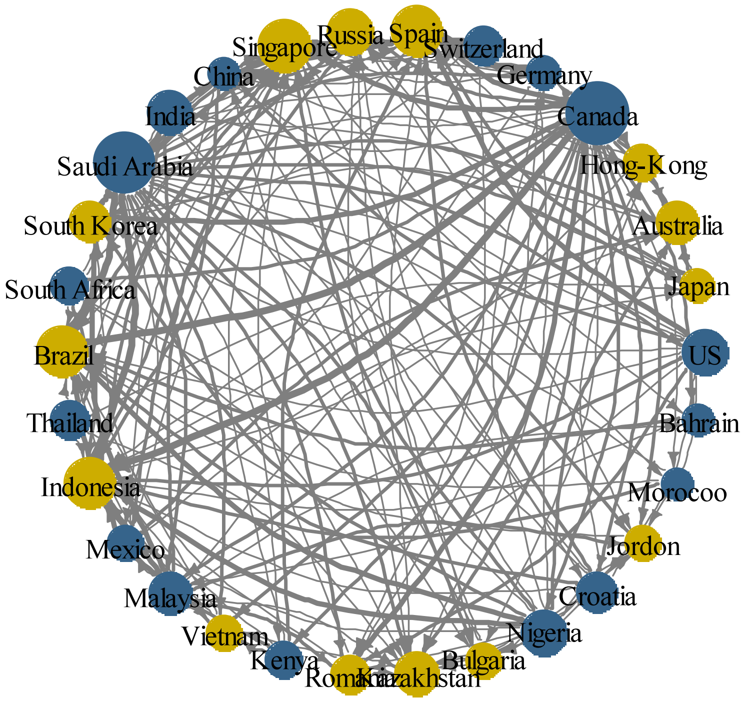
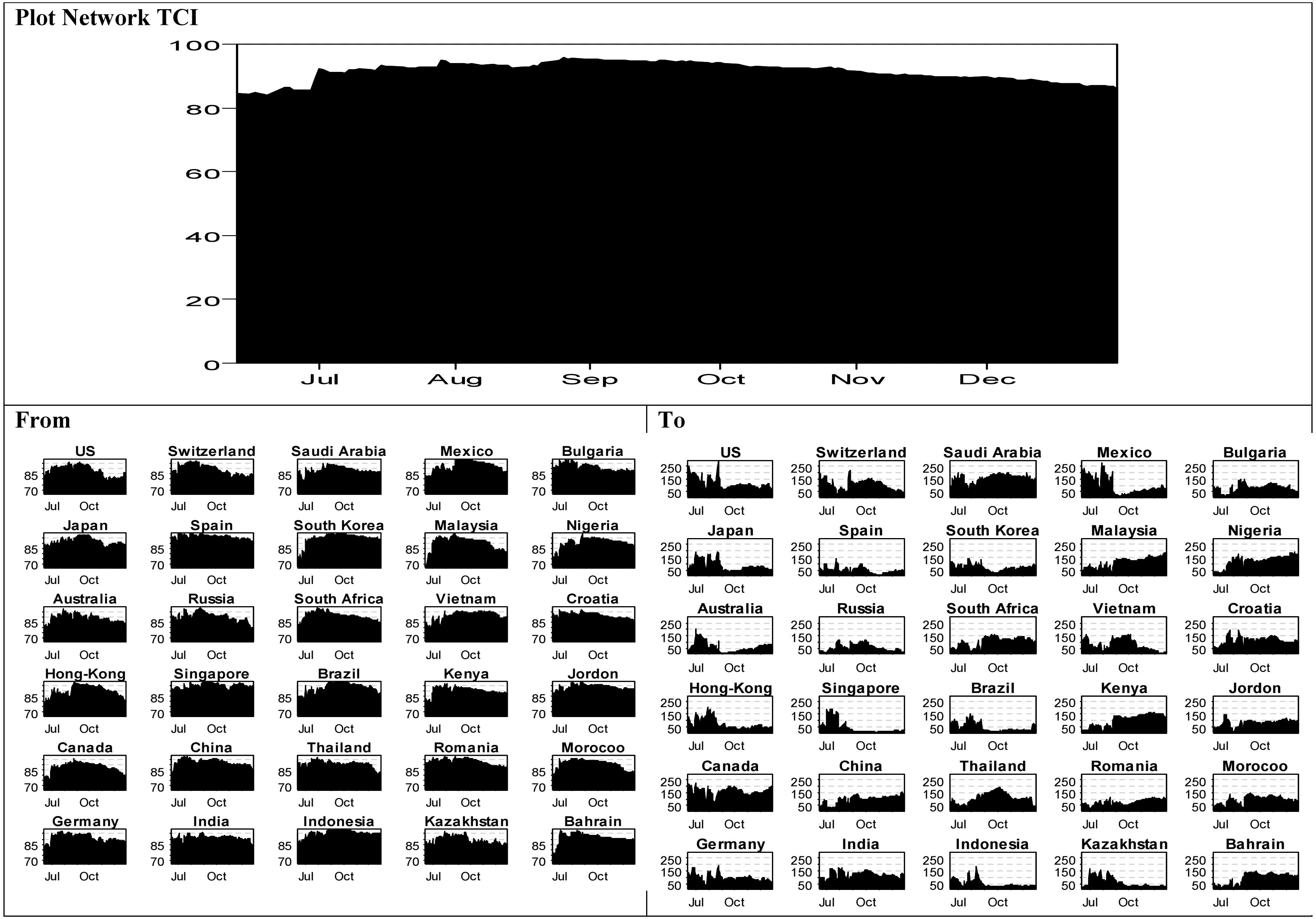


Fig. 4.20: During Chinese interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).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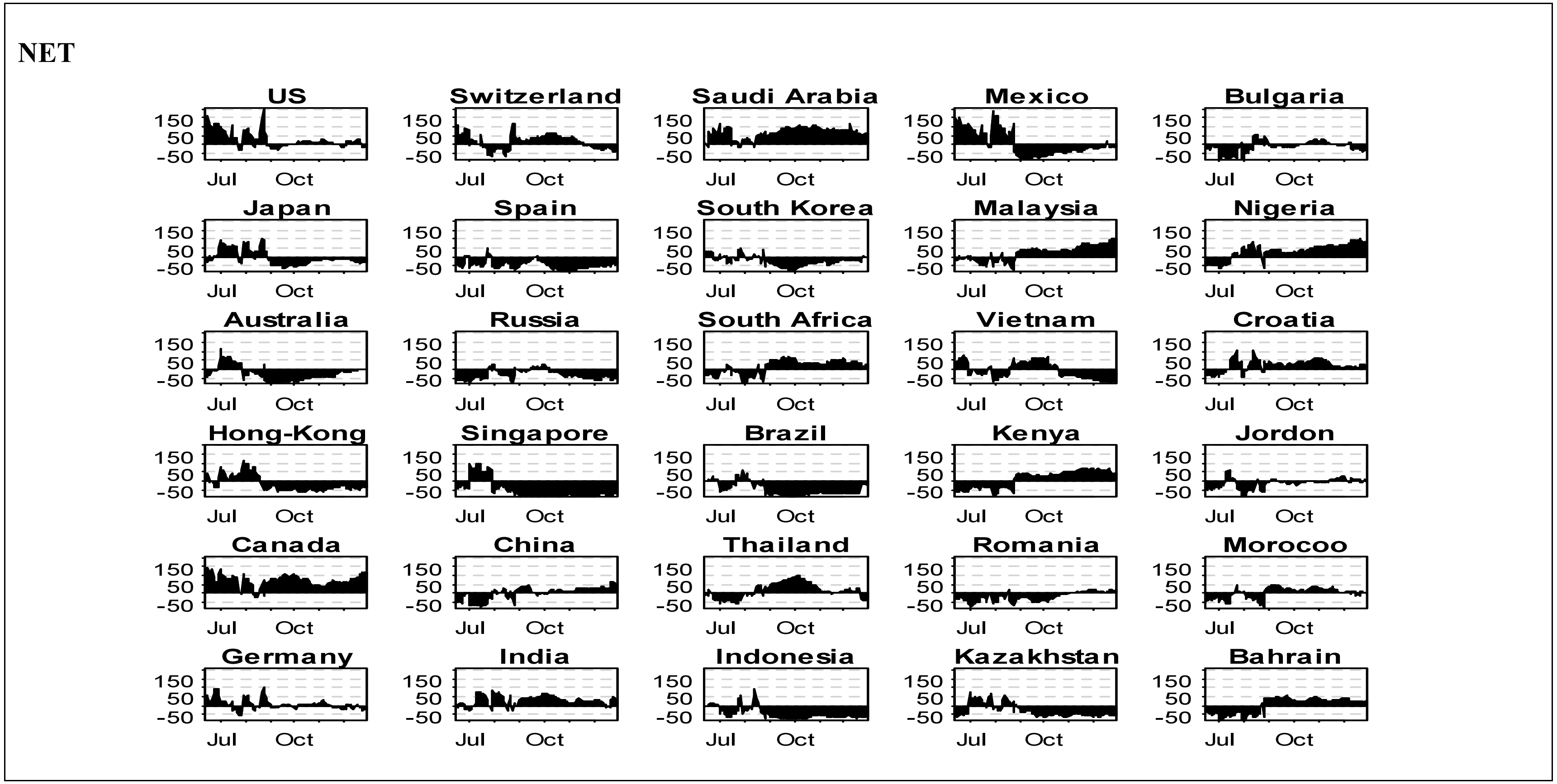


Fig. 4.21: During the Chinese burst bubble, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software).

Table 4.8.0: During Chinese Brust Bubble using TVP-VAR Model in the selected developed, emerging, and frontier countries. (Source: Author using R software).

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**11.8**	4.9	2.1	2.7	6.8	5.6	6.5	1.6	2.1	1.6	1.7	3.7	6.7	2.1	2.3	2.1	3.6	1.5	4.4	1.9	2.8	2.6	1.0	2.5	3.3	2.4	3.8	1.4	2.1	2.5	88.2
JN	5.0	**8.6**	2.1	3.0	5.9	3.3	3.7	1.7	1.8	1.6	2.6	4.8	6.8	2.8	3.2	1.3	3.8	1.8	3.4	2.5	2.4	3.6	1.4	2.7	3.7	3.8	4.4	2.1	3.1	3.3	91.4
AA	2.4	3.9	**11.1**	2.5	4.6	1.7	1.8	3.4	1.5	2.0	4.1	2.9	4.3	3.3	3.5	1.5	2.8	1.8	5.4	3.7	2.0	3.1	4.0	2.5	1.9	5.2	3.4	3.6	3.3	2.9	88.9
HG	4.0	3.4	1.5	**10.0**	4.5	3.5	3.6	1.4	2.7	2.1	3.3	4.6	4.4	2.7	4.0	2.3	3.6	0.9	2.6	3.3	3.1	3.4	2.0	1.7	3.0	3.8	4.6	3.5	3.6	3.0	90.1
CAA	6.1	3.2	1.9	3.0	**11.9**	3.0	4.2	1.2	2.8	1.6	2.6	4.9	6.8	2.0	4.0	1.2	4.9	0.8	4.4	3.6	2.9	3.0	2.1	1.8	1.9	3.0	3.1	2.8	2.8	2.6	88.1
GY	5.9	4.0	1.6	2.7	4.8	**8.9**	7.3	1.7	1.7	1.5	2.3	3.7	6.0	1.4	3.3	1.9	3.1	1.6	3.4	2.7	2.3	3.3	1.6	2.6	4.7	3.8	4.6	1.8	2.7	3.1	91.1
SD	7.4	3.7	1.7	2.4	5.2	8.7	**10.7**	1.5	1.9	1.6	2.0	3.5	5.1	1.4	3.0	1.8	2.9	1.8	3.9	2.6	2.6	2.8	1.7	2.8	4.1	2.5	4.2	1.8	2.4	2.6	89.3
SN	5.9	4.4	2.2	3.2	5.3	7.0	7.2	**4.2**	2.0	1.4	2.2	3.2	5.5	1.4	3.1	1.9	3.3	1.4	3.7	2.9	2.2	3.5	1.7	2.2	3.6	3.7	3.9	1.9	3.1	2.9	95.8
RUS	3.7	3.8	2.5	3.0	5.9	2.5	3.0	2.3	**9.9**	1.7	3.2	4.1	4.1	2.9	3.3	2.2	5.3	1.8	4.1	2.7	3.1	3.0	1.9	2.9	2.9	3.3	3.5	2.5	2.4	2.9	90.1
SA	3.8	1.8	3.0	2.7	5.6	3.5	3.7	1.6	2.3	**5.1**	4.1	3.7	5.3	2.3	3.6	1.7	3.4	4.2	3.6	5.3	2.3	3.7	3.1	2.1	2.5	4.3	3.4	2.9	3.1	2.4	95.0
CA	4.1	2.3	2.8	3.0	4.7	3.2	3.8	1.8	1.9	1.4	**7.3**	5.0	4.8	2.4	3.5	1.5	4.5	1.4	3.8	3.9	3.0	3.6	2.8	1.9	2.4	5.6	3.9	2.9	3.7	3.3	92.7
IA	4.7	2.8	2.0	2.8	6.9	2.3	3.0	1.6	2.2	1.6	3.6	**8.8**	4.9	3.2	5.2	1.4	4.4	1.5	4.4	3.6	3.8	2.8	3.0	1.1	1.2	4.3	3.8	3.4	3.2	2.9	91.2
SAA	4.3	3.6	1.8	2.4	5.7	3.6	3.7	1.4	1.7	1.9	2.7	5.5	**11.1**	2.1	3.8	1.2	4.6	1.0	3.4	3.8	2.9	3.8	1.5	1.9	3.0	3.6	4.3	2.6	3.3	3.8	88.9
SK	3.8	2.2	1.6	2.3	6.4	2.3	2.9	1.9	2.5	1.1	3.0	4.4	6.1	**5.5**	4.6	1.9	3.8	1.1	2.7	5.7	4.1	4.2	2.5	1.2	2.0	5.1	4.5	3.0	3.7	4.1	94.5
SA	3.0	2.0	2.1	2.9	7.0	2.3	2.8	1.5	2.5	1.8	3.4	4.4	4.1	3.6	**8.7**	1.8	3.3	1.1	3.5	4.8	2.8	3.8	3.4	1.7	1.3	5.1	3.9	4.3	3.3	3.8	91.3
BL	3.9	1.7	1.4	1.8	6.6	2.5	2.9	1.3	1.9	1.8	3.3	4.1	5.9	2.0	3.9	**6.6**	3.4	2.3	2.8	5.1	2.9	4.1	3.4	1.8	2.7	5.0	4.1	3.9	3.2	3.7	93.4
TD	3.9	2.0	2.2	2.6	6.0	2.5	3.1	2.1	2.9	1.2	4.2	4.9	6.0	3.4	3.5	1.5	**8.9**	1.7	4.7	3.2	3.4	3.3	2.6	1.4	2.0	4.3	4.2	2.8	2.9	2.8	91.1
IA	3.9	1.8	1.7	2.6	5.8	3.3	3.6	1.7	1.9	1.7	4.2	4.4	5.8	2.0	3.9	2.5	3.8	**4.3**	3.4	5.3	3.0	4.2	3.1	1.4	2.6	5.1	3.7	2.9	3.8	3.0	95.7
MO	4.1	2.0	2.5	2.7	5.5	3.1	3.6	1.7	1.6	1.5	3.5	3.9	5.5	2.9	3.8	2.0	3.4	2.3	**7.3**	4.4	2.6	3.8	3.3	1.9	2.1	5.3	3.7	3.3	3.5	3.4	92.7
MA	3.6	2.2	2.1	2.0	6.1	2.7	3.0	2.0	1.8	2.4	4.1	4.4	6.9	1.8	3.8	1.4	4.2	1.5	2.6	**10.0**	2.4	4.2	2.2	1.7	2.7	4.6	3.6	2.9	4.3	3.1	90.0
VN	3.3	1.8	2.3	2.4	5.7	2.7	3.3	1.5	2.3	1.5	3.4	4.3	5.3	2.6	4.0	1.5	3.6	2.2	3.4	4.8	**8.7**	4.9	3.7	1.7	2.1	4.4	3.8	3.3	3.1	2.7	91.3
KA	3.1	2.8	2.2	2.0	5.6	2.7	3.1	1.2	1.9	1.6	3.4	3.9	5.7	3.0	3.5	2.0	3.5	1.6	3.3	4.6	2.0	**9.5**	3.3	1.9	3.2	4.5	4.1	3.0	3.5	4.3	90.5
RA	4.0	1.9	2.8	2.2	5.8	3.2	3.9	1.7	1.7	1.4	4.1	4.3	4.7	2.3	4.1	1.9	3.3	2.1	3.5	5.2	2.9	3.5	**6.7**	1.6	2.3	4.7	3.4	4.1	3.8	3.4	93.4
KN	3.5	3.2	3.6	3.0	4.3	4.2	3.4	1.4	1.7	1.6	3.5	3.3	4.3	2.0	3.5	0.9	3.0	2.5	2.5	3.8	3.0	2.8	3.4	**10.9**	4.9	3.6	3.9	3.0	2.6	2.8	89.1
BA	3.9	5.0	1.3	1.8	3.3	5.4	4.5	1.6	1.5	1.4	2.7	3.4	5.4	2.8	3.0	1.8	3.4	2.2	2.8	2.6	2.3	4.0	2.0	3.6	**8.4**	4.5	5.8	1.8	3.7	4.2	91.6
NA	3.3	2.6	2.6	2.3	5.9	2.3	2.8	2.5	1.8	1.1	3.8	4.4	4.8	2.6	4.5	1.3	3.9	1.5	3.2	4.4	2.8	4.0	3.3	1.6	2.4	**9.7**	3.8	3.3	3.7	4.0	90.3
CA	5.8	4.4	2.4	2.7	5.4	3.5	4.0	1.4	1.7	1.2	2.8	4.2	6.4	3.2	3.0	1.6	4.1	1.6	4.0	2.2	2.5	3.5	1.6	2.3	3.7	4.2	**8.3**	1.7	3.4	3.3	91.7
JON	3.6	2.3	2.4	2.3	6.0	2.6	3.0	1.6	1.9	2.0	4.7	4.8	6.1	2.4	4.0	1.7	3.7	1.7	2.6	5.8	2.9	3.7	3.3	1.5	2.3	4.7	3.5	**6.3**	3.6	3.3	93.7
MO	2.6	3.4	2.1	4.5	4.5	2.5	2.9	1.8	1.8	1.2	4.0	3.9	5.2	2.3	3.5	1.7	3.6	1.4	2.9	5.7	3.1	4.5	3.2	1.9	2.7	4.0	3.8	2.8	**9.1**	3.7	90.9
BH	2.9	3.8	2.2	2.0	5.1	2.3	2.5	2.6	1.7	1.8	3.3	4.0	5.4	3.4	4.1	1.2	3.2	1.4	2.6	4.8	2.2	4.5	3.4	2.3	3.1	4.7	3.9	3.2	4.1	**8.4**	91.6
TO	119.7	86.6	62.8	75.3	160.9	97.9	106.5	50.2	57.3	46.3	95.6	120.3	158.0	72.0	106.2	48.3	107.3	49.8	100.9	114.8	80.3	105.2	75.1	58.2	80.2	123.1	114.4	82.4	94.6	93.5	2743.4
Inc.Own	131.5	95.2	73.9	85.3	172.8	106.8	117.2	54.4	67.2	51.3	102.9	129.1	169.1	77.5	114.9	54.9	116.2	54.1	108.2	124.8	89.0	114.7	81.7	69.2	88.6	132.8	122.6	88.7	103.7	102.0	
NET	31.5	-4.8	-26.1	-14.7	72.8	6.8	17.2	-45.6	-32.8	-48.7	2.9	29.1	69.1	-22.5	14.9	-45.1	16.2	-45.9	8.2	24.8	-11.0	14.7	-18.3	-30.8	-11.4	32.8	22.6	-11.3	3.7	2.0	**91.5**

➢ Robustness

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 100-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 80, 100, and 120 days. Examining the spillover curves illustrated in Fig. 4.22 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

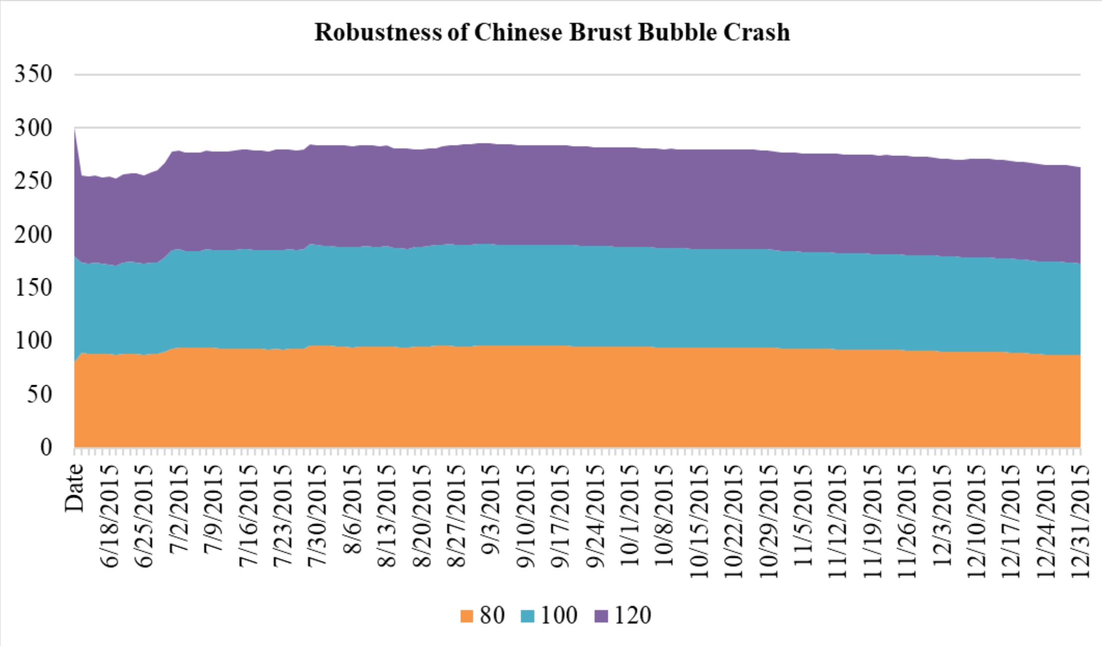


Fig. 4.22: During the robustness of the Chinese crash, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR.

Note: In the above figure the orange colour shows 80 window size, blue shows 100 window size, and Purple shows 250 window size (due to the number of observations window size taken in different crises as per the requirement of different crises based on the number of observations). (Source- Author using R software).

➢ Chinese crash frequency dynamics (using TVP-VAR-BK Model)

Fig. 4.23 indicated the interconnectedness among the developed, emerging, and frontier countries on different frequency dynamics, i.e. short period (1-4 days), medium period (4-Inf.), and entire period. Throughoutthe analysis of different frequencies, this study identified the stock markets of Switzerland, Germany, and Canada.

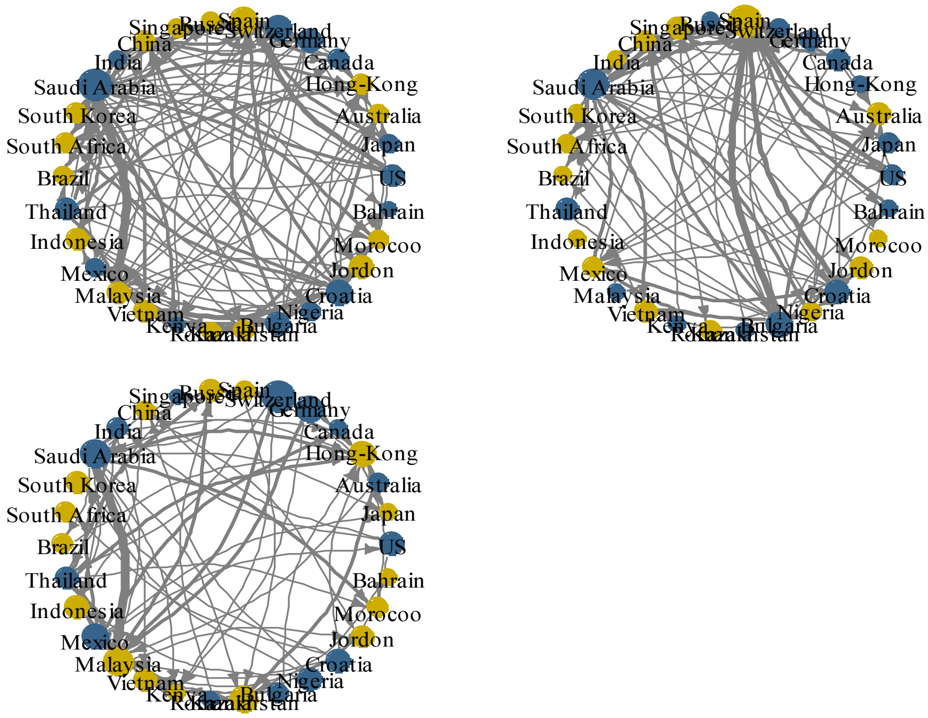


Fig. 4.23: During the Chinese crisis, interconnectedness among the developed, emerging, and frontier countries was observed using the TVP-VAR-BK Model.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Frequency spillover based on Baruník - Křehlík (TVP-VAR-BK) during Chinese in Short term (1–5), Long term (above 5 days to Inf.), and entire period (total period black represents 1–5 days, pink colour represents 1–5 days, and green colour, above 5 days) (Fig. 4.24).

In the short frequency (Table 4.9.0), the Chinese crash generated 37.10% volatility spillover; the medium frequency (Table 4.9.1) generated 51.93% volatility spillover, and in the entire period (Table 4.9.2) generated 89.03% volatility spillover, indicated in long period Chinese crash impacted the selected countries significantly it impacted more emerging countries, as simultaneously oil crises also emerged which impacted more than the Chinese burst (i.e., China).

Table 4.9.0: During the Chinese crash, interconnectedness in the short period (1-4 Days) among the developed, emerging, and frontier countries using TVP-VAR-BK models. (Source: Author using R software)

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**4.6**	2.2	0.4	0.6	2.2	3.4	3.5	0.2	0.8	0.2	0.5	0.8	2.3	0.5	0.5	1.6	1.4	0.5	1.3	0.3	0.7	1.3	0.3	1.2	3.3	1.0	2.4	0.2	0.6	1.6	35.9
JN	2.0	**4.8**	0.5	0.6	1.2	2.4	2.3	0.5	0.8	0.5	0.7	1.0	2.4	0.7	0.7	0.8	1.6	0.8	0.6	0.2	0.3	1.4	0.3	1.4	3.4	1.2	2.6	0.4	0.9	1.4	33.4
AA	1.9	1.6	**5.1**	1.3	1.3	2.3	2.4	1.4	0.9	0.8	1.8	0.8	2.3	1.2	0.8	0.7	1.4	0.9	1.6	0.7	0.5	1.4	1.5	1.2	2.7	2.7	2.2	0.7	1.2	1.8	42.1
HG	0.7	0.7	0.6	**3.2**	0.6	0.9	0.9	0.2	0.7	0.6	0.3	0.3	0.8	0.5	0.3	0.4	0.6	0.3	1.0	0.2	0.2	0.5	0.4	0.5	0.9	0.4	0.8	0.2	0.3	0.6	15.4
CAA	1.6	0.8	0.2	0.2	**3.4**	1.2	1.6	0.1	0.7	0.1	0.5	0.6	1.0	0.4	1.0	0.5	0.9	0.3	0.5	0.5	0.4	0.7	0.3	0.5	1.4	1.0	1.3	0.3	0.9	1.3	20.6
GY	3.9	3.2	0.6	1.3	2.2	**6.5**	5.8	0.4	1.4	0.5	0.9	1.3	4.2	0.7	1.0	1.3	2.5	0.7	1.9	0.5	0.8	2.0	0.7	1.7	5.0	1.7	3.6	0.6	1.2	2.5	54.0
SD	4.4	3.0	0.5	0.9	3.0	6.1	**6.9**	0.3	1.6	0.4	1.2	1.6	4.4	0.8	1.4	1.1	2.9	0.8	1.8	0.7	1.0	2.5	0.8	2.1	5.5	1.7	4.2	0.6	1.9	3.4	60.5
SN	3.7	3.1	1.1	1.3	2.7	5.5	5.4	**2.0**	1.4	0.4	1.3	1.4	3.9	0.9	1.6	1.2	2.5	0.7	2.0	0.7	0.7	2.3	0.7	2.0	4.8	2.4	3.7	0.6	1.7	3.1	62.6
RUS	1.0	1.3	0.5	0.6	0.9	1.4	1.4	0.3	**3.4**	0.3	0.7	0.6	1.6	0.6	0.6	0.5	1.1	0.7	0.5	0.3	0.3	1.1	0.4	1.1	2.1	1.3	1.8	0.3	0.9	1.2	25.1
SA	1.7	1.4	0.9	0.9	1.3	2.3	2.2	0.3	1.2	**3.5**	0.9	1.2	2.2	0.9	0.9	1.0	1.9	1.4	1.2	0.7	0.4	1.1	1.8	1.2	2.2	1.8	2.3	1.0	1.5	1.6	39.3
CA	2.2	2.0	0.7	0.6	1.8	2.8	3.1	0.4	1.2	0.4	**3.3**	1.2	2.7	1.2	1.1	0.9	2.8	0.7	1.1	0.7	0.6	1.9	0.8	1.6	3.7	2.5	3.2	0.6	1.8	2.1	46.3
IA	1.2	1.6	0.3	0.6	1.2	1.7	1.8	0.4	1.1	0.8	1.1	**3.3**	2.2	0.7	1.4	0.6	2.2	0.6	0.7	0.5	0.5	1.0	0.5	0.7	1.8	1.5	2.5	0.5	1.1	1.3	31.8
SAA	0.9	1.4	0.4	0.5	0.6	1.7	1.6	0.2	0.9	0.3	0.6	0.7	**2.9**	0.4	0.4	0.5	1.9	0.3	0.4	0.1	0.2	0.8	0.4	0.7	2.2	0.7	2.1	0.3	0.6	0.7	22.6
SK	1.1	1.3	0.4	0.5	0.9	1.8	1.9	0.3	0.9	0.5	0.9	0.7	2.0	**2.5**	1.2	0.5	1.3	0.8	0.6	0.4	0.3	1.5	0.5	1.2	2.6	1.5	2.5	0.4	1.1	1.9	31.2
SA	1.5	1.3	0.4	0.5	1.8	2.9	3.0	0.4	1.4	0.3	0.7	1.1	2.7	0.8	**4.4**	0.7	1.5	0.5	0.8	0.7	0.4	1.7	0.4	1.2	2.6	1.8	2.8	0.4	1.6	2.0	37.7
BL	2.4	1.5	0.4	0.4	1.1	2.2	1.9	0.2	1.2	0.6	0.4	0.9	2.1	0.4	0.3	**4.5**	1.4	0.6	1.0	0.3	0.5	1.1	0.8	0.9	2.5	0.8	2.3	0.6	0.4	0.9	30.1
TD	1.2	1.5	0.4	0.6	1.2	1.8	1.9	0.4	1.4	0.6	1.5	1.2	2.7	0.7	0.8	0.8	**4.0**	0.5	0.6	0.2	0.4	1.0	0.4	0.8	2.4	1.5	2.6	0.3	1.0	0.9	31.4
IA	1.2	1.0	0.6	0.6	1.0	1.5	1.5	0.4	1.0	1.5	0.8	1.1	1.4	1.1	0.8	0.8	1.2	**3.8**	1.7	0.2	0.2	0.8	0.7	0.5	1.2	1.1	1.4	0.4	0.8	0.7	27.0
MO	3.1	2.2	0.7	1.1	2.3	3.6	3.4	0.3	1.1	0.6	1.1	1.4	3.0	1.1	1.0	1.1	1.9	1.2	**3.7**	0.4	0.6	1.7	0.6	1.1	3.3	1.7	2.6	0.5	1.0	1.7	45.4
MA	0.6	0.4	0.6	0.4	0.7	0.4	0.4	0.2	0.4	0.8	0.5	0.3	0.7	0.5	0.3	0.5	0.5	0.5	0.7	**1.2**	0.2	0.3	1.2	0.3	0.4	0.8	0.5	0.9	0.4	0.6	14.5
VN	1.2	1.5	0.7	0.7	1.2	1.8	1.9	0.4	0.9	0.5	0.9	1.1	2.3	0.9	0.8	0.7	2.1	0.5	0.7	0.4	**4.2**	1.2	0.5	1.0	2.4	1.2	2.5	0.3	0.8	1.4	32.5
KA	1.3	2.0	1.1	0.6	1.2	2.1	2.1	0.4	1.1	1.2	1.0	1.1	2.0	1.5	0.8	0.7	1.3	0.8	0.8	0.9	0.5	**6.2**	1.3	1.1	3.1	1.8	2.4	0.8	1.0	2.7	38.4
RA	1.0	0.7	1.8	0.9	0.9	1.0	1.2	0.2	1.0	2.7	1.3	1.1	1.9	1.2	0.4	1.6	1.3	1.4	1.6	1.9	0.4	0.7	**7.0**	0.6	1.1	1.6	1.7	3.7	1.4	1.6	37.7
KN	1.2	1.6	0.4	0.4	0.7	1.7	1.7	0.3	0.5	0.2	0.9	0.5	1.6	0.8	0.5	0.5	1.3	0.6	0.6	0.3	0.3	1.1	0.5	**4.3**	2.7	1.4	2.3	0.2	1.2	1.2	27.3
BA	2.5	3.4	0.4	0.5	1.5	4.1	4.0	0.4	1.3	0.6	1.4	1.1	4.1	1.1	1.0	1.0	3.1	0.7	0.7	0.6	0.7	2.6	0.5	2.2	**6.8**	1.9	4.3	0.4	1.6	2.7	50.1
NA	1.7	3.0	1.2	0.5	1.8	3.2	2.9	0.9	1.2	0.8	2.3	1.5	3.1	1.8	2.2	0.6	2.6	1.1	0.9	1.0	0.4	2.7	1.2	1.9	4.4	**8.1**	3.7	0.8	2.4	3.4	54.9
CA	1.8	2.5	0.3	0.3	1.3	3.1	3.2	0.5	1.2	0.3	1.2	1.5	4.0	1.2	1.1	1.1	3.3	0.6	0.4	0.3	0.5	2.1	0.5	1.6	4.5	2.0	**7.0**	0.4	1.4	1.7	43.8
JON	1.2	1.1	0.9	0.4	1.2	1.5	1.5	0.2	0.8	1.1	1.5	0.9	2.0	1.2	0.8	1.2	1.5	0.8	1.7	1.6	0.4	1.1	3.2	0.7	1.9	1.5	1.7	**5.3**	1.3	2.0	36.8
MO	1.2	1.4	0.9	0.7	1.6	1.7	2.0	0.3	0.6	0.7	1.6	0.8	1.4	1.3	1.3	0.6	1.4	0.7	0.9	1.1	0.6	1.5	1.4	1.7	2.4	2.3	2.4	1.1	**4.3**	2.2	37.9
BH	1.5	2.5	0.8	0.5	1.6	2.8	2.8	0.5	1.1	1.1	1.4	1.5	2.6	1.5	1.2	0.6	1.7	0.7	0.7	1.3	0.6	2.3	1.7	1.8	4.1	2.3	2.9	1.2	1.9	**5.6**	46.9
TO	50.6	50.8	18.7	18.8	41.1	68.9	69.1	10.8	29.9	19.3	30.1	29.5	69.5	26.3	25.9	23.8	50.7	20.7	28.8	17.6	13.5	41.2	24.2	34.2	80.4	45.2	71.3	18.4	33.6	50.1	1113.1
Inc.Own	55.1	55.6	23.8	22.0	44.5	75.3	76.0	12.7	33.2	22.8	33.4	32.8	72.4	28.8	30.3	28.3	54.8	24.5	32.5	18.8	17.7	47.5	31.2	38.5	87.3	53.3	78.3	23.7	37.9	55.6	
NET	14.7	17.4	-23.5	3.4	20.5	14.8	8.6	-51.8	4.7	-19.9	-16.2	-2.3	46.9	-4.9	-11.8	-6.3	19.4	-6.3	-16.6	3.1	-18.9	2.9	-13.5	6.9	30.4	-9.7	27.6	-18.4	-4.3	3.2	**37.1**

Table 4.9.1: During Chinese interconnectedness in the medium period (4-Inf. Days) among the developed, emerging, and frontier countries using TVP-VAR-BK models. (Source: Author using R software)

	US	**JN**	**AA**	**HG**	**CAA**	**GY**	**SD**	**SN**	**RUS**	**SA**	**CA**	**IA**	**SAA**	**SK**	**SA**	**BL**	**TD**	**IA**	**MO**	**MA**	**VN**	**KA**	**RA**	**KN**	**BA**	**NA**	**CA**	**JON**	**MO**	**BH**	**FM**
US	**6.6**	3.3	1.9	2.0	4.8	2.7	3.3	0.6	1.3	1.5	0.6	2.6	4.5	1.7	0.8	1.7	2.8	1.1	4.6	0.5	1.1	1.2	1.2	1.2	1.5	0.7	1.6	1.1	0.6	0.7	53.0
JN	4.5	**7.0**	1.8	2.1	4.2	3.0	3.5	0.4	0.9	1.3	0.7	3.7	5.2	1.9	0.8	0.7	2.7	0.8	2.7	0.6	0.9	1.5	0.6	1.5	2.3	1.3	1.9	0.8	1.6	1.2	54.8
AA	2.0	3.5	**6.9**	1.4	2.5	1.5	1.7	0.7	1.1	2.4	1.1	1.5	2.9	1.3	1.0	1.4	1.4	0.7	2.0	1.1	0.8	1.6	2.0	1.2	1.6	2.1	1.8	1.1	1.3	1.5	45.9
HG	3.0	3.7	3.3	**10.6**	1.9	3.3	3.4	0.8	3.4	2.7	1.9	2.8	4.9	2.4	1.4	2.8	5.2	0.8	1.7	1.1	1.7	1.4	2.6	0.7	3.4	1.9	3.7	2.1	1.8	1.2	70.8
CAA	6.0	3.4	1.7	2.3	**10.0**	3.2	4.4	0.5	2.2	1.7	0.9	3.9	5.5	1.6	1.4	1.9	4.7	1.3	6.2	0.9	1.7	1.1	1.3	0.9	1.5	0.9	2.0	1.1	1.0	0.7	66.0
GY	2.5	1.3	1.2	1.0	1.8	**3.9**	3.2	0.4	0.9	1.2	0.4	1.7	2.5	0.7	1.6	1.1	1.0	1.2	2.4	0.5	0.6	0.8	1.2	1.0	1.1	1.3	1.6	0.4	0.6	0.6	35.6
SD	2.3	1.0	1.3	0.9	2.0	2.5	**2.8**	0.3	0.6	1.1	0.5	1.7	1.6	0.7	1.0	1.0	0.5	1.1	2.5	0.6	0.5	0.5	1.2	1.0	0.6	0.8	1.1	0.5	0.5	0.3	29.8
SN	2.2	2.1	1.0	1.7	2.1	3.1	2.8	**0.9**	0.8	0.9	0.5	1.1	1.6	0.6	1.0	1.1	0.6	0.8	2.2	0.4	0.5	1.0	1.0	0.9	0.9	1.1	1.3	0.3	0.7	0.5	34.6
RUS	2.2	1.6	2.8	2.3	3.5	2.2	2.9	0.8	**8.3**	3.0	1.2	2.4	3.8	1.2	1.4	2.9	5.4	1.3	2.7	0.7	1.6	1.7	3.0	2.4	1.8	2.0	2.3	1.1	1.9	1.5	63.2
SA	1.9	0.9	4.0	2.3	1.7	1.8	1.6	0.6	1.8	**7.5**	2.0	1.4	1.7	1.7	0.7	1.8	1.4	5.8	3.4	2.7	0.8	1.0	2.7	0.5	0.8	1.6	0.9	1.1	0.6	0.7	49.7
CA	2.7	1.4	1.1	1.3	1.7	2.0	2.2	0.6	0.7	1.4	**5.3**	3.1	2.4	1.2	1.0	0.8	2.4	0.4	2.6	1.1	1.2	1.1	1.0	1.1	1.5	3.2	2.1	0.8	1.8	1.3	45.1
IA	4.8	2.5	0.8	0.8	4.3	1.9	2.4	0.8	1.5	1.2	1.2	**9.0**	2.7	2.8	2.5	1.6	2.4	1.9	4.7	0.8	3.0	1.0	1.3	0.8	1.2	2.0	2.2	1.0	1.1	0.8	55.9
SAA	3.2	2.9	2.2	1.6	2.7	4.4	4.5	0.9	1.7	2.2	0.7	5.4	**10.9**	1.5	1.9	0.5	4.5	1.2	3.1	0.5	1.6	1.6	1.4	1.2	2.4	1.2	3.8	1.6	1.6	1.4	63.7
SK	2.2	2.1	1.4	2.3	2.1	1.9	2.0	0.8	2.0	1.5	1.3	2.1	2.8	**6.6**	2.6	2.5	2.3	0.6	2.0	1.7	2.8	2.5	1.4	1.5	2.2	3.8	3.9	1.5	1.7	2.5	59.7
SA	2.0	1.3	1.3	1.0	2.5	2.3	2.3	1.2	2.2	1.4	0.9	2.4	3.4	2.5	**4.9**	1.7	1.5	0.8	2.7	1.5	1.6	1.6	1.3	1.4	1.5	2.5	3.8	1.1	1.5	1.8	53.0
BL	2.3	0.6	1.3	0.7	3.5	1.3	1.6	1.2	1.6	3.1	0.9	1.4	2.8	1.5	1.7	**9.6**	3.1	2.5	2.2	2.3	1.2	2.0	2.8	1.3	1.6	2.1	2.5	2.8	1.6	2.4	55.8
TD	3.5	1.6	1.3	1.4	3.6	2.2	3.1	0.8	1.6	1.0	1.6	4.9	5.6	1.6	1.0	1.4	**8.1**	1.7	3.5	0.4	2.8	0.9	2.0	0.7	1.4	1.4	2.7	1.2	1.1	0.7	56.6
IA	2.1	1.4	1.7	1.5	2.0	2.2	2.2	0.8	1.6	2.9	3.2	2.2	3.9	1.4	1.4	3.5	2.8	**7.6**	3.0	2.5	1.8	2.8	2.1	0.8	2.4	2.7	2.4	1.1	2.1	1.3	61.6
MO	1.8	0.7	1.4	1.3	2.0	1.4	1.7	0.7	1.2	2.1	1.2	1.4	2.4	1.6	1.5	1.1	2.0	1.3	**4.7**	1.7	0.9	1.8	2.1	1.1	1.6	3.2	2.4	1.6	1.5	1.7	46.2
MA	1.9	1.3	3.3	1.9	2.6	3.6	3.6	1.9	3.8	3.2	2.0	3.2	8.2	1.2	2.5	1.1	5.1	0.9	1.8	**10.0**	0.9	3.1	1.9	0.8	3.1	2.2	3.3	1.3	2.7	1.8	74.3
VN	1.8	1.1	0.9	0.7	1.4	2.1	2.2	0.7	1.9	1.0	1.3	2.2	4.1	2.1	2.2	1.1	2.5	1.7	3.3	1.3	**7.3**	5.3	1.4	0.7	2.9	2.4	3.6	0.8	1.6	1.7	56.1
KA	2.4	1.6	0.9	0.8	2.1	3.1	3.2	0.3	1.7	0.9	0.7	1.8	3.7	1.1	1.7	1.7	2.2	0.8	1.7	1.2	0.7	**7.8**	1.4	0.8	2.9	1.5	3.0	0.7	1.2	1.8	47.7
RA	2.1	0.8	2.3	1.2	2.2	1.5	1.7	0.6	0.5	2.8	2.1	1.8	1.4	1.8	1.5	1.4	1.1	1.8	2.1	2.8	1.1	1.5	**6.0**	0.6	1.3	3.3	1.9	2.2	2.0	1.9	49.3
KN	2.5	1.5	5.3	1.2	1.7	2.4	2.2	3.1	1.8	1.6	2.1	2.2	3.4	0.9	1.4	0.7	2.5	1.8	1.3	2.7	2.3	1.3	3.4	**5.9**	2.2	2.5	2.1	1.5	1.5	3.5	62.5
BA	2.4	1.6	0.8	0.9	1.9	2.2	2.4	0.6	1.1	1.0	0.7	1.9	2.4	0.9	1.3	1.5	1.8	0.8	1.6	0.8	1.0	1.3	1.7	0.9	**2.3**	2.1	2.3	0.6	1.3	1.2	40.8
NA	2.0	1.2	1.3	0.8	1.8	1.3	1.5	0.8	0.7	1.1	0.5	1.4	1.8	1.0	0.9	0.9	1.5	0.7	1.7	0.9	0.9	0.6	1.8	0.6	1.3	**4.1**	1.5	0.8	0.8	0.8	32.9
CA	4.3	2.1	1.1	1.6	3.6	2.1	2.6	0.3	0.8	0.9	0.5	2.2	3.6	1.4	1.2	1.5	1.9	0.7	2.7	0.5	0.7	1.1	1.0	1.2	1.8	1.5	**3.6**	0.7	1.0	0.9	45.6
JON	1.9	1.9	1.8	0.8	2.2	1.5	1.5	0.7	1.3	2.9	2.9	1.6	2.5	2.2	1.4	1.5	1.4	1.3	2.0	3.7	1.1	1.3	2.5	0.8	1.1	2.5	2.0	**6.0**	1.8	2.1	52.0
MO	0.9	2.6	2.2	4.1	1.2	2.2	2.1	1.3	2.5	0.9	1.5	1.7	5.4	0.9	1.3	0.8	3.5	0.6	1.0	1.6	2.4	2.3	1.5	0.7	2.6	0.9	2.2	0.6	**5.0**	1.5	52.9
BH	1.4	2.1	1.4	1.1	1.7	1.6	1.8	2.3	1.3	1.3	0.7	1.4	2.6	1.2	1.8	1.0	1.9	0.5	0.7	1.4	0.8	1.5	1.9	1.0	1.9	2.0	1.7	1.0	2.0	**4.6**	43.0
TO	74.9	53.1	52.6	42.6	71.4	66.1	73.5	25.4	44.4	50.3	35.6	67.1	99.2	42.4	41.6	42.6	71.9	36.9	73.9	38.4	38.8	46.1	50.7	29.2	52.3	56.9	67.5	32.3	40.3	39.9	1557.8
Inc.Own	81.5	60.1	59.5	53.2	81.4	70.0	76.3	26.3	52.8	57.8	40.9	76.2	110.0	49.0	46.6	52.2	79.9	44.5	78.6	48.4	46.1	53.8	56.7	35.1	54.6	61.0	71.2	38.3	45.2	44.5	
NET	21.9	-1.7	6.7	-28.2	5.4	30.4	43.7	-9.2	-18.7	0.6	-9.5	11.2	35.5	-17.3	-11.4	-13.2	15.3	-24.7	27.7	-35.9	-17.2	-1.6	1.4	-33.3	11.5	24.0	21.9	-19.7	-12.6	-3.1	**51.9**

Table 4.9.2: During the Chinese crash, interconnectedness in the Full Period (Panel-C) among the developed, emerging, and frontier countries using TVP-VAR-BK models. (Source: Author using R software).

	US	**JN**	**AA**	**HG**	**CAA**	**GY**	**SD**	**SN**	**RUS**	**SA**	**CA**	**IA**	**SAA**	**SK**	**SA**	**BL**	**TD**	**IA**	**MO**	**MA**	**VN**	**KA**	**RA**	**KN**	**BA**	**NA**	**CA**	**JON**	**MO**	**BH**	**FM**
US	**11.2**	5.5	2.3	2.5	7.0	6.2	6.8	0.8	2.1	1.8	1.1	3.5	6.8	2.2	1.3	3.3	4.2	1.6	5.9	0.8	1.8	2.5	1.5	2.4	4.9	1.7	4.0	1.3	1.2	2.3	88.8
JN	6.5	**11.8**	2.4	2.7	5.4	5.3	5.7	0.8	1.7	1.7	1.4	4.7	7.5	2.6	1.5	1.5	4.3	1.7	3.2	0.8	1.3	2.9	0.9	2.9	5.6	2.5	4.5	1.2	2.4	2.6	88.2
AA	3.9	5.1	**12.0**	2.6	3.8	3.8	4.0	2.1	2.0	3.3	3.0	2.2	5.2	2.4	1.8	2.2	2.8	1.6	3.7	1.7	1.3	3.0	3.5	2.4	4.4	4.9	4.0	1.8	2.5	3.3	88.0
HG	3.6	4.4	3.9	**13.8**	2.5	4.1	4.3	1.0	4.1	3.2	2.2	3.1	5.7	3.0	1.7	3.2	5.8	1.2	2.7	1.3	1.9	1.9	2.9	1.2	4.3	2.3	4.5	2.3	2.1	1.8	86.2
CAA	7.6	4.2	1.8	2.5	**13.4**	4.4	6.0	0.6	2.9	1.8	1.4	4.5	6.4	2.0	2.5	2.4	5.6	1.6	6.6	1.4	2.2	1.8	1.7	1.4	2.9	2.0	3.3	1.4	1.9	2.0	86.6
GY	6.4	4.4	1.9	2.3	3.9	**10.3**	8.9	0.8	2.3	1.7	1.4	3.0	6.7	1.4	2.6	2.4	3.5	1.9	4.3	0.9	1.4	2.8	2.0	2.7	6.2	3.0	5.2	1.0	1.7	3.1	89.7
SD	6.7	4.0	1.8	1.8	5.0	8.6	**9.7**	0.6	2.2	1.6	1.7	3.3	6.1	1.5	2.3	2.1	3.3	1.9	4.2	1.3	1.5	3.0	2.0	3.0	6.1	2.5	5.3	1.1	2.3	3.7	90.4
SN	5.8	5.2	2.1	3.0	4.9	8.6	8.2	**2.8**	2.2	1.3	1.8	2.5	5.5	1.5	2.5	2.3	3.1	1.5	4.1	1.2	1.2	3.2	1.7	2.9	5.7	3.5	5.0	0.9	2.4	3.5	97.2
RUS	3.2	2.8	3.2	2.9	4.5	3.6	4.3	1.1	**11.7**	3.3	1.9	3.0	5.4	1.8	1.9	3.3	6.5	2.0	3.1	1.0	1.9	2.8	3.4	3.5	3.8	3.2	4.1	1.4	2.8	2.7	88.3
SA	3.6	2.3	4.8	3.2	3.1	4.0	3.9	0.9	3.0	**11.0**	2.9	2.6	3.9	2.6	1.6	2.7	3.3	7.2	4.6	3.4	1.2	2.0	4.5	1.7	3.0	3.4	3.2	2.1	2.0	2.3	89.0
CA	4.9	3.4	1.8	1.9	3.5	4.9	5.3	1.0	2.0	1.8	**8.6**	4.2	5.1	2.3	2.1	1.7	5.2	1.1	3.8	1.7	1.9	3.0	1.8	2.7	5.1	5.7	5.3	1.4	3.6	3.4	91.4
IA	6.0	4.1	1.1	1.4	5.6	3.5	4.2	1.1	2.6	1.9	2.3	**12.4**	4.8	3.5	3.8	2.2	4.6	2.5	5.4	1.3	3.4	2.0	1.8	1.5	3.0	3.6	4.7	1.6	2.2	2.1	87.7
SAA	4.1	4.3	2.6	2.1	3.3	6.1	6.1	1.2	2.6	2.6	1.3	6.2	**13.7**	1.9	2.4	1.0	6.4	1.5	3.5	0.7	1.9	2.4	1.8	1.9	4.6	1.9	6.0	1.9	2.2	2.2	86.3
SK	3.2	3.4	1.8	2.7	3.0	3.7	3.9	1.0	3.0	2.0	2.2	2.8	4.8	**9.1**	3.8	3.0	3.6	1.4	2.6	2.0	3.1	4.0	1.9	2.7	4.8	5.2	6.4	1.8	2.8	4.4	91.0
SA	3.5	2.6	1.7	1.6	4.3	5.2	5.3	1.6	3.6	1.7	1.6	3.5	6.1	3.2	**9.3**	2.4	3.0	1.3	3.5	2.2	1.9	3.4	1.7	2.6	4.0	4.4	6.6	1.6	3.1	3.9	90.7
BL	4.8	2.1	1.7	1.1	4.6	3.5	3.6	1.3	2.8	3.7	1.3	2.3	4.9	1.8	2.0	**14.2**	4.5	3.1	3.1	2.5	1.7	3.1	3.5	2.2	4.2	2.9	4.8	3.4	2.1	3.3	85.9
TD	4.7	3.1	1.7	1.9	4.8	3.9	5.0	1.2	3.0	1.6	3.1	6.2	8.3	2.3	1.8	2.2	**12.1**	2.2	4.1	0.7	3.3	1.9	2.5	1.4	3.9	2.9	5.3	1.5	2.1	1.6	87.9
IA	3.3	2.3	2.4	2.2	2.9	3.7	3.6	1.2	2.6	4.4	3.9	3.4	5.4	2.5	2.2	4.3	4.0	**11.4**	4.7	2.7	2.0	3.5	2.8	1.3	3.6	3.8	3.8	1.4	2.8	2.0	88.6
MO	4.9	2.9	2.0	2.4	4.3	5.0	5.1	1.0	2.3	2.7	2.3	2.8	5.4	2.8	2.5	2.2	3.9	2.5	**8.4**	2.1	1.5	3.5	2.6	2.2	4.9	4.9	5.0	2.0	2.5	3.4	91.6
MA	2.4	1.7	4.0	2.3	3.3	4.0	4.0	2.1	4.2	4.0	2.5	3.5	8.8	1.7	2.8	1.6	5.5	1.4	2.5	**11.2**	1.1	3.3	3.1	1.1	3.4	3.0	3.8	2.2	3.1	2.4	88.8
VN	3.0	2.6	1.6	1.4	2.7	3.9	4.1	1.1	2.8	1.5	2.2	3.3	6.4	3.0	2.9	1.9	4.5	2.2	4.0	1.8	**11.5**	6.5	1.9	1.7	5.4	3.7	6.1	1.1	2.4	3.0	88.5
KA	3.7	3.6	2.1	1.4	3.3	5.1	5.3	0.8	2.8	2.1	1.7	2.9	5.7	2.5	2.5	2.3	3.5	1.6	2.5	2.1	1.2	**14.0**	2.7	1.9	6.0	3.4	5.4	1.5	2.1	4.4	86.0
RA	3.1	1.6	4.1	2.1	3.1	2.5	2.9	0.8	1.6	5.4	3.4	2.9	3.3	3.1	1.9	2.9	2.4	3.2	3.7	4.7	1.5	2.2	**13.0**	1.2	2.4	5.0	3.7	5.9	3.3	3.5	87.0
KN	3.7	3.1	5.8	1.6	2.4	4.1	3.9	3.4	2.3	1.8	3.0	2.8	5.0	1.7	1.9	1.2	3.7	2.4	1.9	2.9	2.6	2.3	3.9	**10.3**	4.9	3.9	4.4	1.7	2.8	4.6	89.7
BA	4.9	5.0	1.2	1.4	3.4	6.3	6.4	1.0	2.4	1.6	2.1	3.0	6.5	2.0	2.2	2.5	4.8	1.5	2.3	1.4	1.6	3.9	2.2	3.1	**9.1**	4.0	6.6	1.0	2.9	3.9	90.9
NA	3.7	4.2	2.6	1.2	3.7	4.5	4.4	1.7	1.9	1.9	2.8	2.9	4.8	2.8	3.1	1.5	4.1	1.8	2.7	1.9	1.3	3.2	3.0	2.5	5.6	**12.2**	5.2	1.6	3.1	4.3	87.8
CA	6.1	4.6	1.4	1.9	4.9	5.2	5.8	0.9	2.1	1.2	1.7	3.8	7.6	2.6	2.3	2.7	5.2	1.3	3.1	0.8	1.2	3.1	1.5	2.8	6.3	3.5	**10.6**	1.0	2.3	2.6	89.4
JON	3.0	3.0	2.8	1.1	3.4	2.9	3.0	0.9	2.0	4.0	4.5	2.5	4.6	3.4	2.2	2.7	2.8	2.1	3.7	5.3	1.5	2.4	5.7	1.5	3.1	4.0	3.7	**11.3**	3.1	4.1	88.8
MO	2.1	4.0	3.1	4.8	2.8	3.9	4.1	1.6	3.1	1.6	3.2	2.5	6.9	2.2	2.6	1.4	4.9	1.3	2.0	2.7	3.0	3.8	2.9	2.4	5.0	3.3	4.6	1.7	**9.2**	3.7	90.8
BH	3.0	4.5	2.1	1.5	3.3	4.4	4.5	2.8	2.4	2.4	2.1	2.9	5.2	2.6	2.9	1.5	3.5	1.2	1.4	2.8	1.4	3.8	3.6	2.8	5.9	4.3	4.6	2.2	3.9	**10.1**	89.9
TO	125.5	103.9	71.3	61.4	112.5	134.9	142.6	36.2	74.3	69.6	65.7	96.6	168.7	68.7	67.5	66.4	122.6	57.7	102.7	56.0	52.4	87.3	74.9	63.4	132.7	102.1	138.9	50.7	73.9	90.0	2671.0
Inc.Own	136.6	115.8	83.3	75.2	125.9	145.3	152.3	39.0	86.0	80.6	74.3	109.0	182.4	77.7	76.8	80.5	134.7	69.0	111.1	67.2	63.8	101.3	87.9	73.6	141.9	114.3	149.5	62.0	83.1	100.2	
NET	36.6	15.8	-16.8	-24.8	25.9	45.3	52.3	-61.0	-14.0	-19.4	-25.7	9.0	82.4	-22.3	-23.2	-19.5	34.7	-31.0	11.1	-32.8	-36.2	1.3	-12.1	-26.4	41.9	14.3	49.5	-38.1	-16.9	0.2	**89.0**

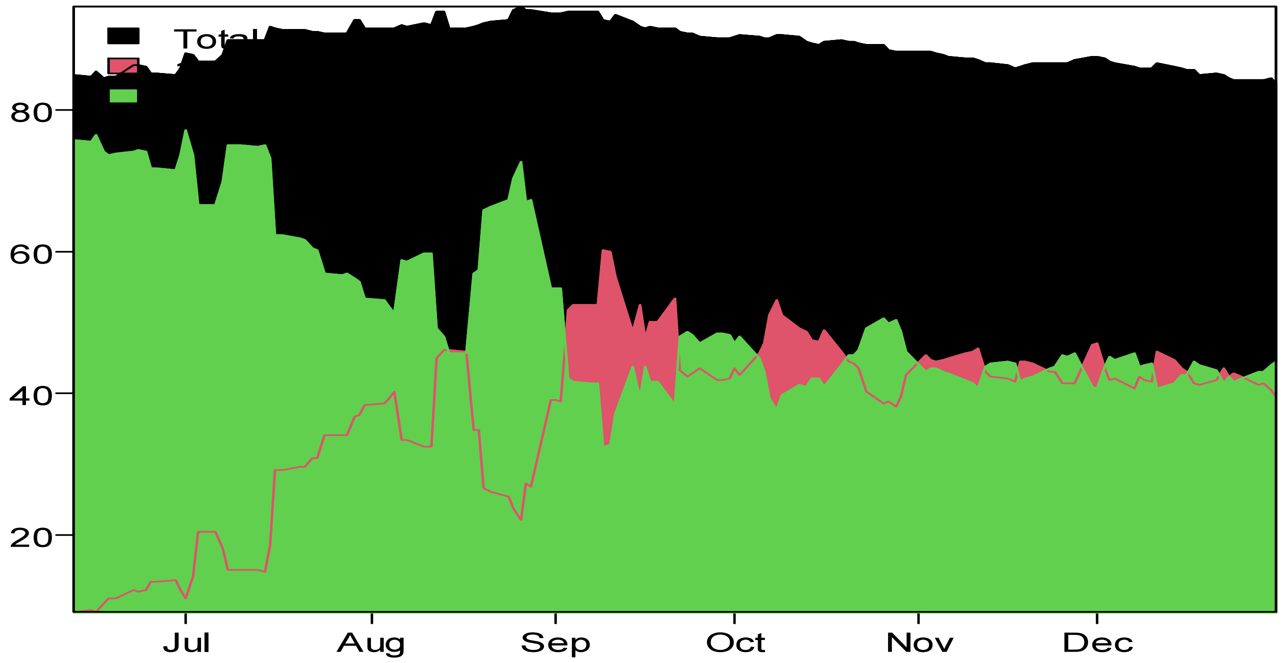


Fig. 4.24: During the Chinese crash, interconnectedness among the developed, emerging, and frontier countries on different frequencies using TVP-VAR-BK models.

Note: Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf Days, Green colour), and total frequency (black colour) (Source: Author's using R software).

4.7 Results of the volatility spillover among the developed, emerging, and frontier countries during the Pre-Brexit Event.

After the severe crises of the Chinese crash, again, a significant event emerged in Europe, i.e., Britain's exit (BREXIT) from the European Union (EU), which indicated that it is crucial to understand the interconnected during the pre-Brexit period covers 01 Jan 2016 to 23 June 2016. David Cameron, the United Kingdom's prime minister, announced the in/out referendum date for 23 June 2016 on Saturday, 20 February 2016. Members of his cabinet began to advocate for or against Britain's participation publicly.

Among developed countries using 100 days window size, this study (Fig.4.25) indicated Japan (31.66%), Germany (30.90%), HongKong (20.97%) were the primary net transmitters, and Australia (-47.92%), Spain (-39.47%), Switzerland (-36.56%) as major net receiver of the volatility spillover.

Among the emerging countries, Malaysia (46%), China (40.54%), Saudi Arabia (29.06%), Thailand (-56.03%), India (-6.53%), South Africa (-1.06%) were identified as the major re net recipient of the volatility spillover (Table 4.10.0). It could occur due toMalaysia's high transmission rate due to its open economy and export dependence, making it a big player in regional and global financial volatility. China is the largest market in the second-largest economy in the world, so it moves the world as a whole and sends ripples of volatility, particularly to emerging markets; as a major oil producer, Saudi Arabia suffers from the transmission of energy market volatility. Thus, in the case of the net receivers (Thailand, India, and South Africa), as a smaller and more open economy, Thailand is more vulnerable to volatility from more significant regional economies like China. India and South Africa, albeit big economies, are not integrated globally to the extent of China and hence absorb rather than transmit volatility.

Among the frontier countries, Jordon (37.23%), Bulgaria (19.14%), and Nigeria (17.28%) are the significant net transmitters, and Morocco (-57.61%), Romania (-24.40%), Bahrain (-4.70%) as the significant net receiver of the volatility spillover (Fig. 4.26).As the net transmitters (Jordan, Bulgaria, Nigeria), while small, play an essential cross-market role, they are sizeable transmitters in their region because of specific sectors (e.g., oil in Nigeria and financial linkages in Bulgaria).Jordan's geography and economy are the basis for the kingdom's outsized effect on the spillover of instability in the neighbourhood. Moreover, in the case of the net Receivers (Morocco, Romania, Bahrain). Morocco, which has a smaller, less diversified economy, takes volatility from more prominent players in its trade network.Romania is an EU member but a net receiver, with poorer financial resilience than developed markets.Attuned to external shocks due to reliance on oil and financial services, Bahrain is an economic hub in the Gulf.

"To Other" Japan (125.09%), HongKong (114.36%), Germany (124.25%) among developed, Malaysia (139.36%), China (133.80%), Saudi Arabia (122.39%) among emerging countries, Jordon (130.75%), Bulgaria (112.69%), Nigeria (108.76%) among the frontier's countries.

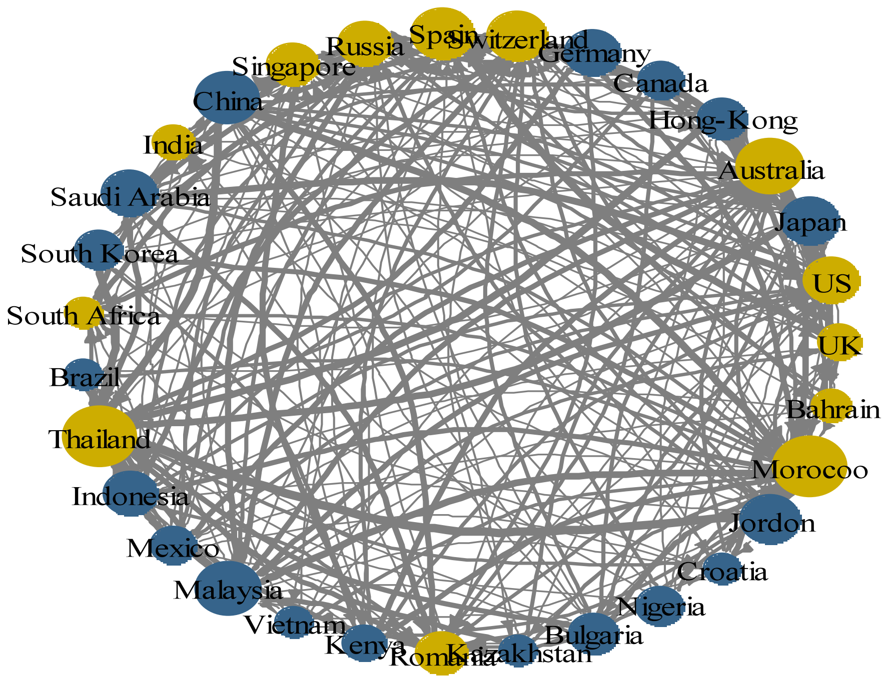
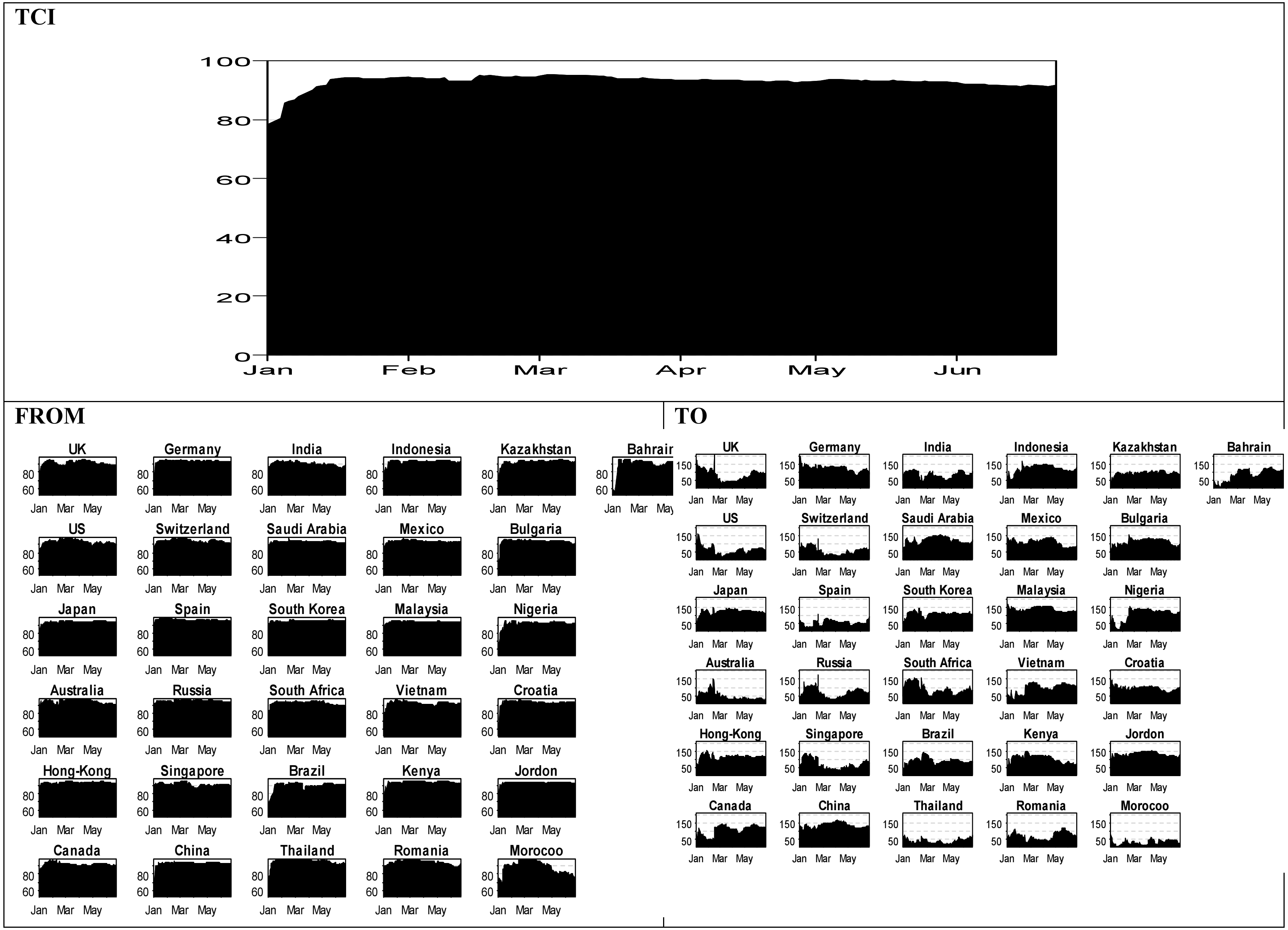


Fig. 4.25: During the Pre-Brexit, interconnectedness among the developed, emerging, and frontier countries on different frequencies using TVP-VAR models.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

"From Other" Spain (95.99%), Russia (95.24%), Australia (94.38%) among developed countries, Thailand (95.69%), South Korea (94.68%), Malaysia (93.60%) among the emerging countries, and Romania (94.26%), Kenya (93.66%), Bulgaria (93.54%) among the frontier countries. The results of this study are consistent with those of Qiao et al. (2021), who revealed that before Brexit, the SandP 500 returns showed an increase in both trend and volatility. Furthermore, while Brexit had a favourable effect on market volatility, which gradually declined over time, it had a negative short-term impact on the trajectory of SandP 500 returns.

Thus, this panel revealed insight that almost all the stock markets show equivalent impact with strong interconnectedness. However, the Malaysia, Jordan, and China stock markets are still dominant in this period.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Australia Russia South Africa Vietnam Croatia
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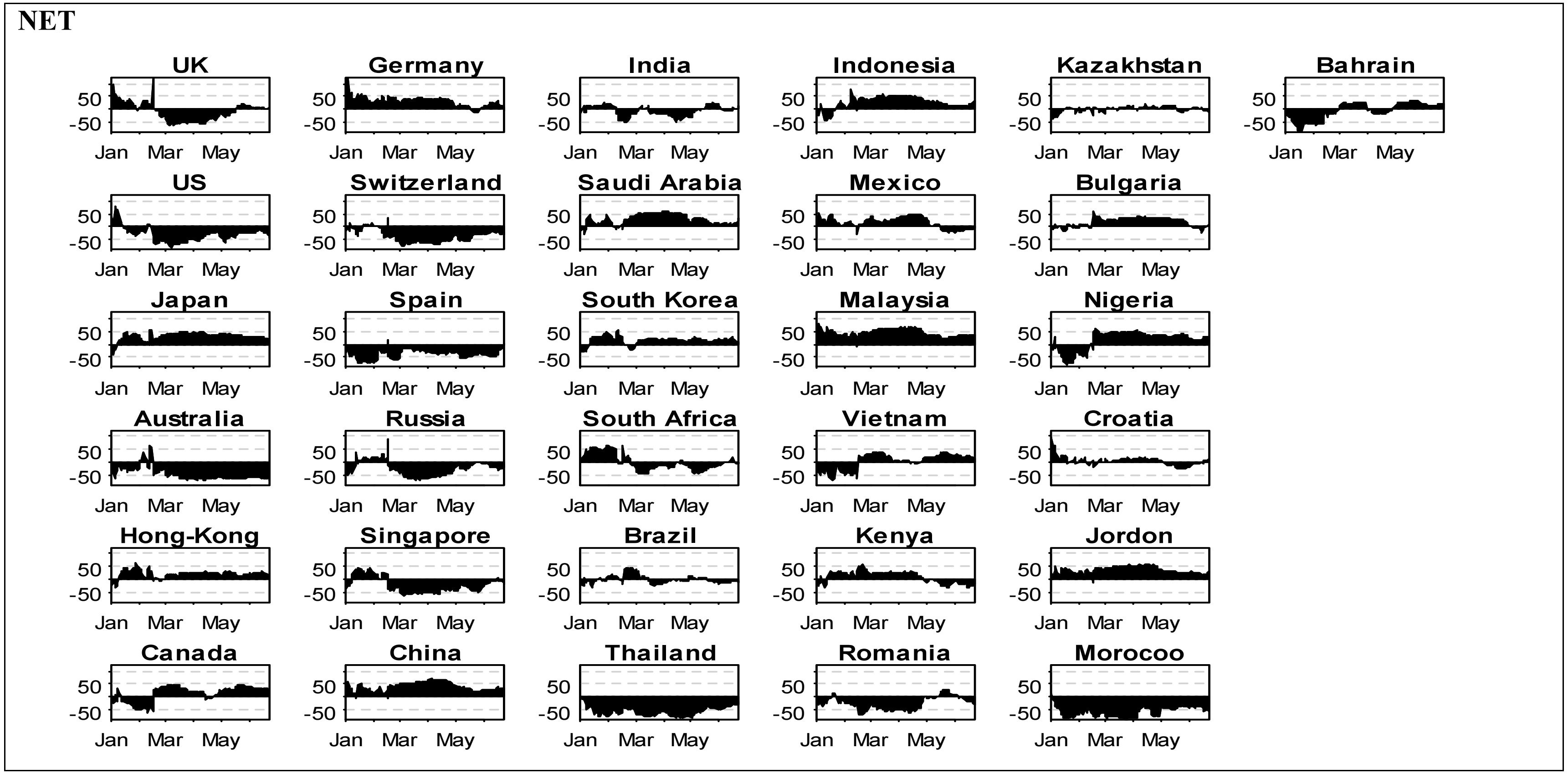


Fig. 4.26: During PRE-BREXIT, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software)

Table 4.10.0: During PRE-BREXIT, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software)

	UK	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
UK	**8.6**	3.8	2.8	2.0	2.4	5.0	3.2	4.8	1.9	3.6	3.2	3.2	4.7	3.0	2.3	4.2	2.6	1.6	2.8	2.9	3.2	3.4	2.3	4.1	2.1	3.0	3.3	2.8	3.1	1.3	2.8	91.4
US	3.2	**6.7**	3.7	1.6	3.6	4.0	4.4	2.3	1.9	1.8	2.5	3.9	3.3	4.9	2.9	3.4	3.1	1.5	3.7	5.1	4.7	2.6	3.1	2.2	3.6	3.0	3.0	3.0	3.7	1.3	2.5	93.3
JN	2.8	1.6	**6.6**	1.7	4.9	3.8	3.9	1.5	1.6	2.0	2.7	4.5	2.6	4.4	4.8	2.4	2.9	0.7	4.5	3.5	4.8	3.8	3.5	2.3	3.1	3.7	3.5	3.0	4.6	1.0	3.5	93.4
AA	4.4	5.0	3.4	**5.6**	3.2	3.2	5.1	3.4	1.5	1.6	3.0	3.8	3.4	3.4	2.4	4.9	2.4	1.5	3.3	4.5	4.1	2.2	3.4	2.4	3.2	3.0	2.7	3.5	3.6	1.1	2.0	94.4
HG	2.3	1.7	5.0	1.7	**6.4**	2.9	4.9	1.9	1.4	1.8	3.6	4.5	2.4	4.8	5.2	4.0	2.8	1.0	4.2	3.2	4.9	2.7	4.4	1.8	3.5	3.3	3.4	2.7	4.4	1.3	2.3	93.6
CAA	3.7	2.1	5.1	0.9	4.2	**7.8**	2.8	2.1	2.0	2.5	2.2	3.7	4.0	5.0	4.1	2.1	2.4	1.0	4.3	2.4	4.2	4.7	2.5	3.6	2.2	3.8	4.3	2.0	3.7	1.1	3.9	92.3
GY	2.3	2.5	4.5	1.6	4.1	2.3	**6.7**	2.0	1.5	1.9	2.7	5.2	1.6	3.8	4.0	3.4	3.5	1.1	4.1	4.9	5.4	2.5	4.0	1.5	3.7	4.1	3.1	4.1	5.0	1.0	2.3	93.4
SD	4.9	3.5	3.5	2.0	4.1	4.7	4.8	**5.8**	1.7	2.0	3.2	3.2	3.6	4.2	3.5	4.1	2.2	1.3	4.1	2.3	3.7	3.0	3.7	2.8	2.5	3.3	3.3	1.8	3.2	1.1	3.1	94.2
SN	5.6	4.1	3.0	2.0	2.5	3.5	4.5	4.5	**4.0**	3.4	2.5	3.7	3.6	3.0	2.5	4.5	2.7	1.7	2.9	3.9	3.7	2.3	2.8	3.6	2.7	3.5	3.3	3.4	3.5	0.7	2.7	96.0
RUS	2.5	1.3	4.1	1.1	3.9	4.1	4.0	1.5	2.1	**4.8**	2.0	4.8	3.3	4.6	3.6	2.4	3.3	1.3	4.1	3.4	4.7	3.7	3.5	3.0	3.2	3.8	4.2	3.3	4.4	0.9	3.3	95.2
SA	4.5	2.4	4.0	3.6	5.0	2.3	4.8	3.8	1.4	2.5	**8.7**	3.0	3.8	3.9	3.7	6.4	2.7	1.2	3.1	2.6	3.7	1.8	4.6	1.6	2.9	3.0	2.4	1.7	3.0	0.5	1.7	91.3
CA	1.3	1.5	4.5	1.6	4.1	3.0	4.6	0.8	1.9	1.9	1.9	**6.8**	2.1	4.3	3.6	2.9	3.8	1.1	4.2	4.7	5.7	3.3	3.5	1.6	3.6	3.9	4.2	4.5	5.4	1.1	2.9	93.3
IA	5.2	2.4	2.9	2.6	2.6	5.2	2.5	3.1	2.8	3.6	2.6	3.3	**9.3**	3.3	2.7	3.6	2.2	2.3	3.4	2.2	3.4	3.4	2.0	4.5	2.2	3.2	4.3	2.3	3.3	0.9	2.8	90.7
SAA	1.7	1.5	4.5	1.8	4.6	2.9	4.8	1.1	2.0	1.5	3.1	5.2	2.4	**6.7**	4.1	3.2	3.1	1.0	3.8	3.8	4.9	3.2	3.8	1.3	3.0	4.4	3.7	3.8	4.6	1.5	3.0	93.3
SK	2.3	1.2	5.0	0.8	4.7	4.1	3.8	1.1	1.9	2.3	2.1	4.7	3.0	4.4	**5.3**	1.9	3.3	1.1	4.8	3.5	5.0	4.0	3.3	2.2	3.4	4.1	4.2	3.0	4.8	1.3	3.5	94.7
SA	4.1	3.4	3.4	2.3	2.9	2.4	4.6	3.9	1.8	3.0	3.4	3.9	3.2	3.1	2.7	**7.4**	3.6	1.6	2.9	4.6	4.2	2.1	3.5	2.8	2.8	3.5	2.8	3.9	3.7	0.9	1.8	92.7
BL	1.9	2.5	4.0	1.0	3.3	2.9	4.0	1.4	2.3	2.4	2.3	4.5	2.6	3.7	3.1	4.4	**10.1**	1.4	3.1	5.7	4.6	3.4	3.8	2.2	2.8	3.7	2.7	3.4	3.8	0.8	2.5	90.0
TD	2.1	1.3	4.5	1.0	4.5	2.7	4.2	1.4	1.9	2.3	2.5	4.7	2.7	4.0	5.1	2.6	3.1	**4.3**	4.1	3.6	5.1	3.3	3.9	2.0	3.5	4.2	3.4	3.9	5.0	0.7	2.6	95.7
IA	2.2	1.6	4.4	1.0	4.2	3.6	4.4	1.4	1.8	2.1	1.8	4.7	2.3	4.4	4.3	2.2	2.9	1.1	**7.4**	3.3	5.3	3.5	3.9	1.9	3.5	4.4	4.4	3.0	5.5	1.1	2.7	92.6
MO	1.4	2.7	4.3	1.5	4.1	3.0	5.0	1.0	2.0	1.7	2.2	5.3	2.3	5.0	3.5	2.9	4.1	1.1	3.9	**6.4**	5.5	2.8	3.7	1.4	3.7	3.7	3.3	3.8	4.7	1.3	2.7	93.6
MA	1.4	1.6	4.7	1.2	4.3	2.8	4.8	0.9	1.8	1.9	2.0	5.5	1.8	4.3	4.5	2.6	3.5	1.0	4.7	4.5	**6.6**	2.8	4.1	1.4	3.9	4.1	3.9	4.2	5.8	0.8	2.6	93.4
VN	2.6	1.4	4.6	1.2	3.2	4.9	3.5	1.3	1.7	2.8	1.5	4.6	2.9	3.9	3.2	2.4	4.4	2.0	3.9	3.4	4.4	**7.7**	3.2	3.1	2.5	4.1	4.2	3.0	4.3	1.0	3.4	92.3
KA	1.8	0.8	4.9	0.9	4.6	3.4	4.7	1.3	1.7	2.1	2.1	4.9	2.1	4.7	5.2	2.3	2.8	0.8	4.9	3.0	5.7	3.2	**6.3**	1.8	3.8	4.5	3.6	2.9	5.6	0.8	3.0	93.7
RA	3.7	2.1	4.2	0.9	3.3	5.3	3.9	2.1	2.0	3.2	1.3	4.3	3.5	3.9	3.3	2.5	2.5	1.7	4.0	3.0	4.4	4.3	2.6	**5.7**	2.6	4.0	4.1	2.9	4.2	1.0	3.6	94.3
KN	3.1	2.1	4.3	1.4	3.8	3.1	3.9	1.3	1.8	2.4	2.2	4.7	3.2	3.6	4.0	2.1	3.1	1.0	4.0	4.0	4.9	3.1	3.2	2.9	**7.5**	3.4	3.7	3.7	4.7	1.2	3.1	92.5
BA	2.2	0.9	5.0	1.1	4.3	3.8	4.1	1.6	2.2	2.2	1.9	4.5	2.3	4.8	4.8	1.9	2.8	0.9	4.8	3.2	5.3	3.5	3.9	1.9	3.5	**6.5**	4.1	2.8	5.2	0.9	3.3	93.5
NA	2.1	1.7	3.6	1.3	3.5	4.3	3.5	1.4	2.6	2.6	1.5	5.0	2.8	4.1	3.2	2.1	2.7	2.2	4.8	3.4	4.4	3.5	2.8	2.3	3.3	4.1	**8.5**	3.2	4.9	1.2	3.4	91.5
CA	1.8	2.2	4.1	1.6	3.3	2.4	4.6	1.3	2.0	2.4	1.9	5.8	2.1	3.7	3.5	2.9	3.6	1.5	4.4	5.0	5.5	2.9	3.6	1.5	3.3	4.0	4.1	**7.0**	5.5	0.7	2.4	93.0
JON	1.8	1.8	4.5	1.3	4.0	2.9	4.3	1.2	1.7	2.0	1.8	5.5	1.8	4.2	4.3	2.5	3.2	0.9	5.0	4.1	5.9	2.8	3.9	1.7	3.8	4.4	4.3	4.3	**6.5**	0.9	2.7	93.5
MO	1.7	1.4	4.0	2.5	3.8	3.5	3.7	1.1	1.7	2.0	1.9	4.5	2.3	3.7	3.8	2.7	2.6	1.1	4.2	2.7	4.5	3.2	3.8	1.6	3.1	3.5	3.6	3.3	4.3	**11.6**	3.0	88.5
BH	1.6	1.1	4.6	1.5	4.0	4.4	3.2	1.1	2.1	2.5	1.9	4.8	2.6	4.3	3.6	2.2	2.8	2.1	3.8	2.9	3.9	4.1	2.9	3.2	2.6	4.0	4.0	3.0	3.6	1.5	**10.1**	89.9
TO	82.1	62.7	125.1	46.5	114.6	106.2	124.3	57.6	56.5	69.7	69.2	133.8	84.2	122.4	111.4	91.6	90.3	39.7	119.7	109.1	139.4	94.9	103.0	69.9	93.2	112.7	108.8	96.1	130.8	30.9	85.2	2881.0
Inc.Own	90.6	69.4	131.7	52.1	121.0	113.9	130.9	63.4	60.5	74.4	77.9	140.5	93.5	129.1	116.7	98.9	100.3	44.0	127.1	115.5	146.0	102.6	109.3	75.6	100.7	119.1	117.3	103.0	137.2	42.4	95.3	
NET	-9.4	-30.6	31.7	-47.9	21.0	13.9	30.9	-36.6	-39.5	-25.6	-22.1	40.5	-6.5	29.1	16.7	-1.1	0.3	-56.0	27.1	15.5	46.0	2.6	9.3	-24.4	0.7	19.1	17.3	3.0	37.2	-57.6	-4.7	**92.9**

➢ **ROBUSTNESS –**

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 100-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 80, 100, and 120 days. Examining the spillover curves illustrated in Fig. 4.27 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

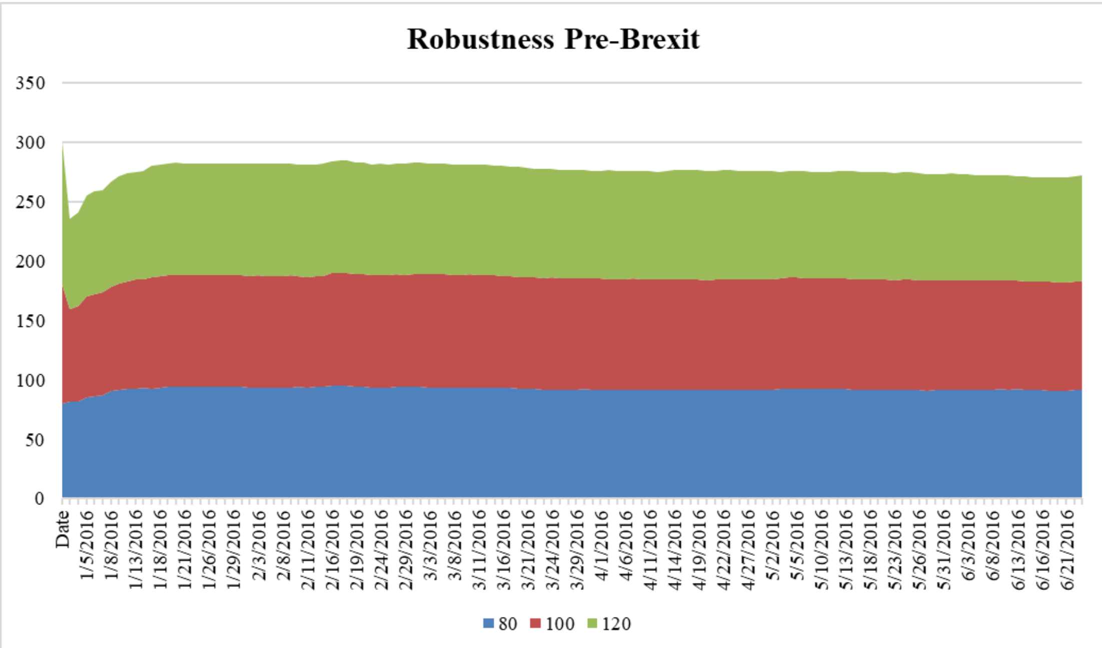


Fig. 4.27: Robustness of Pre-BREXIT on window sizes 80, 100, and 120.(Source: Author using R software).

Note: In the above figure the Green colour shows 80 window size, Red show 100 window size, and Blue show 120 window size.

4.8 Results of the volatility spillover among the developed, emerging, and frontier countries during the Brexit Event.

All the selected countries generated 89.50% volatility spillover during Brexit using the TVP-VAR during the specified period. On analyzing the net volatility spillover among developed countries, the UK (35.44%), Switzerland (24.35%), and Singapore (22.46%) were net transmitters. Brexit was, after all, a UK-centric event, and the direct fallout of the divorce from the EU caused massive uncertainty on trade policies, economic stability, and market access. That led to extreme volatility in the UK,which shocked other markets. London is a significant hub for global finance. Disruptions in its markets naturally impact other interwoven economies. Once your trading strategy is set, you can develop a plan for using domestic and international currencies (think safe-haven currency (Swiss Franc) to conduct business as usual and to maintain investments, as the increased transmission of volatility may have resulted from substantial capital inflows and outflows as a result of Brexit uncertainty. Moreover, the Swiss economy is heavily integrated into the EU despite Switzerland not being an EU member, magnifying the reaction of Switzerland's markets to Brexit. Singapore's status as a central financial hub in Asia made its markets particularly sensitive to global events like Brexit, which increased uncertainty regarding global trade: Brexit raised questions on international trade policies that had implications for trade-reliant economies like Singapore stock markets.

On the other side, Canada (-41.29%), Hong Kong (-6.34%), and Singapore (-5.97%) weresignificant net receptors (Fig 4.28).Canada's relatively stable economy and lower direct exposure to Brexit could have made it a net absorber of volatility from other countries. Canada's markets are driven more by commodity prices than European political events, limiting volatility transmission. Moreover, the Canadian economy is tightly linked to the US economy, so Canada may have experienced US-fueled volatility without transmitting it further.Hong Kong markets are much more driven by regional (China, Asia) factors than by Brexit, making them less of a volatility conduit, and the well-developed systems in place in Hong Kong probably buffered the thrust of the volatility rather than magnified it. The dual trade role: Singapore is a receptor even as it is a transmitter, indicating that its markets absorbed the volatility from some global channels and transmitted it through others, and the complex interconnectivity of markets, the high level of integration in world markets may also be responsible for this dual behaviour with net effects depending on the transmission channels.

Among the emerging countries, Indonesia (39.77%), Mexico (14.76%), and Saudi Arabia (14.73%) were net transmitters; Malaysia (-34.77%), South Korea (-25.12%), South Africa (-25.70%) were identified as the significant receiver (Fig 4.28).

In the case of a transmitter, Indonesia does not have a significant direct reliance on trade with the UK or EU. However , its dependence on global markets for exports (commodities such as palm oil and minerals) might have increased its function (as a transmitter of shocks). Moreover, Indonesia's stock and currency markets are in an emerging market economy that can also prove sensitive to global financial uncertainty, and this volatility can transfer to other regions. Moreover, Mexico's economy is more closely tied to US trade than with the UK/EU. Thus, it may be positioned to be less directly impacted by Brexit and transmit financial shocks, as Mexico's manufacturing and export sector may have had little direct impact. Still, indirect uncertainty spreads through global investors' behaviour. The Saudi economy hinges on oil. Brexit caused volatility in oil prices and global demand, making Saudi Arabia a volatility transmitter. The Kingdom has made sizable investments in international markets, which may have propagated financial contagions worldwide.

In the case of spillover receiver, Malaysia has strong trade and investment ties with the UK and EU. The outcome of Brexit uncertainties would have enormous implications for exports and financial markets outside of Malaysia. The Malaysian ringgit and its financial market are sensitive to the mood of global investors and have seen massive capital outflows amid uncertainties. Case South Korea has an export-driven economy, with a high reliance on electronics and automobiles, making such industries sensitive to fluctuations in global trade mood after Brexit due to the deeper integration of international financial markets as South Korea's deep integration with global financial markets rendered it vulnerable to shocks from Europe. As a component of the emerging market basket, South Africa tends to have hefty capital outflows from foreign investments when faced with global crises.

Among frontier countries, Croatia (19.10%), Romania (16.68%), and Kazakhstan (16.31%) were significant transmitters; Kenya (-36.04%), Bulgaria (-47.21%), Bahrain (-16.72%) were substantial receptor (Fig 4.28) as the Croatia and Romania had more significant economic and financial linkages to the EU, as EU member countries. The market reactions were probably influenced by investor sentiment regarding EU stability and post-BREXIT adjustments.While not part of the EU, Kazakhstan does have its share of trade and investment ties with the EU, which might have meant that it acted as a transmitter country by its energy export role. As the significantreceptor, Bulgaria is an EU member, and its financial market is not profoundly integrated, making it sensitive to external shocks, so it is prone to absorb shocks rather than transmit them. As geographically and economically peripheral to the EU as Bahrain and Kenya are, their responses to BREXIT uncertainty were likely weak and deferential, expressing not so much influence as exposure.

On analyzing “To others” spillover, the UK (128.86%), Switzerland (117.43%), and Singapore (114.25%) among developed countries; Indonesia (132.37%). Mexico (106.58%), Thailand (109.38%) among emerging countries, Croatia (93.64%), Kazakhstan (107.11%), and Romania (106.6%) among the frontier countries (Fig 4.29).

On analyzing “From others” Spain (93.64%), UK (93.45%), US (93.45%) among developed countries; Indonesia (92.59%), South Africa (92.37%), India (92.23%) among the emerging countries, and Nigeria (88.84%), Romania (89.92%), Kazakhstan (90.80%) among the frontier countries (Fig 4.29).

Overall, the UK and the US were primary transmitters for the event period, and Malaysia, Kenya, Bulgaria, and Canada were identified as the significant receptors (Table 4.11.0).

During this period, Breinlich et al. (2018) found tentative evidence that market reactions to two subsequent speeches by Theresa May (her Conservative party conference and Lancaster House speeches) were more closely correlated with potential changes to tariffs and non-tariff barriers on UK–EU trade. Exchange rate fluctuations and investors' anticipation of a slowdown in the economy were the primary drivers of stock market responses to the Brexit referendum. Companies with greater exposure to the UK market consistently have poor stock market performance. There is less proof that investors anticipate more trade barriers with the EU in the future. Sectoral stock market performance in reaction to the referendum is not influenced by reliance on EU immigrants.

Thus, from this panel of crises,this study revealedthe high interconnectedness revealed by this period, but some market dynamics changed, due to which some countries shiftedfrom spillover receivers to transmitters (and vice-versa); thus, it got strong insights which caused due to changes in the crises origin country.

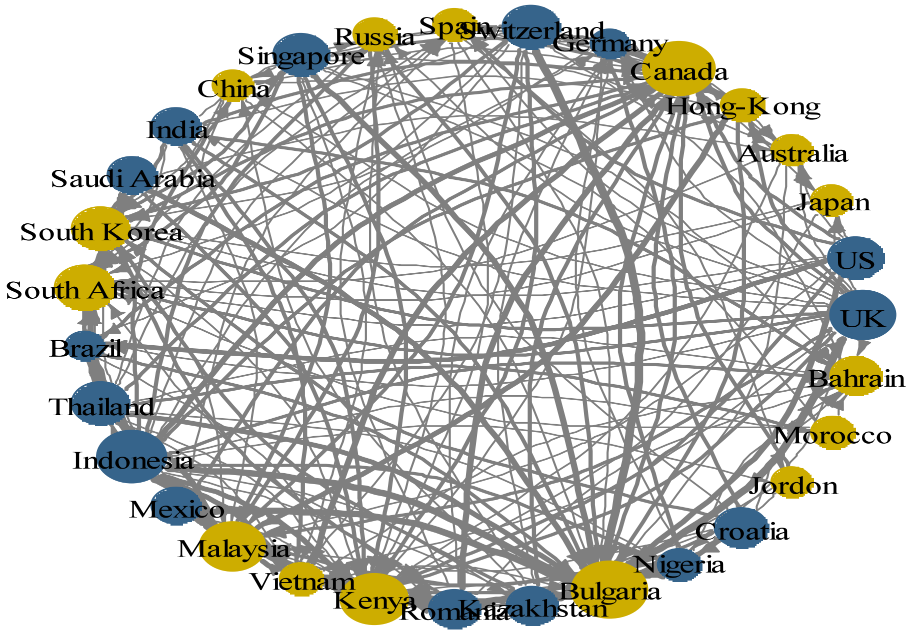
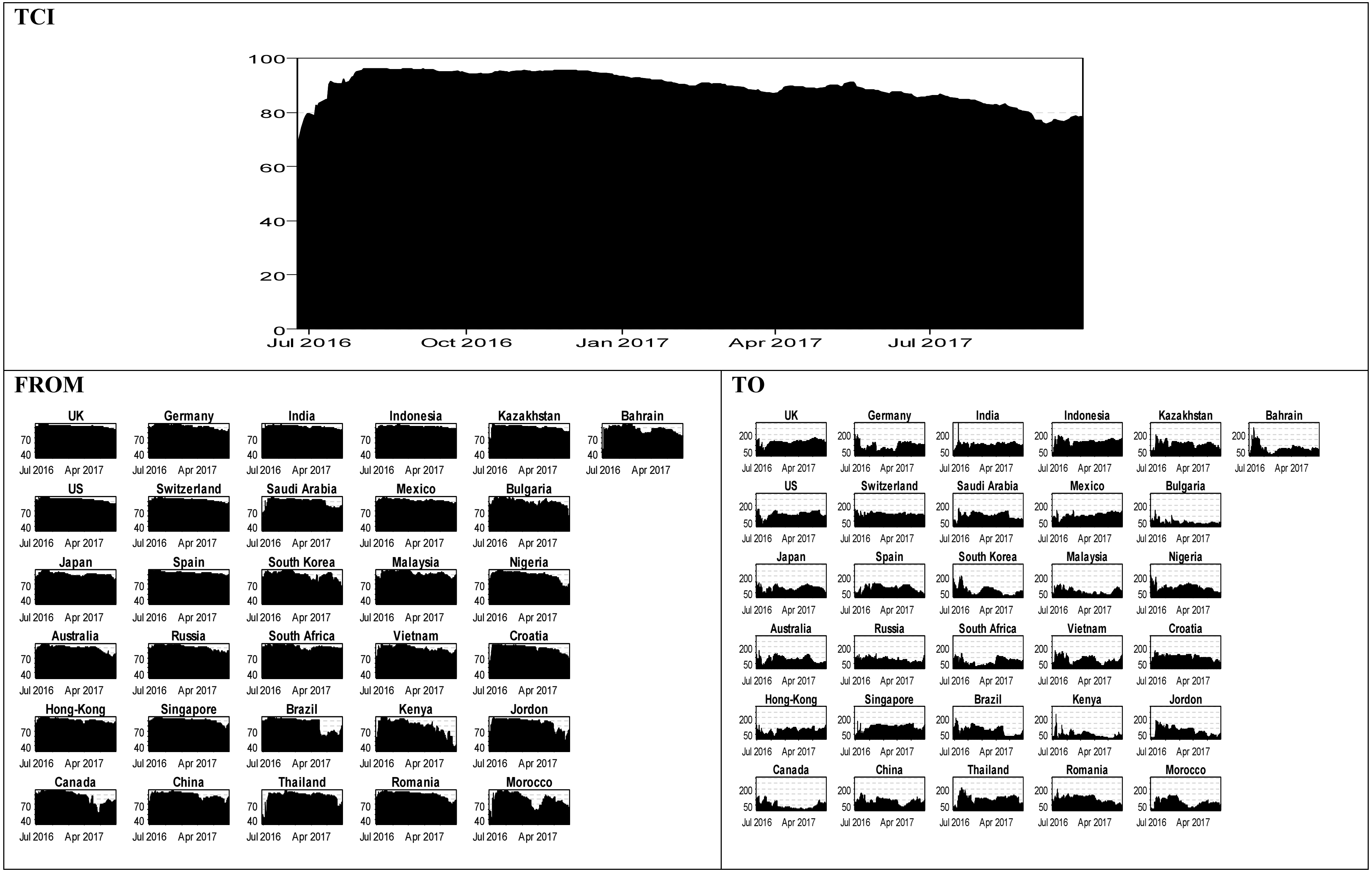


Fig. 4.28: During BREXIT, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).



TCI
100
80
60
40
20
0
Jul 2016
Oct 2016
Jan 2017
Apr 2017
Jul 2017
FROM
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Germany
India
Indonesia
Kazakhstan
Bahrain
US
Switzerland
Saudi Arabia
Mexico
Bulgaria
Japan
Spain
South Korea
Malaysia
Nigeria
Australia
Russia
South Africa
Vietnam
Croatia
Hong-Kong
Singapore
Brazil
Kenya
Jordon
Canada
China
Thailand
Romania
Morocco
70
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Jul 2016
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TO
UK
Germany
India
Indonesia
Kazakhstan
Bahrain
US
Switzerland
Saudi Arabia
Mexico
Bulgaria
Japan
Spain
South Korea
Malaysia
Nigeria
Australia
Russia
South Africa
Vietnam
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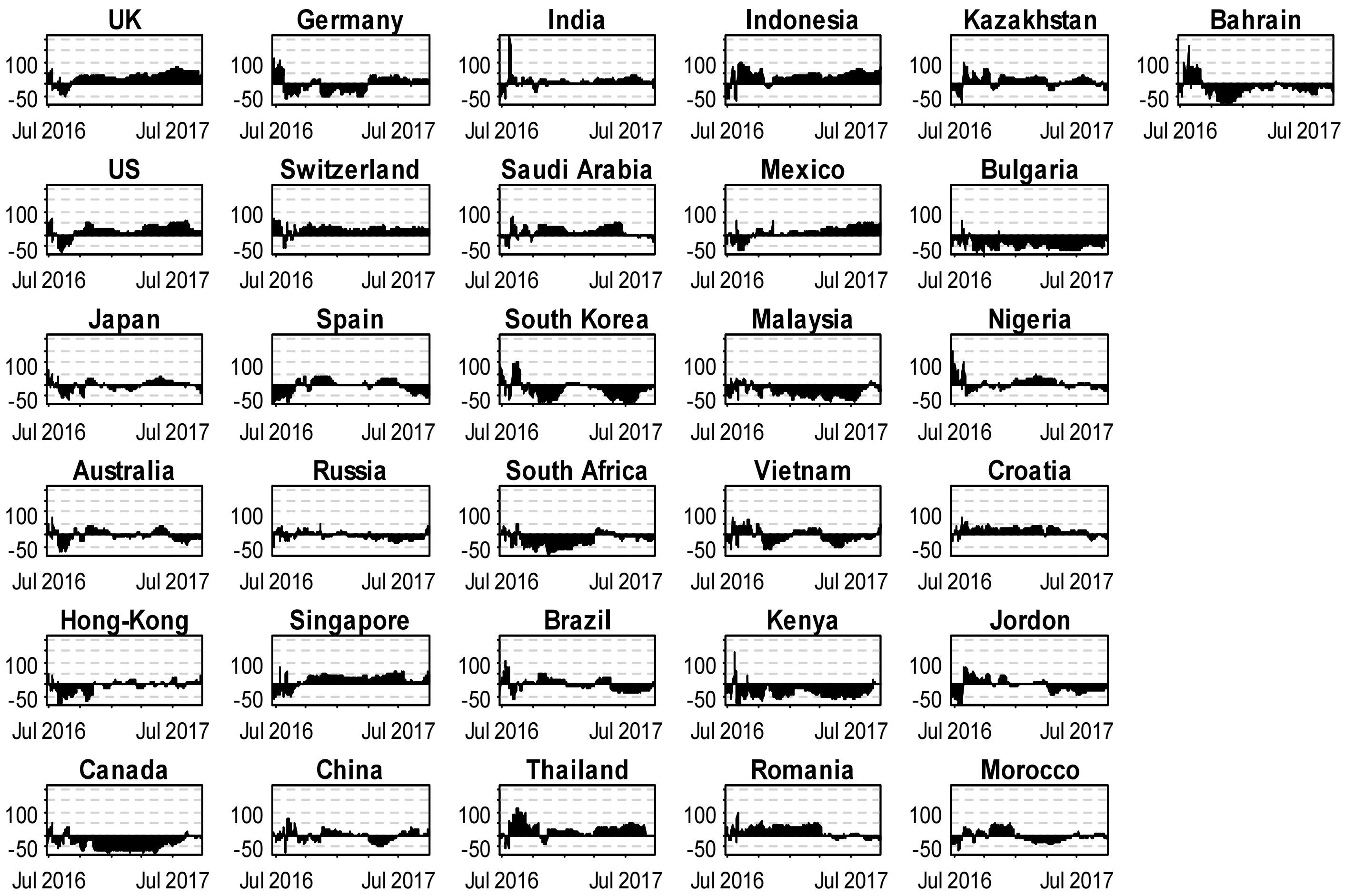


Fig. 4.29: During BREXIT,TO, FROM, NET spillover among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software).

Table 4.11.0: During BREXIT using the TVP-VAR Model in the selected developed, emerging, and frontier countries. (Source: Author using R software).

	UK	**US**	**JN**	**AA**	**HG**	**CAA**	**GY**	**SD**	**SN**	**RUS**	**SA**	**CA**	**IA**	**SAA**	**SK**	**SA**	**BL**	**TD**	**IA**	**MO**	**MA**	**VN**	**KA**	**RA**	**KN**	**BA**	**NA**	**CA**	**JON**	**MO**	**BH**	**FM**
UK	**6.6**	4.7	3.0	3.1	3.0	1.2	3.6	5.2	3.7	3.1	4.4	2.8	4.3	4.1	1.4	2.5	3.3	3.6	4.8	4.0	1.3	2.2	0.7	4.3	4.2	0.6	3.6	4.3	2.6	2.2	1.8	93.5
US	5.3	**6.6**	3.9	2.9	2.8	1.9	4.2	5.2	3.1	3.0	3.9	2.5	4.2	3.6	1.8	2.4	3.4	3.7	4.4	4.1	1.5	2.4	1.1	3.6	3.8	1.1	3.4	3.9	2.6	2.3	1.7	93.4
JN	4.3	5.3	**9.5**	5.7	2.2	2.0	4.6	4.0	4.1	2.2	3.7	2.2	4.1	3.9	2.6	2.3	3.6	2.9	2.7	2.7	3.0	1.9	2.7	2.1	2.1	2.2	2.0	2.6	1.7	2.8	2.3	90.5
AA	4.5	4.4	5.3	**10.9**	2.3	1.8	4.1	4.0	5.1	1.9	4.6	2.5	3.4	5.1	2.2	1.9	3.8	2.7	2.9	2.6	2.1	1.6	2.1	2.6	2.6	1.7	2.1	2.6	2.3	2.5	2.0	89.2
HG	4.9	3.4	2.6	2.7	**8.0**	1.3	3.0	4.0	2.4	3.1	4.7	3.5	4.6	3.1	2.1	2.7	2.2	4.3	5.4	3.6	1.4	3.4	1.1	3.7	4.1	0.8	3.4	3.2	2.8	2.4	2.1	92.0
CAA	3.3	4.0	2.8	2.3	2.6	**13.7**	2.8	2.9	1.9	2.9	3.1	2.7	3.3	2.3	3.4	1.8	3.3	2.9	4.0	3.2	2.2	4.0	2.3	3.6	3.1	1.7	3.1	2.9	3.4	2.6	1.9	86.3
GY	4.9	4.8	4.0	2.9	2.5	1.4	**7.6**	5.0	2.5	3.2	3.4	2.0	3.8	3.4	2.1	3.3	2.9	4.0	3.6	3.8	2.0	2.2	1.4	2.9	3.0	1.4	3.8	4.5	2.3	2.3	3.6	92.4
SD	5.8	5.1	3.0	2.7	2.6	1.4	4.5	**6.9**	3.3	3.2	3.7	2.6	4.0	3.7	1.5	2.5	3.5	3.5	4.5	4.1	1.5	2.4	0.8	3.8	3.8	0.9	3.7	4.0	2.7	2.0	2.3	93.1
SN	5.1	4.9	4.3	4.4	2.4	1.5	3.8	5.1	**6.4**	2.5	4.0	2.7	3.6	4.3	1.8	2.4	3.6	3.3	3.7	3.8	1.8	1.9	1.5	3.4	3.4	1.4	2.9	3.7	2.5	2.1	2.1	93.6
RUS	4.5	3.6	2.4	1.9	3.3	1.7	3.2	3.9	2.2	**9.0**	3.3	1.9	4.3	3.3	2.2	3.6	2.5	3.5	4.7	4.0	1.7	3.1	1.0	4.2	3.4	1.0	4.1	4.8	3.0	2.0	2.9	91.0
SA	4.9	3.8	2.8	3.7	3.8	0.9	2.3	3.8	3.7	2.6	**8.2**	3.4	3.7	4.3	1.3	1.6	3.0	4.2	5.3	3.8	1.3	2.2	0.7	4.8	4.3	0.9	3.8	3.7	2.8	3.1	1.4	91.8
CA	4.1	3.0	2.2	2.8	2.8	1.4	2.1	3.7	2.7	1.8	4.5	**11.3**	2.9	3.4	3.6	1.4	2.5	4.0	5.3	2.5	2.1	3.9	1.2	4.2	5.7	1.4	2.5	3.0	3.5	3.1	1.6	88.7
IA	5.2	4.9	3.8	3.1	3.3	1.6	4.2	4.4	3.1	3.2	4.0	2.3	**7.8**	4.0	1.6	2.1	3.2	3.5	4.5	3.8	1.7	2.1	1.1	3.4	3.2	1.2	3.4	3.9	2.3	2.5	1.8	92.2
SAA	4.6	4.1	3.2	4.1	2.4	2.1	3.0	3.9	3.9	2.6	4.7	2.6	3.7	**11.2**	1.1	1.7	3.7	3.6	4.0	3.1	2.1	1.8	1.2	3.3	3.7	1.3	2.4	3.9	2.4	3.0	1.8	88.8
SK	3.5	2.8	3.6	2.9	2.9	1.6	3.3	3.7	2.0	2.3	3.4	4.7	3.2	3.0	**11.1**	2.4	2.1	3.8	4.1	2.7	1.8	3.2	2.6	3.7	3.5	1.4	2.4	3.4	2.8	2.8	3.2	88.9
SA	4.4	3.9	3.8	3.3	3.4	1.7	4.2	3.5	2.6	3.4	3.6	2.8	3.4	3.5	2.3	**7.6**	2.5	3.5	3.8	4.3	1.8	2.0	2.1	2.4	2.4	2.3	3.8	3.4	1.7	2.7	4.1	92.4
BL	4.4	5.6	2.9	3.2	1.9	1.5	3.4	4.9	3.3	2.6	3.4	2.4	3.2	3.5	1.5	1.9	**14.4**	2.7	3.5	4.8	2.2	1.7	1.1	3.1	3.0	1.8	3.0	3.6	2.1	2.0	1.3	85.6
TD	4.2	3.7	2.4	2.6	3.5	1.0	3.5	3.8	2.2	2.3	4.6	3.7	3.3	3.7	2.0	1.8	2.3	**13.6**	5.7	3.1	1.8	2.1	1.2	3.0	3.7	1.0	2.4	3.7	2.8	3.2	2.5	86.4
IA	4.8	3.7	2.0	2.4	3.7	1.1	2.5	4.0	2.8	3.2	4.9	3.5	3.8	3.7	1.7	1.8	2.9	4.7	**7.4**	4.3	1.1	3.4	0.9	4.7	4.7	1.1	3.4	4.0	3.1	2.8	2.0	92.6
MO	4.8	4.5	2.3	2.2	3.3	1.6	3.3	4.2	2.6	3.7	4.1	2.4	3.7	3.4	1.4	3.1	3.6	3.9	4.9	**8.2**	1.5	2.5	1.0	3.7	3.4	1.3	3.8	4.3	2.3	2.8	2.3	91.8
MA	3.3	2.9	2.7	2.1	3.7	2.0	2.3	3.1	2.1	3.3	3.0	2.7	2.8	2.4	3.2	2.1	2.5	4.4	4.8	3.8	**8.0**	4.9	2.8	3.0	3.6	2.9	3.1	3.2	3.4	3.1	2.9	92.0
VN	3.7	2.4	2.0	1.9	4.0	1.5	2.0	3.5	2.1	3.4	3.4	3.7	3.6	2.2	2.9	1.6	2.0	3.4	5.9	3.4	2.2	**11.2**	2.4	5.0	5.0	1.2	3.7	3.0	3.7	2.2	1.8	88.8
KA	2.5	2.6	4.0	3.3	1.7	1.5	2.4	3.0	2.8	2.2	2.3	2.2	2.7	2.8	3.8	1.8	2.5	2.4	3.2	2.3	2.2	4.3	**20.6**	3.0	2.5	1.9	2.9	2.6	2.5	2.1	3.3	79.4
RA	4.6	3.0	2.0	2.5	3.3	1.2	1.7	3.6	3.2	3.1	4.5	3.8	3.6	3.6	1.8	1.7	2.8	3.6	5.9	3.7	1.1	3.8	0.8	**10.1**	5.3	0.9	3.9	3.7	3.4	2.2	1.6	89.9
KN	4.8	3.7	1.9	2.8	3.3	1.1	1.9	4.5	3.4	2.5	4.6	4.4	3.2	3.9	1.5	1.4	2.8	4.2	5.7	3.7	1.2	3.6	0.8	5.0	**9.2**	0.7	2.8	3.5	3.7	2.5	1.7	90.8
BA	4.0	3.8	2.5	2.9	2.3	1.1	3.1	4.1	2.9	2.9	3.1	2.8	3.3	3.8	1.4	2.2	3.8	3.8	4.1	4.9	1.9	2.2	1.1	3.2	3.1	**11.3**	3.2	3.6	2.7	2.3	2.9	88.7
NA	4.6	3.4	2.0	1.8	3.2	1.5	2.5	3.7	2.5	3.7	3.7	2.9	3.9	2.9	1.9	3.1	2.7	3.6	4.9	3.9	1.5	3.0	1.0	4.2	3.6	1.0	**11.2**	4.3	2.7	2.3	3.2	88.8
CA	4.7	3.8	2.6	2.3	2.6	0.9	4.0	3.9	3.3	3.5	3.6	2.6	3.8	4.0	1.9	2.6	3.0	4.0	4.1	3.7	2.1	2.0	0.7	3.7	3.4	0.9	3.1	**11.2**	2.5	2.3	3.6	88.8
JON	3.5	2.6	2.3	3.1	2.7	1.6	1.8	3.3	3.8	3.1	3.4	3.1	3.2	3.0	2.1	1.7	2.5	3.4	4.3	2.8	3.3	3.2	1.3	4.1	4.2	1.7	2.8	3.1	**13.8**	2.3	2.9	86.2
MO	2.7	3.0	2.8	2.8	2.6	2.8	2.1	2.4	2.6	2.2	4.5	2.9	2.6	3.1	2.4	1.5	2.5	4.8	4.0	2.9	3.1	2.3	2.0	2.4	2.8	1.5	2.1	2.9	2.2	**20.0**	1.5	80.0
BH	3.3	2.5	3.0	2.3	1.7	1.3	4.2	3.4	2.3	3.1	2.4	1.7	3.4	2.6	3.2	4.1	2.2	3.5	3.8	3.1	2.7	2.8	2.6	2.6	2.5	2.2	4.3	4.5	2.8	2.6	**13.3**	86.7
TO	128.9	114.1	88.0	86.3	85.6	45.0	93.4	117.4	88.1	85.6	114.3	85.8	106.4	103.5	63.8	66.7	87.0	109.4	132.4	106.6	57.3	82.1	43.4	106.6	107.1	41.5	94.5	107.9	81.2	74.5	70.0	2774.4
Inc.Own	135.4	120.6	97.4	97.2	93.7	58.7	101.0	124.4	94.4	94.6	122.5	97.1	114.2	114.7	74.9	74.3	101.4	123.0	139.8	114.8	65.3	93.3	64.0	116.7	116.3	52.8	105.7	119.1	95.0	94.5	83.3	
NET	35.4	20.6	-2.6	-2.8	-6.3	-41.3	1.0	24.4	-5.6	-5.4	22.5	-2.9	14.2	14.7	-25.1	-25.7	1.4	23.0	39.8	14.8	-34.7	-6.7	-36.0	16.7	16.3	-47.2	5.7	19.1	-5.0	-5.5	-16.7	**89.5**

➢ Robustness during Brexit Event

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 200, 250, and 300 days. Examining the spillover curves illustrated in Fig. 4.30 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

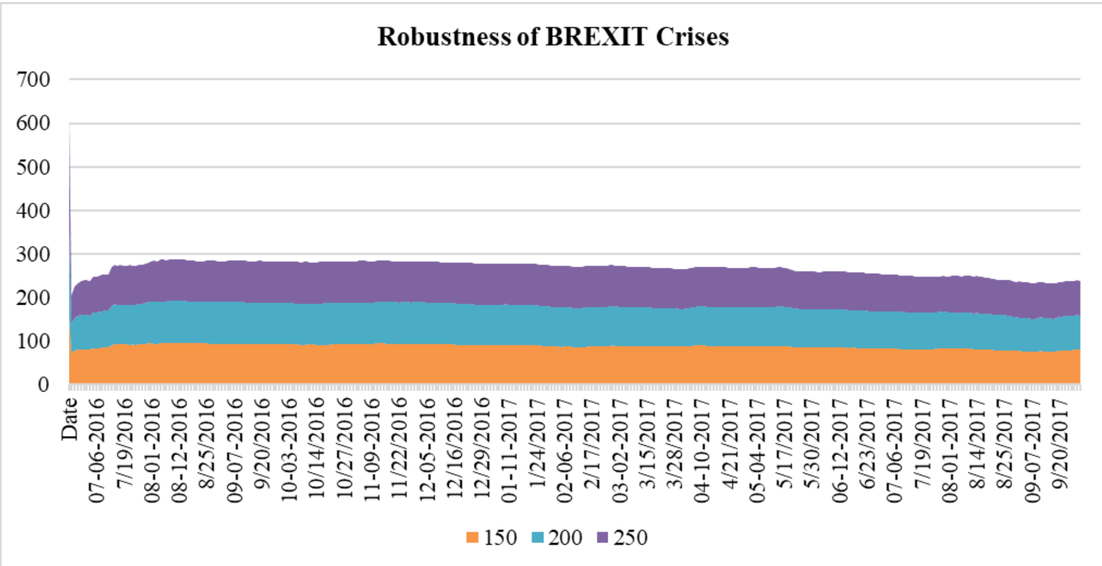


Fig. 4.30: During robustness of BREXIT interconnectedness among the developed, emerging, and frontier countries using TVP-VAR.

Note: Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf Days, Green colour), and total frequency (black colour) (Source: Author's using R software).

➢ TVP-VAR-BK TEST

Frequency spillover based on Baruník - Křehlík (TVP-VAR-BK) during Chinese in Short term (0–5), Long term (above 5 days), and entire period (total period black represents 1–5 days, pink colour represents 1–5 days, and green colour, above 5 days) (Fig. 4.31). On analyzing different frequencies, 45.78% volatility spillover in the short period (Table 4.12.0), 44.81% volatility spillover in the medium period (Table 4.12.1),and 90.59% volatility spillover in the entire period Table 4.12.2). This indicates that the Brexit event generated a high volatility spillover over the period, and high integration was identified. Fig. 4.32 also showed a high volatility impact on all all-selected countries in the entire period.

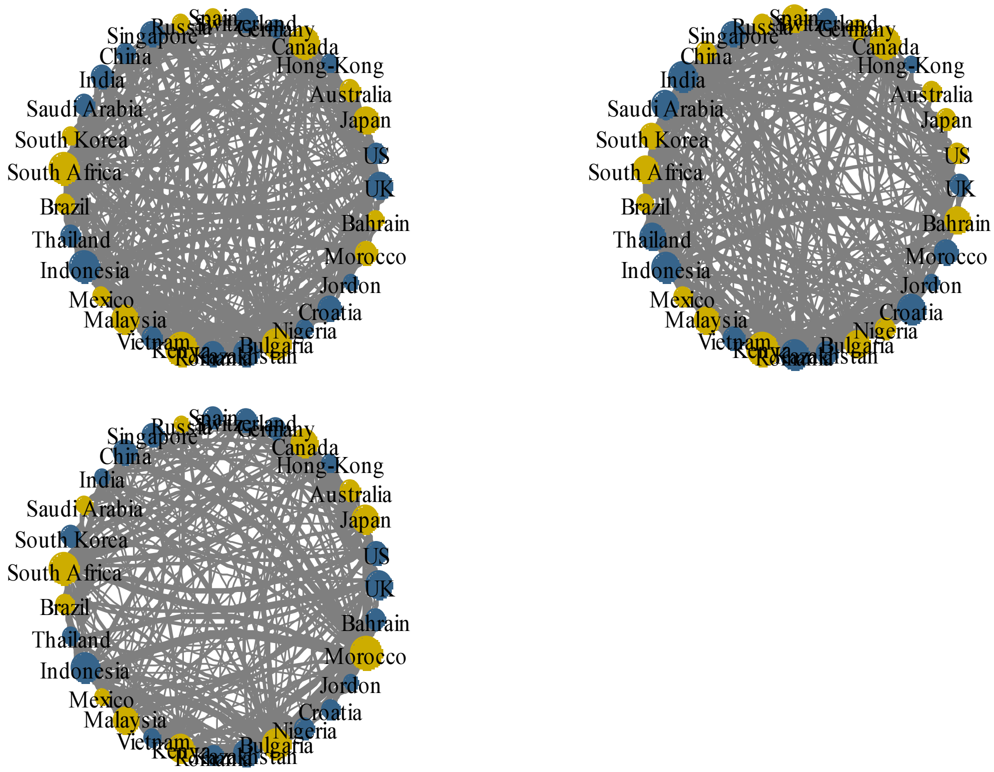


Fig. 4.31: During BREXIT, interconnectedness among the developed, emerging, and frontier countries.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Table 4.12.0 During BREXIT interconnectedness in the medium period (1-4 Days) among the developed, emerging, and frontier countries using TVP-VAR-BK models. (Source: Author using R software).

	UK	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO
UK	**3.4**	2.4	1.0	1.6	2.3	0.5	1.9	2.8	2.3	2.0	2.9	1.9	2.7	2.3	1.3	0.9	1.9	2.1	3.1	2.1	0.6	2.3	0.2	3.2	2.9	0.2	2.2	2.8	2.4	1.26
US	2.8	**2.9**	1.0	1.4	1.8	0.7	2.0	2.6	1.9	1.9	2.5	1.7	2.4	2.0	1.2	0.9	1.9	1.8	2.7	1.9	0.5	2.0	0.2	2.8	2.6	0.3	1.9	2.5	2.1	1.19
JN	1.4	1.3	**3.0**	1.7	0.9	0.4	1.1	1.3	1.4	1.0	1.5	1.4	1.7	1.1	1.0	0.4	0.9	1.2	1.8	0.6	0.8	1.0	0.2	1.5	1.3	0.5	0.9	1.2	1.1	1.06
AA	2.0	1.6	1.7	**3.0**	1.4	0.5	1.4	1.7	1.8	0.9	1.6	1.6	1.8	1.3	0.8	0.8	1.3	1.5	2.0	1.0	0.5	1.1	0.2	1.6	1.6	0.4	1.0	1.4	1.5	0.89
HG	2.2	1.4	0.8	1.3	**2.5**	0.3	1.5	2.2	1.6	1.5	2.4	2.0	2.2	1.7	1.3	1.0	1.1	1.8	2.7	1.3	0.6	2.0	0.3	2.3	2.5	0.4	1.3	2.3	2.0	1.08
CAA	1.7	1.7	0.8	0.9	1.0	**3.9**	1.0	1.4	1.1	1.2	1.5	1.2	1.5	1.2	1.2	0.8	1.4	1.1	1.8	1.2	0.5	1.4	0.2	2.0	1.6	0.3	1.2	1.6	1.4	1.11
GY	2.5	2.2	0.8	1.2	1.8	0.4	**2.8**	2.6	1.3	2.0	2.1	1.4	2.2	1.6	0.9	1.0	1.5	1.6	2.4	1.7	0.5	1.6	0.2	2.1	2.4	0.4	1.6	2.3	1.8	0.95
SD	3.0	2.3	0.9	1.4	2.1	0.3	2.2	**3.2**	1.9	2.0	2.7	1.9	2.4	2.1	1.1	0.7	1.7	1.9	2.9	1.8	0.5	2.1	0.2	2.7	2.8	0.3	1.8	2.6	2.2	1.11
SN	3.5	3.2	2.0	2.6	2.5	0.5	2.4	3.6	**4.0**	1.8	3.2	2.6	2.8	2.9	1.2	0.8	2.2	2.3	3.4	2.2	0.5	2.2	0.2	3.3	3.1	0.3	1.9	2.6	2.4	1.25
RUS	2.6	1.8	0.7	0.9	1.9	0.5	1.8	2.2	1.4	**3.7**	2.3	1.3	2.2	1.7	1.2	1.0	1.5	1.6	2.5	2.0	0.7	2.1	0.3	2.7	2.6	0.5	2.0	2.6	2.0	1.09
SA	2.7	1.8	1.0	1.3	2.1	0.2	1.5	2.5	2.2	1.6	**3.9**	2.5	2.4	2.6	1.8	0.4	1.2	2.1	3.4	1.4	0.5	2.5	0.3	3.3	3.1	0.2	1.7	2.8	2.4	1.42
CA	2.5	1.6	1.5	1.6	1.7	0.4	1.6	3.0	2.5	1.2	3.6	**5.3**	2.5	2.9	2.9	0.7	1.1	3.1	4.4	0.8	0.8	3.1	0.4	3.5	3.7	0.4	1.1	3.1	2.8	1.98
IA	1.8	1.2	0.8	0.9	1.3	0.3	1.0	1.6	1.3	1.3	2.0	1.5	**2.6**	1.4	1.4	0.5	0.9	1.5	2.3	1.0	0.7	1.6	0.1	2.2	2.0	0.3	1.3	1.9	1.7	1.22
SAA	1.7	1.0	0.6	0.9	1.1	0.1	0.8	1.6	1.4	0.9	2.0	1.6	1.5	**2.4**	1.2	0.3	0.8	1.4	2.1	0.9	0.5	1.6	0.2	2.2	1.9	0.2	1.1	1.8	1.6	0.92
SK	2.0	1.1	0.8	0.9	1.2	0.4	1.4	2.4	1.5	1.2	3.1	3.5	2.3	2.3	**5.2**	1.0	0.8	2.8	4.0	0.9	1.0	3.3	0.5	3.5	3.4	0.3	1.2	2.8	2.4	1.72
SA	1.6	1.2	0.7	0.9	1.3	0.8	1.2	1.5	1.0	1.3	1.5	2.0	1.4	1.2	1.4	**2.5**	1.2	1.3	1.8	1.4	0.4	1.2	0.2	1.5	1.6	0.5	1.3	1.5	1.3	0.91
BL	2.0	1.9	0.9	1.2	1.2	0.8	1.3	1.7	1.6	1.3	1.7	1.4	1.8	1.5	1.0	0.8	**2.8**	1.4	2.1	1.5	0.5	1.4	0.2	2.1	1.8	0.3	1.3	1.9	1.6	1.02
TD	1.8	1.3	0.8	1.0	1.2	0.2	1.2	1.9	1.4	1.0	2.2	2.1	1.7	1.7	1.3	0.3	0.9	**3.3**	2.6	0.8	0.5	1.7	0.1	2.1	2.2	0.2	0.9	1.8	1.8	1.12
IA	2.7	1.7	1.0	1.4	2.0	0.2	1.6	2.6	2.1	1.6	3.3	2.7	2.6	2.5	2.1	0.4	1.2	2.7	**4.2**	1.4	0.7	2.8	0.3	3.4	3.4	0.3	1.6	2.9	2.6	1.54
MO	2.4	2.0	0.6	1.1	1.7	0.6	1.5	1.8	1.5	2.1	1.9	1.0	2.0	1.4	0.8	1.3	2.0	1.3	2.1	**3.2**	0.5	1.5	0.2	2.2	2.0	0.6	2.1	2.0	1.7	0.86
MA	1.6	1.1	0.5	0.7	1.0	0.2	0.9	1.4	1.1	1.4	1.6	1.3	1.6	1.3	1.3	0.4	0.8	1.5	2.0	1.0	**2.2**	1.6	0.2	1.8	1.9	0.6	1.2	1.6	1.5	0.95
VN	2.2	1.3	0.6	0.8	1.8	0.3	1.2	2.0	1.6	1.6	2.6	2.1	2.1	1.9	1.9	0.4	0.9	1.9	3.1	1.3	0.6	**4.0**	0.6	2.9	3.0	0.4	1.4	2.4	2.0	1.27

KA	1.4	0.7	0.6	0.6	1.1	0.3	0.8	1.3	0.8	1.1	1.8	1.2	1.4	1.3	1.6	0.4	0.6	1.2	2.0	0.9	0.6	2.2	**5.9**	1.9	1.9	0.4	1.1	1.7	1.6	0.9
RA	2.6	1.6	0.9	1.2	1.8	0.4	1.3	2.4	2.2	1.4	2.9	2.5	2.2	2.6	2.2	0.4	1.2	2.1	3.3	1.4	0.6	2.5	0.3	**4.1**	3.0	0.3	1.5	2.7	2.3	1.35
KN	3.1	1.9	0.8	1.6	2.7	0.2	2.1	3.2	2.2	1.9	3.5	2.9	2.8	2.8	1.9	0.6	1.4	2.5	4.0	1.7	0.6	3.1	0.4	3.4	**4.6**	0.4	1.7	3.2	3.0	1.42
BA	0.9	0.5	0.6	0.6	0.6	0.2	0.7	1.0	0.6	0.8	1.2	1.3	1.2	0.9	1.2	0.5	0.5	1.2	1.6	0.6	0.7	1.2	0.2	1.3	1.4	**2.7**	0.6	1.3	1.2	1.01
NA	2.9	2.0	0.7	1.0	1.9	0.5	1.4	2.0	1.7	2.2	2.4	1.3	2.5	1.9	1.3	1.0	1.9	1.6	2.7	2.2	0.7	2.1	0.3	3.0	2.4	0.4	**4.1**	2.7	1.9	0.96
CA	2.1	1.2	0.5	0.8	1.8	0.2	1.3	2.1	1.4	1.5	2.4	1.8	1.9	2.0	1.3	0.5	1.0	1.7	2.6	1.4	0.5	2.0	0.4	2.6	2.8	0.3	1.2	**2.9**	2.0	1.05
JON	2.9	1.7	0.8	1.4	2.1	0.3	1.7	2.7	2.1	2.0	2.8	2.0	2.5	2.3	1.7	0.7	1.4	2.3	3.3	2.0	1.0	2.6	0.4	3.2	3.4	0.4	1.9	2.8	**6.5**	1.14
MO	0.8	0.5	0.5	0.5	0.5	0.1	0.5	0.9	0.7	0.6	1.1	1.1	0.9	0.8	1.0	0.2	0.5	1.0	1.4	0.5	0.5	1.1	0.1	1.3	1.3	0.1	0.5	1.2	1.1	**1.47**
BH	2.4	1.4	0.7	0.8	1.6	0.4	2.4	2.3	0.9	2.4	2.3	1.5	2.9	1.3	2.1	0.8	1.1	2.6	3.5	1.7	1.5	2.3	0.4	2.3	3.3	0.7	1.9	2.8	2.2	1.26
TO	65.6	46.7	25.3	33.9	47.0	11.2	42.6	62.1	46.5	44.8	68.4	54.1	62.0	54.4	42.3	19.8	36.7	54.1	79.2	40.3	19.0	59.3	7.3	73.8	72.6	10.8	42.3	66.8	57.4	35.02
Inc.Own	69.0	49.5	28.3	36.8	49.5	15.1	45.4	65.3	50.4	48.5	72.3	59.5	64.5	56.8	47.5	22.3	39.5	57.3	83.4	43.5	21.2	63.3	13.2	77.9	77.2	13.4	46.4	69.7	64.0	36.49
NET	**8.3**	**-5.5**	**-7.1**	**-3.7**	**0.4**	**-24.7**	**-3.7**	**9.3**	**-17.9**	**-4.3**	**14.4**	**-7.6**	**23.7**	**19.8**	**-13.8**	**-16.0**	**-3.4**	**15.6**	**22.5**	**-3.8**	**-16.1**	**12.1**	**-27.4**	**21.9**	**10.1**	**-16.1**	**-8.3**	**23.3**	**0.4**	**13.07**

Table 4.12.1 During BREXIT, interconnectedness in the medium period (4-Inf Days) among the developed, emerging, and frontier countries using TVP-VAR-BK models. (Source: Author using R software).

	UK	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
UK	**2.5**	1.6	0.9	1.3	1.6	0.6	1.9	1.9	1.2	1.1	1.5	1.2	1.8	1.4	1.0	0.8	1.0	1.5	2.0	1.1	0.7	1.3	0.4	1.5	1.5	0.3	1.8	1.5	0.9	0.5	1.0	36.8
US	2.2	**3.3**	1.7	1.6	1.5	1.2	2.5	2.0	1.4	1.2	1.4	1.1	1.8	1.5	1.5	0.9	1.5	1.5	1.9	1.7	0.9	1.4	0.7	1.3	1.4	0.5	1.8	1.4	0.8	0.6	1.0	41.7
JN	2.5	3.5	**6.7**	4.3	1.5	2.0	2.8	2.5	2.9	1.2	1.7	2.2	1.8	2.3	2.8	1.0	2.2	1.6	2.0	1.8	2.3	1.5	0.8	1.6	1.3	1.7	1.7	1.2	0.9	1.0	1.6	58.0
AA	2.6	2.8	3.2	**6.0**	1.9	1.2	2.7	2.7	2.6	1.0	1.8	2.0	1.8	2.2	2.4	0.9	2.0	1.8	2.3	1.6	1.4	1.4	0.7	1.6	1.6	1.1	1.5	1.4	1.4	0.9	1.3	53.5
HG	3.0	1.9	0.9	1.6	**3.8**	0.4	2.5	2.7	1.4	1.3	2.2	1.9	2.5	2.0	1.2	0.8	0.9	2.1	2.6	1.4	0.4	1.8	0.4	1.8	2.3	0.3	1.8	2.0	1.3	0.6	1.4	47.1
CAA	2.0	2.7	1.6	1.5	1.3	**10.3**	1.7	1.3	1.1	1.3	1.5	1.5	2.0	1.1	2.4	1.6	2.6	1.7	2.2	1.9	1.1	1.6	1.0	1.8	1.7	2.4	2.1	1.6	1.1	0.8	1.7	49.9
GY	2.5	2.4	1.4	1.6	1.8	0.8	**3.6**	2.4	1.3	1.6	1.9	1.5	1.9	1.7	1.9	0.9	1.1	1.8	2.3	1.5	1.4	1.7	0.6	1.7	1.8	0.8	2.1	1.8	1.1	0.8	1.5	47.3
SD	2.1	1.9	1.2	1.3	1.5	0.6	2.4	**2.7**	1.2	1.2	1.6	1.7	1.7	1.6	1.6	0.6	1.0	1.6	2.1	1.1	1.2	1.5	0.6	1.5	1.6	0.7	1.6	1.6	1.0	0.7	1.2	41.3
SN	1.2	1.2	0.8	0.8	1.1	0.8	1.4	1.1	**1.0**	1.0	1.0	0.9	1.0	1.1	1.6	0.8	1.0	1.1	1.3	1.0	1.3	1.1	0.7	1.1	1.0	0.8	1.7	1.0	0.6	0.6	1.0	30.7
RUS	2.1	1.9	1.0	0.9	1.6	0.6	2.2	1.8	1.2	**4.7**	1.8	1.1	1.8	1.4	1.2	0.9	1.1	1.5	2.2	1.7	1.0	1.7	0.4	1.8	1.8	0.7	1.9	1.8	1.2	0.7	1.4	42.6
SA	1.9	1.4	0.9	1.1	1.9	0.4	1.5	1.7	1.3	1.1	**3.1**	1.6	1.6	1.9	1.2	0.5	1.0	1.9	2.3	1.0	0.6	1.5	0.6	1.7	1.7	0.5	1.9	1.7	1.0	0.7	1.0	39.0
CA	1.4	0.9	0.7	1.1	1.1	0.2	1.4	1.5	1.0	0.4	1.6	**4.0**	1.4	1.5	1.1	0.1	0.6	1.6	1.9	0.3	0.3	1.4	0.2	1.2	1.8	0.5	0.7	1.3	0.7	0.5	0.8	28.9
IA	3.5	2.7	1.2	1.9	2.4	0.5	3.0	3.0	1.9	1.4	2.4	1.9	**4.7**	2.7	0.9	0.6	1.9	2.0	3.3	1.8	0.7	1.6	0.4	2.1	2.2	0.4	2.3	2.4	1.4	0.7	1.3	54.5
SAA	2.6	2.9	1.3	2.1	2.2	1.2	2.0	2.7	2.3	1.0	2.8	2.9	2.0	**8.6**	1.9	0.9	2.1	2.1	2.7	1.4	1.1	1.5	0.5	2.0	2.1	1.1	1.3	2.2	1.4	1.1	1.1	54.5
SK	1.5	1.5	0.8	1.1	1.5	0.6	1.8	1.6	0.8	1.0	1.1	1.0	1.1	1.2	**4.2**	1.1	0.8	1.2	1.4	1.2	1.5	1.4	0.8	1.4	1.2	0.7	1.5	1.3	0.6	0.7	1.3	34.5
SA	3.4	3.0	1.5	2.5	2.8	0.9	3.5	2.7	2.2	1.7	2.5	2.0	2.5	2.5	1.4	**3.0**	1.7	1.9	2.6	2.1	1.1	1.7	0.5	1.9	2.0	0.9	2.3	2.0	1.3	0.9	1.1	58.7
BL	2.7	3.3	1.0	1.5	1.3	1.7	2.4	2.1	1.5	2.0	1.5	1.1	2.0	1.3	1.1	1.3	**7.3**	1.3	2.1	4.3	0.9	1.2	0.3	1.5	1.4	1.8	2.5	1.7	1.0	0.7	1.5	49.9
TD	2.5	1.7	1.0	1.3	1.7	0.8	1.6	2.0	1.3	0.9	2.2	2.3	2.0	2.0	1.9	0.5	1.1	**10.8**	3.3	1.0	1.2	2.1	0.5	1.9	2.3	0.6	1.4	1.9	1.5	1.0	2.0	47.4
IA	1.8	1.4	0.6	1.0	1.3	0.2	1.5	1.6	1.0	0.9	1.8	1.7	1.9	1.5	1.1	0.2	1.4	1.8	**3.4**	1.2	0.5	1.4	0.5	1.5	1.8	0.5	1.1	1.8	1.0	0.6	1.2	35.7
MO	2.5	2.6	1.2	1.6	1.8	0.9	2.0	2.2	1.9	1.8	1.8	1.4	1.8	1.9	1.2	1.1	2.0	1.5	2.1	**5.2**	1.0	1.5	0.5	1.5	1.6	1.3	1.9	1.7	1.1	0.8	1.4	47.5
MA	2.6	3.2	1.0	0.8	1.9	1.7	2.3	2.3	1.3	2.9	2.3	1.4	1.7	2.1	1.5	1.1	1.8	1.9	2.2	3.3	**5.9**	2.1	0.8	1.9	1.9	3.2	2.0	2.0	1.2	0.9	1.6	56.8
VN	2.3	1.4	0.6	0.9	1.5	0.4	1.5	1.7	1.2	1.6	2.2	1.7	2.1	1.6	2.0	0.4	1.1	1.9	2.7	1.1	1.3	**4.8**	0.6	1.9	2.3	0.6	1.9	2.0	1.4	0.8	1.6	44.1
KA	2.2	1.3	0.9	1.2	1.4	0.6	1.6	1.8	1.1	1.9	1.8	1.5	1.9	1.5	1.5	0.6	1.4	2.0	2.2	1.6	1.3	2.2	**11.9**	1.6	2.0	1.7	1.8	1.8	1.5	0.8	3.0	47.5

RA	2.0	1.2	0.7	0.9	1.7	0.6	1.1	1.3	1.2	1.6	1.9	1.3	1.8	1.8	1.3	0.7	1.3	1.5	2.3	1.3	0.9	1.9	0.9	**3.4**	1.8	0.5	2.6	1.9	1.2	0.6	0.8	40.6
KN	1.4	1.1	0.5	0.7	1.2	0.3	1.1	1.2	0.9	0.9	1.5	1.5	1.1	1.4	0.9	0.2	0.6	1.5	1.8	0.7	0.5	1.7	0.4	1.2	**3.7**	0.3	0.8	1.4	1.1	0.5	1.0	29.3
BA	3.2	2.6	0.7	1.1	1.6	0.7	2.0	1.9	1.7	3.1	2.2	1.4	2.7	2.6	1.8	1.2	2.1	1.9	2.5	4.5	1.4	2.3	0.4	2.3	1.9	**10.8**	2.8	2.1	1.4	0.8	2.9	59.7
NA	2.2	1.5	0.5	0.8	1.6	0.8	1.2	1.5	1.0	1.6	1.6	1.1	2.1	1.3	1.3	1.1	1.4	1.5	2.1	1.6	1.2	1.8	0.8	1.6	1.6	0.6	**5.5**	1.7	1.0	0.8	1.4	39.9
CA	2.2	1.3	0.4	0.9	1.7	0.3	1.8	1.7	1.1	1.7	2.2	1.9	2.1	2.1	1.6	0.4	1.2	2.2	2.7	1.0	1.6	2.1	0.7	1.9	2.1	0.7	1.8	**7.9**	1.4	0.9	2.2	45.6
JON	1.4	0.9	0.5	1.2	1.3	0.4	1.1	1.4	1.0	1.0	1.6	1.7	1.2	1.5	1.2	0.3	0.8	1.6	2.0	0.8	0.6	1.3	0.7	1.3	1.9	0.7	0.8	1.4	**3.3**	0.9	1.0	33.1
MO	2.5	1.7	1.9	1.8	2.1	0.5	2.4	2.3	2.2	2.0	3.6	3.4	2.9	2.5	2.5	0.3	1.2	3.0	3.8	1.1	1.1	2.3	0.7	2.0	2.8	0.9	1.6	3.0	1.7	**14.7**	1.9	61.9
BH	1.3	1.1	0.6	0.6	0.9	0.8	1.6	1.2	0.7	1.3	1.1	0.8	1.2	0.9	1.7	0.4	0.7	1.4	1.7	1.0	1.7	1.1	0.4	0.8	1.6	0.7	1.2	1.3	0.9	0.6	**8.4**	31.1
TO	67.2	58.3	31.1	40.7	48.7	22.7	58.2	57.9	42.6	42.5	56.2	48.5	54.9	52.2	46.4	21.9	40.7	51.5	68.4	46.9	32.2	48.7	17.3	48.8	53.7	27.5	52.2	51.6	34.1	22.4	43.1	1389.1
Inc.Own	69.7	61.6	37.7	46.7	52.5	33.0	61.7	60.6	43.6	47.2	59.4	52.6	59.6	60.8	50.5	24.9	48.0	62.3	71.8	52.1	38.1	53.4	29.2	52.2	57.4	38.3	57.7	59.5	37.5	37.1	51.5	
NET	30.3	16.6	-26.9	-12.8	1.5	-27.2	10.8	16.6	11.9	-0.1	17.2	19.6	0.4	-2.3	11.8	-36.8	-9.1	4.1	32.7	-0.6	-24.7	4.6	-30.2	8.2	24.5	-32.1	12.3	5.9	1.0	-39.5	12.0	**44.8**

Table 4.12.2 During BREXIT, interconnectedness in the full period (Full days) among the developed, emerging, and frontier countries using TVP-VAR-BK models. (Source: Author using R software).

	UK	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
UK	**5.9**	4.0	1.9	2.9	3.9	1.1	3.8	4.7	3.5	3.1	4.5	3.1	4.5	3.7	2.3	1.6	2.9	3.5	5.1	3.2	1.3	3.7	0.6	4.7	4.4	0.6	4.0	4.3	3.3	1.8	2.2	94.1
US	5.0	**6.1**	2.7	3.0	3.2	1.9	4.5	4.6	3.3	3.1	4.0	2.7	4.2	3.5	2.7	1.7	3.4	3.3	4.6	3.6	1.5	3.4	0.9	4.1	4.0	0.8	3.7	3.9	2.9	1.8	2.1	93.9
JN	3.9	4.8	**9.7**	6.0	2.4	2.4	3.8	3.8	4.3	2.1	3.2	3.6	3.4	3.4	3.8	1.4	3.2	2.9	3.8	2.5	3.0	2.5	1.0	3.0	2.5	2.2	2.6	2.4	2.0	2.0	2.4	90.3
AA	4.5	4.4	4.8	**9.0**	3.3	1.7	4.1	4.5	4.4	1.8	3.5	3.6	3.6	3.5	3.2	1.7	3.3	3.2	4.3	2.5	1.9	2.5	0.8	3.2	3.2	1.4	2.5	2.7	2.9	1.8	2.2	91.0
HG	5.3	3.3	1.7	2.8	**6.3**	0.8	4.0	4.9	3.0	2.7	4.6	3.8	4.6	3.8	2.5	1.8	2.1	3.9	5.2	2.8	1.0	3.7	0.6	4.1	4.8	0.7	3.2	4.3	3.3	1.7	2.8	93.7
CAA	3.6	4.4	2.3	2.4	2.3	**14.2**	2.6	2.7	2.2	2.5	3.1	2.7	3.5	2.3	3.6	2.4	4.0	2.8	3.9	3.1	1.6	3.0	1.2	3.8	3.4	2.8	3.3	3.2	2.5	1.9	2.8	85.8
GY	5.0	4.6	2.2	2.8	3.5	1.1	**6.4**	5.0	2.6	3.6	4.0	3.0	4.1	3.2	2.8	1.9	2.6	3.4	4.6	3.2	1.9	3.3	0.8	3.8	4.2	1.2	3.8	4.1	2.9	1.8	3.0	93.6
SD	5.1	4.2	2.1	2.7	3.5	0.9	4.6	**5.9**	3.1	3.2	4.3	3.6	4.1	3.7	2.7	1.4	2.7	3.5	5.0	2.9	1.8	3.7	0.8	4.2	4.4	1.0	3.4	4.1	3.3	1.8	2.5	94.1
SN	4.8	4.3	2.7	3.4	3.6	1.3	3.8	4.7	**4.9**	2.8	4.2	3.4	3.8	4.0	2.8	1.6	3.1	3.4	4.7	3.2	1.8	3.3	0.9	4.4	4.0	1.0	3.6	3.7	3.0	1.8	1.9	95.1
RUS	4.7	3.7	1.7	1.8	3.5	1.1	4.0	4.0	2.6	**8.4**	4.1	2.4	4.1	3.1	2.4	1.9	2.6	3.1	4.7	3.7	1.7	3.8	0.6	4.4	4.4	1.2	4.0	4.4	3.2	1.8	3.0	91.6
SA	4.6	3.2	1.8	2.4	4.0	0.6	3.1	4.3	3.4	2.7	**7.0**	4.0	4.1	4.5	2.9	1.0	2.2	3.9	5.6	2.5	1.1	4.0	0.9	5.0	4.8	0.7	3.6	4.5	3.4	2.2	2.0	93.0
CA	3.9	2.5	2.2	2.7	2.8	0.6	3.0	4.6	3.4	1.6	5.2	**9.4**	4.0	4.5	3.9	0.8	1.6	4.7	6.3	1.1	1.1	4.5	0.6	4.7	5.5	0.9	1.7	4.3	3.5	2.5	2.1	90.6
IA	5.3	4.0	2.0	2.8	3.6	0.8	4.0	4.6	3.2	2.7	4.4	3.4	**7.3**	4.1	2.3	1.1	2.9	3.5	5.5	2.8	1.4	3.2	0.5	4.3	4.2	0.7	3.6	4.3	3.1	1.9	2.4	92.7
SAA	4.3	3.9	1.9	3.0	3.2	1.3	2.9	4.2	3.8	1.9	4.7	4.5	3.5	**10.9**	3.1	1.2	2.9	3.6	4.8	2.3	1.5	3.0	0.7	4.2	4.1	1.4	2.4	3.9	3.0	2.1	1.9	89.1
SK	3.5	2.6	1.7	1.9	2.7	1.0	3.1	4.0	2.3	2.3	4.2	4.6	3.4	3.5	**9.4**	2.0	1.6	3.9	5.4	2.1	2.5	4.7	1.3	4.9	4.5	1.0	2.7	4.1	3.0	2.5	3.6	90.6
SA	5.0	4.2	2.2	3.4	4.0	1.8	4.6	4.1	3.2	3.0	3.9	4.0	4.0	3.7	2.8	**5.5**	2.9	3.2	4.4	3.4	1.5	2.8	0.6	3.4	3.5	1.4	3.6	3.5	2.6	1.8	2.0	94.5
BL	4.7	5.1	1.8	2.7	2.5	2.5	3.7	3.8	3.1	3.3	3.3	2.5	3.8	2.7	2.1	2.0	**10.1**	2.7	4.2	5.8	1.5	2.6	0.5	3.6	3.3	2.1	3.8	3.6	2.6	1.7	2.5	89.9
TD	4.3	3.0	1.8	2.3	2.9	1.0	2.7	3.9	2.7	1.9	4.4	4.4	3.7	3.7	3.3	0.8	2.0	**14.1**	5.9	1.8	1.7	3.8	0.6	4.0	4.5	0.7	2.3	3.8	3.2	2.1	3.1	85.9
IA	4.6	3.1	1.6	2.4	3.3	0.4	3.0	4.3	3.2	2.5	5.1	4.4	4.5	4.0	3.1	0.5	2.7	4.4	**7.6**	2.6	1.3	4.2	0.7	4.9	5.2	0.8	2.7	4.7	3.6	2.1	2.7	92.4
MO	5.0	4.6	1.8	2.7	3.5	1.5	3.6	4.0	3.4	3.9	3.7	2.4	3.8	3.4	2.0	2.4	4.0	2.7	4.2	**8.4**	1.5	3.0	0.7	3.7	3.6	1.8	4.0	3.8	2.7	1.7	2.8	91.6
MA	4.2	4.3	1.5	1.5	2.9	1.9	3.2	3.7	2.5	4.3	3.9	2.7	3.3	3.4	2.8	1.5	2.6	3.3	4.2	4.3	**8.1**	3.6	1.0	3.7	3.8	3.8	3.2	3.6	2.8	1.9	2.8	91.9
VN	4.5	2.7	1.1	1.7	3.3	0.7	2.7	3.7	2.7	3.3	4.8	3.8	4.2	3.5	3.9	0.9	2.0	3.8	5.8	2.3	1.9	**8.7**	1.2	4.8	5.3	1.0	3.3	4.4	3.4	2.0	2.9	91.3

KA	3.6	1.9	1.5	1.8	2.5	0.9	2.4	3.1	1.9	3.1	3.6	2.7	3.3	2.8	3.0	0.9	2.1	3.2	4.2	2.5	1.8	4.4	**17.8**	3.5	3.9	2.1	2.9	3.5	3.1	1.7	4.4	82.2
RA	4.6	2.8	1.6	2.1	3.5	0.9	2.4	3.6	3.4	3.0	4.9	3.8	4.0	4.4	3.5	1.1	2.5	3.6	5.6	2.7	1.5	4.4	1.1	**7.5**	4.8	0.7	4.2	4.6	3.4	2.0	2.0	92.5
KN	4.4	3.0	1.3	2.2	3.9	0.6	3.2	4.5	3.1	2.8	5.0	4.4	3.9	4.2	2.8	0.8	2.0	4.1	5.8	2.3	1.1	4.8	0.8	4.7	**8.3**	0.6	2.5	4.6	4.0	1.9	2.9	91.8
BA	4.1	3.1	1.3	1.6	2.2	0.9	2.7	2.9	2.3	3.9	3.3	2.7	3.8	3.5	3.0	1.7	2.6	3.1	4.1	5.0	2.0	3.5	0.5	3.6	3.3	**13.5**	3.4	3.5	2.6	1.9	4.3	86.5
NA	5.1	3.5	1.2	1.8	3.4	1.4	2.6	3.5	2.7	3.7	4.0	2.4	4.6	3.2	2.6	2.0	3.2	3.0	4.7	3.8	1.8	3.9	1.0	4.6	4.0	1.0	**9.5**	4.3	2.9	1.8	2.9	90.5
CA	4.2	2.5	0.9	1.7	3.5	0.5	3.1	3.8	2.5	3.1	4.6	3.8	4.0	4.1	2.8	0.9	2.2	3.8	5.3	2.3	2.1	4.1	1.1	4.6	4.8	1.0	3.1	**10.8**	3.4	1.9	3.5	89.2
JON	4.3	2.6	1.3	2.6	3.4	0.7	2.8	4.1	3.1	2.9	4.4	3.7	3.7	3.8	2.9	1.0	2.3	3.8	5.3	2.8	1.6	3.9	1.0	4.4	5.3	1.1	2.7	4.2	**9.9**	2.0	2.8	90.1
MO	3.3	2.3	2.4	2.3	2.5	0.6	2.9	3.2	2.9	2.7	4.8	4.5	3.7	3.3	3.5	0.5	1.7	4.1	5.2	1.6	1.6	3.4	0.8	3.4	4.1	1.1	2.1	4.2	2.8	**16.2**	2.6	83.8
BH	3.7	2.5	1.3	1.4	2.5	1.2	4.0	3.5	1.5	3.7	3.4	2.3	4.2	2.2	3.9	1.2	1.8	3.9	5.2	2.7	3.2	3.5	0.8	3.1	4.8	1.4	3.1	4.1	3.1	1.9	**15.1**	84.9
TO	132.7	105.0	56.4	74.6	95.7	33.9	100.8	120.0	89.1	87.3	124.6	102.7	116.9	106.6	88.7	41.7	77.5	105.6	147.6	87.1	51.1	108.0	24.6	122.7	126.3	38.3	94.5	118.4	91.6	57.5	81.2	2808.3
Inc.Own	138.7	111.1	66.0	83.6	102.0	48.1	107.2	125.9	94.0	95.6	131.6	112.0	124.2	117.5	98.0	47.2	87.5	119.7	155.2	95.6	59.3	116.7	42.4	130.1	134.6	51.8	104.0	129.2	101.4	73.6	96.4	
NET	38.7	11.1	-34.0	-16.5	2.0	-52.0	7.2	25.9	-6.0	-4.4	31.6	12.0	24.2	17.5	-2.0	-52.8	-12.5	19.7	55.2	-4.4	-40.7	16.7	-57.6	30.1	34.6	-48.2	4.0	29.2	1.4	-26.4	-3.6	**90.6**

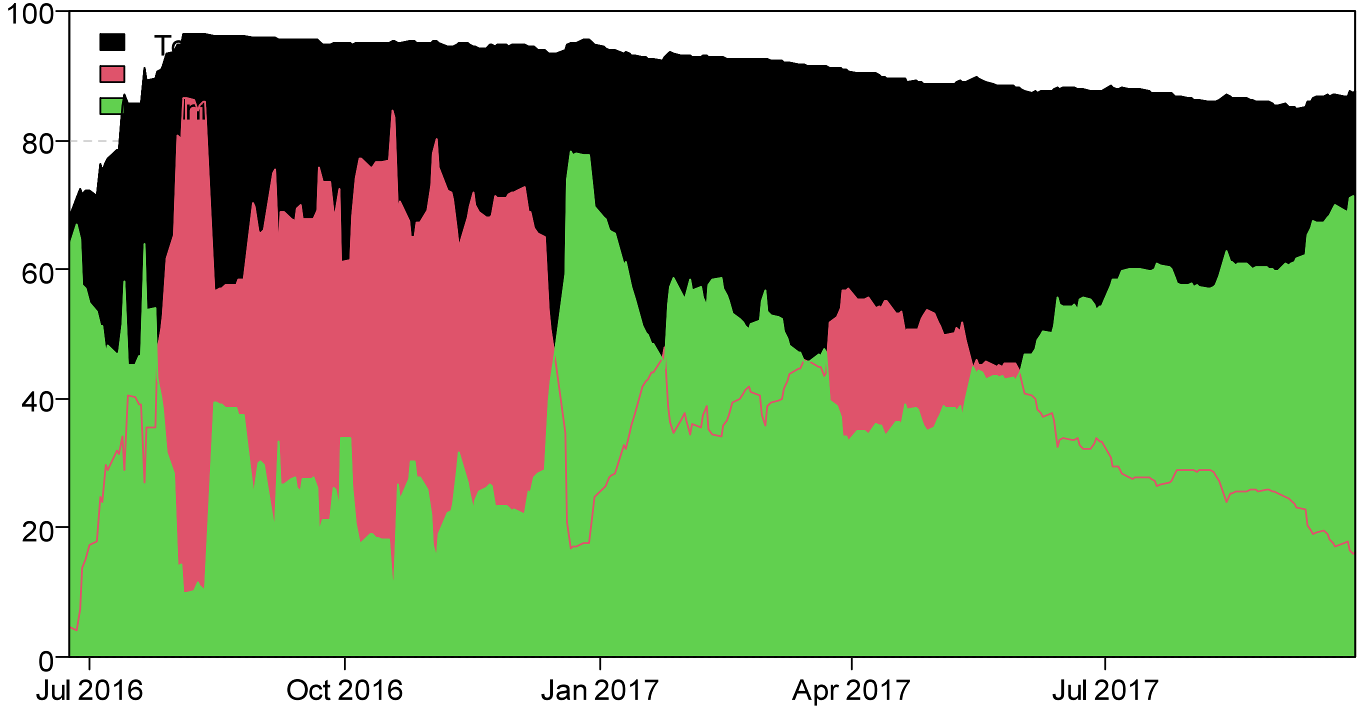


Fig. 4.32 During BREXIT Interconnectedness among the developed, emerging, and frontier countries using TVP-VAR-BK (2018).

Note:For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this thesis. Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf Days, Green colour), and total frequency (black colour) (Source: Author's using R software).

4.9 Results of the volatility spillover among the developed, emerging, and frontier countries during the Pre-COVID-19.

During Pre-COVID-19, no such interconnectedness was identified as it acted as a standard period, but still, it generated 84.64% volatility spillover among the selected stock market (Fig. 4.33). Germany (28.22%), HongKong (25.39%), and US (15.26%) among developed countries; South Africa (30.35%), Brazil (15.71%), China (15.30%) among emerging countries; Croatia (20.69%), Bahrain (7.23%), Bulgaria (5.71%) among frontier countries is identified as the net volatility spillover (Table 4.13.0).Germany is among the world's most open, export-oriented economies, vitally connected to world trade. Two of its key pillars of the economy, the automotive and industrial sectors, tend to be sensitive to global supply chain disruptions and the dynamics of financial markets.As the EU’s largest economy, German market volatility often has spillover effects on other EU countries and international markets.HongKong is a significanteconomic centre with considerable capital flows and linkages with mainland China. Its stock market and banking sector are channels for global investors looking for exposure to China, making it very sensitive to international and regional shocks.It is a crucial cog in Asia-Pacific financial linkages, generating volatility spillovers.The USis the world’s largest economy, and its capital markets, especially its equity and bond markets, are benchmarks globally. Internationally, the dollar’s status as the main reserve currency enhances its role in the spillovers of global volatilities.For example, movements in U.S. markets, interest rates, and fiscal policy cast their shadows on many other economies.

Russia (-26.83%), Spain (-21.1%), Canada (-3.03%) among developed countries; Mexico (-27.62%), Saudi Arabia (-11.97%), India (-9.73%) among emerging countries; Romania (-43.30%), Morocco (-34.93%), Kazakhstan (-21.18%) among the frontier counties were the net receiver of the spillover (Fig. 4.34) as the reason could be that Russia’s economy is dependent on oil and gas exports. But Pre-COVID-19 oil price volatility driven by OPEC disputes and global demand stagnation led to significant disruptions; anticipated business sanctions of Western nations and trade barriers curtailed foreign investments and enhanced the adverse impact of international shocks, and high unemployment and slow GDP growth in Spain resulted in vulnerability to external shocks in Euro-area.Tourism accounts for over a tenth of Spain’s GDP, and fears around COVID-19led to jitters about travel patterns abroad earlier in the crisis.Like Russia, Canada is a resource-rich economy. Dropping oil prices weighed on stocks,but Canada’s overall drop was less severe thanks to a wider-ranging economic base that includes technology and manufacturing.U.S. trade exposure: Mexico is very reliant on trade with the U.S. On pre-COVID-19 policy changes, economic uncertainty in the U.S. had a direct spillover effect.The peso's slide heightened fears among investors, prompting a flight of capital from the country.Saudi Arabia’s economy is so reliant on oil that, as the world’s largest oil exporter, its stock market absorbed the shock of declining oil prices. This was exacerbated by lacklustre global energy demand leading up to the pandemic, as the steady government spending on long-delayed diversification projects was not enough to compensate for the losses in oil. Moreover, in the case of India, the economic slowdown revealed that economic growth had already begun to slow due to a decline in consumer spending and bad loans in banking, even before COVID-19. As an emerging market vulnerable to global risks, India witnessed portfolio outflows that intensified external shocks.In the case of the frontier countries, the high fiscal deficit in Romania and dependence on foreign investments made it highly sensitive to financial volatility, as the low investor confidence revealed thatworries over government reforms and political instability led to sharp declines. Morocco's stock market was impacted due to the inherent volatility, and spillover effects were exacerbated by limited market depth. Moreover,Kazakhstan’s reliance on commodity exports made it susceptible to energy market disruptions beforeCOVID-19; Kazakhstan relied heavily on trade with Central Asia and Russia, further enhancing the spillover.

On analyzing “To Other” Hong (112.78%), Germany (108.88%), US (99.23%) among developed countries; South Africa (118.08%), Brazil (103.99%), China (103.36%) among emerging countries; Croatia (108.95%), Bulgaria (93.27%), Bahrain (90.50%) were identified among frontier countries (Fig. 4.34).

On analysing “From other,” Spain (89.94%), Australia (88.73%), HongKong (87.39%) among developed countries; Brazil (88.27%), China (88.16%), Malaysia

(87.99%) among emerging countries; Romania (89.09%), Croatia (88.27%), Bulgaria (87.57%) among frontier countries (Fig. 4.34).

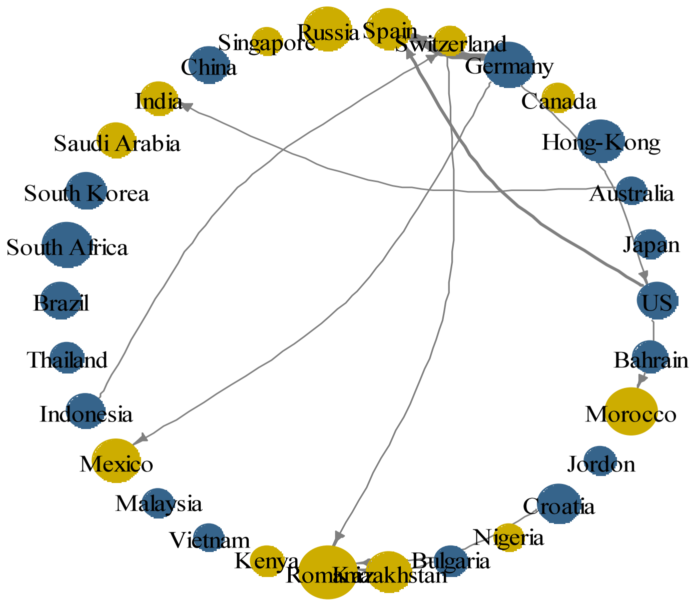
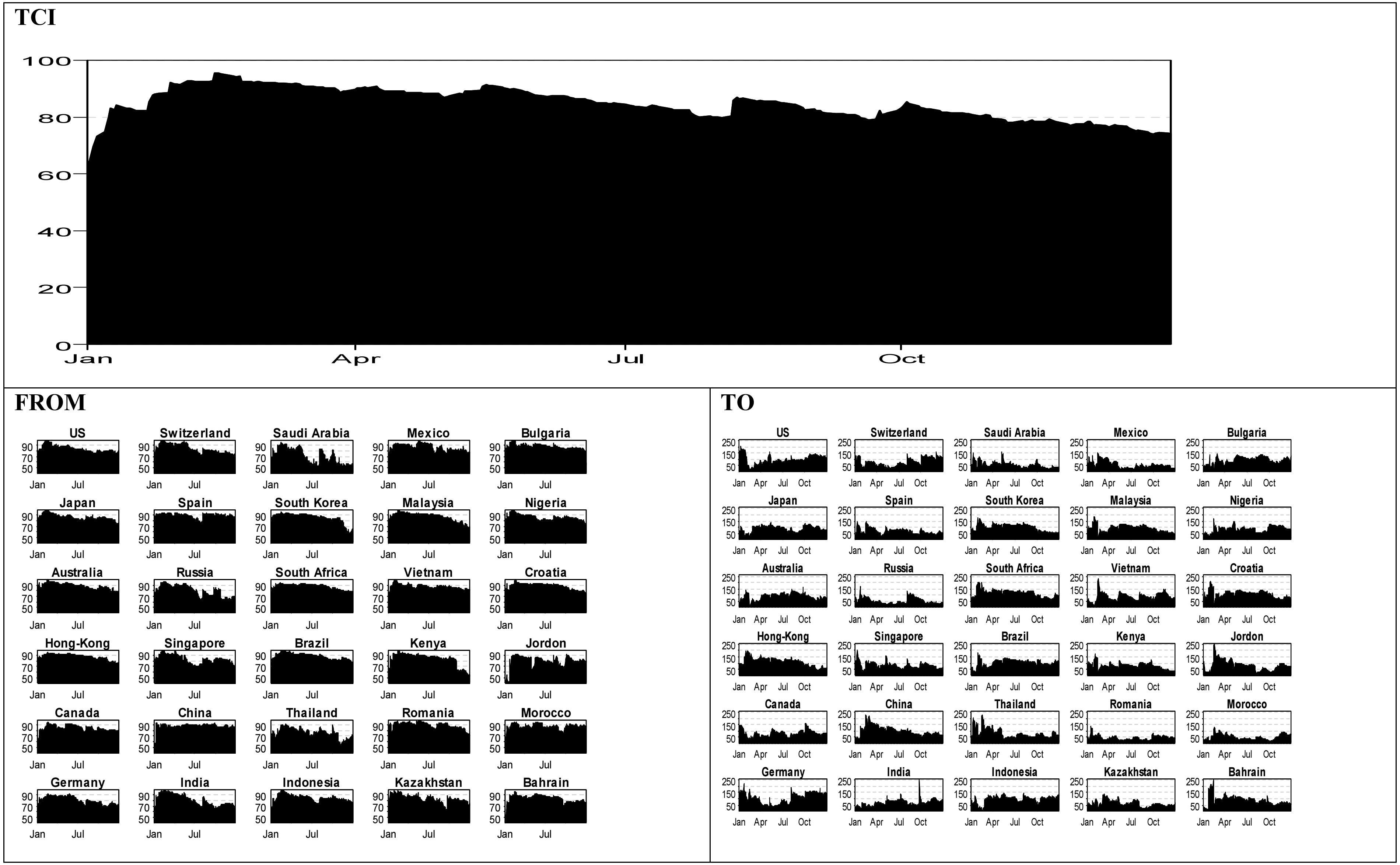


Fig. 4.33: Interconnectedness during the Pre-COVID among the developed, emerging, and frontier countries using the TVP-VAR model.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).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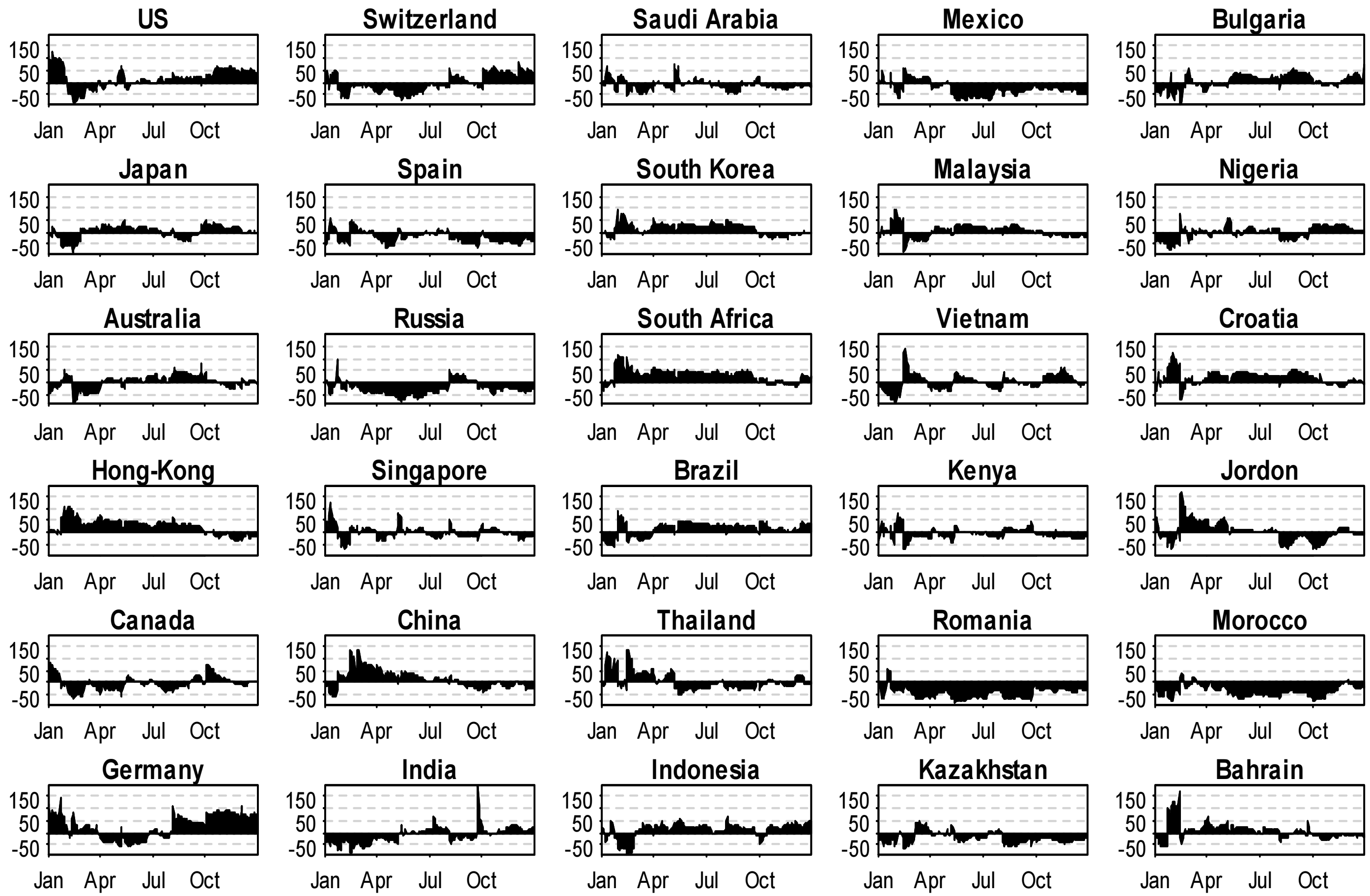
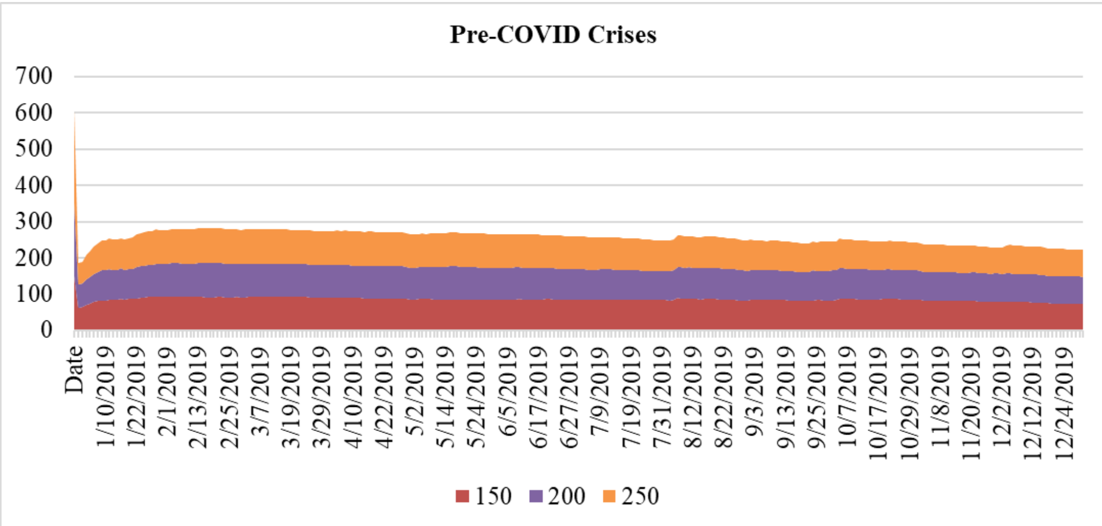


Fig. 4.34: During PRE-COVID, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software).

➢ ROBUSTNESS –

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 100-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Examining the spillover curves illustrated in Fig. 4.35 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.



.**Fig. 4.35:** Robustness of Pre-COVID on window sizes 150, 200, and 250.

Note: Red indicates the volatility spillover of 150 observations, Purple shows 200 observations, and orange shows 250 observations.Note: Author using R software

Table 4.13.0: During PRE-COVID, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software).

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**16.0**	2.2	1.8	3.1	3.2	9.6	5.0	3.3	3.1	4.5	2.0	2.4	2.8	2.3	2.5	2.5	3.7	1.9	1.9	2.5	2.4	1.9	1.5	3.3	1.2	3.7	3.2	2.6	1.5	2.7	84.0
JN	4.6	**13.2**	3.8	2.5	4.8	2.7	1.7	2.6	2.3	4.0	4.0	1.8	1.6	2.4	2.6	2.2	2.8	4.8	2.3	2.1	4.9	3.6	1.5	2.7	2.2	6.1	2.7	3.5	2.0	2.2	86.8
AA	3.5	2.8	**11.3**	4.3	3.4	4.1	4.0	2.1	1.3	2.7	3.6	1.2	2.2	5.4	4.9	4.3	2.8	3.5	2.5	4.2	3.3	3.7	1.4	1.8	2.4	2.1	4.3	2.6	1.2	3.1	88.7
HG	2.7	1.6	3.2	**12.6**	1.3	3.1	1.9	1.6	1.5	2.8	5.3	2.2	1.4	7.4	7.2	4.6	2.7	2.6	1.9	4.5	2.4	1.8	1.9	2.0	3.8	1.8	5.5	3.1	1.2	4.4	87.4
CAA	5.5	4.6	2.4	2.5	**15.5**	4.1	2.2	2.6	1.5	3.5	3.1	1.5	2.5	2.0	2.9	3.1	3.3	4.7	2.6	2.2	3.9	3.7	1.5	2.3	1.9	5.3	2.6	2.1	2.1	2.4	84.5
GY	6.5	2.3	1.7	3.6	3.2	**19.3**	7.2	1.4	3.1	2.5	3.7	2.5	2.0	2.8	3.5	3.9	2.0	4.0	2.2	1.8	2.7	1.6	1.1	1.6	2.9	1.9	2.1	3.1	1.8	2.3	80.7
SD	5.2	4.0	2.0	2.6	2.9	9.5	**15.6**	2.3	3.0	2.4	4.1	1.5	1.3	2.1	3.0	2.4	2.5	6.5	1.8	1.8	3.2	2.3	1.3	2.0	2.7	2.8	2.3	2.9	1.8	2.0	84.4
SN	8.6	2.1	3.6	2.7	4.2	12.8	6.4	**10.1**	3.2	2.8	2.3	2.4	2.8	1.8	2.2	2.1	2.4	3.0	2.4	1.5	2.0	2.7	1.5	2.6	2.0	3.0	2.0	1.9	1.2	1.8	89.9
RUS	4.2	3.2	2.4	2.3	2.3	5.6	5.3	2.1	**19.7**	3.4	2.7	4.2	2.7	1.9	2.5	2.2	3.5	1.9	2.5	2.2	2.6	2.5	1.6	1.6	2.9	2.8	2.9	2.2	2.1	2.0	80.4
SA	4.2	3.2	3.1	4.3	2.1	3.3	2.5	3.0	1.2	**17.6**	3.5	1.7	4.4	4.7	2.5	3.0	3.3	3.5	2.8	2.9	3.4	1.9	2.0	2.1	2.0	3.7	2.4	1.9	2.1	1.9	82.4
CA	2.5	3.2	5.0	4.6	3.1	2.6	1.5	2.6	1.2	2.5	**11.8**	2.9	1.9	3.2	4.9	4.6	2.9	6.1	1.2	2.7	4.2	2.1	1.2	1.7	4.5	2.5	4.5	3.4	2.3	2.7	88.2
IA	1.8	4.0	4.3	2.9	2.5	1.6	1.5	1.6	1.9	1.9	3.2	**19.3**	3.2	3.7	3.1	3.0	2.1	3.2	1.4	2.8	3.3	3.7	2.0	2.2	3.0	2.5	3.9	2.7	2.1	5.7	80.7
SAA	3.3	2.2	2.3	2.6	2.5	2.2	1.5	1.6	2.6	6.2	3.4	2.3	**29.3**	2.5	1.9	1.9	3.4	2.5	2.5	2.6	1.9	2.7	1.6	1.5	2.5	2.4	2.1	2.1	1.6	2.6	70.7
SK	2.3	2.2	4.6	7.7	1.1	2.8	1.9	1.3	1.1	3.0	4.6	2.6	1.3	**14.2**	5.8	4.7	2.1	3.0	2.2	4.4	3.6	2.9	1.8	1.7	3.6	1.4	4.4	2.7	1.7	3.5	85.8
SA	2.4	1.5	2.7	7.5	2.0	3.1	1.9	1.8	1.5	1.2	4.0	1.8	1.1	5.6	**12.3**	5.9	2.6	1.9	1.3	5.6	2.4	2.5	1.6	2.1	4.5	2.1	5.9	3.6	1.6	6.1	87.7
BL	1.8	3.6	4.0	4.4	3.2	2.1	1.9	1.9	1.1	2.0	3.6	2.1	1.1	4.2	6.0	**11.7**	1.8	3.3	3.4	5.2	3.2	3.2	1.7	1.7	4.9	2.5	5.9	2.8	2.1	3.4	88.3
TD	4.9	1.4	2.0	3.2	2.4	3.8	3.9	1.9	1.9	4.7	2.1	2.1	1.3	2.8	3.0	1.8	**24.0**	3.1	2.7	1.9	2.4	1.8	1.2	3.6	2.0	4.6	2.1	3.4	1.0	3.3	76.1
IA	2.0	4.0	2.8	3.6	3.8	3.0	3.6	3.1	1.2	2.4	4.8	2.3	1.5	3.3	4.4	3.1	2.2	**15.3**	1.5	3.4	4.6	3.0	1.7	2.2	3.0	3.5	3.5	2.5	2.6	2.1	84.7
MO	4.1	3.2	3.1	3.4	2.5	5.1	3.5	4.4	1.5	2.6	3.4	2.9	2.2	3.0	3.3	3.3	4.4	2.4	**13.9**	2.5	2.5	2.8	1.3	2.6	4.0	2.1	3.2	3.0	1.9	2.2	86.1
MA	2.2	2.4	3.4	5.5	2.9	1.7	1.3	2.1	1.0	1.2	4.2	2.1	1.2	5.3	6.5	6.0	2.9	2.7	3.0	**12.2**	2.8	3.5	1.2	1.7	4.5	1.4	6.1	3.3	1.4	4.4	87.8
VN	1.9	4.9	3.9	4.0	3.2	2.2	1.5	1.7	1.1	2.5	4.3	2.8	2.0	3.9	4.7	4.4	1.7	4.8	1.2	3.5	**12.6**	3.8	1.3	1.5	3.8	3.1	4.7	3.6	2.9	2.7	87.4
KA	1.8	3.3	4.1	3.5	4.4	1.9	1.6	2.4	1.4	1.9	3.3	1.6	2.3	3.8	4.0	3.9	3.0	4.3	1.9	4.9	3.2	**16.9**	1.6	1.8	2.7	2.5	4.7	2.5	1.8	3.2	83.1
RA	1.9	4.3	3.1	4.1	2.3	3.5	4.3	2.6	2.0	2.5	3.4	2.8	1.9	3.8	4.3	3.9	1.9	2.9	1.5	3.2	3.6	2.9	**10.9**	1.5	5.1	2.4	4.6	3.4	2.5	3.3	89.1
KN	4.3	2.5	2.4	3.2	2.7	2.3	2.4	4.8	2.0	3.1	2.8	4.4	3.4	2.0	3.4	2.1	4.1	2.7	2.1	1.9	1.8	1.7	1.7	**16.7**	4.1	6.6	2.8	1.8	1.2	3.1	83.3
BA	1.3	3.7	2.5	4.1	2.0	2.8	2.8	1.8	1.4	2.2	3.9	2.4	1.8	3.9	4.8	5.4	2.0	4.9	1.9	4.6	4.0	3.0	1.6	1.6	**12.4**	1.8	6.5	3.3	2.0	3.7	87.6
NA	3.6	5.7	4.9	2.9	5.0	2.4	2.6	4.0	2.4	3.7	3.0	1.7	1.2	2.2	3.6	2.8	3.9	3.5	2.0	1.9	3.4	2.6	1.8	4.6	2.1	**14.2**	2.3	2.0	1.8	2.5	85.8
CA	2.7	2.8	3.4	6.6	1.5	2.0	1.2	1.7	1.1	1.7	4.7	2.4	1.3	5.4	6.3	5.6	2.6	2.1	1.3	5.7	3.3	3.0	1.4	2.3	4.6	2.1	**11.7**	3.2	1.5	5.0	88.3
JON	2.0	3.4	2.4	2.7	2.7	3.2	1.5	2.5	4.6	2.1	4.1	2.6	2.5	2.7	3.9	3.2	3.2	1.6	2.0	3.4	2.7	1.7	2.6	1.3	3.8	1.8	2.9	**21.1**	2.2	3.9	78.9
MO	4.8	3.0	3.6	3.1	3.0	4.4	3.8	2.6	1.5	4.6	2.4	4.1	2.0	2.3	3.2	3.8	2.4	3.2	1.6	2.4	3.2	2.5	1.8	2.3	3.2	4.0	3.9	2.4	**12.8**	2.3	87.2
BH	2.6	1.9	2.3	5.3	1.6	1.5	1.6	1.4	1.0	1.7	3.7	3.9	2.1	4.6	7.3	4.3	4.2	2.1	1.0	3.8	2.3	2.4	1.4	2.4	3.7	2.8	5.0	4.3	1.3	**16.7**	83.3
TO	99.2	89.2	90.5	112.8	81.5	108.9	81.5	68.8	53.5	82.1	103.4	70.9	58.7	100.7	118.1	104.0	81.9	96.6	58.5	92.0	88.9	77.5	45.8	62.1	93.3	85.1	109.0	81.9	52.3	90.5	2539.1
Inc.Own	115.3	102.4	101.8	125.4	97.0	128.2	97.1	78.9	73.2	99.7	115.2	90.3	88.0	114.9	130.4	115.7	105.8	111.9	72.4	104.3	101.5	94.3	56.7	78.8	105.7	99.3	120.7	103.0	65.1	107.2	
NET	15.3	2.4	1.8	25.4	-3.0	28.2	-2.9	-21.1	-26.8	-0.3	15.2	-9.7	-12.0	14.9	30.4	15.7	5.8	11.9	-27.6	4.3	1.5	-5.7	-43.3	-21.2	5.7	-0.8	20.7	3.0	-34.9	7.2	**84.6**

4.10 Results of the volatility spillover among the developed, emerging, and frontier countries during the COVID-19.

On analyzing volatility spillover during COVID-19, this study finds strong connectedness among all the selected developed, emerging, and frontier countries (Fig. 4.36). TheUS (54.42%), Switzerland (33.40%),and Singapore (14.88%) among developed countries; Mexico (48.66%), Brazil (26.53%), Malaysia (23.16%) among emerging countries; and Croatia (9.36%), Morocco (2.69%) among frontier countries shown high net volatility spillovertransmitter (Table 4.14.0). The reason could be that the US, the world's most affluent and most developed economy,is almost fully ensconced in the world financial markets. Changes in the U.S. economy have far-reaching implications for global trade, investment and financial flows, market depth and financial liquidity. These markets are often the centre of global volatility during crises, as capital flees to safety or suddenly reprices risk.The abrupt monetary/fiscal policy reconfigurations under COVID-19 (e.g., Federal Reserve intervention) transmitted volatility to other economies.Switzerland indicated that its assets (Swiss Franc) have wild inflows and outflows during crises,which is a transmittal of volatility.As a centre of international banking with many investment banks, volatility in Switzerland can mirror its financial sector's global market links.Singapore has an open economy and depends on trade, making it very sensitive to freshwater disruptions in global supply chains, as it serves to transmit volatility.At the same time, it functions as a financial centre in Asia, more vigorously affecting regional and global trading.

In the emerging markets,Mexico (48.66%), as the economic dependence on the U.S., Mexico's close trade relationship with the US leaves it vulnerable to spillover from its northern neighbour's volatility, primarily via remittances and supply chains,as the oil-exporting economy saw volatility during COVID-19 with fluctuating oil prices. Similarly, Brazil's dependence on other commodities, such as soybeans and iron ore, has made it susceptible to global swings in demand and cost. At the same time,the policy remains inconsistent, pandemic management is poorly done, and market volatility has escalated.Malaysia (23.16%),with a heavy reliance on exports (electronics, oil, etc.), Malaysia was prone to global demand shocks; based on the regional interdependence, Economic and financial connections with regional partners (China, in particular) played a role in spillovers.The frontier marketsrevealed that Croatia's economy is entirely dependent on tourism, which was affected by COVID-19, also transmitting volatility domestically and regionally.Linkages to the EU enabled the amplification of spillovers.Limited volatility passes through to Morocco, which possesses economic ties to Europe and exposure to global supply chains,a roller coaster ride for key pieces of the economy.

On analyzing the net receiver of the spillover,Japan (-34.68%), Canada (-12/26%), and Germany (-6.79%) among the developed countries; Indonesia (-17.20%), India (-14.67%), South Korea (-11.45%) among emerging countries; Kenya (-36.79%), Nigeria (-36.02%), Romania (-21.74%). The reason could be that Japan's financial markets act as safe havens, especially government bonds, and the yen is considered a safe-haven asset. In times of crisis, capital from abroad enters the country. It stabilizes the domestic markets, turning Japan into a net absorber of volatility. Japan's relatively unchanged continuum of monetary and fiscal policies during COVID-19 diminished it as a transmitter of volatility.A robust domestic market and lower reliance on boom-and-bust sectors (e.g., oil) enabled Japan to contain rather than diffuse volatility.Canada punches well above its weight when it comes to being a commodity exporter, as the resiliency of the Canadian banking sector served as a bulwark against the transmission of international financial volatility. As one of the E.U.'s core members, Germany typically acts as a stabilizing influence on regional markets. Germany's strong industrial base and leadership of the eurozone made it capable of absorbing some volatility from weaker EU economies.

Conservative fiscal and monetary policies damped its inclination to transmit volatility.In emerging countries, Indonesia's economy is predominantly driven by domestic consumption, giving it less leverage to external shocks and volatility transmission. Lower integration into financial markets: its low level of integration into global financial markets meant that it could not transmit volatility but instead acted as a net receiver. Moreover, Indian stock markets have shown policy-leveraged stability; India’s broad, internally driven economy and government interventions in the pandemic to stabilise markets mitigated outward transmission of volatility; as dynamic capital flows as, to sum up, the high levels of foreign investments into India’s markets during the recovery phase absorbed global volatilities, rather than transmitting it. South Korea’s export reliance is offset by its technology and industry. The pandemic may have disrupted global demand, but strong domestic policies soaked up more of the volatility; stable institutions as the strong institutions and rapid policy responses kept volatility transmission during COVID-19 in check. In the Frontier countries, the reason could be their dependency on foreign aid and investment, as Kenya is heavily dependent on foreign aid and remittances, thus tending to absorb volatility in donor economies rather than transmit it. Secondly, the reduced financial market connectedness is less likely to transmit volatility because of little integration into worldwide financial systems. Nigeria's economy is very dependent on the global oil price. However, domestic financial markets did not transmit external volatility, which was absorbed; instead, Nigeria’s fledging financial markets restricted her participation in the global volatility spillovers. Romania was a net beneficiary of stability mechanisms and EU structural funds during the pandemic, making it a net recipient of volatility. There are several twinkling stars for the emerging EU economy; as an emerging European economy, Romania absorbed shocks from more significant EU economies (Germany and France).

- On analyzing *“To Other”* US (145.44%), Switzerland (119.81%), Singapore (106.98%) among developed countries; Mexico (139.87%), Brazil (117.48%), Malaysia (113.86%) among emerging countries; and Croatia (101.26%), Morocco (93.46%), Jordon (80.16%) among the frontier countries (Fig. 4.37) generated high spillover.

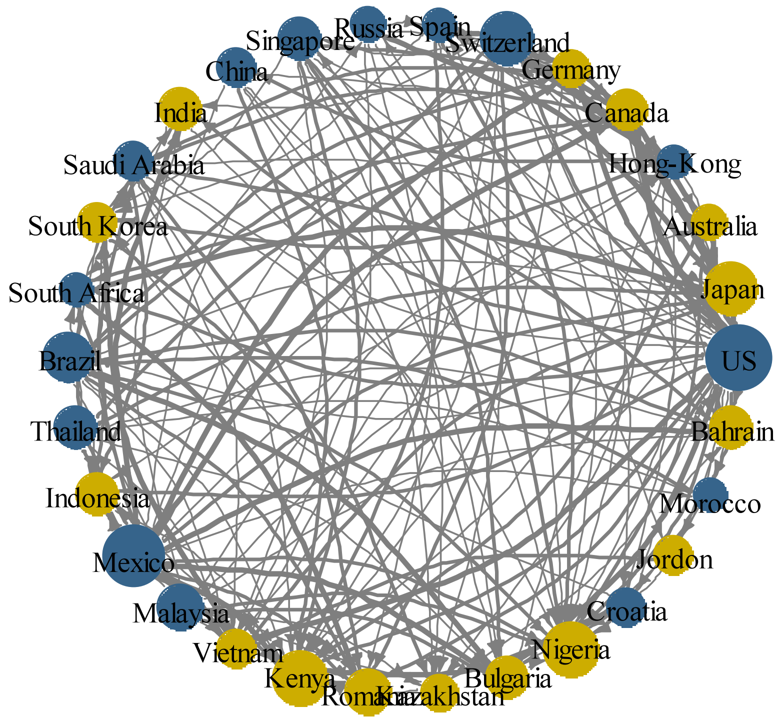
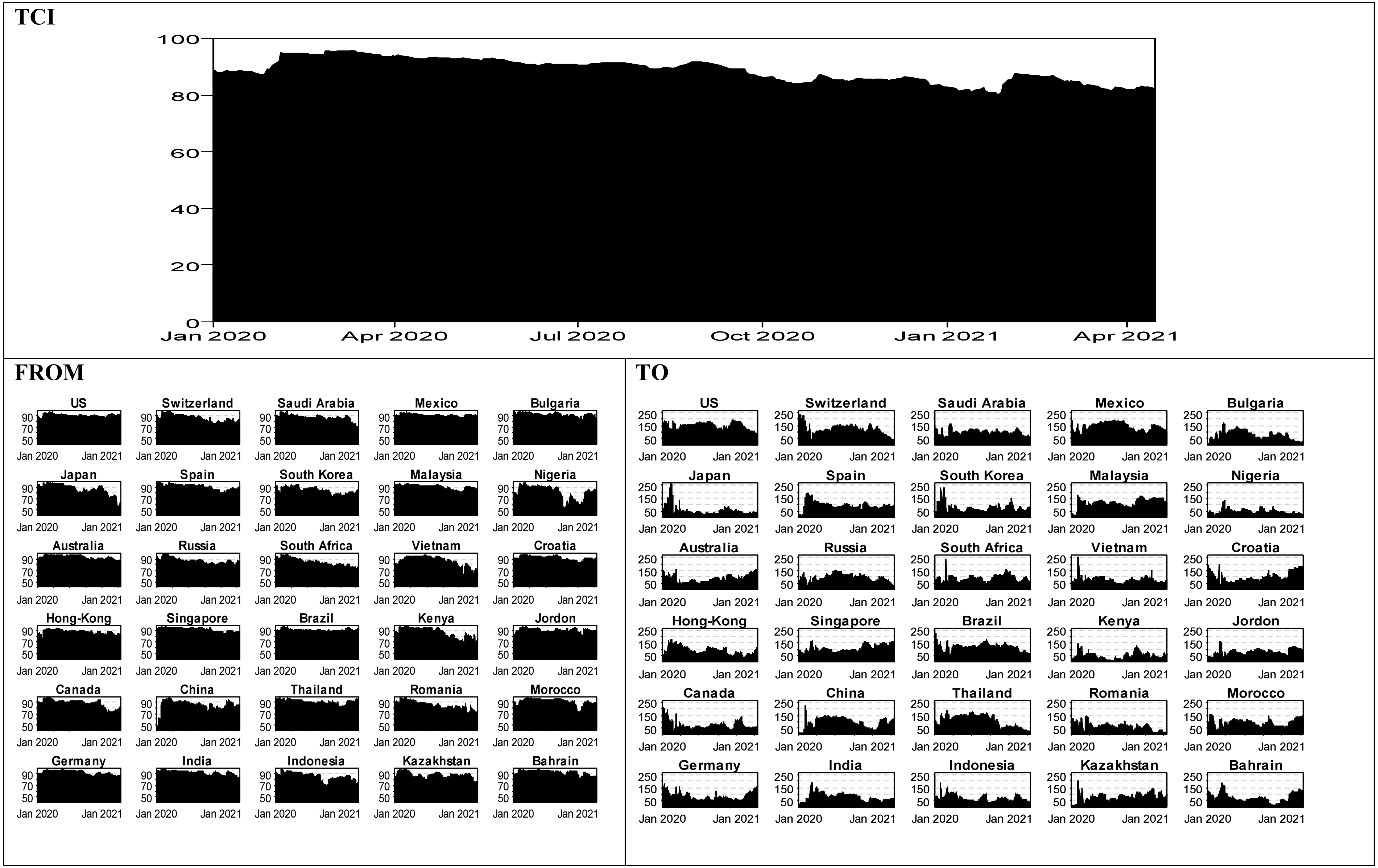


Fig. 4.36: During COVID-19, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR-BK models.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).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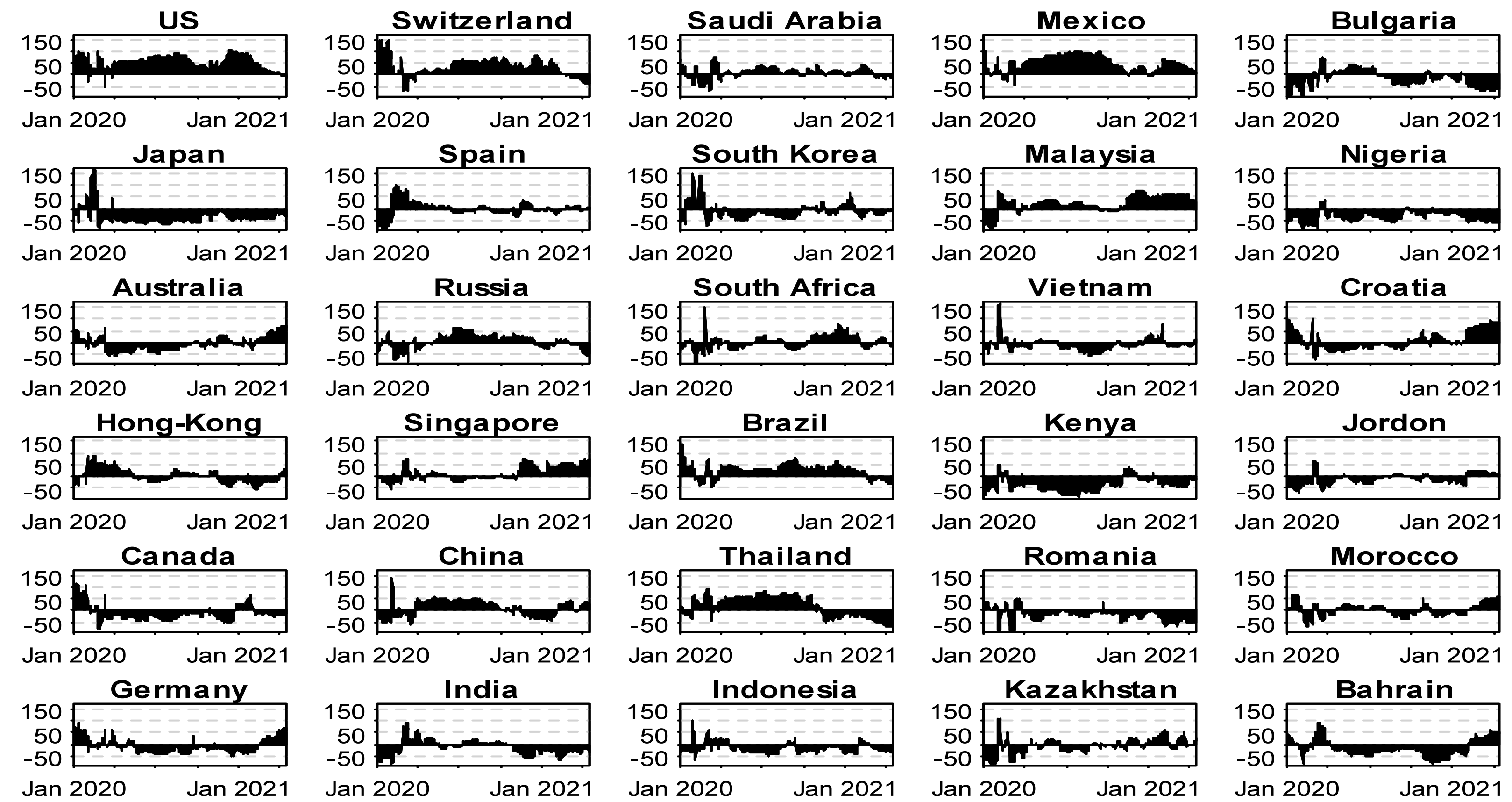


Fig. 4.37: During COVID-19, "To", "From", and "Net" among the developed, emerging, and frontier countries using TVP-VAR models (Source: Author's using R software).

- On analyzing *"From Other"* Australia (93.15%), Germany (92.1%), and US (91.02%) among developed countries; India (91.98%), Mexico (91.20%), Brazil (90.95%) among emerging countries; and Bahrain (92.31%), Bulgaria (92.07%), and Croatia (91.89%) among the frontier countries, they have indicated high recipient (Fig. 4.37).
- Thus, this panel of crisis insights revealed a high volatility spillover among all the global stock markets in which the US and Mexico stock markets have acted as significant transmitters of the spillover. The above results are aligned with Kakran et al. (2023; 2024), Pandey et al. (2023), and Nepal et al. (2023) revealed that COVID-19 impacted several stock markets.

- **Robustness during COVID-19**

To assess the robustness of our findings, we performed a sensitivity analysis on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Fig. 4.38 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

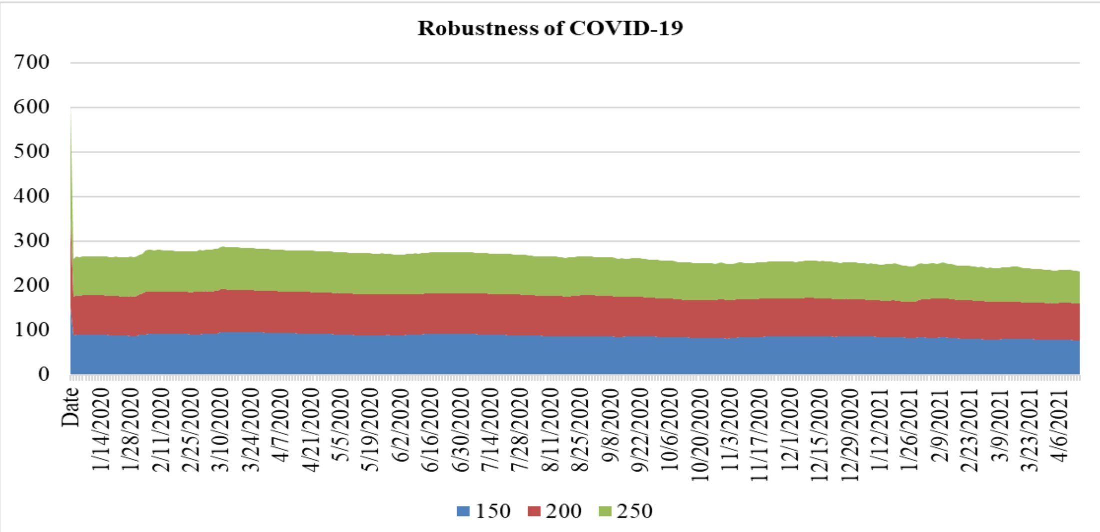


Fig. 4.38: During the robustness of COVID-19, interconnectedness among the developed, emerging, and frontier countries was observed using TVP-VAR on different windows.

Note: Red colours show robustness on window size 200, window size 150, and window size 250 (Source: Author's using R software).

Table 4.14.0: During COVID-19 using the TVP-VAR Model in the selected developed, emerging, and frontier countries

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**9.0**	1.8	3.2	2.7	3.4	2.3	5.1	3.0	3.4	3.5	3.4	2.0	3.8	2.2	3.5	5.7	4.4	2.7	6.0	4.2	1.7	1.6	2.1	2.7	2.8	1.6	3.4	2.8	3.7	2.6	91.0
JN	4.5	**13.7**	2.4	2.1	3.3	2.6	6.3	2.1	4.4	2.4	2.4	2.2	2.7	3.3	5.2	3.6	4.4	2.5	3.4	2.2	3.1	2.5	2.6	2.8	2.6	2.4	2.3	1.6	2.4	1.9	86.3
AA	6.3	1.7	**6.9**	2.7	3.6	2.5	4.8	3.7	2.9	4.2	3.4	2.4	3.5	1.8	2.4	4.5	3.4	2.3	5.3	4.7	2.2	1.5	1.8	3.8	2.8	1.5	4.3	3.1	3.5	2.4	93.2
HG	3.7	2.2	3.1	**12.7**	2.1	3.1	3.1	3.8	2.0	5.2	4.3	4.4	2.1	4.8	2.1	3.2	2.5	1.6	3.3	4.6	5.3	1.7	1.5	1.4	1.6	1.3	3.5	3.0	3.1	3.4	87.3
CAA	7.9	1.9	2.5	2.0	**12.4**	3.2	6.9	1.8	4.1	2.1	2.5	1.9	3.5	1.7	5.8	4.8	4.1	2.8	4.5	2.4	2.2	1.0	2.7	2.4	2.7	1.2	2.6	1.6	2.5	2.5	87.6
GY	5.5	1.4	2.6	2.6	2.8	**7.9**	5.6	3.0	4.2	3.7	3.3	3.1	4.2	2.3	3.7	4.1	3.4	2.1	5.2	4.2	2.0	1.3	2.5	2.2	3.0	1.3	3.5	2.9	3.6	2.8	92.1
SD	7.2	1.8	1.8	2.0	3.4	3.8	**13.7**	2.0	5.1	2.0	2.9	2.1	3.4	1.9	4.1	5.0	4.7	2.2	5.7	3.1	1.6	1.0	2.2	2.1	3.6	1.2	2.1	2.9	3.7	2.0	86.3
SN	4.7	1.5	3.5	2.8	3.4	4.5	4.9	**9.0**	3.8	4.3	2.7	2.9	2.9	2.2	3.2	3.8	3.0	1.8	4.3	4.4	2.2	1.9	2.2	2.4	2.9	2.0	4.5	2.5	3.4	2.4	91.0
RUS	5.0	1.5	2.0	2.3	2.6	3.5	5.8	2.3	**13.0**	2.2	3.5	1.8	3.9	2.5	6.3	3.2	4.9	2.8	4.6	2.3	1.8	2.1	2.6	2.9	2.7	2.3	2.8	1.7	2.7	2.3	87.0
SA	4.7	2.0	4.1	3.3	3.0	3.8	3.8	3.9	2.5	**7.9**	3.4	2.9	2.8	2.9	2.6	4.2	3.1	2.2	4.7	5.5	2.6	1.7	2.0	2.7	2.2	1.2	4.7	3.5	3.4	2.8	92.1
CA	3.8	2.1	2.1	6.5	1.7	2.8	2.6	3.4	3.1	4.2	**15.5**	3.6	2.7	2.8	1.6	2.7	3.5	1.6	4.4	4.3	3.7	1.6	1.7	1.6	2.1	1.3	3.0	3.1	4.0	2.9	84.5
IA	4.5	1.7	3.0	4.3	2.7	3.0	3.7	3.7	2.4	4.0	3.3	**8.0**	2.7	3.1	2.2	4.0	2.6	2.4	5.2	4.7	4.4	2.0	2.5	2.4	2.5	1.5	3.7	3.1	3.3	3.4	92.0
SAA	5.4	1.5	2.5	2.1	1.6	2.0	4.3	1.9	4.3	2.7	3.2	1.8	**12.9**	1.9	3.0	4.3	5.3	2.9	6.6	3.5	2.1	1.7	2.3	3.9	4.1	1.6	2.7	2.9	3.1	1.9	87.1
SK	2.4	4.0	2.7	6.8	2.1	3.4	2.6	3.5	1.6	4.4	3.5	4.3	1.6	**15.7**	3.9	2.0	2.5	2.9	2.4	3.2	4.9	2.3	2.1	1.4	1.6	1.4	3.4	2.0	2.4	3.1	84.3
SA	5.9	1.5	1.7	2.4	4.8	3.8	6.3	2.6	5.9	2.1	2.9	2.0	2.5	2.7	**15.3**	4.0	4.2	2.7	4.1	1.7	1.6	1.6	2.9	2.7	2.4	1.2	2.4	1.5	2.5	2.5	84.7
BL	6.8	1.9	3.6	3.4	2.8	2.2	4.4	3.7	2.6	4.0	3.8	2.3	3.3	2.1	2.6	**9.1**	5.1	3.0	5.8	4.1	2.0	2.0	1.6	2.7	1.6	1.4	3.8	2.8	2.9	2.6	91.0
TD	5.0	2.2	2.9	3.1	1.7	3.1	3.8	3.3	3.9	4.0	3.5	2.3	4.1	3.2	3.7	4.5	**9.3**	3.1	4.9	3.2	1.8	2.4	2.3	2.6	2.4	2.6	3.4	2.4	3.2	2.5	90.7
IA	5.1	2.4	2.7	2.1	3.1	2.1	3.4	1.7	3.3	2.8	2.5	1.6	4.9	2.8	4.7	4.8	5.2	**14.5**	5.6	2.9	2.1	1.4	3.1	3.6	2.4	1.3	2.3	1.9	2.0	1.9	85.5
MO	6.1	1.0	3.8	2.7	1.7	1.9	3.9	3.2	3.1	4.1	3.8	2.4	4.2	2.1	1.9	5.4	3.9	2.7	**8.8**	5.0	2.2	1.9	2.3	3.5	2.5	1.5	4.2	3.8	3.4	2.7	91.2
MA	5.0	0.9	4.5	3.2	2.1	3.1	3.1	4.4	1.9	5.7	3.5	3.0	2.8	1.9	1.1	4.1	3.0	1.6	5.1	**9.3**	2.8	1.3	1.7	3.1	2.7	1.5	6.0	4.6	4.3	3.1	90.7
VN	4.8	1.3	2.8	3.7	2.3	2.3	3.3	2.6	3.1	3.9	3.6	3.5	3.8	1.9	1.4	3.6	3.5	2.8	5.3	4.4	**13.7**	1.6	1.7	2.5	2.9	1.3	3.7	3.0	3.1	2.9	86.3
KA	3.7	1.5	3.7	3.2	1.6	2.5	2.7	4.2	2.7	3.9	3.5	2.4	3.0	3.4	2.4	3.7	2.7	2.6	4.8	3.9	2.6	**13.5**	3.1	3.2	1.9	2.3	4.1	2.3	2.4	2.5	86.6
RA	4.8	1.9	1.8	2.0	3.3	3.6	4.7	1.8	4.3	2.4	2.2	1.9	4.5	2.2	6.0	4.0	3.4	2.8	4.6	2.4	1.7	1.3	**15.3**	3.3	3.1	1.9	2.4	1.6	2.6	2.3	84.7
KN	4.2	2.3	4.7	2.7	2.7	2.5	2.8	3.6	2.1	3.9	3.0	1.9	3.2	4.1	2.0	3.6	2.9	2.3	4.5	4.5	3.2	1.7	2.3	**12.9**	2.5	2.1	3.7	3.9	2.6	1.9	87.1
BA	5.6	1.3	2.5	2.6	2.5	2.3	4.5	3.6	2.5	4.0	3.3	3.6	5.0	1.7	1.5	4.6	4.1	1.8	5.8	5.1	2.4	1.4	2.2	2.8	**7.9**	1.4	3.4	3.3	4.6	2.7	92.1
NA	3.4	1.9	3.9	2.5	1.5	2.9	2.6	4.1	3.8	3.5	2.8	2.1	3.1	2.1	1.6	3.2	3.0	1.8	4.1	3.8	2.3	2.9	2.1	3.1	2.7	**18.4**	3.2	2.3	2.9	2.4	81.6
CA	4.8	1.4	4.4	3.3	3.9	3.8	3.6	4.1	2.6	4.5	4.0	2.8	2.5	2.1	2.3	3.5	3.3	1.9	4.1	5.0	3.1	1.3	1.3	3.6	2.8	1.1	**8.1**	3.6	4.5	2.8	91.9
JON	4.3	2.2	3.4	3.3	2.0	3.0	3.4	3.2	2.1	5.0	3.1	3.1	2.8	2.7	1.8	3.7	3.0	1.9	4.5	5.4	5.0	1.5	2.0	2.8	2.7	1.6	4.2	**9.7**	4.2	2.8	90.3
MO	5.6	1.6	2.8	3.0	2.0	3.0	4.5	3.6	2.6	3.9	3.8	3.4	3.2	1.9	1.6	5.0	4.6	2.0	5.0	4.5	2.6	1.7	1.8	2.1	3.1	1.4	4.0	3.6	**9.2**	3.0	90.8
BH	4.8	1.4	3.3	3.4	1.8	2.9	3.3	3.3	2.3	4.1	3.6	3.4	3.7	2.8	2.3	4.6	3.8	2.8	6.0	4.8	2.4	2.1	1.9	3.0	2.7	1.3	4.1	3.1	3.6	**7.7**	92.3
TO	145.4	51.6	88.2	88.9	75.4	85.3	119.8	91.0	92.5	107.0	94.8	77.3	96.2	72.9	86.5	117.5	107.2	68.3	139.9	113.9	77.5	49.8	63.0	79.0	75.0	45.6	101.3	80.2	93.5	74.9	2659.0
Inc.Own	154.4	65.3	95.0	101.6	87.7	93.2	133.5	100.1	105.5	114.9	110.3	85.3	109.1	88.6	101.8	126.5	116.5	82.8	148.7	123.2	91.2	63.2	78.3	91.9	83.0	64.0	109.4	89.9	102.7	82.6	
NET	54.4	-34.7	-5.0	1.6	-12.3	-6.8	33.5	0.1	5.5	14.9	10.3	-14.7	9.1	-11.5	1.8	26.5	16.5	-17.2	48.7	23.2	-8.8	-36.8	-21.7	-8.1	-17.1	-36.0	9.4	-10.1	2.7	-17.4	**88.6**

➢ **Frequency Dynamic using the TVP-VAR-TVP-VAR-BK Model**

During the Chinese crash on analyzing the selected period on the different Frequencies (Short term (1–5 days) (Panel-A), Long term (5-Inf.) (Panel B), and entire period (Panel C)) using Barunik-Krehlik (TVP-VAR-BK) (Fig. 4.39) indicated high interconnectedness among all the countries. On analyzing frequency dynamics, short shows although low impact (Table 4.15.0 (35.73%)), as compared to the medium (Table 4.15.1 (52.22%)), and the entire period (Table 4.15.2 (87.95%)).

Moreover, Fig. 4.40 also indicated different dynamics of the volatility spillover among all the selected stock markets. It clearly shows high interconnectedness among the developed, emerging, and frontier countries in both entire and short periods.

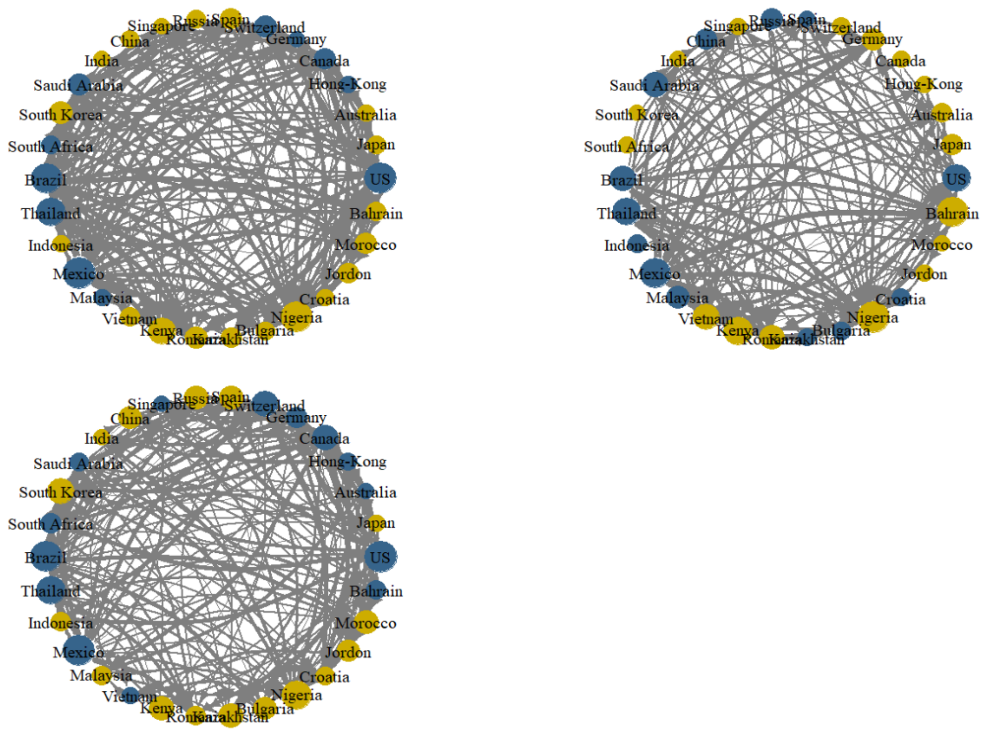


Fig. 4.39: During COVID, interconnectedness on the different frequencies among the developed, emerging, and frontier countries using the TVP-VAR-BK Model.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Table 4.15.0: During COVID-19, interconnectedness in the short period (1-4 Days) among the developed, emerging, and frontier countries using TVP-VAR models.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**5.1**	0.9	0.8	0.9	0.9	0.3	1.9	1.6	2.2	0.9	2.0	1.2	2.4	0.3	1.0	4.0	3.7	1.6	4.3	2.0	0.7	0.5	0.9	1.1	2.1	0.1	0.8	1.5	1.5	0.4	42.5
JN	1.4	**5.3**	0.6	0.7	0.9	1.4	0.6	0.6	0.8	0.9	0.7	1.1	1.5	0.5	0.4	1.5	1.5	0.7	1.6	0.9	0.5	0.6	0.8	1.0	1.0	0.1	0.5	0.6	0.5	0.9	24.8
AA	2.1	0.4	2.9	1.4	1.0	1.1	0.7	1.6	1.3	2.0	1.9	1.7	1.7	0.7	0.3	1.7	2.2	0.8	3.0	2.3	1.2	0.8	0.5	1.7	1.8	0.1	1.5	1.6	1.5	0.3	38.5
HG	1.6	0.4	1.6	**4.2**	0.6	1.4	0.3	1.4	0.9	2.8	1.7	2.4	0.7	1.1	0.2	1.4	1.8	0.4	2.1	2.8	1.8	0.5	0.5	0.6	1.3	0.1	1.4	1.6	1.8	0.9	36.0
CAA	1.2	0.6	1.0	0.8	**2.3**	1.3	0.9	0.6	0.7	1.3	0.8	1.1	0.8	0.3	0.5	1.1	1.1	0.6	1.4	0.9	0.6	0.2	0.8	0.6	0.9	0.0	0.7	0.6	0.5	0.4	22.3
GY	2.2	0.8	1.1	1.6	1.2	**3.3**	0.9	1.7	1.5	2.2	1.6	2.5	1.7	0.3	0.5	2.0	2.3	1.1	3.5	2.3	1.3	0.7	1.0	1.2	2.1	0.1	1.0	1.3	1.2	0.7	41.5
SD	2.3	0.6	0.5	0.5	1.1	1.0	**2.9**	0.8	1.7	0.7	1.0	1.0	1.2	0.2	1.2	2.0	2.0	1.1	2.7	1.1	0.6	0.4	1.0	0.7	1.3	0.0	0.3	0.7	0.5	0.2	28.5
SN	2.7	0.6	1.0	1.1	1.0	1.3	1.0	**3.6**	1.5	1.5	1.9	1.7	2.0	0.3	0.4	2.5	2.4	1.0	3.4	2.1	1.0	0.5	1.0	1.2	1.9	0.2	0.7	1.2	1.2	0.4	38.6
RUS	2.3	0.4	0.6	0.6	0.2	0.4	1.1	1.0	**4.4**	0.7	1.3	1.2	1.6	0.2	1.3	2.0	2.4	1.2	3.5	1.3	0.8	0.5	1.0	1.1	1.6	0.0	0.6	0.9	0.8	0.3	30.8
SA	2.2	0.6	1.7	2.2	1.0	1.7	0.6	1.8	1.3	**3.4**	2.1	2.5	1.4	0.7	0.3	1.9	2.3	0.8	3.1	2.9	1.3	0.5	0.8	1.1	2.0	0.1	1.3	1.8	1.9	0.7	42.4
CA	2.6	0.3	1.1	1.2	0.2	0.6	0.6	1.6	1.4	1.5	**4.1**	1.6	1.9	0.6	0.3	2.0	2.6	0.6	3.2	1.9	0.8	0.4	0.4	1.0	2.0	0.1	1.0	1.3	1.9	0.3	34.7
IA	2.4	0.6	1.4	1.9	0.8	1.9	0.8	2.0	1.9	2.4	2.1	**4.2**	1.5	0.5	0.5	2.3	2.4	1.1	3.9	3.0	1.6	1.1	0.8	1.4	2.2	0.1	1.4	1.8	1.7	1.0	46.6
SAA	2.2	0.9	0.6	0.5	0.6	0.7	0.7	0.8	1.2	0.6	1.3	0.8	**4.5**	0.2	0.3	2.0	2.4	1.2	2.8	0.9	0.5	0.4	1.0	1.9	1.8	0.1	0.3	0.7	0.5	1.6	29.4
SK	0.5	0.3	0.8	1.0	0.4	0.5	0.2	0.5	0.3	1.0	0.6	0.7	0.4	**2.3**	0.4	0.4	0.6	0.3	0.6	0.8	0.4	0.2	0.4	0.3	0.5	0.0	0.5	0.4	0.7	0.2	13.7
SA	1.3	0.3	0.3	0.4	0.7	0.5	1.1	0.5	1.4	0.4	0.4	0.5	0.6	0.5	**2.3**	1.2	1.1	0.9	1.5	0.5	0.3	0.3	0.9	0.4	0.7	0.0	0.3	0.3	0.3	0.2	17.9
BL	4.0	0.8	1.0	1.1	0.7	0.4	1.4	1.7	1.8	1.0	1.9	1.3	2.1	0.5	0.7	**4.9**	3.7	1.7	4.3	2.2	1.0	0.7	0.6	1.3	1.9	0.1	0.8	1.4	1.4	0.3	41.5
TD	3.9	0.9	1.2	1.1	0.3	0.4	1.2	1.4	2.1	1.3	2.2	1.3	2.8	0.5	0.9	3.6	**5.2**	1.5	4.3	2.0	0.9	0.6	0.6	1.4	2.4	0.1	0.9	1.6	1.6	0.4	43.2
IA	2.0	0.4	0.2	0.3	0.6	0.5	0.9	0.6	1.5	0.3	0.7	0.7	1.6	0.3	1.0	2.0	2.0	**4.2**	2.8	0.8	0.5	0.5	0.9	0.9	1.3	0.1	0.2	0.5	0.3	0.4	24.5
MO	4.8	0.5	1.4	1.3	0.7	0.9	1.8	2.1	3.3	1.5	2.8	2.2	3.6	0.4	1.2	4.4	4.7	2.5	**7.3**	3.1	1.4	1.1	1.4	2.4	3.2	0.1	1.2	2.1	1.6	0.6	58.4
MA	2.6	0.3	1.1	1.9	0.5	1.4	0.8	2.3	1.5	2.2	2.0	2.5	1.1	0.5	0.3	2.3	2.3	1.0	3.6	**4.1**	1.6	0.6	0.4	1.0	1.6	0.2	1.6	2.2	1.9	0.7	41.8
VN	2.5	0.3	1.7	2.5	0.8	1.8	0.6	1.9	1.7	2.4	1.9	2.6	1.6	0.5	0.4	2.5	2.8	1.1	3.9	3.3	**4.9**	1.0	0.5	1.6	2.2	0.2	1.6	2.1	1.7	0.9	48.5
KA	1.7	0.6	2.4	1.3	0.8	1.1	0.6	1.5	1.7	1.2	1.2	1.7	1.3	0.7	0.5	2.0	2.0	1.1	3.5	2.4	2.0	**11.6**	0.7	2.9	1.7	0.2	1.8	1.0	0.9	0.8	41.0
RA	2.3	0.7	0.8	1.0	1.2	1.5	1.3	1.0	1.8	1.5	1.3	1.5	2.3	0.4	0.9	2.2	2.4	1.3	3.3	1.3	0.7	0.6	**3.9**	1.3	2.0	0.1	0.5	0.8	0.8	0.8	37.6
KN	1.9	0.3	1.4	0.6	0.3	0.7	0.6	1.3	1.0	0.9	1.4	0.9	2.3	0.3	0.3	1.7	2.1	1.1	2.9	1.6	0.8	0.7	0.6	**3.5**	1.5	0.1	0.8	1.2	0.8	0.3	30.3
BA	3.5	0.6	0.9	1.1	0.8	1.0	1.2	1.6	1.6	1.4	2.1	1.6	3.0	0.3	0.5	2.9	3.5	1.3	4.0	1.8	1.0	0.5	0.9	1.3	**4.5**	0.0	0.5	1.3	1.3	0.7	42.1
NA	1.9	0.4	1.1	0.9	0.7	0.7	0.7	1.9	1.1	1.0	1.2	1.3	1.3	0.4	0.4	2.1	1.9	1.1	2.6	1.7	1.2	0.8	0.7	1.2	1.3	**7.9**	0.8	1.0	1.0	0.4	32.9
CA	0.8	0.2	1.3	1.1	0.7	1.0	0.2	1.2	0.6	1.4	1.2	1.3	0.5	0.5	0.2	0.6	0.9	0.3	1.3	2.0	1.0	0.3	0.2	0.6	0.7	0.0	**2.2**	1.4	1.3	0.5	23.5
JON	2.3	0.3	1.3	1.6	0.4	1.1	0.8	1.7	1.2	2.2	2.0	1.9	1.3	0.4	0.3	2.0	2.4	0.7	3.1	3.2	1.2	0.4	0.4	1.0	1.5	0.1	1.5	**3.6**	2.0	0.6	38.7
MO	2.6	0.4	1.0	1.4	0.5	0.8	0.7	1.7	1.2	1.6	2.4	1.8	1.4	0.5	0.2	2.2	2.4	0.7	2.8	2.3	0.8	0.3	0.4	0.8	1.7	0.1	1.1	1.9	**3.0**	0.4	35.8
BH	2.2	0.9	0.9	1.9	1.1	2.0	0.8	1.4	1.5	1.9	1.4	2.5	2.6	0.3	0.5	2.2	2.2	1.3	3.3	2.4	1.6	0.9	1.1	1.2	1.8	0.1	1.2	1.5	1.4	**4.0**	44.0
TO	65.9	15.1	31.0	33.7	20.6	29.3	25.1	39.6	41.5	40.8	45.0	45.1	48.2	12.7	16.0	60.3	65.9	29.9	86.1	55.6	29.1	16.7	20.9	34.1	47.7	2.2	26.6	36.4	34.6	16.3	1071.9
Inc.Own	71.0	20.5	33.9	37.9	22.9	32.6	28.0	43.2	45.9	44.1	49.1	49.3	52.7	15.0	18.3	65.2	71.1	34.1	93.4	59.7	33.9	28.3	24.9	37.6	52.2	10.1	28.8	40.0	37.5	20.3	
NET	23.4	-9.7	-7.5	-2.4	-1.7	-12.2	-3.3	1.0	10.7	-1.6	10.2	-1.5	18.9	-1.0	-2.0	18.8	22.7	5.5	27.6	13.8	-19.4	-24.3	-16.7	3.7	5.6	-30.7	3.2	-2.3	-1.2	-27.7	**35.7**

Table 4.15.1: During COVID-19, interconnectedness in the medium period (4-Inf Days) among the developed, emerging, and frontier countries using TVP-VAR models.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**5.8**	1.8	1.3	1.8	2.7	1.7	3.6	1.1	1.3	1.2	1.4	1.2	1.7	0.9	3.6	3.4	3.7	1.8	3.1	1.3	0.6	0.2	0.9	0.7	1.4	0.2	1.3	0.8	1.0	1.3	46.6
JN	3.8	**9.0**	2.1	2.3	5.5	3.6	5.0	1.1	1.1	2.1	0.9	1.6	1.7	2.9	4.3	3.6	3.4	1.8	2.0	1.1	1.7	0.5	1.0	0.7	0.6	0.2	2.7	0.9	0.9	2.0	60.9
AA	4.1	1.6	**4.7**	1.8	5.2	2.1	4.5	1.0	1.0	1.8	0.9	1.4	1.4	1.1	3.5	3.3	2.4	2.2	2.7	1.2	1.0	0.2	1.7	0.8	0.7	0.1	2.5	1.0	1.2	1.5	53.9
HG	1.3	3.4	1.8	**8.8**	3.7	3.7	1.8	1.0	0.6	3.4	0.9	2.7	2.0	2.7	1.3	1.6	1.2	0.7	1.0	1.9	3.2	0.4	1.3	0.6	0.5	0.3	2.0	1.3	1.6	3.5	51.0
CAA	6.1	2.2	2.6	1.4	**8.7**	2.6	6.5	0.8	1.6	1.6	0.7	1.1	3.3	1.7	4.5	6.1	3.7	3.3	3.8	0.7	0.8	0.2	2.6	0.3	0.8	0.1	3.3	0.6	0.8	3.0	66.7
GY	4.0	1.9	1.0	1.2	3.0	**4.8**	3.9	0.8	1.9	1.1	1.0	1.0	3.9	0.9	2.8	3.8	2.9	1.6	2.9	0.8	0.7	0.4	2.2	0.8	1.1	0.1	1.6	0.6	0.6	2.2	50.4
SD	5.9	1.6	1.3	1.7	3.6	2.2	**9.1**	1.1	2.5	1.0	1.0	1.7	3.2	1.4	4.8	5.3	4.3	2.0	4.6	1.7	0.7	0.4	1.7	0.3	1.3	0.1	1.1	0.9	0.7	1.3	59.6
SN	2.9	1.7	1.6	1.8	3.9	4.5	3.6	**2.5**	1.6	2.1	0.8	1.3	2.8	1.1	2.8	3.1	2.4	1.9	2.5	1.3	1.1	0.3	2.4	0.6	0.8	0.4	2.4	0.8	1.0	1.9	55.3
RUS	4.4	1.9	1.4	1.7	2.5	1.8	4.5	1.0	**6.2**	1.2	1.1	1.7	2.1	1.3	6.9	4.1	4.2	2.1	3.8	1.3	0.9	0.5	1.9	0.8	1.2	0.2	1.5	0.9	0.8	1.2	58.6
SA	2.5	2.2	2.0	2.0	4.8	3.3	3.5	0.8	0.8	**4.1**	0.6	1.3	1.5	1.8	2.8	2.9	1.7	1.6	1.7	1.2	1.3	0.3	2.0	0.3	0.4	0.1	2.5	1.0	1.1	2.3	50.2
CA	1.7	2.6	1.5	4.3	2.5	1.8	0.6	1.7	1.0	2.9	**11.9**	2.3	1.6	1.4	0.6	1.2	2.6	0.6	2.1	2.1	1.7	0.4	1.1	1.2	1.4	0.2	1.0	2.0	3.3	1.7	49.2
IA	1.3	2.9	1.4	3.8	3.8	3.7	1.7	0.8	0.5	2.3	0.6	**4.7**	1.5	2.1	1.2	1.8	0.8	1.1	0.9	1.2	2.2	0.4	1.5	0.4	0.4	0.2	1.9	0.7	1.4	2.4	44.6
SAA	4.4	2.1	1.2	1.2	1.2	1.4	2.0	1.2	1.5	1.1	1.8	1.0	**10.8**	0.7	1.7	4.9	5.8	2.0	4.4	1.5	0.9	0.4	1.2	2.2	3.1	0.2	0.9	1.2	1.0	3.2	55.4
SK	3.1	3.9	2.8	3.9	5.0	2.8	4.9	1.3	1.1	3.3	1.4	1.7	2.0	**13.7**	5.3	3.5	3.1	3.5	2.8	1.4	2.8	0.6	1.7	0.7	0.8	0.4	2.4	1.1	1.3	1.8	70.4
SA	6.7	1.7	1.9	1.4	4.6	2.0	7.4	1.1	3.6	1.1	1.4	1.2	2.1	2.0	**12.7**	5.8	4.9	2.8	4.2	1.2	0.6	0.4	2.0	0.7	1.4	0.2	2.0	0.7	0.8	1.4	67.0
BL	4.1	2.1	1.7	1.3	4.2	2.0	4.0	0.9	1.2	1.4	0.6	1.0	2.2	1.3	3.2	**5.7**	3.2	2.1	2.6	0.8	0.5	0.2	1.3	0.4	0.6	0.3	2.1	0.6	0.6	1.5	47.9
TD	3.4	1.8	1.3	1.8	1.6	1.8	2.6	1.2	1.4	1.5	1.3	1.4	1.8	1.2	3.3	2.9	**5.8**	1.8	2.8	1.4	0.8	0.4	0.7	0.9	1.5	0.4	1.8	1.1	1.4	1.0	45.9
IA	5.2	1.5	2.6	1.1	4.8	1.1	5.2	0.7	1.9	1.2	0.8	1.0	1.3	2.8	7.4	4.9	3.7	**10.2**	4.0	0.9	1.0	0.5	2.0	0.6	0.9	0.2	1.7	0.8	0.6	0.9	61.1
MO	2.4	0.8	0.9	1.1	1.0	1.2	1.4	0.8	1.1	1.1	0.9	1.3	1.3	0.6	1.5	2.2	2.4	1.1	**3.2**	1.3	0.8	0.4	0.5	0.8	1.2	0.1	0.7	1.0	0.9	0.6	31.0
MA	1.3	0.8	4.0	2.4	4.0	2.3	1.8	1.3	0.6	3.5	0.8	1.6	0.9	1.0	1.1	1.2	1.3	0.9	1.3	**4.7**	2.4	0.6	0.9	2.4	0.7	0.2	4.1	2.3	2.1	1.8	49.4
VN	1.6	1.0	1.2	2.8	1.8	1.7	1.4	0.6	0.3	1.1	0.8	1.5	2.0	1.3	0.7	1.5	1.6	1.3	1.3	1.2	**10.5**	0.4	0.8	0.9	0.9	0.5	2.2	0.7	0.8	2.5	36.2
KA	1.9	1.4	1.4	1.5	1.3	1.6	1.6	0.9	0.9	1.1	0.5	2.0	1.4	0.9	1.7	2.6	2.2	0.8	2.7	1.4	1.4	**9.0**	1.2	1.3	0.7	0.2	1.4	0.6	0.7	1.3	38.4
RA	4.5	1.5	0.8	1.3	2.0	1.6	3.4	0.9	2.4	1.0	1.0	1.2	3.5	0.8	4.4	4.2	3.7	2.3	4.0	1.0	0.5	0.6	**6.0**	0.8	1.5	0.1	1.5	0.5	0.6	1.2	52.5
KN	1.3	4.2	3.5	2.2	2.3	1.8	1.2	1.2	0.7	1.7	1.0	1.9	2.2	2.4	1.5	1.2	1.9	0.9	1.8	1.8	2.7	1.9	0.8	**14.6**	1.5	0.6	2.3	2.7	1.5	1.2	51.6
BA	3.4	1.4	0.9	1.7	2.0	1.8	2.5	1.5	1.0	1.5	1.1	1.7	4.3	0.7	1.4	3.9	3.9	2.0	3.4	1.5	1.0	0.2	1.8	0.8	**2.0**	0.1	1.3	0.7	1.1	2.8	51.5
NA	1.7	1.4	1.6	2.4	0.9	2.6	0.8	2.4	0.5	2.1	1.3	2.8	2.7	0.9	0.7	1.8	1.6	0.8	1.8	2.1	2.7	1.1	0.6	1.4	1.3	**13.1**	1.0	1.4	1.5	2.4	46.0
CA	3.7	1.9	4.0	2.2	6.6	3.0	4.5	1.2	0.9	2.7	1.0	1.9	1.3	1.1	3.8	3.8	2.9	2.7	2.2	2.0	2.1	0.6	1.5	2.0	0.8	0.2	**7.4**	1.6	2.2	2.5	67.0
JON	1.5	2.0	3.0	2.5	2.2	2.4	1.7	1.3	0.6	2.3	1.0	1.8	0.8	1.2	1.4	1.3	1.4	0.7	1.4	2.2	2.9	0.3	1.2	2.3	1.1	0.2	2.9	**9.5**	2.9	1.8	48.2
MO	3.5	1.4	2.3	1.7	3.7	2.2	3.7	1.2	0.9	1.7	1.0	1.5	2.7	0.9	2.3	4.2	3.4	2.2	2.7	1.5	0.9	0.3	1.8	0.6	1.1	0.1	3.4	1.3	**4.6**	2.7	56.7
BH	2.2	2.0	1.3	1.3	3.0	1.2	1.5	0.5	0.6	1.0	0.7	0.8	5.2	1.2	1.5	3.3	2.7	2.0	2.0	0.5	0.7	0.2	1.7	1.0	1.4	0.1	2.6	0.5	0.9	**8.5**	43.5
TO	93.7	56.6	54.2	57.6	93.4	65.3	90.7	31.2	35.1	50.8	28.2	44.2	64.1	40.4	81.5	93.2	82.9	50.7	76.3	39.4	40.6	13.2	41.9	27.1	31.0	6.0	57.9	30.0	34.8	54.7	1566.6
Inc.Own	99.5	65.6	58.9	66.4	102.1	70.1	99.8	33.7	41.2	54.9	40.1	48.8	74.9	54.0	94.2	98.9	88.7	60.9	79.6	44.1	51.1	22.2	47.8	41.7	33.0	19.1	65.3	39.5	39.4	63.2	
NET	47.1	-4.3	0.3	6.6	26.7	14.9	31.1	-24.1	-23.5	0.6	-21.0	-0.4	8.7	-30.0	14.4	45.3	37.0	-10.4	45.3	-10.1	4.4	-25.2	-10.7	-24.5	-20.4	-40.0	-9.1	-18.2	-21.9	11.2	**52.2**

Table 4.15.2: During COVID, interconnectedness in the long period (Full Period) among the developed, emerging, and frontier countries using TVP-VAR-BK models.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**10.9**	2.7	2.1	2.7	3.6	2.0	5.5	2.7	3.5	2.1	3.4	2.4	4.1	1.2	4.6	7.4	7.4	3.4	7.4	3.3	1.3	0.7	1.7	1.8	3.5	0.2	2.0	2.4	2.5	1.7	89.1
JN	5.2	**14.3**	2.7	3.0	6.4	5.0	5.6	1.7	1.9	3.1	1.6	2.7	3.1	3.4	4.7	5.1	4.9	2.4	3.6	2.1	2.3	1.1	1.8	1.7	1.6	0.3	3.1	1.4	1.4	2.9	85.7
AA	6.1	1.9	**7.6**	3.2	6.2	3.2	5.2	2.6	2.2	3.8	2.8	3.1	3.1	1.8	3.8	5.0	4.6	3.0	5.7	3.4	2.2	1.0	2.3	2.5	2.5	0.2	4.0	2.6	2.6	1.9	92.4
HG	2.9	3.8	3.4	**13.0**	4.4	5.1	2.1	2.4	1.6	6.2	2.5	5.0	2.7	3.8	1.4	3.0	3.0	1.1	3.1	4.7	5.0	0.9	1.7	1.2	1.7	0.3	3.4	2.9	3.4	4.4	87.0
CAA	7.2	2.8	3.6	2.2	**11.0**	3.8	7.4	1.4	2.4	2.9	1.5	2.2	4.1	2.0	5.1	7.2	4.8	3.9	5.3	1.6	1.4	0.4	3.4	0.9	1.7	0.1	4.0	1.2	1.3	3.4	89.0
GY	6.2	2.7	2.1	2.7	4.2	**8.0**	4.8	2.5	3.4	3.3	2.7	3.5	5.5	1.2	3.3	5.8	5.2	2.8	6.4	3.1	2.0	1.1	3.2	2.0	3.1	0.2	2.6	1.8	1.9	2.9	92.0
SD	8.3	2.2	1.8	2.2	4.8	3.2	**12.0**	1.9	4.1	1.7	2.0	2.7	4.4	1.7	6.0	7.2	6.2	3.1	7.3	2.8	1.3	0.8	2.8	1.1	2.7	0.2	1.4	1.6	1.2	1.5	88.0
SN	5.6	2.3	2.5	2.9	4.9	5.8	4.6	**6.1**	3.1	3.6	2.6	3.0	4.8	1.4	3.2	5.6	4.8	2.9	5.9	3.4	2.1	0.8	3.3	1.8	2.8	0.6	3.2	2.0	2.3	2.4	93.9
RUS	6.7	2.3	2.0	2.3	2.7	2.3	5.6	2.0	**10.6**	1.8	2.4	2.9	3.7	1.5	8.2	6.0	6.6	3.3	7.3	2.6	1.7	1.0	2.9	1.8	2.8	0.2	2.1	1.7	1.5	1.6	89.4
SA	4.7	2.8	3.7	4.2	5.8	5.0	4.1	2.7	2.1	**7.4**	2.7	3.8	2.9	2.5	3.1	4.8	4.0	2.4	4.7	4.1	2.5	0.8	2.8	1.4	2.4	0.2	3.8	2.8	2.9	3.0	92.6
CA	4.3	2.9	2.6	5.5	2.7	2.4	1.2	3.3	2.5	4.3	**16.0**	3.9	3.6	2.0	0.9	3.2	5.2	1.2	5.2	4.0	2.5	0.8	1.5	2.2	3.4	0.3	2.0	3.4	5.3	1.9	84.0
IA	3.7	3.5	2.8	5.7	4.6	5.6	2.5	2.8	2.3	4.7	2.7	**8.9**	3.1	2.6	1.6	4.1	3.2	2.2	4.8	4.2	3.9	1.5	2.2	1.7	2.5	0.3	3.3	2.5	3.1	3.4	91.1
SAA	6.6	3.0	1.8	1.7	1.8	2.1	2.7	2.0	2.7	1.7	3.1	1.8	**15.2**	0.9	2.0	6.9	8.2	3.1	7.2	2.4	1.5	0.8	2.2	4.1	4.8	0.3	1.2	1.9	1.5	4.8	84.8
SK	3.5	4.2	3.7	4.9	5.4	3.3	5.1	1.8	1.4	4.3	2.0	2.3	2.5	**16.0**	5.7	3.9	3.7	3.8	3.4	2.2	3.2	0.8	2.1	1.0	1.3	0.4	2.9	1.5	2.0	2.0	84.0
SA	8.0	2.0	2.2	1.8	5.3	2.5	8.6	1.6	4.9	1.6	1.9	1.7	2.8	2.5	**15.0**	6.9	6.0	3.7	5.7	1.7	0.9	0.8	2.9	1.1	2.1	0.2	2.2	1.0	1.1	1.6	85.0
BL	8.1	2.9	2.6	2.3	5.0	2.3	5.3	2.6	3.0	2.4	2.5	2.2	4.3	1.7	3.9	**10.6**	6.9	3.8	6.9	3.0	1.5	0.9	1.9	1.6	2.5	0.4	3.0	2.0	2.0	1.8	89.4
TD	7.3	2.7	2.5	3.0	1.8	2.3	3.7	2.6	3.5	2.7	3.6	2.7	4.6	1.7	4.1	6.5	**11.0**	3.3	7.0	3.4	1.7	1.0	1.3	2.2	3.8	0.4	2.7	2.7	3.0	1.3	89.0
IA	7.1	1.9	2.8	1.4	5.4	1.6	6.1	1.3	3.4	1.5	1.5	1.7	2.9	3.1	8.4	6.8	5.7	**14.4**	6.8	1.7	1.5	1.0	2.8	1.6	2.2	0.2	1.9	1.2	0.9	1.3	85.6
MO	7.2	1.4	2.3	2.4	1.6	2.1	3.2	2.9	4.5	2.6	3.7	3.5	4.8	1.0	2.6	6.6	7.0	3.7	**10.5**	4.4	2.3	1.4	1.9	3.2	4.3	0.3	1.9	3.1	2.5	1.2	89.5
MA	3.8	1.0	5.1	4.3	4.5	3.6	2.6	3.6	2.0	5.7	2.8	4.1	2.0	1.4	1.4	3.5	3.6	1.9	4.9	**8.8**	4.0	1.2	1.3	3.5	2.3	0.4	5.7	4.5	4.0	2.5	91.2
VN	4.1	1.3	2.9	5.3	2.6	3.4	2.1	2.4	2.0	3.5	2.7	4.1	3.6	1.8	1.0	4.0	4.4	2.5	5.1	4.4	**15.4**	1.4	1.3	2.5	3.2	0.7	3.8	2.8	2.5	3.3	84.6
KA	3.7	2.0	3.8	2.8	2.1	2.7	2.2	2.3	2.6	2.2	1.7	3.7	2.7	1.6	2.2	4.6	4.2	1.9	6.2	3.7	3.4	**20.6**	1.8	4.1	2.4	0.3	3.2	1.6	1.5	2.1	79.4
RA	6.8	2.2	1.6	2.3	3.2	3.1	4.7	1.9	4.3	2.5	2.3	2.7	5.7	1.2	5.3	6.4	6.1	3.6	7.3	2.3	1.2	1.2	**9.9**	2.1	3.5	0.2	2.0	1.3	1.4	2.0	90.1
KN	3.3	4.5	4.9	2.9	2.6	2.4	1.7	2.5	1.7	2.6	2.4	2.8	4.5	2.7	1.8	2.9	4.0	2.0	4.8	3.5	3.4	2.7	1.4	**18.1**	3.0	0.7	3.1	3.8	2.3	1.5	81.9
BA	6.9	2.0	1.9	2.7	2.8	2.8	3.7	3.0	2.6	2.8	3.2	3.3	7.3	1.0	1.9	6.8	7.4	3.3	7.5	3.3	2.0	0.7	2.7	2.2	**6.5**	0.2	1.8	2.0	2.4	3.4	93.6
NA	3.6	1.8	2.8	3.4	1.6	3.3	1.6	4.2	1.6	3.1	2.5	4.1	4.0	1.3	1.1	3.9	3.5	1.9	4.4	3.8	3.9	1.9	1.3	2.6	2.6	**21.0**	1.8	2.4	2.4	2.8	79.0
CA	4.6	2.1	5.3	3.4	7.4	4.0	4.8	2.4	1.5	4.1	2.2	3.1	1.8	1.6	4.0	4.5	3.7	3.0	3.5	4.0	3.1	1.0	1.8	2.6	1.5	0.2	**9.6**	3.0	3.5	3.0	90.4
JON	3.8	2.3	4.3	4.1	2.6	3.4	2.5	3.0	1.8	4.4	3.0	3.7	2.0	1.6	1.7	3.3	3.8	1.4	4.5	5.4	4.1	0.6	1.6	3.4	2.6	0.2	4.4	**13.1**	4.9	2.4	86.9
MO	6.0	1.8	3.4	3.1	4.2	3.0	4.4	2.9	2.1	3.3	3.4	3.3	4.1	1.4	2.5	6.4	5.7	2.8	5.5	3.8	1.8	0.6	2.2	1.4	2.8	0.1	4.5	3.2	**7.6**	3.1	92.4
BH	4.4	3.0	2.2	3.2	4.1	3.2	2.4	1.9	2.1	2.9	2.1	3.3	7.8	1.5	2.0	5.4	5.0	3.4	5.3	2.9	2.2	1.1	2.8	2.3	3.1	0.2	3.8	1.9	2.3	**12.5**	87.5
TO	159.6	71.7	85.2	91.3	113.9	94.7	115.8	70.8	76.6	91.5	73.2	89.2	112.3	53.0	97.4	153.5	148.8	80.6	162.4	95.0	69.7	29.9	62.8	61.2	78.7	8.2	84.5	66.4	69.4	71.0	2638.5
Inc.Own	170.5	86.0	92.9	104.3	125.0	102.7	127.8	76.9	87.2	99.0	89.2	98.1	127.6	69.0	112.5	164.1	159.8	95.1	172.9	103.8	85.0	50.5	72.7	79.3	85.2	29.3	94.1	79.5	76.9	83.5	
NET	70.5	-14.0	-7.2	4.3	25.0	2.7	27.8	-23.1	-12.9	-1.0	-10.8	-1.9	27.6	-31.0	12.5	64.1	59.8	-4.9	72.9	3.8	-15.0	-49.5	-27.4	-20.8	-14.8	-70.7	-5.9	-20.5	-23.1	-16.5	**88.0**

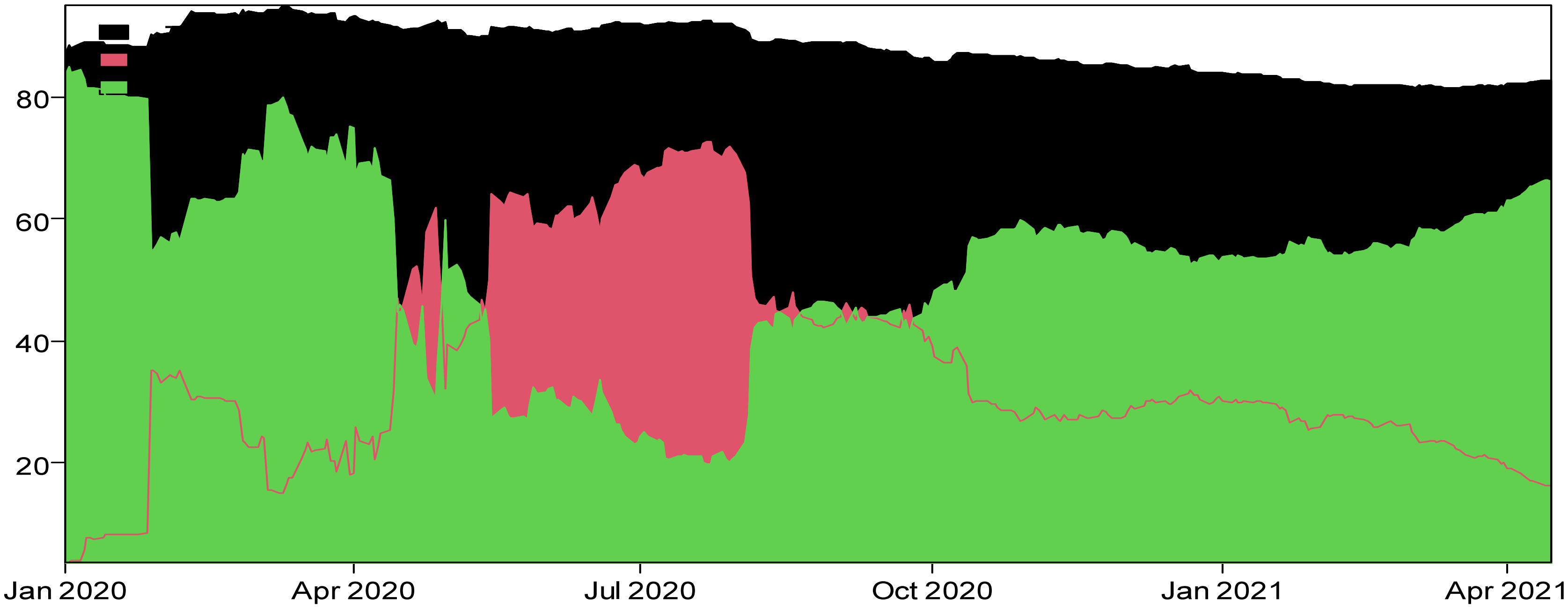


Fig. 4.40: During COVID, interconnectedness on the different frequencies among the developed, emerging, and frontier countries using the TVP-VAR-BK Model.

Note: Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf Days, Green colour), and total frequency (black colour) (Source: Author's using R software).

4.11 Results of the volatility spillover among the developed, emerging, and frontier countries during the Pre-Russia-Ukraine Crises.

The consequences of Russia's invasion of Ukraine are impacted severally to the rest of the world. As of now, the war has immediate effects on the international economy. Thus, to understand the dynamics among the selected stock markets, it becomes crucial to understand their behaviour. Fig. 4.41 also indicates high interconnectedness among all the selected stock markets. Table 4.16.0 demonstrates that volatility spillover occurred during this period among all the selected stock markets (91.62%). The colossal disturbance was also identified among all the selected stock markets due to the different waves and instability of the stock market.

Volatility spillover among the developed countries indicates Russia (54.4%), Germany (49.09%), and Spain (48.41%) as central net transmitters, Singapore (-53.90%), Hong Kong (-52.87%), Japan (-52.60%) identified as the significant net receiver.The Russian crisis impacted Russia as it is one of the world's major exporters of oil and gas in its primary dependence framework, thus being a significant spreader of volatility based on the changes in commodity prices during COVID-19. In Germany's case, being Europe's biggest market with considerable trade and industrial production, Germany's market dynamics drove the global volatilities. In the case of Spain (48.41%), our findings aligned, as Spain was still facing economic pressures given COVID-19's implications on its tourism-dependent economy, leading to financial misinformation and volatility spillover.Delayed or uneven policy measures in these countries led to uncertainty and impacted global investor sentiment.These countries were central in transmitting regional volatility internationally due to high international trade and investment linkages.

Among the emerging markets, Thailand (59%), Malaysia (52.44%), and India (25.79%) are the significant net transmitters; on the other side, Saudi Arabia (-63.15%), Indonesia (-58.53%), Brazil (-37.80%) were identified as the significant net receiver. Thailand's economy depends much on tourism, which has been severely hampered by the pandemic, leading to increased economic instability and stalling transmission.A large percentage of Thailand's GDP is derived from exports.

Disruptions to global supply chains further exacerbated economic uncertainty in the regional market.Malaysia's heavy reliance on oil and palm oil exports left its economy vulnerable to demand shocks by the rest of the world during COVID-19.A highly interlinked financial system amplifies spillovers from Malaysia to other markets. In the context of India as a recurrent driver of the global economy, India, a major emerging market economy, served as a transmitter. The domestic uncertainty indicated thatmarket volatility and spillovers were spurred by uncertainty surrounding domestic quarantines, healthcare provision and outcomes, and domestic policies during the pandemic. In the context of the ripples in the oil market, Saudi Arabia, as a significant oil producer, took much of the global volatility associated with oil prices. Saudi Arabia emerged as a net receiver as OPEC+ agreements and interventions stabilized markets.Its large fiscal reserves have enabled the kingdom to absorb external shocks.Indonesia is not the only country with more stable macro policies and capital inflows that have allowed it to absorb some of the volatility of other markets.However, its dependence on domestic consumption rather than exports cushioned the impact of external shocks.Given its agricultural and mining economy, Brazil was used to adjusting its economy around volatility in commodities pricing.Brazil, as one of the major economies in Latin America, absorbed external shocks by the depth and liquidity of its financial markets.

Among the frontier countries, Jordon (61.46%), Morocco (49.17%), and Bahrain (38.61%) were significant net transmitters, Kazakhstan (-68.48%), Bulgaria (-48.50%), Vietnam (-29.69) were identified as the significant net receiver of the volatility spillover (Fig. 4.42). The reason for substantial net transmitters is that the Jordanian economy depends on foreign aid, remittances, and services, all affected by the pandemic, leading to instability and volatility transmission. The mid-1980s witnessed widespread social discord linked to economic hardships. Jordan also felt the repercussions in a region marked by instability and growing economic interconnectedness that heightened the chances of economic spillovers to neighbouring countries.Morocco's dependency on exports such as phosphates and agricultural products led to vulnerability to global demand shocks, transmitting volatility.Like many nations, Morocco struggled to cope with the financial ramifications of the pandemic, with the tourism sector especially hit hard during these trying times.Zeeland (a city in southwestern Netherlands) and Munster (a town in northwestern Germany)Lubeck oil price sensitivity;oil price volatility during COVID-19 was passed through to Bahrain, which is highly oil revenue dependent,being a small, open economy very much exposed to global markets, shocks in Bahrain's financial sector transmitted to other regions.The energy sector in Kazakhstan, a leading oil producer, insulated itself from global volatility involving energy prices due to the government's stabilization efforts .Kazakhstan's comparatively less integrated financial markets provided a buffer against external volatility. In the context of EU stabilization, Bulgaria's integration into the EU came with an essential layer of "protection," as Bulgaria could absorb external volatility through EU financial and economic stabilization policies.Bulgaria's currency peg to the Euro helps ensure stability, fuelling a lower risk of volatility transmission. In the context of Vietnam, as it depends on manufacturing resilience and its role in global supply chains, Vietnam's manufacturing sector has remained largely intact, absorbing shocks from other countries.Vietnam acted as a volatility absorber due to its diversified economy, solid exports and effective management of the pandemic.

On analyzing "To Other" among developed countries, Russia (144.29%), Germany (141.88%), and Spain (140.98%) were top transmitters; among emerging countries, Thailand (151.81%), Malaysia (143.12%), India (118.67%), among frontier countries Jordon (159.99%), Morocco (139.76%), Bahrain (131.93%) were significant contributor (Fig. 4.42).

On identifying "From other" among developed countries Hong-Kong (95.81%), Japan (94.05%), and Switzerland (92.93%) were identified as the top receiver; among the emerging countries, South Africa (93.01%), India (92.87%), Thailand (92.82%) and the frontier countries Kazakhstan (96.01%), Bulgaria (94.41%), Bahrain (93.33%) were significant recipient.

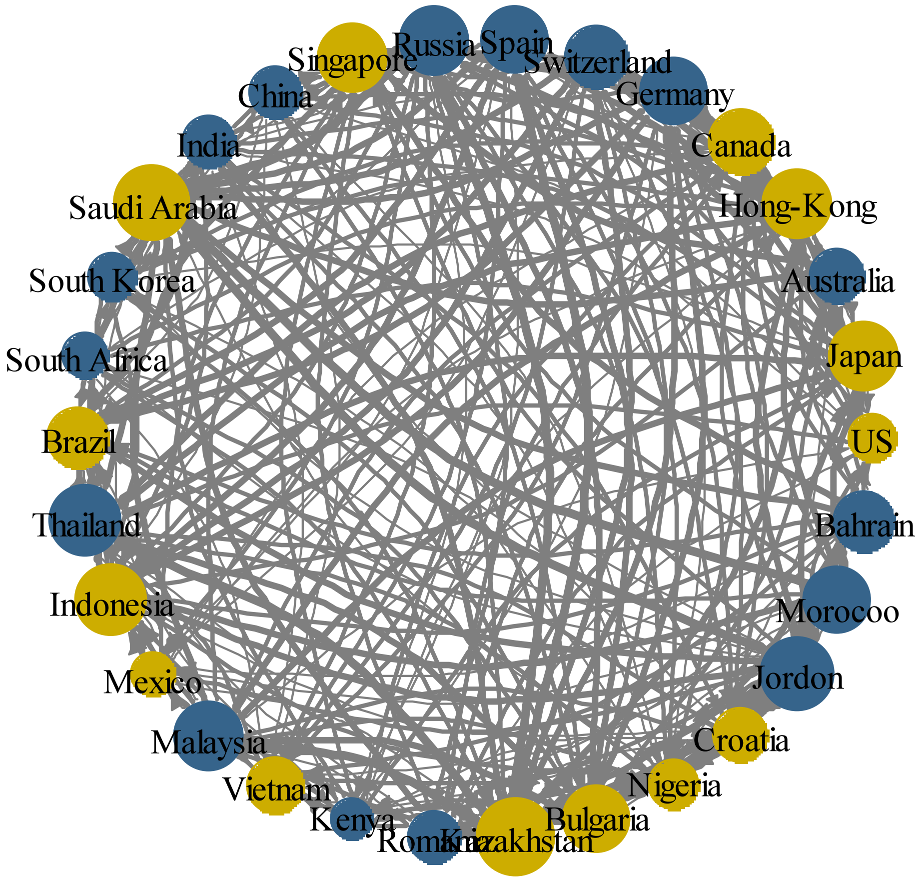
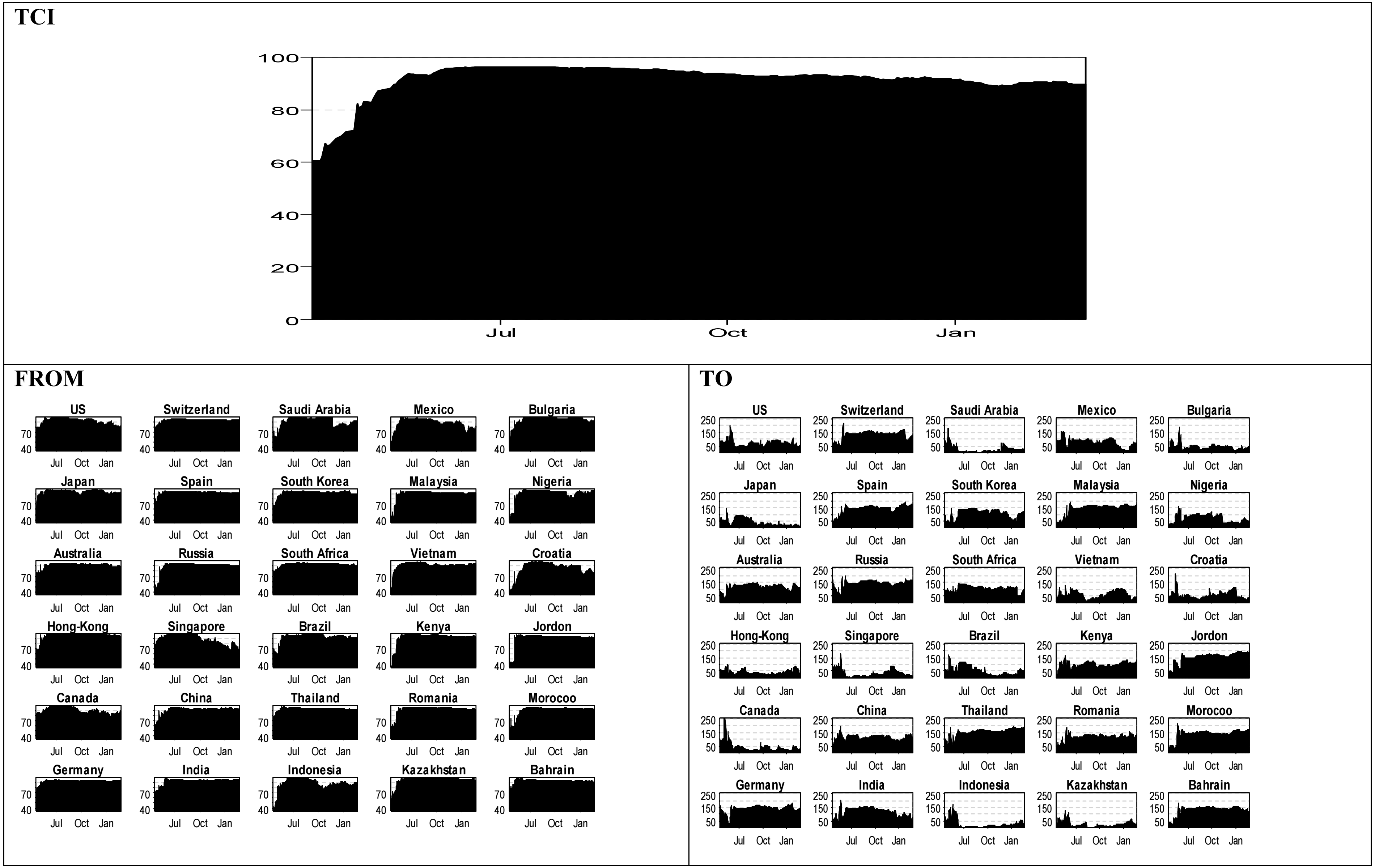


Fig. 4.41: During Pre-Russia-Ukraine Interconnectedness among the developed, emerging, and frontier countries using TVP-VAR-BK (2018). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this thesis).

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).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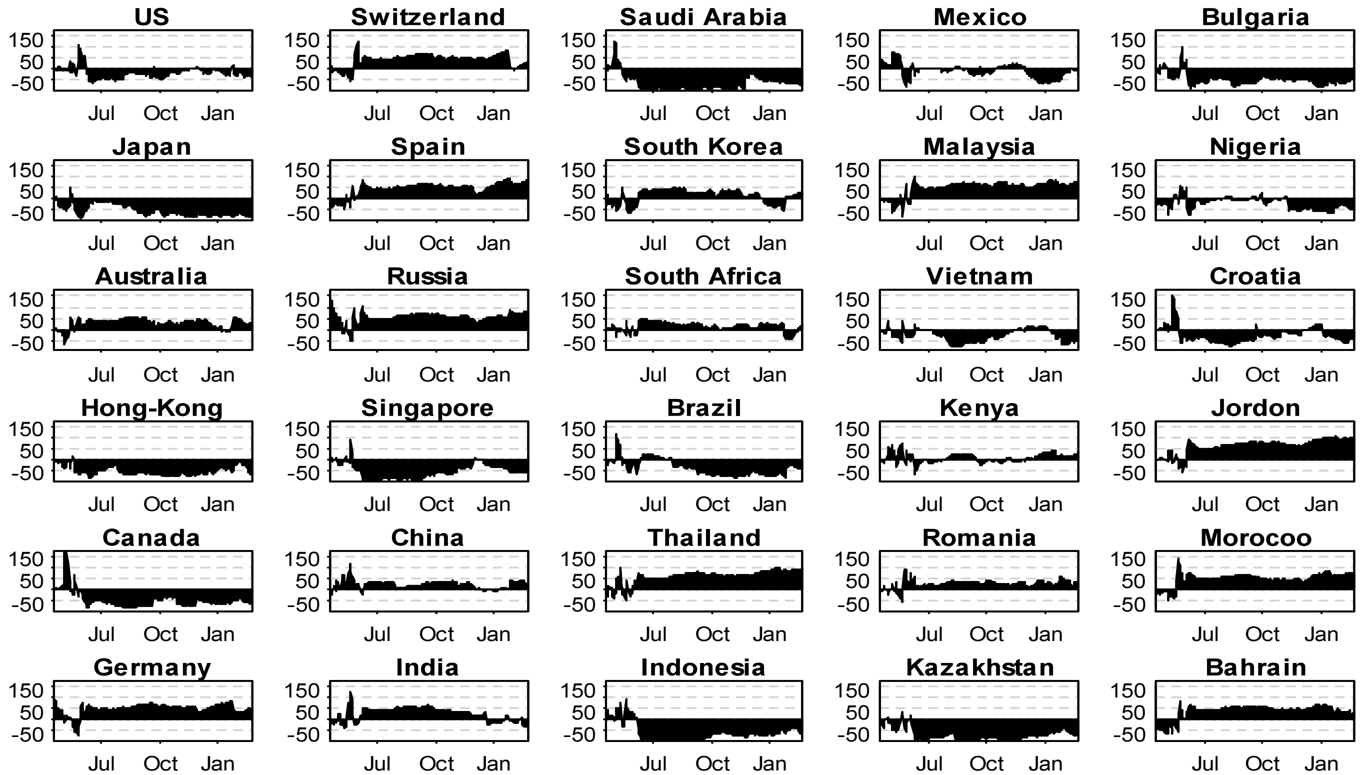


Fig. 4.42: During Pre-Russia-Ukraine, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models (Source: Using R software).

Table 4.16.0: During Pre-Russia-Ukraine, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models.

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**8.5**	1.5	4.7	1.4	3.6	4.6	4.0	4.5	4.5	1.4	3.6	3.7	0.8	3.3	3.5	1.8	4.6	1.6	3.7	4.6	2.2	2.8	4.0	1.2	1.6	2.5	2.8	4.7	4.5	3.9	91.5
JN	2.5	**6.0**	3.9	1.5	1.6	5.2	4.9	4.7	4.6	1.6	4.1	4.2	0.8	3.5	3.8	2.1	5.2	1.3	2.4	4.7	2.4	3.4	4.2	1.2	2.0	2.5	1.9	5.0	4.6	4.2	94.1
AA	3.1	1.6	**8.3**	1.3	2.0	5.1	4.7	4.8	5.0	1.1	3.6	3.8	0.6	3.7	3.6	2.4	5.2	0.9	2.9	4.9	2.2	3.2	4.3	0.8	1.4	2.4	3.2	5.1	4.7	4.6	91.7
HG	2.1	1.5	4.1	**4.2**	1.4	5.1	4.6	5.0	5.0	1.2	5.5	4.3	0.7	4.4	3.7	2.2	5.1	1.0	2.9	5.0	1.9	3.1	3.7	0.9	1.2	2.9	2.1	5.7	5.1	4.5	95.8
CAA	6.2	1.3	4.3	1.1	**9.7**	4.3	3.9	3.7	4.1	2.1	3.0	2.9	1.2	3.1	3.9	2.3	4.6	1.6	3.8	3.7	2.8	3.1	3.7	1.3	2.4	2.2	2.1	4.0	3.5	4.1	90.3
GY	2.7	1.1	4.0	1.3	1.9	**7.2**	5.9	5.5	5.1	1.0	4.2	4.2	0.7	3.4	4.7	1.6	5.5	0.8	2.7	5.1	2.1	3.5	4.1	0.7	1.6	2.3	1.9	5.4	5.1	4.8	92.8
SD	2.3	1.1	4.3	1.2	1.4	6.1	**7.1**	5.4	5.1	0.8	4.3	4.0	0.5	3.6	4.4	1.5	5.4	0.7	2.5	5.3	2.5	3.8	4.3	0.9	1.9	2.6	1.9	5.4	5.1	4.7	92.9
SN	2.6	1.3	4.0	1.5	1.6	5.9	5.2	**7.4**	5.3	1.1	3.8	4.6	1.1	3.2	3.8	1.6	5.6	0.8	2.8	5.2	2.3	3.6	4.4	0.6	1.7	2.1	1.8	5.3	4.8	4.9	92.6
RUS	2.3	1.2	4.4	1.5	0.8	4.9	4.8	5.1	**10.1**	0.7	3.9	4.1	0.9	3.9	3.5	1.6	5.6	0.9	2.4	5.4	1.7	3.7	4.9	0.7	1.3	2.4	1.7	5.7	5.1	4.8	89.9
SA	2.5	1.7	4.5	1.3	1.9	3.9	3.7	3.9	3.9	**11.6**	3.0	3.3	2.3	4.1	3.0	2.2	5.1	1.0	3.3	4.1	3.0	3.5	3.4	1.5	1.8	2.2	2.0	4.1	3.6	4.6	88.5
CA	2.2	1.2	3.4	3.0	2.2	5.3	4.7	4.8	4.4	1.3	**9.2**	3.8	0.9	3.7	4.0	1.6	4.8	1.4	2.4	4.8	2.1	3.0	3.6	1.1	1.6	2.4	2.5	5.3	5.0	4.3	90.8
IA	2.3	1.3	3.9	1.3	0.9	5.1	4.9	5.2	5.6	0.9	4.1	**7.1**	1.3	3.8	4.1	1.6	5.5	0.9	3.0	5.4	2.0	3.6	4.3	0.7	1.5	2.7	1.7	5.9	5.0	4.5	92.9
SAA	2.1	1.3	4.1	1.2	1.0	4.4	4.2	4.6	5.5	1.6	3.8	4.1	**9.5**	4.0	3.7	1.6	5.4	1.2	2.4	4.3	1.9	3.5	4.6	1.0	1.3	2.1	1.7	4.8	4.7	4.8	90.5
SK	2.3	2.2	4.5	1.5	0.9	4.7	4.6	4.7	5.1	1.1	4.2	3.9	1.7	**7.9**	3.3	2.1	5.3	0.8	2.7	5.5	1.7	3.5	3.6	0.7	1.4	2.8	2.2	5.8	4.8	4.5	92.1
SA	2.4	1.3	4.0	1.2	2.1	5.5	4.9	4.8	4.6	1.1	4.3	4.6	0.6	3.7	**7.0**	1.7	5.4	0.8	3.5	5.1	2.3	3.8	3.6	0.8	1.8	2.5	1.9	5.3	5.0	4.3	93.0
BL	2.3	1.8	3.6	2.0	1.4	5.3	4.9	5.1	4.6	1.4	3.6	5.2	0.7	3.1	3.7	**8.2**	5.0	1.3	2.7	4.3	2.1	3.4	3.4	1.2	1.5	2.4	1.6	5.2	4.7	4.6	91.8
TD	2.4	1.3	4.3	1.4	0.9	5.1	4.8	5.0	5.6	1.2	4.0	4.2	1.3	3.8	3.6	1.7	**7.2**	0.7	2.6	5.6	2.2	3.8	4.7	0.7	1.5	2.7	1.7	5.7	5.1	5.2	92.8
IA	2.6	1.8	3.7	1.5	2.2	4.0	3.9	4.3	4.0	1.6	3.4	3.9	1.6	3.3	2.7	2.4	4.1	**12.2**	2.9	4.0	2.0	2.7	3.2	1.6	1.6	3.0	2.8	4.5	4.5	4.1	87.8
MO	3.6	1.8	4.1	1.5	1.8	3.9	3.8	4.8	4.7	1.1	3.5	3.7	1.3	3.7	3.2	2.4	4.6	1.3	**12.0**	4.5	1.9	2.9	3.7	1.0	2.3	2.4	2.0	4.6	4.1	3.8	88.0
MA	2.5	1.5	4.6	1.6	1.0	4.9	4.6	5.2	5.0	1.1	4.0	4.3	0.8	4.2	3.5	1.8	5.5	0.7	2.9	**9.3**	1.8	3.4	3.8	0.9	1.3	2.6	1.3	6.1	5.2	4.7	90.7
VN	2.0	1.6	3.5	1.2	2.3	5.1	5.3	5.1	4.5	1.8	3.8	3.9	1.7	2.9	3.8	1.7	5.2	0.9	2.2	4.2	**8.1**	3.7	4.2	1.3	2.1	1.9	2.6	4.5	4.4	5.0	91.9
KA	2.4	1.2	4.3	1.4	0.9	5.0	4.9	5.2	5.2	1.0	3.9	4.0	0.6	3.9	3.5	1.8	5.7	0.7	2.5	5.6	2.1	**7.7**	4.5	0.8	1.4	2.6	1.5	5.7	5.0	5.0	92.3
RA	2.4	1.3	4.2	1.5	1.0	5.1	4.9	5.2	7.0	0.8	3.8	4.0	0.6	3.8	3.6	1.5	5.7	0.7	2.6	5.4	2.0	3.5	**7.9**	0.6	1.4	2.6	1.7	5.8	4.9	4.8	92.1
KN	2.2	1.5	4.2	1.5	1.0	4.8	4.7	5.3	5.8	1.0	4.0	4.6	0.7	3.8	3.4	1.6	5.5	0.9	2.5	5.4	2.5	3.4	4.2	**4.0**	1.5	2.5	1.8	6.0	5.1	4.8	96.0
BA	2.4	1.3	4.2	1.2	1.3	5.0	4.8	4.8	5.2	1.0	4.5	3.9	0.5	3.6	4.1	1.6	5.6	1.3	2.3	5.4	2.1	3.8	4.2	0.8	**5.6**	2.6	1.7	5.3	5.3	4.8	94.4
NA	2.2	1.5	4.2	1.7	1.2	4.6	4.4	4.7	4.9	1.0	4.0	4.1	0.6	4.4	3.2	1.7	5.2	0.9	2.5	5.2	1.8	3.7	4.1	0.9	1.4	**9.2**	2.2	5.5	4.7	4.3	90.8
CA	2.1	1.3	3.8	1.5	1.8	4.4	4.3	4.3	4.3	1.4	2.8	4.7	0.9	3.2	3.2	1.9	4.8	1.2	2.3	4.1	2.5	3.3	3.6	1.2	1.8	2.6	**13.6**	4.4	4.8	4.0	86.4
JON	2.2	1.4	4.1	1.6	1.0	4.8	4.6	4.8	5.1	1.1	4.1	4.4	0.4	4.2	3.6	2.0	5.6	0.8	2.5	6.0	1.7	3.5	3.9	0.8	1.4	2.8	1.8	**9.5**	5.7	4.6	90.5
MO	2.1	1.4	4.2	1.4	1.0	4.9	4.6	5.2	5.1	1.1	4.3	4.4	0.4	3.8	3.8	2.0	5.6	1.0	2.2	5.4	2.4	3.3	4.2	0.7	1.4	2.4	1.6	5.8	**9.4**	4.8	90.6
BH	2.2	1.2	3.9	1.5	1.3	5.1	4.8	5.1	5.8	1.1	4.1	3.9	1.5	3.9	3.6	2.2	5.7	1.1	2.3	5.1	2.1	3.6	5.3	0.9	1.2	2.3	2.0	5.3	5.4	**6.7**	93.3
TO	73.2	41.4	119.1	42.9	43.1	141.9	134.3	141.0	144.3	34.6	113.2	118.7	27.4	106.9	105.5	54.0	151.8	29.3	78.6	143.1	62.2	98.8	117.3	27.5	45.9	71.7	57.4	152.0	139.8	131.9	2748.7
Inc.Own	81.8	47.4	127.4	47.1	52.8	149.1	141.4	148.4	154.4	46.1	122.5	125.8	36.9	114.8	112.4	62.2	159.0	41.5	90.6	152.4	70.3	106.5	125.2	31.5	51.5	80.9	71.0	161.5	149.2	138.6	
NET	-18.2	-52.6	27.4	-52.9	-47.2	49.1	41.4	48.4	54.4	-53.9	22.5	25.8	-63.2	14.8	12.4	-37.8	59.0	-58.5	-9.4	52.4	-29.7	6.5	25.2	-68.5	-48.5	-19.1	-29.0	61.5	49.2	38.6	**91.6**

➢ **ROBUSTNESS –**

To assess the robustness of the findings of this study, sensitivity analysis was conducted on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 180, 200, and 220 days. Examining the spillover curves illustrated in Fig. 4.43 indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

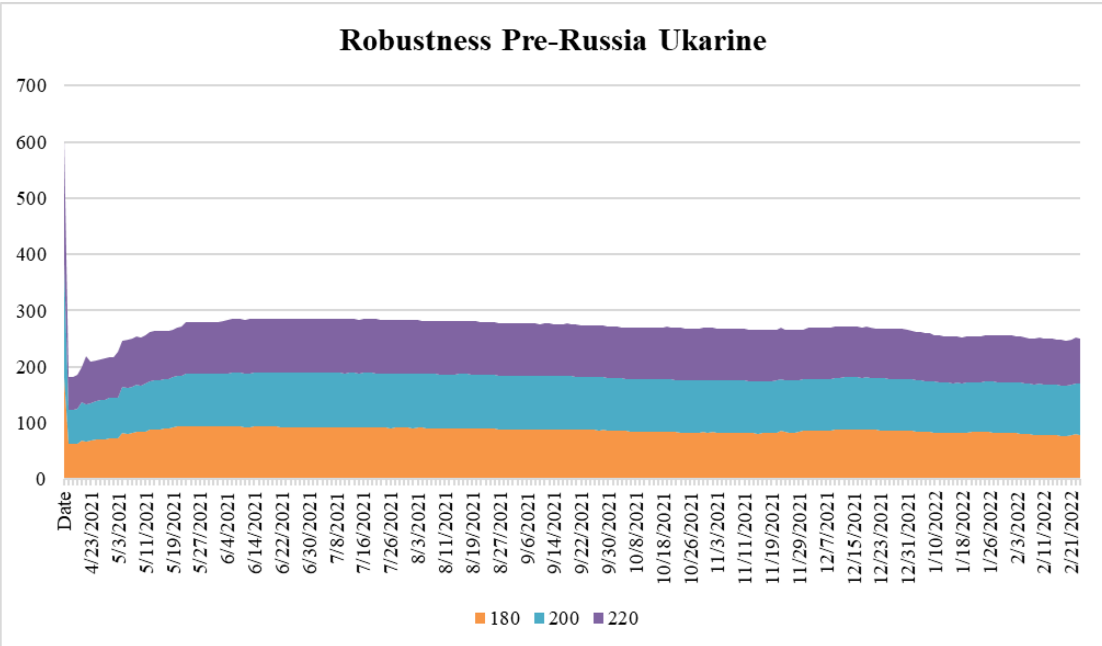


Fig. 4.43 Robustness during Pre-Russia-Ukraine crises (different window sizes, i.e. 180 (orange colour, short frequency), 200 (blue colour, short frequency), 220 (purple colour, long frequency)) among the developed, emerging, and frontier countries using TVP-VAR models. (Source: Author using R software).

4.12.0 Results of the volatility spillover among the developed, emerging, and frontier countries during the Russia-Ukraine Crises.

During the Russia-Ukraine crisis, a strong interconnectedness was identified among the developed, emerging and frontier countries (Fig. 4.44). As indicated, Germany, Britain, Switzerland, and Romania were primary transmitters, and Singapore, China, HongKong, and Australia weresignificant spillover receptors, with a total of 85.80%. On analyzing primary net volatility spillover transmitters, Germany (39.74%), Switzerland (29.52%), Japan (8.16%) among developed countries; India (31.89%), South Africa (30.66%), Thailand (22.24%) among emerging countries; Bahrain (33.65%), Romania (31.82%), Croatia (20.25%) among frontier countries.As the largest economy in Europe, Germany’s financial and trade linkages with Russia and Ukraine (e.g., energy dependency on Russia and supply chain disruptions) might have increased the market volatility.The policies of the European Central Bank and Germany's role in European Union sanctions against Russia probably influenced spillovers.As a world leader in wealth management and financial stability, Switzerland's financial institutions experienced volatility due to changes in risk perception and their relationships with the world's commodity markets (i.e., energy and gold).Bahrain is a major oil producer in the Gulf, and its spillovers could be related to energy price volatility, as oil markets are sensitive to geopolitical crises.Romania’s geographic position close to Ukraine and its economic and financial vulnerability exacerbated stress in its financial markets.

On the other hand, Germany, Switzerland, and Japan revealedthat these nations' mature financial systems and networks often set benchmarks for global markets. Their volatility can create ripples around the world during crises.Japan indicated its currency (the yen) is a haven due to geopolitical ambiguity.India, South Africa and Thailand;while the emerging developing markets have often been on the receiving end of volatility, they may even pass on shocks because of their increasing weight in global markets.India and South Africa are large commodity consumers and producers; therefore, they are sensitive to price swings in international energy and metals.Thailand is heavily reliant on exports, which makes it more vulnerable to trade disruptions like those caused by geopolitical crises.

On the other hand, Bahrain, Romania, and Croatia, where the frontier markets tend to be less liquid, mean significant swings in investor sentiment can result in pronounced volatility.They were leading transmitters because of their regional proximity to the crisis zone (e.g., Romania and Croatia) or heavy dependence on particular sectors (e.g., oil in Bahrain).The future of energy markets (oil, gas, coal) , generators, and receptors (to) markets were struggling due to issues over Russia and Ukraine. Price volatility upset major energy importers and exporters, which fed through to broader financial markets.In particular, the crisis precipitates a spike in risk-aversive behaviour across local currencies and fixed-income asset classes, prompting capital outflows from emerging and frontier markets and reallocations to perceived safe havens in Switzerland and Japan.These changes magnified volatility spillovers as financial systems around the world reacted to changes in risk sentiment.

During this crisis, Australia (-39.80%), Singapore (-35.65%), and HongKong (-27.31%) among developed countries; China (-36.45%), Saudi Arabia (-27.49%), Indonesia (-5.47%) among emerging countries; Kenya (-21.74%), Bulgaria (-19.39%), and Kazakhstan (-11.06%) among frontier countries were identified as the significant net receptor of the volatility spillover.Australia heavily relies on the sales of commodities (most notably iron ore, coal, and natural gas), whose prices fluctuated sharply with the crisis.Using disruptions in energy supply chains as a guide, there were also substantial market adjustments.Geopolitical tensions contributed to a global trend towards risk aversion, adding to Australian equities' outflows.Being one of the leadinginternational financial hubs, Singapore is highly vulnerable to global capital flows.Rising uncertainty created risk-off sentiment among investors, casting a more negative outlook on foreign investment-dependent markets.The Russia-Ukraine crisis and economic issues in China pressured the Hong Kong market.

In Asian markets, global investors recalibrated risks, causing capital to fly out of Hong Kong's stocks.China’s reliance on trade and energy rendered it susceptible to the array of global supply chain disruptions triggered by the war.Rising tensions with Western economies about its neutral stance in the crisis weighed on investors, too; lockdowns in that period curtailed economic activity and investor sentiment.While Saudi Arabia is a net oil exporter, it also faced volatility driven by changing oil prices and global uncertainty.Higher crude prices didn’t incentivise stock market investments due to investors’ risk aversion.Indonesia’s heavy dependence on energy and commodity exports exposed its economy to fluctuations in global demand.Due to diversified export markets, the country experienced lower-than-normal volatility as the spillover effect was buffered.Kenya’s reliance on imported food and fuel, mainly from Russia and Ukraine, triggered economic shocks.These, together with inflationary pressures and diminished investor enthusiasm for frontier markets, made stock markets even more volatile.Despite its geographical position as a European frontier market, Bulgaria risked not only several proximity effects concerning the conflict but economic and geopolitical implications as well.Dependence on Russian gas increased the market's exposure to volatility spillovers.Kazakhstan’s proximity and trade relations with Russia made it vulnerable to the indirect effects of sanctions and investor jitters.On analyzing “To other” Germany (130.73%), Switzerland (119.42%), Japan (98.49%) among developed countries; India (6.57%), Thailand (5.5%), South Africa (5.38%) among emerging countries; Bahrain (125.09%), Romania (123.48%), Croatia (111.06%) among frontier countries were major transmitters (Fig. 4.45) (Table 4.17.0).On analyzing “From other”, Spain (92.49%), Germany (90.99%), Japan (90.33%) among developed countries; India (91.77%), South Africa (90.82%), South Korea (90.99%) among emerging countries; Bulgaria (92.02%), Romania (91.66%), Bahrain (91.45%) among frontier countries were major receptor (Fig. 4.45) (Table 4.17.0).

Thus, this panel of crisis insights revealed high volatility spillover among all the global stock markets, with the US and Mexico stock markets being the primary spillover transmitters. The above results are aligned with Kakran et al. (2023; 2024), Pandey et al. (2023), and Nepal et al. (2023) revealed that Russia-Ukraine impacted severally stock markets.

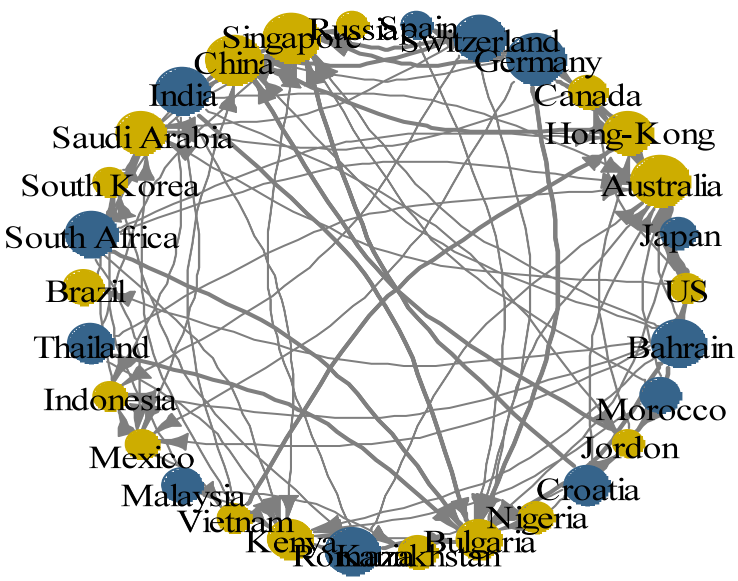
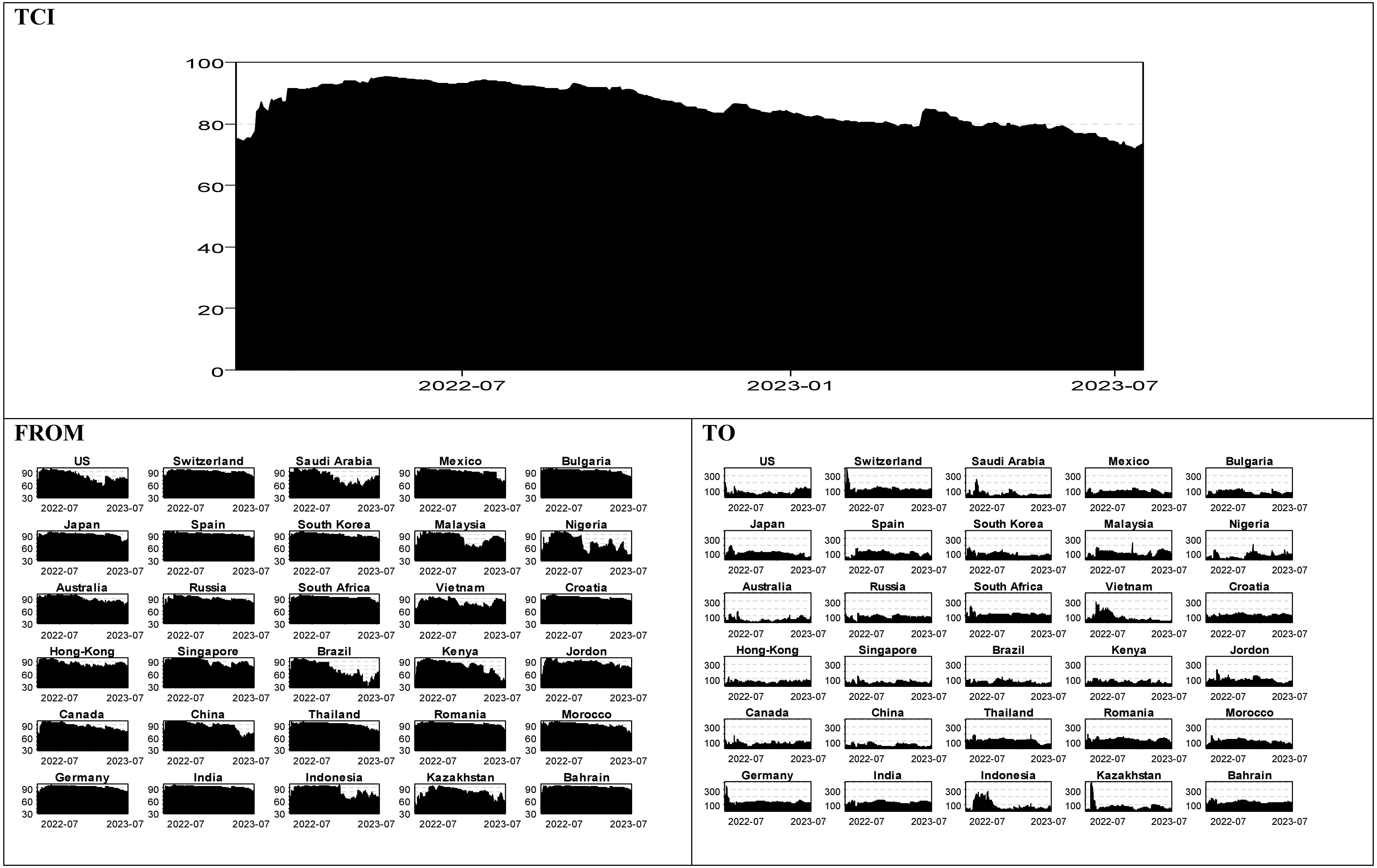


Fig. 4.44: During Russia-Ukraine, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR-BK models.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).



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Vietnam
Croatia
Hong-Kong
Singapore
Brazil
Kenya
Jordon
Canada
China
Thailand
Romania
Morocco
Germany
India
Indonesia
Kazakhstan
Bahrain
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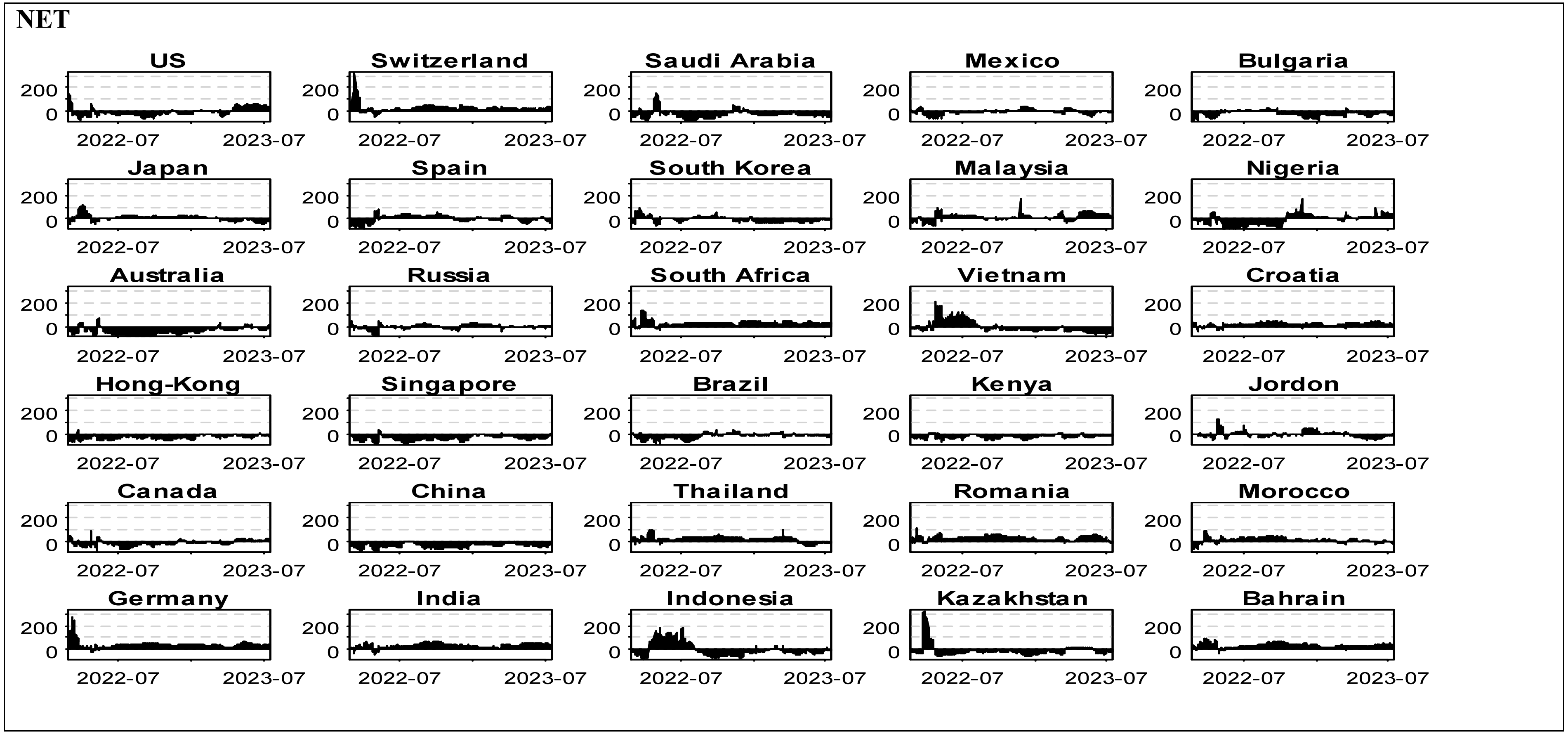


Fig. 4.45: During Russia-Ukraine, interconnectedness among the developed, emerging, and frontier countries using TVP-VAR models.

➢ Robustness

To assess the robustness of the findings of this study, sensitivity analysiswas conducted on the spillover effect by employing different window sizes. This study used a 200-day rolling window size as the benchmark. Additionally, three rolling window widths based on technique were utilized: 150, 200, and 250 days. Examining the spillover curves illustrated in Fig. 4.46. indicates that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that window length has minimal impact on the conclusions drawn in this study.

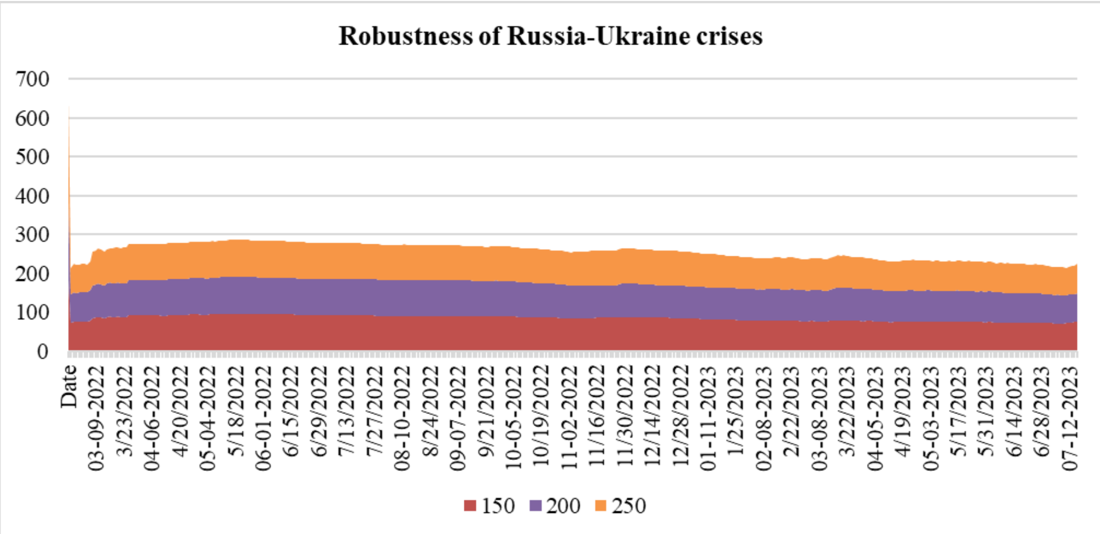


Fig. 4.46: Robustness of the crises during the Russia-Ukraine crises.

Note: For robustness of the model, short frequency, i.e. 150 (Red colour), medium frequency, i.e. 200 (Purple colour), and extended frequency, i.e. 250 (Orange Colour.) (Source: Author).

Table 4.17.0: During Russia-Ukraine using TVP-VAR Model in the selected developed, emerging, and frontier countries. (Source: Author using R software).

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**20.6**	3.0	2.0	1.8	5.7	4.6	3.4	2.9	2.2	2.0	1.6	3.4	1.4	2.8	3.2	1.8	2.8	3.0	2.2	3.4	3.0	1.9	3.1	2.6	2.6	1.7	2.8	2.7	2.7	3.3	79.4
JN	2.8	**9.7**	1.2	1.4	2.0	5.6	4.3	3.7	2.6	1.6	2.3	4.2	1.5	3.9	4.9	1.6	4.3	3.3	3.3	3.0	2.4	1.9	5.2	3.2	2.1	1.9	4.3	2.8	4.1	4.8	90.3
AA	8.8	2.6	**11.3**	1.6	5.8	4.4	3.1	2.3	3.6	3.1	1.2	3.0	2.1	2.5	3.3	2.2	2.9	3.2	1.9	3.5	2.4	2.2	3.2	2.3	3.2	1.8	3.4	3.3	3.5	2.7	88.7
HG	1.9	2.4	1.8	**15.5**	3.2	2.9	4.3	2.4	1.9	2.6	4.4	2.4	2.5	2.7	3.5	4.2	2.8	3.3	2.4	3.1	6.0	1.7	2.5	2.6	2.2	3.3	2.1	4.1	2.7	2.7	84.5
CAA	7.6	2.4	3.1	3.0	**14.6**	4.6	5.2	2.1	2.5	1.9	1.0	3.7	1.8	2.5	4.4	3.7	2.7	2.1	3.4	2.8	2.5	1.2	3.0	2.3	2.3	1.7	2.4	3.4	2.7	3.5	85.5
GY	3.3	4.2	1.3	1.6	2.9	**9.0**	5.9	3.8	3.1	1.7	1.7	5.1	1.0	2.9	5.9	1.4	4.4	2.6	3.3	3.3	2.4	1.7	5.6	2.0	2.3	1.6	4.7	2.7	3.8	4.9	91.0
SD	2.3	4.0	1.3	2.0	3.8	7.1	**10.1**	2.9	3.4	2.3	1.2	5.7	0.7	3.2	6.2	2.1	4.5	1.2	3.6	2.6	1.0	1.7	4.9	1.9	1.7	1.6	4.3	4.0	3.4	5.6	89.9
SN	2.5	3.8	1.5	1.8	2.3	6.6	5.0	**7.5**	2.9	1.8	1.8	4.9	1.5	2.8	4.6	2.0	4.6	3.5	3.0	3.8	2.9	1.6	5.5	2.1	2.7	1.5	4.1	2.5	3.9	5.1	92.5
RUS	1.8	3.1	2.4	1.6	2.2	4.2	4.1	3.3	**12.0**	3.4	1.9	4.9	1.6	2.5	4.0	1.3	3.3	2.3	2.8	2.8	2.1	2.5	4.4	2.5	2.4	2.6	6.5	3.1	4.3	4.4	88.0
SA	2.7	3.0	2.6	2.3	3.1	4.9	5.4	3.1	5.5	**11.4**	1.6	4.9	2.1	3.5	4.0	1.5	3.5	1.3	2.3	2.6	1.4	1.7	4.4	1.8	2.4	1.5	4.9	2.6	4.2	3.9	88.6
CA	1.4	3.5	1.7	7.3	2.3	3.5	4.3	2.8	2.9	1.9	**13.9**	2.6	2.9	2.4	3.3	1.7	3.1	2.8	2.1	2.4	4.2	2.4	2.9	3.5	1.6	1.8	3.0	5.6	2.6	3.4	86.1
IA	2.6	3.8	1.1	1.3	2.4	5.7	5.1	4.1	3.8	1.8	1.4	**8.2**	1.2	3.6	5.0	1.6	4.8	2.1	3.5	3.4	2.0	1.8	5.7	1.7	2.6	1.9	5.0	2.6	3.9	6.3	91.8
SAA	3.7	3.0	2.0	2.3	3.7	2.6	2.4	3.0	2.1	2.4	1.5	2.6	**22.9**	3.3	2.4	2.7	2.5	3.6	2.3	3.8	5.5	1.8	2.8	2.4	1.8	1.8	1.9	2.0	3.1	2.2	77.1
SK	3.5	3.9	1.4	1.7	2.2	4.2	3.8	3.5	2.7	1.8	1.3	4.9	1.8	**9.9**	4.4	2.4	4.0	3.2	3.3	4.1	2.2	2.2	5.6	2.3	2.9	1.9	3.7	2.6	3.7	5.1	90.1
SA	2.6	4.1	1.4	1.4	3.2	6.8	5.6	3.5	2.9	1.3	1.5	5.1	1.0	3.2	**9.2**	1.3	4.8	2.6	3.8	3.4	2.3	1.9	5.0	2.2	2.2	1.4	4.6	2.6	4.3	5.2	90.8
BL	2.2	2.3	2.4	2.5	4.0	2.7	3.6	2.2	2.0	1.2	1.1	2.9	2.5	2.8	2.8	**29.5**	2.8	2.1	2.8	2.7	2.6	1.3	3.2	2.4	1.5	2.3	1.6	2.6	2.1	3.6	70.5
TD	1.6	4.1	1.1	1.4	1.8	5.8	5.3	4.6	2.3	1.7	1.5	5.4	1.1	3.3	5.1	1.4	**10.3**	3.4	3.3	3.6	2.3	2.1	5.4	1.8	2.4	2.0	4.1	2.7	3.7	5.5	89.7
IA	2.2	3.0	1.9	1.7	2.9	3.7	3.9	2.9	2.1	1.7	1.5	4.0	1.6	2.6	4.0	1.0	4.7	**18.0**	2.6	4.4	2.8	1.7	3.4	2.1	2.3	3.6	3.1	2.9	3.8	4.0	82.1
MO	1.7	4.3	1.0	1.2	2.3	5.0	4.5	3.7	2.3	1.2	1.6	5.4	0.7	3.7	5.9	1.5	4.9	0.9	**11.3**	2.8	1.3	2.4	4.7	2.4	3.4	4.1	3.8	2.4	3.8	5.7	88.7
MA	3.0	2.3	2.8	1.9	1.9	3.1	2.6	3.7	2.8	1.5	1.3	4.0	2.3	2.4	2.7	1.8	3.0	4.8	1.9	**18.2**	4.1	2.0	3.8	1.8	3.2	4.4	3.3	2.9	3.4	3.0	81.8
VN	2.3	2.6	2.2	2.8	2.6	3.1	2.5	3.0	2.3	2.2	2.2	3.4	3.2	2.4	3.2	3.6	2.8	3.7	3.4	3.1	**20.1**	1.4	2.9	2.6	3.1	2.4	2.7	2.2	3.0	3.0	79.9
KA	1.2	3.3	1.6	1.4	1.0	3.4	2.5	3.0	3.1	1.0	2.4	3.5	1.2	3.4	3.8	1.3	4.4	1.9	2.9	4.2	1.5	**21.9**	3.9	2.5	3.4	2.2	3.8	2.3	4.2	4.0	78.1
RA	1.6	4.4	1.2	1.5	1.8	5.7	4.5	4.2	3.3	1.7	1.6	5.5	1.2	3.7	5.0	1.7	4.6	2.7	3.7	3.3	1.9	2.0	**8.3**	2.3	2.8	2.2	4.9	2.8	4.1	6.0	91.7
KN	2.0	3.1	1.7	2.2	1.4	3.2	2.7	2.8	2.6	1.3	2.6	3.0	3.7	2.4	3.2	1.8	3.3	2.4	2.2	3.6	2.9	2.1	3.4	**21.8**	2.4	2.6	3.7	3.0	3.9	3.3	78.3
BA	1.5	4.2	1.3	1.1	1.2	5.7	4.2	4.5	2.6	1.2	1.7	5.4	0.9	3.1	5.2	1.0	6.4	1.6	3.8	4.2	1.7	3.2	5.6	2.1	**8.0**	1.6	5.3	2.0	4.5	5.5	92.0
NA	1.5	2.6	1.9	2.6	1.8	2.7	3.0	2.2	2.1	1.8	1.5	2.7	2.0	1.9	2.8	1.6	2.9	2.8	3.1	4.4	3.9	1.5	2.6	1.9	2.1	**29.5**	2.5	3.2	2.4	2.8	70.5
CA	2.0	4.5	1.2	1.0	1.6	5.3	3.9	4.3	6.1	2.1	1.8	5.6	1.3	3.0	4.7	1.1	4.1	1.8	2.5	3.3	1.6	2.0	5.6	2.7	3.1	1.6	**9.2**	2.1	5.7	5.4	90.8
JON	1.1	3.3	1.9	2.4	2.6	3.3	5.1	2.6	4.4	1.8	1.6	4.5	2.4	2.3	3.6	1.7	3.6	3.7	2.1	3.5	2.4	2.7	3.3	2.5	2.1	2.2	4.0	**14.9**	2.8	5.9	85.1
MO	1.3	3.8	1.3	1.4	1.6	5.2	3.7	4.2	3.3	1.9	1.4	4.6	1.7	2.7	5.1	1.8	4.0	2.8	3.0	3.7	2.7	2.1	5.6	2.7	3.5	2.0	5.8	2.1	**10.8**	4.4	89.2
BH	1.6	4.3	0.7	1.2	1.8	5.5	5.4	4.4	3.2	1.2	1.5	6.6	0.8	3.8	5.4	1.8	5.6	1.9	3.7	3.2	1.5	1.9	6.3	2.0	2.4	1.9	5.0	3.2	3.8	**8.6**	91.5
TO	73.7	98.5	48.9	57.2	75.0	130.7	119.4	95.4	86.6	52.9	49.7	123.7	49.6	85.2	121.5	54.5	111.9	76.6	84.2	97.8	75.4	56.3	123.5	67.2	72.6	63.2	111.1	82.8	103.7	125.1	2573.9
Inc.Own	94.3	108.2	60.2	72.7	89.6	139.7	129.5	103.0	98.6	64.4	63.6	131.9	72.5	95.1	130.7	83.9	122.2	94.5	95.6	116.0	95.5	78.3	131.8	88.9	80.6	92.7	120.3	97.7	114.5	133.7	
NET	-5.7	8.2	-39.8	-27.3	-10.4	39.7	29.5	3.0	-1.4	-35.7	-36.5	31.9	-27.5	-4.9	30.7	-16.1	22.2	-5.5	-4.5	16.0	-4.5	-21.7	31.8	-11.1	-19.4	-7.3	20.3	-2.3	14.5	33.7	**85.8**

➢ TVP-VAR-BK TEST

During the medium-term Russia-Ukraine crisis, high connectedness was shown (especially in frontier and developed countries), indicating less interconnectedness is observed throughout the period (Fig. 4.47).

On analyzing the volatility spillover on the different frequency domains, this study found short frequency (27.49%), high spillover in just starting, medium frequency (56.11%), and total frequency (83.60%). TVP-VAR-BK Model results indicated in just four days, 27.49% (Table 4.18.0) volatility spillover is generated, 56.11% (Table 4.18.1) in medium-term or frequency, 83.60% volatility spillover in longer-term or frequency (Table 4.18.2). Fig. 4.48 indicated the spillover in different frequencies, which means over the period in various frequencies, volatility spillover in the series is reduced.

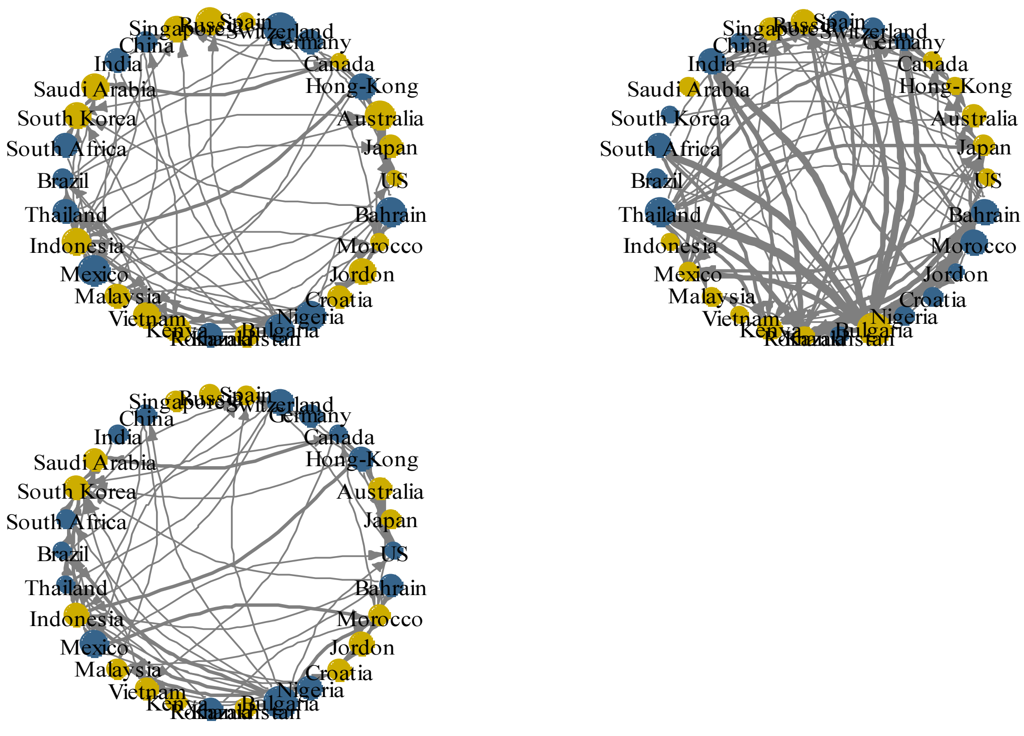


Fig. 4.47: During robustness of Russia-Ukraine interconnectedness among the developed, emerging, and frontier countries using TVP-VAR.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Table 4.18.0: Volatility spillover among the developed, emerging, and frontier countries during the Russia-Ukraine crises in the frequency of 1-4 days using the TVP-VAR-BK Model.(Source: Author using R software).

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**4.2**	1.0	0.2	0.7	1.8	2.0	1.6	1.6	0.2	0.4	0.4	1.6	0.1	0.4	1.2	0.7	1.5	0.1	1.3	0.4	0.1	0.2	1.4	0.4	0.6	1.1	1.0	0.2	0.9	1.5	24.3
JN	0.7	**7.5**	0.2	0.5	0.6	2.7	1.9	2.1	0.3	0.9	1.7	2.1	0.8	3.1	1.5	0.6	2.5	0.3	1.0	0.7	0.2	0.5	2.9	1.4	0.7	1.2	2.9	1.7	2.6	2.5	40.8
AA	1.0	0.9	**3.8**	0.4	0.9	1.2	1.0	0.7	0.8	0.8	0.7	1.1	0.2	0.6	1.1	0.6	1.0	0.2	1.0	0.4	0.1	0.4	1.0	0.4	1.0	0.9	0.9	1.0	0.9	1.0	22.0
HG	0.4	0.5	0.3	**4.8**	1.3	1.2	2.0	1.2	0.3	0.3	2.1	2.5	0.4	0.6	1.7	1.5	1.8	0.2	2.0	0.2	0.2	0.3	2.0	0.4	1.5	0.8	0.6	0.6	0.9	2.7	30.0
CAA	1.5	0.9	0.2	1.5	**4.7**	1.6	2.1	1.2	0.1	0.2	0.5	2.2	0.5	0.8	1.7	1.5	1.3	0.3	2.1	0.3	0.2	0.5	1.8	0.5	1.2	0.5	1.0	0.3	1.2	1.8	29.1
GY	1.5	2.3	0.1	0.9	1.3	**4.8**	3.3	2.9	0.2	0.4	0.4	3.3	0.5	1.1	2.9	1.0	3.3	0.2	2.0	0.7	0.1	0.4	4.0	1.3	1.3	0.7	2.5	0.4	2.4	3.5	44.6
SD	0.9	1.8	0.2	1.1	1.2	2.8	**3.6**	1.9	0.2	0.3	0.5	3.0	0.4	0.9	2.5	1.0	2.5	0.2	1.9	0.5	0.1	0.4	2.8	0.9	1.1	0.7	1.6	0.5	1.8	2.9	36.5
SN	0.8	1.2	0.1	0.7	0.5	2.2	1.8	**3.2**	0.3	0.2	0.3	1.9	0.3	0.5	1.7	0.6	2.1	0.1	1.2	0.5	0.1	0.2	2.3	0.6	0.9	0.8	1.1	0.2	1.3	2.3	26.5
RUS	0.6	0.6	1.1	0.9	0.7	0.6	0.7	0.9	**8.0**	2.3	2.0	0.8	0.3	0.5	1.0	0.6	0.8	0.3	1.1	0.3	0.3	0.5	0.6	0.8	1.5	0.5	2.8	1.4	1.3	0.7	26.2
SA	1.1	1.0	0.6	1.0	1.1	1.4	1.3	1.1	0.7	**3.2**	1.2	1.6	0.3	0.7	1.2	0.7	1.3	0.2	1.4	0.5	0.2	0.5	1.4	0.5	1.5	1.0	1.6	0.6	1.4	1.4	28.2
CA	0.2	1.2	0.4	1.8	0.6	0.5	0.6	0.3	0.6	0.7	**3.5**	0.7	0.6	0.7	0.8	0.6	0.5	0.4	0.8	0.1	0.2	0.3	0.8	0.5	1.0	0.8	0.8	1.4	0.4	0.9	18.9
IA	0.7	1.1	0.2	1.3	0.9	2.0	2.1	1.7	0.1	0.3	0.4	**3.6**	0.3	0.9	1.9	1.0	2.4	0.2	1.7	0.6	0.2	0.5	2.4	0.8	1.3	0.9	1.6	0.3	1.7	2.8	32.2
SAA	0.5	0.9	0.2	0.5	0.5	0.6	0.6	0.4	0.3	0.3	0.6	0.7	**4.1**	0.6	0.7	0.4	0.6	0.3	0.7	0.3	0.2	0.4	0.8	0.5	0.8	0.7	0.8	0.8	0.7	0.8	15.8
SK	0.3	1.8	0.2	0.5	0.6	1.1	1.1	0.7	0.3	0.4	0.6	1.3	0.7	**2.6**	1.0	0.4	1.3	0.2	1.0	0.4	0.1	0.6	1.3	0.5	0.8	0.6	1.0	0.9	0.9	1.4	22.0
SA	0.6	1.1	0.3	0.8	1.0	2.1	1.8	1.5	0.2	0.2	0.4	1.9	0.2	0.6	**3.3**	0.7	2.0	0.1	1.4	0.4	0.1	0.3	1.9	0.7	0.9	0.8	0.9	0.2	1.1	2.1	26.1
BL	0.4	0.4	0.2	1.1	1.2	0.7	1.1	0.7	0.1	0.1	0.4	1.2	0.3	0.3	0.9	**3.3**	1.0	0.1	1.0	0.1	0.2	0.2	1.0	0.2	0.5	0.3	0.4	0.2	0.5	1.2	16.1
TD	0.6	1.1	0.1	0.7	0.4	1.7	1.5	1.6	0.1	0.2	0.2	1.9	0.2	0.6	1.5	0.6	**2.7**	0.1	1.1	0.5	0.1	0.3	1.8	0.5	0.7	0.7	1.0	0.2	1.1	2.1	23.1
IA	0.2	0.3	0.1	0.4	0.3	0.5	0.5	0.4	0.1	0.4	0.2	0.7	0.1	0.3	0.5	0.2	0.6	**4.0**	0.5	0.2	0.2	0.2	0.7	0.2	0.4	0.7	0.4	0.1	0.5	0.7	10.2
MO	1.3	1.5	0.5	1.6	2.1	2.9	3.0	2.2	0.3	0.3	0.9	3.6	0.4	1.1	3.2	1.5	3.0	0.3	**4.9**	0.6	0.2	1.0	3.1	0.6	2.2	1.0	1.5	0.4	1.8	3.4	45.6
MA	0.4	0.6	0.2	0.9	0.4	1.0	1.1	1.0	0.2	0.3	0.5	1.2	0.2	0.3	1.2	0.6	1.4	0.2	1.1	**2.6**	0.2	0.3	1.2	0.4	0.9	1.2	0.4	0.2	0.8	1.4	19.9
VN	0.3	0.3	0.2	0.5	0.3	0.3	0.4	0.3	0.1	0.1	0.3	0.4	0.2	0.2	0.3	0.5	0.4	0.3	0.3	0.3	**6.3**	0.2	0.4	0.2	0.3	0.7	0.2	0.3	0.3	0.5	9.0
KA	0.8	1.4	0.6	0.7	1.2	1.4	1.5	1.0	0.3	0.4	0.7	1.9	0.4	1.2	1.8	0.7	1.7	0.4	1.9	0.5	0.4	**12.7**	1.6	0.5	1.7	0.7	1.0	0.6	1.3	1.8	29.8
RA	1.4	2.7	0.2	1.6	1.5	4.3	3.7	3.7	0.2	0.5	0.5	4.7	0.8	1.8	3.1	1.5	4.2	0.2	2.7	0.9	0.3	0.6	**6.3**	1.5	1.8	0.5	3.1	0.6	3.2	5.3	57.1
KN	0.4	0.6	0.1	0.5	0.3	1.0	0.9	0.7	0.3	0.2	0.2	1.2	0.2	0.4	0.8	0.4	1.2	0.1	0.6	0.2	0.1	0.1	1.3	**4.7**	0.4	0.5	1.4	0.4	0.9	1.3	16.1
BA	2.1	1.3	0.6	2.3	2.0	3.9	3.9	3.4	0.7	0.6	1.7	4.7	0.4	0.9	3.9	1.5	4.2	0.4	4.5	1.3	0.2	1.5	4.2	0.6	**7.0**	1.1	1.7	1.1	2.3	4.5	61.3
NA	0.3	0.9	0.1	0.8	0.3	0.8	0.8	0.5	0.1	0.3	0.4	0.8	0.2	0.7	0.7	0.5	0.9	0.2	0.8	0.3	0.2	0.2	1.0	0.3	0.5	**9.9**	0.5	0.6	0.5	1.1	15.3
CA	0.9	2.0	0.2	0.7	0.7	1.6	1.2	1.0	1.1	1.7	1.2	1.9	0.7	1.0	0.8	0.5	1.4	0.2	0.7	0.4	0.2	0.3	1.8	1.6	0.6	0.8	**4.8**	1.1	2.6	1.5	30.4
JON	0.3	0.8	0.3	0.6	0.5	0.4	0.5	0.3	0.5	0.4	1.0	0.7	1.0	0.9	0.6	0.5	0.5	0.2	0.7	0.2	0.4	0.4	0.7	0.5	1.1	1.2	0.6	**3.7**	0.3	0.8	16.7
MO	0.6	1.0	0.1	0.6	0.4	0.9	0.8	0.7	0.2	0.7	0.7	1.0	0.2	0.4	0.7	0.4	0.9	0.2	0.6	0.3	0.2	0.2	0.9	0.6	0.6	0.9	1.4	0.4	**2.1**	0.9	17.4
BH	0.9	1.3	0.2	1.3	1.0	2.2	2.2	2.1	0.1	0.2	0.4	2.9	0.3	0.9	2.1	1.0	2.6	0.1	1.8	0.6	0.1	0.3	2.8	0.7	1.2	0.8	1.5	0.3	1.5	**3.4**	33.3
TO	21.6	32.4	7.8	26.7	25.2	45.6	44.9	37.6	8.7	13.9	20.7	53.4	11.0	23.1	42.7	21.9	48.7	6.1	38.9	12.5	5.1	11.7	49.8	18.8	28.9	22.8	35.9	17.0	37.0	54.6	824.6
Inc.Own	25.8	39.8	11.6	31.5	29.9	50.5	48.5	40.8	16.7	17.1	24.2	57.0	15.1	25.7	45.9	25.1	51.3	10.0	43.8	15.1	11.4	24.4	56.1	23.5	35.9	32.7	40.7	20.7	39.1	58.0	
NET	-2.7	-8.4	-14.2	-3.3	-3.9	1.0	8.4	11.0	-17.5	-14.3	1.8	21.2	-4.8	1.1	16.5	5.8	25.6	-4.2	-6.8	-7.4	-3.9	-18.2	-7.3	2.7	-32.4	7.4	5.5	0.2	19.6	21.3	**27.5**

Table 4.18.1: Volatility spillover among the developed, emerging, and frontier countries during the Russia-Ukraine crises in the frequency of 4-Inf. Days, using the TVP-VAR-BK Model.(Source: Author using R software).

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**13.4**	1.2	0.8	2.4	4.9	3.6	3.7	2.1	0.8	1.1	2.0	2.3	1.1	0.8	2.7	3.3	2.2	0.7	3.7	1.3	0.9	0.5	1.9	1.1	3.4	3.1	0.7	2.0	1.6	2.5	58.1
JN	1.7	**5.6**	0.4	1.2	0.9	3.4	3.6	2.0	0.6	0.7	1.0	2.1	0.9	1.6	2.2	1.1	2.6	0.5	1.9	0.7	0.4	0.6	2.8	2.1	1.5	2.8	1.4	0.7	2.1	2.8	46.2
AA	11.0	0.9	**10.3**	1.8	7.3	2.3	1.9	1.2	1.1	1.7	1.5	1.4	1.2	1.6	2.0	3.3	1.5	0.8	3.1	1.2	0.6	0.9	1.3	2.2	2.6	2.3	1.0	2.7	2.1	1.7	63.9
HG	0.9	2.0	0.9	**10.3**	1.7	1.3	3.0	1.0	0.4	1.4	7.3	2.0	0.9	0.6	2.7	4.5	1.4	0.9	3.3	0.8	3.2	0.5	1.7	1.1	4.0	2.4	0.4	1.2	1.0	2.6	54.9
CAA	7.4	1.2	2.0	2.1	**14.2**	2.0	2.3	1.2	0.3	0.6	1.5	1.6	1.4	0.9	2.2	4.9	1.2	1.0	3.5	1.0	1.3	0.5	1.3	1.7	2.2	1.6	0.8	0.8	2.0	1.6	52.0
GY	2.2	0.8	0.5	1.6	1.1	**5.0**	4.6	1.9	0.4	0.7	1.2	2.1	1.0	0.6	3.5	1.5	2.6	0.4	2.9	1.1	0.4	0.4	2.5	0.5	2.3	3.7	0.8	0.4	1.2	2.7	45.5
SD	1.8	0.5	0.4	3.4	1.4	3.7	**6.6**	1.8	0.6	0.8	2.9	2.8	0.9	0.5	3.3	2.7	2.7	0.7	4.2	1.0	0.7	0.6	2.5	0.7	4.0	3.1	0.5	0.8	1.1	3.2	53.3
SN	1.8	1.0	0.7	2.9	1.1	5.1	6.1	**4.5**	0.6	1.0	2.2	3.1	1.2	0.7	4.3	2.5	4.2	0.6	4.5	1.3	0.6	0.7	3.7	0.6	3.7	4.2	0.8	0.7	1.6	4.3	65.8
RUS	1.1	1.2	2.7	1.8	1.0	1.2	2.1	1.9	**19.2**	2.5	2.3	1.3	0.6	0.8	1.4	1.4	1.7	1.2	1.7	0.8	1.3	1.0	1.4	2.4	2.5	2.0	3.0	1.0	1.7	1.8	46.6
SA	2.8	1.3	1.1	3.0	3.0	2.9	2.9	1.5	1.6	**10.2**	2.1	2.7	0.8	1.8	2.3	2.0	1.9	1.9	2.8	0.6	1.8	0.5	2.1	0.8	3.0	2.1	3.2	1.0	2.8	2.3	58.4
CA	0.4	1.8	0.7	8.7	0.9	1.6	4.1	0.9	1.0	2.2	**18.1**	2.0	0.9	0.6	3.5	2.8	1.8	0.8	4.7	0.5	1.8	0.9	1.8	0.9	5.7	2.9	0.6	1.1	0.8	3.3	59.6
IA	1.6	0.7	0.7	3.3	1.5	3.8	5.1	2.5	0.5	0.7	1.8	**5.2**	0.9	1.1	3.0	2.3	3.6	0.8	4.1	1.4	0.5	0.5	3.4	0.6	3.6	3.3	1.2	0.4	1.8	4.6	59.0
SAA	3.1	1.8	1.0	2.5	7.3	1.5	2.4	1.3	0.6	1.1	2.8	2.6	**15.8**	3.0	2.6	3.2	1.4	2.1	3.9	2.7	2.5	0.9	1.3	1.5	3.2	1.9	0.7	1.3	2.3	2.0	64.3
SK	2.5	1.5	1.3	3.2	1.9	3.0	4.0	2.1	0.6	0.9	2.5	3.6	1.0	**7.6**	3.4	2.5	3.1	0.7	4.8	3.4	0.8	1.0	3.5	2.4	4.4	2.2	1.1	1.1	1.7	3.8	67.8
SA	1.5	0.6	1.0	4.4	1.5	3.9	5.2	1.8	0.5	1.2	4.7	2.6	1.0	0.6	**7.5**	2.6	3.3	0.7	5.3	1.6	0.7	0.8	2.3	0.8	4.6	4.3	0.4	0.5	1.1	3.5	63.1
BL	1.5	0.8	0.7	5.2	2.4	2.9	5.0	2.3	0.8	0.8	4.0	3.1	0.8	1.0	3.7	**13.6**	3.0	0.7	5.5	1.1	2.1	0.7	3.3	1.2	5.1	2.6	0.5	1.0	1.2	4.2	67.1
TD	1.3	1.0	0.8	3.5	0.7	4.7	6.5	3.2	0.7	0.9	2.2	3.9	1.3	1.1	4.0	2.2	**6.8**	0.6	4.5	1.5	0.5	0.8	4.1	0.5	3.9	5.2	0.9	0.4	1.8	5.0	67.5
IA	0.9	0.7	1.5	5.6	1.9	2.0	3.8	1.2	0.4	1.1	4.5	3.2	1.5	1.6	3.4	2.3	3.8	**17.4**	4.1	1.9	1.7	0.9	2.0	0.7	6.7	4.0	0.5	0.8	2.1	3.8	68.4
MO	1.0	0.6	0.6	3.2	1.3	1.7	3.2	1.3	0.6	0.8	3.6	2.3	0.5	0.5	2.4	1.9	2.1	0.4	**7.4**	1.0	0.4	0.6	1.8	0.7	3.7	1.2	0.4	0.9	0.8	2.8	42.1
MA	2.1	1.4	1.9	3.0	1.1	1.8	2.9	1.5	0.6	2.5	4.0	2.2	1.0	1.4	2.8	1.9	2.3	0.6	3.0	**17.8**	0.8	1.0	2.4	1.6	2.4	5.8	0.9	0.7	2.4	3.7	59.7
VN	2.8	1.2	1.1	4.1	4.2	1.7	2.5	1.1	0.4	1.1	3.3	2.4	1.5	1.2	1.7	5.8	2.2	3.0	2.9	2.3	**21.8**	0.6	1.6	0.7	4.5	4.3	0.4	1.4	0.9	2.2	62.9
KA	0.9	0.6	1.5	2.5	0.5	1.1	2.2	1.2	0.4	0.9	2.1	1.9	0.4	0.9	1.9	1.8	2.3	0.9	3.4	0.6	0.8	**16.7**	1.6	0.3	2.9	2.8	0.4	0.6	0.9	2.4	40.8
RA	0.7	0.8	0.3	1.5	0.6	2.3	2.8	1.5	0.4	0.8	1.3	1.7	0.8	0.6	2.0	1.0	1.8	0.5	1.8	0.6	0.4	0.3	**3.0**	0.6	1.6	2.5	0.8	0.6	1.0	2.3	33.7
KN	1.3	1.5	1.3	2.3	0.9	2.4	2.8	1.6	2.6	1.8	3.0	2.2	1.1	0.8	2.7	1.6	2.7	0.7	2.9	0.9	1.1	0.8	2.3	**22.4**	2.7	3.7	3.0	0.9	2.4	2.9	56.7
BA	0.7	0.5	0.4	1.8	0.5	1.4	2.2	0.8	0.5	0.8	1.8	1.1	0.8	0.4	1.1	0.8	1.2	0.8	1.5	0.4	0.5	0.4	1.3	0.3	**4.8**	2.0	0.3	0.8	0.4	1.5	26.9
NA	0.8	1.7	0.7	3.0	0.8	1.7	2.7	1.8	0.6	0.8	2.0	2.2	1.5	1.2	2.1	2.7	2.0	0.9	2.8	1.6	0.6	0.7	2.2	0.5	2.7	**28.0**	0.7	1.0	1.4	3.3	46.7
CA	1.4	1.8	1.0	2.4	0.9	2.9	2.8	1.8	2.7	1.9	1.8	3.1	1.4	1.4	2.0	1.7	2.7	0.9	2.6	1.2	0.9	0.7	2.6	1.9	3.1	2.5	**6.4**	0.6	4.5	3.6	58.5
JON	3.3	2.2	2.6	3.2	2.7	1.7	2.5	1.8	1.9	1.0	3.4	1.6	3.0	1.3	2.2	2.2	2.5	1.4	3.0	1.4	1.8	1.5	2.1	0.9	3.0	3.3	1.5	**16.5**	1.1	3.0	63.1
MO	0.9	0.9	0.7	5.0	0.8	3.4	5.2	2.3	0.8	1.0	3.3	4.1	1.7	1.4	3.7	2.9	3.4	1.7	5.0	1.3	1.0	0.9	3.9	0.9	6.5	3.1	1.8	1.1	**7.1**	4.9	73.4
BH	0.9	0.8	0.7	3.8	0.9	3.3	5.1	2.6	0.4	1.0	2.3	3.4	1.3	1.0	3.3	2.3	3.6	0.8	3.8	1.1	0.4	0.7	3.8	0.7	3.3	3.9	0.9	0.4	1.6	**5.6**	57.7
TO	60.3	33.0	29.9	92.4	55.4	74.0	103.2	48.9	23.4	33.6	77.9	70.5	32.1	30.8	78.1	71.5	70.6	27.6	101.2	36.1	30.3	20.9	68.4	30.7	102.7	88.7	29.7	26.6	47.0	88.1	1683.4
Inc.Own	73.8	38.5	40.2	102.7	69.6	79.0	109.8	53.3	42.6	43.8	96.0	75.7	47.9	38.3	85.6	85.0	77.4	45.0	108.6	53.9	52.1	37.6	71.3	53.1	107.4	116.8	36.0	43.1	54.1	93.7	
NET	2.2	-13.3	-34.0	37.6	3.4	28.5	49.8	-16.9	-23.2	-24.8	18.4	11.5	-32.2	-37.0	15.0	4.4	3.1	-40.8	59.1	-23.6	-32.6	-19.9	34.7	-26.0	75.7	42.0	-28.8	-36.5	-26.4	30.4	**56.1**

Table 4.18.2: During Russia-Ukraine, interconnectedness among the developed, emerging, and frontier countries using the TVP-VAR-BK Model. (Source: Author using R software).

	US	JN	AA	HG	CAA	GY	SD	SN	RUS	SA	CA	IA	SAA	SK	SA	BL	TD	IA	MO	MA	VN	KA	RA	KN	BA	NA	CA	JON	MO	BH	FM
US	**17.7**	2.2	1.0	3.1	6.6	5.6	5.3	3.7	1.0	1.5	2.4	3.8	1.2	1.2	3.9	3.9	3.7	0.8	5.0	1.7	1.0	0.6	3.4	1.5	4.0	4.2	1.7	2.2	2.5	4.0	82.4
JN	2.4	**13.0**	0.6	1.7	1.5	6.1	5.5	4.1	0.9	1.5	2.6	4.3	1.6	4.7	3.7	1.7	5.1	0.8	3.0	1.4	0.6	1.1	5.7	3.6	2.2	4.0	4.4	2.4	4.7	5.3	87.0
AA	12.0	1.8	**14.1**	2.2	8.2	3.5	2.9	1.9	1.8	2.5	2.2	2.5	1.4	2.2	3.0	3.8	2.5	1.0	4.1	1.6	0.8	1.3	2.3	2.6	3.6	3.1	2.0	3.7	3.0	2.7	85.9
HG	1.3	2.5	1.2	**15.1**	3.0	2.4	5.0	2.2	0.7	1.6	9.3	4.5	1.2	1.2	4.4	6.0	3.2	1.1	5.2	1.0	3.4	0.8	3.7	1.5	5.5	3.1	1.0	1.8	1.9	5.2	84.9
CAA	9.0	2.1	2.2	3.6	**18.9**	3.6	4.3	2.3	0.4	0.8	2.0	3.9	1.9	1.6	3.9	6.4	2.5	1.3	5.7	1.2	1.5	1.0	3.0	2.2	3.4	2.2	1.8	1.1	3.1	3.5	81.1
GY	3.7	3.1	0.6	2.5	2.3	**9.9**	7.9	4.7	0.6	1.0	1.6	5.4	1.5	1.7	6.5	2.5	5.9	0.6	4.9	1.8	0.6	0.8	6.4	1.8	3.6	4.4	3.3	0.8	3.6	6.2	90.2
SD	2.7	2.3	0.6	4.5	2.6	6.6	**10.2**	3.7	0.8	1.0	3.3	5.7	1.2	1.4	5.8	3.7	5.2	0.9	6.1	1.5	0.8	1.1	5.3	1.6	5.2	3.9	2.2	1.4	2.9	6.2	89.8
SN	2.6	2.2	0.8	3.6	1.6	7.3	7.8	**7.7**	0.9	1.2	2.5	5.1	1.4	1.2	6.0	3.0	6.2	0.7	5.7	1.8	0.8	0.9	5.9	1.3	4.6	5.0	1.9	0.9	3.0	6.5	92.4
RUS	1.7	1.8	3.8	2.7	1.6	1.8	2.8	2.8	**27.2**	4.8	4.3	2.1	1.0	1.3	2.4	1.9	2.5	1.5	2.8	1.1	1.5	1.4	2.0	3.1	4.0	2.5	5.7	2.4	2.9	2.5	72.8
SA	3.9	2.3	1.7	3.9	4.1	4.3	4.3	2.5	2.2	**13.4**	3.3	4.3	1.1	2.5	3.5	2.7	3.2	2.1	4.3	1.1	1.9	1.0	3.4	1.3	4.5	3.1	4.8	1.6	4.1	3.7	86.6
CA	0.6	3.0	1.1	10.5	1.5	2.1	4.7	1.2	1.6	2.9	**21.5**	2.7	1.5	1.3	4.3	3.3	2.3	1.2	5.5	0.6	2.0	1.2	2.6	1.3	6.7	3.7	1.3	2.5	1.2	4.1	78.5
IA	2.4	1.8	0.9	4.6	2.4	5.7	7.2	4.2	0.6	1.0	2.2	**8.8**	1.2	2.0	5.0	3.2	6.0	0.9	5.8	2.0	0.7	1.0	5.8	1.4	4.9	4.2	2.8	0.6	3.4	7.3	91.2
SAA	3.5	2.7	1.2	2.9	7.8	2.1	3.0	1.8	0.8	1.4	3.4	3.3	**19.9**	3.6	3.2	3.6	2.0	2.5	4.6	2.9	2.6	1.3	2.1	2.0	3.9	2.6	1.5	2.1	3.0	2.8	80.1
SK	2.8	3.4	1.5	3.7	2.5	4.1	5.1	2.8	0.9	1.4	3.1	4.9	1.7	**10.2**	4.4	3.0	4.4	0.9	5.8	3.7	0.9	1.6	4.8	2.9	5.2	2.8	2.1	2.0	2.7	5.1	89.8
SA	2.2	1.8	1.3	5.2	2.5	6.0	7.0	3.3	0.7	1.4	5.1	4.5	1.2	1.2	**10.8**	3.3	5.3	0.8	6.8	1.9	0.8	1.2	4.3	1.6	5.4	5.0	1.3	0.7	2.2	5.6	89.3
BL	1.9	1.1	0.9	6.3	3.6	3.6	6.1	3.0	0.9	1.0	4.4	4.3	1.1	1.3	4.6	**16.9**	3.9	0.8	6.5	1.3	2.3	0.9	4.3	1.4	5.7	2.9	0.9	1.2	1.8	5.5	83.1
TD	1.8	2.1	0.9	4.1	1.2	6.4	8.0	4.8	0.8	1.1	2.4	5.8	1.4	1.7	5.5	2.8	**9.5**	0.7	5.6	2.1	0.6	1.1	5.9	1.0	4.6	5.9	1.9	0.6	2.9	7.0	90.6
IA	1.1	1.0	1.5	6.0	2.1	2.5	4.3	1.6	0.6	1.6	4.6	3.8	1.6	1.9	3.9	2.4	4.3	**21.4**	4.6	2.0	1.9	1.1	2.7	0.9	7.1	4.7	0.9	0.9	2.6	4.5	78.6
MO	2.3	2.1	1.0	4.9	3.4	4.5	6.2	3.5	0.9	1.1	4.5	5.9	0.9	1.6	5.6	3.4	5.1	0.6	**12.3**	1.6	0.6	1.6	4.8	1.3	5.9	2.2	1.9	1.3	2.6	6.2	87.7
MA	2.6	2.0	2.1	3.9	1.5	2.9	4.1	2.4	0.8	2.8	4.5	3.4	1.2	1.7	4.0	2.6	3.8	0.7	4.1	**20.4**	1.0	1.3	3.6	2.0	3.4	7.0	1.3	0.9	3.1	5.1	79.6
VN	3.1	1.5	1.2	4.6	4.5	2.0	2.9	1.4	0.5	1.2	3.5	2.7	1.7	1.3	2.0	6.3	2.7	3.3	3.2	2.7	**28.1**	0.7	2.0	0.8	4.8	5.0	0.5	1.7	1.2	2.7	72.0
KA	1.7	2.0	2.2	3.2	1.7	2.6	3.7	2.2	0.6	1.3	2.8	3.8	0.8	2.2	3.8	2.4	4.0	1.3	5.3	1.0	1.2	**29.4**	3.2	0.8	4.6	3.4	1.4	1.2	2.2	4.3	70.6
RA	2.1	3.6	0.4	3.1	2.1	6.7	6.5	5.2	0.6	1.3	1.7	6.4	1.5	2.4	5.0	2.5	6.1	0.7	4.4	1.5	0.6	1.0	**9.3**	2.1	3.4	3.0	4.0	1.2	4.2	7.6	90.8
KN	1.7	2.0	1.4	2.8	1.2	3.4	3.7	2.3	2.8	2.0	3.2	3.4	1.4	1.2	3.5	2.0	3.8	0.7	3.5	1.1	1.2	0.9	3.6	**27.2**	3.0	4.2	4.3	1.2	3.3	4.1	72.9
BA	2.8	1.8	1.0	4.1	2.5	5.3	6.1	4.2	1.2	1.4	3.5	5.8	1.2	1.2	5.0	2.4	5.4	1.1	6.1	1.7	0.7	1.9	5.5	0.9	**11.8**	3.1	2.1	1.9	2.7	6.0	88.2
NA	1.1	2.6	0.9	3.8	1.1	2.5	3.6	2.3	0.7	1.1	2.3	3.1	1.7	1.9	2.7	3.3	2.8	1.1	3.7	2.0	0.8	0.9	3.2	0.8	3.2	**38.0**	1.2	1.6	1.8	4.4	62.0
CA	2.3	3.8	1.2	3.2	1.5	4.5	4.0	2.8	3.8	3.6	3.0	4.9	2.1	2.5	2.8	2.2	4.0	1.1	3.3	1.6	1.1	1.0	4.4	3.5	3.7	3.3	**11.2**	1.6	7.0	5.1	88.8
JON	3.6	3.0	2.8	3.8	3.2	2.1	3.0	2.1	2.3	1.4	4.4	2.2	4.0	2.3	2.8	2.7	3.0	1.6	3.7	1.5	2.1	1.9	2.7	1.5	4.1	4.5	2.1	**20.2**	1.4	3.8	79.8
MO	1.5	1.9	0.8	5.6	1.3	4.3	5.9	3.0	1.1	1.6	3.9	5.0	1.9	1.8	4.3	3.2	4.2	1.9	5.6	1.6	1.2	1.2	4.9	1.6	7.1	4.0	3.2	1.4	**9.2**	5.8	90.8
BH	1.7	2.1	0.8	5.1	1.9	5.5	7.3	4.6	0.6	1.2	2.7	6.3	1.6	1.9	5.3	3.3	6.2	0.9	5.6	1.7	0.6	1.0	6.6	1.4	4.5	4.7	2.3	0.7	3.1	**9.0**	91.0
TO	81.9	65.3	37.7	119.1	80.6	119.7	148.0	86.4	32.1	47.5	98.7	123.9	43.1	53.9	120.8	93.3	119.3	33.6	140.0	48.6	35.5	32.6	118.2	49.5	131.6	111.5	65.5	43.5	84.0	142.7	2508.0
Inc.Own	99.6	78.3	51.8	134.2	99.5	129.5	158.2	94.1	59.3	60.9	120.2	132.7	63.0	64.1	131.6	110.2	128.7	55.1	152.4	69.0	63.5	62.0	127.4	76.6	143.4	149.5	76.7	63.7	93.2	151.7	
NET	-0.4	-21.7	-48.2	34.2	-0.5	29.5	58.2	-5.9	-40.7	-39.1	20.2	32.7	-37.0	-36.0	31.6	10.2	28.7	-44.9	52.4	-31.0	-36.5	-38.0	27.4	-23.4	43.4	49.5	-23.3	-36.3	-6.8	51.7	**83.6**

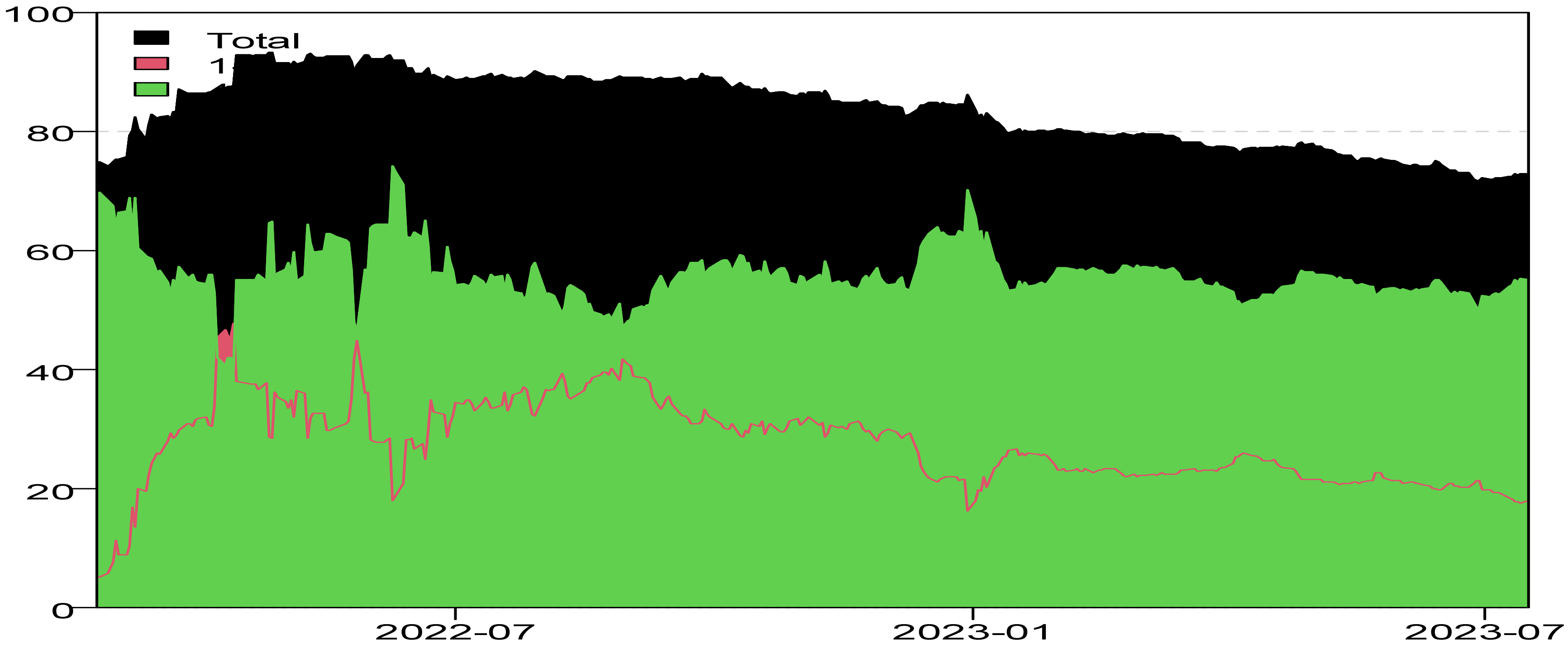


Fig. 4.48: During Russia-Ukraine, interconnectedness in different frequencies among the developed, emerging, and frontier countries using TVP-VAR.

Note: Volatility spillover based on the Baruník and Křehlík (2018), in short frequency (1-4 Days, red colour), medium frequency (4-Inf Days, Green colour), and total frequency (black colour) (Source: Author's using R software).

4.12.1Implication of the volatility spillover based on the TVP-VAR model.

- Implications based on the GFC crises.

Outliers in Diversification Across Developed Markets, such as the US, Canada, and Mexico, sent net volatility, indicating strong linkages with global markets. These markets caused an increase in systemic risk to portfolios with exposure to them, given their high virulence in the volatility transmission process. Investors looking for diversification during that GFC era would not have gained much benefit in risk reduction had they overallocated to either or both of those markets. In contrast, markets such as Australia and Spain, which are considered net absorbers of volatility, showed potential for mitigating portfolio volatility during the crisis. However, Spain faced added risks in its banking and real estate sectors. Mexico, Brazil, and India were big net transmitters of volatility in emerging markets. Many investors in these markets would take on additional risks as their stock markets dominated regional and global financial systems. Conversely, China's, Malaysia's, and Thailand's statuses as net receptors may have provided them with some role as stabilizers in a more diversified portfolio. However, their vulnerability to non-tariff barriers and trade disruptions is a factor to include. In the context of risk management and the cases of frontier markets, most of the primary frontier market volatility transmitters were two ex-Soviet Republics: Jordan and Kazakhstan. The vulnerabilities and lack of market depth mean more significant idiosyncratic investor risks. On the other hand, receptor markets such as Nigeria, Vietnam, and Croatia proved to have lower spillover effects, positioning them as suitable candidates for diversification. It is possible, however, that political instability and structural inefficiency countervail those benefits.

Based on sectoral implications, the global financial crisis's (GFC) impact on energy markets, especially in the U.S. and Russia, reaffirms the risk of portfolios highly concentrated in energy and commodity sectors. It can be seen that falling oil prices resulted in enormous loss of revenue and capital flight in those regions, reinforcing the need to diversify the economy away from oil and hydrocarbons. While fiscal and monetary stimulus measures across these economies offered a temporary cushion, they could not alleviate longer-term structural risks. U.S., Canada and Mexico are so intertwined that they show how over-concentration in North American markets is always at risk during crises. Asian emerging markets (e.g., China, Malaysia, Thailand) and frontier markets (e.g., Vietnam, Morocco) offered some potential for geographic diversification, given their positions as net receivers of volatility. However, investors had to consider trade policy risks and infrastructure bottlenecks.

❖ Policy responses and prospects for recovery-

Recent market rebounds in Russia (on higher oil prices and fiscal stimulus) highlight the significance of monitoring government intervention and economic policies when driving your crisis-time investment selection. Corruption and legal inefficiencies in some economies limited the effectiveness of policy responses, demonstrating that qualitative assessments must accompany quantitative analysis. In crisis periods, dynamic portfolio rebalancing is indispensable to reduce portfolio weights in high-risk transmitters (i.e., U.S., Canada, Mexico) while selectively increasing allocations in markets with lower volatility spillovers. Adding alternative asset classes, including bonds, commodities or defensive equities in receptor markets, can add diversification.

❖ Policy implications for crisis management –

During crises, the Eurozone "one-size-fits-all" policy of the European Central Bank proved insufficient. Future strategies must account for the heterogeneity of the member states to prevent the exacerbation of vulnerabilities. This requires strengthening fiscal and banking regulations (especially in weaker economies) to avoid spillovers on public finance during other crises. More balanced and equitable economic integration can reduce the asymmetric impact on smaller economies. Rising activity in stable zones (the US and Germany) during instability exacerbated volatility elsewhere, such as in the PIIGS and Kenya. This underscores the need for emerging markets to build their resistance to investor risk aversion. For economies like Australia and Japan, which serve broad international geographical spheres but can also act as transmitters and receptors, portfolio strategies to manage diversification should consider both roles. The crisis led to the reform of fiscal discipline, banking supervision and crisis management in the Eurozone. Such measures can be strengthened to forestall future crises. International institutions, such as the US

Federal Reserve and European stability mechanisms, because managing global economic crises requires long-term cooperation.

- Implications based on the Chinese crises.

These findings show that based on stock price fluctuations and correlations, stock investors can diversify their portfolios to reduce the risk of stock prices falling, especially in light of the close interrelation between the global financial markets and the more common occurrence of volatility spillover effects in times of crisis. High volatility and spillover effects: this study found that 91.45% of daily net volatility spillover during the China stock market crash is higher than the pre-event period (81.29%). This highlights the growing linkages between world financial markets. However, investors should be aware that crises in one region can transmit shocks worldwide, particularly when they involve major economies like China, and can change asset prices in every area. One of the sectors that passed the spillover effect was Canada (72.81%). This is related to its dependence on oil exports and the impact of falling crude oil prices on its economy and financial markets. The other significant transmitting nation was Saudi Arabia (69.08%), which was in line with its oil-dependent economy and the volatility of the global oil markets during the crash. In the frontier market Nigeria (32.79%), this left oil exporting countries open to external shocks; countries like Canada, Saudi Arabia, and Nigeria actively engaged in the cross-sectoral global volatility spillover due to excessive dependency in specific sectors such as the energy sector and commodity exports. Net receivers like Singapore, spanning across Europe (Spain) to the Indo-West Pacific (Indonesia), which borrowed even more cycle from external (external) shock, given their alibis, reminisced on paychools for global trade and capital inflow reaping. The dependence of Canada, Saudi Arabia and Nigeria on oil- and gas revenues intensified their vulnerabilities during the crash.

Developing hinterland roads and ports in less-dependent regions may also reduce the risks of pipeline closures during similar incidents. Emerging markets such as India (29.08%) and Malaysia (24.79%) also behaved as net transmitters, which indicates their increasing importance in global financial integration. In contrast, markets such as Indonesia (−45.89%) and Brazil (−45.07%) were the major recipients, at least again superficially, where diversification into less shock-transmitting markets could be considered. Notable transmitters of spillover effects were frontier markets, including Nigeria, Croatia and Kenya. However, some, such as Kazakhstan and Romania, were net receivers, suggesting heterogeneity in risk transmission across frontier economies. The crisis reinforced the burgeoning interconnectedness of financial markets, in which shocks in one major economy can reverberate worldwide. The nations that most mutually intertwined were Canada (160.88%), Saudi Arabia (157.97%), and Nigeria (123.12%), demonstrating how significant these countries play in the market conditions of the world.

❖ Policy Implications based on the Chinese crises:

Do not have excessive exposure in sectors closely linked to international capital markets or those highly focused on single goods. Diversify amongst regions with different levels of integration/volatility. Diversify investments to avoid excessive exposure to commodity markets such as oil, which exhibited extreme price fluctuations and contagion during the crash. Based on hedging against volatility, investors can check for investing in options and futures derivatives to hedge against losses when volatility spikes, especially in correlated markets. Even the best investment asset can be risky during a systemic downturn, so invest in the countries and markets identified as net receivers (e.g., Singapore, Indonesia, Brazil) during crises, as they will help your overall portfolio risk in future downturns.

➢ Implications based on the BREXIT crises.

Financial integration and spillover effects revealed how interconnected global stock markets have become, with events in one corner of the world, such as Britain's exit from the European Union, affecting others far away.Developed countries, including the UK, Switzerland, and Singapore, served as major transmitters due to their status as global financial centres, demonstrating how disturbances in these centres can transmit global volatility.Emerging markets (e.g. Indonesia, Mexico) and frontier markets (e.g. Croatia, Romania) were significant transmitters, given their sensitivity to global developments via their dependence on external trade and investment.The volatility these markets are experiencing highlights the importance of diverse economic policies that can help cushion against external shocks.The financial structures of countries determine whether they act as transmitters or receivers:Commodities-dependent economies (i.e., Saudi Arabia, Indonesia, etc.) spread volatility due to the world's influence on commodity prices.In particular, economies with high trade dependence (e.g., Malaysia and South Korea) were vulnerable as receivers as they entered global trade networks. Developed economies with functioning financial market levers acted as buffers, showing the stabilizing effect of established financial markets.In contrast, frontier markets with underdeveloped financial integration absorbed shocks instead, reflecting a diminished role in global volatility dynamics.

- ❖ Policy Implications based on the BREXIT crises:

Policymakers in emerging and frontier markets need to embrace risk mitigation strategies, like diversifying trade partners and deepening the resilience of financial markets, to better cope with global shocks.Safe-haven assets:the study reaffirms the value of safe-haven assets (e.g., Swiss Franc) in crisis, aiding investment strategies.The need for global collaboration: Greater international collaboration can potentially mitigate systemic risks from events such as Brexit from having disproportionate consequences on vulnerable economies.Trade-dependent economies, particularly those heavily reliant on global trade networks, need to be ready to change or adjust policy to stabilise in times of crisis.

- ➢ Implications based on the COVID-19 crisis.

The successes and failures of developed, emerging, and frontier markets are linked and highlight the highly systemic risk in the global financial system. Any volatility in developed markets (such as the US or Switzerland) can be felt across other economies, amplifying the impact of shocks like COVID-19. Advanced economies, especially the US, Switzerland and Singapore, are essential transmitters of volatility due to their size, financial depth and trade linkages. To avoid a cascading effect on the rest of the world, policymakers in these countries need to go on the offensive to stabilize their markets in times of crisis.

❖ Stabilizers: Safe-Haven Economies

Countries such as Japan, Canada and Germany are net absorbers of volatility, stabilizing regional and global markets. This underscores the need to preserve solid institutional architecture, sound domestic markets, and prudent fiscal and monetary policies. Mexico, Brazil and Malaysia are especially vulnerable to volatility owing to their reliance on commodities, trade and financial flows from more significant economies. This highlights the importance of diversifying and building more robust domestic policy structures to insulate the economy from external shocks. Frontier markets like Croatia and Morocco are less integrated into global financial systems, serving predominantly as volatility receivers. This reduces their direct exposure to global shocks, but their reliance on foreign aid, tourism, and commodities makes them vulnerable to regional spillovers. Economies that depend on a few sectors (tourism in Croatia, oil in Nigeria, commodities in Brazil) are highly susceptible to external disruptions. This underlines how we must diversify our economic bases to provide them greater resilience in times of global crisis. In this way, effective policy moves like Japan's well-timed dovish monetary policies or India's market interventions show how prompt measures can restrict the transmission of volatility and draw up the stability of economies at home. Countries with good governance and policy frameworks are better able to absorb shocks. As financial hubs, countries like Singapore and Switzerland serve as conduits for global and regional volatility transmission. As critical nodes in the global economic network, they rely upon trade, open financial systems, and interconnected markets. Globalisation often leads to systemic crises in the interconnected system of developed and emerging markets; a shock in any central market, such as the US, ripple through rapidly. Global coordination and risk-sharing mechanisms are needed. Stable institutions and low dependence on volatile sectors in developed markets (e.g., Germany, Japan) function as absorbers, while smaller economies with little resilience (e.g., Morocco, Kenya) tend to be the receptors of the volatility, reflecting global economic asymmetry.

➢ Implications based on the Russia-Ukraine crises.

Geopolitical and economic sensitivities are based on energy dependency; countries more dependent on Russian energy (for example, Germany and Bulgaria) experience more intense stress in markets and policy spillovers. They include higher commodity prices: increased volatility in energy and metals prices, in addition to supply chain disruptions, greatly affected industry commodity importers (e.g., India, Thailand) and exporters (e.g., Saudi Arabia, Indonesia). Closer countries to the crisis (e.g., Romania and Kazakhstan) reported more excellent economic shocks due to investor sentiment and trade linkages. The capital flows, and risk aversion; the crisis unleashed a worldwide dash for safety. Safe havens such as Switzerland and Japan experienced a surge in capital inflows during this period, emphasizing the role of safe havens during crises. Capital outflows from emerging and frontier markets occur as risk-averse behaviour takes hold.A significant volatility factor was the ECB and Germany's leadership in sanctions, which followed the traditional role of monetary and fiscal policies during crises.The frontier markets' illiquidity amplified volatility, reiterating the need for stronger institutionalmechanisms and a diversified economic approach.

❖ Risk Hedging Countries

Japan and Switzerland are hedging risk nations within the network; both are central nodes, with edges leading to numerous other countries. Their positions suggest that they provided safe havens by soaking up spillovers, especially during periods of elevated geopolitical risk. The major transmitters countries with firm outgoing edges in the network were big transmitters of volatility; high cross-border linkages wellreflect Germany's role as a channel through which volatility flows, owing to trade, energy dependency and EU sanctions. Bahrain is an oil producer, and its transmission to other nations and the volatility in energy markets that accompanied it rose. Romania: Its geographic proximity to Ukraine helped make it an essential regional transmitter.US: As a global economic leader, US spillovers impacted most international markets. As prominent recipients of volatility,Singapore, Australia, and Hong Kong's high dependence on global trade and capital flows made them vulnerable to volatility spillovers.The twin pressures of supply chain snarls and geopolitical neutrality made it especially vulnerable.

Kenya and Bulgaria, the frontier markets with high dependence on imports and geographic proximity to the crisis, see amplified spillovers.The neighbours of the crisis countries share the same fate, as economies like Romania, Bulgaria, and Croatia show heavy regional correlation.Oil-exporting countries like Saudi Arabia and

Bahrain exported volatility through energy-price fluctuations, while commodity-importing ones like India and Thailand were key receptors.The interconnectedness highlights the systemic nature of how geopolitical crises ripple through global financial and trade networks.The capital flow into countries such as Japan and Switzerland evidenced risk hedging plays.Policymakers must consider these spillover effects when creating mechanisms to stabilize markets in times of future geopolitical dislocation.

4.13 Regional Bloc Connectedness as a Case Study - "Exploring Crisis-Driven Return Spillovers in APEC Stock Markets: A Frequency Dynamics Analysis".

4.13.1 Importance of APEC Stock Markets

The recent global pandemic (Akhtaruzzaman et al., 2021; Goodell, 2020; Liu et al., 2022a; Pandey and Kumari, 2021) and Russia-Ukraine war (Boubaker et al., 2022; Chortane and Pandey, 2022; Fang and Shao, 2022; Kumari et al., 2023; Singh et al., 2022) significantly impacted stock markets worldwide. These unprecedented crises have underscored the interconnectedness of global financial markets, prompting an increased interest in studying the transmission of shocks and return spillovers across different economies. As members of the Asia-Pacific Economic Cooperation (APEC) face diverse economic structures and varying degrees of vulnerability to external shocks, understanding the dynamics of return spillovers within the region becomes crucial for policymakers, investors, and market participants. Furthermore, stock market integration has distinct ramifications, and empirical research may significantly influence diverse situations (Mohti et al., 2019). Cross-country stock price co-movements are considerably influenced by financial integration (Bekaert et al., 2002; Boubaker and Jouini, 2014;Khoury et al., 2023), and strongly interconnected stock markets exhibit statistically significant long-term correlations (Goetzmann and Rouwenhorst, 2001). Obstfeld's (1996) theoretical model indicates that international risk-sharing enhances resource allocation and supports economic development. In addition, stock market integration is favourably connected to economic growth (Korajczyk, 1996). However, greater stock indices integration is related to increasing market volatility spillovers (McIver and Kang, 2020; Guru and Yadav, 2023; YoUSf et al., 2023). The spillover effect implies that a significant shock to a stock market results in magnificent returns and interconnectedness within that market and other stock markets. An additional inference can be drawn that the volatilities and correlations of stock returns exhibit persistent co-movement over some time (Kenourgios and Dimitriou, 2015; Bahcivan and Karahan, 2022). Furthermore, in addition to financial crises like the Global Financial Crisis of 2007-2008 and the European Sovereign Debt Crises of 2010-2012, the recent COVID-19 pandemic also magnified preexisting spillover effects (Rehman et al. 2022; Mensi et al. 2022). These crises, often referred to as "black swan" events, can act as contagion triggers, capturing the media's attention and leveraging other information transmission channels (Yarovaya et al., 2022). As a result, they may induce short-term surges or modifications in spillover behaviours, creating a ripple effect throughout financial markets (Candelon and Tokpavi, 2016). Improve portfolio risk-adjusted returns by adjusting asset allocations to reduce spillover effects and contagion risks (Syriopoulos and Roumpis, 2009; Boubaker et al., 2016; Fan et al., 2020; Akhtaruzzaman et al., 2021c).

Motivated by these financial risk transmission characteristics, this study empirically examines the information transmission across the strength by intensity, magnitude, and direction of the spillover across the APEC economic bloc. APEC (established in 1989 with its headquarters in Singapore, represents over 2.9 billion people and approximately 60% of the global GDP (apec.org)), the intergovernmental forum, consisting of 21 member nations, serves as a platform for promoting free trade among countries in the Asia-Pacific region. In a groundbreaking exploration, this study dives a novelty into uncharted territory by uncovering spillover effects within the APEC bloc during three critical crises (GFC, COVID-19, and the Russia-Ukraine war). Employing innovative techniques, it analyses both time and frequency domains, shedding light on the magnitude, intensity, and direction of spillover among APEC countries. Using the cutting-edge methodology developed by Diebold and Yilmaz (2012) within the framework of GFEVD, the research unveils the specific pairwise contributions of spillover, quantifying their impact within the APEC group. Additionally, by applying the TVP-VAR-BK (2018) approach, the study examines spillover patterns across short, medium, and long-term periods. This study pioneers a new understanding of spillover dynamics in the APEC bloc during major crises, providing valuable insights for policymakers and investors alike.

4.13.2 Results of APEC

4.13.2.1. Time Domain

Table 4.19.0, based on the methodology proposed by Diebold and Yilmaz (2012), presents the return spillover outcomes for three distinct sub-periods. The *"FROM"* column indicates how much each market's volatility influences other markets' volatility. Conversely, the *"TO"* row shows the extent to which the volatility of other markets influences each market's volatility. The Net return spillover of each market is computed by subtracting the values in the *"FROM"* column from those in the *"TO"* row. On the top of the table, the Total Spillover Index (TSI) is shown, representing the proportion of the total cross-variance spillovers relative to the overall total (i.e., 100 per market). The "total" row showcases the impact of a market shock attributable to its shock and the shocks from other markets. The TSI is highest during the COVID-19 pandemic (81.48%), followed by the GFC (79.6%) and the Russia-Ukraine conflict (60.99%) (Fig. 4.49).

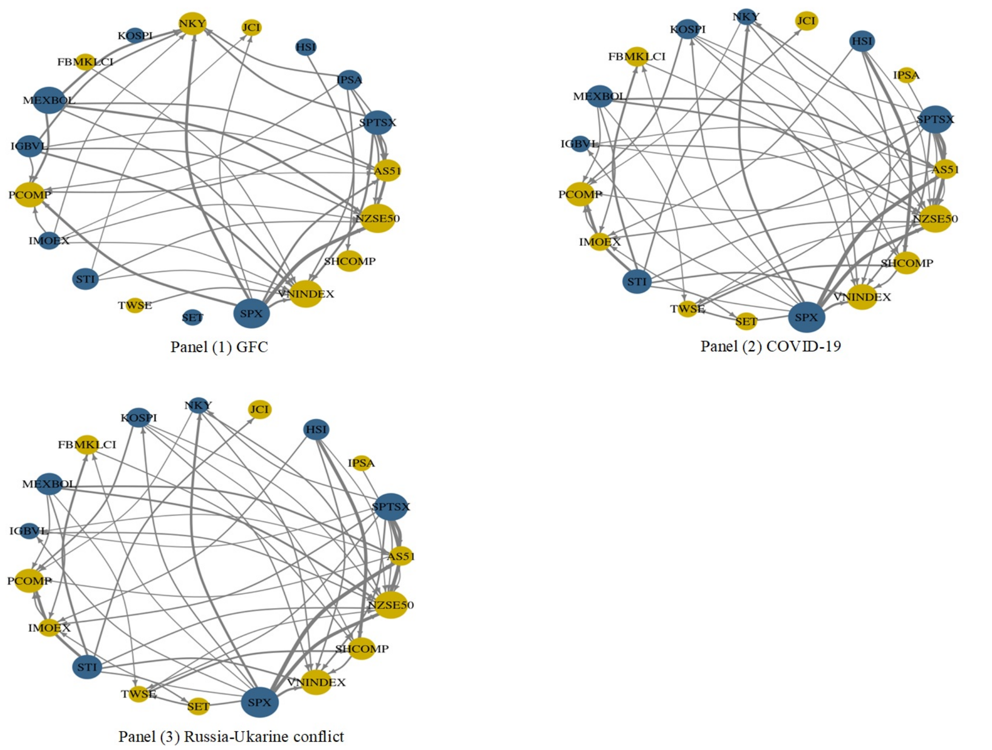


Fig. 4.49: Directional spillover network plot during the GFC, COVID-19, and Russia-Ukraine conflict in the APEC bloc.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software)

.**Table 4.19.0:Results of Diebold Yilmaz (2012) model for returns spillover in three panels representing three major crises.**(Source: Author using R software).

	AS51	**FBMKLCI**	**HSI**	**IGBVL**	**IMOEX**	**IPSA**	**JCI**	**KOSPI**	**MEXBOL**	**NKY**	**NZSE50**	**PCOMP**	**SET**	**SHCOMP**	**SPTSX**	**SPX**	**STI**	**TWSE**	**VNINDEX**	**FROM**
AS51	**15.01**	3.23	4.67	8.83	5.25	6.43	3.17	4.17	10.03	2.44	1.62	0.55	4.22	1.05	8.31	12.48	4.9	3.26	0.36	84.97
FBMKLCI	2.62	**19.65**	6.05	6.39	4.69	3.56	6.48	4.24	6.4	2.12	1.15	3.88	7.31	2.71	3.43	5.03	8.59	4.9	0.79	80.34
HSI	3.8	4.22	**16.77**	5.27	4.03	3.59	3.91	6.56	8.23	3.42	0.33	2.87	6.82	5.11	4.26	6.34	9.07	5.17	0.24	83.24
IGBVL	2.47	4.03	4.16	**20.97**	6.28	7.76	5.15	4.05	9.88	1.73	1.05	1.71	5.5	1.89	5.48	7.92	6.47	2.72	0.77	79.02
IMOEX	1.76	3.63	3.85	7.78	**26.27**	4.63	3.18	5.07	8.34	5.23	0.91	1.63	3.75	1.33	7.19	6.54	3.57	4.34	0.99	73.72
IPSA	2.57	2.54	3.18	9.92	4.37	**25.08**	2.52	3.34	11.96	0.64	1.54	1.27	5.01	1.14	6.73	11.98	4.17	1.37	0.66	74.91
JCI	2.67	4.52	5.15	7.93	4.74	3.95	**20.87**	5.04	6.64	2.96	1.48	2.69	7.2	1.57	4.03	5.67	8.61	3.62	0.67	79.14
KOSPI	4.66	2.97	7.66	5.71	5.12	3.7	3.54	**19.68**	7.34	6.38	0.64	1.76	4.15	3.54	3.75	5.69	6.19	7.13	0.4	80.33
MEXBOL	2.45	2.68	5.39	9.1	5.39	9.43	2.62	4.97	**19.33**	1.68	0.75	0.78	5.33	1.41	8.29	13.15	4.93	1.81	0.53	80.69
NKY	3.1	1.38	4.1	9.93	5.4	9.28	2.27	5.11	12.25	**13.58**	0.55	0.94	4.44	0.82	7.4	12.25	3.78	3.03	0.41	86.44
NZSE50	4.12	2.87	4.01	8.6	3.98	7.34	3.8	2.78	9.96	1.56	**13.34**	1.52	4.72	0.98	9.31	13.97	4.72	1.65	0.77	86.66
PCOMP	1.86	3.95	5.13	7.2	6.86	5.04	4.23	5.53	8.99	3.63	1.36	**16.93**	4.95	1.7	4.99	9.32	4.4	2.95	0.98	83.07
SET	2.52	5.05	7.32	5.89	4.38	5.55	6.08	4.84	7.62	2.44	1.13	3.19	**17.8**	2.41	4.44	6.13	8.49	3.62	1.1	82.2
SHCOMP	0.95	4.92	9.29	4.81	4.9	2	3.28	4.24	4.38	1.11	0.65	2.54	4.42	**37.3**	1.94	2.99	5.5	3.46	1.32	62.7
SPTSX	2.71	2.74	3.62	6.91	5.7	6.78	2.52	3.19	9.94	3.35	1.23	0.97	4.84	0.72	**22.99**	14.2	4.24	2.55	0.81	77.02
SPX	4.31	2.6	3.83	7.86	4.11	9.65	1.79	3.93	13.54	1.54	1.3	0.87	4.58	0.68	12.74	**20.44**	3.92	1.86	0.47	79.58
STI	3.33	6.56	8.95	5.66	3.12	3.17	6.51	5.11	6.49	2.31	1.13	2.81	7.86	3.18	4.21	5.51	**17.63**	6	0.45	82.36
TWSE	3.67	4.65	6.9	4.47	5.4	2.8	5.18	7.79	5.5	4.9	0.28	2.43	4.43	2.39	5.18	5.58	8.14	**19.93**	0.39	80.08
VNINDEX	2.45	3.57	2.93	9.38	6.06	5.43	4.09	3.28	8.38	2.05	1.04	0.73	3.94	1.57	5.25	7.48	5.15	3.54	**23.66**	76.32
TO	52.02	66.11	96.19	131.64	89.78	100.09	70.32	83.24	155.87	49.49	18.14	33.14	93.47	34.2	106.93	152.23	104.84	62.98	12.11	**1512.79**
NET	-32.95	-14.23	12.95	52.62	16.06	25.18	-8.82	2.91	75.18	-36.95	-68.52	-49.93	11.27	-28.5	29.91	72.65	22.48	-17.1	-64.21	**79.62**
Panel B : Return spillover during COVID-19 pandemic (Total Spillover =81.48%)																				
AS51	**17.87**	2.52	3.8	4.3	4.93	3.71	4.55	4.22	5.05	5.18	4.22	4.63	6.21	1.62	7.47	6.97	4.85	3.62	4.27	82.12
FBMKLCI	3.87	**17.58**	5.13	3.39	4.45	4.96	4.11	4.36	3.33	5.87	3.31	3.12	6.06	3.16	5.79	5.98	7.65	5.96	1.93	82.43
HSI	3.92	5.33	**16.9**	2.95	3.98	4.22	2.79	6.57	4.65	4.93	2.52	1.96	6.14	6.26	4.76	5.14	7.53	7.26	2.19	83.1
IGBVL	4.15	1.58	2.73	**20.16**	5.42	6.19	2.27	2.21	10.22	2.62	2.64	2.45	5.98	1.92	10.63	9.1	4.11	2.75	2.89	79.86
IMOEX	2.95	1.66	3.38	5.11	**27.76**	4.96	1.75	3.87	6.6	4.53	3.32	1.23	6.24	1.17	11.52	6.95	2.34	2.24	2.43	72.25
IPSA	3.98	3.75	3.98	6.29	6.31	**18.01**	3.35	3.68	4.9	3.8	3.72	4.15	7.08	1.86	7.84	6.68	4.76	4.12	1.74	81.99
JCI	4.57	4.72	3.49	2.95	4.28	5.67	**18.52**	5.26	4.5	3.8	3.19	6.6	5.34	1.95	6.52	6.38	5.84	4.52	1.9	81.48
KOSPI	3.72	4.11	6.16	2.78	6.71	4.62	3.32	**14.69**	3.79	6.13	3.19	3.01	5.85	2.3	6.46	6.15	6.53	7.78	2.69	85.3
MEXBOL	4.88	1.98	2.6	10.41	4.49	5.27	3.1	3.23	**21.81**	4.83	2.26	1.54	2.28	1.73	10.52	10.79	3.46	2.11	2.71	78.19
NKY	5.13	3.17	4.38	3.5	5.94	3.38	2.06	6.23	5.69	**19.31**	3.72	1.25	3.84	1.87	7.89	9.22	5.62	3.75	4.03	80.67
NZSE50	6.01	2.82	3.33	5.76	4.63	6.01	2.22	4.23	5.46	5.88	**17.04**	2.36	4.92	1.85	8.3	8.03	4.06	5.43	1.65	82.95
PCOMP	5.18	4.4	3.91	4.2	4.82	5.25	6.72	5.22	6.05	3.31	1.75	**21.7**	3.39	1.59	5.8	4.44	5.15	3.35	3.77	78.3

SET	4.4	4.47	4.81	4.56	5.41	4.83	3.39	4.28	3.56	3.92	3.97	2.69	**17.1**	3.33	8.15	6.33	7.06	4.49	3.26	82.91
SHCOMP	2.3	5.4	10.12	3.21	2.4	3.18	2.84	4.06	3.35	2.87	2.95	1.07	5.62	**26.49**	3.7	4.45	5.96	7.79	2.24	73.51
SPTSX	4.67	2.78	2.54	7.31	6.96	5.02	2.93	3.63	6.61	4	3.52	3	8.45	1.42	**14.13**	10.93	4.68	3.71	3.72	85.88
SPX	5.12	2.33	2.58	6.79	6.12	4.31	2.99	3.98	6.48	4.15	3.61	3.51	7.88	1.51	12.2	**14.62**	4.75	3.83	3.25	85.39
STI	4.54	5.66	5.8	4.01	4.15	4.4	3.59	5.92	5.25	5.33	2.44	2.56	7.73	2.49	6.6	6.76	**12.97**	5.95	3.83	87.01
TWSE	3.53	4.68	6.27	4.56	5.71	5.52	2.68	6.92	4.54	5.51	4.07	2.27	5.03	3.75	7.16	6.86	6.07	**13.19**	1.71	86.84
VNINDEX	6	2.17	3.05	4.31	3.75	2.69	2.18	4.71	5.37	3.82	2.73	3.89	3.92	2.72	9.04	7.87	6.55	3.11	**22.12**	77.88
TO	78.92	63.53	78.06	86.39	90.46	84.19	56.84	82.58	95.4	80.48	57.13	51.29	101.96	42.5	140.35	129.03	96.97	81.77	50.21	1548.06
NET	-3.2	-18.9	-5.04	6.53	18.21	2.2	-24.64	-2.72	17.21	-0.19	-25.82	-27.01	19.05	-31.01	54.47	43.64	9.96	-5.07	-27.67	**81.48**
Panel C: Return spillover during Russia-Ukraine conflict (Total Spillover =60..99%)																				
AS51	**19.12**	1.02	1.06	8.7	0.79	2.76	0.5	5.49	8.51	2.54	2.62	0.27	3.82	0.56	18.72	18.25	2.02	3.08	0.16	80.87
FBMKLCI	2.82	**38.72**	2.33	5.03	1.47	2.56	1.96	4.65	4.16	3.01	1.44	1.45	6.84	1.05	7.14	8.82	2.19	3.41	0.96	61.29
HSI	2.01	2.57	**34.68**	2.98	0.25	0.8	1.18	5.62	2	2.81	1.98	0.95	4.45	14.5	4	4.06	6.74	6.4	2.03	65.33
IGBVL	1.74	1.85	1.74	**37.82**	1.09	4.68	1.86	2.54	10.3	1.29	0.91	0.33	4.19	1	14.73	8.24	4.64	0.88	0.17	62.18
IMOEX	0.29	1.09	0.42	1.81	**84.27**	1.56	1.17	0.67	0.81	0.6	1.19	0.39	1.01	0.21	0.77	0.49	0.87	0.42	1.97	15.74
IPSA	0.65	2.4	1.26	6.58	1.72	**51.94**	0.87	2.51	5.63	1.16	0.66	0.21	2.4	0.72	10.63	7.05	1.22	1.39	1	48.06
JCI	2.39	3.15	1.55	4.81	2.11	3.6	**48.62**	4.12	1.95	1.1	1.33	1.64	4	0.34	6.42	5.04	2.93	2.51	2.39	51.38
KOSPI	7.08	2.84	4.32	4.94	1.12	1.56	1.49	**25.52**	5.34	5.09	1.93	1.34	4.12	2.38	7.22	7.51	4.49	10.32	1.38	74.47
MEXBOL	2.07	3.52	1.07	11.1	1.24	4.26	0.37	1.47	**43.82**	0.2	1.52	2.02	3.32	1.33	10.45	10.09	1.97	0.05	0.14	56.19
NKY	3.88	2.4	2.59	3.7	1.14	2.82	0.83	6.12	4.53	**27**	1.14	0.42	4.23	1.76	11.48	15.52	3.17	6.59	0.68	73
NZSE50	4.41	1.3	1.79	4.38	1.97	2.2	1.59	2.39	5.63	1.65	**30.51**	2.59	4.83	0.71	10.4	15.45	4.39	1.64	2.16	69.48
PCOMP	2.76	1.51	1.85	4.17	3.99	2.48	2.17	2.59	5.2	1.57	2.91	**42.35**	1.48	1.31	8.52	9.4	3.06	1.04	1.62	57.63
SET	3.73	4.06	3.94	4.69	0.66	2.03	2.48	5.06	4.89	3.3	2.65	1.44	**33.07**	3.03	5.94	7.36	4.23	5.54	1.9	66.93
SHCOMP	1.36	1.47	18.01	2.9	0.28	0.57	0.49	4.37	2.36	2.31	0.61	0.61	3.82	**44.07**	2.87	2.53	3.14	6.25	1.98	55.93
SPTSX	2.17	1.51	0.93	12.98	0.85	6.58	1.36	1.46	9.04	1.4	0.58	0.32	3.57	0.79	**31.74**	21.34	2	1.31	0.07	68.26
SPX	2.1	2.06	0.51	7.55	0.91	4.61	0.72	1.05	8.14	2.07	1.93	0.44	4.94	0.28	23.88	**35.77**	1.56	1.19	0.27	64.21
STI	3.12	2.03	5.67	6.25	2.19	1.89	1.43	4.46	4.06	3.55	3.28	1.52	4.93	3.44	7.34	9.96	**30.72**	2.61	1.57	69.3
TWSE	4.48	2.14	4.86	5.18	0.87	2.28	1.45	9.73	4.72	5.73	1.78	0.65	5.76	3.38	8.86	9.07	3.57	**24.41**	1.08	75.59
VNINDEX	0.31	1.21	4.04	3.04	2.74	0.74	2.95	2.57	0.92	0.7	0.72	1.84	4.41	2.02	3.94	5.34	3.52	1.98	**57.02**	42.99
TO	47.37	38.13	57.94	100.79	25.39	47.98	24.87	66.87	88.19	40.08	29.18	18.43	72.12	38.81	163.31	165.52	55.71	56.61	21.53	1158.83
NET	-33.5	-23.16	-7.39	38.61	9.65	-0.08	-26.51	-7.6	32	-32.92	-40.3	-39.2	5.19	-17.12	95.05	101.31	-13.59	-18.98	-21.46	**60.99**

The analysis reveals significant variations in the gross directional spillovers "to others" from the 19 stock markets across different sub-periods. Vietnam exhibits the lowest variance contribution to others at 12.11%, while Mexico has the highest at 155.87%. Regarding spillovers received, China receives the lowest at 62.7%, while New Zealand gets the highest at 86.6%. Net volatility spillovers indicate that Mexico (75.18%) and the US (72.65%) contribute maximum to the error variance in forecasting return volatility of other stock markets (Fig. 4.50, Fig. 4.51, Fig. 4.52). Notably, New Zealand, Vietnam, Philippines, and Japan receive the highest gross volatility spillovers from others, while the US, Canada, and Mexico are significant transmitters during the three-crisis period. During the GFC, New Zealand (68.52%), Vietnam (64.21%), and the Philippines (49.93%) emerged as the primary net recipients of volatility spillovers (Fig. 4.50). Amidst the COVID-19 pandemic, China (31.01%), Vietnam (27.27%), and the Philippines (27.01%) are the primary recipients of volatility spillovers. In comparison, Canada (54.47%) and the US (43.64%) act as significant transmitters (Fig. 4.53). In the case of the Russia-Ukraine conflict, the US (101.31%), Canada (95.05%), Peru, and Mexico are the primary transmitters of spillovers. In contrast, New Zealand (40.3%), the Philippines (39.2%), Australia, and Japan receive the volatility spillovers (Fig. 4.54).

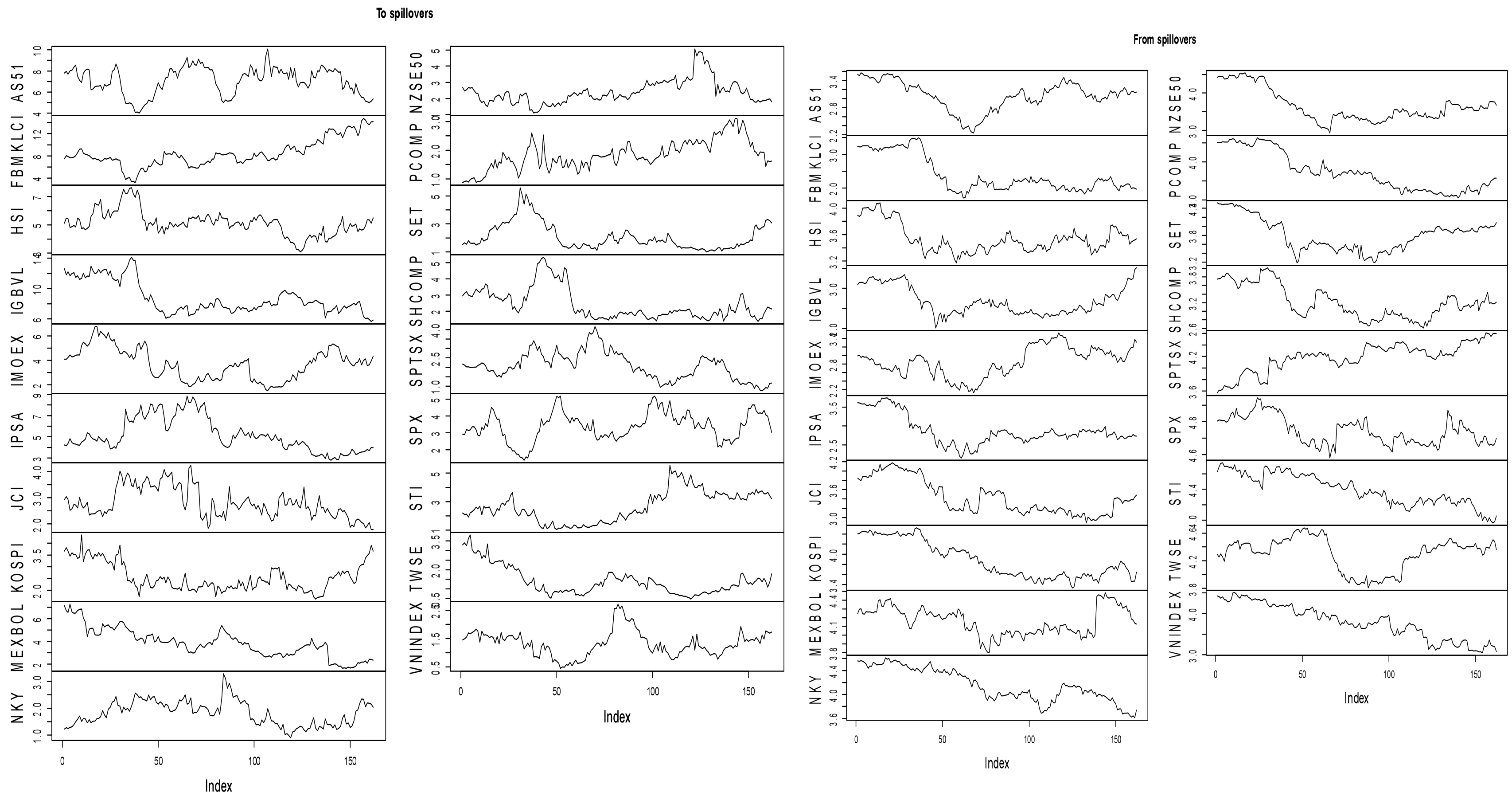


Fig. 4.50: Transmission of the volatility spillover “to spillover” (transmitter) and “from spillover” (receiver) during the GFC in APEC bloc. (Source: Author’s using R software).

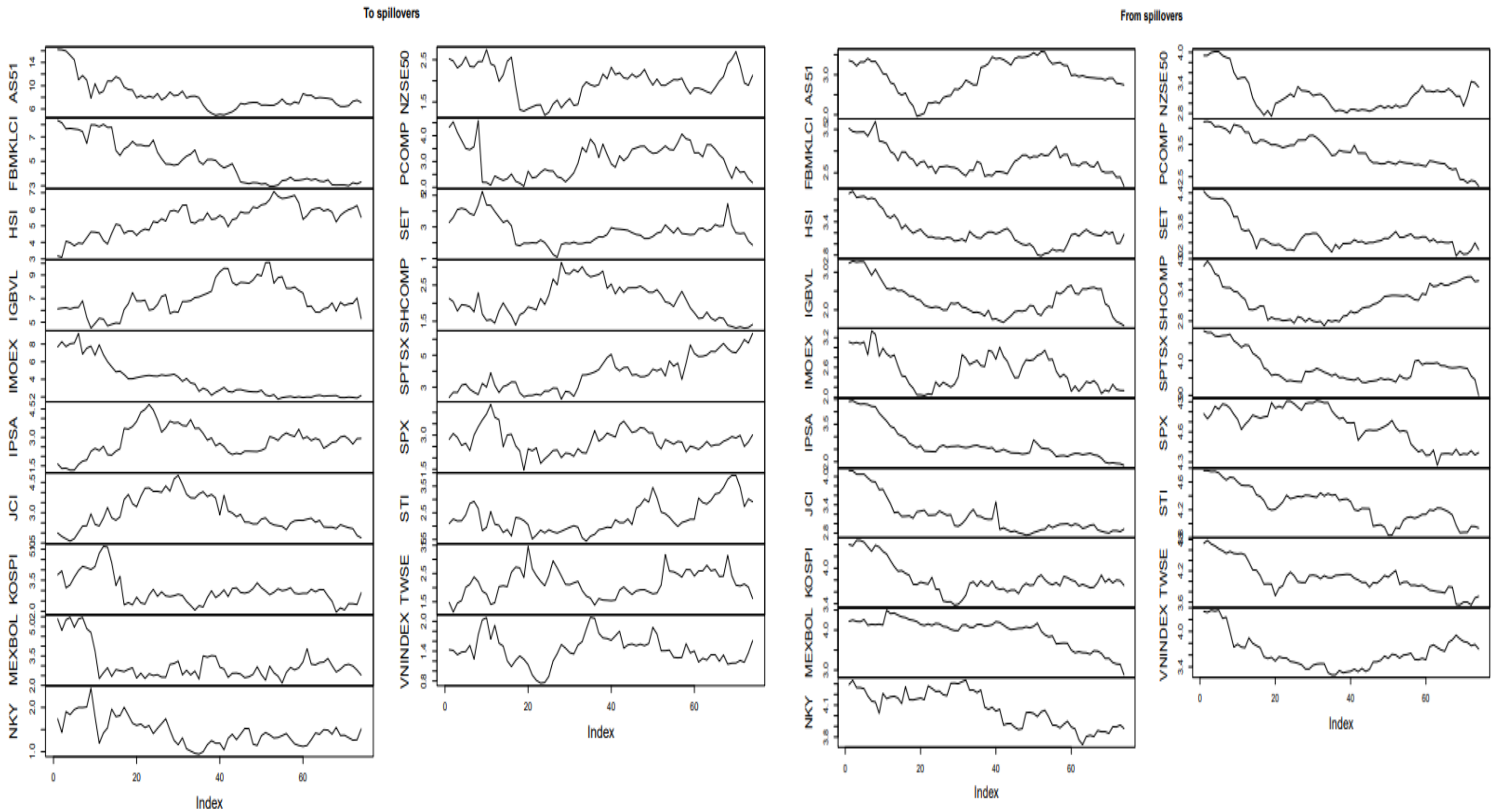


Fig. 4.51: Transmission of the volatility spillover "to spillover" (transmitter) and "from spillover" (receiver) during the COVID-19in the APEC bloc. (Source: Author's using R software).

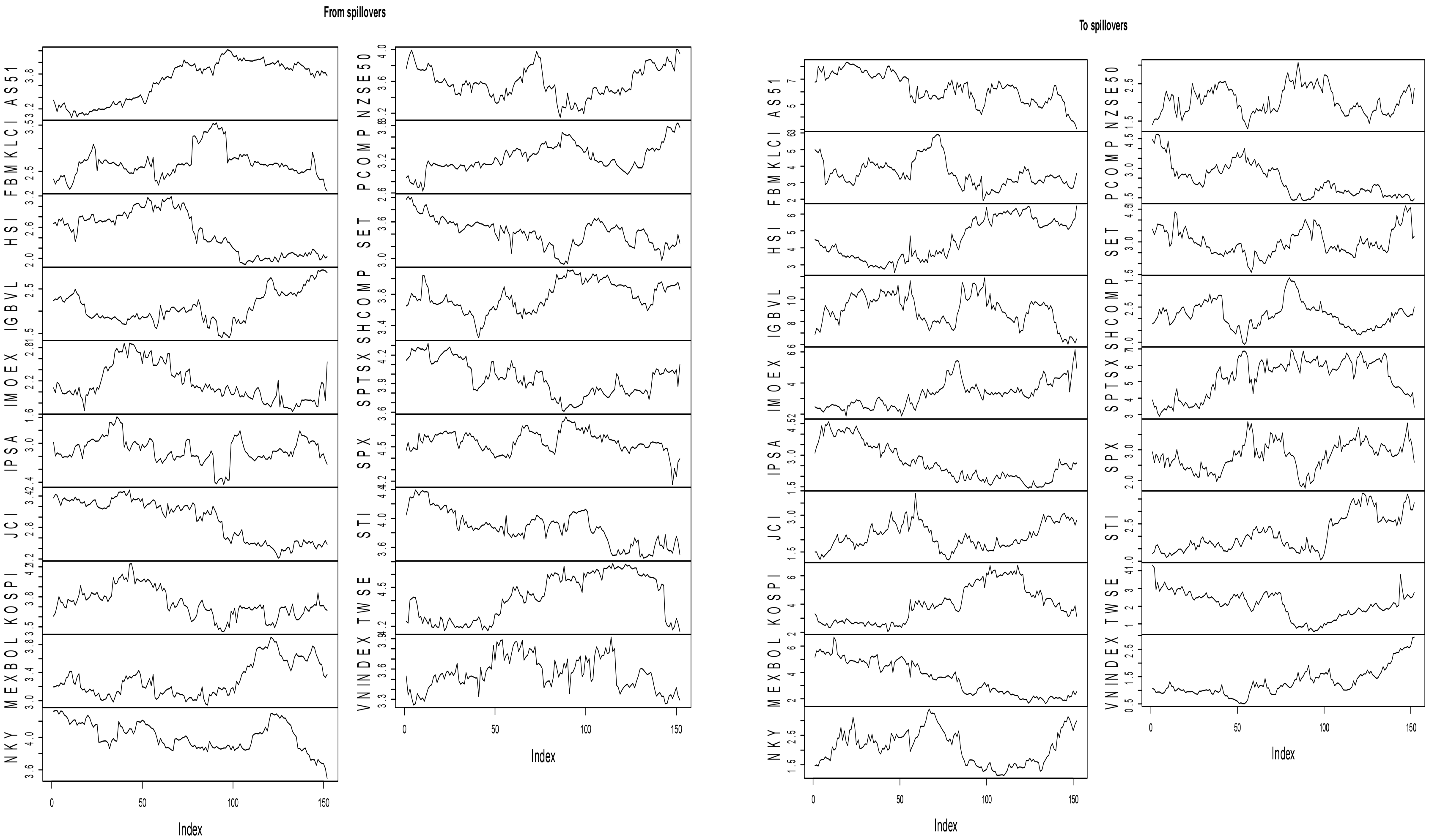


Fig. 4.52: Transmission of the volatility spillover “to spillover” (transmitter) and “from spillover” (receiver) during the Russia-Ukraine war in the APEC bloc. (Source: Author using R software).

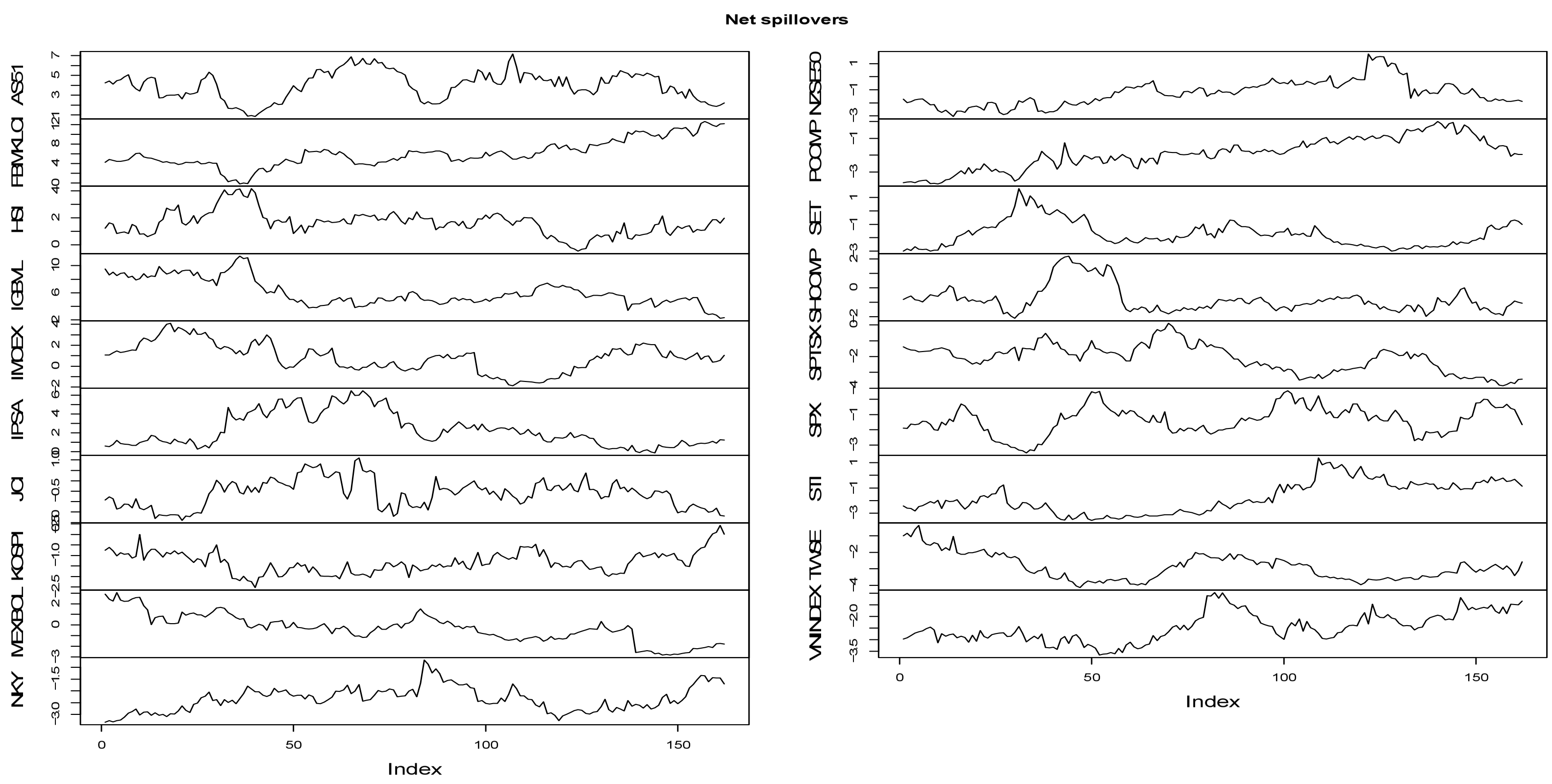


Fig. 4.53: Net spillover during GFC in APEC bloc (Source: Author's using R software).

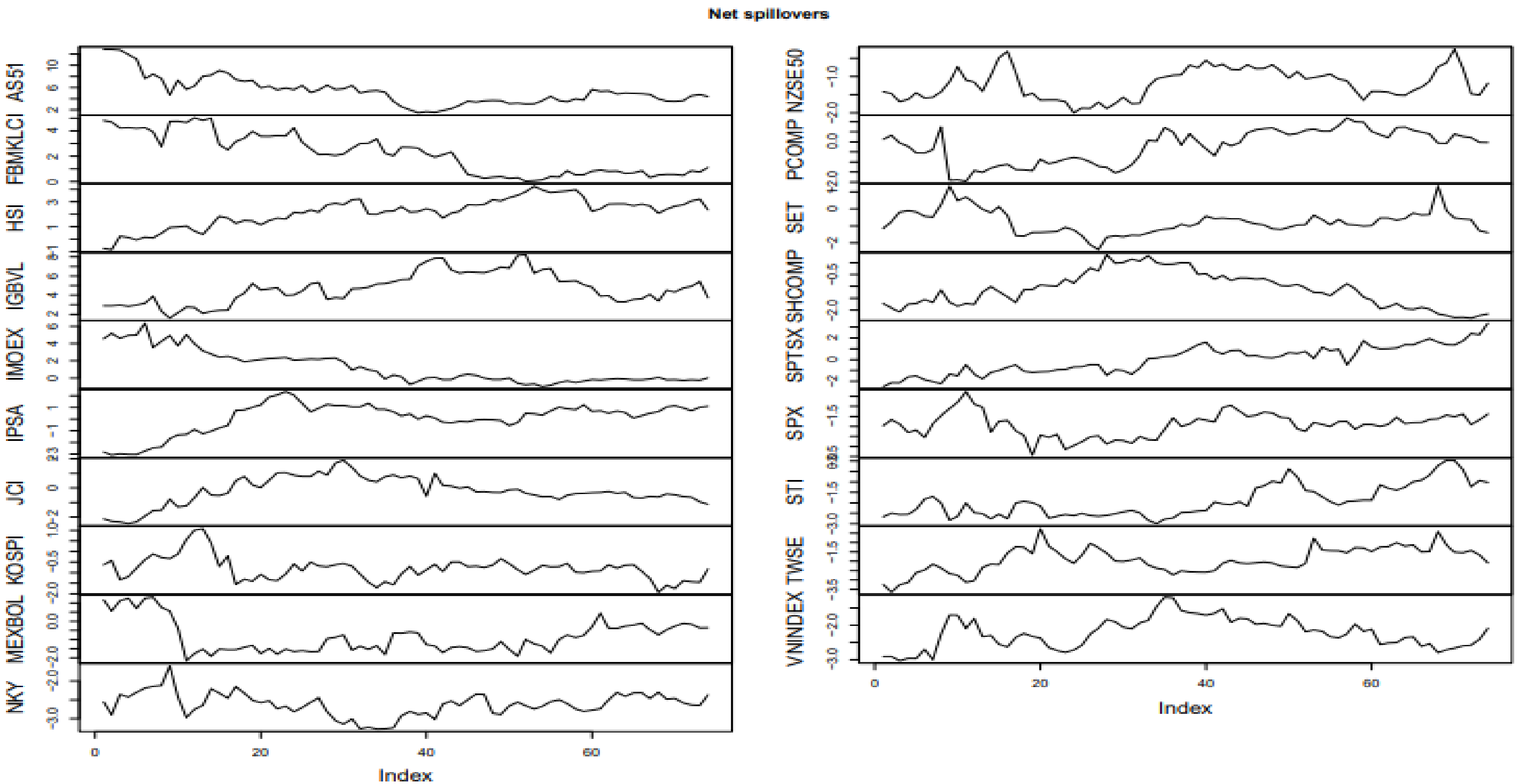


Fig. 4.54: Net total directional connectedness during COVID-19(Source: Author's using R software).

4.13.2.2 Frequency Domain

Unlike DY (2012), which only considered the time domain, this study addresses this limitation by incorporating the TVP-VAR-BK (2018) method to examine the spillover effects across different frequencies. The results of this analysis are presented in Table 4.20.0, Table 4.21.0, and Table 4.22.0, providing a comprehensive overview of return spillover patterns at short-term, medium-term, and long-term frequencies for different sub-periods.

In the system, the total return connectedness is higher in the short term during the Global Financial Crisis (GFC) period, reaching 58.87%, in comparison to the short-term connectedness observed during the COVID-19 pandemic, which amounted to 51.27%, and the Russia-Ukraine conflict, which stood at 45.40%). These results indicate that the interactions among these markets were more significant within one week. Analyzing the spillover effects, this study finds that the directional spillovers listed in Table 3 persist at different frequencies. For instance, the US and Canada transmit to New Zealand, Vietnam, Philippines, and Japanese equity markets across various frequency levels. Therefore, we conclude that the spillover from all three significant crises to these APEC blocs mainly occurs in the short term (less than one week). However, it is worth noting that in the medium-term (less than a month) and long-term (more than one month), the COVID-19 pandemic dominates the other crisis. Therefore, investors can adjust their investment strategies accordingly in the short term. Fig. 4.55 covers the Net spillover during the Russia-Ukraine war.

Table 4.20.0:TVP-VAR-BK (2018) Return spillover results for GFC on APEC (Source: Author’s).

	AS51	FBMKLCI	HSI	IGBVL	IMOEX	IPSA	JCI	KOSPI	MEXBOL	NKY	NZSE50	PCOMP	SET	SHCOMP	SPTSX	SPX	STI	TWSE	VNINDEX	FROM
Panel A: Frequency 1 of short term 1-5 days																				
AS51	**12.37**	2.59	3.23	6.81	3.48	4.58	1.81	2.93	6.88	1.61	1.31	0.44	2.96	1.01	5.74	8.84	2.98	2.22	0.17	59.59
FBMKLCI	1.93	**15.56**	3.72	3.91	2.17	1.92	3.58	2.25	3.07	1.1	0.94	2.54	4.8	2.11	1.77	2.62	5.28	3.28	0.38	47.37
HSI	3.21	3.86	**14.32**	4.11	2.72	2.62	2.84	5.04	5.37	2.57	0.3	2.65	5.83	4.82	2.81	4.27	6.97	4.21	0.14	64.34
IGBVL	2.18	3.4	3.01	**16.5**	3.9	5.91	3.73	2.57	6.72	0.99	0.98	1.26	4.27	1.68	4.04	5.79	4.33	1.67	0.5	56.93
IMOEX	1.54	3.34	3.17	6.03	**21.19**	3.39	2.25	3.96	5.94	4.28	0.86	1.44	3.2	1.27	5.33	4.82	2.68	3.71	0.75	57.96
IPSA	2.47	2.13	2.62	8.27	2.96	**19.67**	1.93	2.57	9.13	0.45	1.39	1.06	3.83	0.98	5.12	9.69	2.95	0.85	0.39	58.79
JCI	2.04	3.55	3.38	4.82	2.35	2.2	**15.39**	2.85	3.33	1.84	1.24	1.84	5.15	1.28	2.29	3.23	5.58	2.47	0.3	49.74
KOSPI	4.05	2.61	6.1	4.25	3.25	2.59	2.55	**15.73**	4.67	5.18	0.56	1.5	3.36	3.29	2.49	3.88	4.38	5.82	0.3	60.83
MEXBOL	2.29	2.51	4.73	8.08	4.33	8.14	2.11	4.1	**15.96**	1.36	0.69	0.72	4.89	1.35	6.92	11.08	3.92	1.41	0.4	69.03
NKY	2.68	1.24	3.17	8.48	3.66	7.98	1.65	3.68	9.5	**11.41**	0.5	0.8	3.67	0.78	5.6	10.03	2.59	2.32	0.23	68.56
NZSE50	3.5	2.41	3.25	7.3	2.78	5.76	2.77	2.14	7.76	1.07	**10.92**	1.3	3.72	0.84	7.25	11.36	3.37	1.17	0.37	68.12
PCOMP	1.56	3.09	3.17	4.78	3.91	3.5	2.66	3.47	5.77	2.04	1.22	**12.63**	3.53	1.31	3.61	6.81	2.42	1.88	0.48	55.21
SET	2.03	4.22	5.58	3.44	2.1	2.91	3.95	2.88	3.73	1.58	0.85	2.47	**13.93**	2.16	2.45	3.3	6.19	2.65	0.5	52.99
SHCOMP	0.9	4.39	7.56	3.74	3.71	1	2.14	3.47	3.3	0.89	0.39	1.84	3.54	**29.6**	1.42	2.27	4.34	2.81	0.89	49.09
SPTSX	2.35	2.58	3.08	5.96	4.72	5.71	1.95	2.54	8.01	2.74	1.18	0.88	4.17	0.69	**19.78**	11.79	3.35	1.95	0.68	64.33
SPX	4.11	2.51	3.48	7.25	3.47	8.61	1.52	3.52	11.74	1.33	1.27	0.82	4.17	0.66	11.37	**18.16**	3.38	1.61	0.41	71.23
STI	2.82	5.87	7.35	4.31	2	2.26	4.98	3.89	4.02	1.63	1.05	2.5	6.54	2.98	2.73	3.56	**14.17**	4.8	0.27	63.56
TWSE	2.8	3.94	4.73	3.19	3.1	2.08	3.16	5.45	3.27	3.47	0.23	1.86	3.35	2.11	3.12	3.51	5.34	**15.43**	0.29	55
VNINDEX	2.06	2.39	1.91	5.73	3.35	3.41	1.97	1.59	4.76	0.85	0.78	0.4	2.4	1.27	3.42	4.96	2.66	1.93	**16.85**	45.84
TO	44.52	56.63	73.24	100.46	57.96	75.06	47.55	58.9	106.97	34.98	15.74	26.32	73.38	30.59	77.48	111.81	72.71	46.76	7.45	1118.51
NET	-15.07	9.26	8.9	43.53	0	16.27	-2.19	-1.93	37.94	-33.58	-52.38	-28.89	20.39	-18.5	13.15	40.58	9.15	-8.24	-38.39	**58.87**
Panel B: Frequency 2 of Medium- Term (6 -22days)																				
AS51	**1.99**	0.52	1.11	1.56	1.38	1.45	1.02	0.96	2.4	0.64	0.25	0.1	1.01	0.04	1.95	2.76	1.46	0.8	0.14	19.55
FBMKLCI	0.54	**3.16**	1.76	1.86	1.9	1.27	2.18	1.49	2.5	0.76	0.18	1.01	1.96	0.47	1.28	1.83	2.48	1.24	0.3	25.01
HSI	0.46	0.33	**1.92**	0.95	1.06	0.82	0.85	1.21	2.26	0.67	0.03	0.19	0.84	0.24	1.16	1.63	1.64	0.78	0.08	15.2
IGBVL	0.23	0.52	0.90	**3.42**	1.83	1.48	1.1	1.14	2.42	0.57	0.08	0.35	1.01	0.18	1.13	1.66	1.64	0.81	0.22	17.27
IMOEX	0.19	0.26	0.55	1.37	**3.91**	0.99	0.73	0.88	1.88	0.74	0.05	0.16	0.47	0.06	1.46	1.36	0.71	0.51	0.19	12.56
IPSA	0.09	0.32	0.45	1.3	1.09	**4.11**	0.45	0.59	2.17	0.16	0.13	0.17	0.92	0.12	1.24	1.79	0.93	0.39	0.21	12.52
JCI	0.51	0.79	1.37	2.36	1.83	1.37	**4.15**	1.67	2.52	0.85	0.21	0.66	1.64	0.24	1.36	1.88	2.29	0.89	0.28	22.72
KOSPI	0.5	0.31	1.23	1.16	1.47	0.91	0.78	**3.05**	2.09	0.94	0.07	0.21	0.67	0.19	1	1.43	1.42	1.04	0.08	15.5
MEXBOL	0.13	0.16	0.54	0.84	0.88	1.1	0.42	0.72	**2.69**	0.27	0.05	0.06	0.4	0.05	1.12	1.66	0.82	0.34	0.11	9.67
NKY	0.34	0.13	0.74	1.16	1.37	1.06	0.49	1.12	2.16	**1.67**	0.05	0.12	0.65	0.04	1.43	1.75	0.93	0.56	0.14	14.24

NZSE50	0.48	0.38	0.6	1.02	0.95	1.26	0.78	0.5	1.71	0.38	**1.85**	0.19	0.8	0.12	1.59	2.01	1.04	0.37	0.31	14.49
PCOMP	0.26	0.72	1.53	1.86	2.27	1.24	1.23	1.59	2.49	1.21	0.13	**3.26**	1.17	0.31	1.11	1.97	1.53	0.85	0.38	21.85
SET	0.4	0.67	1.34	1.86	1.74	2.04	1.6	1.48	2.94	0.65	0.24	0.56	**3.01**	0.21	1.54	2.17	1.73	0.74	0.45	22.36
SHCOMP	0.05	0.44	1.31	0.81	0.91	0	0.88	0.6	0.84	0.17	0.19	0.52	0.69	**5.68**	0.4	0.56	0.89	0.5	0.32	10.47
SPTSX	0.27	0.14	0.43	0.76	0.78	0.88	0.45	0.52	1.51	0.47	0.05	0.08	0.56	0.03	**2.45**	1.86	0.7	0.47	0.1	10.06
SPX	0.16	0.08	0.28	0.49	0.52	0.84	0.22	0.33	1.4	0.17	0.03	0.04	0.34	0.02	1.06	**1.76**	0.43	0.2	0.05	6.66
STI	0.4	0.57	1.25	1.06	0.89	0.76	1.17	0.95	1.92	0.53	0.07	0.25	1.08	0.16	1.16	1.51	**2.64**	0.94	0.14	14.81
TWSE	0.67	0.62	1.7	1.04	1.83	0.63	1.59	1.85	1.78	1.11	0.04	0.46	0.93	0.23	1.61	1.62	2.19	**3.49**	0.08	19.98
VNINDEX	0.32	0.93	0.79	2.76	2.04	1.58	1.61	1.27	2.71	0.9	0.23	0.25	1.24	0.25	1.42	1.93	1.89	1.23	**5.05**	23.35
TO	6	7.89	17.88	24.22	24.74	20.07	17.55	18.87	37.7	11.19	2.08	5.38	16.38	2.96	23.02	31.38	24.72	12.66	3.58	308.27
NET	-13.55	-17.12	2.68	6.95	12.18	7.55	-5.17	3.37	28.03	-3.05	-12.41	-16.47	-5.98	-7.51	12.96	24.72	9.91	-7.32	-19.77	**16.22**
Panel C: Frequency 3 of Longer than 22 days																				
AS51	**0.65**	0.12	0.33	0.46	0.4	0.4	0.34	0.28	0.75	0.2	0.06	0.01	0.26	0	0.62	0.88	0.47	0.25	0.04	5.87
FBMKLCI	0.14	**0.92**	0.56	0.62	0.62	0.37	0.72	0.5	0.83	0.25	0.03	0.32	0.55	0.14	0.38	0.58	0.83	0.38	0.11	7.93
HSI	0.12	0.04	**0.53**	0.22	0.25	0.15	0.22	0.3	0.6	0.18	0	0.03	0.15	0.04	0.3	0.44	0.46	0.19	0.02	3.71
IGBVL	0.05	0.11	0.25	**1.05**	0.55	0.38	0.32	0.34	0.74	0.17	0	0.09	0.22	0.04	0.31	0.47	0.5	0.23	0.06	4.83
IMOEX	0.04	0.04	0.13	0.38	**1.16**	0.25	0.2	0.23	0.52	0.21	0	0.03	0.08	0	0.4	0.36	0.18	0.12	0.05	3.22
IPSA	0.01	0.09	0.11	0.35	0.32	**1.3**	0.14	0.17	0.66	0.04	0.02	0.04	0.25	0.04	0.37	0.5	0.28	0.13	0.06	3.58
JCI	0.12	0.18	0.4	0.75	0.56	0.38	**1.33**	0.52	0.79	0.27	0.03	0.19	0.41	0.06	0.38	0.56	0.74	0.26	0.09	6.69
KOSPI	0.11	0.05	0.33	0.3	0.4	0.2	0.2	**0.9**	0.57	0.27	0.01	0.05	0.12	0.05	0.25	0.38	0.39	0.27	0.02	3.97
MEXBOL	0.02	0.01	0.12	0.17	0.18	0.19	0.09	0.16	**0.68**	0.05	0	0	0.03	0	0.25	0.4	0.19	0.06	0.02	1.94
NKY	0.08	0.01	0.18	0.29	0.36	0.23	0.12	0.3	0.58	**0.5**	0	0.02	0.12	0	0.38	0.46	0.25	0.16	0.04	3.58
NZSE50	0.14	0.08	0.16	0.28	0.25	0.33	0.24	0.13	0.5	0.11	**0.57**	0.03	0.19	0.02	0.48	0.6	0.31	0.1	0.1	4.05
PCOMP	0.04	0.15	0.43	0.55	0.67	0.3	0.34	0.47	0.73	0.37	0.01	**1.04**	0.25	0.08	0.27	0.54	0.46	0.22	0.12	6
SET	0.1	0.17	0.41	0.58	0.54	0.6	0.52	0.48	0.95	0.21	0.04	0.16	**0.85**	0.05	0.46	0.66	0.58	0.23	0.15	6.89
SHCOMP	0	0.08	0.42	0.25	0.28	0	0.27	0.17	0.24	0.05	0.07	0.18	0.2	**2.02**	0.12	0.17	0.27	0.15	0.11	3.15
SPTSX	0.09	0.01	0.11	0.19	0.2	0.2	0.12	0.13	0.42	0.13	0	0.01	0.11	0	**0.75**	0.55	0.19	0.14	0.02	2.62
SPX	0.04	0	0.06	0.12	0.12	0.21	0.05	0.07	0.39	0.04	0	0	0.07	0	0.31	**0.52**	0.11	0.05	0.01	1.65
STI	0.11	0.12	0.36	0.29	0.23	0.16	0.35	0.27	0.56	0.15	0.01	0.06	0.24	0.03	0.32	0.44	**0.81**	0.26	0.04	4
TWSE	0.2	0.09	0.47	0.24	0.48	0.09	0.44	0.49	0.45	0.32	0	0.1	0.15	0.05	0.44	0.45	0.6	**1.01**	0.01	5.07
VNINDEX	0.07	0.24	0.23	0.9	0.68	0.44	0.51	0.42	0.9	0.31	0.03	0.07	0.31	0.05	0.42	0.59	0.61	0.38	**1.77**	7.16
TO	1.48	1.59	5.06	6.94	7.09	5	5.19	5.43	11.18	3.33	0.31	1.39	3.71	0.65	6.46	9.03	7.42	3.58	1.07	85.91
NET	-4.39	-6.34	1.35	2.11	3.87	1.42	-1.5	1.46	9.24	-0.25	-3.74	-4.61	-3.18	-2.5	3.84	7.38	3.42	-1.49	-6.09	**4.52**

Table 4.21.0: Baruník and Křehlík (2018) return spillover results of APEC countries for the COVID-19 pandemic.(Source: Author using R software)

	AS51	FBMKLCI	HSI	IGBVL	IMOEX	IPSA	JCI	KOSPI	MEXBOL	NKY	NZSE50	PCOMP	SET	SHCOMP	SPTSX	SPX	STI	TWSE	VNINDEX	FROM
Panel A: Frequency 1 of short-term (1-5 days)																				
AS51	**15.09**	1.85	3.06	2.81	3.03	2.17	3.72	2.92	3.14	3.12	3	4.23	5.21	1.46	4.43	3.92	3.44	2.74	3.64	57.89
FBMKLCI	2.17	**13.63**	3.17	1.3	1.84	2.9	3.01	2.78	1.57	2.59	1.83	2.59	3.3	2.19	2.26	2.3	4.58	4.27	0.66	45.31
HSI	2.64	4.25	**13.38**	1.75	1.81	2.48	2.2	4.72	3.06	2.89	1.58	1.63	4.7	4.76	2.3	2.51	5.54	5.82	1.49	56.13
IGBVL	3.02	1.26	1.95	**15.55**	3.32	4.36	1.79	1.2	7.04	1.36	1.88	2.07	4.79	1.74	7.56	6.17	2.85	2.07	2.22	56.65
IMOEX	2.02	1.17	2.47	4.08	**20.34**	3.81	1.52	2.74	4.99	2.47	2.29	1.21	3.85	0.91	7.72	4.1	1.46	1.82	1.64	50.27
IPSA	2.12	2.24	2.67	4.48	2.93	**12.05**	2.27	1.95	3.02	1.09	1.99	3.61	4.39	1.42	3.88	2.87	2.76	2.77	1.36	47.82
JCI	2.72	3.02	1.9	1.32	1.4	2.58	**14.72**	2.6	2.12	1.19	1.75	5.45	3.2	1.07	2.54	2.26	3.21	2.56	1.15	42.04
KOSPI	2.28	2.36	4.01	1.08	2.74	2.05	2.29	**10.43**	1.96	2.77	2.02	2.55	3.48	1.58	2.37	2.17	3.76	5.24	1.49	46.2
MEXBOL	4.14	1.74	2.02	8.64	3.19	3.81	2.69	2.12	**17.9**	3.62	1.87	1.22	1.89	1.61	8.35	8.51	2.75	1.39	2.26	61.82
NKY	3.66	2.26	2.89	1.84	2.27	1.93	1.73	4.02	3.25	**12.95**	3.06	1.14	2.18	1.41	3.65	4.78	3.72	2.68	2.11	48.58
NZSE50	3.28	1.44	1.78	2.88	1.85	3.74	1.18	1.84	2.83	2.86	**12.42**	1.63	2.83	1.16	3.52	3.36	1.69	2.81	0.72	41.4
PCOMP	3.43	2.68	2.2	2.53	2.14	2.09	4.86	2.67	4.05	1.2	1.11	**18.31**	1.63	1.3	2.58	1.67	2.58	1.88	2.66	43.26
SET	2.9	3.92	4	2.81	2.65	3.46	2.68	2.68	1.93	1.9	2.57	2.38	**13.88**	3.05	4.55	3.26	5.24	3.61	1.62	55.21
SHCOMP	1.37	3.25	6.89	1.48	0.94	2	1.81	2.73	1.72	1.64	1.69	0.71	3.83	**19.4**	1.64	1.98	3.74	5.14	1.46	44.07
SPTSX	3.87	2.31	2.02	6.25	4.92	4.06	2.59	2.65	5.23	2.38	2.87	2.89	7.43	1.26	**11.18**	8.31	3.7	3.05	3.06	68.85
SPX	4.47	1.92	2.03	5.87	4.76	3.53	2.63	2.96	5.08	2.8	3.13	3.31	7.22	1.26	9.9	**11.85**	3.87	3.22	2.66	70.62
STI	2.94	4.24	3.76	1.96	1.55	1.98	2.81	3.84	2.84	2.29	1.7	1.93	5.92	1.88	2.92	2.96	**9.6**	4.57	2.33	52.42
TWSE	1.91	2.8	3.76	2.08	1.96	2.53	1.91	4.33	2.36	2.19	2.42	2	2.48	2.54	2.71	2.55	3.24	**9.74**	0.7	44.47
VNINDEX	3.26	1.68	1.87	2.14	1.12	1.1	1.41	2.11	2.67	2.38	1.64	2.34	2.72	1.61	4.01	3.57	3.8	1.77	**14.96**	41.2
TO	52.2	44.39	52.45	55.3	44.42	50.63	43.1	50.86	58.86	40.74	38.4	42.89	71.05	32.21	76.89	67.25	61.93	57.41	33.23	974.21
NET	-5.69	-0.92	-3.68	-1.35	-5.85	2.81	1.06	4.66	-2.96	-7.84	-3	-0.37	15.84	-11.86	8.04	-3.37	9.51	12.94	-7.97	**51.27**
Panel B: Frequency 2 of Medium-Term (6-22 days)																				
AS51	**1.83**	0.42	0.44	0.96	1.08	0.93	0.55	0.78	1.23	1.22	0.78	0.27	0.55	0.11	1.83	1.86	0.86	0.57	0.35	14.79
FBMKLCI	1.09	**2.75**	1.29	1.4	1.58	1.28	0.75	0.95	1.14	2.1	0.97	0.33	1.74	0.69	2.22	2.35	1.99	1.15	0.78	23.8
HSI	0.82	0.7	**2.4**	0.78	1.29	1.1	0.39	1.16	1.03	1.25	0.61	0.21	0.86	1.08	1.51	1.65	1.28	0.98	0.41	17.11
IGBVL	0.7	0.19	0.48	**3.1**	1.22	1.12	0.3	0.6	2.09	0.74	0.48	0.23	0.68	0.12	1.87	1.79	0.76	0.44	0.38	14.19
IMOEX	0.61	0.34	0.61	0.69	**4.96**	0.73	0.15	0.72	1.08	1.34	0.7	0.02	1.57	0.19	2.5	1.87	0.57	0.28	0.48	14.45
IPSA	1.17	0.95	0.8	1.13	1.91	**3.79**	0.72	1.01	1.15	1.58	1.12	0.36	1.57	0.32	2.34	2.28	1.21	0.89	0.18	20.69
JCI	1.15	1.08	0.98	1.01	1.64	1.91	**2.65**	1.64	1.5	1.53	0.93	0.79	1.22	0.61	2.38	2.5	1.62	1.31	0.4	24.2
KOSPI	0.86	1.14	1.36	1.07	2.32	1.57	0.67	**2.66**	1.12	2	0.72	0.28	1.39	0.5	2.45	2.4	1.72	1.72	0.67	23.96
MEXBOL	0.47	0.15	0.36	1.19	0.75	0.92	0.27	0.71	**2.74**	0.73	0.24	0.21	0.21	0.08	1.36	1.44	0.44	0.49	0.27	10.29
NKY	0.94	0.59	0.99	1.12	2.28	0.9	0.22	1.39	1.63	**4.22**	0.42	0.06	1	0.33	2.7	2.86	1.21	0.74	1.22	20.6

NZSE50	1.74	0.86	0.95	1.86	1.57	1.36	0.68	1.46	1.66	1.79	**3.08**	0.49	1.17	0.47	2.88	2.84	1.46	1.76	0.52	25.52
PCOMP	1.08	1.12	1.09	1.05	1.58	1.99	1.27	1.57	1.27	1.22	0.37	**2.39**	1.01	0.21	1.89	1.62	1.61	1	0.63	21.58
SET	0.96	0.33	0.5	1.14	1.66	0.81	0.46	0.98	1.06	1.25	0.94	0.19	**2.03**	0.2	2.25	1.93	1.13	0.57	1.04	17.4
SHCOMP	0.61	1.5	2.22	1.16	0.91	1	0.73	0.86	1.07	0.78	0.85	0.24	1.16	**5.15**	1.32	1.61	1.48	1.87	0.47	19.58
SPTSX	0.5	0.31	0.33	0.7	1.24	0.59	0.23	0.62	0.9	1.01	0.42	0.07	0.6	0.12	**1.87**	1.66	0.62	0.46	0.39	10.77
SPX	0.41	0.26	0.35	0.61	0.8	0.48	0.25	0.65	0.93	0.83	0.31	0.13	0.38	0.18	1.44	**1.77**	0.55	0.42	0.35	9.33
STI	1.01	0.92	1.33	1.34	1.53	1.5	0.52	1.27	1.57	1.87	0.46	0.41	1.04	0.44	2.24	2.36	**2.15**	0.93	0.89	21.63
TWSE	1	1.22	1.63	1.61	2.24	1.87	0.49	1.57	1.38	2.02	1.05	0.16	1.51	0.85	2.71	2.65	1.77	**2.37**	0.57	26.3
VNINDEX	1.8	0.29	0.71	1.42	1.51	0.96	0.49	1.63	1.77	0.79	0.69	1.07	0.63	0.77	3.15	2.67	1.72	0.88	**4.88**	22.95
TO	16.92	12.37	16.42	20.24	27.11	20.76	9.14	19.57	23.58	24.05	12.06	5.52	18.29	7.27	39.04	38.34	22	16.46	10	359.14
NET	2.13	-11.43	-0.69	6.05	12.66	0.07	-15.06	-4.39	13.29	3.45	-13.46	-16.06	0.89	-12.31	28.27	29.01	0.37	-9.84	-12.95	**18.90**
Panel C: Frequency 3 of Longer than 22 days																				
AS51	**0.95**	0.25	0.3	0.54	0.81	0.6	0.27	0.52	0.68	0.85	0.44	0.13	0.45	0.06	1.2	1.19	0.55	0.31	0.28	9.43
FBMKLCI	0.6	**1.2**	0.67	0.69	1.03	0.77	0.35	0.63	0.62	1.17	0.5	0.2	1.03	0.28	1.31	1.33	1.08	0.54	0.5	13.3
HSI	0.45	0.38	**1.13**	0.42	0.88	0.64	0.2	0.68	0.55	0.79	0.33	0.11	0.59	0.42	0.94	0.98	0.72	0.46	0.29	9.83
IGBVL	0.43	0.13	0.3	**1.51**	0.88	0.7	0.17	0.41	1.08	0.52	0.29	0.14	0.51	0.06	1.21	1.14	0.49	0.25	0.29	9
IMOEX	0.32	0.16	0.3	0.34	**2.46**	0.41	0.08	0.41	0.53	0.72	0.34	0	0.82	0.06	1.31	0.98	0.31	0.14	0.3	7.53
IPSA	0.69	0.55	0.51	0.68	1.48	**2.17**	0.36	0.71	0.73	1.12	0.61	0.18	1.12	0.13	1.63	1.52	0.78	0.46	0.2	13.46
JCI	0.69	0.62	0.61	0.61	1.24	1.18	**1.16**	1.02	0.88	1.08	0.51	0.37	0.93	0.27	1.6	1.62	1	0.64	0.35	15.22
KOSPI	0.58	0.62	0.79	0.63	1.65	1	0.35	**1.6**	0.72	1.36	0.45	0.18	0.97	0.22	1.65	1.57	1.06	0.82	0.53	15.15
MEXBOL	0.27	0.09	0.21	0.58	0.54	0.54	0.14	0.4	**1.18**	0.47	0.14	0.11	0.19	0.04	0.81	0.83	0.28	0.23	0.18	6.05
NKY	0.54	0.31	0.51	0.54	1.39	0.56	0.12	0.81	0.82	**2.15**	0.25	0.05	0.66	0.13	1.54	1.58	0.69	0.33	0.7	11.53
NZSE50	0.99	0.52	0.59	1.03	1.21	0.92	0.36	0.94	0.96	1.23	**1.54**	0.24	0.92	0.23	1.9	1.83	0.91	0.86	0.41	16.05
PCOMP	0.66	0.6	0.62	0.62	1.1	1.18	0.6	0.98	0.74	0.89	0.26	**0.99**	0.75	0.09	1.33	1.14	0.95	0.48	0.48	13.47
SET	0.53	0.22	0.31	0.6	1.11	0.55	0.24	0.61	0.57	0.77	0.47	0.12	**1.19**	0.08	1.35	1.15	0.68	0.31	0.61	10.28
SHCOMP	0.32	0.65	1.01	0.58	0.55	0	0.31	0.48	0.55	0.45	0.4	0.11	0.63	**1.95**	0.74	0.86	0.74	0.78	0.31	9.86
SPTSX	0.29	0.16	0.19	0.37	0.8	0.37	0.11	0.37	0.47	0.6	0.23	0.04	0.42	0.05	**1.09**	0.96	0.36	0.21	0.27	6.27
SPX	0.24	0.14	0.2	0.32	0.55	0.31	0.12	0.37	0.47	0.52	0.17	0.07	0.29	0.07	0.86	**0.99**	0.33	0.2	0.24	5.47
STI	0.59	0.5	0.72	0.7	1.07	0.92	0.27	0.81	0.84	1.18	0.28	0.22	0.77	0.18	1.43	1.44	**1.21**	0.45	0.6	12.97
TWSE	0.62	0.65	0.89	0.87	1.5	1.12	0.27	1.02	0.8	1.3	0.6	0.11	1.03	0.35	1.74	1.66	1.06	**1.08**	0.44	16.03
VNINDEX	0.93	0.21	0.46	0.75	1.11	0.63	0.28	0.97	0.93	0.66	0.39	0.48	0.57	0.34	1.89	1.63	1.04	0.47	**2.28**	13.74
TO	9.74	6.76	9.19	10.87	18.9	12.79	4.6	12.14	12.94	15.68	6.66	2.86	12.65	3.06	24.44	23.41	13.03	7.94	6.98	214.64
NET	0.31	-6.54	-0.64	1.87	11.37	-0.67	-10.62	-3.01	6.89	4.15	-9.39	-10.61	2.37	-6.8	18.17	17.94	0.06	-8.09	-6.76	**11.30**

Table 4.22.0 Baruník and Křehlík (2018) return spillover results for the Russia - Ukraine crisis.(Source: Author using R software)

	AS51	FBMKLCI	HSI	IGBVL	IMOEX	IPSA	JCI	KOSPI	MEXBOL	NKY	NZSE50	PCOMP	SET	SHCOMP	SPTSX	SPX	STI	TWSE	VNINDEX	FROM
Panel A: Frequency 1 of short term 1-5 days																				
AS51	**15.12**	0.63	0.94	6.13	0.52	2.22	0.39	4.38	5.49	1.77	1.86	0.24	3.32	0.52	14.09	13.38	1.51	2.84	0.16	60.39
FBMKLCI	1.79	**31.82**	2.04	2.77	0.77	1.45	1.46	3.27	2.17	2.19	1.24	1.1	5.22	1.02	4.55	5.82	1.78	2.73	0.89	42.26
HSI	1.63	2.46	**29.46**	1.89	0.16	0.64	1.07	5.01	1.28	2.12	1.47	0.83	4.08	12.93	2.82	2.67	5.15	5.72	1.7	53.63
IGBVL	1.51	1.62	1.63	**28.88**	0.86	3.73	1.58	2.14	6.36	1.1	0.72	0.26	3.86	0.87	11.19	6.24	4.25	0.83	0.16	48.91
IMOEX	0.21	1.02	0.35	1.57	**64.38**	1.11	1.1	0.57	0.42	0.52	0.96	0.21	0.57	0.19	0.5	0.28	0.86	0.33	1.78	12.55
IPSA	0.52	1.96	1.06	4.81	1.03	**43.55**	0.74	1.78	3.52	1.05	0.61	0.18	2.28	0.54	7.94	5.32	1.08	1.29	0.65	36.36
JCI	1.7	1.98	1.5	2.02	1.07	2.17	**38.71**	3.73	0.91	0.92	0.72	1.3	2.61	0.27	3.18	2.6	1.53	2.21	2.06	32.48
KOSPI	5.08	2.35	3.76	2.8	0.61	1.01	1.3	**20.93**	2.78	3.79	1.4	1.13	3.59	2.16	4.81	5.11	3.13	8.95	1.27	55.03
MEXBOL	1.53	3.29	1.04	8.32	1.12	3.64	0.3	1.12	**33.15**	0.16	1.39	1.97	3.14	1.32	7.96	7.64	1.79	0.05	0.08	45.86
NKY	2.49	1.82	2.12	2.21	0.71	2.2	0.62	4.91	3.09	**21.33**	0.79	0.39	3.59	1.43	8.03	10.84	2.1	5.6	0.66	53.6
NZSE50	2.81	0.75	1.58	2.45	1.65	2.1	1.09	1.44	3.02	0.85	**23.61**	1.76	3.32	0.63	7.15	10	2.5	1.42	1.62	46.14
PCOMP	2.01	1.09	1.67	3.36	3.05	1.91	1.93	1.82	2.93	1.12	2.5	**36.71**	1.17	1.28	6.61	7.05	2.44	0.91	1.34	44.19
SET	2.39	3.17	3.64	2.22	0.35	1.24	1.79	4.16	2.2	2.39	1.48	1.06	**27.33**	2.82	2.66	3.46	2.74	5	1.72	44.49
SHCOMP	1.28	1.42	14.39	2.43	0.22	1	0.36	4.09	1.76	1.74	0.55	0.59	3.43	**36.6**	2.2	1.75	2.78	5.68	1.47	46.65
SPTSX	1.66	1.12	0.86	9.43	0.53	5.27	1.19	1.07	5.47	1.23	0.5	0.29	3.35	0.72	**25.3**	16.55	1.76	1.24	0.06	52.3
SPX	1.73	1.63	0.48	6	0.72	3.85	0.66	0.83	6.27	1.75	1.75	0.41	4.68	0.28	20.21	**30.13**	1.33	1.15	0.23	53.96
STI	1.72	1.4	4.99	3.18	1.05	1.59	1.09	2.81	2.08	2.09	1.95	1.28	4.13	3.25	4.46	6.89	**22.9**	2.15	1.35	47.46
TWSE	2.81	1.74	3.5	3.25	0.46	1.41	1.18	7.62	3.04	4.45	1.08	0.53	4.9	2.83	5.81	5.84	2.14	**20.33**	0.97	53.56
VNINDEX	0.29	1.04	3.9	2.34	1.35	0.46	2.26	2.3	0.5	0.56	0.5	1.26	2.92	1.93	2.6	3.83	2.88	1.82	**45.75**	32.74
TO	33.16	30.49	49.45	67.18	16.23	36.51	20.11	53.05	53.29	29.8	21.47	14.79	60.16	34.99	116.77	115.27	41.75	49.92	18.17	862.56
NET	-27.23	-11.77	-4.18	18.27	3.68	0.15	-12.37	-1.98	7.43	-23.8	-24.67	-29.4	15.67	-11.66	64.47	61.31	-5.71	-3.64	-14.57	**45.40**
Panel B: Frequency 2 of Medium-Term (6-22 days)																				
AS51	**2.99**	0.3	0.11	1.95	0.21	0.42	0.09	0.83	2.22	0.57	0.58	0.03	0.42	0.03	3.51	3.69	0.41	0.2	0	15.57
FBMKLCI	0.78	**5.2**	0.23	1.69	0.53	0.82	0.39	1.03	1.44	0.63	0.16	0.27	1.27	0.03	1.95	2.27	0.36	0.53	0.05	14.43
HSI	0.3	0.1	**3.92**	0.85	0.07	0.13	0.09	0.47	0.56	0.5	0.39	0.11	0.33	1.17	0.93	1.08	1.2	0.52	0.28	9.08
IGBVL	0.19	0.2	0.09	**6.74**	0.19	0.73	0.23	0.33	2.89	0.16	0.15	0.05	0.29	0.08	2.71	1.53	0.36	0.05	0.01	10.24
IMOEX	0.06	0.06	0.05	0.2	**14.81**	0.35	0.07	0.08	0.3	0.06	0.15	0.13	0.32	0.02	0.21	0.17	0.01	0.07	0.16	2.47
IPSA	0.11	0.36	0.16	1.36	0.54	**6.37**	0.11	0.57	1.56	0.09	0.04	0.02	0.11	0.13	2.08	1.32	0.13	0.1	0.25	9.04
JCI	0.48	0.84	0.05	1.96	0.74	1.05	**7.24**	0.26	0.73	0.13	0.45	0.26	1.06	0.07	2.3	1.75	1.03	0.24	0.25	13.65
KOSPI	1.48	0.4	0.44	1.61	0.39	0.43	0.16	**3.38**	1.86	0.95	0.4	0.18	0.46	0.18	1.82	1.81	1.03	1.04	0.09	14.73
MEXBOL	0.41	0.21	0.03	2.14	0.1	0.49	0.05	0.26	**7.82**	0.03	0.1	0.04	0.16	0.01	1.91	1.86	0.15	0	0.04	7.99
NKY	1.03	0.45	0.37	1.12	0.33	0.49	0.17	0.88	1.06	**4.17**	0.28	0.04	0.52	0.25	2.6	3.52	0.8	0.76	0.02	14.69

NZSE50	1.16	0.41	0.18	1.4	0.25	0.08	0.38	0.68	1.86	0.57	**5.1**	0.64	1.16	0.07	2.39	4.01	1.37	0.18	0.42	17.21
PCOMP	0.57	0.33	0.15	0.63	0.73	0.44	0.21	0.58	1.67	0.33	0.32	**4.31**	0.26	0.03	1.46	1.79	0.49	0.1	0.22	10.31
SET	0.95	0.66	0.25	1.76	0.22	0.58	0.51	0.63	1.88	0.66	0.85	0.3	**4.36**	0.19	2.36	2.81	1.08	0.41	0.14	16.24
SHCOMP	0.07	0.05	2.68	0.4	0.06	0	0.1	0.25	0.49	0.41	0.05	0.02	0.31	**5.5**	0.55	0.6	0.3	0.44	0.41	7.25
SPTSX	0.4	0.31	0.07	2.71	0.26	1	0.15	0.31	2.64	0.14	0.07	0.02	0.2	0.05	**4.91**	3.64	0.22	0.06	0.01	12.26
SPX	0.28	0.33	0.03	1.19	0.15	0.59	0.05	0.17	1.39	0.25	0.14	0.03	0.22	0.01	2.8	**4.31**	0.19	0.04	0.03	7.89
STI	1	0.48	0.55	2.2	0.82	0.23	0.27	1.15	1.38	1.05	0.97	0.21	0.69	0.17	2.1	2.26	**5.67**	0.34	0.18	16.05
TWSE	1.23	0.33	1.03	1.46	0.31	0.68	0.24	1.54	1.25	0.93	0.52	0.1	0.75	0.42	2.31	2.44	1.07	**3.05**	0.09	16.7
VNINDEX	0.02	0.13	0.11	0.53	1.03	0.22	0.53	0.2	0.32	0.1	0.17	0.45	1.13	0.06	1.03	1.17	0.49	0.13	**8.43**	7.82
TO	10.52	5.95	6.58	25.16	6.93	8.79	3.8	10.22	25.5	7.56	5.79	2.9	9.66	2.97	35.02	37.72	10.69	5.21	2.65	223.62
NET	-5.05	-8.48	-2.5	14.92	4.46	-0.25	-9.85	-4.51	17.51	-7.13	-11.42	-7.41	-6.58	-4.28	22.76	29.83	-5.36	-11.49	-5.17	**11.77**
Panel C: Frequency 3 of Longer days (more than 22 days)																				
AS51	**1.01**	0.09	0.01	0.62	0.06	0.12	0.02	0.29	0.8	0.2	0.17	0	0.08	0.01	1.11	1.18	0.1	0.04	0	4.9
FBMKLCI	0.24	**1.7**	0.06	0.56	0.17	0.29	0.11	0.34	0.54	0.19	0.03	0.07	0.35	0.01	0.63	0.73	0.05	0.15	0.02	4.54
HIS	0.08	0.01	**1.3**	0.24	0.01	0.02	0.01	0.14	0.16	0.19	0.12	0.01	0.05	0.39	0.25	0.31	0.38	0.16	0.06	2.59
IGBVL	0.04	0.02	0.02	**2.19**	0.03	0.21	0.05	0.07	1.04	0.03	0.04	0.01	0.05	0.05	0.83	0.47	0.04	0.01	0	3.01
IMOEX	0.02	0.01	0.02	0.04	**5.08**	0.1	0	0.02	0.09	0.02	0.07	0.05	0.12	0	0.06	0.05	0	0.02	0.03	0.72
IPSA	0.02	0.09	0.04	0.41	0.15	**2.01**	0.02	0.16	0.55	0.02	0	0	0.01	0.06	0.62	0.4	0	0.01	0.09	2.65
JCI	0.2	0.33	0	0.83	0.31	0.38	**2.66**	0.13	0.31	0.05	0.17	0.08	0.33	0.01	0.94	0.69	0.37	0.05	0.08	5.26
KOSPI	0.52	0.09	0.11	0.53	0.12	0.12	0.02	**1.22**	0.7	0.35	0.13	0.03	0.07	0.05	0.59	0.59	0.33	0.34	0.02	4.71
MEXBOL	0.14	0.02	0	0.64	0.01	0.13	0.02	0.09	**2.85**	0.01	0.03	0	0.01	0	0.58	0.59	0.03	0	0.02	2.32
NKY	0.36	0.14	0.1	0.37	0.1	0.14	0.04	0.33	0.38	**1.5**	0.08	0	0.11	0.07	0.85	1.16	0.27	0.23	0	4.73
NZSE50	0.44	0.14	0.03	0.54	0.07	0.02	0.12	0.27	0.75	0.23	**1.8**	0.19	0.36	0.01	0.86	1.44	0.52	0.04	0.12	6.15
PCOMP	0.18	0.09	0.03	0.18	0.22	0.13	0.04	0.19	0.6	0.12	0.09	**1.33**	0.05	0.01	0.45	0.57	0.13	0.02	0.06	3.16
SET	0.39	0.23	0.05	0.71	0.08	0.2	0.19	0.27	0.81	0.25	0.32	0.08	**1.38**	0.03	0.93	1.09	0.41	0.12	0.04	6.2
SHCOMP	0.01	0	0.95	0.07	0	0	0.03	0.03	0.11	0.16	0.01	0	0.08	**1.97**	0.12	0.17	0.07	0.12	0.09	2.03
SPTSX	0.11	0.08	0.01	0.84	0.06	0.3	0.02	0.08	0.92	0.03	0.01	0	0.02	0.02	**1.53**	1.15	0.02	0.01	0	3.68
SPX	0.09	0.1	0	0.36	0.04	0.18	0.01	0.05	0.48	0.08	0.03	0	0.04	0	0.86	**1.34**	0.04	0.01	0.01	2.38
STI	0.4	0.15	0.12	0.87	0.32	0.06	0.07	0.5	0.6	0.41	0.36	0.03	0.12	0.02	0.78	0.81	**2.15**	0.12	0.04	5.78
TWSE	0.43	0.08	0.34	0.47	0.1	0.19	0.03	0.56	0.43	0.35	0.17	0.01	0.12	0.12	0.74	0.79	0.36	**1.03**	0.02	5.31
VNINDEX	0	0.04	0.03	0.17	0.36	0.07	0.16	0.07	0.1	0.04	0.05	0.13	0.36	0.02	0.31	0.35	0.15	0.02	**2.84**	2.43
TO	3.67	1.71	1.92	8.45	2.21	2.67	0.96	3.59	9.37	2.73	1.88	0.69	2.33	0.88	11.51	12.54	3.27	1.47	0.7	72.55
NET	-1.23	-2.83	-0.67	5.44	1.49	0.02	-4.3	-1.12	7.05	-2	-4.27	-2.47	-3.87	-1.15	7.83	10.16	-2.51	-3.84	-1.73	**3.82**

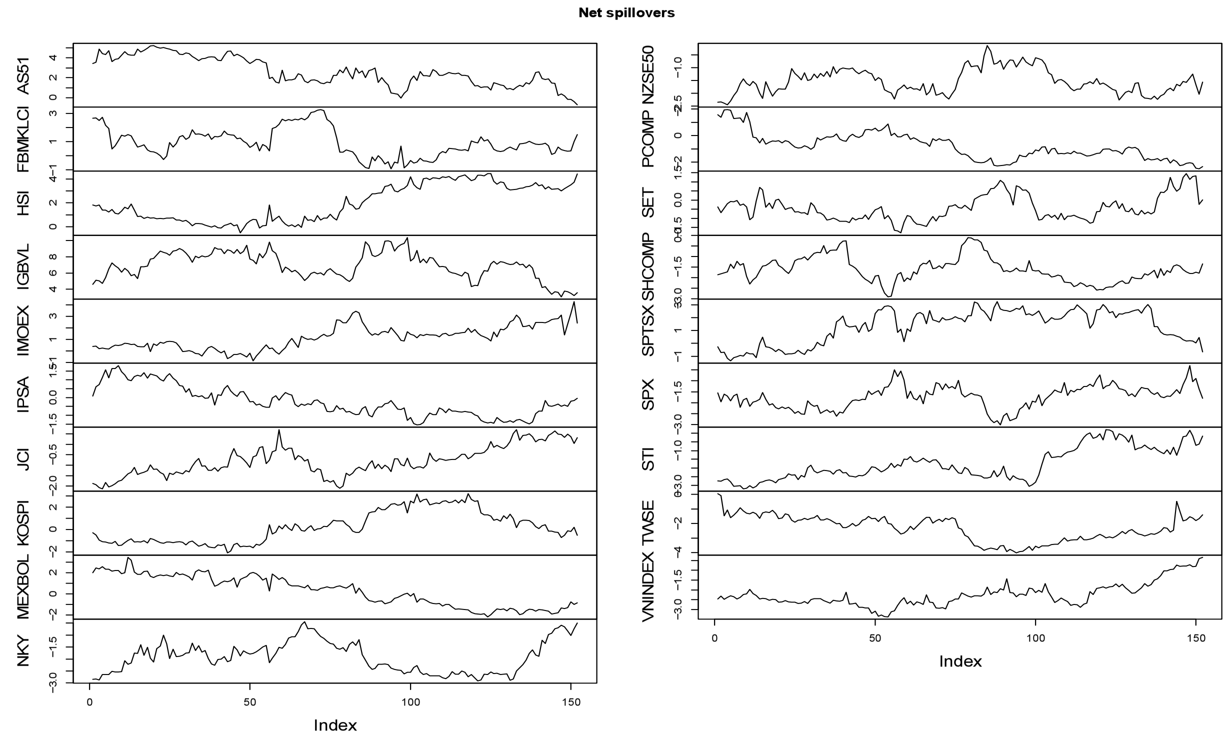


Fig. 4.55: Net spillover during the Russia-Ukraine war (Source: Author's using R software).

➢ Robustness of the models with APEC Results.

To assess the robustness of our findings, we performed a sensitivity analysis on the spillover effect by employing different window sizes. This study used a 33-day rolling window size as the benchmark. Additionally, three rolling window widths based on the DY (2012) technique were utilized: 28, 33, and 38 days. By examining the spillover curves illustrated in Figure 4.56, this study noted that the overall trend remains relatively consistent across the various rolling window sizes. This suggests that the window length has minimal impact on the conclusions drawn in this study.

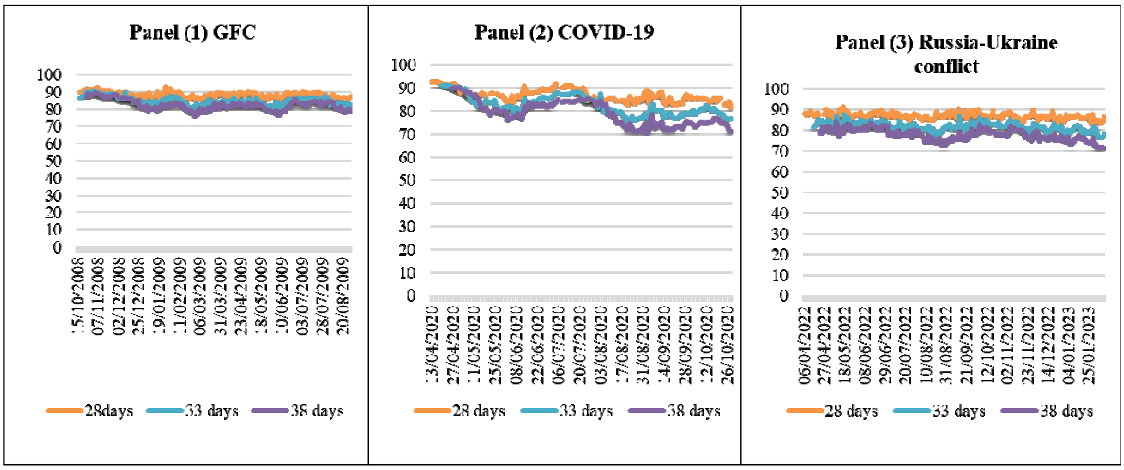


Fig. 4.56: Using different rolling window sizes dynamic total spillover.

Note: In the above figure the Orange colour shows 28 window size, blue shows 33 window size, and purple show 38 window size (Source: Author's using R software).

4.13.3 Volatility spillover in APEC Bloc.

Table 4.23.0 displays a comprehensive matrix of the VS for 19 APEC region stock markets, which includes the stock market indices of Australia (AS51), Canada (SPTSX), Chile (IPSA), Japan (NKY), Hong Kong (HSI), Indonesia (JCI), South Korea (KOSPI), Malaysia (FBMKLCI), Mexico (MEXBOL), Peru (IGBVL), Philippines (PCOMP), Russia(IMOEX), Singapore (STI), Taiwan (TWSE), Thailand (SET), US (SPX), Vietnam (VNINDEX), China (SHCOMP), and New Zealand (NZSE50). The Variance decomposition (VD) matrix has off-diagonal elements of 24*24 dimensions that indicate the contribution to the FEV of a specific equity market due to shockwaves from other markets, except itself. The spillover's directionality is presented in the *"From Others"* column and the *"To Others"* row, which shows off-diagonal column sums and row sums, respectively. The net VSs can be calculated by subtracting the *"From Others"* column from the *"To Others"* row. The top row of the table shows the total spillover index (TSI), which indicates the extent to which cross-market spillovers occur in either direction. The "total" row aggregates the effects of a market shock on its variance and that of other markets. Directional spillovers "to others" from every 19 equity markets illustrate significant differences in the transmitted VSs. The contribution of an equity market shock projecting the volatility of other financial markets concerning the error variance exhibits more significant variability than the spillovers received by stock markets from others. The contribution of variance to different needs varies widely across countries, from 16.29% in Vietnam to 133% in the US. Likewise, spillovers received by stock markets from other markets also range significantly, from 33.74% in Vietnam to 70.27% in HongKong. In terms of VS transmitter, the results indicated the US (69.54%) as the significant transmitter, followed by Canada (52.92%), Mexico (37.09%), Chile (13.20%), Peru (10.42%), HongKong (5.61%) and others to the error variance (Table 3). Over the years (2001, 2021) (total trade with the US) (in billion US \$), Canada (\$ 446.24, \$ 664.77), Mexico (\$112.63, \$ 779.08) were the major trading partners of the US (US Census Bureau, 2023). The results of this study aligned with the fact that Canada had maximum trading with the US over the years, in a similar sequence level of net spillover identified (Statsapec, 2023). It indicates cyclic trading between the countries, resulting in strong connectedness among them. Moreover, the US, Canada, and Mexico have strong connectedness due to a free trade agreement indicating strong trading ties through a regional bloc, i.e., the North Atlantic Free Trade Agreement (NAFTA). Conversely, In Latin America, Chile is the third largest bilateral goods trading partner (Hong Kong \$ 20.9 billion) in 2021. YoUSf and Ahmed (2018) also indicated positive volatility spillover among the US and central Latin America (Mexico, Argentina, Chile, and Peru).Johnson and Soenen (2003) also found that Canada and Mexico have same-day solid Intermarket reactions (at least 91%). Argentina, Brazil, Chile, and Peru have 50% same-day Intermarket response as they interact considerably on the same day, indicating excellent market integration and efficiency. Moreover, In 2022, the Canada-Chile commercial relationship celebrated the 25th anniversary of the Canada-Chile Free Trade

Agreement (CCFTA) (the agreement covers trade in goods, services, and investments and includes side agreements on the environment and labour relations), the cornerstone of Canada's strong trade and investment relationship with Chile (Government of Canada, 2023).

Although Russia has lowest net spillover (0.01%) as it almost infuses and diffuse equivalent spillover among APEC countries, in 2001 (in USD million), Russia had highest exports (2001, 2021) with China ($3942.6, $66305.3), US ($2897.6, $16622.8) and imports (2001, 2021) with China ($1646.3, $ 72380.1), US ($3257.5, $11916.9) which raised over the period significantly (StatsAPEC, 2023). Russia has the highest portfolio investment (in USD millions, 2021) with the US ($23216.4), Canada ($1935.9), Mexico ($1381.7), and Singapore ($5633), which reflects the spillover transmitter behaviour of all these countries almost negligible net spillover transmission by Russia to spillover receiver APEC countries. Singapore (in USD million) (2001, 2022) exports Malaysia (20,814.1, 48,275.8), US (18,442.9, 44,244.1), Hong-Kong (10,491.2, 52,810.3) and imports with Malaysia (20,066.8, 59,242.2), US (18,727.5, 50,845.1), Hong-Kong (2,761.7, 1,648.9) which indicates minor net trading difference (StatsAPEC, 2023). Similarly, Singapore neutralizes the spillover effect as it has the second lowest transmitter (4.78%) in net directional spillover in APEC. These findings are partially supported by Al-Hajieh (2023), who indicated that China had been observed to be primarily receiving net inflows, Hong Kong and Singapore exhibit a distinct trend of reintegration with other stock markets, while this study indicates Hong Kong and Singapore are lowest net spillover transmitter of APEC, which shows these countries also have close trade ties.

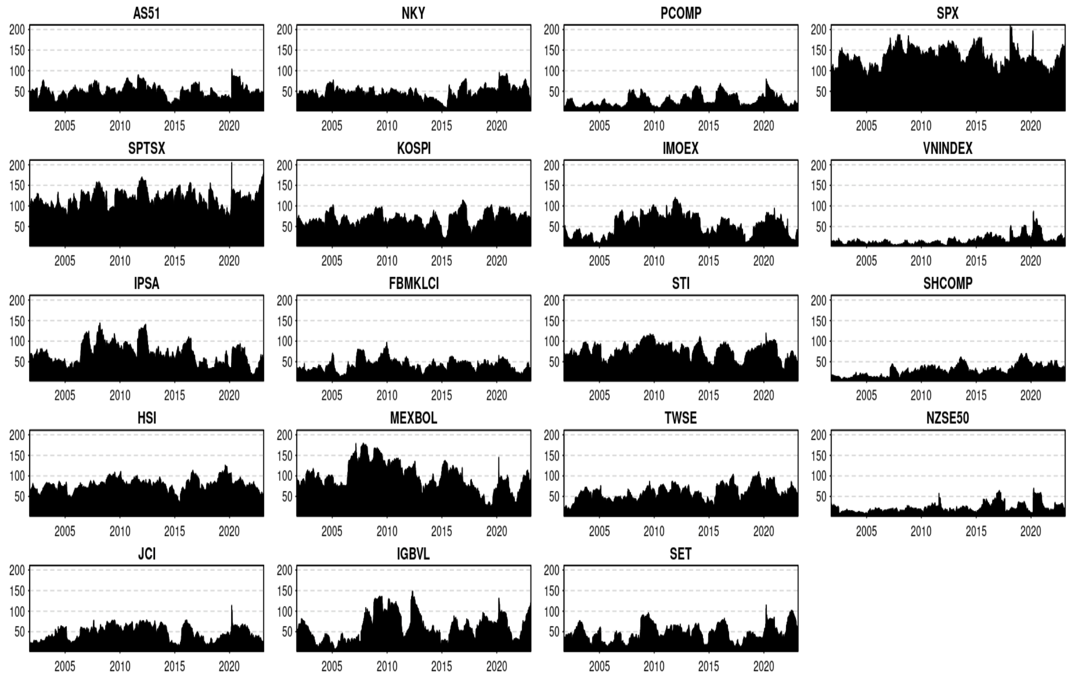
On the other hand, New Zealand (32.86%) has the highest net inflow of VSs, followed by Philippines (30.91%), Japan (21.05%), Australia (20.37%), Malaysia (19.70%), Vietnam (17.44), China (16.88%), Indonesia (12.84%), Thailand (10.40%), Taiwan (8.98%), South Korea (2.12%) (Table 3). These findings are aligned with Panda et al. (2021) and Al-Hajieh (2023) results, which indicated negative spillover in Australia, China, Hong Kong, Malaysia, and Korea, that there is an extraordinary level of innovation diffusion between different stock markets, as pairwise directional spillover is between China-Australia, Japan-Australia, Malaysia-Australia, Thailand-

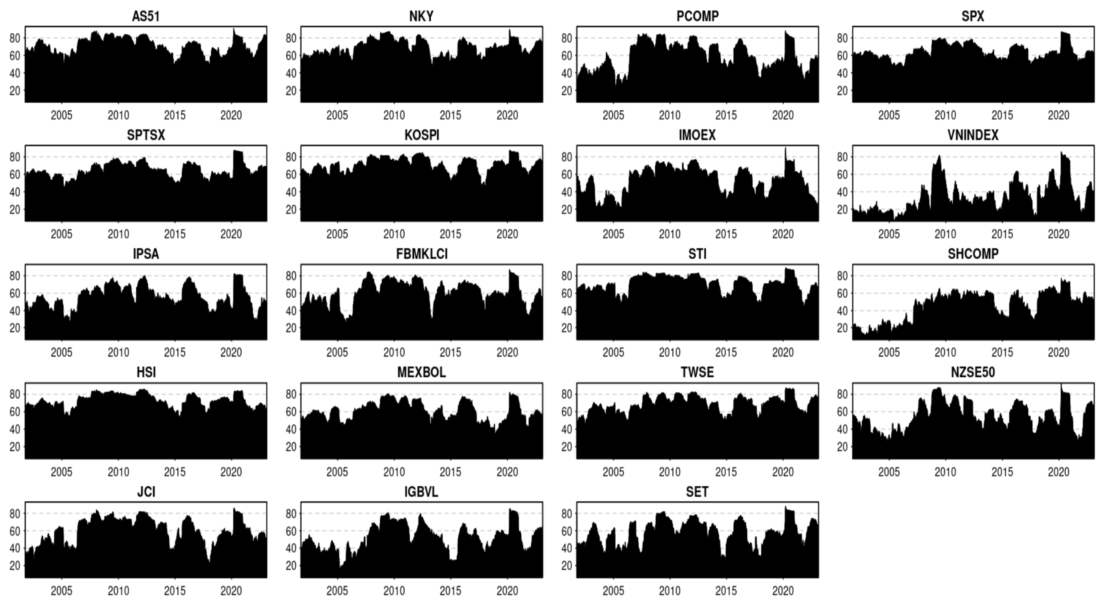
Australia, Malaysia-Hong Kong, Philippine-Hong Kong, Taiwan-Japan, and Thailand-Japan. Moreover, Hung (2019) results were partially consistent with results that stated volatility spillover from the China stock market to Vietnam, Thailand, Singapore and Malaysia. Still, in this study, Singapore is the third lowest transmitter. Mbarki et al. (2022) indicated that Japan tends to contribute considerably to the sentiment network, while China looks to contribute the least; a similar quantitative pattern of net spillover recipient was identified in Japan (21.05%), and China (16.88%). Hence, sentiment networks have significant impacts on the stock market. Moreover, the results of this study are partially consistent with Kim et al. (2015) as they supported the level of stock market integration varies among Asia-Pacific economic regions and inconsistent with the results as China continues to have an impact with the diminished influence of Japan on stock markets in the Asia-Pacific region. Over the period (2001-2023), this study encountered China (16.88%) as a diminished influence as a spillover receiver over Japan (21.05%), which indicates that in the APEC bloc, Japan is a more significant spillover receptor than China. The China - ASEAN trade agreement (2010), i.e.CAFTA (aims to increase trade cooperation by maximizing the China-ASEAN free trade zone effect), was utterly operational, significantly changing the quantity of trading with Japan. Although sometimes a different behaviour (receiver or transmitter) of spillover is understandable even in free trade agreements, the presence of domestic demand serves as a protective measure against external disturbances, safeguarding their economies from fluctuations in the global market and mitigating the transmission of adverse effects. They, moreover, established vital policy steps to control their economies and avoid external risks. This comprises strategies like cautious fiscal policy, effective monetary policy, and exchange rate management, which buffer the effects of external shocks and prevent volatility spillover. New Zealand (in USD Millions) (2001, 2022) significant imports from Australia (2907.8, 5848.8), US (2144.9, 4886.3), Japan (1467.4, 3283.7), China (927.2, 12579.2) and significant exports to Australia (2501.8, 5052.6), US (2038.7, 2568.0), Japan (1716.1, 2568.0), China (567.1, 12417.3) (StatsAPEC, 2023) indicates strong integration in these economies. Hence, Japan, Australia, and New Zealand are primary net directional spillover receptors from the US and Canada (as depicted in Fig. 4.57).

Although South Korea (2.12%, only received from the US and Canada), Taiwan (8.98%, obtained from Mexico, Canada, US, and Thailand), Thailand (10.40%, received from Canada and the US) are the lowest receptor of net directional spillover. These results are consistent with Hwang et al. (2013), who identified similar significant breaks during the crises between these countries (Korea, Thailand, and Taiwan), which created a single bloc of these countries and in phases of adjustment, results are similar with different magnitude. Moreover, all these countries have major trading with China, the US, Japan, and Hong Kong, which indirectly created an internal trade bloc where the US and Hong Kong are the central net directional spillover transmitters to these countries. This trading share represents the cyclic integration in the economies of similar countries. This shows these countries have a similar nature, which is due to different collaboration, agreements and partnerships under the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) elven Pacific Rim countries between 11 (Canada, Mexico, Peru, Chile, New Zealand, Australia, Brunei, Singapore, Malaysia, Vietnam, and Japan) connected under a free-trade agreement (FTA).

Moreover, The US possesses the world's biggest and most prominent stock market, with significant trading volumes and diverse international investors (Eun and Shim, 1989). The US market's size and high trading volumes make it an important player (with the level of activity and liquidity) in the global financial landscape (as influenced by the interest and participation of a wide range of investors in US equities). Therefore, fluctuations in the US stock market can impact investor sentiment and risk appetite globally (including APEC). Due to different uncertainties in the US stock market, investors may adjust their investments and portfolios, affecting the APEC stock markets. The total spillover index, which encompasses overflow components in every direction, suggests that spillovers account for 59.81% of the error variance in predicting volatility across all 19 APEC equity markets.

Fig. 4.57 displays the "To spillover," "From spillover," and "Net directional spillovers" plots for APEC stock markets, which indicates that the US's SPX, Canada's SPTSX, Mexico's MEXBOL, Peru's IGBVL, Hong-Kong's HIS, Singapore's STI, and Chile's IPSA are the primary net sources of volatility transmission throughout the sample period. On the other hand, all the other APEC countries are net recipients of VSs. Fig.4.58 depicts the network plot of the spillover and connectedness of the APEC nations. Results of the study stated that the US is the largest transmitter of VSs in APEC nations, accounting for 69.54%, followed by Canada (52.92%) and Mexico (37.09%).





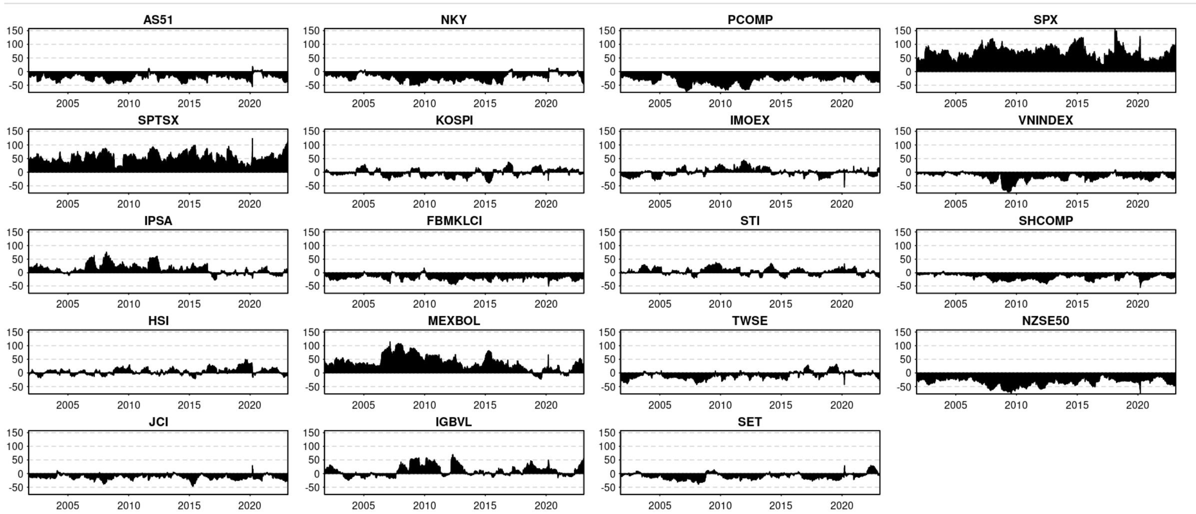


Fig. 4.57:APEC countries Transmitters (to others), Receiver (from others), and Net directional volatility spillover.

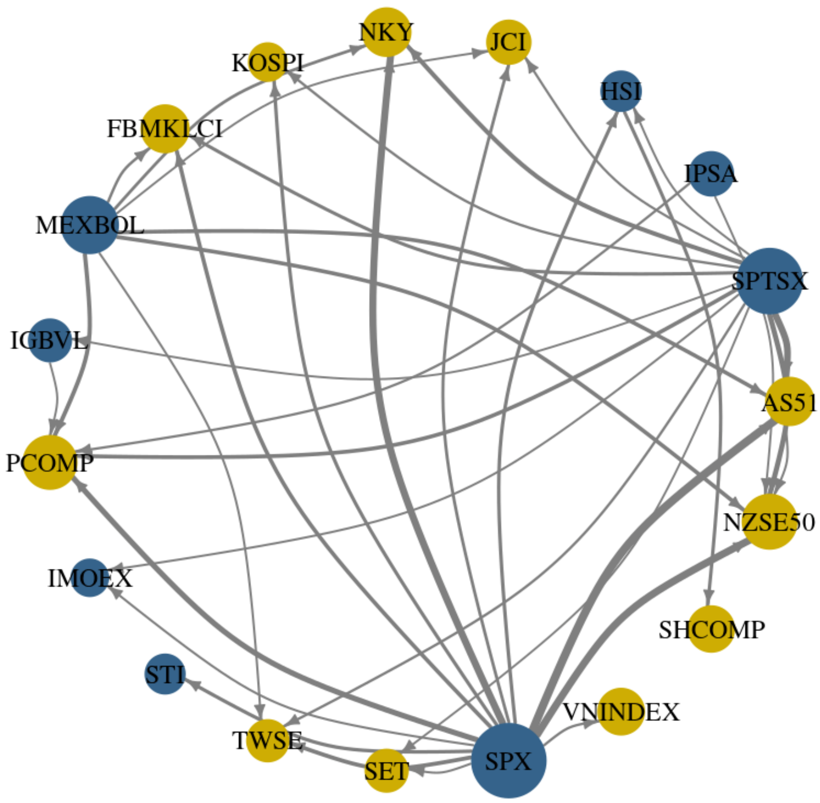


Fig. 4.58: Net directional connectedness of the APEC countries.

Note: In the above figure, each node represents interconnectedness with each variable. Arrows indicate the directional flow of spillover, with each arrow's width reflecting the quantity or strength of the spillover impact; the return spillover receiver is depicted in yellow, and the transmitter is in blue (Source: Author using R software).

Table - 4.23.0Representation of volatility spillover among APEC countries. (Source: Author using R software).

	AS51	**SPTSX**	**IPSA**	**HSI**	**JCI**	**NKY**	**KOSPI**	**FBMKLCI**	**MEXBOL**	**IGBVL**	**PCOMP**	**IMOEX**	**STI**	**TWSE**	**SET**	**SPX**	**VNINDEX**	**SHCOMP**	**NZSE50**	**FROM**
AS51	**29.73**	9.46	3.44	4.32	2.08	4.39	4.19	1.65	6.16	3.62	1.13	3.04	4.52	3.37	2.04	11.24	0.92	1.18	3.53	70.27
SPTSX	2.08	**35.81**	5.46	2.59	1.45	1.79	2.18	1.16	9.19	6.60	0.79	4.14	2.89	1.64	1.96	18.01	0.70	0.90	0.65	64.19
IPSA	1.50	7.29	**44.71**	2.49	2.54	1.21	2.39	1.93	8.29	4.96	1.37	3.58	2.71	2.13	2.30	8.28	0.64	0.88	0.81	55.29
HSI	3.87	5.01	3.22	**27.73**	3.41	4.26	7.26	2.88	4.61	2.76	1.42	2.99	8.09	5.73	3.53	5.87	0.93	5.36	1.07	72.27
JCI	2.44	4.13	3.79	4.65	**40.37**	2.24	4.08	4.24	4.05	2.77	3.23	2.39	5.68	3.84	3.98	4.63	0.98	1.38	1.13	59.63
NKY	4.91	6.72	3.36	5.19	2.08	**31.63**	6.61	1.80	4.73	2.65	1.21	3.08	5.31	4.81	2.40	9.67	0.88	1.37	1.61	68.37
KOSPI	4.32	5.07	3.13	7.77	3.14	6.02	**29.47**	2.65	4.41	2.45	1.60	2.93	5.97	8.22	3.04	5.78	0.88	1.96	1.22	70.53
FBMKLCI	2.14	4.92	3.70	4.08	4.51	2.02	3.78	**39.54**	4.61	2.96	2.84	2.60	5.82	3.67	3.95	5.39	1.01	1.28	1.17	60.46
MEXBOL	1.80	10.12	6.69	2.63	1.68	1.34	2.62	1.53	**39.86**	5.26	1.21	4.02	2.44	1.77	2.03	12.43	0.66	0.99	0.94	60.14
IGBVL	1.60	8.95	5.14	2.35	1.63	1.25	1.82	1.35	6.28	**48.35**	1.25	3.80	2.58	1.65	1.91	7.14	0.86	1.29	0.78	51.65
PCOMP	1.96	5.17	4.15	2.92	4.44	1.79	3.00	3.33	5.89	3.61	**41.97**	2.66	3.43	2.66	3.03	6.82	0.88	1.11	1.18	58.03
IMOEX	1.89	6.60	4.14	3.62	2.24	1.92	2.51	1.81	5.59	4.10	1.01	**47.56**	3.50	2.24	2.67	5.86	0.80	1.10	0.85	52.44
STI	3.90	5.15	3.21	8.26	4.26	4.26	5.76	3.99	4.35	2.89	1.54	2.97	**29.61**	4.90	4.52	6.46	0.82	1.78	1.36	70.39
TWSE	3.72	4.52	2.99	6.93	3.20	4.71	8.99	3.08	4.23	2.31	1.89	2.52	5.82	**31.60**	2.92	6.14	0.99	2.15	1.28	68.40
SET	2.23	4.28	3.42	4.91	4.11	2.52	3.98	3.51	3.79	2.66	1.99	2.88	6.02	3.43	**42.13**	4.27	1.09	1.63	1.13	57.87
SPX	2.07	18.22	6.22	2.02	1.22	1.84	1.94	0.99	11.37	5.24	0.72	3.34	2.54	1.61	1.79	**36.54**	0.76	0.76	0.82	63.46
VNINDEX	1.55	2.80	1.59	1.88	1.41	1.73	1.90	1.55	2.39	2.24	1.22	1.75	1.85	2.10	1.69	3.57	**66.26**	1.62	0.88	33.74
SHCOMP	1.94	2.35	1.69	9.14	1.96	1.96	3.34	1.89	1.94	1.95	1.29	1.51	3.23	3.52	1.97	2.41	1.48	**55.20**	1.21	44.80
NZSE50	6.00	6.33	3.15	2.16	1.44	2.08	2.07	1.42	5.34	3.04	1.39	2.23	2.76	2.12	1.73	9.02	1.02	1.19	**45.51**	54.49
To Others	49.90	117.11	68.49	77.89	46.79	47.33	68.41	40.76	97.22	62.06	27.12	52.45	75.17	59.42	47.47	133.00	16.29	27.92	21.62	**1136.43**
Total	79.63	152.92	113.20	105.61	87.16	78.95	97.88	80.30	137.09	110.42	69.09	100.01	104.78	91.02	89.60	169.54	82.56	83.12	67.14	1900
NET	-20.37	52.92	13.20	5.61	-12.84	-21.05	-2.12	-19.70	37.09	10.42	-30.91	0.01	4.78	-8.98	-10.40	69.54	-17.44	-16.88	-32.86	**59.81**

➢ **Robustness of volatility spillover in APEC**

On analysing the volatility spillover on different window sizes, i.e. 150, 200, 250. From Fig. 4.59, this study identified results robust to the global stock market, as similar volatility spikes were identified over different periods.

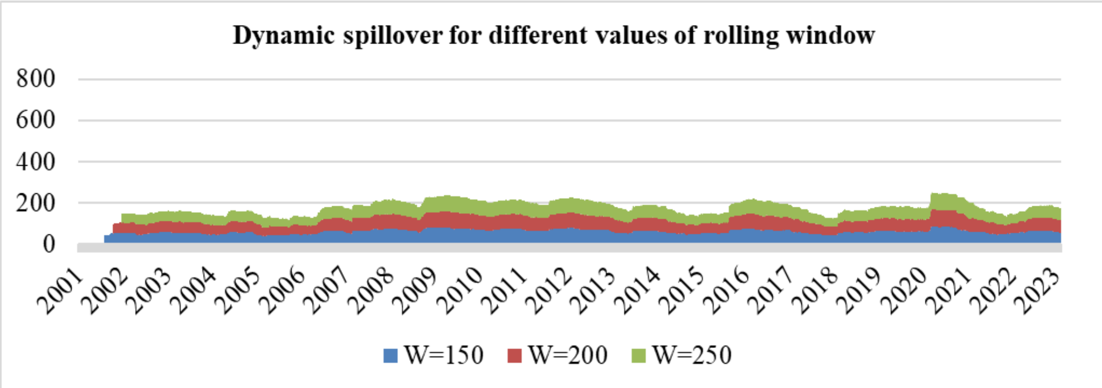


Fig. 4.59: Dynamic spillover on different values of W indicates the robustness of APECcountries.

Note: Blue shows spillover on window size 150, red on 200 window size, and green shows the largest window size, i.e. 250 (Source: Author's using R software).

4.13.4 Conclusion of regional interconnectedness case study- APEC stock market

Return spillovers in stock markets of the APEC region are influenced by three major crises (the global financial crisis (GFC), the COVID-19 Pandemic, and the Russia - Ukraine conflict). This Diebold and Yilmaz (2012) approach is used to capture the frequency dynamics of spillover, and to capture the long, medium, and short-term impact, Baruník and Křehlík (2018) methodology is employed. The results indicate that the spillover effect is crisis-sensitive, time-varying, and frequency-dependent across the APEC countries' equity markets. The GFC had the most significant spillover effect, followed by COVID-19 and the Russia-Ukraine conflict. Due to these crises, the net risk recipients in the system are New Zealand, Vietnam, and the Philippines. At the same time, the more significant economies of the US, Canada, and Mexico are net risk contributors. Moreover, this studyanalysed return spillover across three different frequencies for three sub-periods. Results reveal that the GFC dominates short-term spillovers (one week), while COVID-19 dominates medium and long-term (more than one month).

4.14.0 Conclusion of the chapter

During the six major crises and twelve sub-panels (Pre-during crises), this study identified different behaviours of all the selected developed, emerging, and frontier countries.

The GFC began in the US subprime mortgage sector and quickly spread throughout the financial system. Although it was most noticeable in 2008-2009, financial markets showed early crisis signals in the third quarter of 2007. The GFChas been regarded as the most catastrophic since the Great Depression. Before GFC 73.68% volatility spillover was generated, Brazil, Switzerland, Germany, and Canada were matransmitterstter; Morocco, Spain and Croatia were primary net receptors of the volatility spillover.During GFC, 84.37% volatility spillover was generated, which suggests a turbulent period. During this period, the US, Mexico, and Canada were identified as the significant transmitters; Australia, Spain, and Nigeria were identified as the primary receptors of the spillover. Moreover, there was a minor impact on short-period frequency (8.13%) and medium (72.77%) but a significanteffect on entire-period (80.91%) frequencies.

Before the GFC had completely recovered, the ESDC occurred in late 2009. A balance of payments imbalance catalyzed the crisis, which was made worse by underlying structural and fiscal issues in the nations that make up the Eurozone. Even though the problem persisted until 2013, containment measures had worked mainly by 2012.

During Pre-EDC, this study identified high volatility spillover, i.e. 83.54%, which indicates PIIGS, Morocco, and Saudi Arabia as major receptors; Kenya, Spain and the US as major transmitters of the spillover. During EDC, 76.47% volatility spillover was generated in the US;Germany was the major transmitter; PIIGS and Kenya were the major receptors of the volatility spillover. It indicates the US remains the epicentre of the spillover among all these countries. Less volatility spillover may be generated during this period due to the pre-EDC period overlapping the GFC period, as EDCs are simulation crises.

During the Pre-Chinese crash, 81.29% volatility spillover was generated in which the US (33.25%), Canada (25.1%), and Kenya (24.44%) were identified as the major net transmitters of the spillover. On analyzing developed countries, the US (33.24%), Canada (25.1%), and Russia (6.20%) were identified as major transmitters, and on the other side, Spain (-19.21%), Singapore (-15.94%), Japan (-7.66%) were identified as major net volatility spillover receiver.

During the Chinese Crash,91.45% volatility spillover was generated in which Canada (72.81%), Saudi Arabia (69.08%), and Nigeria (32.79%) are identified as the major transmitter; Singapore (-48.70%), Indonesia (-45.89%), Spain (-45.63%) are identified as the major receptor of the volatility spillover. Chinese crash generated 37.10% volatility spillover in short frequency, medium frequency generated 51.93%, and 89.03% in the entire period as generated volatility spillover.

Significant events occurred during this time, such as the oil shock, Russia's invasion of Crimea, volatility in the Chinese stock market, the Brazilian economic crisis, and the ongoing Brexit process (2014-2017). This era lacks a clear definition because of different nations' wide range of political, financial, and military events. As a result, it stands apart from the other crisis eras we examine.

During Pre-Brexit 92.94% volatility spillover and the reason may be due to oil crises;among developed countries, this study (indicated Japan (31.66%), Germany (30.90%), HongKong (20.97%) were the major net transmitter, and Australia (-47.92%), Spain (-39.47%), Switzerland (-36.56%) as major net receiver of the volatility spillover.

During Brexit volatility spillover,89.50% generated UK (35.44%), Switzerland (24.35%), Singapore (22.46%) were net transmitter; Canada (-41.29%), Hong-Kong (-6.34%), Singapore (-5.97) was major net receptor.During Pre-COVID-19, no such interconnectedness was identified as it acted as a standard period, but still, it generated 84.64% volatility spillover among the selected stock market. South Africa (30.35%), Germany (28.22%), and HongKong (25.39%) were the major transmitters; Romania (-43.30%), Morocco (-34.93%), and Russia (-26.83%) were the major receptor of the spillover.

During COVID-19, 88.63% volatility spillover generated by the US (54.42%), Switzerland (33.40%), and Mexico (48.66%) were major transmitters; Kenya (-36.79%), Nigeria (-36.02%), and Japan (-34.68%) were major receptor of the spillover. On testing, different frequencies also it has shown low impact (35.73%), as compared to the medium (52.22%) and entire period (87.95%).During the Pre-Russia-Ukraine crises, volatility spillover among the developed countries indicates Russia (54.4%), Germany (49.09%), Spain (48.41%) as major net transmitters; Singapore (-53.90%), HongKong (-52.87%), Japan (-52.60%) identified as the major net receiver.

On analyzing significant net volatility spillover during Russia-Ukraine crises Germany (39.74%), Switzerland (29.52%), Japan (8.16%) among developed countries are major transmitter; India (31.89%), South Africa (30.66%), Thailand (22.24%) among emerging countries; Bahrain (33.65%), Romania (31.82%), Croatia (20.25%) among frontier countries. On analyzing the volatility spillover on the different frequency domains, this study found short frequency (27.49%), high spillover in just starting, medium frequency (56.11%), and total frequency (83.60%). TVP-VAR-BK Model results indicated that in just four days, 27.49% (Table 4.22.1) of volatility spillover is generated, 56.11% (Table 4.22.2) in the medium term, and 83.60% in the longer term.

CHAPTER -5

FINANCIAL CONTAGION AMONG SELECTED STOCK MARKETS DURING SEVERAL TURMOILS

CHAPTER -5

FINANCIAL CONTAGION AMONG SELECTED STOCK MARKETS DURING SEVERAL TURMOILS

This chapter examines the impact of contagion and volatility spillovers across foreign stock markets. The chapter is divided into three sections: Section 5.1 focuses on the importance and understanding (with relevance to the study) of financial contagion, while Section 5.2 discusses financial contagion results. Finally, the chapter conclusion is shown in Section 5.3.

5.1 Overview of the chapter focusing on the financial contagion and global market capitalization (in USD ($) value).

The global financial system has become significantly intertwined in the past twenty years. After implementing financial deregulation in numerous nations in the 1980s, the transmission of financial shocks accelerated, leading to a higher occurrence of financial crises (Bello et al., 2022). The Tequila Crisis (1994), Asian Flu (1997), Russian Default (1998), GFC (2008), and European Sovereign Debt Crisis (EDC) (2010) illustrated the interconnectedness of the global financial system, showing that instability in one country may rapidly propagate to others. Numerous studies have drawn an analogy between the economy and epidemics, referring to the rapid transmission of financial shocks as "contagion" (Franch et al., 2024; Atasoy et al., 2024).

However, followed by GFC and EDC, the Chinese stock market appeared less like a "casino" and more like a significant emerging market in the years preceding 2015. The Chinese stock market (June 12, 2015) crashed, with significant aftershocks on July 27 and August 24. The Shanghai stock market had dropped 30% in three weeks by July 9, 2015, when 1,400 companies, more than half of which were listed, filed for a trading suspension to stop additional losses[1]. After that, Brexit has led to economic uncertainty, complicating domestic politics, migration, and trade relations between the UK and EU. In March 2020, one of the most severe stock market crashes occurred due to COVID-19. Over four trading days, the Dow Jones index dropped by almost

[1] https://www.bloomberg.com/news/articles/2015-07-27/chinese-stock-index-futures-drop-before-industrial-profits

6500 basis points. This phenomenon was also widely noted in other stock markets worldwide. The crash was primarily triggered by governments' responses to the novel coronavirus, such as local and national lockdowns and quarantines. The virus originated in the Chinese city of Wuhan in December 2019 and rapidly spread globally. Thereafter, the geopolitical crisis started with the Russian soldier invasion of Ukraine (24 June 2022), which caused panic and instability in Europe and its trading partner Russia, as several studies (Kakran et al., 2023; Pandey et al., 2023) reported this war generated volatility spillover globally.

Financial contagion refers to the transmission of disruptions in financial market instruments through their simultaneous movements. Although it was first proposed in the early 1990s, the concept of contagion remains controversial. Several studies (Kakran et al., 2023; Akhtaruzzaman et al., 2021b; 2021c; 2021d) elucidate the transmission of financial risks using the ideas of interconnectedness and spillovers. Some studies recognize interconnections and spillovers in positive and negative situations, i.e., the asymmetric effect (Chen et al., 2025). Still, they emphasize that the spread of these effects is more noticeable during crises (Vilpisauskas, 2013).

This study examines six recent crises in global stock markets (focusing on the developed, emerging, and frontier countries): the global financial crisis (GFC), the European debt crisis (EDC), the Chinese Burst Bubble (CBB), the UK's vote to leave the European Union (Brexit), the coronavirus pandemic (COVID-19), and the political crises (Russia-Ukraine war). The GFC originated from the subprime credit crisis in the US, leading to a significant decline in the values of stocks connected to the US real estate sector and causing widespread damage to financial institutions worldwide. The crisis inevitably disseminated globally. Several Eurozone members, notably PIIGS (Portugal, Ireland, Italy, Greece, and Ireland), caused the economic and monetary union (EMU) debt crisis due to their inability to repay government debt and significant deficits.

Although numerous studies have been conducted on developed countries dominantly over the years, the researcher focused on emerging countries. Moreover, Chapter 2 indicated the limited literature on the frontier countries as Bello et al. (2022) focused on the African region. This is mainly because investments in frontier regions have only recently undergone a surge in international portfolio investments. This surge has been accompanied by an eruption in mutual and exchange-traded funds prioritising equity investment in frontier markets (e.g., Groot et al., 2012). The minimal correlations between those markets and global markets are a significant factor in their popularity (Alagidede, 2009) and may be due to restricted institutional and regulatory factors; still, it is crucial to check whether the frontier is still isolated from global markets despite high market capitalization ranking. Thus, this is the first study to unveil the financial contagion among all variants (developed, emerging, and frontier) of economies with a high level of market capitalization[2] and by considering Morgan Stanley Capital International (MSCI) classification (categorised based on the market accessibility, economic development, size and liquidity requirements). Portfolio investments in frontier markets have increased in recent decades due to the emergence of mutual funds and exchange-traded funds focused on frontier market equities investment (Groot et., 2012). Alagidede (2009) attributes the appeal of these markets to their poor correlation with global markets.

Over the period (Fig.5.1), capitalisation has fluctuated among the selected frontier counties. Overall, Vietnam shows significant capital infuse (over the period, market capitalization indicates significant relevance of these countries in the current era compared to earlier) compared to other frontier countries. Still, it also highly reduced Post-GFC Jordon, Morocco, and Nigeria investments. Over the period, analysing individual countries reveals that market capitalization infuses and defuses money, contributing to volatility spillover or contagion among all countries. Kazakhstan can recapture its position post-COVID-19 as of GFC. Still, like other countries, Croatia cannot regain its market capitalization post-GFC, indicating that investors have switched from Croatia to other developed countries. The reason could be that investors are moving to a more secure, well-established European stock market, i.e., Germany and Switzerland.

[2]https://www.theglobaleconomy.com/rankings/stock_market_capitalization_dollars/

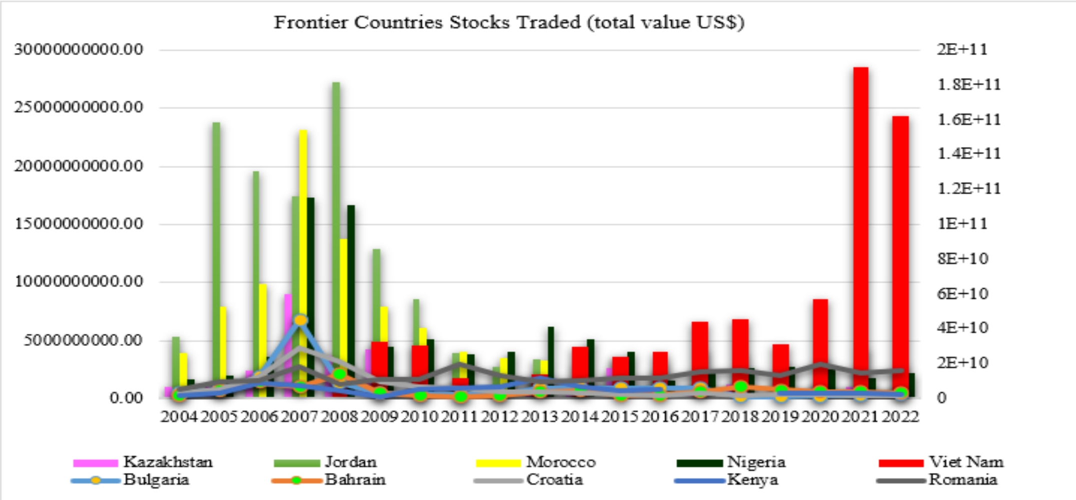


Fig. 5.1: Annual stock market capitalization from 2004 to 2022 in the selected frontier countries (Source: www.theglobaleconomy.com).

Before GFC among emerging markets, South Korea, Malaysia and Mexico were identified as significant stock-traded countries. South Korea was the major stock-traded country, but post-GFC, China, South Korea, India and Brazil were recognised as highly trading countries (Fig. 5.2). Over the period, it indicates that China has overtaken all the countries and became the high traded (as an investment hub in the Asia region) country post-COVID-19.

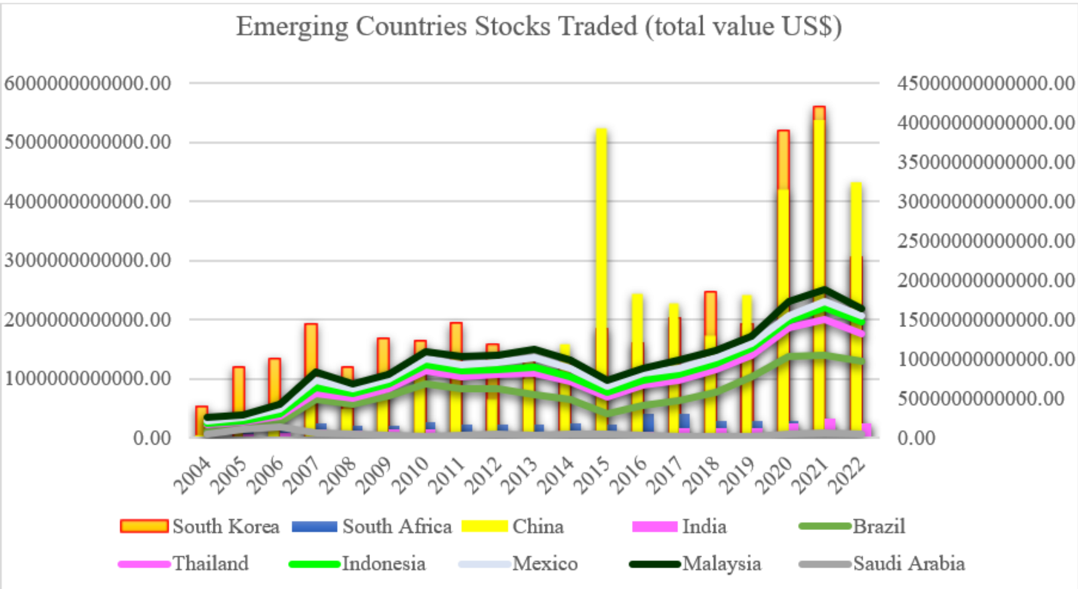


Fig. 5.2: High annual stock trading from 2004 to 2022 in the selected emerging countries (Source: www.theglobaleconomy.com).

Before the GFC, developed countries such as the US, Japan, and Germany were identified as the highly traded countries (Fig. 5.3). Although the US remained the most highly traded (in value US dollar ($)) among all the countries over the period, COVID-19 US and Japan remained dominant. Still, Hong Kong and Canada surpass Germany, indicating that German investors shifted to other investment sources or European countries. Among developed countries, Hong Kong is identified as dominant in the Asia region.

During different periods, all the market's investments showed significant fluctuation, which indicates either the generated volatility spillover (also proved in Chapter 4) or impacted through financial contagion directly or through channels from the crisis source country. Thus, the US dominates stock trading among the global stock markets (developed, emerging, and frontier countries). Now, it becomes crucial to acknowledge these countries' behaviour during all the significant crises (targeting financial, health and political crises).

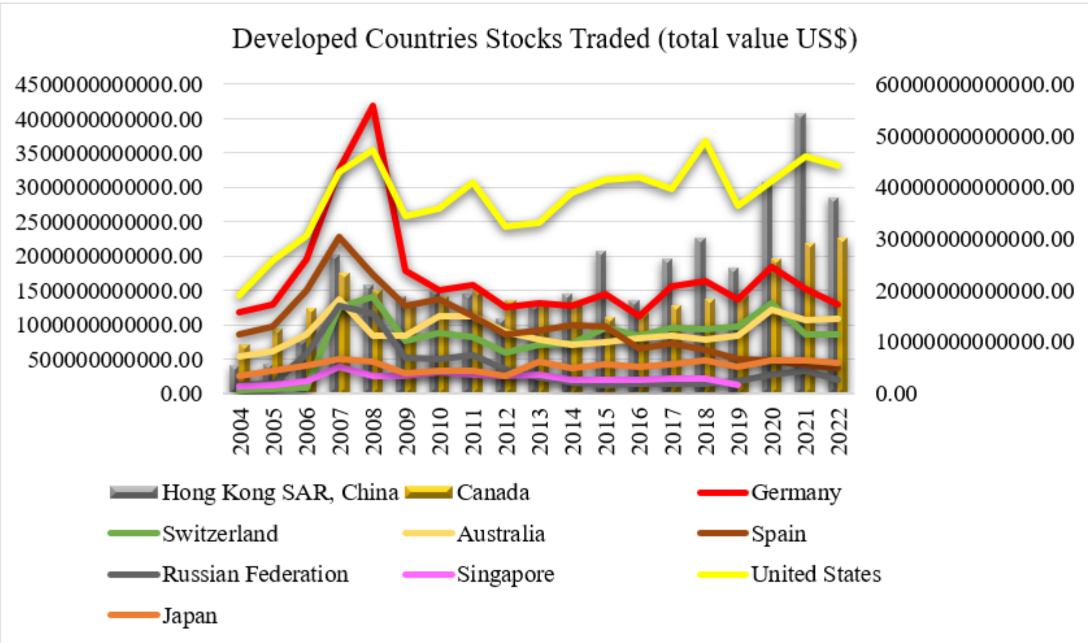


Fig. 5.3: Annual stock trading from 2004 to 2022 in the selected developed countries (Source: www.theglobaleconomy.com).

This study focuses only on the significant crises to unveil the contagion effects from the origin of crises. This study examines whether diversification benefits exist in global stock markets, focusing on the crisis period. It also sheds light on global financial systems' vulnerability to global shocks. This study covers the 19 years (2004 (based on availability)-2023 (till the impact of the Russia-Ukraine war)), which unveils the chronological disparities (caused by the switch in FII, DII, and other sources of investments). This study focuses on turmoil instead of a stable crisis period as the contagion effect emerges during the crisis period (which impacts the investors' sentiments); thus, focusing on the high market capitalization countries plays a vital role. In analysing previous literature, Castagneto-Gissey and Nivorozhkin (2016) identified no contagion from Russia towards the global equity market from international sanctions. Mohti et al. (2019) focused on the EDC crises relating to the frontier countries. They indicated that Slovenia, Romania, Nigeria, Kuwait, Oman, and Vietnam were among the countries hardest hit by the Eurozone financial crisis. Also, the financial contagion was weaker in the case of the European debt crisis, implying that border stock exchanges suffered the most from the US economic crisis. Mohiti et al. (2019) reported only the Croatian and Romanian (European region) statistically significant evidenced contagion remaining European markets and in America, the Middle East, Africa, and Asia appear to have been unaffected by the subprime crisis. Mendoza et al. (2023) concluded that developed markets, like the UK, US, Canada, and the Eurozone, are the primary sources of liquidity spillovers. However, rising markets such as Brazil, Mexico, South Africa, Romania, and Bulgaria are essential in transmitting and propagating liquidity shocks. Other emerging markets are the least sensitive to such shocks, providing the best possibilities to diversify portfolios globally and minimize financial contagion. Thus, emerging countries have taken a significant position in the global stock market. It became crucial to unveil the effects of contagion in different turmoil, which has not yet been discovered with comparable relevance to market capitalization. Globalization has had a significant impact in recent decades (Asongu and De Moor, 2017; Inci et al., 2011; Jones and Knaack, 2019; Martin et al., 2018; Mendoza and Quadrini, 2010; Morales and Andreosso-O'Callaghan, 2014), and each crisis has the potential to impact the global stock market.

This study examines the impact of six significant crises on global stock markets and the region over 15 years, adding to existing material. Although the GFC and EDC have received considerable attention in the literature, the COVID-19 and Russia-Ukraine crises offer fresh chances to study contagion in developed, emerging, and frontier countries, as each circumstance is distinctive. Understanding the mechanisms and nature of financial crises can help policymakers enhance market stability and efficiency while investors can better hedge against them. Understanding market interconnectedness is essential for rescue packages and portfolio diversification (Alagidede et al., 2011; Kakran et al., 2025).

5.2 Results of the financial contagion among developed, emerging and frontier countries.

5.2.1 DCC-GARCH Analysis

This sub-section discusses the results of the GARCH model, as discussed in Chapter-3. This section covers testing for contagion effect and analyses findings based on the types of crises studied. As per the equation in the methodology section, the pairwise estimates of the GFC and EDC are reported in Table 5.1.0; the Chinese burst bubble and Brexit event are reported in Table 5.1.1; and the COVID-19 crises and Russia-Ukraine crises reported in the Tabel 5.1.2.

During GFC, results revealed that significant ARCH effects for Japan, Australia, Canada and Hong Kong emerged among developed countries as Alpha *(α),* revealing that past shocks substantially impacted volatility at present times (Table 5.1.0). Volatility persistence Beta *(β)* was highly significant for all developed countries, showing the effects of financial shocks for a longer duration (indicated contagion characteristics). Regarding the leverage effect Gamma *(γ)*, Canada showed weak crisis dependence but was insignificant. Russia had the same result, which meant that bad news did not significantly increase market volatility for both these markets. Distress *(γ)* the leverage effect may be implied in crisis scenarios with the addition of one of those countries mentioned.

In emerging countries, ARCH effects *(α)* were strong in Malaysia, Brazil, Thailand, China, Saudi Arabia, and South Korea. This makes these economies more responsive to past market shocks than others elsewhere. Among emerging countries, India, South Korea, and Indonesia had weak (as below 1% level significant levels) ARCH effects, which suggests they were less sensitive to prior financial shocks than locations closer to Europe, where this usually is quite evident from past results like low volatilities on long time scales. Moreover, the volatility persistence (β) was insignificant for China, demonstrating that financial shocks did not have such a far-reaching effect. The leverage effect (γ) was weak for Malaysia, India and China and insignificant. This suggests that adverse shocks had relatively little impact on volatility in these markets.

Almost all frontier market countries (except Bahrain and Croatia, with low significant levels) were sensitive to ARCH effects. The volatility persistence (β) was insignificant for Morocco, showing that any shocks in this field fade quickly. The leverage effect (γ) was weak for Vietnam, Morocco, Kenya, Jordan, and Nigeria. It was insignificant in Kazakhstan and Romania, so these countries were not strongly affected from a financial distress standpoint.

Moreover, Bulgaria, Bahrain, and Croatia have shown a strong leverage effect among all frontier countries.

Regarding implications from GFC, it can be stated that although developed countries have a high degree of long-term volatility, the leverage effect varies significantly between different cases. Canada and Russia are less affected because they do not participate in this situation; their market shut down much earlier than others. In emerging markets, the degree of ARCH effect varies significantly. Some, such as Malaysia and China, are responsive to previous shocks at an outstandingly high level; others, like India or South Africa, do not react. Frontier market countries, both past-shocked and prone to a high level of volatility in general: The sensitivity of ARCH effects decreases with distance from the larger markets. Regarding the business implications, emerging and frontier market organizations should strengthen risk management frameworks as many markets still have strong ARCH effects from historical crises.

During EDC based on Table 5.1.0 (based on Eq. 3.45), pairwise conditional variances were estimated, as among developed countries, this study identified the US, Canada

Spain shown least significant results (indicating their volatility is not strongly linked with crises), and Australia, Spain, Russia, Singapore shown insignificant results (suggesting these markets were relatively stable) and rest countries (Japan, Hong-Kong, Germany, Switzerland) demonstrated significant results (indicating above markets are more sensitive to financial shocks.).

The coefficient of volatility (β) is highly significant for all the developed countries (revealing the long-lasting effect of each crisis), but gamma (γ) shows the least crisis relationship with the US and Japan; the rest of all countries show significant results.

Alpha (α) shows ARCH effects in emerging countries such as China, Saudi Arabia, South Africa, Thailand, Indonesia, and Malaysia, which showed significant impact (indicating it experienced string volatility due to past shocks). Conversely, India, Brazil, and Mexico showed the least or insignificant relationship with crisis-origin countries (indicated least reactive to past shocks).

The volatility coefficient (β) showed an insignificant relationship with China (indicated shocks didn't have prolonged impacts). Gamma (γ) showed the least crisis relationship with Malaysia, and China had an insignificant relationship (as a weaker relationship indicated adverse shocks had not disproportionately increased volatility in these markets).

In frontier countries, Alpha (α), all frontier countries have shown strong ARCH effects. The coefficient of volatility (β) shows an insignificant relationship with only Kenya. Gamma (γ) shows the least or insignificant crisis relationship with all forntier countries (i.e. Vietnam, Morocco, Nigeria, Bulgaria, Kazakhstan, Romania, Bahrain, Croatia, Kenya, Jordon, and PIIGS).

In terms of policy implications, all the developed countries exhibited strong volatility persistence, but some (e.g., the US and Japan) showed weak crisis-related leverage effects. In emerging countries, China stands out insignificantly in long-term volatility persistence *(β)*, and the rest of the countries have shown varying entities to the past shocks. The frontier countries with weak crisis-related leverage effects (volatility identified but unnecessary due to crisis contagion) are highly sensitive. Financial risk management, crisis response systems, and regulatory supervision should be bolstered in countries experiencing high volatility and ARCH effects to reduce the impact of crises on other countries.

During CBB crises, based on Table 5.1.1 (based on Eq. 3.45), pairwise conditional variances were estimated, as among developed countries, this study identified no country had shown highly significant results although Canada and Russia only with the least significant results (indicating their volatility is not strongly linked with crises), and rest all the developed countries shown insignificant results (suggesting these markets were relatively stable). Alpha (α) shows ARCH effects in emerging countries, which have not demonstrated highly significant results, as China, Saudi Arabia, South Africa, Thailand, Indonesia, and Malaysia have shown significant impact (indicating they experienced string volatility due to past shocks), on another side India, Brazil, and Mexico shown a least or insignificant relationship with crises origin country (indicated least reactive to past shocks). The coefficient of volatility (*β*) Beta was significant among all the emerging countries during the crises. Gamma (*γ*) showed Mexico, Thailand, South Africa, and Saudi Arabia with the least crisis relationship. China, South Korea, Brazil, Indonesia, and Malaysia demonstrate an insignificant relationship. Interestingly, only India has shown significant contagion effects.

In frontier countries, Alpha (α) Vietnam, Kazakhastan and Bahrain only have shown significant ARCH effect (Morcoo and Bulgaria showed insignificant results), and Nigeria, Bulgaria, Romania, Croatia, Kenya, and Jordon shown least significant results indicating ARCH effects. The volatility coefficient (β) showed an insignificant relationship with only Vietnam, Kazakhstan, Romania, Croatia, and Jordon. On the other side, Morocco showed the least significant relationship. Nigeria, Bulgaria, Bahrain, and Kenya have demonstrated only a significant relationship representing the volatility coefficient (*β)*. Gamma (*γ*) showed the least or insignificant crisis relationship with major frontier countries (i.e., Vietnam, Nigeria, Kazakhstan, Romania, Bahrain, Croatia, and Jordan) except with the least impact in Morcoo, Kenya, as Bulgaria is the only country that has shown a significant asymmetric volatility effect.

From the point of view of the implication, the CBB crisis had little to no impact on developed nations; the only two that exhibited any volatility were Russia and Canada. China, South Africa, and Saudi Arabia were emerging markets that responded more strongly to previous turbulence. It appears that crisis-driven volatility was more severe in India, the only emerging market that showed significant spillover effects. Vietnam, Kazakhstan, and Bahrain's frontier markets responded to previous shocks, but only Bulgaria's demonstrated significant asymmetric volatility impacts. Regarding implications, emerging markets require more robust risk mitigation mechanisms because of their enduring volatility during crises. More robust financial market resilience is necessary for frontier markets, particularly for managing asymmetric volatility. Stability in developed markets was high, indicating that these economies could weather the CBB crisis with minor damage to their financial systems.

During BREXIT, based on Table 5.1.1 (based on Eq. 3.45), pairwise conditional variances estimated, as among developed countries, this study identified the US, Germany, Switzerland, Spain, Russia, and the UK has only shown significant results; Canada and Hong-Kong shown weak significant impact (indicating their volatility is not strongly linked with crises), although Japan, Australia, and Singapore has shown insignificant results (suggesting these markets were relatively stable). The coefficient of volatility (β) Beta US, Japan, Australia, Hong Kong, Germany, Switzerland, Singapore and the UK showed significant results. Canada and Spain were the least significant; Russia alone showed insignificant results. Gamma (γ) showed weak significant results with the UK, Singapore, Spain, Switzerland, Australia, and Canada and insignificant results with the US, Japan, Hong Kong, Germany and Russia. Alpha (α), China, Brazil and Malaysia showed insignificant results in emerging countries. ARCH effects have not shown highly significant results, as South Korea, Saudi Arabia, South Africa, Thailand, Indonesia, and Mexico have shown significant impact (indicating it experienced substantial volatility due to past shocks). Conversely, India has shown the least significant relationship with crises (indicated least reactive to past shocks). The coefficient of volatility (β) Beta was significant among all the emerging countries except Brazil during the crises. Gamma (γ) showed significant results with India, South Africa, and Brazil; on the other side, Indonesia showed the least relationship. The insignificant relationship is shown by China, Saudi Arabia, South Korea, Thailand, Mexico, and Malaysia. Alpha (α), except Vietnam and Jordon, the rest of all countries, has shown a significant ARCH effect in frontier countries. The volatility coefficient (β), except for Kazakhstan, Bahrain, and the rest of the countries, has shown a significant volatility coefficient (β). Gamma (γ) showed a significant relationship in Jordon, with the least significant results in Romania. Rest all countries shown insignificant results.

Based on Table 5.1.2, during COVID-19, the US, Canada, Hong Kong, and Germany showed strong significant results (in all parameters, i.e. Alpha, Beta and Gamma), indicating that the market experienced persistent, intense asymmetric volatility, high-risk aversion and uncertainty. US, Canada, Japan, Australia, Hong Kong, Germany, Russia, Singapore, and Switzerland showed significant results with beta (persistent volatility) and in gamma (adverse shocks had a more considerable impact on volatility than positive shocks along with leverage effect) except Spain all countries shown significant implications with the moderate level in Russia and Singapore.

In emerging countries, China, India, South Korea, Brazil, Thailand, Indonesia, Mexico, and Malaysia showed significant alpha, indicating that these emerging markets were very reactive to new information or events, as the alpha signifies their vulnerability to external or internal shocks, a characteristic of emerging market economies born of underdeveloped financial systems and greater susceptibility to world volatility. India, Saudi Arabia, South Korea, South Africa, Brazil, Thailand, Indonesia, Mexico, and Malaysia have shown significant beta (measures the persistence of volatility), indicating once volatility increases elevated for a longer duration. Saudi Arabia, South Korea, South Africa, and Brazil have shown significant gamma based on the presence of leverage effect, as a more substantial impact identified negative than positive shocks volatility could be due to factors such as commodity dependence and investor behaviour.

Some regional impacts also emerged in Asia **(**China, India, South Korea, Thailand, Indonesia, Malaysia**),** Latin America (Brazil, Mexico), and the Middle East and Africa (Saudi Arabia, South Africa) with high sensitivity to shocks and persistent volatility due to market maturity, investor behaviour or sentiments along with the economic structure (e.g., dependence on commodities).

Moreover, in the frontier countries, Vietnam, Nigeria, and Bahrain have shown significant gamma; Vietnam, Morocco, Nigeria, Kazakhstan, Romania, Bahrain, Croatia, Kenya and Jordon have shown significant alpha. A significant gamma suggests that these countries' markets react more intensely to adverse shocks (like those caused by a crisis) than positive ones. During the COVID-19 crisis, Vietnam's economy was affected by global supply chain disruptions, waning demand and falling tourism. Its financial markets, for example, likely saw a sharp surge of volatility in answer to the press of uncertainty over what would happen economically (or recover). The adverse shocks (lock-outs, new variants) would have amplified market volatility more than positive news. Due to its heavy reliance on oil exports, Nigeria would have had significant volatility due to gyrations in oil prices and pandemic shutdowns. The market reaction to bad news, such as oil price crashes or a worsening health situation, could have been sharper than responses to good news because of uncertainty. Bahrain would have had troubles during the pandemic as a small oil-producing economy. Volatility would be asymmetrical, with adverse (e.g. oil price shocks) leading to more drastic market reactions than were experienced for positive news questions on pandemic restrictions or changes in general economic policy based on Alpha; the persistence of shocks in the past leads to influences in future stock indexes. If alpha is significant, volatility in the market in these countries is exceptionally susceptible to past events, such as the style of times in financial distress like COVID-19. Specific terms are used differently in these countries, as the Vietnam market would be susceptible to past shocks, meaning past disruptions (like lockdowns and supply chain issues) likely continued to influence market behaviour in the short term. Similar to Vietnam, Morocco's markets would have been impacted by past shocks (such as tourism collapse or disruptions in trade with Europe), which means the volatility would have persisted in the aftermath of initial COVID-19 disruptions. Nigeria, the oil price crash and lockdowns would have created significant volatility. The alpha effect suggests that the market would be heavily influenced by how these shocks unfolded and interacted with other global events during the crisis. During the pandemic, Kazakhstan and Romania experienced economic strain due to supply chain disruptions and reduced global demand. The alpha effect suggests that markets in these countries were reactive to previous shocks and crises during this period. Bahrain: As a smaller oil-dependent economy, Bahrain would have shown high volatility sensitivity to past shocks (oil price fluctuations, policy shifts, COVID-19 waves), which could have had prolonged impacts. Croatia, Kenya, and Jordan: These countries also showed significant alpha, showing that market volatility during the COVID-19 crisis was greatly influenced by past economic disruption (such as government intervention, shutdown legally or global recession fears). Moreover, the significant gamma values in places like Vietnam, Nigeria, and Bahrain suggest how much their markets were negatively affected by the COVID-19 crisis. This means that when bad news arrived (such as lockdowns, oil-price collapse or outbreaks of COVID-19), their behaviour became worse than if it had just reached a well-period that one had been pursuing all along. Suppose good news (such as vaccine rollouts or recovery plans) came along. The markets responded differently at best and with much greater force for the same message at worst.

During the last crises of this study, i.e., the Russia-Ukraine crises, Australia, Spain among developed countries (with ** significance level); China, Saudi Arabia, South Korea, Brazil, and Indonesia (with ** significance level) among emerging countries;

Among frontier countries, Vietnam, Morocco, Bulgaria, Kazakhstan, and Romania showed significant results in all the parameters.

Moreover, Russia and Singapore were the only countries that reacted to the alpha parameter with strong, significant results. Because of the geopolitical environment and economic sanctions imposed on Russia by the war, its volatility must have become more responsive to past shocks (such as new sanctions or military escalations). The market would have reflected these shocks as the war started in Singapore; even though it is a financial hub, Singapore might also have suffered from the effects the war was having on world trade or energy prices, changes like this causing its market to respond to past shocks global economic disruptions or move away from regional trade. Australia, Hong Kong, Singapore, Germany, Switzerland, Spain, and Russia stock markets showed significant beta, and the US, Australia, Switzerland, and Spain showed strong significant gamma among developed countries. China, India, Saudi Arabia, South Korea, South Africa, Brazil, Indonesia, Mexico, Malaysia, Vietnam, Morocco, Bulgaria, Kazakhstan, Bahrain, Romania, and Croatia in beta significant results as these countries have observations shown stable volatility.

Moreover, the Gamma parameter showed significant results for China, Saudi Arabia, South Africa, Brazil, Indonesia, Vietnam, and Morocco stock markets. These markets were more sensitive to adverse shocks during the war. For instance, volatility increased sharply in places like the US and Switzerland whenever an adverse event occurred, such as military escalations resulting in sanctions or higher future energy prices. Similarly, Australia and Spain likely had markets that responded more to bad news. However, concerning the war, Europe's energy crisis and its impact on world markets gained from this increased sensitivity of one's own but not so much others'; it probably made general conditions everywhere worse and only affected sensitive places locally.

During the Russia-Ukraine war, the developed markets and emerging countries were volatile, as they were sensitive to past shocks and reacted asymmetrically in response. Revealed the implications for investors, policymakers and businesses, particularly in energy-exporting economies and economies dependent on raw materials as their main exports. These results underline the need for strategic risk management, policy intervention, and long-term economic resilience in negotiating the ongoing impacts of this crisis phase.

This study observed that the coefficient of volatility (Beta) indicated China as insignificant during the GFC, EDC, and COVID-19 but highly significant during Brexit, the Chinese burst bubble, and the Russia-Ukraine crises. During GFC (China, Morocco), EDC (China), Chinese Burst bubble (Switzerland, Vietnam, Kazakhstan, Romania, and Jordon), Brexit (Russia, Brazil, Bahrain, and Kazakhstan), COVID-19 (China), and Russia-Ukraine crises (Japan, Nigeria, Kenya, Jordon) (insignificant to the coefficient of volatility (beta)) rest of countries shown highly significant coefficient of volatility.

Table 5.1.0: During GFC and EDC results estimation using the GJR-GARCH (1,1) Model. (Source: Author using R software).

GFC Crises					EDC Crises				
Developed Countries									
Variance Eq. Country	Alpha	Beta	Gamma	P value	Variance Eq. Country	Alpha	Beta	Gamma	P value
US (Estimate)	0.002267	**0.89101**	**0.188021**	0.9872875	US (Estimate)	0.093513	**0.75361**	0.235831	0.9650385
t value	0.071384	**(38.09684)*** **	**(3.241277)*** **		t value	(2.28576)**	**(8.06057)*** **	(1.92135)**	
Pr(>|t|)	0.943093	**0**	**0.00119**		Pr(>|t|)	0.022268	**0**	0.054688	
Canada	0.078677	**0.837645**	0.140685	0.9866645	Canada	0.028819	**0.83325**	**0.199567**	0.9618525
t value	(1.74226)*	**(21.4718)*** **	(2.5563)**		t value	(2.1517)**	**(31.7783)*** **	**(7.5723)*** **	
Pr(>|t|)	0.081463	**0**	0.010579		Pr(>|t|)	0.031417	**0**	**0**	
Japan Estimate	**0.062231**	**0.809345**	**0.157655**	0.9504035	Japan	**0.251961**	**0.394877**	0.216678	0.755177
t value	**(3.5113)*** **	**(28.4576)*** **	**(3.2709)*** **		t value	**(3.2987)*** **	**(3.5738)*** **	(2.4879)**	
Pr(>|t|)	**0.000446**	**0**	**0.001072**		Pr(>|t|)	**0.000971**	**0.000352**	0.01285	
Australia	**0.076228**	**0.751825**	**0.21351**	0.934808	Australia	0.000535	**0.886863**	**0.150785**	0.9627905
t value	**(3.8398)*** **	**(19.66317)*** **	**(3.55938)*** **		t value	0.21725	**(67.08935)*** **	**(5.75328)*** **	
Pr(>|t|)	**0.000123**	**0**	**0.000372**		Pr(>|t|)	0.828013	**0**	**0**	
Hong-Kong	**0.098572**	**0.792592**	**0.15005**	0.966189	Hong-Kong	**0.015517**	**0.898671**	**0.091088**	0.959732
t value	**(4.9081)*** **	**(19.88)*** **	**(2.8005)*** **		t value	**(3.0018)*** **	**(65.278)*** **	**(4.7079)*** **	
Pr(>|t|)	**0.000001**	**0**	**0.005103**		Pr(>|t|)	**0.002684**	**0**	**0**	
Germany	0	**0.889733**	**0.191279**	0.9853725	Germany	**0.094282**	**0.725414**	**0.27303**	0.956211
t value	0	**(28.70689)*** **	**(2.88111)*** **		t value	**(2.8474)*** **	**(25.2447)*** **	**(5.1956)*** **	
Pr(>|t|)	1	**0**	**0.003963**		Pr(>|t|)	**0.004408**	**0**	**0**	
Switzerland	0	**0.890549**	**0.172719**	0.9769085	Switzerland	**0.090659**	**0.643052**	**0.335523**	0.9014725
t value	0.000008	**(39.30227)*** **	**(5.460567)*** **		t value	**(3.93)*** **	**(18.4351)*** **	**(5.3543)*** **	
Pr(>|t|)	0.999994	**0**	**0**		Pr(>|t|)	**0.000085**	**0**	**0**	
Spain	0	**0.906926**	**0.166292**	0.990072	Spain	0.063164	**0.809462**	**0.229267**	0.9872595
t value	0.000004	**(28.463839)*** **	**(3.329939)*** **		t value	(1.86293)*	**(14.84742)*** **	**(3.61337)*** **	
Pr(>|t|)	0.999997	**0**	**0.000869**		Pr(>|t|)	0.062473	**0**	**0.000302**	
Russia	0.163025	**0.776036**	0.119877	0.9989995	Russia	0.047069	**0.809382**	**0.156893**	0.9348975
t value	1.93291	**(18.29135)*** **	1.32628		t value	3.1658	**(38.4915)*** **	**(4.5879)*** **	
Pr(>|t|)	0.053248	**0**	0.184749		Pr(>|t|)	0.156893	**0**	**0.000004**	
Singapore	0.023594	**0.915908**	**0.100991**	0.9899975	Singapore	0.039299	**0.890014**	**0.092354**	0.97549
t value	0.15021	**(4.98444)*** **	**(3.77369)*** **		t value	1.2556	**(27.25327)*** **	**(3.92153)*** **	
Pr(>|t|)	0.880595	**0.000001**	**0.000161**		Pr(>|t|)	0.209262	**0**	**0.000088**	
Emerging Countries									

GFC Crises					EDC Crises				
Developed Countries									
China	**0.37667**	0	0.024226	0.388783	China	**0.364407**	0	0.020867	0.3748405
t value	**(3.43563)*** **	0	0.15624		t value	**(4.10068)*** **	0	0.17411	
Pr(>|t|)	**0.000591**	1	0.87584		Pr(>|t|)	**0.000041**	1	0.861779	
India	0.145644	**0.625396**	0.2405	0.89129	India	0.055137	**0.844856**	**0.122237**	0.9611115
t value	(1.9548)*	**(6.3114)*** **	(2.474)**		t value	1.63848	**(21.32621)*** **	**(2.55171)*** **	
Pr(>|t|)	0.050611	**0**	0.013361		Pr(>|t|)	0.101321	**0**	**0.01072**	
Saudi Arabia	**0.163762**	**0.790484**	**0.089507**	0.9989995	Saudi Arabia	**0.112906**	**0.588332**	**0.359812**	0.881144
t value	**(4.32518)*** **	**(109.95983)*** **	**(3.92936)*** **		t value	**(3.2701)*** **	**(18.9391)*** **	**(4.855)*** **	
Pr(>|t|)	**0.000015**	**0**	**0.000085**		Pr(>|t|)	**0.001075**	**0**	**0.000001**	
South Korea	0.042354	**0.849584**	**0.160302**	0.972089	South Korea	0.000001	**0.885862**	**0.164643**	0.9681845
t value	(2.4734)**	**(30.3728)*** **	**(4.1772)*** **		t value	0.000143	**(46.100299)*** **	**(6.362562)*** **	
Pr(>|t|)	0.013382	**0**	**0.00003**		Pr(>|t|)	0.999886	**0**	**0**	
South Africa	0	**0.932249**	**0.133501**	0.9989995	South Africa	**0.125327**	**0.677719**	**0.247786**	0.926939
t value	0	**(46.72681)*** **	**(4.65027)*** **		t value	**(3.8082)*** **	**(17.59)*** **	**(3.7145)*** **	
Pr(>|t|)	1	**0**	**0.000003**		Pr(>|t|)	**0.00014**	**0**	**0.000204**	
Brazil	**0.050414**	**0.834448**	**0.150332**	0.960028	Brazil	0.000002	**0.946824**	**0.075072**	0.984362
t value	**(3.3964)*** **	**(26.18377)*** **	**(2.9861)*** **		t value	0.000128	**(45.337558)*** **	**(3.724468)*** **	
Pr(>|t|)	**0.000683**	**0**	**0.002826**		Pr(>|t|)	0.999898	**0**	**0.000196**	
Thailand	**0.027412**	**0.868903**	**0.148058**	0.970344	Thailand	**0.137067**	**0.642551**	**0.263354**	0.911295
t value	**(3.89896)*** **	**(34.52272)*** **	**(4.30929)*** **		t value	**(4.8507)*** **	**(18.4054)*** **	**(4.6968)*** **	
Pr(>|t|)	**0.000097**	**0**	**0.000016**		Pr(>|t|)	**1.00E-06**	**0.00E+00**	**3.00E-06**	
Indonesia	0.139917	**0.462571**	**0.408421**	0.8066985	Indonesia	**0.196759**	**0.56005**	**0.303306**	0.908462
t value	(1.75587)*	**(3.49237)*** **	**(3.46462)*** **		t value	**(4.3072)*** **	**(13.7206)*** **	**(4.178)*** **	
Pr(>|t|)	0.07911	**0.000479**	**0.0005**		Pr(>|t|)	**1.70E-05**	**0.00E+00**	**2.90E-05**	
Mexico	0.030567	**0.897641**	**0.138323**	0.9973695	Mexico	0.006289	**0.921684**	**0.098814**	0.97738
t value	0.59033	**(17.40068)*** **	**(4.13219)*** **		t value	0.41238	**(60.18497)*** **	**(4.09485)*** **	
Pr(>|t|)	0.554972	**0**	**0.000036**		Pr(>|t|)	0.680064	**0**	**0.000042**	
Malaysia	**0.332207**	**0.40411**	0.215603	0.8441185	Malaysia	**0.448807**	**0.114875**	0.190058	0.658711
t value	**(2.8217)*** **	**(8.5665)*** **	(1.6484)*		t value	**(4.8814)*** **	**(4.0283)*** **	1.4783	
Pr(>|t|)	**0.004777**	**0**	0.099267		Pr(>|t|)	**0.000001**	**0.000056**	0.139326	
Frontier Countries									
Vietnam	**0.299074**	**0.595213**	0.183	0.985787	Vietnam	**0.459051**	**0.217147**	0.02685	0.689623
t value	**(3.7019)*** **	**(7.7901)*** **	(1.9274)*		t value	**(5.10171)*** **	**(2.9762)*** **	0.24652	
Pr(>|t|)	**0.000214**	**0**	0.053933		Pr(>|t|)	**0**	**0.002918**	0.805279	
Morocco	**0.523691**	0.126243	0.365711	0.8327895	Morocco	**0.376522**	**0.354855**	0.168304	0.815529
t value	**(4.10985)*** **	1.456806	(1.702801)*		t value	**(5.5864)*** **	**(10.4465)*** **	(1.653)*	

GFC Crises					EDC Crises				
Developed Countries									
Pr(>|t|)	**0.00004**	0.14517	0.088605		Pr(>|t|)	**0**	**0**	0.09833	
Nigeria	**0.382529**	**0.510257**	0.212429	0.9990005	Nigeria	**0.606558**	**0.179162**	-0.112048	0.729696
t value	**(5.164)*** **	**(20.0811)*** **	(1.9807)**		t value	**(6.34894)*** **	**(6.89169)*** **	-0.93167	
Pr(>|t|)	**0**	**0**	0.04763		Pr(>|t|)	**0**	**0**	0.35151	
Bulgaria	**0.411602**	**0.377487**	**0.419822**	0.999	Bulgaria	**0.401827**	**0.541405**	-0.01779	0.934337
t value	**(3.7598)*** **	**(5.0946)*** **	**(2.7148)*** **		t value	**(5.81259)*** **	**(24.04684)*** **	-0.24222	
Pr(>|t|)	**0.00017**	**0**	**0.006631**		Pr(>|t|)	**0**	**0**	0.80861	
Kazakhstan	**0.32604**	**0.594649**	0.156622	0.999	Kazakhstan	**0.331042**	**0.381991**	0.186163	0.8061145
t value	**(4.3625)*** **	**(9.2526)*** **	1.5103		t value	**(4.719526)*** **	**(3.796721)*** **	(1.754936)*	
Pr(>|t|)	**0.000013**	**0**	0.130965		Pr(>|t|)	**0.000002**	**0.000147**	0.07927	
Romania	**0.42012**	**0.451975**	0.199032	0.971611	Romania	**0.35778**	**0.549332**	0.136976	0.9756
t value	**(3.7436)*** **	**(5.722)*** **	1.5554		t value	**(5.2599)*** **	**(19.9673)*** **	1.5882	
Pr(>|t|)	**0.000181**	**0**	0.119862		Pr(>|t|)	**0**	**0**	0.112248	
Bahrain	0.068732	**0.821782**	**0.140469**	0.9607485	Bahrain	**0.456725**	**0.182452**	0.107274	0.692814
t value	(1.89856)*	**(21.72221)*** **	**(2.77112)*** **		t value	**(5.00369)*** **	**(6.76046)*** **	0.92885	
Pr(>|t|)	0.057622	**0**	**0.005586**		Pr(>|t|)	**0.000001**	**0**	0.352965	
Croatia	0.210751	**0.627091**	**0.275884**	0.975784	Croatia	**0.471541**	**0.406853**	-0.069379	0.8437045
t value	(2.5244)**	**(11.0515)*** **	**(3.0253)*** **		t value	**(5.23648)*** **	**(9.14207)*** **	-0.73901	
Pr(>|t|)	0.011588	**0**	**0.002484**		Pr(>|t|)	**0**	**0**	0.4599	
Kenya	**0.580758**	**0.232155**	0.372175	0.9990005	Kenya	**0.78744**	0.034733	-0.082244	0.781051
t value	**(5.222)*** **	**(6.1165)*** **	(2.1357)**		t value	**(7.15988)*** **	(2.46292)**	-0.58158	
Pr(>|t|)	**0**	**0**	0.032702		Pr(>|t|)	**0**	0.013781	0.560849	
Jordon	**0.239931**	**0.49583**	0.223546	0.847534	Jordon	**0.315648**	**0.42607**	0.142744	0.81309
t value	**(3.3092)*** **	**(12.7384)*** **	(2.4405)*		t value	**(4.73001)*** **	**(19.97673)*** **	(1.69423)*	
Pr(>|t|)	**0.000936**	**0**	0.014668		Pr(>|t|)	**0.000002**	**0**	0.090222	
					PIIGS	**0.33537**	**0.44981**	0.13173	0.851045
					t value	**(3.8278)*** **	**(4.6048)*** **	1.4302	
					Pr(>|t|)	**0.000129**	**0.000004**	0.152674	

Note: The above table reports the average variance (based on Equation 3.45). Only those countries highlighted showed a highly significant level (moreover, the below 1%, 5%, and 10% represent ****, **, * respectively to and probability represented by (Pr(>|t|)*)). Beta (β) indicates the GARCH (as it indicates the enduring nature of volatility across time. (in short, it can be stated as volatility persistence). A high β (approaching 1) indicates that historical volatility has a persistent impact, signifying that financial shocks continue to affect the market over an extended duration) and Alpha (α) shows ARCH effects (It assesses the immediate effects of novel shocks on conditional variance. A substantial α indicates that recent unforeseen volatility (shocks) profoundly affects present market volatility, i.e., in short, it can be stated as shock sensitivity). While gamma (γ) is an asymmetric volatility effect (In GJR-GARCH models, γ measures the degree to which negative shocks (adverse news) generate greater volatility than positive shocks (favourable news) (in short, it explains leverage effects). If $\gamma > 0$ and significant, it denotes asymmetric effects, suggesting that negative news has a more pronounced impact on market volatility than positive news). The *t*-statistics are in parentheses (the *t*-statistic quantifies the number of standard errors the calculated coefficient deviates from zero. An elevated absolute *t*-value indicates that the coefficient is markedly distinct from zero). *, ** and *** represent the *p-values* <0.10, <0.05, and < 0.01. P represents persistence. Only highly significant results of each parameter are highlighted.

Table 5.1.1: During CBB and BREXIT results estimation using the GJR-GARCH (1,1) Model. (Source: Author using R software).

Chinese Brust Bubble					BREXIT Event				
Developed Countries									
Variance Eq. → Country	Alpha	Beta	Gamma	P	Variance Eq. → Country	Alpha	Beta	Gamma	P
US (Estimate)	0.015419	**0.551507**	**0.556048**	0.84495	**US (Estimate)**	**0.386638**	**0.206544**	0.259407	0.7228855
t value	0.395401	**(7.689618)***	**(2.692558)***		**t value**	**(3.1472)***	**(3.6608)***	1.3457	
Pr(>|t|)	0.692547	**0**	**0.007091**		**Pr(>|t|)**	**0.001648**	**0.000251**	0.178415	
Canada	0.134872	**0.455271**	0.463399	0.8218425	Canada	0.169989	0.164384	0.333704	0.501225
t value	(1.855)*	**(4.2029)***	(1.8673)*		t value	(2.5044)**	(2.4366)**	(1.8873)*	
Pr(>|t|)	0.063595	**0.000026**	0.061866		Pr(>|t|)	0.012266	0.014826	0.059123	
Japan	0.020949	**0.688472**	**0.429626**	0.924234	Japan	0	**0.858588**	0.187414	0.952295
t value	0.44158	**(8.31012)***	**(2.62725)***		t value	0.000029	**(31.708521)***	3.554413	
Pr(>|t|)	0.658793	**0**	**0.008608**		Pr(>|t|)	0.999977	**0**	0.000379	
Australia	0	**0.722062**	0.255839	0.8499815	Australia	0.000001	**0.893891**	0.134847	0.9613155
t value	0	**(11.580974)***	(1.992308)**		t value	0.000012	**(28.596406)***	(2.009751)**	
Pr(>|t|)	1	**0**	0.046337		Pr(>|t|)	0.99999	**0**	0.044458	
Hong-Kong	0.000009	**0.797345**	**0.323507**	0.9591075	Hong-Kong	0.020421	**0.98492**	-0.01377	0.998456
t value	0.000414	**(16.257563)***	**(2.625637)***		Std. Error	(0.00851))**	**(0.004399)***	0.014788	
Pr(>|t|)	0.99967	**0**	**0.008649**		Pr(>|t|)	0.016407	**0**	0.351769	
Germany	0.000009	**0.797345**	0.323507	0.9591075	Germany	**0.42829**	**0.154473**	0.13798	0.651753
t value	0.000414	**(16.257563)***	2.625637		t value	**(3.34668)***	**(2.97527)***	0.76531	
Pr(>|t|)	0.99967	**0**	0.008649		Pr(>|t|)	**0.000818**	**0.002927**	0.444087	
Switzerland	0.123517	0.000003	0.315791	0.2814155	Switzerland	**0.220443**	**0.292228**	0.34243	0.683886
t value	0.774713	0.000011	1.289721		t value	**(2.8098)***	**(4.4405)***	(2.3237)**	
Pr(>|t|)	0.438509	0.999991	0.197148		Pr(>|t|)	**0.004958**	**0.000009**	0.020142	
Spain	0	**0.871826**	0.192812	0.968232	Spain	**0.573885**	0.177925	-0.146495	0.6785625
t value	0.000001	**(9.253027)***	(2.506523)**		t value	**(3.78163)***	(2.04045)**	(-0.79305)**	
Pr(>|t|)	0.999999	**0**	0.012193		Pr(>|t|)	**0.000156**	0.041306	0.427751	
Russia	0.296534	**0.441429**	0.262186	0.869056	Russia	**0.427443**	0.080481	-0.039491	0.4881785

Chinese Brust Bubble					BREXIT Event				
Developed Countries									
t value	(1.94669)*	**(4.55297)*** **	1.04332		t value	**(3.17472)*** **	0.86789	-0.22881	
Pr(>|t|)	0.051572	**0.000005**	0.2968		Pr(>|t|)	**0.0015**	0.38546	0.81902	
Singapore	0.000663	**0.947118**	**0.099279**	0.9974205	Singapore	0.003586	**0.960887**	0.049656	0.989301
t value	0.035331	**(43.559935)*** **	**(2.757967)*** **		t value	0.99094	**(53.11252)*** **	(1.92218)*	
Pr(>|t|)	0.971815	**0**	**0.005816**		Pr(>|t|)	0.321714	**0**	0.054583	
					UK	**0.267944**	**0.41955**	0.301784	0.838386
					t value	**(2.7071)*** **	**(6.7133)*** **	(1.9411)*	
					Pr(>|t|)	**0.006787**	**0**	0.052243	
Emerging Countries									
China	0.089116	**0.696726**	0.243313	0.9074985	China	0.006388	**0.994455**	-0.00498	0.998353
t value	0.81132	**(4.36835)*** **	1.44197		t value	1.4342	**(1231.51356)*** **	-0.60314	
Pr(>|t|)	0.417183	**0.000013**	0.14931		Pr(>|t|)	0.151516	**0**	0.546418	
India	0.160641	**0.362051**	**0.60348**	0.824432	India	0.132302	**0.348612**	**0.358118**	0.659973
t value	(2.0284)**	**(3.9792)*** **	**(2.6879)*** **		t value	(2.2217)**	**(4.4441)*** **	**(2.439)*** **	
Pr(>|t|)	0.042522	**0.000069**	**0.007191**		Pr(>|t|)	0.026303	**0.000009**	**0.014729**	
Saudi Arabia	0.120709	**0.560864**	0.386451	0.8747985	Saudi Arabia	**0.138805**	**0.800485**	0.089606	0.984093
t value	(1.7438)*	**(6.3295)*** **	(2.2905)**		t value	**(3.0345)*** **	**(18.049435)*** **	1.465819	
Pr(>|t|)	0.081197	**0**	0.021995		Pr(>|t|)	**0.002409**	**0**	0.142698	
South Korea	0.235339	**0.489279**	0.281714	0.865475	South Korea	**0.510262**	**0.111636**	-0.096057	0.5738695
t value	(1.71164)*	**(4.23811)*** **	1.41229		t value	**(3.81718)*** **	**(4.43508)*** **	-0.57313	
Pr(>|t|)	0.086963	**0.000023**	0.157864		Pr(>|t|)	**0.000135**	**0.000009**	0.566556	
South Africa	0	**0.878652**	0.154913	0.9561085	South Africa	**0.021886**	**0.654151**	**0.258755**	0.8054145
t value	0	**(21.20894)*** **	(2.19546)**		t value	**(1.9756)*** **	**(15.9972)*** **	**(2.822)*** **	
Pr(>|t|)	1	**0**	0.028131		Pr(>|t|)	**0.048195**	**0**	**0.004772**	
Brazil	0.302535	**0.463348**	0.218292	0.875029	Brazil	0.134765	0	**0.603575**	0.4365525
t value	(2.20105)**	**(3.16926)*** **	0.90024		t value	1.3136	0	**(3.0162)*** **	
Pr(>|t|)	0.027733	**0.001528**	0.367991		Pr(>|t|)	0.18898	1	**0.00256**	
Thailand	0.029514	**0.744742**	0.284942	0.916727	Thailand	**0.3687**	**0.517315**	0.181216	0.976623
t value	1.2314	**(12.9714)*** **	(2.2858)**		t value	**(3.2336)*** **	**(16.1652)*** **	1.1845	
Pr(>|t|)	0.218158	**0**	0.022269		Pr(>|t|)	**0.001222**	**0**	0.236222	

Chinese Brust Bubble					BREXIT Event				
Developed Countries									
Indonesia	0.391052	**0.364808**	0.323254	0.917487	Indonesia	**0.212342**	**0.599042**	0.230932	0.92685
t value	1.302926	**(3.390707)*** **	1.214848		t value	**(2.6159)*** **	**(20.2307)*** **	(1.8409)*	
Pr(>|t|)	0.1926	**0.000697**	0.224424		Pr(>|t|)	**0.008899**	**0**	0.065636	
Mexico	0.094425	**0.512634**	0.382365	0.7982415	Mexico	**0.598255**	**0.332852**	-0.134736	0.863739
t value	1.5585	**(4.95946)*** **	(2.02961)**		t value	**(4.14261)*** **	**(6.47902)*** **	-0.74246	
Pr(>|t|)	0.119116	**0.000001**	0.042396		Pr(>|t|)	**0.000034**	**0**	0.457811	
Malaysia	0.276893	**0.612085**	0.218659	0.9983075	Malaysia	0.00729	**0.979654**	0.021838	0.997863
t value	(2.19801)**	**(5.0391)*** **	1.2854		t value	0.503963	**(85.313205)*** **	1.352468	
Pr(>|t|)	0.027949	**0**	0.198653		Pr(>|t|)	0.61429	**0**	0.17623	
Frontier Countries									
Vietnam	**0.513347**	0	0.0606	0.543647	Vietnam	0.102462	**0.803026**	0.067696	0.939336
t value	**(8.76314)*** **	0	0.21741		t value	1.525	**(14.62245)*** **	0.69946	
Pr(>|t|)	**0**	1	0.827892		Pr(>|t|)	0.12726	**0**	0.484266	
Morocco	0.152803	0.131999	0.477227	0.5234155	Morocco	**0.580133**	**0.510151**	-0.182569	0.9989995
t value	1.06835	(1.89974)*	(1.86843)*		t value	**(4.236)*** **	**(17.8564)*** **	-1.3174	
Pr(>|t|)	0.285364	0.057467	0.061702		Pr(>|t|)	**0.000023**	**0**	0.187706	
Nigeria	0.648741	**0.177349**	-0.242517	0.7048315	Nigeria	**0.789905**	**0.215875**	-0.250536	0.880512
t value	(2.40441)**	**(2.35115)*** **	-0.72968		t value	**(4.7299)*** **	**(4.0701)*** **	-0.20928	
Pr(>|t|)	0.016198	**0.018716**	0.465587		Pr(>|t|)	**0.000002**	**0.000047**	0.195819	
Bulgaria	0.027527	**0.999983**	**-0.057043**	0.9989885	Bulgaria	**0.714505**	**0.179714**	-0.043684	0.872377
t value	2.82E+00	**(156915.3189)*** **	**(-4.3594)*** **		t value	**(4.19649)*** **	**(3.39321)*** **	2.14808	
Pr(>|t|)	1	**0**	**0.000013**		Pr(>|t|)	**0.000027**	**0.000691**	0.834228	
Kazakhstan	**1**	0	-0.316512	0.841744	Kazakhstan	**0.306316**	0.094445	0.154263	0.4778925
t value	**(3.85612)*** **	0	-0.84525		t value	**(2.61635)*** **	0.70058	0.90908	
Pr(>|t|)	**0.000115**	1	0.397969		Pr(>|t|)	**0.008887**	0.483567	0.36331	
Romania	0.376834	0	0.519624	0.636646	Romania	**0.331578**	**0.280183**	0.327686	0.775604
t value	(2.05927)**	0	1.51512		t value	**(3.3999)*** **	**(6.4736)*** **	(2.0267)**	
Pr(>|t|)	0.039469	1	0.129741		Pr(>|t|)	**0.000674**	**0**	0.042696	
Bahrain	**0.049894**	**0.955118**	-0.013033	0.9984955	Bahrain	**0.55771**	0	-0.224163	0.4456285
t value	**(4.922144)*** **	**(19.332545)*** **	-0.218497		t value	**(3.9025)*** **	1.40E-05	-1.20E+00	

Chinese Brust Bubble					BREXIT Event				
Developed Countries									
Pr(>|t|)	**0.000001**	**0**	0.827042		Pr(>|t|)	**0.000095**	0.999989	0.230175	
Croatia	0.345918	0	-0.157042	0.267397	Croatia	**0.457463**	**0.36382**	0.284343	0.9634545
t value	(1.8806)*	0.000001	-6.90E-01		t value	**(2.8226)*****	**(5.3108)*****	1.5237	
Pr(>|t|)	0.06002	1	0.49002		Pr(>|t|)	**0.004764**	**0**	0.127571	
Kenya	0.267077	**0.47947**	0.363544	0.928319	Kenya	**0.465145**	**0.175191**	0.140692	0.710682
t value	(1.6517)*	**(4.1579)*****	(1.8872)**		t value	**(3.58873)*****	**(5.35111)*****	0.76044	
Pr(>|t|)	0.0986	**0.000032**	0.059134		Pr(>|t|)	**0.000332**	**0**	0.446993	
Jordon	0.567413	0	-0.219658	0.457584	Jordon	0.00055	**0.963048**	**0.043863**	0.9855295
t value	(2.35256)**	0	-0.74892		t value	0.06102	**(40.75359)*****	**(5.34069)*****	
Pr(>|t|)	0.018645	1	0.453904		Pr(>|t|)	0.95134	**0**	**0**	

Note: The above table reports the average variance (based on Equation 3.45). Only those countries highlighted showed a highly significant level (moreover, the below 1%, 5%, and 10% represent ****, **, * respectively to and probability represented by (Pr(>|t|)*)).* Beta (*β*) indicates the GARCH (as it indicates the enduring nature of volatility across time. (in short, it can be stated as volatility persistence). A high *β* (approaching 1) indicates that historical volatility has a persistent impact, signifying that financial shocks continue to affect the market over an extended duration) and Alpha (α) shows ARCH effects (It assesses the immediate effects of novel shocks on conditional variance. A substantial *α* indicates that recent unforeseen volatility (shocks) profoundly affects present market volatility, i.e., in short, it can be stated as shock sensitivity). While gamma (*γ*) is an asymmetric volatility effect (In GJR-GARCH models, *γ* measures the degree to which negative shocks (adverse news) generate greater volatility than positive shocks (favourable news) (in short, it explains leverage effects). If $\gamma > 0$ and significant, it denotes asymmetric effects, suggesting that negative news has a more pronounced impact on market volatility than positive news). The *t*-statistics are in parentheses (the *t*-statistic quantifies the number of standard errors the calculated coefficient deviates from zero. An elevated absolute *t*-value indicates that the coefficient is markedly distinct from zero). *, ** and *** represent the *p-values* <0.10, <0.05, and < 0.01. P represents persistence. Only highly significant results of each parameter are highlighted.

Table 5.1.2: During the COVID-19 and Russia-Ukraine crises, the results were estimated using the GJR-GARCH (1,1) Model. (Source: Author using R software).

COVID-19 Crises					**Russia-Ukraine Crises**				
Developed Countries									
Variance Eq. → Country	**Alpha**	**Beta**	**Gamma**	**P value**	**Variance Eq. → Country**	**Alpha**	**Beta**	**Gamma**	**P value**
US (Estimate)	**0.237487**	**0.596017**	**0.319162**	0.993085	US (Estimate)	0	**0.801729**	**0.178329**	0.8908935
t value	**(3.2722)***	**(23.7217)***	**(2.7988)***		t value	0	**(24.2324)***	**(2.35105)***	
Pr(>|t|)	**0.001067**	**0**	**0.005129**		Pr(>|t|)	1	**0**	**0.018721**	
Canada	**0.25808**	**0.506054**	**0.469731**	0.9989995	Canada	0.432587	**0.300656**	0.232947	0.8497165
t value	**(3.2527)***	**(7.6848)***	**(3.4548)***		t value	(2.5217)**	**(4.1887)***	1.1069	
Pr(>|t|)	**0.001143**	**0**	**0.000551**		Pr(>|t|)	0.011679	**0.000028**	0.268353	
Japan	0.090782	**0.766366**	**0.243552**	0.978924	Japan	0.204567	0.255226	0.26856	0.594073
t value	(2.20457))**	**(16.48697)***	**(2.80637)***		t value	(1.80146)**	0.92393	1.43249	
Pr(>|t|)	0.027484	**0**	**0.00501**		Pr(>|t|)	0.07163	0.35552	0.15201	
Australia	0.086271	**0.770652**	**0.201988**	0.957917	Australia	0.001779	**0.842008**	**0.224004**	0.955789
t value	(2.2568)**	**(24.4202)***	**(3.6124)***		t value	(0.097838)**	**(26.213325)***	**(4.354571)***	
Pr(>|t|)	0.024019	**0**	**0.000303**		Pr(>|t|)	0.922061	**0**	**0.000013**	
Hong-Kong	**0.032705**	**0.745339**	**0.144576**	0.850332	Hong-Kong	0.194657	**0.607075**	0.2467	0.925082
t value	**(2.79791)***	**(24.2087)***	**(2.65195)***		t value	1.6348	**(3.8325)***	1.812	
Pr(>|t|)	**0.005143**	**0**	**0.008003**		Pr(>|t|)	0.102088	**0.000127**	0.069992	
Germany	**0.215218**	**0.542883**	**0.481797**	0.9989995	Germany	0.302926	**0.376596**	0.233533	0.7962885
t value	**(3.2434)***	**(35.0598)***	**(3.5086)***		t value	(1.8223)*	**(2.6543)***	1.3488	
Pr(>|t|)	**0.001181**	**0**	**0.00045**		Pr(>|t|)	0.068414	**0.007948**	0.177386	
Switzerland	0.110208	**0.618261**	**0.486935**	0.9719365	Switzerland	0.030364	**0.842876**	**0.17643**	0.961455
t value	(2.3357))**	**(12.578)***	**(3.9216)***		t value	0.590727	**(14.868153)***	**(2.715988)***	
Pr(>|t|)	0.019509	**0**	**0.000088**		Pr(>|t|)	0.554703	**0**	**0.006608**	
Spain	**0.516329**	**0.371163**	0.223016	0.999	Spain	0.201173	**0.416921**	**0.427577**	0.8318825
t value	**(3.8756)***	**(4.79367)***	1.16021		t value	(2.2474)**	**(4.9217)***	**(2.5933)***	
Pr(>|t|)	**0.000106**	**0.000002**	0.245961		Pr(>|t|)	0.024611	**0.000001**	**0.009506**	
Russia	**0.172619**	**0.574844**	0.210471	0.8526985	Russia	**0.136435**	**0.844712**	**-0.009534**	0.97638

COVID-19 Crises					Russia-Ukraine Crises				
Developed Countries									
t value	(2.7643)***	(9.7172)***	(2.1509)**		t value	(4.78855)***	(121.37619)***	-0.17218	
Pr(>|t|)	0.005704	0	0.031486		Pr(>|t|)	0.000002	0	0.863296	
Singapore	0.219783	0.684034	0.190365	0.9989995	Singapore	0.30788	0.133006	0.146486	0.514129
t value	(3.35926)***	(12.07468)***	(2.2637)**		t value	(2.80299)***	(2.11743)**	0.87263	
Pr(>|t|)	0.000782	0	0.023592		Pr(>|t|)	0.005063	0.034223	0.382865	
Emerging Countries									
China	0.30853	0.157159	0.180146	0.555762	China	0.110306	0.296773	0.704685	0.7594215
t value	(2.9416)***	1.34903	1.09467		t value	(4.03107)***	(3.9088)***	(6.54775)***	
Pr(>|t|)	0.003265	0.177328	0.273662		Pr(>|t|)	0.000056	0.000093	0	
India	0.278694	0.424402	0.378228	0.89221	India	0.002314	0.96845	0.055219	0.9983735
t value	(3.0032)***	(3.6713)***	(2.5522)**		t value	1.088634	(94.231717)***	(1.957796)**	
Pr(>|t|)	0.002671	0.000241	0.010703		Pr(>|t|)	0.276315	0	0.050254	
Saudi Arabia	0.06726	0.818919	0.225643	0.9990005	Saudi Arabia	0.029046	0.746847	0.324668	0.938227
t value	1.37932	(28.18421)***	(3.32028)***		t value	(1.86249)*	(15.58134)***	(3.55385)***	
Pr(>|t|)	0.167796	0	0.000899		Pr(>|t|)	0.062534	0	0.00038	
South Korea	0.161102	0.535163	0.359878	0.876204	South Korea	0.02686	0.729438	0.146572	0.829584
t value	(4.4234)***	(9.7971)***	(3.0965)***		t value	(2.40031)**	(19.32799)***	(2.10246)**	
Pr(>|t|)	0.00001	0	0.001958		Pr(>|t|)	0.016381	0	0.035513	
South Africa	0.045815	0.789803	0.224373	0.9478045	South Africa	0.000093	0.975403	0.041644	0.996318
t value	(1.9083)*	(20.3075)***	(3.3083)***		t value	0.005746	(49.314094)***	(3.306946)***	
Pr(>|t|)	0.056358	0	0.000939		Pr(>|t|)	0.995415	0	0.000943	
Brazil	0.077217	0.728801	0.226574	0.919305	Brazil	0.00244	0.999937	-0.010212	0.997271
t value	(3.2311)***	(18.6865)***	(3.184)***		t value	(39.073)***	(12490000)***	(-3.7319)***	
Pr(>|t|)	0.001233	0	0.001452		Pr(>|t|)	0	0	0.00019	
Thailand	0.126199	0.802719	0.071104	0.96447	Thailand	0.005317	0.780897	0.205124	0.888776
t value	(3.06082)***	(51.78623)***	1.42127		t value	1.1132	(22.93658)***	(3.05816)***	
Pr(>|t|)	0.002207	0	0.155238		Pr(>|t|)	0.265622	0	0.002227	
Indonesia	0.340766	0.557035	0.138612	0.967107	Indonesia	0	0.747943	0.192983	0.8444345
t value	(3.4998)***	(11.8085)***	1.2342		t value	(0.000002)***	(26.041)***	(3.3066)***	
Pr(>|t|)	0.000466	0	0.217145		Pr(>|t|)	0.999999	0	0.000944	

COVID-19 Crises					Russia-Ukraine Crises				
Developed Countries									
Mexico	**0.381581**	**0.395092**	0.076166	0.814756	Mexico	0	**0.976782**	0.044436	0.999
t value	**(2.57953)*****	**(3.40671)*****	0.52619		t value	0.000006	**(112.485588)*****	(2.09131)**	
Pr(>|t|)	**0.009894**	**0.000658**	0.598754		Pr(>|t|)	0.99999	**0**	0.0365	
Malaysia	**0.23733**	**0.594198**	0.030866	0.846961	Malaysia	0.000539	**0.978826**	0.037429	0.9980795
t value	**(2.97337)*****	**(13.08744)*****	0.3446		t value	0.087023	**(79.652449)*****	(2.416962)**	
Pr(>|t|)	**0.002946**	**0**	0.730394		Pr(>|t|)	0.930653	**0**	0.015651	
Frontier Countries									
Vietnam	0.167745	**0.424553**	**0.402582**	0.793589	Vietnam	0.043693	**0.866335**	**0.12784**	0.973948
t value	1.5416	**(2.9541)*****	**(2.9948)*****		t value	(2.32069)**	**(15.48531)*****	**(2.33405)*****	
Pr(>|t|)	0.123168	**0.003136**	**0.002746**		Pr(>|t|)	0.020304	**0**	**0.019593**	
Morcoo	**0.530803**	**0.359541**	0.115857	0.9482725	Morcoo	**0.472081**	**0.173919**	**0.706001**	0.9990005
t value	**(3.51688)*****	**(8.87341)*****	0.68593		t value	**(3.594)*****	**(4.2364)*****	**(3.1224)*****	
Pr(>|t|)	**0.000437**	**0**	0.492756		Pr(>|t|)	**0.000326**	**0.000023**	**0.001794**	
Nigeria	**1**	**0.121069**	**-0.419996**	0.911071	Nigeria	**0.696159**	0	0.573682	0.983
t value	**(5.9503)*****	**(3.531)*****	**(-2.0856)*****		t value	**(4.0067)*****	0	1.5088	
Pr(>|t|)	**0**	**0.000414**	**0.037018**		Pr(>|t|)	**0.000062**	1	0.131339	
Bulgaria	**0.734744**	0.06756	0.393391	0.9989995	Bulgaria	**0.359062**	**0.372693**	0.304027	0.8837685
t value	**(4.6361)*****	(2.0319)**	1.5297		t value	**(3.7405)*****	**(6.4895)*****	(2.0602)**	
Pr(>|t|)	**0.000004**	0.042168	0.126085		Pr(>|t|)	**0.000184**	**0**	0.039378	
Kazakhstan	**0.353532**	**0.286683**	0.125068	0.702749	Kazakhstan	**0.272522**	**0.455121**	0.235235	0.8452605
t value	**(3.05356)*****	**(6.89106)*****	0.87623		t value	**(2.7277)****	**(7.7008)*****	(1.6727)*	
Pr(>|t|)	**0.002261**	**0**	0.380903		Pr(>|t|)	**0.006378**	**0**	0.094381	
Romania	**0.471619**	**0.523566**	0.007572	0.998971	Romania	0.215908	**0.367917**	0.376947	0.7722985
t value	**(3.05856)*****	**(38.466282)*****	(0.056807)*		t value	(1.95781)*	**(4.82267)*****	(2.25631)**	
Pr(>|t|)	**0.002224**	**0**	0.954699		Pr(>|t|)	0.050252	**0.000001**	0.024051	
Bahrain	**0.297745**	**0.570541**	**0.261422**	0.998997	Bahrain	**0.249791**	**0.69935**	0.099719	0.9990005
t value	**(6.06564)*****	**(27.48783)*****	**(2.88796)*****		t value	**(3.33592)*****	**(11.88822)*****	1.21985	
Pr(>|t|)	**0**	**0**	**0.003877**		Pr(>|t|)	**0.00085**	**0**	0.22252	
Croatia	**0.481821**	**0.275495**	0.483368	0.999	Croatia	**0.194378**	**0.672159**	0.0225	0.877787
t value	**(4.2064)*****	**(9.5137)*****	(2.3611)**		t value	**(3.13213)*****	**(15.99086)*****	0.32039	

COVID-19 Crises					Russia-Ukraine Crises				
Developed Countries									
Pr(>|t|)	**0.000026**	**0**	0.01822		Pr(>|t|)	**0.001735**	**0**	0.748675	
Kenya	**0.317208**	**0.558535**	0.117803	0.9346445	Kenya	**0.712981**	0	-0.172318	0.626822
t value	**(3.7738)*** **	**(13.4911)*** **	1.0865		t value	**(3.7249)*** **	0	-0.701	
Pr(>|t|)	**0.000161**	**0**	0.277248		Pr(>|t|)	**0.000195**	1	0.483305	
Jordon	**0.533686**	**0.098684**	0.017375	0.6410575	Jordon	**0.591945**	0.026887	-0.210298	0.513683
t value	**(3.753341)*** **	**(7.348644)*** **	0.092386		t value	**(3.21982)*** **	1.41586	-0.93614	
Pr(>|t|)	**0.000174**	**0**	0.926392		Pr(>|t|)	**0.001283**	0.156817	0.349201	

Note: The above table reports the average variance (based on Equation 3.45). Only those countries highlighted showed a highly significant level (moreover, the below 1%, 5%, and 10% represent ****, **, * respectively to and probability represented by (Pr(>|t|))*)*. Beta (β) indicates the GARCH (as it indicates the enduring nature of volatility across time. (in short, it can be stated as volatility persistence). A high β (approaching 1) indicates that historical volatility has a persistent impact, signifying that financial shocks continue to affect the market over an extended duration) and Alpha (α) shows ARCH effects (It assesses the immediate effects of novel shocks on conditional variance. A substantial α indicates that recent unforeseen volatility (shocks) profoundly affects present market volatility, i.e., in short, it can be stated as shock sensitivity). While gamma (γ) is an asymmetric volatility effect (In GJR-GARCH models, γ measures the degree to which negative shocks (adverse news) generate greater volatility than positive shocks (favourable news) (in short, it explains leverage effects). If $\gamma > 0$ and significant, it denotes asymmetric effects, suggesting that negative news has a more pronounced impact on market volatility than positive news). The *t*-statistics are in parentheses (the *t*-statistic quantifies the number of standard errors the calculated coefficient deviates from zero. An elevated absolute *t*-value indicates that the coefficient is markedly distinct from zero). *, ** and *** represent the *p-values* <0.10, <0.05, and < 0.01. P represents persistence. Only highly significant results of each parameter are highlighted.

Tables 5.2.0, 5.2.1, and 5.2.2 report the results of conditional correlation based on Eqs 3.51, explained in Methodology chapter 3. The total of α and β for many markets during crises is <1, indicating a mean-reverting model. During the GFC and Brexit crises, linkages between the origin markets (the US for the GFC and the UK for Brexit) and Egypt, Mauritius, and South Africa were substantial. During the GFC, Canada and Germany, among developed countries; India, Saudi Arabia, and Thailand, among emerging countries; and Morocco and Croatia, among frontier countries, only showed significant association with the US. During the EDC crash, Japan, Germany, Spain, and Singapore, among developed countries; Malaysia, only among emerging countries; and Croatia, only among the frontier countries, were positively impacted by PIIGS. During the Brexit event, only the US strongly associated with China, Mexico, and Saudi Arabia, as well as the UK and the Chinese crash. However, during COVID-19, Canada, Japan, Hong Kong, and Singapore were developed countries; India, South Korea, and Malaysia were emerging; and Croatia, among frontier countries, has shown significant association with China. Due to the geo-political instability during the Russia-Ukraine war, the US and Hong Kong, among developed countries; India and Saudi Arabia, among emerging countries; and Vietnam, among frontier countries, have shown strong association (as positive and significant) with Russia.

Table 5.2.0 During the GFC and EDC conditional correlation results from the DCC-GJR-GARCH (1,1) Model. (Source: Author using R software).

Panel 1 - GFC										Panel 2 –EDC								
	Developed Countries			Emerging Countries			Frontier Countries			Developed Countries			Emerging Countries			Frontier Countries		
	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta
Estimate	US-Canada	0.0498	0.9454	US-China	0.0066	0.9293	US-Vietnam	0.0292	0.8929	PIIGS-Canada	0.0313	0.7145	PIIGS-China	0.000	0.9161	PIIGS-Vietnam	0.0000	0.9170
t Value		(3.910405)***	(59.776778)***		0.3243	(26.377311)***		1.2540	(17.660132)***		0.9510	1.3500		0.006	(10.418)***		0.1192	(4.001253)***
Pr(>|t|)		0.0001	0.0000		0.7457	0.0000		0.2099	0.0000		0.3416	0.1782		0.995	0.0000		0.9051	0.0001
Estimate	US-Japan	0.0000	0.9227	US-India	0.0382	0.9378	US-Morocco	0.0237	0.9572	PIIGS-Japan	0.0150	0.9752	PIIGS-India	0.006	0.9736	PIIGS-Morocco	0.0000	0.9228
t Value		0.0015	(6.033006)***		(1.845098)*	(22.985247)***		(2.475338)**	(93.495298)***		(2.321599)**	(82.087262)***		0.870	(108.11)***		0.0014	(7.646221)***
Pr(>|t|)		0.9988	0.0000		0.0650	0.0000		0.0133	0.0000		0.0203	0.0000		0.384	0.0000		0.9989	0.0000
Estimate	US-Australia	0.0075	0.8166	US-Saudi Arabia	0.0000	0.9179	US-Nigeria	0.0301	0.7614	PIIGS-Australia	0.0159	0.9385	PIIGS-Saudi Arabia	0.011	0.8921	PIIGS-Nigeria	0.0000	0.9373
t Value		0.2841	(3.37379)***		0.0002	(7.252159)***		0.7160	(4.38908)***		1.1164	(21.794627)***		0.505	(22.825555)***		0.0000	0.6325
Pr(>|t|)		0.7764	0.0007		0.9998	0.0000		0.4740	0.0000		0.2642	0.0000		0.614	0.0000		1.0000	0.5270
Estimate	US-Hong -Kong	0.0141	0.9505	US-South Korea	0.0061	0.9582	US-Bulgaria	0.0004	0.9254	PIIGS-Hong -Kong	0.0122	0.9384	PIIGS-South Korea	0.002	0.9848	PIIGS-Bulgaria	0.0040	0.9890
t Value		1.0251	(21.968063)***		0.4473	(40.619931)***		0.0175	(3.742504)***		1.5733	(26.702714)***		0.210	(101.23639)***		0.7895	(68.225406)***
Pr(>|t|)		0.3053	0.0000		0.6546	0.0000		0.9860	0.0002		0.1157	0.0000		0.834	0.0000		0.4298	0.0000
Estimate	US-Germany	0.0243	0.9611	US-South Africa	0.0238	0.9618	US-Kazakhstan	0.0997	0.0000	PIIGS-Germany	0.0070	0.9838	PIIGS-South Africa	0.006	0.9512	PIIGS-Kazakhstan	0.0000	0.9271
t Value		(1.939453)**	(47.14324)***		(2.374218)**	(72.380916)***		1.1774	0.0000		(1.704355)*	(168.220179)***		0.512	(11.820096)***		0.0001	2.5112
Pr(>|t|)		0.0524	0.0000		0.0176	0.0000		0.2390	1.0000		0.0883	0.0000		0.609	0.0000		0.9999	0.0120
Estimate	US-Switzerland	0.0615	0.5691	US-Brazil	0.0642	0.8842	US-Romania	0.0049	0.9812	PIIGS-Switzerland	0.0464	0.8615	PIIGS-Brazil	0.024	0.9324	PIIGS-Romania	0.0060	0.9756
t Value		1.2886	(2.865437)***		1.4683	(8.61239)***		0.5315	(90.1752)***		1.5757	(8.308495)***		1.207	(16.05092)***		0.8385	(119.454319)***
Pr(>|t|)		0.1975	0.0042		0.1420	0.0000		0.5951	0.0000		0.1151	0.0000		0.228	0.0000		0.4018	0.0000
Estimate	US-Spain	0.0168	0.9374	US-Thailand	0.0366	0.9522	US-Bahrain	0.0000	0.9362	PIIGS-Spain	0.0228	0.9243	PIIGS-Thailand	0.000	0.9162	PIIGS-Bahrain	0.0866	0.0000
t Value		1.4323	(37.960454)***		(2.9163)***	(67.058279)***		0.0000	0.0289		(1.712934)*	(36.949395)***		0.011	(7.386909)***		0.9952	0.0000
Pr(>|t|)		0.1521	0.0000		0.0035	0.0000		1.0000	0.9769		0.0867	0.0000		0.991	0.0000		0.3196	1.0000
Estimate	US-Russia	0.0011	0.9789	US-Indonesia	0.0066	0.9252	US-Croatia	**0.0469**	**0.9265**	PIIGS-Russia	0.0000	0.9343	PIIGS-Indonesia	0.017	0.9587	PIIGS-Croatia	**0.0194**	**0.9682**
t Value		0.0873	(30.835913)***		0.3709	(26.757321)***		(2.655601)***	(40.254799)***		0.0000	0.8539		1.512	(37.523737)***		(2.076465)**	(52.665906)***
Pr(>|t|)		0.9305	0.0000		0.7107	0.0000		0.0079	0.0000		1.0000	0.3932		0.130	0.0000		**0.0379**	**0.0000**
Estimate	US-Singapore	0.0081	0.9601	US-Mexico	0.0905	0.5493	US-Kenya	0.0000	0.9337	PIIGS-Singapore	0.0129	0.9707	PIIGS-Mexico	0.006	0.9874	PIIGS-Kenya	0.0121	0.9459
t Value		0.7356	(29.765323)***		0.1439	0.0811		0.0000	1.0774		(2.202359)**	(197.327215)***		1.336	150.7210		1.0400	(34.35)***
Pr(>|t|)		0.4620	0.0000		0.8856	0.9353		1.0000	0.2813		0.0276	0.0000		0.181	0.0000		0.2967	0.0000
				US-Malaysia	0.0028	0.9762	US-Jordon	0.0000	0.9110	PIIGS-US	0.0103	0.9147	PIIGS-Malaysia	0.010	0.9869	PIIGS-Jordon	0.0000	0.9271
					0.2657	(36.611599)***		0.0000	(7.392348)***		0.5692	(7.798647)***		(2.351948)**	(234.686418)***		0.0007	(5.5192)***
					0.7905	0.0000		1.0000	0.0000		0.5692	0.0000		0.019	0.0000		0.9994	0.0000

Note: Based on the conditional correlation results estimated from Eqs. 3.49, and Eqs. 3.50 of DCC-GJR-GARCH (1,1) models in the above table. The t-statistics are in the parentheses. *,**, and *** represet the p-values <0.10, <0.05, <0.01.

Table 5.2.1: During the CBB and BREXIT Conditional Correlation Results from the DCC-GJR-GARCH (1,1) Model. (Source: Author using R software).

	Panel 3- Chinese Crash									Panel -4 BREXIT								
	Developed Countries			Emerging Countries			Frontier Countries			Developed Countries			Emerging Countries			Frontier Countries		
	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta
Estimate	China-US	0.098931	0.727274	China-India	0.052554	0.775902	China-Vietnam	0	0.918708	UK-US	0.126573	0.24314	UK-China	0	0.924151	UK-Vietnam	0.110739	0.383388
t Value		(1.9955)**	(5.063299)***		5.88E-01	(4.385103)***		6.25E-04	(4.679797)***		(1.6765)*	5.63E-01		7.30E-05	(3.2091)***		(2.1772)**	1.20E+00
Pr(>|t|)		0.045988	0		0.556259	1.20E-05		0.999501	0.000003		0.093643	0.573258		0.999942	0.001332		0.029462	0.231901
Estimate	China-Canada	0.0046	0.96012	China-Saudi Arabia	0.010053	0.950093	China-Morcoo	0	0.923685	UK-Canada	0.142382	0	UK-India	0	0.916993	UK-Morcoo	0.007294	0.979125
t Value		1.88E-01	(34.674982)***		3.45E-01	(43.703639)***		0.002408	(3.002929)***		(2.4069)**	0.00E+00		1.22E-04	(4.0643)***		0.82937	(87.87825)***
Pr(>|t|)		0.851004	0		0.730068	0		0.998079	0.002674		0.016088	1		0.999903	4.06E+00		0.406897	0
Estimate	China-Japan	0.169538	0	China-South Korea	0	0.932472	China-Nigeria	0	0.923285	UK-Japan	0	0.923782	UK-Saudi Arabia	0.033139	0.929321	UK-Nigeria	0	0.932414
Standard Error		0.111491	0.330427		0.006399	2.353592		0.000015	0.231536		0.000091	0.589227		0.019917	0.037021		0.000365	0.506837
t Value		1.52E+00	1.00E-06		1.00E-06	3.96E-01		0.00E+00	(3.987661)***		4.20E-05	1.57E+00		(1.6639)*	(2.5103)***		8.00E-06	(1.8397)*
Pr(>|t|)		0.12835	0.999999		0.999999	0.691964		1	0.000067		0.999967	0.116931		0.096133	0		0.999994	0.065816
Estimate	China-Australia	0	0.907471	China-South Africa	0	0.933971	China-Bulgaria	0.105644	0.474695	UK-Australia	0.076737	0	UK-South Korea	0	0.92262	UK-Bulgaria	0	0.92393
t Value		1.48E-03	(1.757826)*		7.00E-06	(3.656729)***		9.53E-01	1.34E+00		6.36E-01	0.00E+00		2.60E-05	(3.3637)***		2.11E-04	(5.5503)***
Pr(>|t|)		0.998816	0.078777		0.999995	0.000255		0.340676	0.181529		0.524584	1		0.999979	0.000769		0.999832	0
Estimate	China-Hong -Kong	0	0.933065	China-Brazil	0	0.918235	China-Kazakhstan	0.046765	0.767411	UK-Hong -Kong	0	0.8796	UK-South Africa	0.006538	0.858242	UK-Kazakhstan	0	0.923461
Standard Error		0.000031	0.526794		0.000001	0.082948		0.039887	0.128719		0.000059	0.125121		0.021958	0.26006		0.000015	(0.220136)***
t Value		9.89E-04	(1.771212)*		5.46E-03	(11.069984)***		1.17E+00	(5.9619)***		3.90E-04	(7.03)***		2.98E-01	(3.3002)***		5.55E-04	4.20E+00
Pr(>|t|)		0.999211	0.076525		0.995641	0		0.241024	0		0.999689	0		0.765904	0.000966		0.999557	0.000027
Estimate	China-Germany	0	0.928315	China-Thailand	0.014795	0.947014	China-Romania	0.038834	0.000001	UK-Germany	0.09497	0.052115	UK-Brazil	0.004063	0.509121	UK-Romania	0	0.900352
t Value		2.00E-06	1.01E+00		6.00E-01	(26.6109)***		3.94E-01	1.00E-06		1.35E+00	1.07E-01		6.60E-01	(145.68)***		8.67E-03	(3.3666)***
Pr(>|t|)		0.999998	0.314766		0.548372	0		0.693293	0.999999		0.176946	0.914987		0.509121	0		0.993082	0.000761
Estimate	China-Switzerland	0.009501	0.957575	China-Indonesia	0	0.92197	China-Bahrain	0	0.929729	UK-Switzerland	0.016029	0.881615	UK-Thailand	0.016718	0.913117	UK-Bahrain	0	0.92972
t Value		2.91E-01	(51.461053)***		0.008896	(5.519748)***		4.00E-05	0.784197		5.71E-01	(4.0863)***		8.87E-01	(23.145)***		1.40E-05	(2.7162)***
Pr(>|t|)		0.770999	0.00E+00		0.992902	0		0.999968	0.432924		0.568267	4.40E-05		0.375208	0		0.999989	0.006603
Estimate	China-Spain	0.106929	0.391991	China-Mexico	0.026184	0.900091	China-Croatia	0	0.950087	UK-Spain	0	0.924335	UK-Indonesia	0.012229	0.85874	UK-Croatia	0.035709	0.502277
t Value		1.12E+00	(2.816635)***		5.50E-01	(9.131791)***		7.10E-05	(2.71387)***		2.10E-05	(3.4316)***		0.57658	(16.98487)***		7.38E-01	(2.6857)***
Pr(>|t|)		0.263183	0.004853		0.582416	0		0.999944	0.00665		0.999983	0.0006		0.564225	0		0.460294	0.007237
Estimate	China-Russia	0	0.927276	China-Malaysia	0	0.925431	China-Kenya	0	0.907121	UK-Russia	0.010062	0.9626	UK-Mexico	0.041977	0.90741	UK-Kenya	0	0.926658
t Value		0.00E+00	3.06E-01		6.02E-02	(6.124179)***		6.23E-04	(3.362453)***		1.03E+00	(67.514)***		(2.0483)**	(22.202)***		3.80E-05	(4.3369)***
Pr(>|t|)		1	0.759704		0.951994	0		0.999503	0.000773		0.301112	0		0.040534	0		0.99997	0.000014
Estimate	China-Singapore	0	0.930559				China-Jordon	0.147652	0.025136	UK-Singapore	0.085425	0.556511	UK-Malaysia	0	0.912386	UK-Jordon	0	0.916725
t Value		8.17E-04	(3.217931)***					1.24E+00	6.05E-02		(1.7783)*	1.63E+00		9.64E-04	(9.592)***		5.89E-03	(8.4045)***
Pr(>|t|)		0.999348	0.001291					0.215777	0.951727		0.075354	0.103239		0.999231	0		0.995302	0

Note: Note: Based on the conditional correlation results estimated from Eqs. 3.49, and Eqs. 3.50 of DCC-GJR-GARCH (1,1) models in the above table. The t-statistics are in the parentheses. *,**, and *** represet the p-values <0.10, <0.05, <0.01.

Table 5.2.2: During the COVID-19 and Russia-Ukraine Crises Conditional Correlation Results from the DCC-GJR-GARCH (1,1) Model. (Source: Author using R software).

Panel- 5 COVID-19 Crises										Panel-6 Russia-Ukraine Crises								
Developed Countries				Emerging Countries			Frontier Countries			Developed Countries			Emerging Countries			Frontier Countries		
Developed Countries	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta	Country	Alpha	Beta
Estimate	China-US	0.04182	0.82513	China-India	0.0285	0.9455	China-Vietnam	0.057	0.843	Russia-US	0.1138	0.7296	Russia-China	0.0023	0.9658	Russia-Vietnam	0.0160	0.9734
t Value		0.95400	(5.81881)***		(2.315459)**	(51.599908)***		1.250	(7.568966)***		(3.346385)***	(9.285214)***		0.1800	(64.427454)***		(1.666698)*	(97.34561)***
Pr(>|t|)		0.34030	0.00000		0.0206	0.0000		0.213	0.000		0.0008	0.0000		0.8572	0.0000		0.0956	0.0000
Estimate	China-Canada	0.05016	0.84362	China-Saudi Arabia	0.0096	0.9805	China-Morcoo	0.211	0.156	Russia-Canada	0.0203	0.9566	Russia-India	0.0164	0.9488	Russia-Morcoo	0.0071	0.0000
t Value		(1.77449)*	(13.15866)***		0.9020	(55.067)***		(2.174)**	1.288		0.5380	(16.544445)***		(1.645232)*	(48.243154)***		1.3508	0.0000
Pr(>|t|)		0.07598	0.00000		0.3672	0.0000		0.030	0.198		0.5906	0.0000		0.0999	0.0000		0.1768	1.0000
Estimate	China-Japan	0.08490	0.73378	China-South Korea	0.1545	0.6483	China-Nigeria	0.001	0.952	Russia-Japan	0.0000	0.9199	Russia-Saudi Arabia	0.0983	0.3501	Russia-Nigeria	0.0000	0.9309
t Value		(1.84302)*	(7.61122)***		(2.68922)***	(4.76499)***		0.000	(2.56774)**		0.0001	(5.272369)***		(1.902458)**	(1.670363)*		0.0000	1.2400
Pr(>|t|)		0.06533	0.00000		0.0072	0.0000		1.000	0.010		0.9999	0.0000		0.0571	0.0948		1.0000	0.2153
Estimate	China-Australia	0.01423	0.93457	China-South Africa	0.0128	0.9379	China-Bulgaria	0.001	0.937	Russia-Australia	0.0148	0.9270	Russia-South Korea	0.0118	0.9648	Russia-Bulgaria	0.0000	0.9168
t Value		0.82900	(27.42892)***		0.8640	(24.964647)***		0.001	0.470		0.9580	(26.685466)***		0.9900	(47.207336)***		0.0002	(7.227262)***
Pr(>|t|)		0.40717	0.00000		0.3874	0.0000		1.000	0.638		0.3378	0.0000		0.3222	0.0000		0.9998	0.0000
Estimate	China-Hong -Kong	0.16287	0.67599	China-Brazil	0.0073	0.8997	China-Kazakhstan	0.001	0.911	Russia-Hong -Kong	0.0000	0.9489	Russia-South Africa	0.0000	0.9182	Russia-Kazakhstan	0.0000	0.9212
t Value		(3.2)***	(7.11)***		0.2580	(18.25127)***		0.001	(4.778195)***		0.0002	(2.2100)**		0.0001	(10.262981)***		0.0003	(10.413776)***
Pr(>|t|)		0.00136	0.00000		0.7965	0.0000		0.999	0.000		0.999834	(0.02679		0.9999	0.0000		0.9998	0.0000
Estimate	China-Germany	0.03366	0.90699	China-Thailand	0.0346	0.9196	China-Romania	0.079	0.820	Russia-Germany	0.0475	0.0000	Russia-Brazil	0.0430	0.8911	Russia-Romania	0.0045	0.9058
t Value		1.63000	(16.7)***		1.3300	(31.325177)***		1.580	(6.10209)***		1.2300	0.0000		1.5400	(8.808693)***		0.2500	(24.251833)***
Pr(>|t|)		0.10233	0.00000		0.1827	0.0000		0.114	0.000		0.2195	1.0000		0.1235	0.0000		0.8025	0.0000
Estimate	China-Switzerland	0.04577	0.00000	China-Indonesia	0.1076	0.2838	China-Bahrain	0.000	0.912	Russia-Switzerland	0.0383	0.5607	Russia-Thailand	0.0127	0.9523	Russia-Bahrain	0.0459	0.0000
t Value		1.40000	0.000001		1.4764	0.8851		0.000	(1.681)*		0.9910	(2.874) ***		0.8890	(50.024)***		0.8260	0.0000
Pr(>|t|)		0.160	1.000		0.1398	0.3761		1.000	0.093		0.3217	0.0040		0.3739	0.0000		0.4086	1.0000
Estimate	China-Spain	0.01041	0.972	China-Mexico	0.0078	0.8587	China-Croatia	0.166	0.442	Russia-Spain	0.0000	0.9298	Russia-Indonesia	0.0187	0.9228	Russia-Croatia	0.0177	0.9125
t Value		0.96800	(55.7) ***		0.2910	(15.391)***		(1.746) *	(2.013)**		0.0003	(4.537) ***		0.0172	(23.465)***		1.5900	(14.044)***
Pr(>|t|)		0.33312	0.00000		0.7712	0.0000		0.081	0.044		0.9998	0.0000		0.2785	0.0000		0.1129	0.0000
Estimate	China-Russia	0.00000	0.92715	China-Malaysia	0.0356	0.9334	China-Kenya	0.000	0.925	Russia-Singapore	0.0000	0.9308	Russia-Mexico	0.0000	0.9005	Russia-Kenya	0.0000	0.9160
t Value		0.00024	(6.32) ***		(2.230)**	(24.783)***		0.001	(0.064)***		0.0000	1.5200		0.0141	(7.754) ***		0.0002	(13.091)***
Pr(>|t|)		0.99981	0.00000		0.0257	0.0000		0.999	0.000		1.0000	0.1284		0.9887	0.0000		0.9999	0.0000
Estimate	China-Singapore	0.04537	0.93126				China-Jordon	0.092	0.549				Russia-Malaysia	0.0000	0.9526	Russia-Jordon	0.0032	0.8862
t Value		(2.99)***	(51.4) ***					1.240	(2.705)***					0.0059	(8.297) ***		0.2390	(17.021)***
Pr(>|t|)		0.00277	0.00000					0.214	0.007					0.9953	0.0000		0.8110	0.0000

Note: Note: Based on the conditional correlation results estimated from Eqs. 3.49, and Eqs. 3.50 of DCC-GJR-GARCH (1,1) models in the above table. The t-statistics are in the parentheses. *,**, and *** represet the p-values <0.10, <0.05, <0.01.

During the GFC (2007 to 2009), Canada, Switzerland, Germany, Singapore, and Russia, among developed countries, have shown financial contagion; among emerging countries Brazil, Mexico, Thailand, Indonesia, and Malaysia; Croatia, Romania, Kazakhstan, Nigeria among frontier countries have shown contagion effect which indicates investors have to hedge risk by shifting from these countries stock markets as shown severe impact.

On analysing correlation (Fig. 5.4) (developed markets have a strong connection with the US, whereas emerging and frontier markets have a low correlation) among all the countries taking the US as a crisis origin (using DCC-GJR-GARCH results) indicated Brazil, Mexico, Canada as highly integrated countries, in which India (Fig. 5.5) acted as connected contagion channel among all the nations, although due to different factors such as financial stability, financial innovation, and irrational behaviour (different sentiments) of investors may impact these contagion channels. Mexico, Canada, and the US are part of the North Atlantic Free Trade Agreement (NAFTA)(Kakran et al., 2023a), which is not surprising to get a high correlation among these countries. Our investigation continues this line of thought but focuses on the Great Financial Crisis, a far more severe shock that affected a more significant number of markets with more intensity.

Furthermore, Silva et al., 2023 also indicated that the GFC acted practically exogenous in emerging countries like Brazil. This contrasts with the Asian and Russian crises, in which the most afflicted nations maintained deeper commercial and financial ties with the countries immediately affected. In the relevance of financial contagion during GFC, our results are consistent with Mohti et al. (2019) as they also find Romania and Croatia are the only significant contagious countries among all the frontier countries (especially in the European region). However, most frontier markets (particularly those outside of Europe) appear to be good diversification options for international investors, as they seem relatively immune to major financial disruptions in more developed markets. However, such potential benefits must be balanced against drawbacks like insufficient liquidity and hefty transaction fees. As in the period of GFC, among all the selected countries, Croatia, Russia, Switzerland, and Germany were identified as the strongest contagion, with the coefficient of dummy variables being significant at the 1% level; this indicates during that period, the developed market is in dominant position predominantly European developed market with the US. As Mollah et al. (2016) stated, dynamic correlations are often strong in advanced economies, whereas emerging economies show various correlation patterns. The US has low dynamic correlations with developing nations in Africa, the Middle East, and Asia. In contrast, Latin American emerging markets have strong correlations, and European emerging markets have a moderate link.

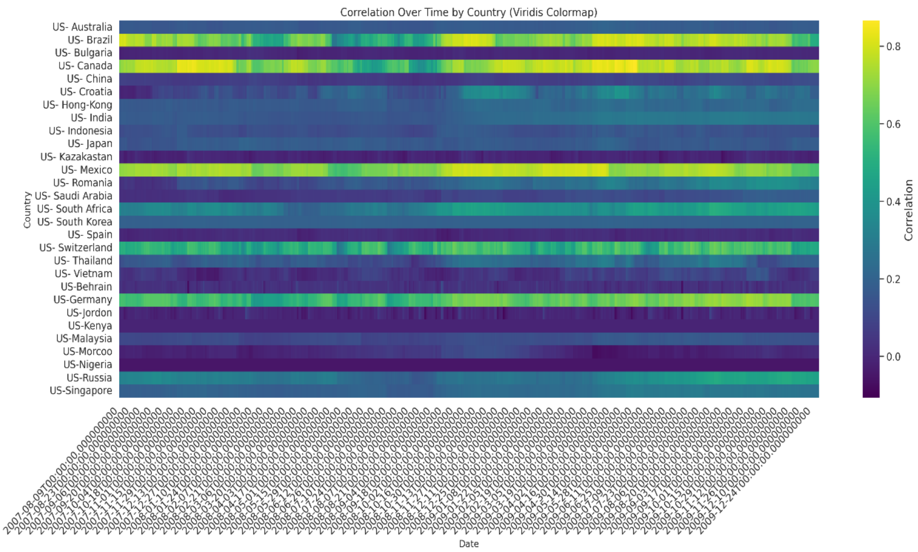


Fig. 5.4: During GFC (Panel-1) Correlation heat map on DCC estimated from the DCC-GJR-GARCH (1,1).

Note: Different colours indicate a correlation level 1 (Source: Author using R software).

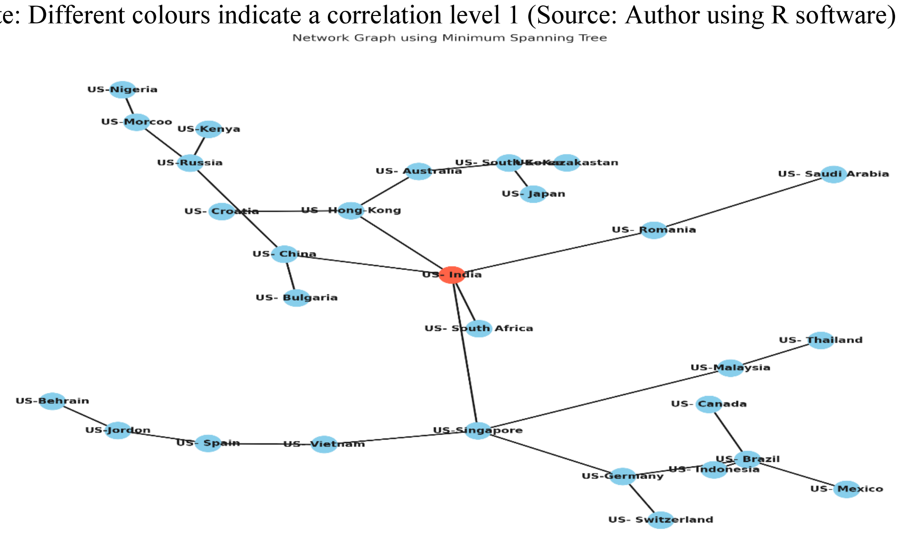


Fig. 5.5; During GFC using DCC-GJR-GARCH, different contagion channels highlighted the core channel (node with the highest degree) in a different colour (red).
Note: Different colours indicate a correlation level 1 (Source: Author using R software)

.The global financial crisis (GFC) of 2007-2009 resulted in central worldwide banks and organizations failing. Some of the banks that were "protagonists" of the crisis were described as "too big and too interconnected to fail (Markose et al., 2010)". As a result, countries all over the globe "sponsored" them by taking on the risk in the banking system, which they managed for a year.

However, the insolvencies that distinguished the crisis were passed on to sovereign governments because of their unsustainable debt to preserve the banking sector. Thus, the global financial crisis has evolved into a full-fledged sovereign debt crisis. The Eurozone became severely troubled in 2010 because of a chain of events that began with Greece's inability to service its debt and ended with the EU and IMF bailing out the country. The issues in Greece raised concerns about the destiny of other European economies, particularly severely indebted nations such as Portugal, Ireland, Italy, and Spain, collectively known as the PIIGS. The EU and the IMF eventually agreed on bailout packages for Ireland and Portugal and one more for Greece. However, these bailouts do not alleviate the danger. They shift the risk to governments and taxpayers in other European nations.

On analysing financial contagion among developed countries taking PIIGS (by creating a combined index using principal component analysis (PCA)) as crisis origin countries, Russia, Spain, Australia, Hong Kong, and Singapore were identified with high contagion (Table 5.3.0). Our results are partially consistent with Ahmad et al. (2013), as Spain generated contagion and Indonesia has shown interdependence. Still, the reverse in South Korea showed contagion (as this study assessed contagion focusing on PIIGS).

In analysing emerging countries, Brazil, China, Saudi Arabia, South Korea, and Thailand were identified as significantly impacted by financial contagion, as it is not surprising that China and Brazil are among emerging countries as both countries are part of BRICS[3] (a major trading partner). These results are consistent with Ahmad et

[3] The BRICs account for 25% of the world's land mass, 40% of its population, and are increasingly operating as global market economies (Frank and Frank, 2010). South Africa has just joined the BRIC economies, becoming the BRICS alliance. By 2015, the BRICS share of global GDP and exports is forecast to expand from 14 to 21.6% and 12.4 to 20.1%, respectively (while the US export share is expected to fall from 25 to 22%) (Wilson and Purushothaman, 2003).

al. (2013) for Brazil, Russia, and China but don't support India and South Africa, as interdependence on PIIGS can be visualised in Fig. 5.6.

This might be owing to the U.S. losing economic supremacy because of the crisis and China emerging as an economic powerhouse and improving trade and economic relations with other markets. Conversely, Croatia, Vietnam, and Romania are identified as having significant (at 1% level) contagion among the frontier countries using dummy variables through regression. Croatia and Romania have shown similar behaviour to those of the GFC period among all frontier countries during the EDC. Although Germany (also acted as a contagion central channel (Fig. 5.7), as part of a significant economic bloc like G-20) Switzerland and Spain showed high DCC-GJR-GARCH results correlation with PIIGS over the period, indicating high positive interconnectedness among these countries and frontier countries (Jordon, Kazakhstan, Kenya, Morocco, Nigeria) shown least interconnectedness as like the results of GFC (Fig. 5.7).

The EU economies in the sample have the most recognized spillover effects in both the first and second moments, highlighting the consequences of the crisis on regional integration. The need for ongoing trade expansion with other economies must be emphasized since it ensures growth sustainability, even if it exposes markets to the danger of shock transmission from impacted nations during financial crises. Open and quick information exchange must also be pushed to increase economic integration. The EU's Banking Union and Capital Markets Union projects are positive moves towards a more balanced financial system in which capital markets play an increasingly prominent role. A multifaceted strategy is needed to prevent and manage future economic and financial crises in such crises. The IMF rates both nations' financial systems as highly developed, sophisticated, and well-managed, with strong prudential regulation and supervision, severe capital requirements, and low-risk tolerance, among other characteristics. It is critical to support the financial integration effort and prevent future crises by strengthening legislation and raising supervisory standards for banks and non-banks. This is especially important for the US financial system, which was at the epicentre of the GFC and remains sensitive to shock transmission due to its strong integration with the global financial system.

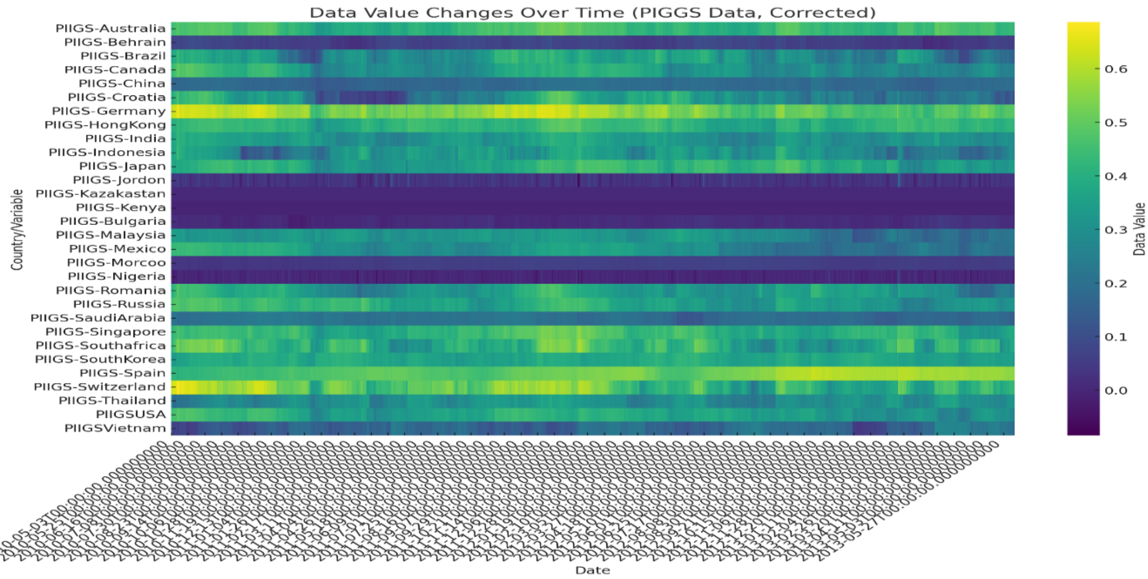


Fig. 5.6: During EDC (Panel-2), the correlation heat map on DCC was estimated from the DCC-GJR-GARCH (1,1).

Note: Different colours indicate correlation level from 1 (Source: Author using R software).

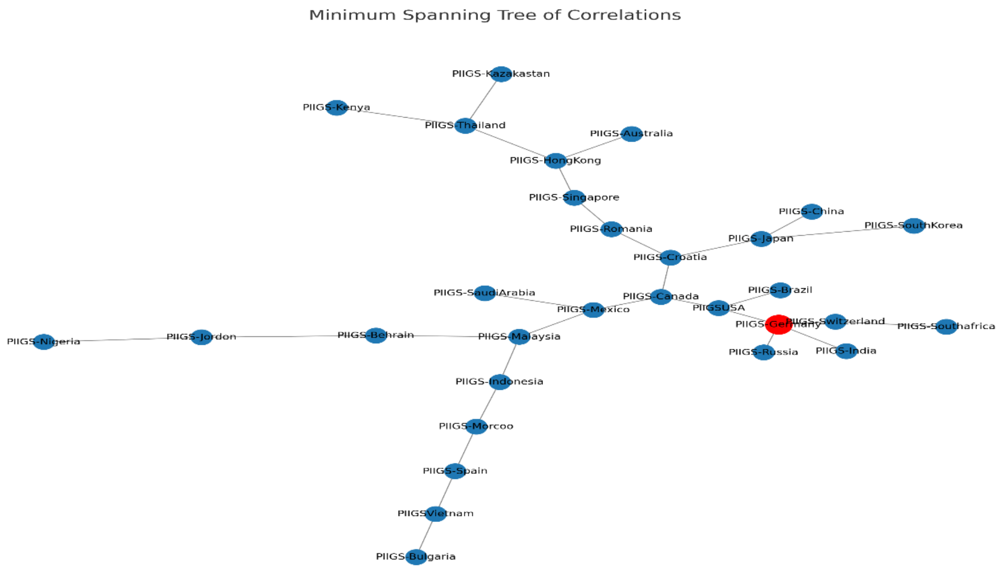


Fig. 5.7: Minimum Spanning tree of correlations during EDC crises taking PIIGS as the origin country.

Note - The dataset's nodes represent a country's potential contagion channel based on the country of crisis origin among all developed, emerging, and frontier countries. Edges link nodes (countries) depending on the extreme correlations (converted into distances), ensuring that the tree encompasses all nodes with the least overall edge weight. (Source: Author using R software).

Table 5.3.0: During GFC Period and EDC Contagion Test on DCC estimated from the DCC-GJR-GARCH (1,1) Model (Based on dummy variable if results are significant than the variable act as contagion effect). (Source: Author using R software).

Panel -1 GFC					Panel -2 EDC				
Developed Countries									
		Coefficients	***t Stat***	***P-value***			***Coefficients***	***t Stat***	***P-value***
US-Japan	Intercept	0.175972361	(588.601136144038))***	0	*PIIGS-Japan*	Intercept	0.395371078	(500.610479062753)***	0
	GFC –Dummy	-0.009446923	(-11.2223042785293)***	7.04E-29		Dummy	-0.009670755	(-4.94681661179226)***	7.79E-07
US-Canada	Intercept	0.705400645	(566.702303149073)***	0	*PIIGS-Canada*	Intercept	0.340370145	(282.749546121281)***	0
	GFC –Dummy	**0.007626088**	(2.17588513979104)**	0.029611		Dummy	-0.010520827	(-3.53078052718915)***	0.0004181
US-Australia	Intercept	0.174292815	(860.108339609955)***	0	*PIIGS-Australia*	Intercept	0.411879926	(589.118152338587)***	0
	GFC –Dummy	-0.005653959	(-9.90926246430677)***	6.19E-23		Dummy	**0.023763337**	(13.7312343869828)***	3.86E-42
US-Switzerland	Intercept	0.492311351	(432.419473794155)***	0	*PIIGS-Switzerland*	Intercept	0.497903663	(366.210654928878)***	0
	GFC –Dummy	**0.031712706**	(9.89267465718038)***	7.28E-23		Dummy	-0.027817115	(-8.26548058767062)***	1.77E-16
US-Germany	Intercept	0.576708314	(559.578913547974)***	0	*PIIGS-Germany*	Intercept	0.561425634	(592.655498407539)***	0
	GFC –Dummy	**0.028025391**	(9.65765841292806)***	7.10E-22		Dummy	-0.02279962	(-9.72317419484826)***	3.78E-22
US-Hong Kong	Intercept	0.202461229	(498.171678505598)***	0	PIIGS-Hong Kong	Intercept	0.39078268	(457.509635047446)***	0
	GFC –Dummy	-0.006731218	(-5.88228235784139)***	4.31E-09		Dummy	**0.024699786**	(11.6823040554345)***	4.00E-31
US-Singapore	Intercept	0.216891125	(307.595119207987)***	0	*PIIGS-Singapore*	Intercept	0.403088672	(446.800148967515)***	0
	GFC –Dummy	**0.011381337**	(5.7325250891974)***	1.05E-08		Dummy	**0.015680549**	(7.02173358408768)***	2.49E-12
US-Russia	Intercept	0.282991734	(193.587769250568)***	0	*PIIGS-Russia*	Intercept	0.321357193	(240.416896751332)***	0
	GFC –Dummy	**0.034637255**	(8.41516540628458)***	5.08E-17		Dummy	**0.050332482**	(15.2123280016226)***	4.11E-51
US-Spain	Intercept	0.013910703	(83.0312348410113)***	0	*PIIGS-Spain*	Intercept	0.487435703	(673.384652909791)***	0
	GFC –Dummy	-0.002613716	(-5.54071485509101)***	3.17E-08		Dummy	**0.027856542**	(15.5468874193287)***	2.96E-53
					PIIGS-US	Intercept	0.362144621	(421.050786487398)***	0
						Dummy	**0.001120624**	0.526359634	0.5986619
Emerging Countries									
		Coefficients	*t Stat*	*P-value*		*Coefficients*		*t Stat*	*P-value*

Panel -1 GFC					Panel -2 EDC				
US-Brazil	Intercept	0.510549649	(227.771343328216)***	0	*PIIGS-Malaysia*	Intercept	0.289693665	(331.355659862222)***	0
	GFC -Dummy	**0.154501579**	(24.4798669553987)***	4.90E-125		Dummy	-0.002225277	-1.028276277	0.30387
US-Mexico	Intercept	0.546707329	(343.230312461824)***	0	*PIIGS-Mexico*	Intercept	0.316963601	(289.81421666636)***	0
	GFC -Dummy	**0.171677013**	(38.2787650094896)***	3.90E-281		Dummy	-0.024872161	(-9.18743315783543)***	5.79E-20
US-China	Intercept	0.099630673	(274.249918207961)***	0	*PIIGS-Indonesia*	Intercept	0.29885614	(263.758771723645)***	0
	GFC -Dummy	-0.023164403	(-22.6459001144206)***	3.90E-108		Dummy	-0.001836882	-0.654932393	0.5125416
US-India	Intercept	0.238641345	(299.954070023485)***	0	*PIIGS-Thailand*	Intercept	0.291334828	(346.693928836931)***	0
	GFC -Dummy	-0.024979916	(-11.15103249814)***	1.54E-28		Dummy	**0.00306451**	1.473279969	0.140739
US-Saudi Arabia	Intercept	0.115476076	(168.977913744073)***	0	*PIIGS-Brazil*	Intercept	0.271133447	(194.869759921664)***	0
	GFC -Dummy	-0.028157323	(-14.6333688166576)***	1.66E-47		Dummy	**0.035857649**	(10.4115057205505)***	3.98E-25
US-South Korea	Intercept	0.194101322	(3119.9600045318)***	0	*PIIGS-South Africa*	Intercept	0.434725693	(281.058650772086)***	0
	GFC -Dummy	-0.000218059	-1.244830878	0.213253		Dummy	-0.028845554	(-7.53409173651525)***	5.81E-14
US-South Africa	Intercept	0.361350475	(377.936626165332)***	0	*PIIGS-South Korea*	Intercept	0.363847323	(643.208526262836)***	0
	GFC -Dummy	0.004083317	1.516765548	0.12939		Dummy	**0.010578556**	(7.5549109951266)***	4.96E-14
US-Thailand	Intercept	0.185135819	(246.844087039353)***	0	*PIIGS-Saudi Arabia*	Intercept	0.175913481	(142.623280081371)***	0
	GFC -Dummy	**0.006144124**	(2.90942569825482)***	0.003637		Dummy	**0.016292049**	(5.33626482383707)***	9.91E-08
US-Indonesia	Intercept	0.135536244	(361.712544998407)***	0	*PIIGS-India*	Intercept	0.33829023	(491.15075520655)***	0
	GFC -Dummy	**0.00386245**	(3.66088413433861)***	0.000254		Dummy	-0.015329814	(-8.99150964403037)***	3.41E-19
US-Malaysia	Intercept	0.121989723	(371.661189167314)***	0	*PIIGS-China*	Intercept	0.148880922	(275.393158138199)***	0
	GFC -Dummy	**0.002633153**	(2.84914841902807)***	0.004402		Dummy	**0.028098204**	(20.9972797917151)***	7.55E-94
Frontier Countries									
		Coefficients	*t Stat*	*P-value*			*Coefficients*	*t Stat*	*P-value*
US-Vietnam	Intercept	0.056642237	(90.0050788149177)***	0	*PIIGS-Vietnam*	Intercept	0.155793506	(149.613478960146)***	0
	GFC -Dummy	-0.008366793	(-4.72172505545155)***	2.40E-06		Dummy	**0.009180822**	(3.56183109339637)***	0.0003717
US-Morocco	Intercept	0.024470581	52.65273018	0	*PIIGS-Morocco*	Intercept	0.069453051	(217.965421674827)***	0
	GFC -Dummy	-0.010180097	-7.779354724	8.81E-15		Dummy	-0.015656348	(-19.8498446054155)***	1.94E-84

Panel -1 GFC					Panel -2 EDC				
US-Kenya	Intercept	-0.00949923	(-3578798.51003214)***	0	*PIIGS-Kenya*	Intercept	-0.006770623	(-10604151.6293768)***	0
	GFC -Dummy	-1.16E-08	-1.558408471	0.1192		Dummy	-6.53E-09	(-4.13439343664472)***	3.62E-05
US-Jordon	Intercept	-0.002510003	(-8.5844695161046)***	1.21E-17	*PIIGS-Jordon*	Intercept	0.031095571	(105.993269619965)***	0
	GFC -Dummy	-0.001146806	-1.392978371	0.163689		Dummy	0.000119822	0.165000403	0.8689504
US-Croatia	Intercept	0.135683931	(93.8763299305571)***	0	PIIGS-Croatia	Intercept	0.228282862	(104.036092665687)***	0
	GFC -Dummy	**0.070439103**	(17.3083844023773)***	3.24E-65		Dummy	**0.04891188**	(9.00524338702449)***	3.01E-19
US-Bahrain	Intercept	0.032728474	(147.281609946779)***	0	*PIIGS-Bahrain*	Intercept	0.072301776	(216.849364752941)***	0
	GFC -Dummy	-0.000909834	-1.454119484	0.145976		Dummy	-0.009151901	(-11.0889614228257)***	3.04E-28
US-Romania	Intercept	0.181763355	(140.900866626756)***	0	*PIIGS-Romania*	Intercept	0.294448223	(227.578944740192)***	0
	GFC -Dummy	**0.028509633**	(7.84899388416605)***	5.10E-15		Dummy	**0.040280157**	(12.5772202111013)***	9.84E-36
US-Kazakhstan	Intercept	-0.007115998	(-37.7759766190879)***	1.10E-274	*PIIGS-Kazakhstan*	Intercept	0.005693451	(7236434.11436116)***	0
	GFC -Dummy	**0.000924921**	(1.74381095912883)*	0.081254		Dummy	2.19E-09	1.126511239	0.2600037
US-Nigeria	Intercept	-0.049518549	(-19509214.5497182)***	0	*PIIGS-Nigeria*	Intercept	0.000641807	(3.6686980708553)***	0.0002463
	GFC -Dummy	**1.04E-08**	1.453783672	0.14607		Dummy	0.000214923	0.496318803	0.6196915
US-Bulgaria	Intercept	0.000612072	(6.35925720650351)***	2.21E-10	*PIIGS-Bulgaria*	Intercept	0.011754228	(66.3186560248853))***	0
	GFC -Dummy	-0.000404111	-1.491144838	0.135987		Dummy	0.000272513	0.621154823	0.5345263

Note: Only those countries highlighted showed significant values (10%, 5%, 1% with *, **, *** respectively) in probability (Pr(>|t|). The regression estimation results are based on Eq.3.51 from the DCC-GJR-GARCH (1,1) model.

During the Chinese crash, among developed countries, Singapore, Hong Kong, Australia, Japan, the US, Germany, and Canada have shown significant contagion effects, taking the US as the country with the crisis origin (Table 5.3.1) and among emerging countries South Africa, South Korea, Indonesia, India, Saudi Arabia, Malaysia, Brazil, Thailand, and Mexico identified impacted with the financial contagion effect. It indicates a crisis in the origin country significantly impacts all emerging countries. Among frontier countries, Morocco, Vietnam, Bahrain, Jordon, Croatia, Kazakhstan, and Romania significantly showed contagion, which indicates the high intensity of the Chinese burst bubble, which reacted with some developed countries; all the selected emerging and frontier countries belong to different American, Europe, Middle East, African, Asian, and Pacific regions (Table 5.3.1). On analysing the correlation among crisis-origin countries, i.e. China and other selected countries, Fig. 5.8 shows China as a highly positive correlation and frontier countries such as Jordon, Kazakhstan, and Kenya were identified as highly negatively correlated during this crash. Croatia (Fig. 5.9) was recognised as a core connected channel of contagion among all the selected countries.

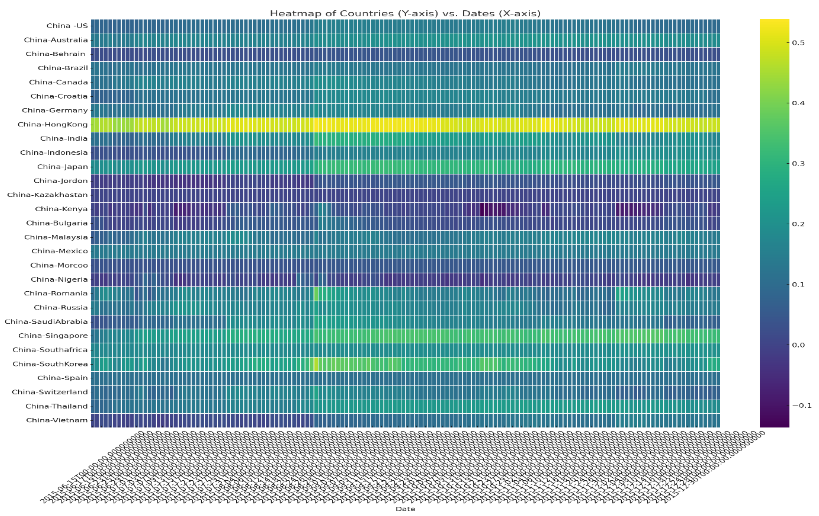


Fig. 5.8: The correlation between China and every country is displayed in the row, and the time points within the selected period are represented in the columns, with the start of the period being the axis point.

Note- In the 'Viridis' colour map, the level of correlation at each time point is shown by the colour scale, which goes from light to dark. Darker colours imply stronger correlations. Different colours indicate correlation levels from 1 (Source: Author using R software).

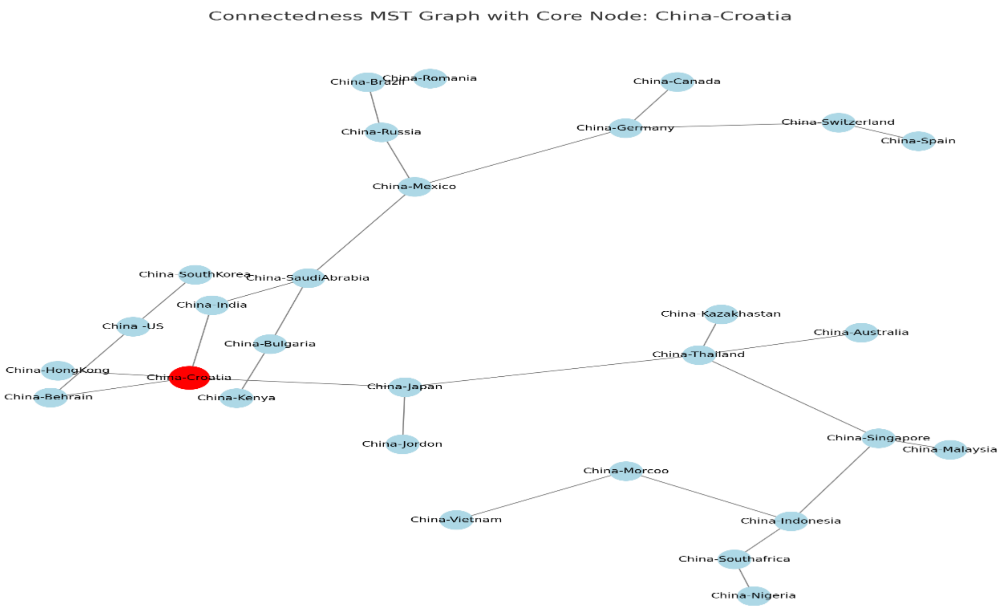


Fig. 5.9: Minimum Spanning tree of correlations during the Chinese Brust Bubble crises, taking China as the country of crisis origin.

Note - The dataset's nodes represent a country's potential contagion channel based on the country of crisis origin among all developed, emerging, and frontier countries. Edges link nodes (countries) depending on the most significant correlations (converted into distances), ensuring that the tree encompasses all nodes with the least overall edge weight. Moreover, this signifies that during the Chinese Burst Bubble crisis, 'China-Croatia' was a crucial node with the most links to other nations' indices within the given dataset and this MST. This indicates that the Chinese financial index, relative to Croatia, was a hub in the network of correlations due to its high levels of correlation with several other indices. Different colours indicate correlation levels from 1 (Source: Author using R software).

Our results, consistent with the study of Ahmed and Huo (2019), indicated strong shock and volatility spillovers from China to the Asia-Pacific markets, as in the crisis period, volatility spillover effects from China to the Asia-Pacific area became more pronounced and indicated the growing regional integration (with contagion) and China as a rising financial behemoth. Ahmed and Huo (2019) showed that key Asia-Pacific markets have recorded strong shock and volatility spillovers from China. During the crash, volatility spillover effects from China to the Asia-Pacific area became more pronounced.

During the post-crisis period, Brexit prompted European Union (EU) countries to reconsider their commercial or international business connectedness with the United Kingdom (UK). This incident resulted in an exodus of money from the UK, reducing its influence in the Eurozone (Liu, 2020). Jackson and Shepotylo (2018) and Samitas et al. (2018) used simulations to assess the probable impact of Brexit on the actual economy and identified significant volatility during this period. Belke et al. (2018) argue that the Brexit news has raised political uncertainty in the PIIGS nations (Portugal, Ireland, Italy, Greece, and Spain). On the one hand, Ramiah et al. (2017) and Burdekin et al. (2018) make it evident that this event is relevant to the returns of the British and worldwide stock markets.

In contrast, Aristeidis and Elias (2018) and Nishimura and Sun (2018) study the interactions within the global stock market returns. However, these contributions did not distinguish the effects of Brexit-related events on individual stock market volatility transmission across markets. Moreover, the results of this study identified that among all the developed countries, Spain, Hong Kong, and Australia reported significant financial contagion (Table 5.3.1). Brexit's uncertainty has reduced the UK's influence in other European Union markets (Li, 2020). The shock of Brexit results in increased market volatility, although to varying degrees. Li (2020) also indicated that during Brexit, co-volatilities behave differently to the shock at first, reflecting market ambivalence, and uncertain markets respond swiftly, synchronising their moves within days. Events destabilising the European Union's institutions will have the most significant influence on market dynamics. Due to this, emerging countries have not shown significant contagion effects, but Vietnam, Bulgaria, and Nigeria have reported financial contagion (Table 5.3.1). During Brexit, Germany and Switzerland identified the least correlation (Fig. 5.10), and South Korea acted as the crucial country, having a core channel of the contagion among all the nations (Fig. 5.11).

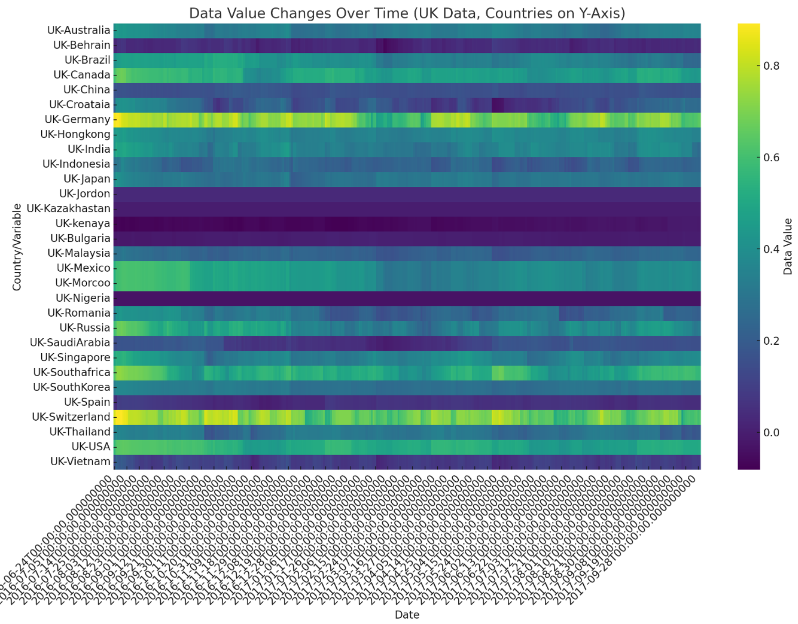


Fig. 5.10: The correlation between the UK and every country is displayed in the row, and the time points within the selected period are represented in the columns, with the start of the period being the axis point. In the 'Viridis' colour map, the level of correlation at each time point is shown by the colour scale, which goes from light to dark. Darker colours imply stronger correlations.

Note: Different colours indicate a correlation level 1 (Source: Author using R software).

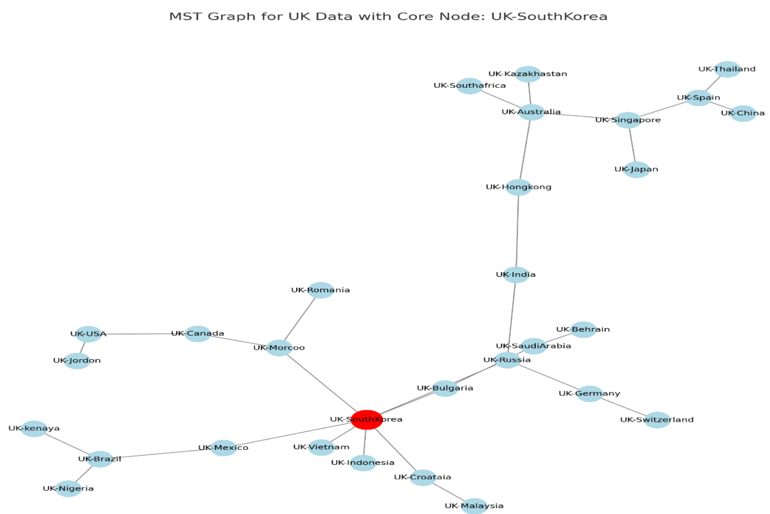


Fig. 5.11: Minimum spanning tree (MST) of correlations during BREXIT crises taking the UK as the crisis origin country.

Note: The central node, shown in red, is 'UK-South Korea'. According to the given dataset and this MST, the UK financial index relative to South Korea stands out as a node with the most links to other nations throughout the given time frame. The essential significance of South Korea in the network of correlations is shown by the enormous interconnection and possible impact between it and several other nations concerning the UK. Note: Different colours indicate a correlation level 1 (Source: Author using R software).

Table 5.3.1: During the Chinese Crash (Panel- 3) and BREXIT (Panel-4) period contagion test, the Dynamic conditional correlation was estimated using the DCC-GJR-GARCH (1,1) Model. (Source: Author using R software).

Panel-3 Chinese Crash					**Panel-4 BREXIT Crash**				
Developed country									
		Coefficients	t Stat	P-value			Coefficients	t Stat	P-value
China-US	Intercept	0.095116999	(264.828905092734)***	0	UK-US	Intercept	0.537446783	469.2929946	0
	GFC -Dummy	**0.02344346**	(17.0087255387547)***	4.22175E-63		Dummy	-0.017690247	(-3.98918666693359)***	6.726E-05
China-Australia	Intercept	0.237960785	(276.650619645455)***	0	UK-Australia	Intercept	0.323692002	492.8017616	0
	GFC -Dummy	**0.044702166**	(13.5424623156345)***	4.67517E-41		Dummy	**0.005067982**	(1.99258677960836)**	0.0463614
China-Canada	Intercept	0.133317234	(446.153050270967)***	0	UK-Canada	Intercept	0.51545228	530.9412021	0
	GFC -Dummy	**0.004544261**	(3.9628139554108)***	7.51119E-05		Dummy	-0.02558979	(-6.80716923350756)***	1.113E-11
China-Germany	Intercept	0.141291725	(302.298218023679)***	0	UK-Germany	Intercept	0.797940029	(621.875386652754)***	0
	GFC -Dummy	**0.004732705**	(2.63858508140326)***	0.008351294		Dummy	-0.097383992	(-19.6002922664707)***	1.885E-82
China-Hong-Kong	Intercept	0.476956222	(259.685891852109)***	0	UK-Hong-Kong	Intercept	0.361226982	(657.061941864792)***	0
	GFC –Dummy	**0.045732194**	(6.48835618971866)***	9.52348E-11		Dummy	**0.004476879**	(2.10301950930589)**	0.0355143
China-Japan	Intercept	0.255027759	(263.416161684726)***	0	UK-Japan	Intercept	0.29809118	(638.219666799276)***	0
	GFC -Dummy	**0.044372**	(11.9428169232893)***	1.96312E-32		Dummy	0.001998044	-1.104760332	0.269317
China-Russia	Intercept	0.154306395	(275.404371859905)***	0	UK-Russia	Intercept	0.463274342	(249.590827203737)***	0
	GFC -Dummy	0.00056714	-0.263766788	0.791970583		Dummy	-0.058044268	(-8.07591183878368)***	8.337E-16
China-Singapore	Intercept	0.27260886	(171.699017983739)***	0	UK-Singapore	Intercept	0.384931566	(511.765232508402)***	0
	GFC -Dummy	**0.067715928**	(11.113772186973)***	2.31875E-28		Dummy	-0.025725815	(-8.83279711460208)***	1.394E-18
China-Switzerland	Intercept	0.117142215	(181.664797758641)***	0	UK-Switzerland	Intercept	0.732039819	(498.393219651599)***	0
	GFC -Dummy	0.002454484	0.991882936	0.321303009		Dummy	-0.039014716	(-6.85974124937156)***	7.744E-12
China-Spain	Intercept	0.108984325	(99609966.4707872)***	0	UK-Spain	Intercept	0.014284415	(34.8744111351127)***	1.6E-238
	GFC -Dummy	-2.82591E-08	(-6.73037668057939)***	1.88388E-11		Dummy	**0.038630965**	(24.3568901968679)***	7.14E-124
Emerging Countries									

		Coefficients	t Stat	P-value			Coefficients	t Stat	P-value
China-Brazil	Intercept	0.125907876	(835.149813374829)***	0	UK-Brazil	Intercept	0.398596059	(234.965781833194)***	0
	GFC -Dummy	**0.00237708**	(4.1086408166633)***	4.04411E-05		Dummy	-0.016061514	(-2.44511877726307)**	0.014515
China-India	Intercept	0.198610399	(256.604317590066)***	0	UK-India	Intercept	0.366647769	(354.072456088087)***	0
	GFC -Dummy	**0.026242887**	(8.83520029850779)***	9.11259E-20		Dummy	-0.009743368	(-2.42993168858435)**	0.0151369
China-Indonesia	Intercept	0.205887583	(196.557800277403)***	0	UK-Indonesia	Intercept	0.246737502	(329.435774970521)***	0
	GFC -Dummy	**0.031307891**	(7.78855262590179)***	1.36457E-18		Dummy	-0.016673147	(-5.7490361054472)***	9.512E-09
China-Saudi Arabia	Intercept	0.096282982	(139.551490235786)***	0	UK-Saudi Arabia	Intercept	0.153196034	(162.584120787947)***	0
	GFC -Dummy	**0.018997978**	(7.17521854632102)***	8.1962E-15		Dummy	-0.035269001	(-9.66641902910844)***	6.527E-22
China-Thailand	Intercept	0.193070183	(174.76114998807)***	0	UK-Thailand	Intercept	0.312895367	(338.250836239435)***	0
	GFC -Dummy	**0.056526169**	(13.3328211815183)***	8.28555E-13		Dummy	-0.025038516	(-6.99020934738969)***	3.108E-12
China-Mexico	Intercept	0.140009951	(362551.266325916)***	0	UK-Mexico	Intercept	0.451839547	(377.6889875162)***	0
	GFC -Dummy	**5.99835E-06**	(4.04748433174587)***	7.19012E-40		Dummy	-0.030705837	(-6.62846366552712)***	3.753E-11
China-Malaysia	Intercept	0.199676441	(247.226960168497)***	0	UK-Malaysia	Intercept	0.226685245	(331.430034503806)***	0
	GFC -Dummy	**0.018513944**	(5.97325107856362)***	5.25592E-05		Dummy	0.000214247	0.080895646	0.9355282
China-South Africa	Intercept	0.215676784	(256.228047497604)***	0	UK-South Africa	Intercept	0.584077669	(490.223867545699)***	0
	GFC -Dummy	**0.068015096**	(21.0557830573351)***	2.48784E-09		Dummy	-0.063406252	-13.743514	3.277E-42
China-South Korea	Intercept	0.294943398	(230.142595393362)***	0	UK-South Korea	Intercept	0.294818837	(754.599517424972)***	0
	GFC -Dummy	**0.044939827**	(9.13760824046874)***	2.43363E-94		Dummy	-0.002529145	(-1.67177110363015)*	0.0946325
							Coefficients	t Stat	P-value
					UK-China	Intercept	0.162965228	(552.398119574001)***	0
						Dummy	-0.002510184	(-2.19737736029165)**	0.0280396
Frontier Countries									
		Coefficients	t Stat	P-value			Coefficients	t Stat	P-value
China-Morocco	Intercept	0.043211581		0	UK-Morocco	Intercept	0.451839547	(377.6889875162)***	0
	GFC -Dummy	**0.006180837**	(16.3263799118967)***	2.08657E-58		Dummy	-0.030705837	(-6.62846366552712)***	3.753E-11

China-Bulgaria	Intercept	0.018637358	(59.3271990420076)***	0	UK-Bulgaria	Intercept	-0.008168083	(-46.5542319377969)***	0
	GFC -Dummy	-0.00715201	(-5.93253693854618)***	3.1852E-09		Dummy	**0.003482818**	(5.12639037845495)***	3.066E-07
China-Vietnam	Intercept	0.120631588	(123.977462591999)***	0	UK-Vietnam	Intercept	0.088803923	(164.499445490298)***	0
	GFC -Dummy	**0.07302144**	(19.5557694264362)***	4.24296E-82		Dummy	**0.00411446**	(1.96828039711562)**	0.0490914
China-Bahrain	Intercept	0.046503734	(188.316872257003)***	0	UK-Bahrain	Intercept	0.031966026	(72.1398067726649)***	0
	GFC -Dummy	**0.015694978**	(16.5617006796611)***	5.24684E-60		Dummy	0.000360896	0.21033414	0.8334155
China-Croatia	Intercept	0.129008002	(208.120009770794)***	0	UK-Croatia	Intercept	0.262329597	(159.157748409444)***	0
	GFC -Dummy	**0.018362161**	(7.71904869355741)***	1.40795E-14		Dummy	-0.085664844	(-13.4222394194992)***	2.252E-40
China-Nigeria	Intercept	-0.005967773	(-17.0372912466857)***	2.66243E-63	UK-Nigeria	Intercept	-0.036028426	(-8902459.69781705)***	0
	GFC -Dummy	-0.003358008	(-2.49811665862477)**	0.01251763		Dummy	**3.88254E-08**	(2.47754961309124))**	0.0132619
China-Jordon	Intercept	0.02740621	(59.2881297304891)***	0	UK-Jordon	Intercept	0.03051077	(459482163.656809)***	0
	GFC -Dummy	**0.019029878**	(10.7274768695947)***	1.47604E-26		Dummy	-1.78503E-10	-0.694229926	0.4875705
China-Kazakhstan	Intercept	0.001284148	(1270432.7695185)***	0	UK-Kazakhstan	Intercept	-0.002068029	(-4230315.91281667)***	0
	GFC -Dummy	**1.42725E-08**	(3.67943198109738)***	0.000236233		Dummy	-9.68469E-09	(-5.11615660189407)***	3.236E-07
China-Kenya	Intercept	-0.001632938	(-2.65509623286073)***	0.007953911	UK-Kenya	Intercept	-0.022465902	(-69.824047520863)***	0
	GFC -Dummy	-0.002458906	-1.041826083	0.297543086		Dummy	-0.030605122	(-24.5650208372704)***	7.54E-126
China-Romania	Intercept	0.139375475	(194.150691806414)***	0		Intercept	0.300752983	(181.852597755334)***	0
	GFC -Dummy	**0.009064312**	(3.29026027037362)***	0.001007938		Dummy	-0.032663256	(-5.10047820608938)***	3.514E-07

Note: Only those countries highlighted showed significant values (10%, 5%, 1% with *, **, *** respectively) in probability (Pr(>|t|)). The regression estimation results are based on Eq.3.51 from the DCC-GJR-GARCH (1,1) model.

During the COVID-19 crisis (Panel 5), China was the crisis origin country as early Jan 2020 siren (with the cases of the pandemic) started with the closing of the Human seafood wholesale market as wild animal sales were found to act as a source of health contagion, following to it on Jan 5, 2020, Chinese government announces unknown phenomena are not like SARS or MERS. Following that, on Jan 7, 2020, Chinese authorities confirmed that they discovered symptoms of novel coronavirus (as 2019-nCoV pronounced by WHO) (Corbet et al., 2020) as the different wave of COVID-19 emerged, resulting in lockdown, which interrupted the global economic activities which further negatively shaken the international stock market[4]. Albulescu's (2020) results also indicated that the geographical distribution of COVID-19 is directly associated with financial instability. Thus, it becomes crucial to understand the contagion in developed, emerging, and frontier countries. Among developed countries, this study identified Singapore, Canada, Germany, Japan, Switzerland, Hong Kong, Australia, Japan, and the US as significantly impacted by the financial contagion (Table 5.3.2). Financial markets are strongly intertwined, and one nation can swiftly spread to others. During the epidemic, this was clear as early market shocks in China swiftly extended to other areas. As the pandemic's uncertainty rose, investors were increasingly risk-averse, resulting in a flight to safety and the sale of hazardous assets across several markets. The pandemic significantly impacted certain businesses, including tourism and travel, and their troubles might spill over into other sectors via supply chains and financial risk.

Among emerging countries, South Africa, Thailand, Malaysia, South Korea, Indonesia, India, Saudi Arabia, Brazil, and Mexico significantly experienced financial contagion due to disruption in economic activities. Thus, all highly market-capitalized countries show a contagion effect. These findings are congruent with those of Baker et al. (2020), who discovered that the COVID-19 epidemic significantly influenced the US stock market. Furthermore, Guo et al. (2021) demonstrate the presence of contagion in the American (US and Canada) and Asian markets (Australia, Hong Kong, Korea, and Singapore) during the COVID-19 pandemic. To reduce the

[4] Financial markets experience "flights to quality" and "flights to safety" when massive amounts of money leave high-yielding, risky assets for safer, lower-yielding rivals. Additionally, low-yield investments are far less risky than high-yield ones.

contagion associated with the subprime crisis, officials in the US devised an appropriate monetary policy that guarantees the liquidity of the local stock market while protecting it from contagion. They reevaluated the global financial system to mitigate the recession through suitable steps. Furthermore, financial risk managers helped troubled financial organizations lower investors' perceived risks.

Conversely, among frontier countries, Vietnam, Kazakhstan, Jordan, Croatia, Bahrain, Romania, and Morrocco experienced significant financial contagion, which indicates disruption in economic activities due to COVID-19, which has negatively impacted these countries. Bulgaria, Kenya, and Nigeria did not experience significant contagion, although they might have been affected by volatility spillover, as intimal days of COVID-19 lockdown have also shown a high correlation. The financial contagion heatmap (Fig. 5.12) shows China and Hong Kong have the least correlation; on the other hand, Kenya and Kazakhstan have a strong correlation with the crisis in the country. Moreover, the interconnectedness (Fig. 5.13) indicated the close interlinkage (spot) of Kenya and Nigeria, as both countries are impacted by the regional interconnectedness as small countries of the region, where Switzerland played a vital role. As East Africa's largest economy, Kenya is one of the lion economies with enormous potential, as stated in the Sub-Saharan Africa Strategy 2021-24. Despite its diverse economy, around 75% of the population remains employed in agriculture. The country's primary exports are flowers, tea, and coffee. In 2020, Kenya was Switzerland's sixteenth-largest African partner[5]. Trade between the two nations was CHF 147 million. Switzerland mostly buys agricultural products from Kenya while exporting medicinal and chemical items. According to Swiss Abroad, 797 Swiss nationals lived in Kenya, while 1,406 Kenyan citizens lived in Switzerland at the end of 2020. Kenya's national parks and beaches make it a popular destination among Swiss tourists[6].

5 https://www.eda.admin.ch/eda/en/home/representations-and-travel-advice/kenya/switzerland-kenya.html

6 https://www.eda.admin.ch/eda/en/home/representations-and-travel-advice/kenya/switzerland-kenya.html

Switzerland has strong bilateral ties with Nigeria due to its 10-year migration cooperation[7]. Moreover, this crisis originated from China and has the most significant investment in Kenya's standard gauge railway (SGR) upgrading project. The SGR connects Mombasa, Kenya's prominent port city, to the country's capital, Nairobi. The Export-Import Bank of China sponsored 90% of the SGR project, with the Kenyan government contributing 10%. The China Road and Bridge Corporation oversaw the SGR installation procedure. This was designed to indicate a commitment to Kenya's development ambitions while directly stimulating growth in the building sector, but it still indicated close ties to Switzerland. In the case of Bulgaria, Dospatliev et al. (2022) stated spillover, but this study confirms it doesn't experience contagion. Moreover, China-Croatia acted as a financial contagion-connected node among the other countries (Fig. 5.13).

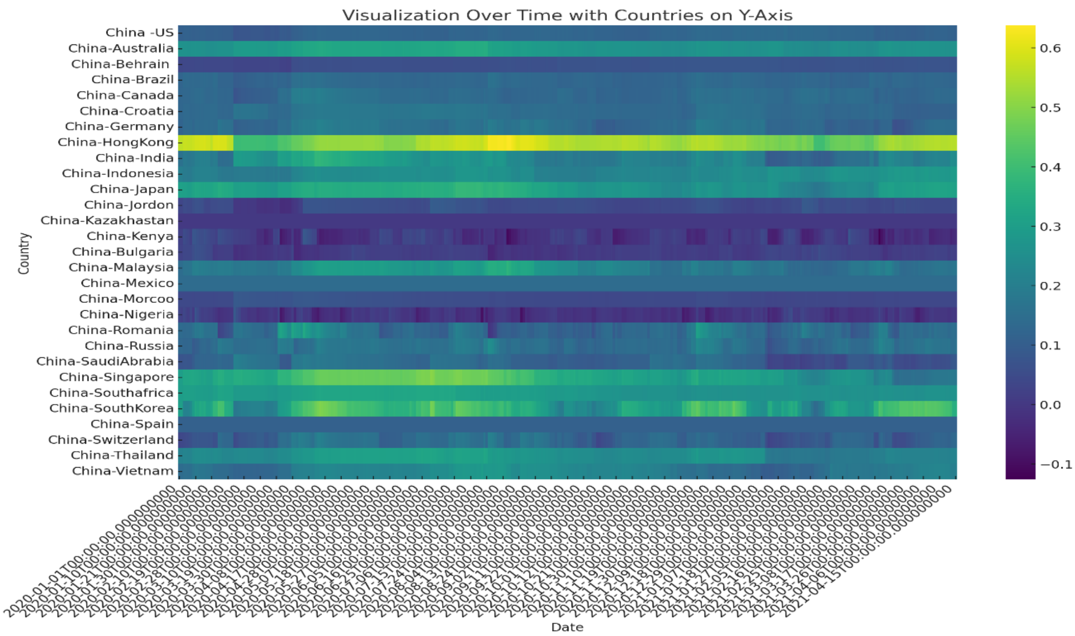


Fig. 5.12: The correlation between China and every country is displayed in the row, and the time points within the selected period are represented in the columns, with the start of the period being the axis point. In the 'Viridis' colour map, the level of correlation at each time point is shown by the colour scale, which goes from light to dark. Darker colours imply stronger correlations.

Note: Different colours indicate the level of correlation from 1 to 0. (Source: Author using R software).

[7] https://migration.swiss/assets/inhaltsbilder/a-perfect-example-of-a-migration-partnership/Nigeria-MP-EN-210225-web_2022-02-21-124956_mxqs.pdf

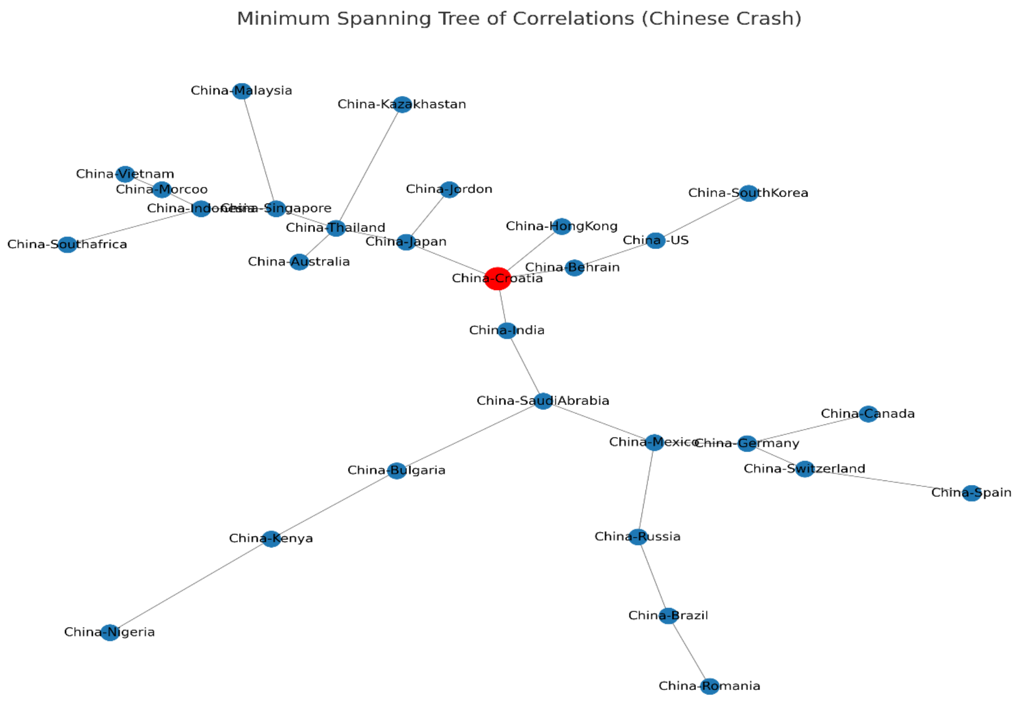


Fig. 5.13: Minimum Spanning tree of correlations during COVID-19 crises taking China as crisis origin country.

Note - The red node is a connecting node representing a country's potential contagion channel based on the country of crisis origin among all developed, emerging, and frontier countries. Edges link nodes (countries) depending on the most significant correlations (converted into distances), ensuring that the tree encompasses all nodes with the least overall edge weight (Source: Author using R software).

During the Russia-Ukraine war (Panel-6), Russia was selected as the origin of the crisis as on 24 Feb 2022, Russia invaded Ukraine but did not impact the selected developed and emerging markets did not lead to contagion. However, volatility can be observed among these countries due to the war. These results are consistent with Izzeldin (2023) results that the severity of the Russian-Ukrainian war has been, on a global scale, muted compared to either the GFC or COVID-19. This study contends that the immediate response of stock markets indicates investors perceived the invasion as "real news." Notwithstanding the protracted mobilization of Russian forces along the Ukrainian frontier, the markets had not discounted the possibility of an actual invasion. They regarded its occurrence as improbable until it occurred. This is perplexing, considering the gravity of the incident in question. It is conceivable that investors could misconstrue this event. Historical warlike experiences have deviated significantly from the present by predominantly encompassing isolated acts of terrorism occurring outside the European continent. As a result, investors might erroneously conclude the actual ramifications of the Russian-Ukrainian conflict by basing their assessments on such previous encounters (The Guardian, 2022).

"As Ukraine crisis has financial markets spooked, but not yet despondent".

- Larry Elliott (The Guardian, 2022)

Nevertheless, with the persistence of Russia's belligerence in Ukraine, there was a growing consensus among international actors that a protracted conflict is an imminent possibility (BBC, 2022). Furthermore, financial institutions have revised their development projections in response to the prolonged strife (JP Morgan, 2022). But these political crises have shaken the stock markets of the frontier countries significantly, such as Croatia, Morocco, Bulgaria, Vietnam, Nigeria, Jordon, Kazakhstan, and Bahrain, as indicated contagion effects which indicated global frontier countries got impacted as the above countries belong to Europe, Middle East, Africa, and Asia-Pacific regions (Table 5.3.2). Interestingly, they have not affected the emerging and developed countries (only Spain has shown a minor contagion effect, although the results are insignificant).

On analysing different possible channels of contagion (Fig. 5.14), Croatia has not acted as a source of contagion[8] among the selected stock markets. However, the heat map (Fig 5.15) indicated Croatia was highly influenced during the Russia-Ukraine crisis and identified as a highly contagious country among the developed, emerging, and frontier countries. The Ukraine conflict with Russia has had a profound effect on numerous European nations, including EU members and border states such as Croatia. Although Croatia encounters distinct obstacles in terms of energy costs, tourism, and instability in the region, it is critical to consider the broader ramifications for other European countries. Croatia is part of the EU and NATO, which has favoured Ukraine and sanctioned the import of goods (crude oil and gas cover a significant share in total import) from Russia. According to the European Council (2024), the proportion of pipeline gas imported by the EU from Russia decreased from more than 40% in 2021 to around 8% in 2023. In 2023, the US and Norway supplanted Russia as the leading gas suppliers.

[8] Contagion channels reveal the country's most centrally connected (potentially acting as contagion sources).

Table 5.3.2: Dynamic conditional correlation results testing through financial contagion test estimated using the DCC-GJR-GARCH (1,1) Model during COVID-19 and Russia-Ukraine war.

Panel 5- COVID-19 crises					**Panel 6- Russia-Ukraine War Crises**				
Developed Countries									
		Coefficients	***t Stat***	***P-value***			***Coefficients***	***t Stat***	***P-value***
China-US	Intercept	0.095116999	(264.828905092734)***	0	*Russia-US*	Intercept	0.2967486	(221.144745705924)***	0
	-Dummy	**0.02344346**	(17.0087255387547)***	4.22175E-63		Dummy	-0.1283538	(-25.8688953995843)***	1.59E-138
China-Australia	Intercept	0.237960785	(276.650619645455)***	0	*Russia-Australia*	Intercept	0.2340784	(399.585303732948)***	0
	-Dummy	**0.04470217**	(13.5424623156345)***	4.67517E-41		Dummy	-0.0262899	(-12.137208675123)***	1.99E-33
China-Canada	Intercept	0.133317234	(446.153050270967)***	0	*Russia-Canada*	Intercept	0.3329572	(336.378389124408)***	0
	-Dummy	**0.00454426**	(3.9628139554108)***	7.51119E-05		Dummy	-0.1012738	(-27.6705603911616)***	7.51E-157
China-Germany	Intercept	0.141291725	(302.298218023679)***	0	*Russia-Germany*	Intercept	0.4481778	(237.173453678178)***	0
	Dummy	**0.0047327**	(2.63858508140326)***	0.008351294		Dummy	-0.1687559	(-24.1521459696403)****	6.09E-122
China-Hong-Kong	Intercept	0.476956222	(259.685891852109)***	0	*Russia-Hong Kong*	Intercept	0.3121835	(296.271024535936)***	0
	Dummy	**0.04573219**	(6.48835618971866)***	9.52348E-11		Dummy	-0.0889793	(-22.8375385375536)***	7.53E-110
China-Japan	Intercept	0.255027759	(263.416161684726)***	0	*Russia-Japan*	Intercept	0.2185296	(353.81141534442)***	0
	Dummy	**0.044372**	(11.9428169232893)***	1.96312E-32		Dummy	-0.0416298	(-18.2283568322975)***	6.54E-72
China-Singapore	Intercept	0.27260886	(171.699017983739)***	0	*Russia-Singapore*	Intercept	0.3077214	(255.35317188967)***	0
	Dummy	**0.06771593**	(11.113772186973)***	2.31875E-28		Dummy	-0.0610363	(-13.6978570012585)***	6.01E-42
China-Switzerland	Intercept	0.117142215	(181.664797758641)***	0	*Russia-Switzerland*	Intercept	0.3947189	(232.969941855014)***	0
	Dummy	**0.00245448**	0.991882936	0.321303009		Dummy	-0.1319588	(-21.0635480715364)***	2.09E-94
China-Spain	Intercept	0.108984325	(99609966.4707872)***	0	*Russia-Spain*	Intercept	0.0463152	(8464663705.06632)***	0
	Dummy	-2.82591E-08	(-6.73037668057939)***	1.88388E-11		Dummy	**3.22E-11**	1.592264084	0.1113891
China-Russia	Intercept	0.154306395	(275.404371859905)***	0					
	Dummy	0.00056714	-0.263766788	0.791970583					
Emerging Countries									
China-Brazil	Intercept	0.125907876	(835.149813374829)***	0	*Russia-Brazil*	Intercept	0.3111388	(219.582294174185)***	0

Panel 5- COVID-19 crises					Panel 6- Russia-Ukraine War Crises				
	-Dummy	**0.00237708**	(4.1086408166633)***	4.04411E-05		Dummy	-0.1662502	(-31.7311966965318)***	2.40E-201
China-India	Intercept	0.198610399	(256.604317590066)***	0	*Russia-India*	Intercept	0.2901303	(256.920609067236)***	0
	Dummy	**0.02624289**	(8.83520029850779)***	1.36457E-18		Dummy	-0.0654065	(-15.6642015767044)***	5.14E-54
China-Indonesia	Intercept	0.205887583	(196.557800277403)***	0	*Russia-Indonesia*	Intercept	0.248125	(284.824879894479)***	0
	Dummy	**0.03130789**	(7.78855262590179)***	8.1962E-15		Dummy	-0.0480094	(-14.9044036759766)***	3.53E-49
China-Thailand	Intercept	0.193070183	(174.76114998807)***	0	*Russia-Thailand*	Intercept	0.257426	(240.008178340029)***	0
	Dummy	**0.05652617**	(13.3328211815183)***	7.19012E-40		Dummy	-0.0409009	(-10.3130699888184)***	1.09E-24
China-Malaysia	Intercept	0.199676441	(247.226960168497)***	0	*Russia-Malaysia*	Intercept	0.2257981	(323.175499611297)***	0
	Dummy	**0.01851394**	(5.97325107856362)***	2.48784E-09		Dummy	-0.0864226	(-33.4523570783731)***	1.98E-221
China-Mexico	Intercept	0.140009951	(362551.266325916)***	0	*Russia-Mexico*	Intercept	0.3139754	(291.304553481571)***	0
	Dummy	**5.9984E-06**	(4.04748433174587)***	5.25592E-05		Dummy	-0.1246754	(-31.2833638335044)***	3.10E-196
China-Saudi Arabia	Intercept	0.096282982	(139.551490235786)***	0	*Russia-Saudi Arabia*	Intercept	0.1352217	(121.001413859034)***	0
	Dummy	**0.01899798**	(7.17521854632102)***	8.28555E-13		Dummy	-0.0060198	-1.456821145	0.145229
China-South Africa	Intercept	0.215676784	(256.228047497604)***	0	*Russia-South Africa*	Intercept	0.4342222	(236.262148685535)***	0
	Dummy	**0.0680151**	(21.0557830573351)***	2.43363E-94		Dummy	-0.199592	(-29.3701740705964)***	5.87E-175
China-South Korea	Intercept	0.294943398	(230.142595393362)***	0	*Russia-South Korea*	Intercept	0.2621007	(275.697902931092)***	0
	Dummy	**0.04493983**	(9.13760824046874)***	9.11259E-20		Dummy	-0.0755561	(-21.4939493224607)***	4.66E-98
					Russia China	Intercept	0.1547371	(275.579055563649)***	0
						Dummy	-0.0053625	(-2.58284391278069)***	0.0098273
Frontier Countries									
China-Morocco	Intercept	0.043211581		0	*Russia-Morocco*	Intercept	0.0471727	(188.248110216663)***	0
	Dummy	**0.00618084**	(16.3263799118967)***	2.08657E-58		Dummy	**0.01639**	(17.6886887961928)***	6.02E-68
China-Bulgaria	Intercept	0.018637358	(59.3271990420076)***	0	*Russia-Bulgaria*	Intercept	0.0182634	(74.6376997585767)***	0
	Dummy	-0.00715201	(-5.93253693854618)***	3.1852E-09		Dummy	**0.000527**	0.582076733	0.5605414
China-Nigeria	Intercept	-0.005967773	(-17.0372912466857)***	2.66243E-63	*Russia-Nigeria*	Intercept	-0.0113345	(-94.1018397843269)***	0
	Dummy	-0.003358008	(-2.49811665862477)**	0.01251763		Dummy	**0.001653**	(3.7115742957512)***	0.0002082

Panel 5- COVID-19 crises					Panel 6- Russia-Ukraine War Crises				
China-Romania	Intercept	0.139375475	(194.150691806414)***	0	*Russia-Romania*	Intercept	0.2366623	(155.658897061991)***	0
	Dummy	**0.00906431**	(3.29026027037362)***	0.001007938		Dummy	-0.0214893	(-3.82251470506649)***	0.0001337
China-Vietnam	Intercept	0.120631588	(123.977462591999)***	0	*Russia-Vietnam*	Intercept	0.0766023	(397.946522183364)***	0
	Dummy	**0.07302144**	(19.5557694264362)***	4.24296E-82		Dummy	**0.003658**	(5.13926161212858)***	2.86E-07
China-Kazakhstan	Intercept	0.001284148	(1270432.7695185)***	0	*Russia-Kazakhstan*	Intercept	-0.0205289	(-21151676.2430993***	0
	Dummy	**1.4273E-08**	(3.67943198109738)***	0.000236233		Dummy	**1.57E-08**	(4.38486917879831)***	1.18E-05
China-Bahrain	Intercept	0.046503734	(188.316872257003)***	0	*Russia-Bahrain*	Intercept	0.0158778	(4023568032.76063)***	0
	Dummy	**0.01569498**	(16.5617006796611)***	5.24684E-60		Dummy	**4.16E-11**	(2.85403688426851)***	0.0043346
China-Croatia	Intercept	0.129008002	(208.120009770794)***	0	*Russia-Croatia*	Intercept	0.207662	(116.193246145561)***	0
	Dummy	**0.01836216**	(7.71904869355741)***	1.40795E-14		Dummy	**0.047937**	(7.25403400029778)***	4.67E-13
China-Kenya	Intercept	-0.001632938	(-2.65509623286073)***	0.007953911	*Russia-Kenya*	Intercept	-0.011883	(-15195760.3504461)***	0
	Dummy	-0.002458906	-1.041826083	0.297543086		Dummy	-4.40E-08	(-15.2317199198962)***	3.09E-51
China-Jordon	Intercept	0.02740621	(59.2881297304891)***	0	*Russia-Jordon*	Intercept	0.0229245	(66.4639756554829)***	0
	Dummy	**0.01902988**	(10.7274768695947)***	1.47604E-26		Dummy	**0.001184**	(0.928091508509766)**	0.3534053

Note- The regression estimation results are based on Eq.3.51 from the DCC-GJR-GARCH (1,1) model. During the COVID-19 (Panel -5) Russia-Ukraine war crises (Panel -6), contagion was reported from the origin country against selected developed, emerging, and frontier countries. The full period of each crisis has been reported based on each crisis period, i.e. Jan 1, 2020 (The first wave of COVID-19, which massively spread in March turned to lockdown) to 15 April 2021 (post-third wave as COVID-19 death cases reduced) Feb 24, 2022 (Russia invaded on Ukraine) to 17 July 2023 (ongoing war till date). The t-statistics are in parentheses as represented *, **, and ***, the p values <0.10, <0.05, and <0.01, respectively. (Source: Author using R software).

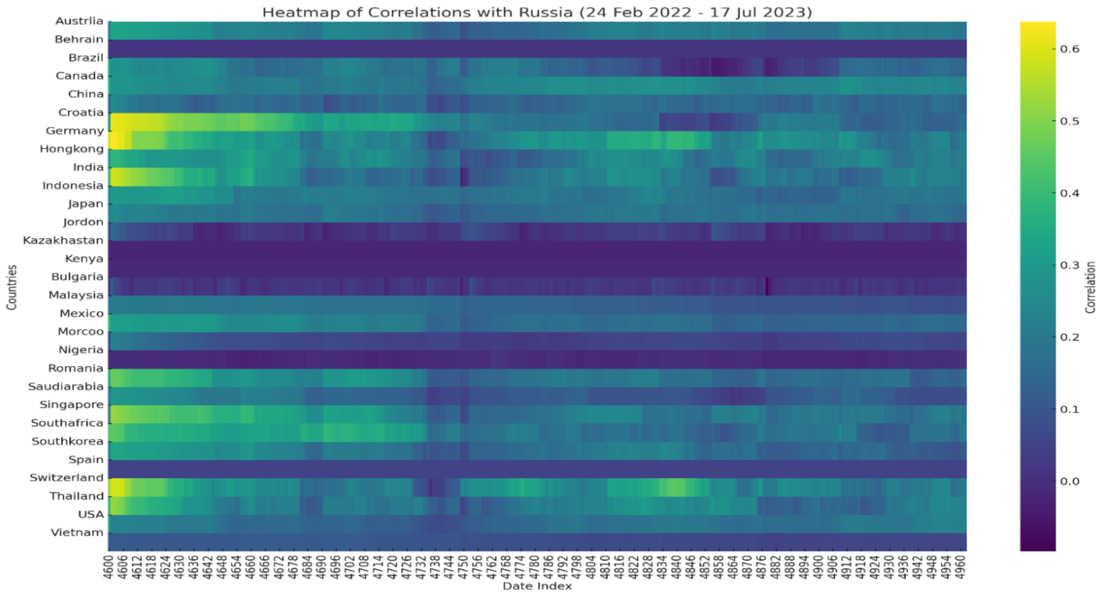


Fig. 5.14: Heat map of DCC-GJR-GARCH (1,1) Model correlation with the crisis origin country.

Note- The correlation between Russia and every country is displayed in the row, and the time points within the selected period are represented in the columns, with the start of the period being the axis point. In the 'Viridis' colour map, the level of correlation at each time point is shown by the colour scale, which goes from light to dark. Darker colours imply stronger correlations. Note: Different colours indicate the level of correlation from 1. (Source: Author using R software).

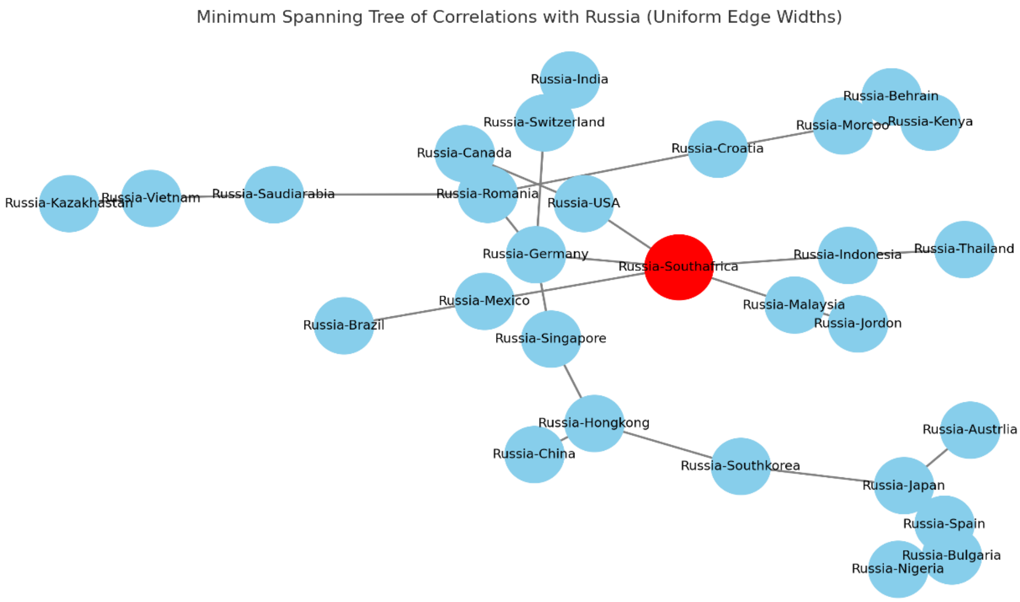


Fig. 5.15: Minimum Spanning tree of correlations during the Russia-Ukraine crises, taking Russia as the country with the crisis origin. Moreover, the summary of the previous literature related to contagion is given below

Note - The dataset's nodes represent a country's potential contagion channel based on the country of crisis origin among all developed, emerging, and frontier countries. Edges link nodes (countries) depending on the most significant correlations (converted into distances), ensuring that the tree encompasses all nodes with the least overall edge weight. (Source: Author using R software).

Crises Panels	Type of Country	Study - Contagion Findings	No Contagion
GFC Crash	Developed Country	US (Nguyen et al., (2022) - Japan, Korea; (Chopra and Mehta, (2022) - Korea, Australia, Hong-Kong, Japan, Singapore); Tilfani et al., (2021)- Canada, Russia	(Chopra and Mehta, (2022) - New Zealand; Tilfani et al., (2021)- Japan, Germany, and China)
GFC Crash	Emerging Country	US (Nguyen et al., (2022)- China, Malaysia, Taiwan, Thailand; Chopra and Mehta, (2022) -India, Indonesia, Malaysia, Taiwan, Thailand.	US (Anyikwa and Roux (2020) - South Africa)
GFC Crash	Frontier Country	US (Nguyen et al., (2022)- Vietnam	US (Anyikwa and Roux (2020) - Kenya, Morocco, Nigeria)
EDC Crash	Developed Country	Greece (Chopra and Mehta, (2022) - Hong-Kong); PIIGS- (Samarakoon, 2017)	Greece (Chopra and Mehta, (2022)- Japan, New Zealand, Singapore, Australia)
EDC Crash	Emerging Country	**US (Anyikwa and Roux (2020)- South Africa);** Chopra and Mehta (2022) - China, Malaysia, Thailand.	Greece (Chopra and Mehta, (2022) - India, Indonesia, South Korea, Taiwan)
EDC Crash	Frontier Country	**US (Anyikwa and Roux (2020)- South Africa, Nigeria)**	**US (Anyikwa and Roux (2020) - Kenya, Morocco)**
Chinese Crash	Developed Country	-	-
Chinese Crash	Emerging Country	-	-
Chinese Crash	Frontier Country	-	-
BREXIT Crash	Developed Country	United Kingdom as a source of contagion and the remaining recipient markets. (Escribano and Iniguez, 2021), and Russia as per Ayadi, (2022)	-
BREXIT Crash	Emerging Country	-	China (Ayadi, 2022) South Africa (Bello et al., 2022)
BREXIT Crash	Frontier Country	Morocco (Bello et al., 2022)	-

COVID-19 Crisis	Developed Country	**US (as source Nguyen et al., (2022)-** Japan); DCC-GARCH model- US, to Spain, present higher contagion effects; COVID-19 pandemic (Gunay and Can, 2022)	-
COVID-19 Crisis	Emerging Country	**US (Nguyen et al., (2022)- China, Thailand);** China (Chopra and Mehta, (2022) - India, Indonesia, Thailand, New Zealand)	**US (Nguyen et al., (2022)- India, Indonesia, Korea, Malaysia);** China (Chopra and Mehta, (2022), Malaysia, South Korea, Australia, Singapore)
Russia-Ukraine war	Frontier Country		**US (Nguyen et al., (2022)-Vietnam)**

Note: The bolded countries show inconsistent results with this study.

5.3 Conclusion of the chapter

This study attempts to unveil the financial contagion among developed, emerging, and frontier countries during the GFC, EDC, Chinese burst bubble, Brexit, COVID-19, and Russia-Ukraine between 2004 and 2023. This study identified different behaviours in the various stock markets of the selected countries. During all the crises, selected countries identified signs of contagion in a few specific markets. During global financial crises (GFC-2007 to 2009), Russia, Switzerland, Germany, Singapore, and Canada among developed countries; Mexico, Brazil, Thailand, South Africa, Indonesia, and Malaysia among emerging countries; and Croatia and Romania among frontier countries reported significant contagion effect among all the frontier countries on taking the US as the origin of crises during GFC. On analysing correlation (developed markets have a strong connection with the US, whereas emerging and frontier markets have a low correlation) among all the countries taking the US as crises origin (using DCC-GJR-GARCH results) indicated Brazil, Mexico, Canada as highly integrated countries, in which India acted as connected contagion channel among all the countries, although due to different factors such as financial stability, financial innovation, and irrational behaviour (different sentiments) of investors may impact these contagion channels.

Similarly, during EDC (May 2010- June 2013), Russia, Spain, Australia, Hong Kong, and Singapore among developed countries; Brazil, China, Saudi Arabia, South Korea, and Thailand among emerging countries; Croatia, Romania, Vietnam were identified as significantly impacted from financial contagion This might be owing to the U.S. losing economic supremacy because of the crisis, as well as China emerging as an economic powerhouse and improving trade and economic relations with other markets.

Chinese burst bubble (June 2015 to Dec 2015) Singapore, Hong Kong, Australia, Japan, US, Germany, and Canada among developed countries; South Africa, Thailand, South Korea, Indonesia, India, Saudi Arabia, Malaysia, and Brazil among emerging countries; Vietnam, Croatia, Jordon, Bahrain, Romania, Morocco, and Kazakhstan among frontier countries.

During the BREXIT (June 2016 to Sept. 2017) event, emerging countries didn't show any contagion, but only Spain, Hong Kong, and Australia among developed countries; Vietnam, Bulgaria, and Nigeria among frontier countries had significant contagion.

During the world health crisis, i.e. COVID-19 (Jan 2020 to April 2021), only Spain and Russia were among the developed countries; Bulgaria, Nigeria, and Kenya, among frontier countries, didn't show significant contagion. The rest of the countries show considerable contagion.

In geopolitical crises, i.e., the Russia-Ukraine crises (Feb 2022 to Feb 2023), all selected developed and emerging countries showed no contagion impact. Still, some volatility may occur among countries or economic blocs during this period. Among all the frontier countries except Bulgaria, Kenya, and Romania, the rest of the countries were impacted due to contagion, which indicates frontier countries showed more contagious effects than other countries.

Thus, for the practical implication, this chapter suggests that investors have to make decisions based on the country of origin of the crisis, as the results vary from country to country based on the country of origin. Thus, investors can hedge risk by shifting their portfolio to other investment sources or countries with non-contagious behaviour if they are looking for long-term investment options.

Overall, this study found that the crises had varying effects on the global stock markets based on the different behaviour of the markets. The reasons behind these discrepancies could stem from various factors, including the type and cause of the crisis, a strong reliance on developed countries via trade, foreign direct investments, and increasing market integration. This study also offers a distinct viewpoint on the nature of the crises and their effects on global markets. Our findings are especially pertinent to fund managers, domestic and foreign portfolio investors, and other practitioners looking to participate in global stock markets and receive consistent returns. Based on the results, this study contends that financial crises' impact on global stock markets varies based on their specific form and source. International investors may profit from various global stock markets' benefits for diversification. The extensive research on co-movements, portfolio diversification, and financial market architecture is relevant to this investigation. The behaviour of financial markets during a crisis is the main topic of discussion. Financial contagion is unlikely to be eradicated, according to numerous studies that contend that the financial markets' increased globalisation has rendered them more vulnerable to contagion events. The task at hand thus involves nations implementing measures to reduce their susceptibility to global financial contagion. However, the form of crises-1) those that occurred gradually over the years and are predicted, like the GFC, EDC, and Chinese burst bubble 2) those from a political standpoint, like Brexit, Russia, and Ukraine crises; and 3) abrupt crises, like COVID-19 indicated that financial contagion pattern changed over the period o time based on the origin and type of crises. This study aims to further investigate financial contagion in global stock markets (developed, emerging, and frontier countries) by focusing on different crises. Thus, for the practical implication, this chapter suggests that investors have to make decisions based on the country of origin of the crisis, as the results vary from country to country based on the country of origin. Long-term investors can make decisions to hedge their funds in similar types of possible crises in the future. Thus, investors can hedge risk by shifting their portfolio to other investment sources or countries with non-contagious behaviour if they are looking for long-term investment options.

CHAPTER -6

EXPLORE TIME-FREQUENCY CO-MOVEMENT BETWEEN SELECTED STOCK MARKETS

CHAPTER -6

EXPLORE TIME-FREQUENCY CO-MOVEMENT BETWEEN SELECTED STOCK MARKETS

After employing TVP-VAR, TVP-VAR-BK Model, and DCC-GJR-GARCH model, in this chapter, this study extended by utilising the wavelet series of models to identify co-movements among the series concerning the highly market-capitalised country, i.e. the US, which has potential to unveil more critical insights for the portfolio investor.

6.1 Introduction

Wavelet techniques offer a unified framework for evaluating the interactions between variables at various frequencies and throughout time (Yadav et al., 2024). These strategies make analyzing the relationship between the variables over different time scales possible. This approach improves our understanding of the dynamic relationship between variables (Nepal et al., 2024). When applied to a time series, wavelet transformations produce indications with varying frequencies, dividing the original time series data into several series. Each of the decomposed time series properties represents a particular time horizon. Determining the link between frequency and scale can be aided by wavelet analysis. As the time window grows (large scale), the wavelet becomes considerably more dispersed, which lowers the frequency. Wavelet coherence, cross wavelet, and continuous wavelet are the three general categories the wavelet family model covers. A time series is examined at all frequencies using the continuous wavelet transformation. Cross-wavelet analysis is a method for simultaneously evaluating two signals in the frequency and time domains (Rua and Nunes, 2009). The primary benefit of cross-wavelet analysis is its capacity to examine the evolution of spectral features over time. Two signals can be related to each other by measuring their wavelet coherence. The link between time-series variables in the frequency domain is the primary focus of this kind of wavelet analysis. It can be applied to ascertain whether one variable is ahead of or behind the other for a specific time interval.

Firstly, this study breaks new ground by integrating advanced wavelet analysis techniques, notably cross wavelet transforms (XWT) and wavelet coherence, to examine frequency connectedness between the US and the selected developed, emerging, & frontier markets. This approach is pivotal in unravelling the complex time-sensitive interactions underlying these markets, especially during heightened volatility and uncertainty. It offers a fresh perspective on the temporal variations of market dynamics, categorizing interactions into short, medium, and long-scale cycles and revealing how these markets respond differently across various time frames. Thus, this technique can potentially evaluate the coherence among the developed, emerging, and frontier countries.

6.1.1 Why is the US a base for all the countries?

As per the market capitalisation ranking (covered in Chapter 3), the US was identified as a highly market-capitalized country. This chapter has the novelty of checking the impact of the crisis throughout the entire period with power spectrum and coherence. The novelty of this study research lies in a comprehensive analysis that, while recognizing the well-trodden path of examining the connectedness of the US and all the selected benchmark stock markets of the different countries, delves into the less explored terrain of the US-Selected stock market nexus, especially under the strain of global crises such as GFC, EDC, Chinese burst bubble crash, Brexit, COVID-19 and the Russia-Ukraine war (RUW). Moreover, the US acted as a significant source of volatility spillover (Chapter 4) in most of the crises among the selected countries.

6.2 Results and Discussion

6.2.1 Developed Countries

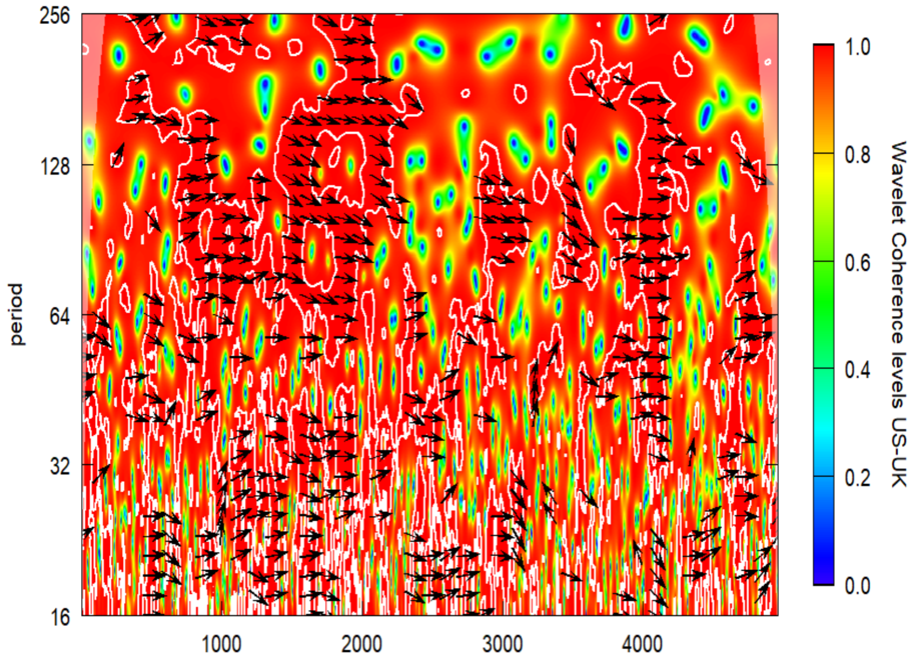
Based on MSCI classification among the developed countries, three crucial regions were covered, i.e. America (Wavelet Coherence Fig. 6.1.0, Cross-Wavelet Transform (XWT) Fig. 6.1.1, Wavelet Correlation Fig. 6.1.2), EMEA (Wavelet Coherence Fig 6.2.0, Cross-Wavelet Transform (XWT) Fig. 6.2.1, Wavelet Correlation Fig. 6.2.2), and APAC (Wavelet Coherence Fig 6.3.0, Cross-Wavelet Transform (XWT) Fig. 6.3.1, Wavelet Correlation Fig. 6.3.2).

6.2.1.1 Developed Countries – America Region

The US exhibits greater and longer co-movement with the UK over the selected period. Moreover, During GFC (dominantly) and EDC (as almost overlapping crises), high co-movement was identified from US-UK; it also proved that all the scale results were consistent in all the periods. A high wavelet coherence value suggests a close link or correlation between the US and UK markets or economies (Fig. 6.1.0 A). This shows that both countries' financial systems are responding in comparable ways to global events such as the global economic crisis, the European debt crisis, and the COVID-19 pandemic. During Brexit, the UK experienced political instability and uncertainty, possibly leading to a deviation from US economic performance. The wavelet coherence analysis also indicated that these correlations could change over time and are not static. Cross-wavelet coherence (Fig. 6.1.1 A) and wavelet correlation (Fig. 6.1.2 A) show a positive relationship between the US anddiffeUK on

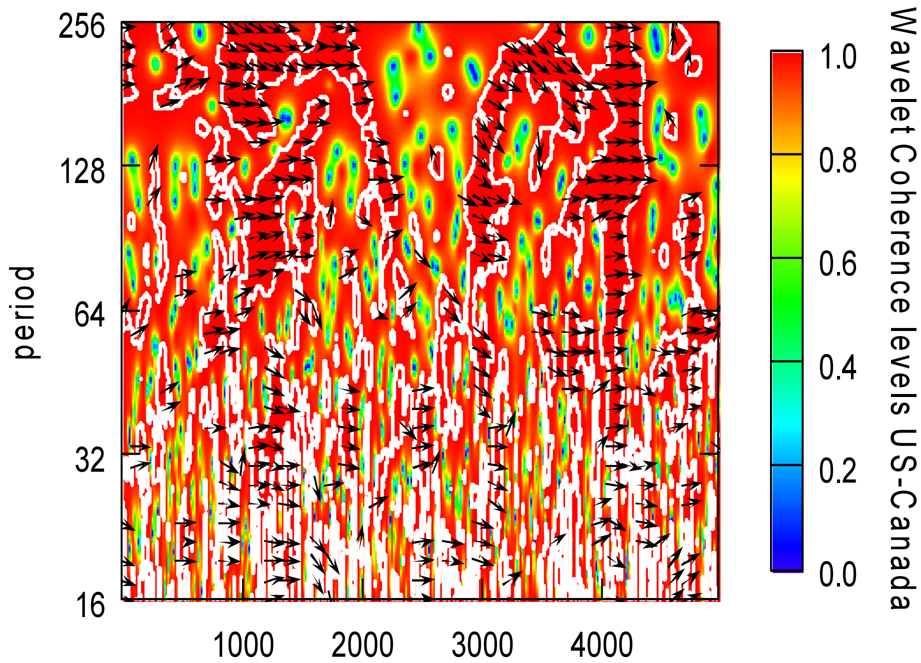
In studying the US-Canada relationship, this study finds a uniform flow of crises from the US to Canada (Fig. 6.1.0 B), (Fig. 6.1.1 B), (Fig. 6.1.2 B). Thus, wavelet coherence and cross-wavelet have shown a significant lead-lag relationship between the US and Canada during GFC and COVID-19, compared to the EDC. The Chinese stock market crash was anticipated to have a less direct influence on the link between the US and UK markets, but it may have created transitory volatility (Fig. 6.1.0 B; Fig. 6.1.1 B). Brexit also produced significant uncertainty, although the association may have been lower than for the GFC and COVID-19, as it was a more localized event affecting the UK's relationship with the EU rather than the global economy. Moreover, the wavelet correlation (Fig. 6.1.2 B) also indicated the variability in the correlation between the US and UK market patterns across these events, exhibiting heightened correlations during some periods (e.g., GFC, COVID-19) and diminished correlations over the other series of correlation. Interestingly, DCC-GJR-GARCH also revealed a contagion effect from the US, which is transmitted to Canada during GFC, with similar results proved by wavelet models.

America



A)

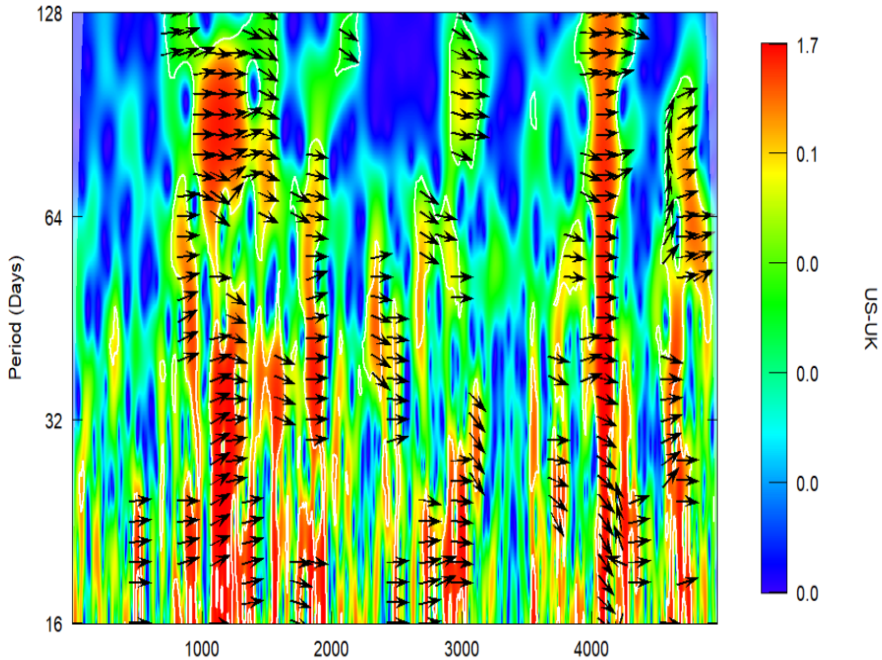
Wavelet Coherence US-UK (Proxy to BREXIT).



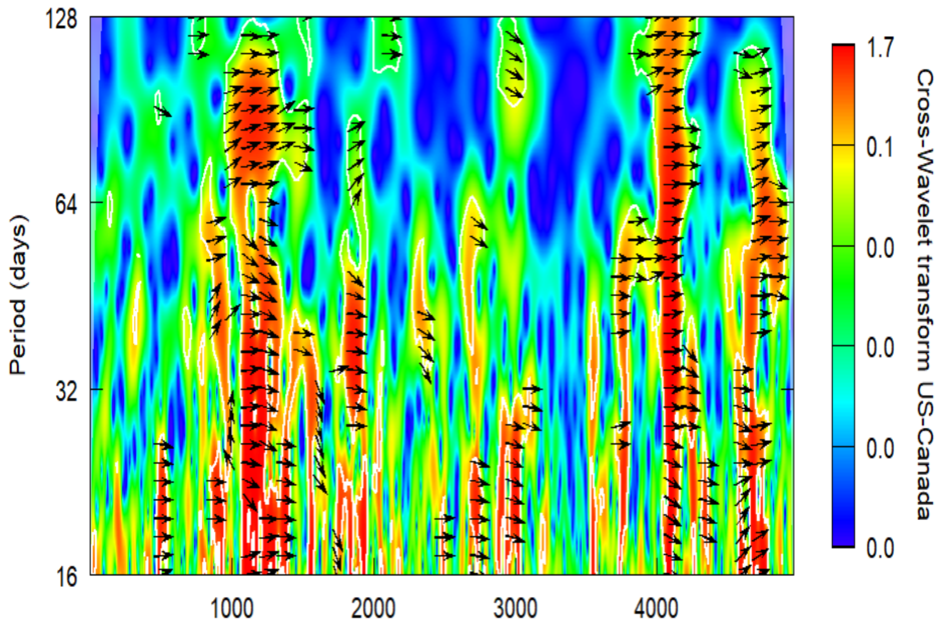
B) Wavelet Coherence US-Canada (Market Capitalisation Ranking- 3).

Fig. 6.1.0: Wavelet Coherence in the developed countries of the American region. (Source: Author using R software).

Americas



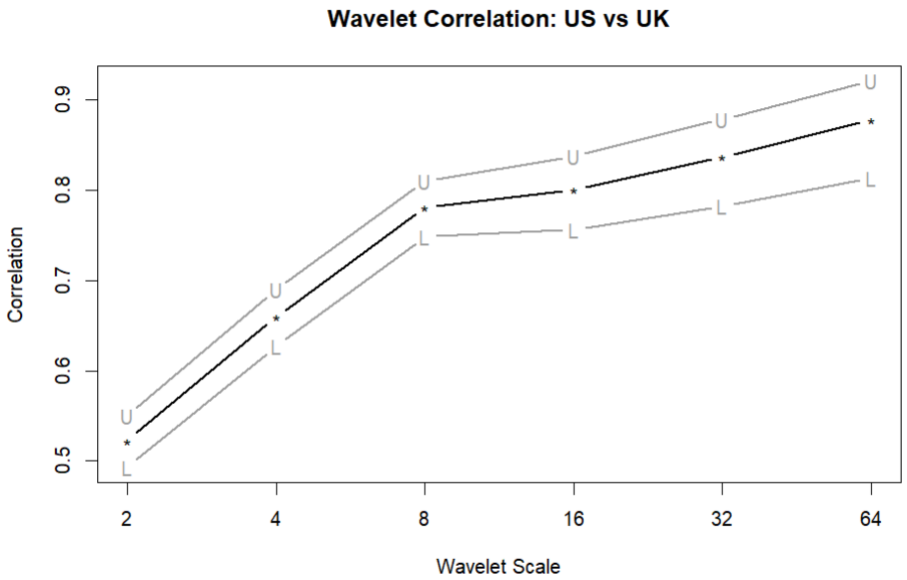
A) Cross-Wavelet Transform (XWT) US-UK (Proxy to BREXIT).



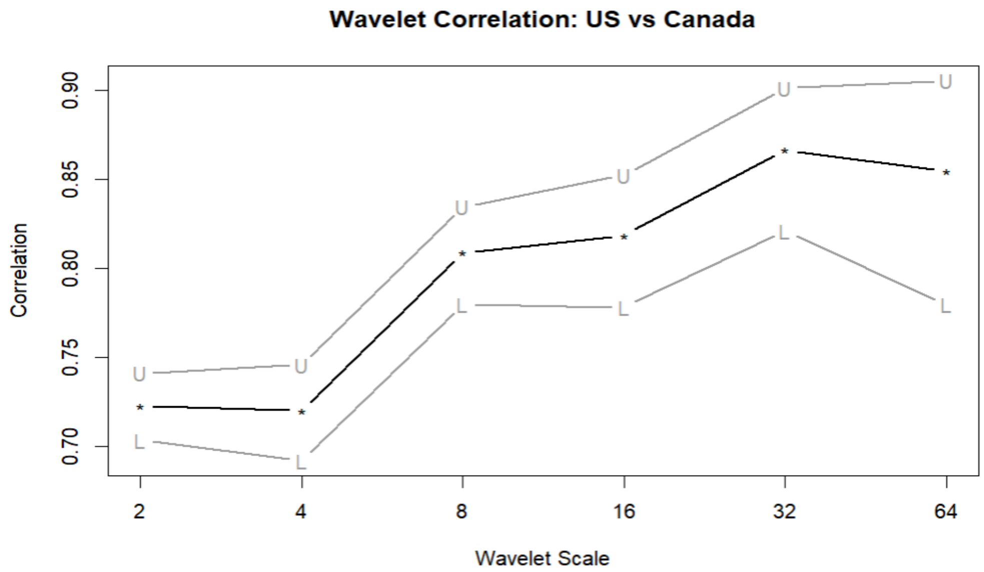
B) Cross-Wavelet Transform (XWT) US-Canada (Market Capitalisation Ranking- 3).

Fig.6.1.1: Cross-Wavelet Transform (XWT) in the developed countries of the American region. (Source: Author using R software).

Americas



A) Wavelet Correlation between US-UK (Proxy to BREXIT).



B) Wavelet Correlation between US-Canada (Market Capitalisation Ranking- 3).

Fig.6.1.2: Wavelet correlation between the US and other developed countries in the American region. (Source: Author using R software).

6.2.1.2 Developed Countries - EMEA Region

Among developed countries studying the EMEA region, this study identified elevated coherence during significant global crises (such as the GFC, EDC, and COVID-19), implying a synchronized response between the US and Germany, signifying that both were equally affected by global market circumstances. Moreover, transient interruptions or divergences (such as during the Chinese market fall, Brexit, or geopolitical conflicts like Russia-Ukraine) may have exhibited more localized oscillations, with intervals of poor coherence indicating transitory disconnections (Fig. 6.2.0 A). Moreover, by studying cross-wavelets, this study identified GFC as anticipated robust coherence between the US and Germany, likely within the long-term low-frequency spectrum (Fig. 6.2.1 A). During a global shock like the GFC, it had an everyday movement for the US-Germany and exhibited little phase difference or synchronized movements. Moreover, EDC indicated that elevated coherence is anticipated again during this interval, mirroring the worldwide economic impacts. The cross-wavelet exhibited distinct phase behaviour since Germany, being part of the Eurozone, might be more directly influenced, whilst the US may respond somewhat differently, albeit still highly correlated. Brexit transient coherence peaks at specific frequencies, as the US and Germany are interconnected via global markets; nevertheless, their responses may vary. The cross-wavelet may indicate some phase shifts, especially with the US either leading or behind in reaction to worries associated with Brexit. COVID-19 and the Russia-Ukraine war also exhibited high co-movement in US -Germany stock markets.

Interestingly, the DCC-GJR-GARCH model also has a proven contagion impact from the US to Germany. On studying the US and Germany wavelet correlation (Fig. 6.2.2 A), this study identified a high correlation indicating synchronized responses to global events, especially for crises like the GFC, COVID-19, Russia-Ukraine crises and potentially Brexit (though it could decouple here). On the other side, lower correlation exhibited more independent responses, like during the Chinese stock market crash, when the US and Germany could have had different exposure or recovery patterns.

In studying wavelet coherence (Fig. 6.2.0 B), this study revealed that between the US and Switzerland, a robust link identified throughout the GFC, Brexit, and the COVID-19 pandemic impacted in the long-term, indicating a common worldwide economic influence. Coherence was low throughout the EDC and the Russia-Ukraine war, with the Chinese market fall exhibiting the weakest correlation, perhaps because of varying exposures to the Chinese economy. In studying cross-wavelet transform (Fig. 6.2.1 B) in the US-Switzerland, this study identified a significant co-movement link during the GFC. The GFC affected both markets similarly, resulting in concurrent market behaviour due to the same economic shocks. As a robust banking industry, Switzerland may have seen increased cross-border financial strain during this period. During EDC, a moderate correlation was identified as both nations experienced the repercussions of the European debt crisis. Switzerland's economy (particularly its banking sector) appeared to be somewhat shielded from the most severe impacts compared to the US. The coherence indicates that although a link existed between the two markets, it was less evident than during the GFC. Switzerland may have been less affected by the collapse of the Chinese stock market during the Chinese crash than the US. As global markets responded to the decline, the US, due to its stronger economic interconnections with China, certainly saw more significant repercussions. Switzerland's response may have been more subdued owing to its neutral stance in international trade dynamics. During Brexit, a minor lead-lag relationship was identified between the US and Switzerland stock market for a very short time while not being members of the European Union, and it would have been impacted by the political and economic instability associated with Brexit.

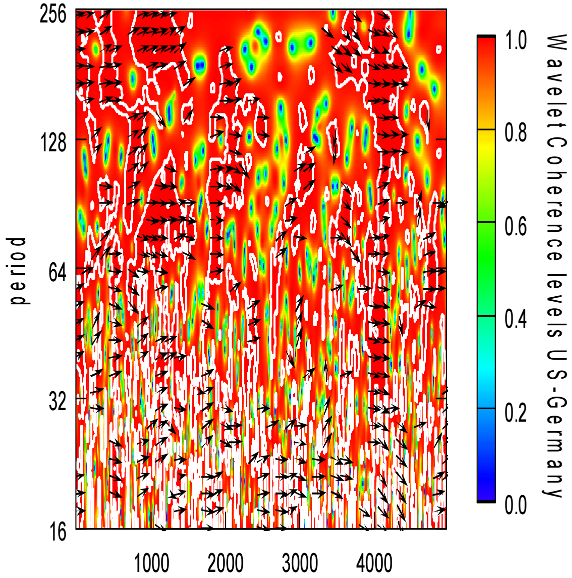
The Swiss markets, particularly within the financial sector, were likely interconnected with the EU economy, and the US experienced the repercussions through alterations in worldwide commerce and investment. This catastrophe triggered substantial market realignments, evidenced by the elevated coherence. Moreover, during COVID-19, a robust correlation significantly affected both the US and Switzerland, resulting in significant economic disruptions, lockdowns, and government stimulus initiatives. Financial markets in both countries were probably influenced similarly by global market volatility, economic deceleration, and changes in investor behaviour. Moreover, during the Russia-Ukraine conflict, moderate connectedness existed as both the US and Switzerland reacted to international volatility. Nonetheless, Switzerland's economic influence may have been less direct than that of the US, particularly concerning oil pricing and sanctions. The US engaged more extensively in international sanctions and military assistance, whilst Switzerland, as a neutral nation, faced distinct economic constraints. Yet, the correlation indicates a notable market response in both cases. On studying wavelet correlation (Fig. 6.2.2 B), the relationship between the US and Switzerland appears strong during periods of acute financial instability (GFC, Brexit, COVID-19) and market shocks (Russia-Ukraine, Chinese stock crash). Moreover, DCC-GJR-GARCH also proved the contagion effect raised from the US to Switzerland during the GFC and COVID-19.

In studying the relationship based on wavelet coherence between the US and Spain, we found that the GFC showed strong synchronization (Fig. 6.2.0 C). During the GFC, the US and Spanish financial markets exhibited significant coherence (64-128 scale) but showed a short-span lead-lag relationship as heterogeneous consistency in the results. Both countries were profoundly affected by the global crisis, experiencing banking crises, stock market collapses, and financial instability. The coherence is likely substantial, stating that both markets exhibited comparable movements and demonstrated a good in-phase connection. Moreover, modest coherence was identified in the EDC as Spain was significantly impacted by the crisis owing to its vulnerability to government debt and financial instability. The US, albeit not directly engaged, had indirect repercussions via global financial contagion. Over this period, the cross-wavelet correlation exhibited a moderate to high positive correlation, indicating that the markets of both nations moved similarly. Still, Spain's response may have been more closely linked to European debt concerns (Fig. 6.2.1 C). Moreover, during the Chinese stock crisis and BREXIT, the weaker coherence identified as the Chinese stock market crisis likely impacted the US more directly owing to its economic inter-connectedness with China and European countries. This era certainly demonstrates a synchronous positive connection since fluctuations would have influenced both nations in European trade and financial stability. During COVID-19, high coherence precipitated global economic disruptions, revealing that the US and Spain were enduring significant economic repercussions from lockdowns, healthcare expenditures, and financial stimulus. The coherence during this era is expected to be substantial since both markets exhibited coordinated responses to global economic shutdowns and uncertainty.

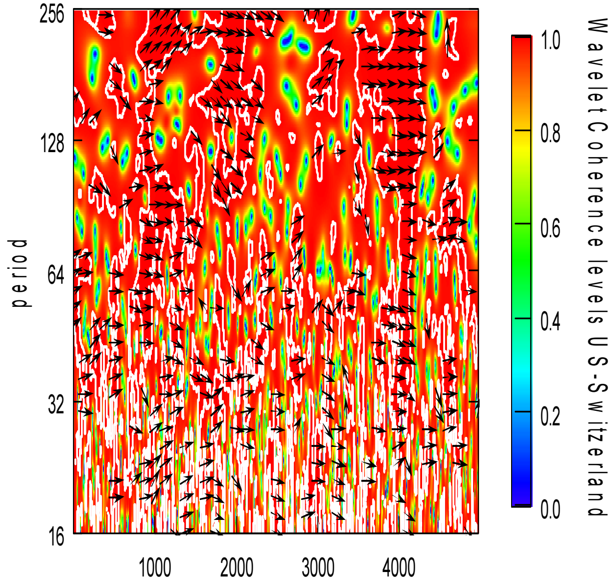
The synchronous association would signify a collective market reaction. During the Russia-Ukraine crisis, moderate coherence was identified for a short period as the Russia-Ukraine crisis has substantial geopolitical ramifications, with the economic repercussions for Spain and the US potentially differing based on oil prices, sanctions, and regional security issues. The correlation between the US and Spain appears modest, indicating some common market reactions, although highlighting disparities in the effects on each country. Spain's vulnerability to energy markets and its geographical closeness to the conflict likely influenced its response differently from that of the US. However, some similarities in market trends may still exist. By applying the cross-wavelet transformation, the US and Spain exhibited differing degrees of wavelet coherence, with significant movements observed during the GFC, Brexit, and COVID-19, when global events prompted synchronized market responses. The wavelet coherence between the EDC and the Chinese stock market crash is modest, suggesting that although both regions were impacted, the extent of effect likely varied, primarily owing to their distinct economic vulnerabilities. The Russia-Ukraine conflict has a substantial in-phase relationship, possibly attributable to both nations experiencing energy price shocks but with varying degrees of impact (Fig. 6.2.1 C).

On studying wavelet correlation (Fig. 6.2.2 C) on the lower scale (L), US-Spain has shown enduring ties and demonstrated substantial consistency amid significant crises such as the GFC, EDC, Brexit, COVID, and the Russia-Ukraine war, implying that both markets reacted similarly to these global events regarding long-term economic repercussions. Conversely, the Upper Scale (U) indicates short-term market responses and exhibits more significant variability in coherence (Fig. 6.2.2 C). Coherence at elevated frequencies was diminished or harmful during specific crises, such as the CBB, indicating short-term market decoupling (Fig. 6.2.2 C). There was more excellent short-term synchronisation in previous crises, such as Brexit or COVID-19, since both markets presumably responded similarly to global uncertainty and governmental measures. Surprisingly, the DCC-GJR-GARCH model has identified no contagion effect among the US (crises origin country)-Spain stock market during the GFC but shown contagion in EDC among US-PIIGS (crises origin country). Thus, wavelet coherence had a similar impact during wavelet correlation and cross-wavelet. There was some lead-lag relationship over the period, but DCC-GJR-GARCH indicated no contagion. Hence, there is some possibility of the volatility spillover from the US to Spain stock markets.

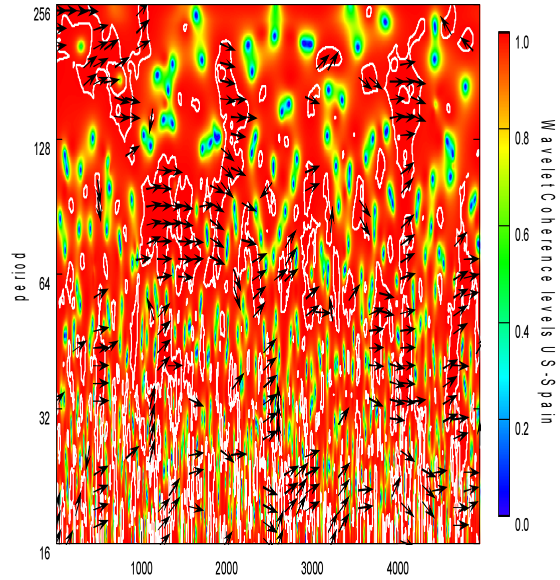
EMEA Region



A) Wavelet Coherence
US-Germany
(Market Capitalisation Ranking- 8).



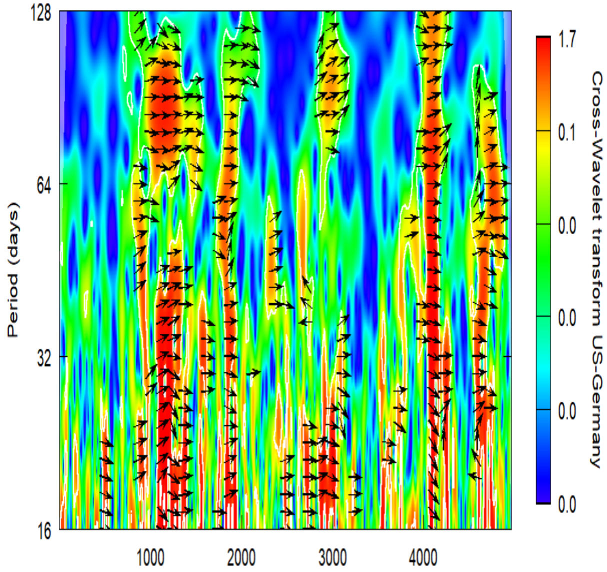
B) Wavelet Coherence
US-Switzerland
(Market Capitalisation Ranking- 10).



C) Wavelet Coherence
US-Spain
(Market Capitalisation Ranking- 15).

Fig. 6.2.0: Wavelet Coherence in the developed countries of the EMEA region. (Source: Author using R software).

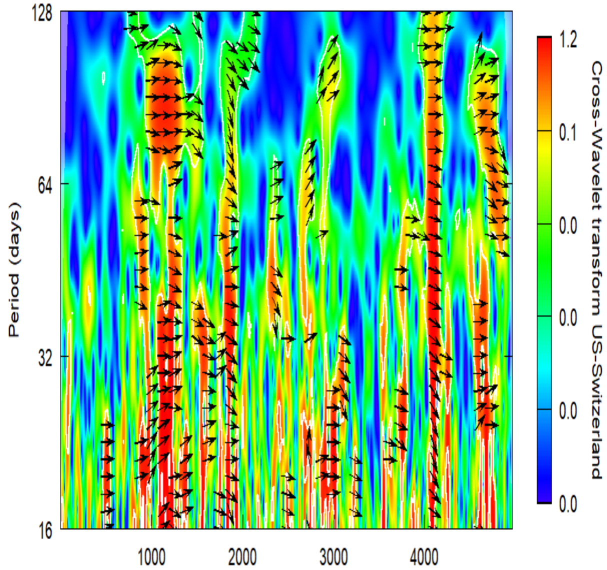
EMEA Region



A) Cross-Wavelet Transform (XWT)

US-Germany

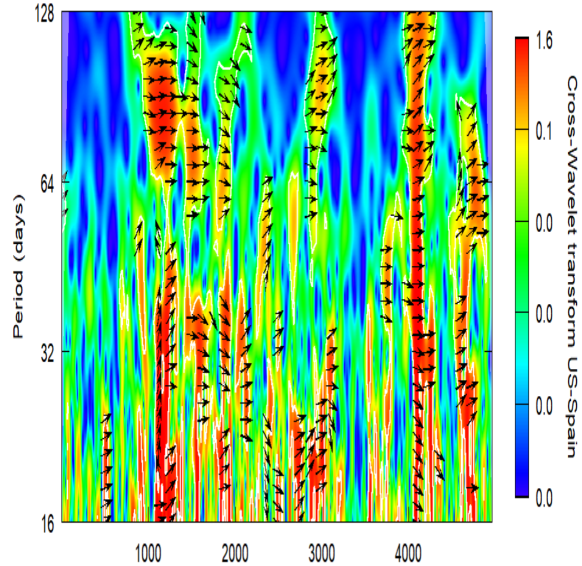
(Market Capitalisation Ranking- 8).



B) Cross-Wavelet Transform (XWT)

US-Switzerland

(Market Capitalisation Ranking- 10).



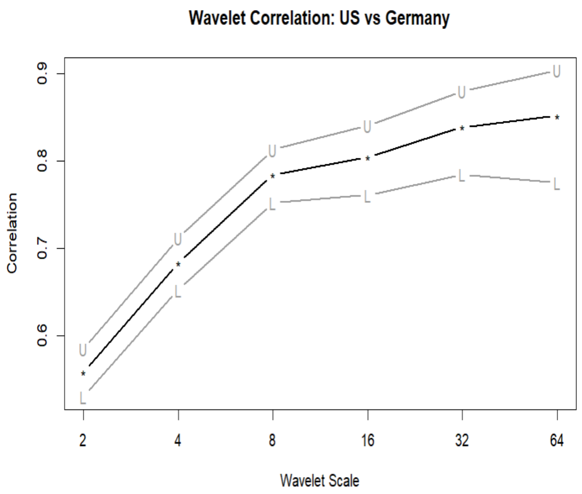
C) Cross-Wavelet Transform (XWT)

US-Spain

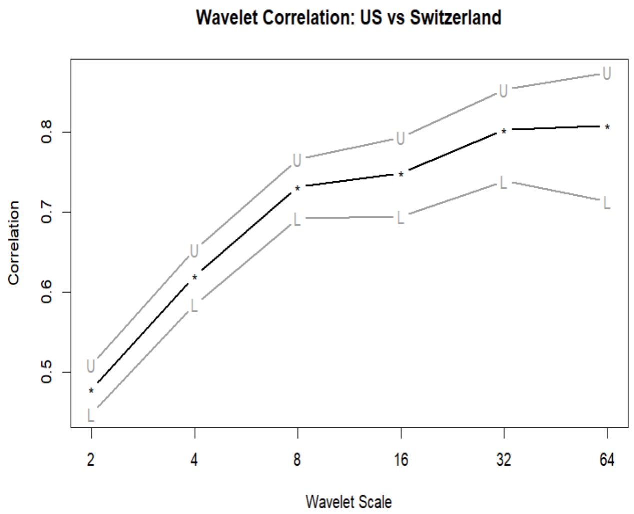
(Market Capitalisation Ranking- 15).

Fig. 6.2.1: Cross-Wavelet Transform in the developed countries of the EMEA region. (Source: Author using R software).

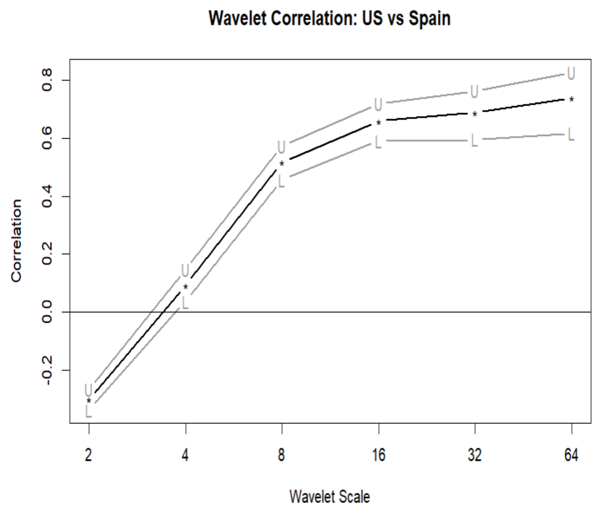
EMEA Region



A) Wavelet Correlation
US-Germany
(Market Capitalisation Ranking- 8).



B) Wavelet Correlation
US-Switzerland
(Market Capitalisation Ranking- 10).



C) Wavelet Correlation
US-Spain
(Market Capitalisation Ranking- 15).

Fig. 6.2.2: Wavelet Correlation in the developed countries of the EMEA region. (Source: Author using R software).

6.2.1.3 Developed Countries – APAC Region

Among developed countries in the APAC region, on analyzing the US-Japan, this study identified a high impact co-movements on all scales (i.e. small, medium and long scale) during the GFC and COVID-19 crises (Fig. 6.3.0 A). Moreover, up to some level, it has shown consistent co-movement in the period of EDC. Interestingly, during the CBB and BREXIT, co-movement was displayed on a medium and lower scale only. Both the US and Japan are key commercial partners of China, and they have faced financial market instability and trade concerns. Japan's exports to China reduced, while US markets revealed volatility due to suspicions (negative market sentiments) of slowing global growth. It showed co-movement from the US in the medium period but lagging in the more extended period. Japan and the US are the significant global powers that revealed capital inflows as investors sought safe-haven currencies. Japan's economy, which is heavily exposed to European markets, experienced moderate shocks, although US markets were more neutral[9]. The US-Hong-Kong lead relationship was identified during the Chinese crash, GFC, and COVID-19. Moreover, high co-movement was identified in the longer window, which may be caused due to the contagion effects (Fig. 6.3.0 A). Even during the Russia-Ukraine war, it existed for a very short span on a medium scale as energy shocks impacted economies differently. On employing the cross-wavelet during the GFC, medium-term periods (32-64 days) revealed a strong cross-wavelet power (red regions) (Fig. 6.3.1A). The arrows are primarily pointing right, signifying significant in-phase synchronization between the US and Japan.

Depicted how the GFC expanded globally as it impacted Japan's export-driven economy. Both countries' financial markets have shown similar declining trajectories as demand and credit markets collapsed. The EDC exhibited localized zones of significant cross-wavelet power, mainly at medium-term frequencies. The arrows again show a strong in-phase connection, albeit some tiny deviations imply minor lead-lag effects, as the global economic fear (or negative sentiments) during the EDC resulted in coordinated capital flows into safe-haven assets such as the US dollar and

[9] https://www.reuters.com/plus/cme/why-global-investors-turn-to-safe-haven-currencies

the Japanese yen, matching both countries' economic patterns. The Chinese crash has substantial cross-wavelet strength (shown by the rightward arrows) during shorter periods (16-32 days). This demonstrates the global spillover effects of China's financial sector disruption, as the US and Japan saw increased volatility in financial markets. Japan, more reliant on Chinese trade, had a stronger reaction, consistent with the overall US trend. At medium-term time scales, the Brexit period has modest cross-wavelet power. While arrows primarily represent in-phase movement, there are specific lead-lag effects. This is likely owing to Japan's greater trade exposure to Europe, which resulted in a significantly sooner response than the US. Nonetheless, global anxiety and capital flight into both countries' currencies (or FOREX) lead to synchronous developments. The COVID-19 pandemic is distinguished by broad, strong cross-wavelet power over extended durations (16-128 days). The phase arrows mostly depicted the in-phase movement and emphasized the coordinated economic collapse and subsequent recovery attempts in the US and Japan. Similar trends in financial markets and economic indicators were generated by coordinated global monetary policy, fiscal stimulus, and a simultaneous pandemic-induced demand shock. During the Russia-Ukraine war, locally high cross-wavelet strength was reported across medium periods. The phase arrows combine in-phase and modest lead-lag effects, indicating varying response times. Japan's significant reliance on imported energy resulted in earlier economic hardship than the United States, which is more energy-self-sufficient[10]. This modest lag emphasizes fundamental disparities between the two economies while reflecting more significant global upheavals. Similarly, US-Japan has shown a high correlation in different crises, as proved by the wavelet correlation model (Fig. 6.3.2 A). Intrestilgy DCC-GJR-GARCH has also proved that during GFC (as US crises origin) revealed contagion on Japan's stock market.

In studying US-Hong-Kong stock markets using the wavelet coherence among developed countries in the APAC region, this study identified during the GFC coherence, the global financial system was significantly affected (Fig. 6.3.0 B). Hong Kong (a central economic hub) has had a substantial impact due to its reliance on

[10] https://www.iea.org/countries/japan/energy-mix

overseas markets, particularly the United States. During the EDC (1518 to 2028), coherence ranges from moderate to high at specific scales. Although the EDC was based in Europe, its global consequences impacted investor sentiment worldwide. Hong Kong's open economy and trade openness most likely correlated its financial movements with US market reactions to the crisis. Due to the Chinese market crash, there is high coherence at medium- to long-term frequencies. Hong Kong's closeness and economic interconnectedness with mainland China exacerbated the impact of the Chinese market breakdown. The US (a significant trading partner) saw associated market swings because of China's economic uncertainty. During Brexit, high coherence was identified as a considerable uncertainty in the global stock markets. Hong Kong and US markets reacted similarly, with investors seeking safer assets and adjusting portfolios in reaction to international developments like the risk aversion theory. Moreover, powerful coherence was identified on different scales based on the epidemic-affected global supply chains, demand, and financial systems. The synchronous reactions unveiled the intertwined global markets are amid a systemic crisis, with Hong Kong mirroring US market volatility and recovery patterns. During the Russia-Ukraine war (4601 to 4963), high coherence revealed influence, as similarly, geopolitical concerns impacted global commodity prices, commerce, and investor confidence (Kushwah et al., 2024). The interconnectedness of the US and Hong Kong financial institutions was evident as both responded similarly to energy market instability and economic penalties[11]. Among developed countries studying the US-Hong-Kong stock markets using cross-wavelet transformation during the GFC revealed the significant high-power zones, especially over longer timescales; large areas of high power (lead-lag relationship) over the more extended periods (e.g., 64-128 days). On studying the EDC, both markets showed moderate to high coherence, indicating that both were affected by the same external shocks. From the arrow orientations, it is possible to deduce whether the US or Hong Kong headed the market moves during this era.

High coherence is strong across this time frame in studying the Chinese burst bubble, particularly for shorter durations. It indicated that the US and Hong Kong were

[11]https://www.atlanticcouncil.org/in-depth-research-reports/report/fractured-foundations-assessing-risks-to-hong-kongs-business-environment/

significantly affected by the instability in the Chinese economy. In Brexit during the 32–64-day time frame, there is a medium to high level of coherence, which indicates that political and economic uncertainty impacts the financial connections between these markets. Moreover, the COVID-19 and Russia-Ukraine crises have also shown strong interconnectedness as substantial transformations have been identified among both countries. There was a lot of coherence during this time, especially in the 32–128-day range. Moreover, during the Russia-Ukraine war, strong coherence over shorter time frames suggests that the market reacted swiftly to global turmoil. Moreover, the above results have been proved by the results of cross-wavelet-transform (Fig. 6.3.1 B)

When investigating wavelet correlation among US-Hong-Kong, the link peaks at lower time scales (movements with a shorter time horizon) and then levels out at bigger time scales (16-64) (Fig. 6.3.2 B). During the GFC, interconnectedness increased among the US and Hong Kong markets, particularly in medium- to long-term trends. Furthermore, moderate correlations at lower scales suggested that the EDC has a less direct influence on the Hong Kong market than the US market. However, at larger scales, stronger inter-linkages revealed that the broader economic situation impacts long-term financial relationships. The CBB reflected the effects of China's financial crisis on the US and Hong Kong markets in the short term. The link flattens at bigger scales, demonstrating that market interdependence is strong and lasting. BREXIT also showed high inter-connectedness at all scales, implying that both markets were influenced by medium- to long-term economic uncertainty. This relationship has gradually grown as a collective response to geopolitical upheavals rattling global markets.

Furthermore, the US and Hong Kong markets responded simultaneously to the global economic shock, as evidenced by the plot's significant and repeatedly high correlations across all scales. Furthermore, the relationship becomes considerably stronger when considering medium- to long-term trends, albeit on more minor scales. This tendency suggested that the conflict's consequences were moderate initially but grew stronger with time, consistent with the more significant economic and geopolitical implications.

Studying the US-Australia wavelet coherence revealed that the GFC has shown strong coherence (red zones) for 32-128-day time scales, as a global crisis that impacted all major financial markets (Fig. 6.3.0 C). Like the United States, Australia had severe drops due to investor fear, liquidity problems, and plummeting global demand. Coherence was high, with both markets reacting identically over medium- to long-term durations. Moreover, EDC showed moderate coherence (yellow/green zones) over 32-64-day timescales, as EDC predominantly affected Europe, with minor direct repercussions on the US and Australian stock markets. Australia's economy, which relies on Asian commerce, has lower exposure[12]. Both markets had considerable inter-connectedness due to indirect impacts such as investor mood and global uncertainty. On studying the CBB, coherence is weak-to-moderate in 16-64-day periods, as the 2015 Chinese market acted bearishly and substantially impacted Asian-Pacific markets, including Australia. Australia had close trading links to China and endured short-term disruptions[13]. The US market had less alignment, resulting in reduced worldwide synchronization. On studying Brexit, at a scale of 32-64 days, coherence is low to moderate. Brexit created political and economic instability, mainly in Europe. The US and Australian markets were less immediately affected, but global investor mood prompted short-term volatility. Weak coherence exhibits localized effects with little long-term alignment. In the COVID-19 pandemic, high coherence (signifying good in-phase synchronization) also created a global economic shock, resulting in coordinated stock market falls and recovery worldwide.

Global lockdowns, fiscal stimulus, and investor fear led to identical tendencies in Australia and the United States. Coherence was strong at all scales, indicating common economic reactions. Similarly, the Russia-Ukraine Conflict showed moderate-to-strong coherence over 32-128-day timescales. The Russia-Ukraine war caused worldwide oil price shocks and inflation fears. Moreover, the rising energy costs harmed Australia's commodity-driven economy, causing market movements to correlate with those of the United States. Due to similar economic constraints, both markets demonstrated medium-term synchronization. Due to coordinated global market reactions, there is considerable coherence across medium-to-long-term scales.

[12] https://www.rba.gov.au/education/resources/explainers/australia-and-the-global-economy.html
[13] https://www.dfat.gov.au/geo/china/china-country-brief

Moreover, the EDC, Chinese crash and Brexit crises have shown moderate-to-weak coherence, indicating localized repercussions with limited or delayed effects on the US and Australian markets. Moreover, the Russia-Ukraine relationship showed moderate to strong coherence caused by the common effects of global energy price volatility.

Furthermore, on extending the above results of US-Australia with the cross-wavelet transform (Fig. 6.3.1 C) in GFC, this study identified considerable consistency between 32 and 64 days (yellow and red zones). The arrows in these locations primarily point to the right, showing an in-phase connection in which the crisis hit both economies at the same time. The link demonstrates the interwoven nature of financial markets, as Australia's economy, which relies on commodities and trade, echoes the decline in the US market. Lower frequencies (shorter periods) exhibited modest coherence, with short-term responses varying per domestic economic situation. The EDC had a minor influence on US-Australia ties. Coherence during this time is more substantial at longer intervals (32-64 days), implying medium- to long-term synchronization between the two countries. The arrows in these zones tilted slightly upward-right, indicating that the US outpaced Australia in responding to economic instability induced by the European crisis. This can be linked to the US more significant linkages to European financial markets, which have had a delayed impact on Australia's trade and banking sectors. The CBB resulted in a noticeable but weaker coherence between the US and Australia, with considerable activity occurring over shorter periods (16-32 days). The arrows in this section point lower and right, showing that Australia outperformed the US in dealing with the aftermath of the tragedy. Australia's economy, which is more directly exposed to China through trade and resource exports, responded rapidly, whereas the US saw indirect repercussions from global market changes (Laurenceson, 2021). The Brexit referendum (2016) created worldwide economic anxiety, which was represented in significant coherence (yellow and red zones) throughout longer periods (32–64 days). The arrows pointing right indicated an in-phase relationship in which the US and Australian economies responded in tandem to Brexit-related shocks. The synchrony was most likely due to their reliance on stable global trade systems and the interconnectedness of financial markets throughout this geopolitical upheaval. The COVID-19 pandemic (2020-2021) had among the most substantial coherence across time scales, with massive red zones apparent across both short (16-32 days) and long (64-128 days) periods. Arrows point continually rightward, indicating a closely coordinated link between the US and Australian economies, as the pandemic's worldwide scope disrupted supply chains, lowered consumer activity, and spurred coordinated fiscal and monetary policy measures (e.g., stimulus packages and interest rate reduction).

The Russia-Ukraine conflict (2022 onwards) brings moderate to high coherence throughout intermediate periods (32-64 days). The arrows point upward and right, signifying that the US spearheaded Australia's response to the conflict. This leading role is likely owing to the US's active engagement in placing sanctions on Russia and its importance in global energy markets. Australia's economy responded slowly, reflecting its reliance on global commodities markets, which were interrupted by the conflict.

Furthermore, on studying wavelet correlation (Fig. 6.3.2 C), the GFC as the global economy experienced instability, US-Australia showed strengthened correlation at the smaller wavelet scales (short-term frequencies), the US-Australia interconnectedness strengthened as for an immediate spillover effect of the US housing market meltdown and consequent financial instability (Fig. 6.3.2 C). Australia's extensive financial linkages to global markets and reliance on commodities exports may explain the increased synchronization with the US throughout this era. At larger wavelet scales (long-term frequencies), the link indicated both nations' prolonged economic policy responses, such as monetary easing and stimulus packages. The EDC impacted global markets by reducing investor confidence and volatility in financial systems. Mid-level wavelet scales revealed a modest link, indicating Australia's indirect exposure to the crisis through trade with the US and Europe. The global investor's strategic transformation by increasing their strategy with the risk aversion, which has affected both economies, may impact alignment. The fall of the Chinese stock market created economic instability in Asia-Pacific markets. Australia's trade reliance on China and the wavelet co-movement at this scale might imply indirect impacts on Australia that are consistent with US market reactions.

The Brexit referendum (2016) created worldwide economic uncertainty, which reverberated across financial markets, as the medium-to-high wavelet scales are expected to exhibit a higher correlation since both the US and Australia saw indirect impacts on trade and investment. The agreement underlines their standard position as essential actors in global markets reacting to geopolitical shocks. The COVID-19 pandemic resulted in worldwide economic disruptions, including lockdowns, supply chain breakdowns, and fiscal interventions. Short-term wavelet scales may indicate a stronger link due to both countries' fast market movements and economic contractions. On the long-term scale, they are likely to align with recovery initiatives, such as vaccine rollouts and fiscal measures targeted at financial stability. Moreover, the conflict between Russia and Ukraine has disrupted global energy and commodities markets. The wavelet correlation at more minor scales has reflected the direct effects of price volatility on both economies. On a larger scale, the association indicates common adaptations to geopolitical concerns and strategic economic responses, such as changes in trade policy and energy security measures.

Studying wavelet coherence co-movement among US-Russia stock markets (GFC and COVID-19) showed high coherence on medium- to long-term scales, indicating synchronous global market movements (Fig. 6.3.0 D). Moreover, CBB and Brexit have shown lower coherence during the EDC, indicating isolated repercussions with delayed or little spillover effects. Moreover, high coherence was demonstrated during the Russia-Ukraine conflict because of the common consequences of energy price volatility and geopolitical uncertainty.

During GFC, US-Russia cross wavelet transform (Fig. 6.3.1 D) co-movement results showed strong power (red zones) across 32–128-day intervals. The arrows primarily point rightward, signifying in-phase co-movement. The GFC (2008–2009) was a worldwide economic crisis that began in the United States, as both markets witnessed simultaneous downturns because of investor fear, capital flight, and worldwide liquidity constraints. Energy-dependent Russia was heavily impacted by falling oil prices, prompting coordinated adjustments on a medium- to long-term scale. Moreover, during the EDC, weak to moderate power is exhibited across 32–64-day intervals on the medium scale for a short period, as the arrows point in many directions, suggesting weaker co-movement and delayed effects. The EDC mainly affected the Eurozone, creating regional instability. Russia, which has trading relations with Europe, had indirect consequences, while US markets mirrored global investor mood. Co-movement remained weaker since both economies had a less direct influence on each other than Europe. Moreover, China's market crash scattered poor power (green/yellow zones) throughout 16-32-day intervals. The CBB collapse was mostly a localized shock with little worldwide ramifications. The Russian economy was less immediately damaged but responded to weakening investor sentiment in developing economies. US markets were highly protected, resulting in minimal coordination. Moreover, during the Brexit (3122-3453), almost negligible weak to moderate power in 32–64-day intervals, with arrows pointing in different directions. Brexit created political and economic instability in Europe but had little immediate impact on the US and Russian markets. Russia's market remained generally separated, but the US saw short-term volatility, reducing synchronization. Moreover, during the COVID-19 pandemic (4040-4377), strong coherence (red zones) developed across 32-128 day intervals. COVID-19 was a worldwide shock, causing synchronized market downturns owing to economic lockdowns, decreasing oil prices, and investor fear.

Russia's oil-dependent economy followed global trends when oil prices plummeted. During the downturn and recovery, the stock markets in the US and Russia moved in lockstep. Interestingly, as compared to other developed countries, Russia has shown. Strong coherence (combining in-phase and lagged interactions) (red zones) develops at 32-128-day intervals[14]. The 2022 conflict between Russia and Ukraine resulted in global energy price shocks and substantial market instability. Russia's market fell sharply owing to sanctions and geopolitical threats, while US markets faced inflation

[14] The above coherence and cross wavelet results (XWT) might be different as XWT has shown intense market fluctuations, highlighted regions may exhibit high energy during crises such as the GFC or COVID-19. However, this does not always imply a continuous association across time. Moreover, the wavelet coherence results concentrated on areas where the association is statistically significant, removing noise and random variations. During crises such as the GFC and COVID-19, coherence is higher because markets respond synchronously and consistently.

fears and investor flight to safe assets. Medium-term synchronization shows the economic implications of energy market disturbances.

In studying US-Russia co-movements by employing the wavelet correlation model, the results in a solid black line depicting the correlation, while the "U" (upper) and "L" (lower) lines reflect confidence intervals (Fig. 6.3.2 D). In GFC at small scales (2-4), correlation is minimal (0.2-0.3). At medium-to-large scales (8-32), the correlation increases to 0.5; as GFC began in the United States, it quickly spread to other economies, including Russia. Short-term swings remained isolated due to Russia's distinct economic structure and reliance on energy exports. Both markets showed synchronised economic recovery at medium- to long-term time frames as oil prices steadied and global monetary policies took effect. In studying EDC, wavelet correlation remains moderate (0.3-0.4) in small to medium sizes as EDC primarily affected the Eurozone, with indirect effects on the US and Russian markets. Russia had strong commercial links to Europe and had spillover effects, although the association with the US remained mild. Localized variables more influenced short-term market swings than global alignment. Moreover, the Chinese crash remains modest in correlation at all scales. The fall of 2015 in the Chinese market was a localized shock that impacted Asian economies more than global markets. The US market remained generally unaffected. However, Russia's market, which is significantly influenced by oil prices, exhibited poor alignment. During Brexit, the correlation increased somewhat (0.4-0.5) for medium scales (8-32). Brexit essentially created anxiety in European markets. While the US faced short-term volatility, Russia's market was less immediately impacted since economic and geopolitical relations with the UK were minimal.

Global investor sentiment caused a slight rise in correlation at medium sizes. During COVID-19, correlation is also strongest (0.6-0.7) on medium-to-large scales (16-64) as COVID-19 was a global economic shock resulting in synchronized declines in major stock markets worldwide. Both the US and Russia witnessed dramatic market drops, followed by recoveries because of fiscal and monetary policy interventions. Long-term alignment indicates global investor mood and stabilization plans. In the Russia-Ukraine Conflict, the correlation reaches (0.5-0.6) on medium-to-long-term scales (16-64), which may be due to the Russia-Ukraine war (2022) caused by worldwide energy price spikes and market instability. Russia's economy, primarily reliant on oil and gas, suffered massive falls, while US markets mirrored global inflation fears. Medium- to long-term synchronization emerged because of common repercussions on commodities prices and international supply chain disruptions.

In studying US-Singapore co-movement through wavelet coherence, the GFC showed strong coherence across 32-128-day intervals (Fig. 6.3.0 E). The GFC resulted in coordinated worldwide economic disruptions, forcing both markets to move simultaneously. Global investor fear and capital flight resulted in persistent medium-term tendencies. Moderate coherence emerges across 32–64-day intervals, with patches of red that are less strong than the GFC (Fig. 6.3.0 E). While it produced volatility, the impact on global markets was somewhat delayed. Singapore's market responded indirectly via trade and investor sentiment, resulting in less coherence. The US and Singapore markets were initially less affected by modest short-term synchronisation. Investor replies were delayed, resulting in partial coherence in isolated instances. Brexit created significant volatility in European markets but had a less severe influence on worldwide markets. Singapore and US markets had short-term responses but recovered rapidly, resulting in lower coherence. COVID-19 was a global catastrophe that caused economic disruptions across the world. Both markets saw synchronous falls and recoveries owing to global lockdowns, stimulus measures, and investor mood. Moreover, the Russia-Ukraine crisis led to worldwide oil price shocks and geopolitical insecurity. Singapore's reliance on trade and energy markets prompted its economy to synchronize with the US on a medium-term scale.

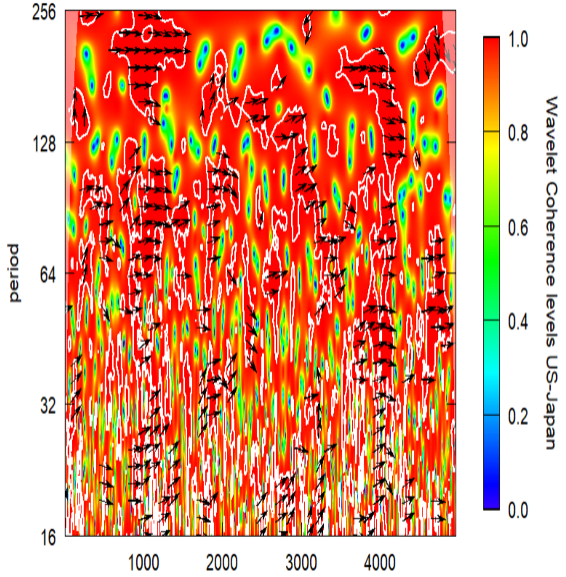
On studying cross wavelet transform among US-Singapore (6.3.1 E), GFC showed high power and in-phase connection, indicating significant synchrony. The GFC (2008-2009) was a global systemic shock precipitated by the failure of major financial institutions in the US, primarily because of subprime mortgage default. As a globally integrated economic system, the crisis quickly extended to Asia and other markets, including Singapore. As a significant financial hub, Singapore witnessed capital flight and market downturns that coincided with the US market. Both markets rebounded simultaneously as global monetary stimulus measures were adopted. In studying the EDC, moderate power zones emerge on 16-64-day timescales, as arrows indicate mixed phase connections, implying lower synchronization and delayed reactions. The EDC (2010-2012) predominantly impacted the Eurozone, precipitated by sovereign debt concerns in Greece, Spain, and Italy. The crisis had a regional emphasis, with less rapid spillover into global markets such as the US and Singapore. Singapore's market saw a delayed and weaker impact since it had less direct financial exposure to Europe. US markets rebounded faster than the Eurozone despite being hit due to better economic fundamentals. In studying the Chinese market crash, low power zones emerge primarily on 16–32-day timescales, indicating less co-movement.

Moreover, the Chinese stock market crash (2015) resulted from speculative booms in China's domestic equities market. The impact was mainly localized, with minimal instant transmission to global markets like the US and Singapore. Singapore's market had localized impacts because of economic ties with China, whilst the US market remained comparatively protected. Co-movement happened over longer durations when global investors reviewed Asian markets following the catastrophe. In studying the Brexit event, low-to-moderate power across 16–64-day intervals was observed, with mixed arrows suggesting poor synchronization and uncertainty. The Brexit referendum (2016) created political and economic uncertainty for the UK and European markets. Singapore and the US were less immediately affected; however, financial market volatility briefly increased. The lack of substantial global economic ramifications explains the lack of synchronization, especially in a short time.

Moreover, during the COVID-19 Pandemic, the powerful and broad during 32–128-day intervals, with rightward arrows suggesting a highly coordinated in-phase connection. Economic shutdowns, monetary interventions, and fiscal stimulus were all met with simultaneous responses in both the US and Singapore markets. This high level of synchronization showed the pandemic's common economic impact and worldwide reach. In the Russian-Ukrainian conflict (4601-4963), moderate-to-high power zones emerge on 32–64-day timescales, with predominantly rightward arrows suggesting strong synchronization. The Russia-Ukraine war (2022) caused worldwide energy price shocks and geopolitical instability, notably in the oil and gas markets. The US and Singapore markets witnessed volatility because of rising prices, supply chain delays, and a risk-off attitude among global investors. Synchronization underscores the conflict's worldwide ramifications, particularly for energy-dependent economies like Singapore.

On analysing the wavelet correlation of US-Singapore (Fig. 6.3.2 E) in the short-term scales, correlation is often weaker during crises, indicating the direct impact of regional shocks and volatility. Moreover, correlation climbs dramatically on medium- to Long-term scales, particularly during global crises such as the GFC, COVID-19, and the Russia-Ukraine conflict. This indicates market synchronization, as global considerations outweigh local market dynamics. COVID-19 and GFC have the highest association at all scales. Localized events (Chinese Crash, Brexit, and EDC) have a lesser association on short-term scales but increasingly align over time.

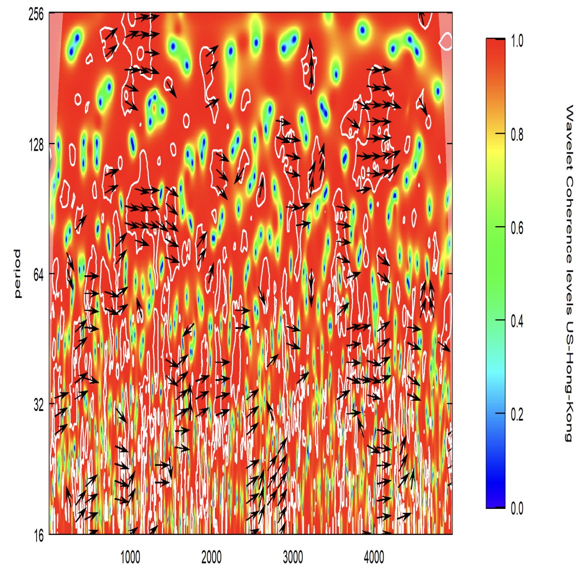
Interestingly, DCC-GJR-GARCH results also revealed that GFC (US origin crises), EDC (PIIGS origin crises), and Chinese brust bubble crash (China origin crises), which revealed financial contagion, indicated robust results.



A) Wavelet Coherence

US-Japan

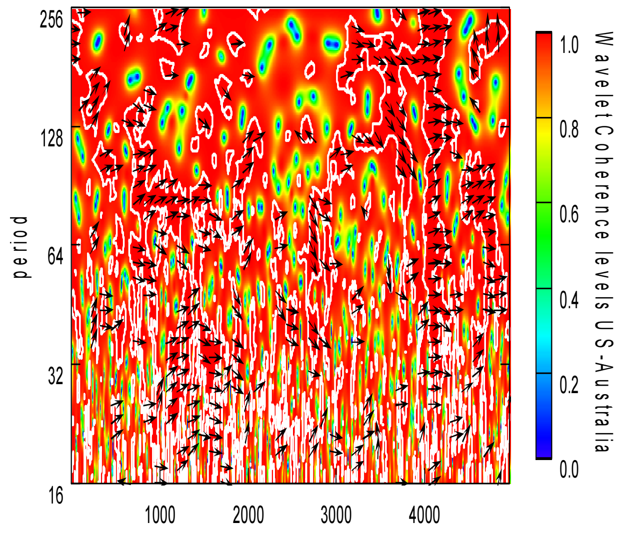
(Market Capitalisation Ranking- 03).



B) Wavelet Coherence

US-Hong-Kong

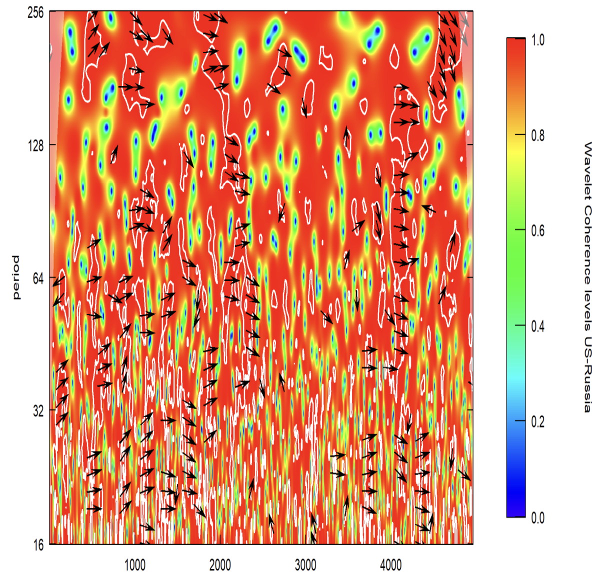
(Market Capitalisation Ranking- 04).



C) Wavelet Coherence

US-Australia

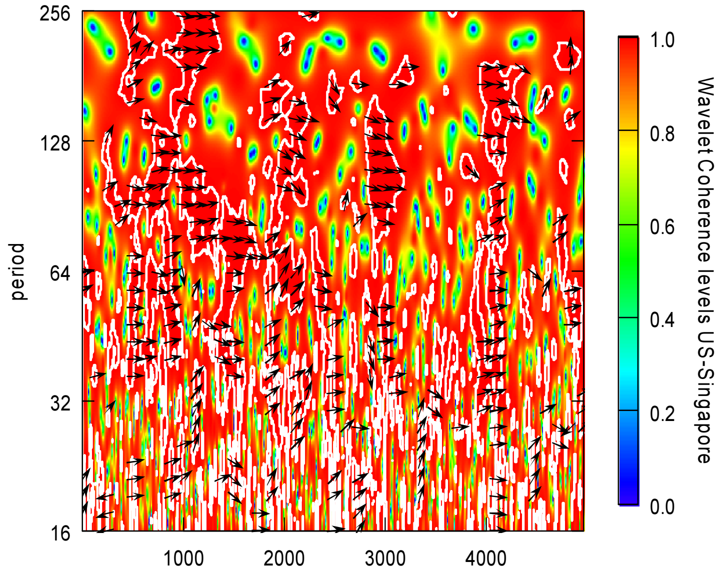
(Market Capitalisation Ranking- 11).



D) Wavelet Coherence

US-Russia

(Market Capitalisation Ranking- 16).

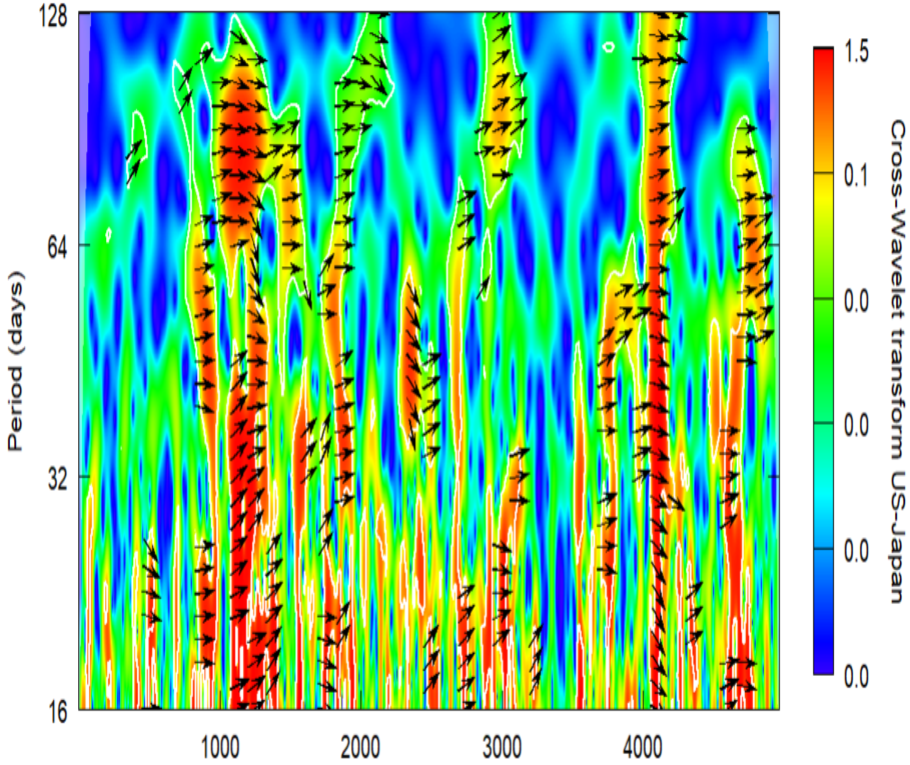


E) Wavelet Coherence

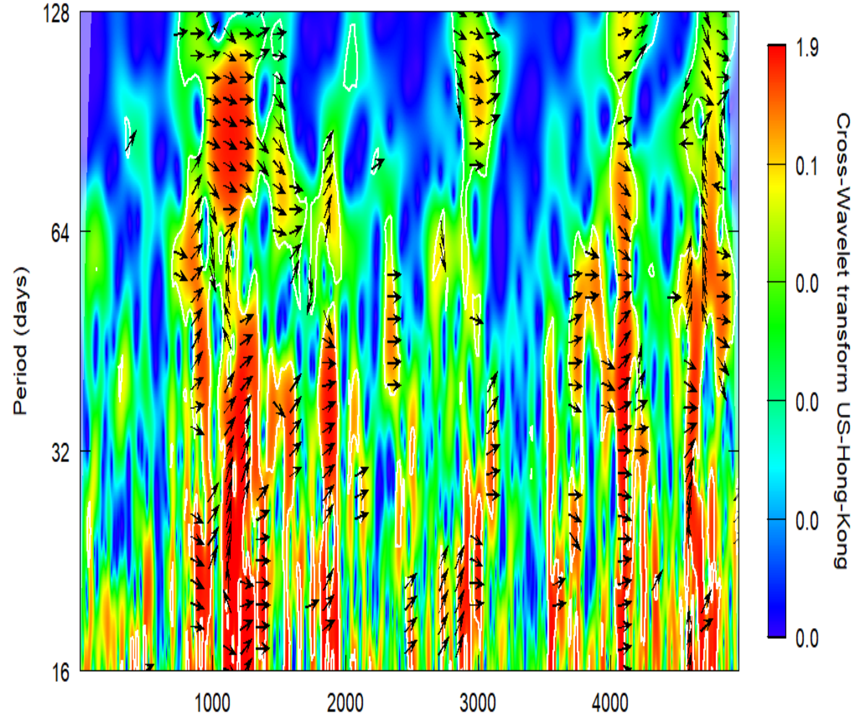
US-Singapore

(Market Capitalisation Ranking- 17).

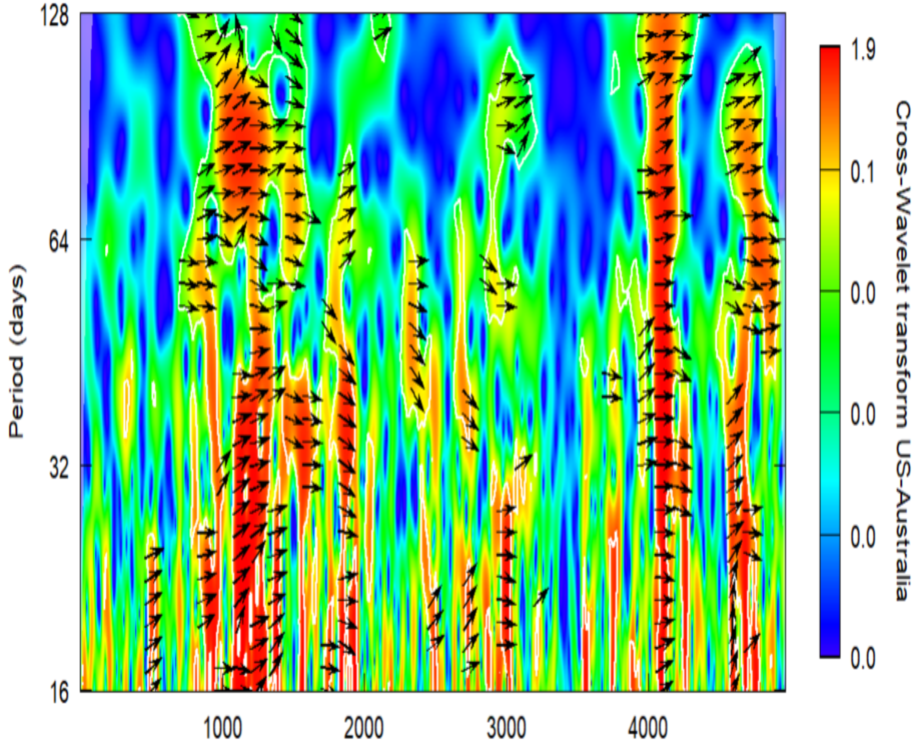
Fig. 6.3.0: Wavelet Coherence in the developed countries of the APAC region. (Source: Author using R software).



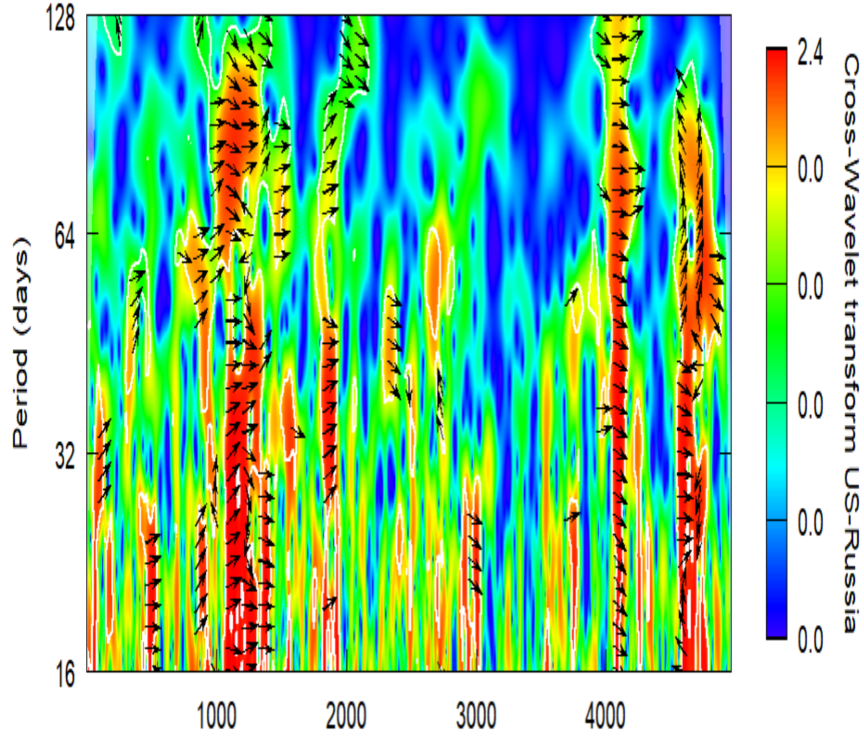
A) Cross-Wavelet Transform (XWT)
US-Japan
(Market Capitalisation Ranking- 03).



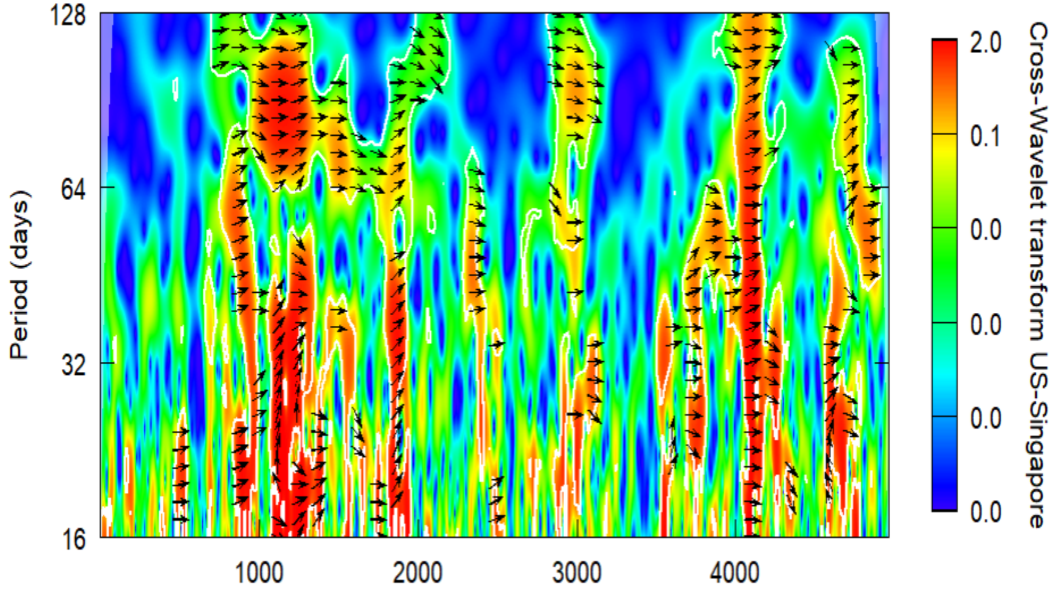
B) Cross-Wavelet Transform (XWT)
US-Hong-Kong
(Market Capitalisation Ranking- 04).



C) Cross-Wavelet Transform (XWT)
US-Australia
(Market Capitalisation Ranking- 11).

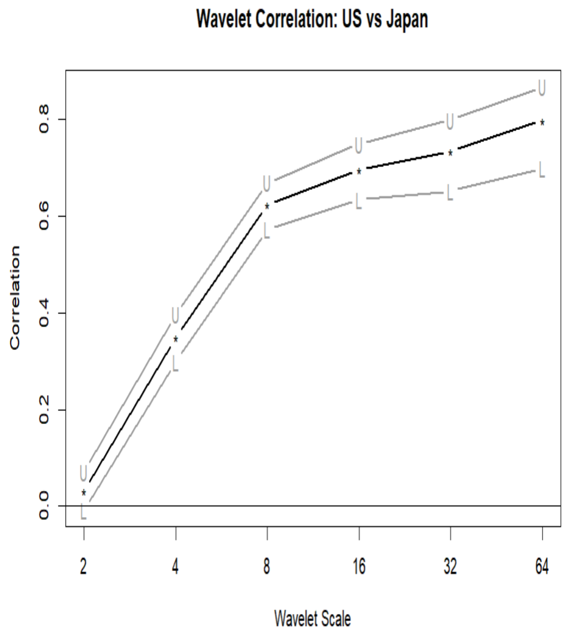


D) Cross-Wavelet Transform (XWT)
US-Russia
(Market Capitalisation Ranking- 16).



E) Cross-Wavelet Transform (XWT)
US-Singapore
(Market Capitalisation Ranking- 17).

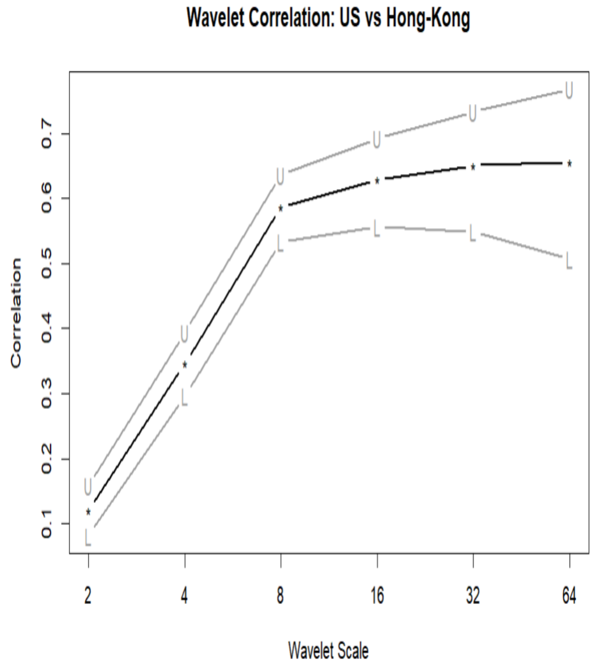
Fig. 6.3.1: Cross-Wavelet Transform (XWT) in the developed countries of the APAC region. (Source: Author using R software).



A) Wavelet Correlation

US-Japan

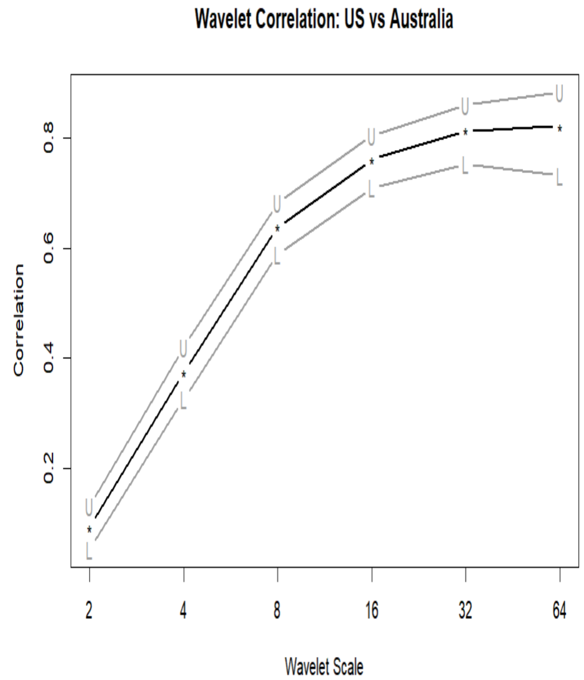
(Market Capitalisation Ranking- 03).



B) Wavelet Correlation

US-Hong-Kong

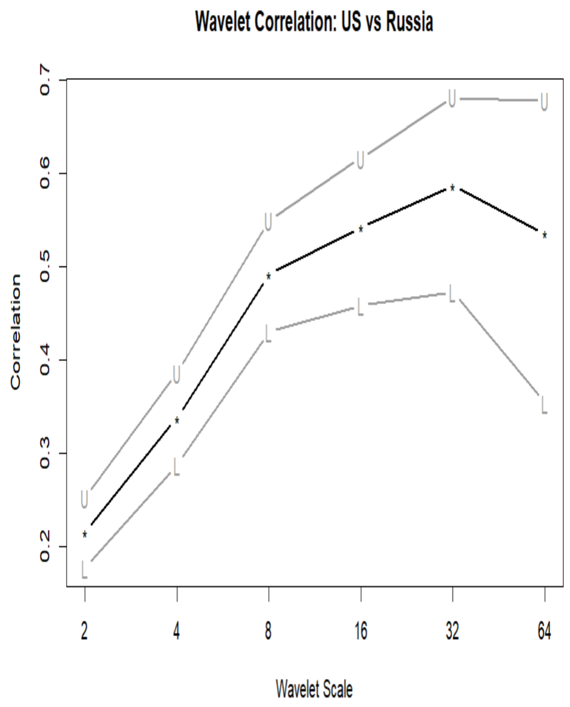
(Market Capitalisation Ranking- 04).



C) Wavelet Correlation

US-Australia

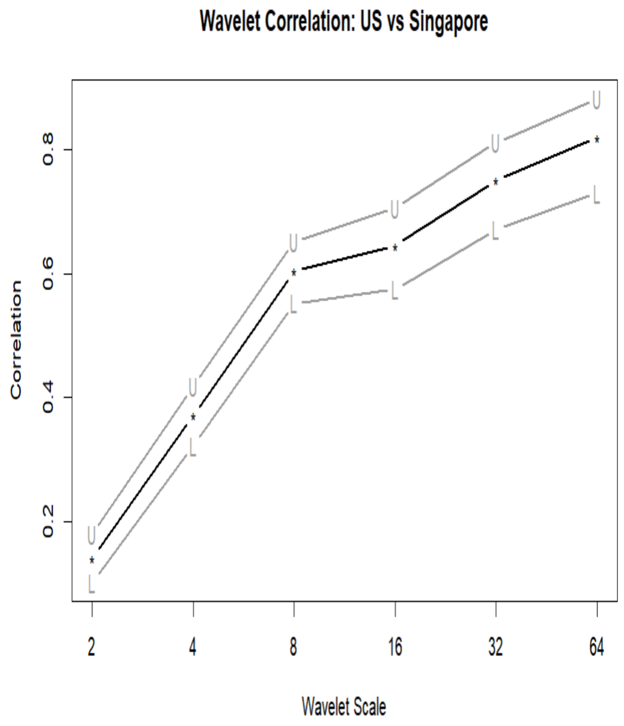
(Market Capitalisation Ranking- 11).



A) Wavelet Correlation

US-Russia

(Market Capitalisation Ranking- 16).



B) Wavelet Correlation

US-Singapore

(Market Capitalisation Ranking- 17).

Fig. 6.3.2: Wavelet correlation in the developed countries of the APAC region. (Source: Author using R software).

6.2.2 Emerging Countries

Based on MSCI classification among the developed countries, three crucial regions were covered, i.e. America (Fig. 6.4.0, Fig. 6.4.1, Fig. 6.4.2), EMEA (Fig 6.5.0, Fig. 6.5.1, Fig. 6.5.2), and APAC (Fig. 6.6.0, Fig. 6.6.1, Fig. 6.6.2).

6.2.2.1 America Region

On analyzing the emerging countries of the American region, US-Brazil revealed highly significant co-movements during the GFC as the US-generated financial crisis had an indirect impact on Brazil through falling global demand for commodities such as oil and metals and slower growth (Fig. 6.4.0 A). During the GFC, falling oil prices sent export revenues straight to the ground, whilst inflationary pressures remained muted with global demand falling. Brazil also showed less coherence with the US during the EDC and Chinese crash. China is among Brazil's top trading partners, and the slowdown of the Chinese economy has caused demand for Brazil's oil and other commodities to drop. The US's role in stabilizing global markets affected Brazil's export recovery trajectory. Brazil followed behind US-dominated global market adjustments as commodity price improvements took time. Even in the BREXIT and Russia-Ukraine crises, almost no co-movements were identified in all the stock markets. However, during COVID-19, consistent co-movements identified as the pandemic triggered similar disruptions to trade and supply chains worldwide, affecting each economy. Oil prices plummeted in 2020, hitting Brazil's export revenues hard. Inflation soared worldwide, and Brazil was under pressure because it relied on imports and fiscal stimulus measures.

Further, employing cross-wavelet transform on the US-Brazil stock market showed co-movement during GFC, minor in EDC (medium scale), COVID-19 (from small scale to large scale), and Russia-Ukraine crises (medium scale) (Fig. 6.4.1 A).

On studying wavelet correlation, GFC correlation was high on different scales but very high at median and large-scale sizes; as a commodity exporter, a drop in global demand affected Brazil's economic performance in a manner that was consistent with perpetrated global trends driven by the US (Fig. 6.4.2 A). During the GFC, falling oil and commodity prices offended Brazil's revenues, while because of the pivotal role of the US in the recovery, financial markets synchronized. During the EDC, there was a high to moderate correlation, especially at medium scales, and Brazil was indirectly affected through trade and investment channels as European demand for commodities dropped. Brazilian inflationary pressures also reflected global trends due to US and EU policies that aimed to stabilize markets. It demonstrated that Brazil's economy is in sync with global account adjustments in the face of regional crises. During the Chinese crash, correlation was high at short-to-medium scales. The slowdown of China affected Chinese demand for Brazilian commodities (iron ore, soybeans), so when China's economic activity dropped, Brazil followed it closer; the US played a role in stabilizing the global market, reflecting Brazil's economic activity. The volatility of oil prices only brought the Brazilian economy more in sync with the US-led global adjustments[15]. During Brexit, the correlation dropped slightly at more minor scales but almost in the same range even on larger scales. However, during COVID-19, the correlation was high for all scales. The pandemic hit Both economies in similar, synchronized ways, including supply chain breakdowns, fiscal stimulus measures and inflationary pressures. Oil crashed in the early pandemic, hitting Brazil hard with opportunistic US-led stabilization efforts aligned with global economic recoveries. During the Russia-Ukraine crises present a high correlation at medium and large scales (16–64), as well as a commodity exporter (e.g., of oil, agricultural goods), economic trends in Brazil have tracked the ups and downs of international energy and food prices driven by the conflict[16]. The US response to inflationary pressures and its influence in shaping global trade policies coordinated the movements of these economies even further.

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[15] https://oilprice.com/Energy/Energy-General/Oil-Price-Volatility-Is-Threatening-Brazils-Economic-Recovery.html

[16] These results are different as during Russia-Ukraine crises, the wavelet coherence reveals weak to moderate synchrony between the US and Brazil , which suggests they exhibited a lack of stable co-movement in certain time-frequency regions. On the contrary, the wavelet correlation picks up on the overall co-movement of the economy due to the same global force that makes all economies think alike, for example oil prices, inflation, commodity trade. Thus, when the network analysis is extended to Brazil over the same time period, we observe a different phenomenon, wavelet coherence suggests weak synchronization during the Russia-Ukraine crisis, but wavelet correlation shows a strong linear relationship between the US and Brazil due to common economic drivers such global commodity prices and inflationary pressures. This difference reflects the nuanced nature of the two economies' relationship.

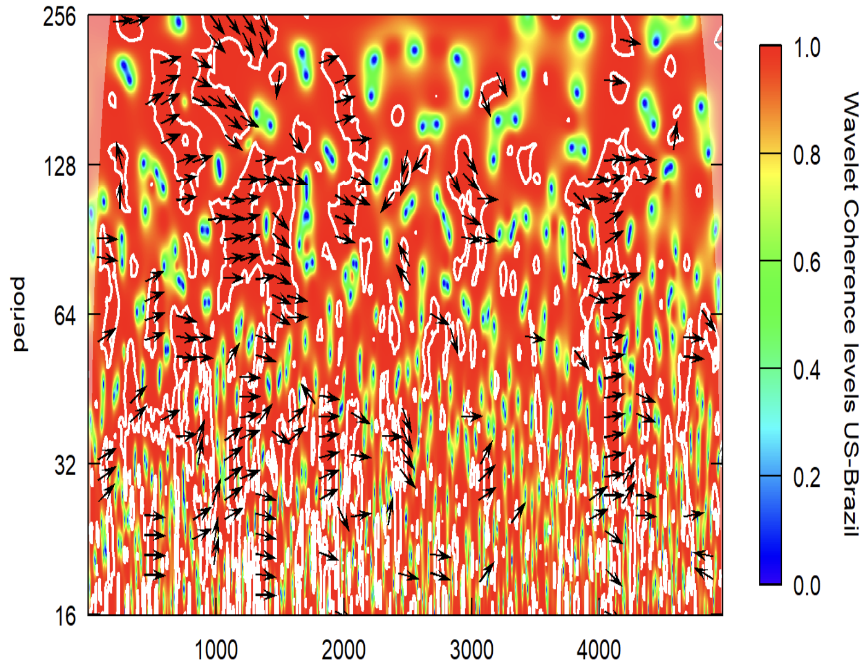
Interestingly, DCC-GJR-GARCH proved robust results as Brazil revealed a contagion effect during GFC (as a US crisis origin country). Except for Brexit and Russia-Ukraine, in all the crises, Brazil has revealed financial contagion from the country of origin in the crisis.

In studying US-Mexico stock markets, this study identified high wavelet coherence as changes in trade-related agreements (in different regional blocs NAFTA/USMCA), oil prices, inflation, remittances and geopolitical interdependence for both countries. In studying US-Mexico, during GFC, high wavelet coherence was identified (Fig. 6.4.0 B). During EDC, from minor to medium scale, the significant coherence of lower European demand had a damaging global trade impact, including for some US-Mexico supply chains. Disruption of oil prices affected both the US and Mexico's economies during the crisis, contributing to inflationary pressure. Moreover, during the Chinese crash, moderate coherence is identified for short-to-medium periods (16-64) by rightward arrows, as may be due to the collapse in world demand for commodities, i.e. Mexico and the United States have been particularly affected. Because Mexico's proximity to the US is politically advantageous, it can be easily plugged into US supply chains, thus operationalizing a simultaneous backlash; when global trade shocks hit, the entails are uniform across borders. During Brexit, an almost negligible relationship was established with the potential for limited effects on commerce or remittances between America and Mexico. Second-round effects comprise a globally coordinated trade outlook and neutralizing US financial market reactions. During the COVID-19 pandemic, high coherence boosts over all bandwidths as the manufacturing sector disruptions; with their manufacturing sectors so tightly linked, the pain was mutual for both countries. The epidemic diminished global oil demand, reducing export revenues and causing a similar economic slowdown in Mexico and the US. Inflationary pressures were tackled similarly by both fiscal and monetary policy, leading to coordinated recovery. During the Russia-Ukraine war, medium-to-long length (32-128) have decent coherence identified as the rising oil prices, driven by US energy market policy, reward Mexico's crude oil exports. The shocks in food and energy prices synchronized both economies. Strong commercial relations between the US and Mexico resulted in internal economic transformation in both countries.

Furthermore, studying cross-wavelet transform (US-Mexico) results revealed the strong co-movements during GFC, EDC (minor for medium scale), COVID-19, and the Russia-Ukraine crisis (Fig. 6.4.1 B). On studying wavelet correlation (Fig. 6.4.2 B), in all scales, GFC has shown a high correlation, with most alignment in larger scales, during EDC and Chinese Crash, moderate correlation at mediums scales identified. Moreover, they are less correlated during Brexit at shorter scales than longer ones. During the COVID-19 pandemic, there was a high correlation at all scales, peaking at larger scales. Moreover, all medium-to-large scales (16–64) had a high correlation during the Russia-Ukraine war. The crisis may also reveal common economic dependencies and vulnerabilities to global commodity markets.

Thus, based on DCC-GJR-GARCH results also during the GFC (US crisis origin country) and COVID-19, only a contagion effect was identified, proving a high co-movement during GFC as per the wavelet family models.

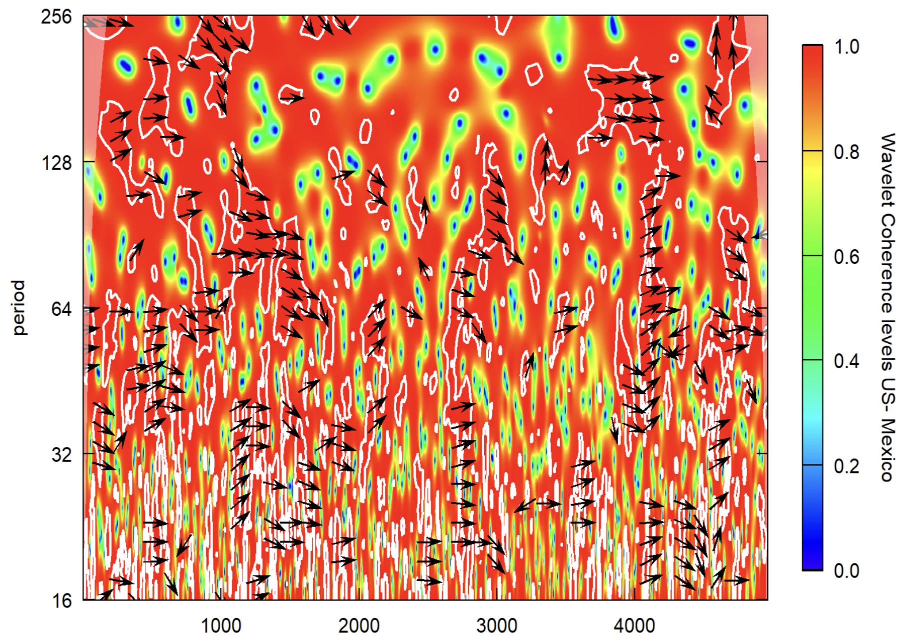
America Region



A) Wavelet Coherence

US-Brazil

(Market Capitalisation Ranking- 14).



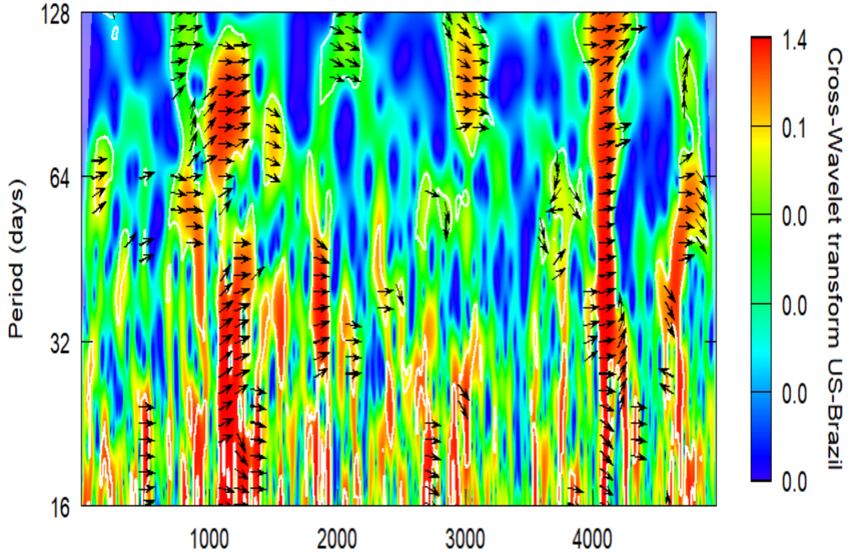
B) Wavelet Coherence

US-Mexico

(Market Capitalisation Ranking- 21).

Fig. 6.4.0: Wavelet Coherence in the developed countries of the American region. (Source: Author using R software).

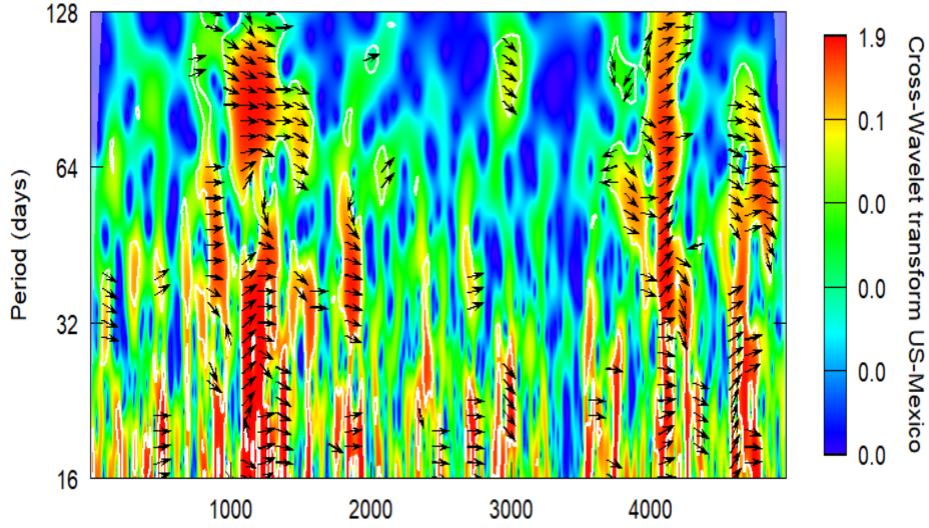
America Region



A) Cross-Wavelet Transform

US-Brazil

(Market Capitalisation Ranking- 14).



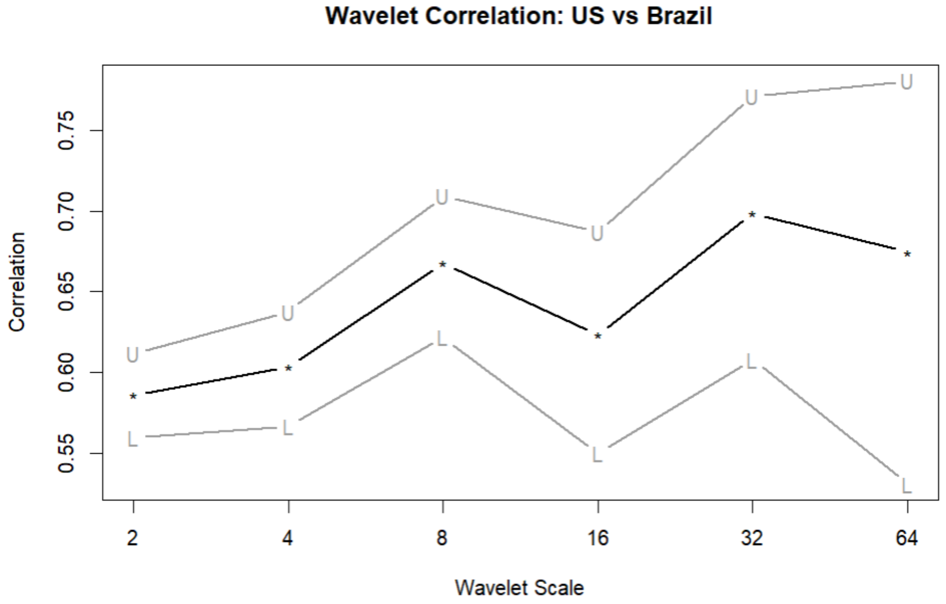
B) Cross-Wavelet Transform

US-Mexico

(Market Capitalisation Ranking- 21).

Fig. 6.4.1: Cross-Wavelet Transform in the emerging countries of the American region. (Source: Author using R software).

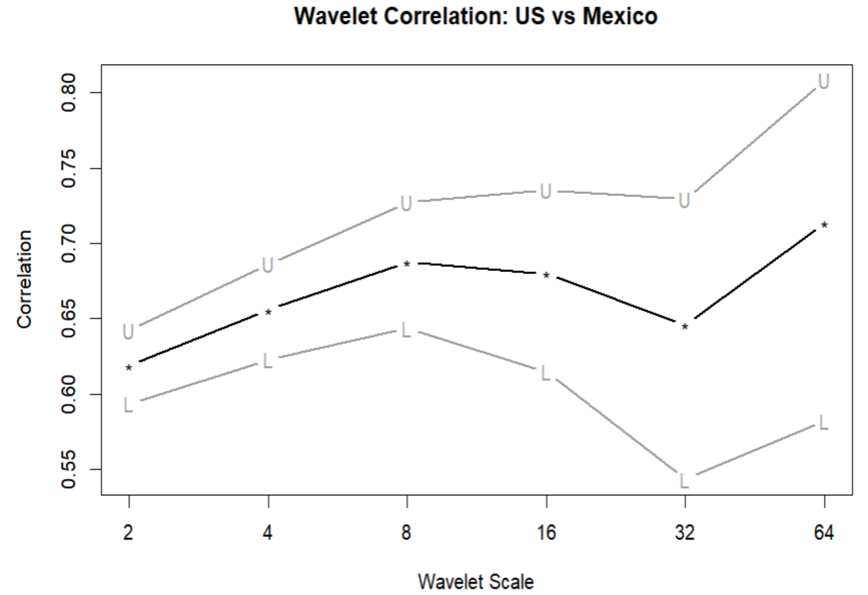
America Region



A) Wavelet Correlation between

US-Brazil

(Market Capitalisation Ranking- 14).



B) Wavelet Correlation between

US-Mexico

(Market Capitalisation Ranking- 21).

Fig. 6.4.2: Wavelet correlation in the emerging countries of the American region.

6.2.2.2 EMEA Region

In studying wavelet coherence in the emerging markets in the EMEA region, US-Saudi Arabia showed coherence for a short period, as high coherence identified during GFC in the small-medium term as the US was the epicentre of the crisis, it weighed on global demand for oil, a Saudi Arabia-export juggernaut (Fig. 6.5.0 A). The economic slowdown drove oil prices down sharply, reducing Saudi revenues[17]. In contrast, Saudi Arabia's oil production policies had ramifications for global energy markets, vital to US economic recovery efforts. An in-phase relationship (arrows pointing right) implies simultaneous responses to the crisis. In studying EDC, wavelet coherence was high, with both short- and long-term effects. The EDC led to economic instability in Europe, a significant US and Saudi Arabia trading partner. European oil demand dropped, and Saudi Arabia took unified measures to calm oil markets. These responses from the US and Saudi Arabia, which came from monetary policy in the US and oil output adjustments from Saudi Arabia, demonstrated a robust interdependence. Anti-phase arrows show when Saudi policies failed to keep up with the US monetary moves. During the Chinese crash, Brexit, and Russia-Ukraine war, no significant coherence was identified—still, very high coherence on multiple scales as the pandemic caused unprecedented disruptions to the world economy. Oil prices crashed as oil demand fell off a cliff (due to lockdowns), which sorely affected Saudi Arabia's economy.

The US introduced large-scale stimuli in their economy and settled down monetary policies. The Saudi oil production cuts during this time (as OPEC) worked hand in glove with the US recovery efforts, highlighting a strong in-phase relationship (right-pointing arrows). On studying cross-wavelet-transform results showed mixed patterns as during GFC, EDC (medium scales), COVID-19 (minor to longer period), and Russia-Ukraine crises (longer scale) high wavelet coherence identified (Fig. 6.5.1 A). On studying wavelet correlation (Fig. 6.5.2 A), GFC revealed wavelet correlation rises from lower scales (for the short term) to higher (for longer periods), peaking just under the 4–5 range at scale 16–64. GFC had synchronized economic effects on both

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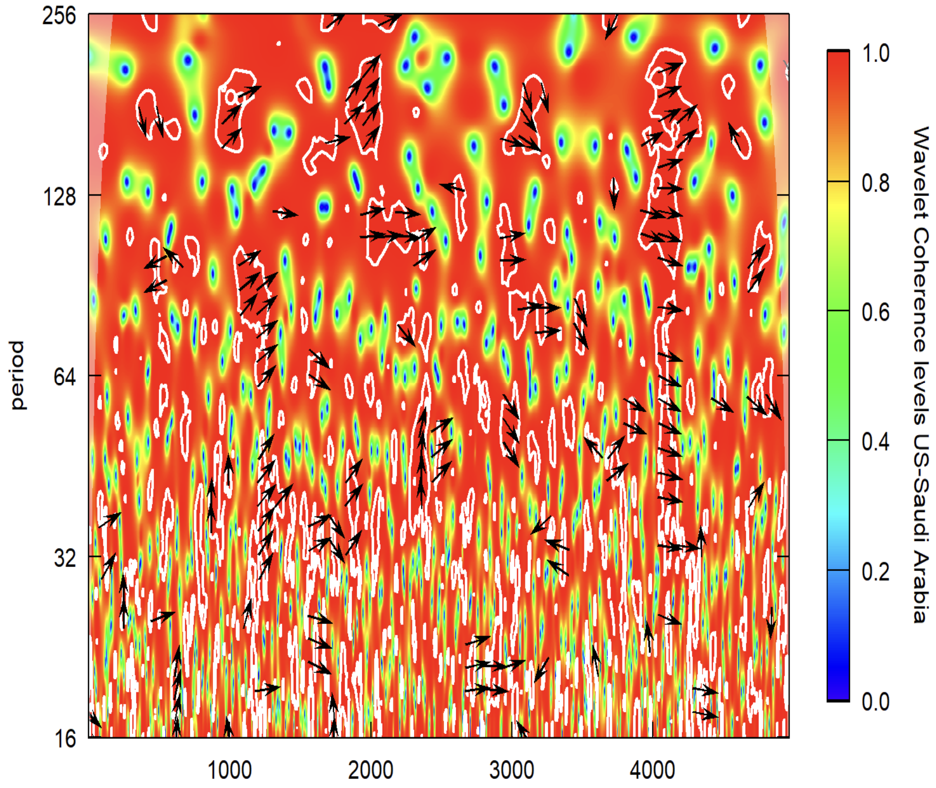
[17] https://oilprice.com/Geopolitics/International/How-Low-Oil-Prices-Have-Decimated-The-Saudi-Economy.html

the US and Saudi Arabia. Oil prices, a key source of Saudi revenues, crashed with falling global demand, connecting any Saudi economic response to US moves to revive its markets. The stronger correlation at these larger scales indicates a more aligned long-term economic strategy between the two countries over this time. During EDC, medium scales (8–16) had a moderate correlation, but larger scales (32–64) strongly correlated, suggesting more alignment over time. Moreover, in the Chinese stock market crash and Brexit at short- to medium-term scales (4–16), wavelet correlation is moderate (0.3–0.4), indicating quick but somewhat limited response synchronization. Moreover, the COVID-19 pandemic revealed that the correlation is stronger for all scales, especially at higher scales, as the pandemic dealt a simultaneous blow to the global economy. Saudi Arabia has been rocked by demand destruction for oil through lockdown and swells of economic sluggishness in the US and massive debt spending; the congruence of their responses to Saudi cuts to oil production and US policies for economic recovery made for the strongest periods of correlation in this assessment. However, the correlation was consistently high during the Russia-Ukraine war, even at vast scales (32–64). The Russia-Ukraine war heavily upset the world energy market.

But the above three model wavelet coherence provided more robust results as per the DCC-GJR-GARCH model also, no contagion effect was identified from the US during GFC during the EDC (PIIGS crises origin country), Chinese crash (crises origin country), and COVID-19 (crises origin country) only contagion effect identified from crises origin country.

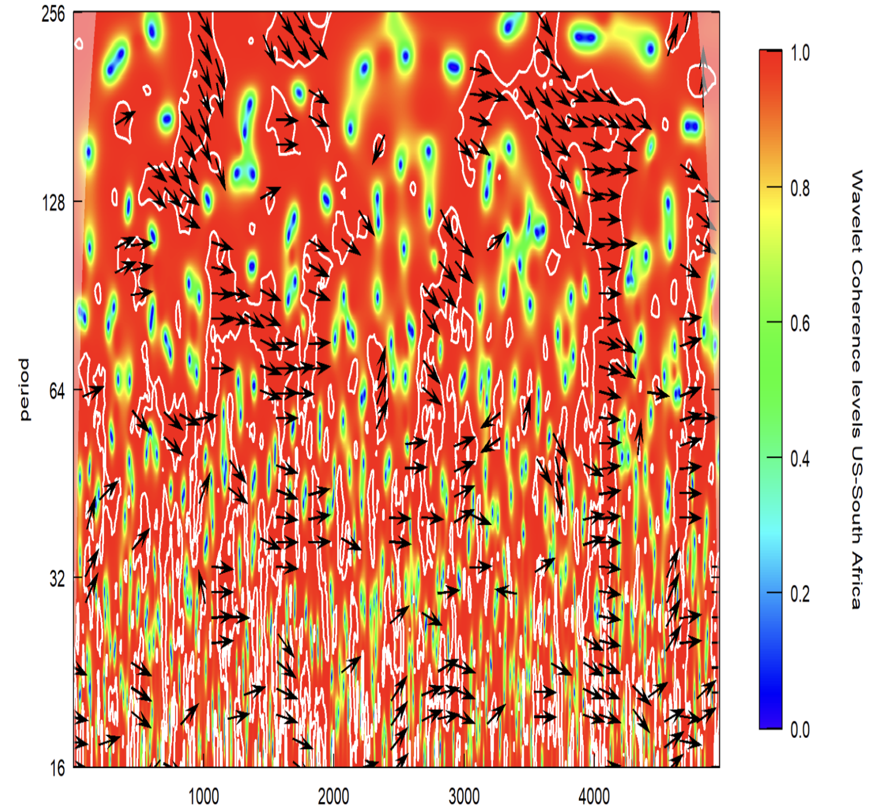
On studying wavelet coherence between the US- South Africa during GFC at medium to long-term periods (32–128), high coherence was observed, as South Africa's economy is largely dependent on mining and exports, which were hit by the decline in global demand for commodities during the GFC (2007–2009) (Fig. 6.5.0 B). The international financial crisis in the US had spillover effects on global markets, including those of South Africa's major trading partners. This strong coherence indicated that economic adjustments by South Africa (e.g. trade volume adjustment, changes in monetary policies) were coordinated in time with US responses to its financial and economic recovery (Fig. 6.5.0 B). EDC from medium and long-term scales (32–128) have increasing coherence with large regions of synchronization, as the global economic uncertainty stemming from the EDC (2010–2012) lowered import demand of South African exports, such as metals and minerals. Indirect effects on the US included trade disruptions and volatility in financial markets; these events have shown coherence in the simultaneous shifts of South Africa's monetary and fiscal policy, and the latter is further tied to global market trends led by the US and European economic decisions. Angled arrows indicate that South Africa is responding with a lag. In studying the Chinese crash, moderate coherence (16–64) was revealed at short to medium-term scales, as the 2015 Chinese stock market crash rocked commodity-exporting economies like South Africa. The weakening of Chinese raw materials demand directly hit South Africa's trade, and the US financial markets responded to global turbulence. It demonstrated the coherence linked to the worldwide commodity cycle bound these economies together. Downward-left arrows show chronic disease, indicating that South Africa's response to the crisis lagged behind the US. In studying the Brexit referendum, moderate to high coherence at medium-term scales (32–128) led to significant synchronization in certain areas. Brexit (2016) ruined trade and financial uncertainty, with South Africa being a key UK trading partner. It unveils the common trade relationship between the US, the UK, and Europe. The observed interdependence attests to the spillover effects of disruption from Brexit on trade and financial markets in both economies. Right-pointing arrows signify in-phase responses, which arguably represent global adjustments to uncertainty. During the COVID-19 pandemic, long-term scales (128–256) showed very high coherence in all networks, as the pandemic led to simultaneous shocks in global trade, supply chains, and financial markets. South Africa's economy contracted sharply because of lockdowns and reduced demand globally for its commodities, while the US unleashed massive monetary and fiscal stimulus. This coherence in this period reflects the fact that this is a global crisis, and countries are responding with coordinated economic measures (e.g. stimulus and changes in monetary policies). The arrows in phase verify that both economies faced and reacted to analogous difficulties. During the Russia-Ukraine war, there was high coherence at medium to long-term scales (32–128). The war rippled through world energy markets and trade, indirectly affecting South Africa with higher fuel and food prices. The US sanctioned Russia and stabilized energy markets through strategic reserve releases. South Africa, a net importer of energy and foods, experienced ripple effects in its economy. The curved arrows indicate a delayed response from South Africa as it adapted to the indirect effects. In studying cross-wavelet transform (Fig. 6.5.1 B), high co-movement identified during GFC, EDC (medium scale), Brexit (short and longer scale), COVID-19 and Russia-Ukraine crises, which indicate that wavelet coherence has robust results as compared to cross-wavelet transform as may not be able to eliminate noise in the series. On studying wavelet correlation between US-South Africa during GFC correlation gradually rises, with moderate to high values (0.5–0.7) at middle scales (8–16) and initial peaks at the long scale (32–64) (Fig. 6.5.2 B), as during GFC the US drive the hubs of the crisis, directly impacting everyone in commodity demand as well as financial stability. These correlations are long-term, as South Africa's mining and export sectors sync to US and global recovery trends. This suggests that there were strong long-run economic linkages at this time. During EDC, the correlation stays moderate (approximately 0.5–0.7) at the medium scales and increases at longer scales (16–32) above 0.7 as global demand for exports and financial stability increases. The US played a pivotal role in absorbing the spillover effects by providing financial and monetary support. The growing correlation at longer scales reflects South Africa's delayed but interlinked response to the global reverberations of the crisis. During the Chinese stock market crash, moderate (0.2/0.5–0.7) to medium-to-high correlation persists at scales from medium to long term, as in the 2015 Chinese stock market crash negatively impacted global commodity markets that are key to South Africa's economy. Being a door to a financial powerhouse like the US had implications for the stability of the international markets. The coefficient indicated that while South Africa experienced immediate effects due to the reduced demand for commodities, South Africa's economy was adjusted by US markets over time. During the Brexit referendum, correlation was low at short scales. Still, it tended to rise at 16–64, as the uncertainties associated with Brexit (2016) for global markets and trading indirectly impacted South African exports and financial flows. The US at least showed some stabilizing impulse in global trade, which also indirectly helped South Africa's economic conditions. While the connection at smaller scales grew weak, the increasingly positive correlation at larger scales represents decades of realignment of South Africa's economy with US-led global trends. Moreover, during the COVID-19 pandemic, correlation is high across scales, peaking (above 0.8) at the longest (32–64) scales, as the global financial disruptions due to the pandemic impacted the US and South Africa. The US undertook considerable monetary and fiscal efforts to help stabilize its economy, and, notwithstanding, South Africa struggled to deal with economic contraction and congestion in world trade. This high correlation mirrors coordinated pandemic recovery plans globally and long-term interdependency. During the Russia-Ukraine war, correlation stayed strong at medium to long scales (16–64), above 0.7, as the Russia-Ukraine war disrupted global energy and food supply chains that have impacted both the US and South Africa. South Africa, where energy needs are also sensitive to price fluctuations, was indirectly affected by the US's role in stabilizing energy markets and imposing sanctions on Russia. This strong correlation shows how interconnected their economic responses to global shocks. Intrestlgy, based on the results of the DCC-GJR-GARCH also during the GFC (US crisis source country) contagion impact revealed, which was further revealed by the Chinese burst bubble (China crisis source country) and COVID-19 (China crisis source country).

EMEA Region



A) Wavelet Coherence

US-Saudi Arabia (Market Capitalisation Ranking- 14).

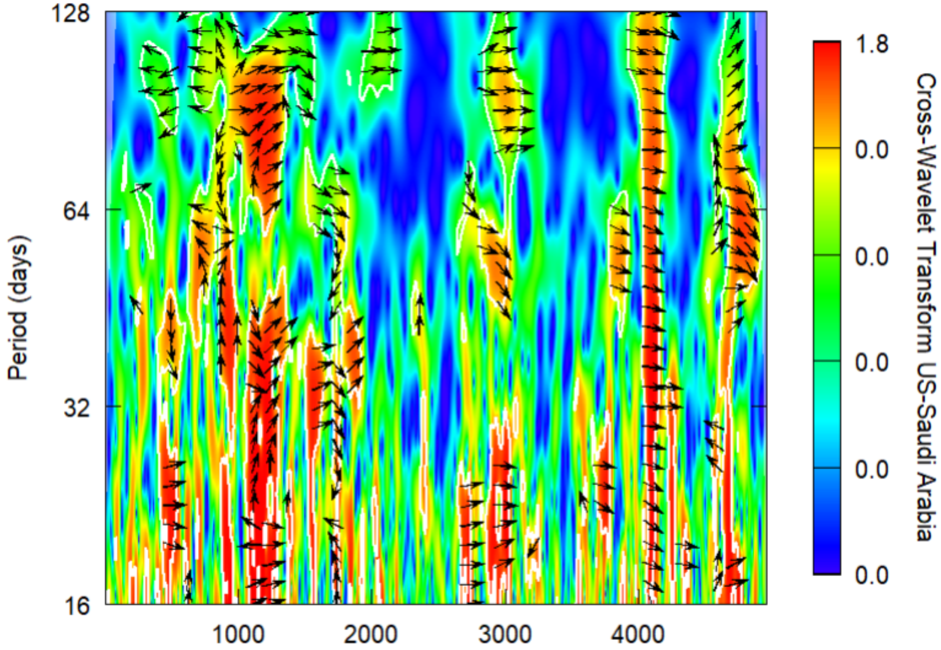


B) Wavelet Coherence

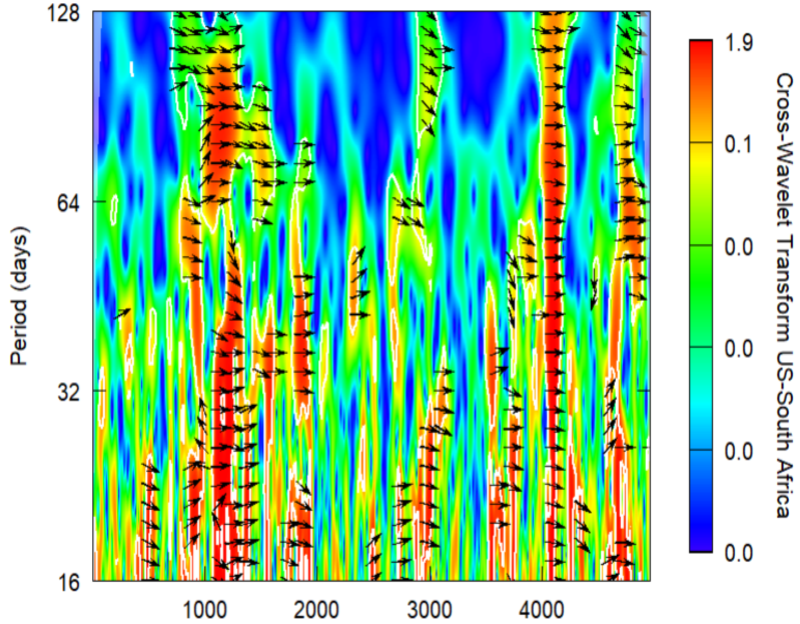
US-South Africa(Market Capitalisation Ranking- 21).

Fig. 6.5.0: Wavelet Coherence in the emerging countries of the EMEA region.

EMEA Region



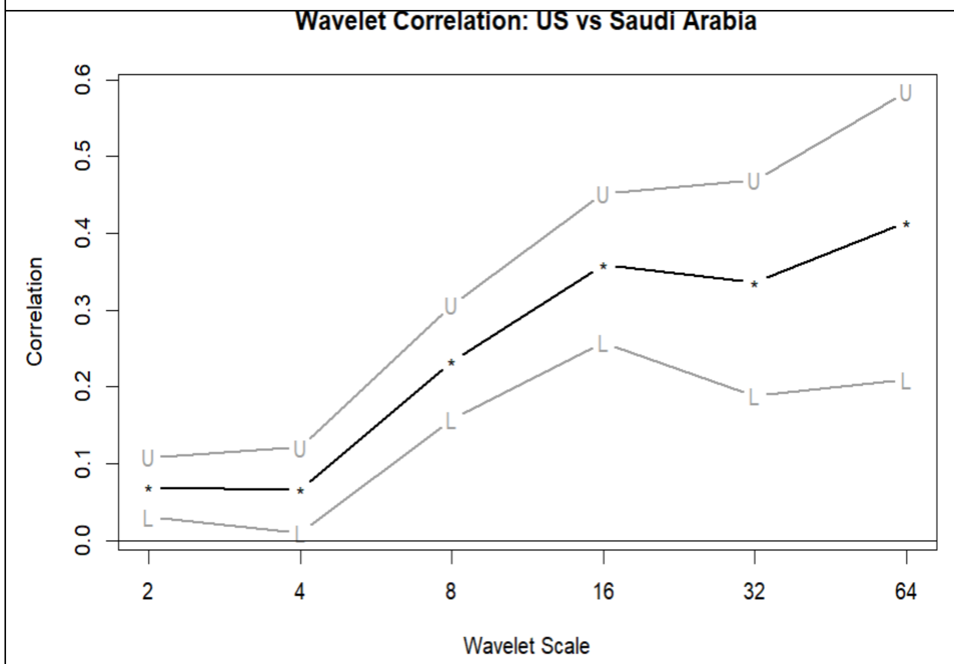
A) Cross-wavelet transform
US-Saudi Arabia
(Market Capitalisation Ranking- 14).



B) Cross-wavelet transform
US-South Africa
(Market Capitalisation Ranking- 21).

Fig. 6.5.1: Cross-wavelet transform in the emerging countries of EMEA region.

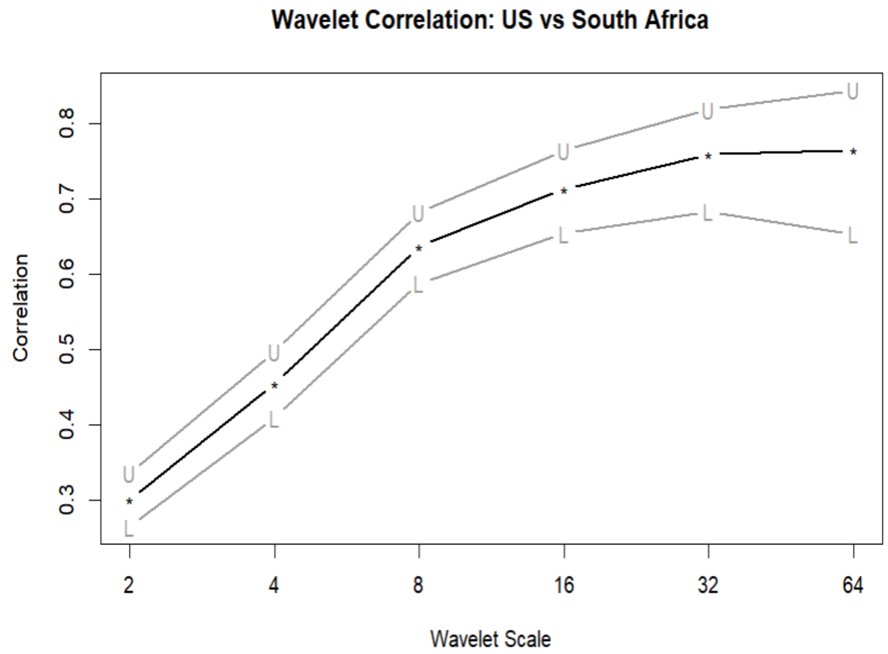
EMEA Region



A) Wavelet correlation

US-Saudi Arabia

(Market Capitalisation Ranking- 14).



B) Wavelet Correlation

US-South Africa

(Market Capitalisation Ranking- 21).

Fig. 6.5.2: Wavelet Coherence in the emerging countries of EMEA Region.

6.2.2.3 APAC Region

On studying emerging countries relationship, i.e. APAC region using wavelet coherence (Fig. 6.6.0), cross-wavelet transform (Fig. 6.6.1), and wavelet correlation (Fig. 6.6.2).

In analyzing US-China, this study identified high co-movement in the shorter-medium period during COVID-19, with heterogeneous results in all-over crises (Fig. 6.6.0 A). On studying cross-wavelet transform results, this study identified during GFC and COVID-19, with minor impacts on CBB, Brexit and Russia-Ukraine crises (Fig. 6.6.1 A), but on studying wavelet correlation in the short-term dynamics, this study identified a weak correlation at smaller scales, as China's economy has been integrated into global trade was relatively cloistered from the US driven financial crisis because of its focus on domestic policy and state-controlled financial systems, which indicate robust results provided by wavelet coherence. Correlation expands at scales 8–16 as China operates as a global control in recovery projects to the US while trade and infrastructure investments correlate with US and current inflation. During the EDC's short-term impact, little correlation was identified at this juncture; China is not directly exposed to the EDC, although it is in the medium term. The positive correlation increases for scales 8–16 as China's export-driven economy syncs up with global trade recovery (dominated by the US and EU). During the Chinese Crash in the short run, there was a positive correlation at the medium scale as both the US and China confronted windfall volatility of their financial markets. The correlation weakens at higher levels, reflecting different long-term responses and recovery paths in the two economies. During Brexit, in the short-term, a weak correlation exists at a lower scale, which embodies China's little- reliance on the UK economy; the US responds more immediately to Brexit uncertainties. In the medium-term trends: The moderate correlation increase is due to Brexit's global trade effects, which can be witnessed worldwide, especially for both countries. During the COVID-19 pandemic in the short time scale, intermediate pandemic, the correlation remains relatively moderate at intermediate scales, as economic slowdown and recovery efforts were synchronized during the pandemic. In long term, the pandemic correlation persists at a larger scale, showing the contrasting routes by which recovery diverges (China is making a state-driven, country-exporting recovery while the US is making a stimulus-consumption-driven recovery). At last, during the Russia-Ukraine Crisis , the short-term, lower correlation at small and medium scales represents the global impacts of the crisis through trade, energy prices, and inflation. Moreover, the results of wavelet correlation (Fig. 6.6.2 C) also have proved the wavelet coherence and cross-wavelet transform results.

Interestingly, DCC-GJR-GARCH results also did not show a contagion effect during the GFC (as the US crisis origin country) but showed a contagion effect from the US to China during the Chinese burst bubble (China crisis origin), which indicates that in the long China acted as a source of contagion to the US, but maybe through another channel as no direct co-movement identified as per results of wavelet coherence and correlation.

On analyzing US-India, this study identified high co-movement based on wavelet coherence during GFC and EDC over a medium to longer scale and the Russia-Ukraine crisis on a medium scale (Fig. 6.6.0 B). But COVID-19 has shown consistent co-movements followed. Still, in more extended and medium periods of Brexit, it showed a higher lag than the Chinese crash. During the EDC and Russia-Ukraine crises, a lag was demonstrated in the surrounding medium frequency (64 -128 period). Cross-wavelet transform also showed high co-movement from on GFC, EDC (minor co-movement), which was further impacted by COVID-19 and Russia-Ukraine crises (Fig. 6.6.1 B).

Furthermore, on studying wavelet correlation (Fig. 6.6.2 B) between India and US during GFC, the correlation increases from short-term scales (0.3–0.4) to long-term scales (0.6–0.7), as the global financial crisis (2007–2009) undermined the worldwide trade and economic system. The indirect decline in US service demand and international financial messiness impacted India’s IT and export sectors. At the same time, India’s economy was relatively insulated as it is surprisingly domestic-driven. The long-term rise in correlation shows India’s alignment with US-led global recovery efforts and its economic stabilization drive. During EDC, medium correlation (between 0.4–0.5) at medium scales, rising to higher at larger scales (0.6), as the EDC (2010–2012) indirectly affected the growth in EDDs as well as India through global trade and international financial markets, since Europe is the primary destination of Indian export. As one of the primary stabilizers during the crisis, the US shaped global financial flows, impacting India indirectly. The elevated correlation at larger scales has a basis in India's medium- to long-term adaptations to these global changes. Moreover, the Chinese stock market crash revealed moderate, simple spatial correlation at intermediate (0.4–0.5) scales, increasing at larger scales, as the breakdown of this 2015 Chinese stock market crash had a significant market impact, driving commodity prices down markedly and many stock prices in the emerging markets. As an Importer and Exporter country, India was indirectly affected. The crash also sent ripples through US financial markets, which reacted to the global volatility. This observed correlation also underscores India's deepening integration with the world markets and the economic interdependence with the US in this period. During the Brexit Referendum (3122–3453), a minor correlation was identified on the medium to long-term scale; Brexit (2016) was about uncertainty regarding global trade and how it affects India indirectly because of its economic relationship with the UK and the US. The US's algo-bubbling financial and trade correction pyramid affected global markets, which dampened India's export sectors and dried out capital inflows. The observed correlation is a statement on the Indian economy's alignment with trends from the Americas at a stage of global restructuring. During the COVID-19 Pandemic, the long-term scales show the highest correlation (0.7–0.8) due to the pandemic simultaneously disrupting global supply chains, trade and financial markets. India and the US implemented large monetary and fiscal measures to stabilize their economies. The dependence of India on global supply chains and the US's recovery strategies resulted in strong synchronicities across those two economies, which can be reflected in the large scales yield high correlation. During the Russia-Ukraine war, the correlation (0.7+) stayed high on long-term scales, as the global energy and food markets were disrupted by the Russia-Ukraine war, leading to inflationary pressures in both the US and India. However, the US initiated sanctions and energy policies while India faced difficulties with energy imports and global food supply chains. The close correlation reflects standard long-term economic adjustments to the conflict's global repercussions.

Interestingly, as per DCC-GJR-GARCH results, US-India showed no contagion during GFC as per results of wavelet family models. Also, some co-movements were identified during GFC, which indicates volatility in the market; furthermore, only during the Chinese crash and COVID-19, which were different crisis origin country sources even proved by co-movement of wavelet coherence.

On analyzing the US-Malaysia wavelet coherence, this study identified high co-movement as a lead relationship in the short period but a lag relationship in the longer period in GFC (807- 1431) (Fig. 6.6.0 C). EDC impacted on a minor scale, the small to medium scale Chinese crash, Brexit minor co-movement on a medium scale, COVID-19 on a longer duration, and Russia-Ukraine crises on a short scale (Fig. 6.6.0 C). Studying cross-wavelet transform also showed that high co-movement was identified during the GFC, the Chinese crash (minor scale), COVID-19, and the Russia-Ukraine war (Fig. 6.6.1 C). Furthermore, on studying wavelet correlation (Fig. 6.6.2 C) during GFC in the ranging short-term (0.2–0.3 scale) to medium- and long-term scales (0.5–0.6 scale), correlation increased steadily as the GFC (2007–2009) had its effects on Malaysia as an economy heavily reliant on exports of electronics, palm oil, and other commodities, mainly from the US and Europe. At the same time, the US, as the centre of the crisis, impacted Malaysia's trade-dependent economy. Increasing correlation at longer scales emanates from Malaysia's convergence to global recovery plans led by the US and its dependency on stable trade flows. In EDC (0.4–0.5), moderate correlation at medium scales and even peak near 0.6 with continued (lag 16-32), as the EDC (2010–2012) indirectly affected Malaysia by reducing global trade demand and causing financial market volatility.

Malaysia's economic dependence on exports to the European Union and the US has transmitted spillover effects, while the US Fed's monetary actions have stabilized the global market. This apparent correlation emphasises the connectedness of global trade and Malaysia's partial synchronisation with the US economic adjustment. The CBB revealed a moderate increase in the correlation on medium-term scales (8–16) and strongly improved on long-term scales (32–64) as the 2015 Chinese market crash jolted Malaysia via its leading trading partner, China. They were mirrored in a financial process that had a cascading effect not only in Malaysia but also an indirect effect through trade linkages and investment flows as the US made monetary adjustments to correct for global volatility. The modest but growing correlation reflects Malaysia's exposure to US and Chinese markets. During BREXIT, the correlation increases for medium to long scales (16–64), peaking around 0.6; due to uncertainties in global trade and finance post-Brexit (2016), Malaysia's exports and investment inflows were indirectly affected. The US and Malaysia, having more or less been affected by the global market realignment, reacted uniformly through their economies. The growing long-term correlation shows Malaysia getting in step with US-led global trends. During the COVID-19 pandemic, the high and increasing correlation across scales peaked at an enormous scale (32-64) above 0.6, as the pandemic upended global supply chains, severely impacting Malaysia's economy, which depends heavily on trade. The US and Malaysia created fiscal and monetary policies to strengthen their economies. The high correlation largely reflects similar global economic challenges and similar strategies adopted worldwide to recover from them. During the Russia-Ukraine war, the correlation was also high at longer (16–64) scales as the impact of the conflict on global energy and commodity prices indirectly hit significant palm oil and electronics exporter Malaysia. The economic and geopolitical responses of the US and its impacts on the world also followed Malaysia's economic gradations. Their high correlation reflects their interlinked economic strategies in this global disruption.

Thus, based on DCC-GJR-GARCH results also, during the GFC (US origin country), Chinese crash (China crises origin country), and COVID-19 (China crises origin country), contagion occurred, which indicates wavelet coherence results are robust.

On analyzing the US-Thailand relationship, during GFC, high co-movement was identified in the short to medium major of the crisis period but started lagging in a longer period (Fig. 6.6.0 D) and did not show any relationship among all the countries in the medium period. During EDC, the Chinese crash, Brexit, and the Russia-Ukraine war, the least co-movement was identified, although during COVID-19, high co-movement was identified (Fig. 6.6.0 D). Similarly, the results of the cross-wavelet transformation also proved to be high in co-movement during the GFC, minor during the EDC, the Chinese crash, Brexit, and the Russia-Ukraine crises. However, during COVID-19, high co-movement was identified (Fig. 6.6.1 D). Furthermore, on studying wavelet correlation (Fig. 6.6.2 D), US-Thailand stock markets showed that correlation rises monotonically with scale, with a peak at medium to long-term scales (0.5–0.6), as the GFC caused instability in global financial markets and international trade flows, hitting hard on Thailand’s arts (which are heavily reliant on global demand for electronics, vehicles and agriculture). The increasing correlation at larger scales indicates Thailand’s convergence with US-led economic stabilization initiatives and its reliance on recovering global trade. During EDC, there is a moderate correlation present across the short- to medium-term time scales (8–16), but this strengthens again when considering previous time scales (32–64) to approximately 0.6, as the EDC indirectly impacted Thailand (2010–2012) via trade disruption and decreased demand from Europe.

The US measures that helped stabilize the American financial markets also indirectly aided global economic recovery, which affected Thailand’s export-oriented economy. The rising correlation at greater scales indirectly reflects the US influence on Thailand’s economic adjustments. The CBB correlation is moderate (0.4–0.6) at medium and increases slightly at larger scales (16–64), as the 2015 Chinese stock market crash injected volatility in global markets, and that extended to Thailand since China is one of Thailand's largest trading partners. Thailand’s economy, meanwhile, which took advantage of the changed nature of global trade, had been indirectly affected by the US’s financial adjustments to state global volatility. The moderate correlation underscores Thailand's intermediate exposure to the US and Chinese markets. During the Brexit referendum through levels medium to long scale (8–64), correlation increases (peaks around 0.6–0.7) as Brexit (2016) created uncertainties in global trade, wielding indirect spillovers on the Thai economy via exports and investments. Shared interests in stable global markets aligned with the US and Thailand's economic adjustments during this period. The growing correlation reflects decades of synchronized economic responses. During the COVID-19 pandemic, there was a high correlation across scales with a maximum at long scale (32–64) over 0.7 as the pandemic upended global supply chains and trade flows, translating into the immediate impact these sectors had on Thailand. The US and Thailand implemented Fiscal and monetary measures to stabilize their economies. The high correlation reflects common worldly economic headwinds and synchronized replenishment strategies. During the Russia-Ukraine war, the correlation stayed high at even medium to long scales (16–64): about 0.7, as the war disrupted world energy and food prices, affecting Thailand as an energy importer and agricultural exporter.

Based on the DCC-GJR-GARCH results, GFC, EDC, the Chinese crash, and COVID-19 showed financial contagion effects. Thus, based on the US-origin crises in GFC, strong co-movement was identified as a medium to scale longer, as revealed by robust results.

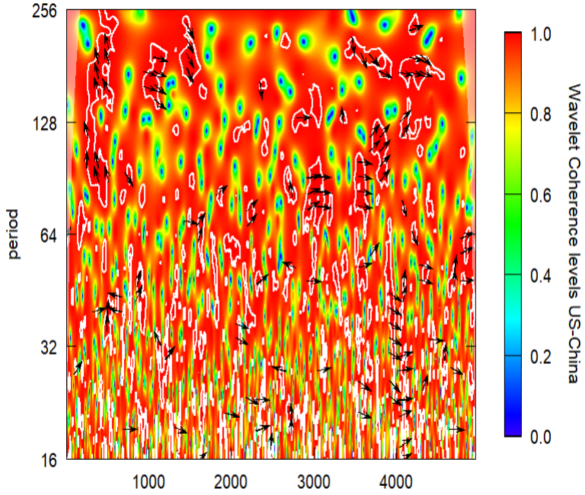
On analyzing US-Indonesia, this study identified leading co-movement during GFC, EDC (minor on medium scale), Chinese crash (minor at medium scale), Russia-Ukraine crisis minimized and COVID-19 in the short to medium period but remained consistent for the COVID-19 period. During the Russia-Ukraine crisis, minor co-movement also occurred in the shorter period (Fig. 6.6.0 E), which was robustly proved by the cross-wavelet transform (Fig. 6.6.1E). Furthermore, on studying wavelet correlation (Fig. 6.6.2 E) during GFC correlation rises from short (0.2–0.3) to long (0.5–0.6) term scales, as may be impacted due to a commodity-based economy heavily dependent on palm oil, coal, and rubber. The slowdown in economic growth was caused by low global demand, especially from the US and Europe. All eyes were on the US, the "ground zero" of the crisis; whatever happened there would drive the global financial recovery. The growing interdependence is a testament to Indonesia's reliance on international trading stability and its tipping as an ally in the US-inflected drive for economic resurgence. During EDC, correlation stayed moderate at mediums (0.4–0.5) and increased to 0.5–0.6 at larger scales, as EDC (2010–2012) indirectly affects Indonesia, driven by global trade and financial markets as a direct consequence of decreased European demand on global commodity prices. The US's stabilizing monetary policies helped engender stability globally, indirectly benefitting export-oriented economies like Indonesia. Correlation at longer scales smoothly links Indonesia's gradual alignment with US economic trends during global crises. During the Chinese stock market crash, mild correlation (0.4-0.5) at medium-term scales tightened to at least 0.6 at longer scales (32-64), as the Chinese stock market crash affected global commodity markets, directly affecting Indonesia's exports to China and global markets. Indirectly, the US has influenced market recovery via its monetary tweaks. A moderate correlation may be generated from Indonesia's rebalance policy, which sat between the US and China during the incident. Brexit revealed a stronger correlation in medium to long scales (0.5–0.6) as the global trade flows were destabilised by Brexit (2016), indirectly affecting Indonesia's export and investment flows. As a stabilizer of global markets, the US also affected Indonesia at the time as the organizational adjustments for survival against changing global dynamics. The increased correlation indicated the long-run alignment of economic reactions; moreover, during COVID-19, correlation peaks at longer scales, as the pandemic wreaked havoc on global supply chains and has had an outsized impact on Indonesia's economy, mainly its export, tourism and domestic consumption sectors. Fiscal and monetary policies were used by both the US and Indonesia to deal with the economic impact. The strong correlation showed how synchronized the global challenges and economic responses to COVID-19 are. During the Russia-Ukraine war, the correlation at med/long scales is still very high (0.5–0.6), as the war caused turmoil in global energy and food prices, which hit Indonesia as a leading exporter of palm oil and a significant energy consumer. The US's measures in the form of sanctions or strategic energy policies also had an impact on the world market, indirectly influencing Indonesia's economic responses. This strong correlation speaks to the common challenges and reactions to global economic disruptions.

Interestingly, as per DCC-GJR-GARCH results, the Indonesian stock market revealed that during the GFC, the Chinese crash, and COVID-19, high co-movement was identified, which was also proved by wavelet coherence results.

In studying US-South Korea stock markets, this study identified high co-movement during GFC, EDC, Chinese crash (minor short scale), Brexit at short scale, COVID-19 consistent co-movement and Russia-Ukraine crises for short to medium scale (Fig. 6.6.0 F). Similarly, on studying cross-wavelet transform high co-movement identified during GFC, EDC, Brexit (minor), COVID-19, and Russia-Ukraine crises (Fig. 6.6.1 F). Moreover, on studying wavelet correlation (Fig. 6.6.2 F), as during GFC, correlation keeps increasing across scales, around 0.6 is achieved at medium to long-term scales, as South Korea is a highly export export-oriented economy. During the GFC (2007–2009), it suffered from reduced global demand (especially from the US, one of its largest trading partners). The US's fiscal and monetary policy responses toward the crisis also significantly contributed to the global economic recovery in tandem with South Korea's trade recovery measure. The increasing correlation at longer scales is a function of South Korea's economic dependence on global demand and US-led recovery patterns. During EDC, the medium-term correlation remains moderate (0.5–0.6) and increases further on longer scales, as EDC indirectly affected South Korea by negatively impacting global trade demand in Europe. US's global financial market stabilization efforts bolstered recoveries that affected South Korea's interest trade accounts, export sector, and financial markets. This increased correlation suggests the synchronization of economic responses at higher scales. During the Chinese stock market crash, there was more than medium correlation at medium scales (0.5-0.6) and even higher at the long-term high, as the 2015 Chinese stock market crash had ripple effects that were felt around the globe, especially in global trade and financial markets, impacting South Korea's export sector given the country's strong trade links with the Chinese economy. The US's financial adjustments and the recovery measures of China spread indirectly to South Korea's economy. This correlation was attributed to South Korea's relative middle ground between the economic activity of the US and that of China. During the Brexit Referendum, the correlation amplified from medium to long time scales and peaks as the global trade and financial uncertainties created by Brexit (2016) indirectly carried over into their effect on South Korea's trade and investment flows. US stabilizing influence on global markets and South Korea's export-driven response to global demand likely underlie this synchronization. Moreover, during the COVID-19 pandemic, all scales of correlation were high, as the pandemic led to massive disruption of global trade, supply chains, and economic activity. The US and South Korea undertook significant fiscal and monetary measures to stabilize their economies. The close correlation reflects their shared economic challenges and similar recovery strategies amid the pandemic. During the Russia-Ukraine war, medium to long-term correlations were still high as the conflict threw a wrench into global energy and commodity markets, which hit South Korea, a significant energy importer and an exporter of high-tech goods. The implications based on the strategic responses to energy markets for global stability indirectly determined South Korea's economic adaptations. The close correlation emphasizes common economic adjustments to worldwide shocks (Fig. 6.6.2 F).

However, the DCC-GJR-GARCH results only showed a contagion effect during the EDC, the Chinese burst bubble, and COVID-19. Indicates only volatility generated during GFC (as US crises origin country) has not demonstrated contagion effect.

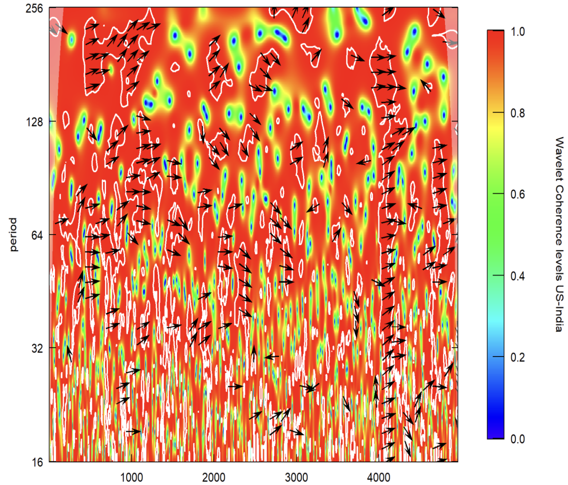
APAC Region



A) Wavelet Coherence

US-China

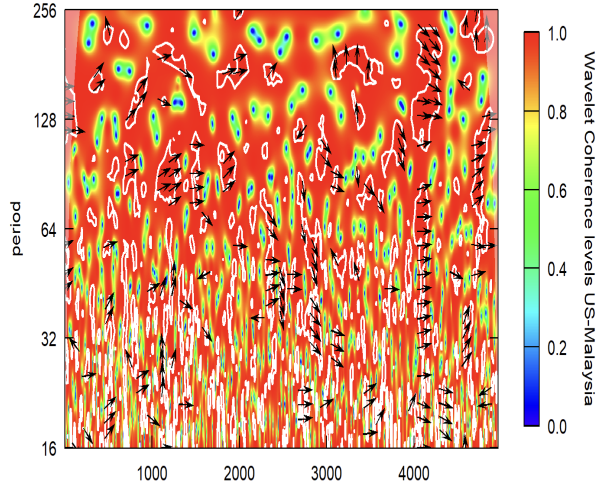
(Market Capitalisation Ranking- 14).



B) Wavelet Coherence

US-India

(Market Capitalisation Ranking- 21).

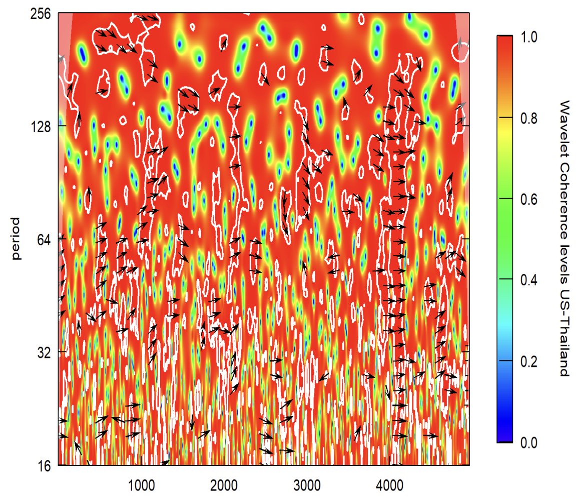


C) Wavelet Coherence

US-Malaysia

(Market Capitalisation Ranking- 20).

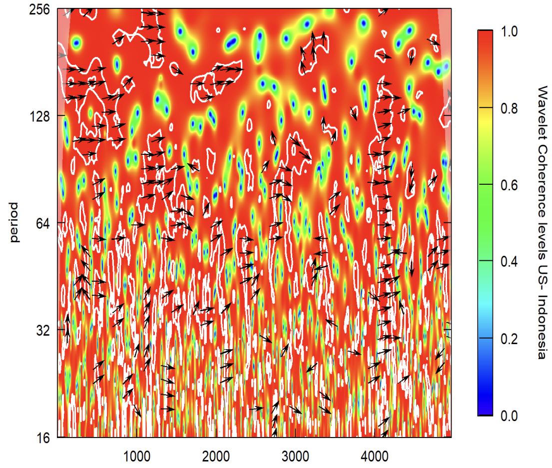
APAC Region



D) Wavelet Coherence

US-Thailand

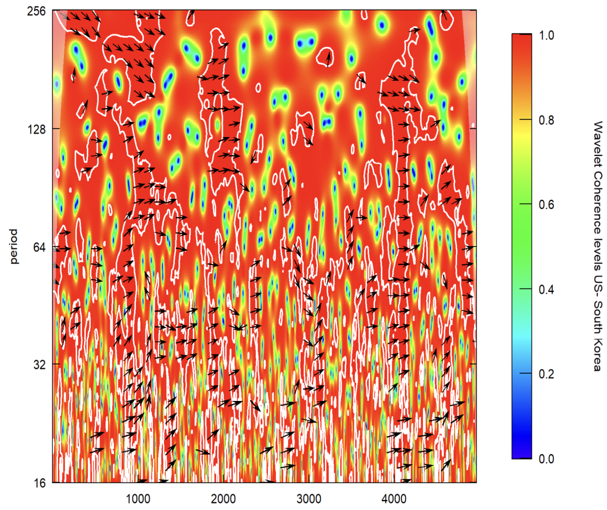
(Market Capitalisation Ranking- 18).



E) Wavelet Coherence

US-Indonesia

(Market Capitalisation Ranking- 19).

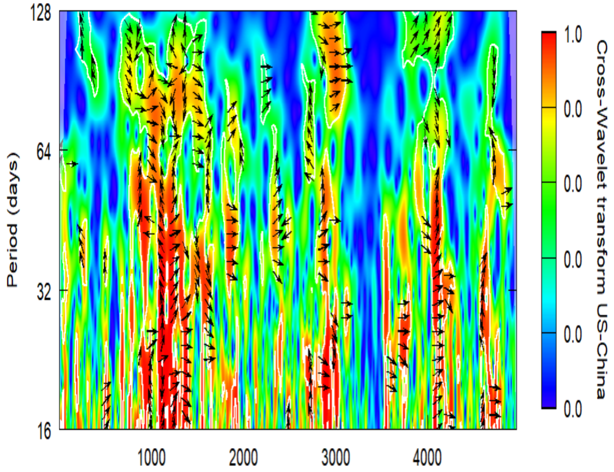


F) Wavelet Coherence

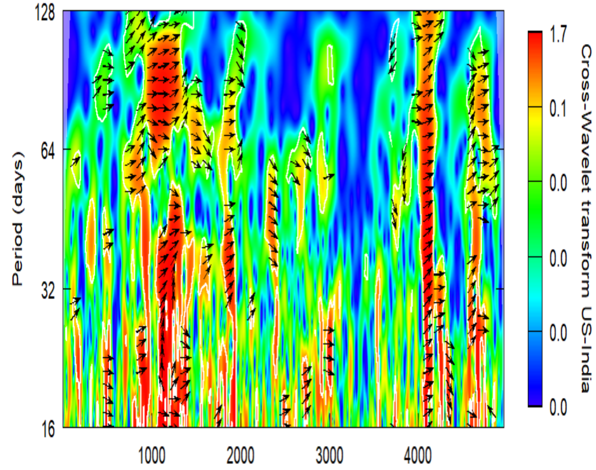
US-South Korea

(Market Capitalisation Ranking- 09).

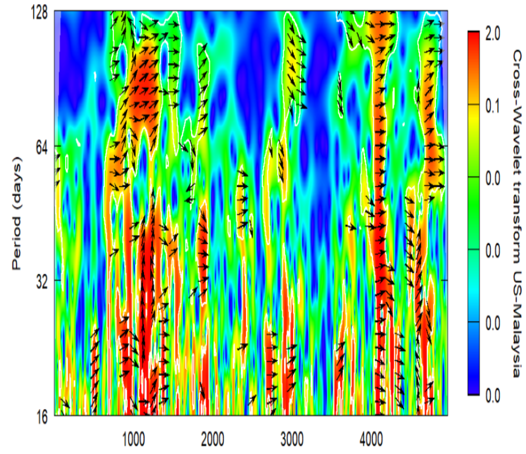
Fig. 6.6.0: Wavelet Coherence in the emerging countries of the APAC region.



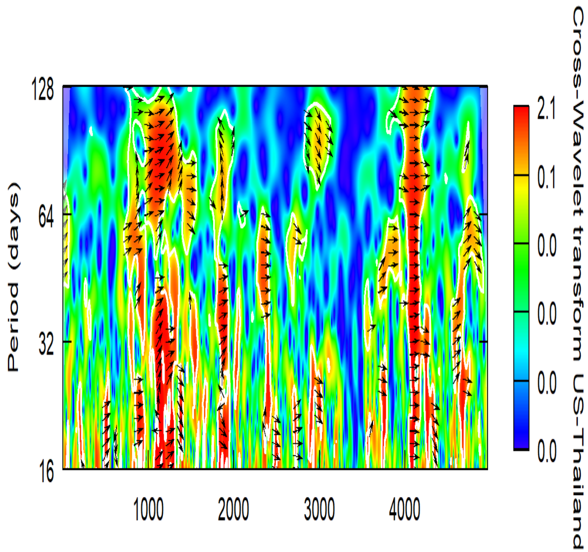
A) Cross-Wavelet Transform US-China (Market Capitalisation Ranking- 14).



B) Cross-Wavelet Transform US-India (Market Capitalisation Ranking- 21).



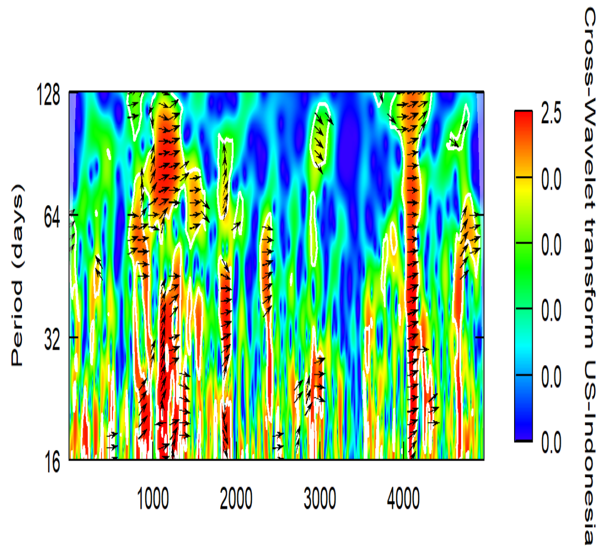
C) Cross-Wavelet Transform US-Malaysia (Market Capitalisation Ranking- 20).



D) Cross-Wavelet Transform

US-Thailand

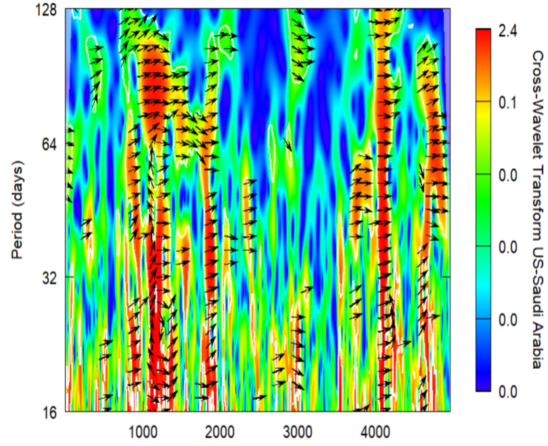
(Market Capitalisation Ranking- 18).



E) Cross-Wavelet Transform

US-Indonesia

(Market Capitalisation Ranking- 19).

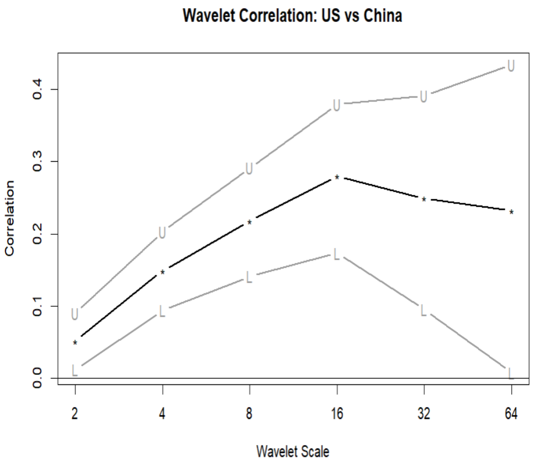


F) Cross-Wavelet Transform

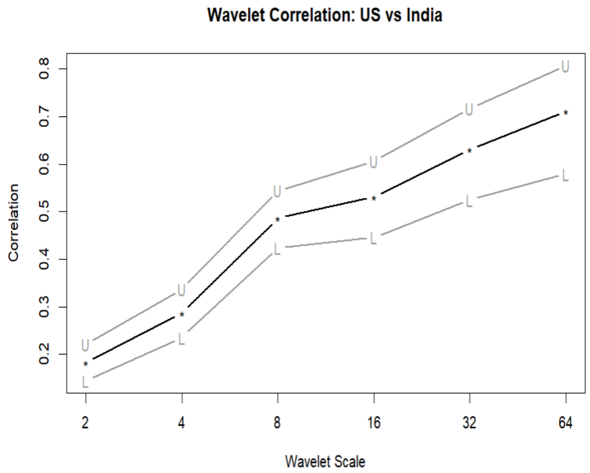
US-South Korea

(Market Capitalisation Ranking- 20).

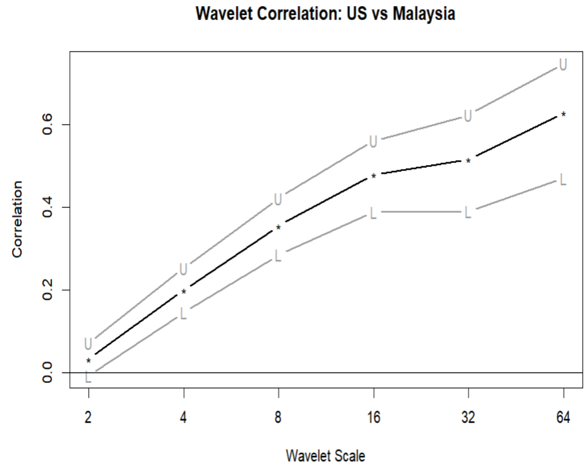
Fig.6.6.1: Cross-Wavelet Transform in the emerging countries of the APAC region.



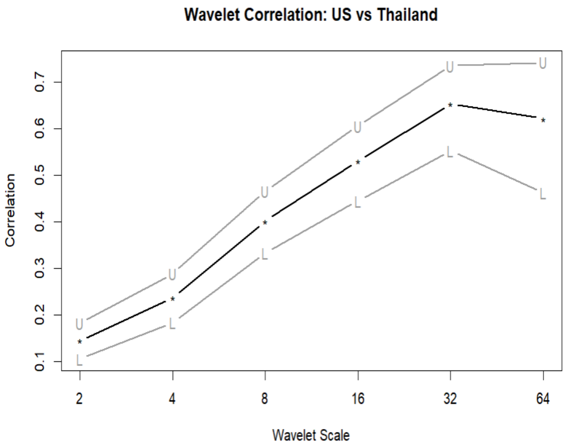
A) Wavelet correlation US-China (Market Capitalisation Ranking- 14).



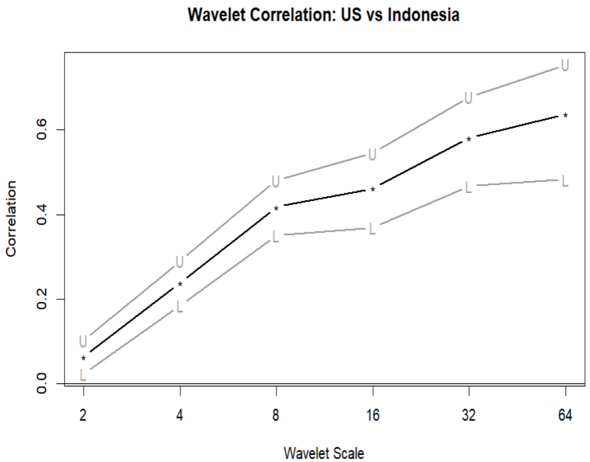
B) Wavelet correlation US-India (Market Capitalisation Ranking- 21).



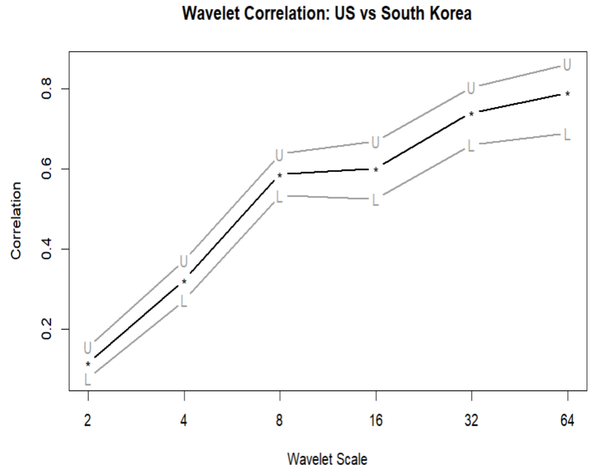
C) Wavelet Correlation US-Malaysia (Market Capitalisation Ranking- 20).



D) Wavelet Correlation US-Thailand (Market Capitalisation Ranking- 18).



E) Wavelet Correlation-Indonesia (Market Capitalisation Ranking- 19).



F) Wavelet correlation US-South Korea (Market Capitalisation Ranking- 09).

Fig.6.6.2: Wavelet Correlation in the emerging countries of the APAC region.

6.2.3 Frontier Countries

Based on MSCI, classification among the frontier countries covered two crucial regions, i.e. EMEA (wavelet coherence - Fig. 6.7.0; cross-wavelet transform - Fig.6.7.1; wavelet correlation - Fig. 6.7.2) and APAC (Fig. 6.8.0 cover wavelet coherence, cross-wavelet transform, and wavelet correlation).

6.2.3.1 EMEA[18] Region

On analyzing the frontier countries in the EMEA region, leading co-movement was identified during COVID-19 on medium and longer scales but minor lagging in a short period during the EDC and Russia-Ukraine war. During Brexit and the CBB also, these were not as significantly impacted.

On studying US-Morocco the GFC, XWT (Fig. 6.7.1 A) showed prolonged intervals indicating high power (16-128 days), meaning persistent co-movement and wavelet coherence (Fig. 6.7.0 A) shown GFC as a sustained, strong association exists at long scales, as demonstrated by high coherence. The coherence plot proved a robust relationship and was statistically significant by the XWT. During EDC, XWT showed moderate co-movement at medium, long duration as the arrows indicate temporal delays in the interconnectedness, with Morocco responding to the US. Similarly, wavelet coherence showed some modest coherence between the same time intervals after verifying that the effect was delayed but strong between the US and Morocco in this event. The coherence plot showed how much it depends normalized by size against other dependencies. Thereafter, the CBB XWT result showed low power, so little or no effect, particularly for short time intervals (16–32 days), as wavelet showed weak coherence, evidenced that the CBB had no significant impact on Morocco-US relations. Moreover, the Brexit XWT outcome showed moderate co-movements in the mid to long wave periods (32–64 days); mixed arrow directions imply some degree of fluctuation in the connection. The coherence increases only in mid-terms, signifying the indirect global uncertainty associated with the Brexit phenomenon, strengthening the Morocco-US relationship. During the COVID-19 Pandemic, XWT and wavelet coherence revealed that in times of global economic

[18] In the emerging countries, there is no country in the America region.

shocks, such as global recession, coherences across all scales imply a stronger association in which shocks propagate to both markets. The appropriate normalized intensity of such a relationship is shown in a coherence plot. During the Russia-Ukraine war, XWT results showed moderate strength (especially at medium durations, (32–64 days)), and wavelet coherence with similar volatility confirms the economic and geopolitical ripple effects of energy and trade disruptions whilst enabling Morocco to align with the market of US.

On studying wavelet correlation in the US-Morocco (Fig 6.7.2 A), GFC shown correlation at short and medium scales (2-16) is relatively modest, yet varied, which indicated that Morocco's financial market integration level with the US, which appears to have been considerably less interconnected during the GFC and EDC, most likely due to disparities in economic structure and regional distance. During the CBB, the correlation was minimal but steady on short scales (2-8), indicating that the volatility of the Chinese market has little direct impact on morality. At medium-to-long scales (16-64), correlation does not significantly rise, indicating limited shock transmission from this event, similar to wavelet coherence and cross-wavelet transform. Moreover, when studying Brexit, the minor correlation increases at mid-to-long scales, indicating that the global uncertainty caused by Brexit indirectly impacted Morocco's financial sector. The increasing trend demonstrates more synchronisation with the US over longer periods, most likely reflecting shared global economic reasons. Moreover, COVID-19 revealed that correlation is slightly stronger throughout scales, especially longer ones (32-64). Indeed, over time, the worldwide scale of the economic impact of this epidemic has resulted in a considerably deeper tie between the US and Morocco. Russia-Ukraine also showed a high correlation at medium scales (16-32) with relatively moderate association increases, suggesting geopolitical and economic spillover from the war in Africa's arid northwest to energy and commodities markets in Morocco. On studying US-Morocco (Fig 6.7.0 A) during GFC, EDC and Chinese burst bubbles showed opposite co-movement among both country stock markets, but COVID-19 demonstrated consistent results with strong co-movements. Interestingly, as per DCC-GJR-GARCH results during GFC (as US crisis origin country), no contagion was generated as coherence resulted in volatility in the stock market of Morocco, the China burst bubble, COVID-19, and the Russia-Ukraine war showed financial contagion effects.

On studying US-Nigeria wavelet coherence (Fig. 6.7.0 B), results revealed less coherence[19] among both the stock markets during all the crises, but on studying US-Nigeria XWT revealed high power (XWT quantifies covariance (shared power)), which can be present even in the absence of a robust correlation between the two series. Coherence, in contrast, emphasises correlation and necessitates that the link be constant and durable) in GFC, BREXIT, COVID-19, Russia-Ukraine crises (Fig. 6.7.1 B). As per XWT, increased joint power (red areas) during extended delays (64–128 days), characterized by a prevalence of right-pointing arrows, signifies that movements were synchronized between the US and Nigeria rather than divergent. Substantial consistency during comparable eras substantiated the robust and statistically significant correlation observed during the GFC. Comparable trends have been identified in both markets, which have predominantly reacted in concert, mainly influenced by oil price fluctuations and global economic downturns. On studying EDC XWT bilateral powers for moderate-duration bonds (32–128 days) in the Nigeria stock markets are trailing behind those of the US, with an upward trend indicated, wavelet coherence was moderate at short intervals, with actual performance indicating a connection, despite seen delays, which are significantly related to the present event. The results indicated a medium-strong relationship between the two series, with wavelet coherence providing clarity regarding the dependency strength and delay. On studying the Chinese market collapse, XWT showed a brief duration of low strength (16–32 days) characterized by mixed arrow patterns, indicating a minimal signal in Nigeria's market. The wavelet's low coherence further indicated limited reliance, suggesting that the Chinese market's rapid downturn had minimal direct impact on Nigeria. Both results indicated that connectedness during this occurrence was constrained, and on studying Brexit, XWT exhibited modest power at intermediate intervals (32–64 days), with both positive and negative slopes indicating

[19]The wavelet coherence plot has fewer co-movement (arrows) as it eliminates inconsequential or weak interactions, concentrating solely on robust and statistically significant dependencies, whereas the XWT plot shows arrows wherever joint power is present, regardless of noise or weakness in the relationships.

diversity in phase relationships. Marginally increased coherence at comparable periods indicates a lagged yet substantial correlation between the two markets, influenced somewhat by global uncertainty. Coherence elucidates the XWT results, affirming the intensity of reliance and standardizing for individual market fluctuations. On studying the COVID-19 pandemic, XWT results showed a robustly positive effect aligning the whole market for both short (16–32 days) and extended durations (64–128 days), with right-pointing arrows indicating interdependence. The aggregated high data coherence across all dimensions enhances the XWT findings, demonstrating a robust and coordinated correlation throughout this planetary disruption event. The tools concur on the strong, synchronous relationship between the US and Nigeria over COVID-19, influenced by the extensive economic repercussions, on studying the Russia-Ukraine Conflict XWT revealed moderate power at intermediate timeframes (32–64 days), shown by upward-tilting arrows representing the lagging reaction of Nigeria.

At similar scales, modest coherence indicates a delayed yet significant effect on Nigeria's market, driven mainly by increasing oil costs and geopolitical worries. Coherence enhances the XWT result by highlighting the intensity of the delayed reliance. XWT illustrated regions of maximal shared power, whereas coherence presents normalized outcomes to improve the interpretability for dependence strength and correlation patterns. Both analyses concur that these associations were robust throughout global crises, such as the GFC and COVID-19, attributable to the coordinated worldwide economic shocks these crises engendered. Both techniques indicate diminished correlations for region-specific catastrophes like the Chinese Crash, primarily because of the restricted direct link with Nigeria. Both tools indicate that long-term relationships (64–128 days) are predominant in significant global events, but short-term relationships (16–32 days) are often poor, except during periods of extreme volatility such as COVID-19. Moreover, the results of the wavelet correlation (Fig. 6.7.2 B) have also proved a robust relationship between the different crises.

Interestingly, as per the DCC-GJR-GARCH model, results of the US-Nigeria stock market showed a contagion effect in BREXIT, COVID-19 and Russia-Ukraine crises only, which indicates over the period, inter-relationship among the frontier and developed countries has been increased. Moreover, wavelet coherence and XWT results proved that a weak relationship was established between the US and Nigeria before the earlier crises.

In studying US-Kazakhstan wavelet coherence (Fig. 6.7.0 C), results revealed that during GFC

moderate coherence at long scales, EDC low-moderate coherence at mid-long scales, Chinese burst bubble mixed low-moderate coherence at mid-scales, Brexit showed low coherence at short scales, during COVID-19 showed high coherence across scales, and Russia-Ukraine crises showed mixed coherence relationship on the different scales. Moreover, when studying XWT (Fig. 6.7.1 C), results indicated that during GFC XWT, the more potent power (red areas) has an extended duration (64–128 days). EDC XWT intermittently moderated during the 32–128-day timeframe, as XWT revealed moderate power at medium to long durations (32 – 128 days). The arrows indicate an upward direction, suggesting they are out of sync with (lagging) the US within the same timeframe. Moderate consistency in common regions further corroborates XWT results, indicating that the relationship persists but with diminished strength compared to the GFC. The lethargic response of the Kazakhstan government is likely attributable to their indirect vulnerability through global commerce and energy markets. XWT results in the Chinese Crash had less of a direct impact on Kazakhstan. XWT findings indicated that oil hedging and substantial trade with neighbouring countries contributed to this outcome. Moreover, during Brexit, XWT had moderate power at medium periods (32–64 days), with right-pointing arrows suggesting partial synchronization. The elevated consistency throughout equivalent times corroborates findings derived from XWT, implying that global uncertainty stemming from Brexit exerted indirect influences on Kazakhstan's market, mediated through trade and oil price fluctuations. During the COVID-19 pandemic, short durations (16-32 days) and lengthy periods (64-128 days) have significant power in XWT. The arrows indicate similar market movements to the right. Elevated coherences for each scale validate the XWT findings, indicating a strong and substantial correlation during this epidemic. The economy of Kazakhstan experienced the repercussions of global oil price fluctuations and simultaneous economic slowdowns. During the Russia-Ukraine war, XWT had moderate power at medium durations (32–64 days), with upward-tilting arrows suggested a delayed reaction from Kazakhstan. Moreover, the wavelet correlation (Fig. 6.7.2 C) shown GFC (moderate at short scales, vigorous at long scales), EDC (moderate correlations at mid-long scales), Chinese crash (weaker correlations at short scales), BREXIT (weak short-term correlations), COVID-19 (strong correlations across scales), and Russia-Ukraine war (strong correlations at mid-long scales) relationship among US-Kazakhstan. As a resource-driven economy responding to global demand trends, Kazakhstan consistently lags behind the US amid global crises.

Interestingly, the Chinese burst bubble and the Russia-Ukraine war showed financial contagion per the DCC-GJR-GARCH model, as both crises have energy and commodity dependencies. The Chinese crash caused demand shocks due to lowering raw materials and energy prices impacting Kazakhstan, as the Russia-Ukraine conflict, characterized by a supply shock and rising oil prices, with Kazakhstan's alignment with the United States, has affected global markets. It indicates that as wavelet coherence showed mixed results, we identified mixed interdependence, but it can be stated that frontier countries impact the US. Due to regional economic interruptions brought on by the Russia-Ukraine war, Kazakhstan was compelled to reorient its trade channels and fortify its connections with other international markets, implicitly aligning itself with the United States. Due to Kazakhstan's reliance on the Chinese demand for natural resources, the Chinese slump rippled Asian markets.

In studying wavelet coherence in US-Romania, GFC and EDC wavelet coherence shows both countries' stock markets have a high degree of synchronization on a mid-to-long timescale, which draws attention to Romania's vulnerability to the global financial system and the trade disruption brought on by the US-led crisis (Fig. 6.7.0 D). During the Chinese stock market crash, wavelet coherence revealed low-to-moderate cross-scale enmeshment, which means the Romanian economy has weaker direct linkages to the Chinese market. During Brexit, moderate coherence at mid-term scales showed some indirect economic implications for Romania via the EU. However, the health crisis, i.e. COVID-19 pandemic, shown high coherence across all scales, implying strong synchronization between the US and Romania due to the pandemic's worldwide economic effect. During the Russian-Ukraine war, on a medium-to-long scale, strong coherence (64-256 days) indicated Romania's proximity to the war and agreement with US-led global economic ambitions. On analysing the phrase relationship, the rightward and upward arrows imply that Romania's response was slightly delayed but synchronized with US trends, driven by shared geopolitical and energy market first-order implications. On studying wavelet XWT results during the GFC, high magnitude (red areas) was observed at mid-to-long-term scales (64–128 days) (Fig. 6.7.0 D). Since the crisis had global financial and commercial implications, the period witnessed high-level US-Romania engagement (as in the phase relationship of the US to Romania shows that most arrows point right, indicating synchronicity of positive economic trending). The upward arrows suggested that Romania lagged behind the US, highlighting its late response to the financial crisis. During EDC, the mid to long-term size points to Romania's weakness to EU-wide financial contagion (indicates trends in the US (same-direction rightward arrows), and some upward arrows (e.g., Romania) indicating a lagged reaction). Studying the Chinese stock market crash, which means that the magnitude is smaller concerning shorter time series lengths, demonstrates that economic linkages from Romania to China are weaker than those from Romania to the US. The Chinese collapse had less immediate impact on Romania’s economy. Still, the indirect consequences rippled through world markets or these mixed-phase relationships (anti-phase movements, leftward arrows) show that economic reactions to this event were heterogeneous in studying Brexit's moderate interaction at the medium-term scales since the EU's economic uncertainty affected Romania indirectly due to Brexit. Overall interaction is weak (dashed rightward arrows at higher periods point to in-phase alignment between global shifts in uncertainty related to Brexit) compared to even the GFC or COVID-19. The international nature of the pandemic leads to high cross-country magnitudes and high synchronization between the US and Romania. The phase relation indicates that both economies behaved similarly to lockdown measures and stimulus packages during the lockdowns, as evidenced by the dominant right arrows. During the Russia-Ukraine war, Romania’s proximity to the war (the rightward arrows indicate the extent to which the two are in synch, and the upward arrows represent that Romania has been a tad slow to respond to economic and geopolitical shocks compared with the US), and its integration into US global economic trends (including as sanctions, energy market disruptions), transformed into relatively high magnitude at mid-to-long-term scales. On studying wavelet correlation (Fig. 6.7.0 D), GFC showed moderate to high correlation at mid-to-long scales (Romania's embrace of the US is a nod to just how global the crisis became, as financial contagion rippled through trade and investment flows worldwide (at a more significant level, the delayed response from Romania to the situation is obvious). During EDC mid-term scales, there is a moderate correlation, slightly lower than during the GFC. During the Chinese burst bubble for short and mid-scales, there was a very low correlation, as the lack of correlation reflects Romania's limited economic connections to China and little direct exposure to the Chinese market. During Brexit, with moderate correlation at mid-to-long scales, the former buttressed US-led global financial realignments that followed Brexit-related uncertainties by facilitating indirect risk through substantial trade and investment links at the EU level. During COVID-19, there was a very high correlation across long-term scales, and the Russia-Ukraine crises showed a good correlation at mid-to-long scales. Romania adopted a position close to the interventionist stance of the US and its allies, chiefly among them NATO states like Poland and the Baltic states, given its geographical proximity to the conflict and shared impacts (e.g., energy markets, sanctions) globally.

Interestingly, based on DCC-GJR-GARCH results, this study identified contagion effects from the crisis origin country GFC (US crisis origin), EDC (PIIGS crisis origin), and Chinese Brust bubble (China crisis origin). Thus, wavelet coherence, correlation and XWT have shown strong co-movements during GFC, EDC (on a long scale), Chinese crash (on a short scale), COVID-19, and Russia-Ukraine (small to medium scale).

On studying US-Bahrain wavelet coherence (Fig. 6.7.0 E), GFC revealed moderate coherence (red zones), apparent across several periods, indicating the extent of coordinated economic repercussions during the crisis. Moreover, periodic consistency was striking during EDC at shorter periods, and there was even closer coupling between shorter-term financial trades. CBB and Brexit co-incident events reflect more on intertwined global market trends at the time, with significant coherence reported. During COVID-19, high coherence revealed that the pandemic may affect different economic sectors differently over this period. Moreover, the Russia-Ukraine conflict revealed higher coherence when the two were key, suggesting how geopolitical disagreements shape global financial benchmarks.

Furthermore, its results showed the least coherence with the US during several crises, such as in the Kenya, Nigeria, and Morocco stock markets. In studying the US-Bahrain cross-wavelet transform during GFC, the considerable cross-wavelet power (red) during mid and low periods shows that the two countries' economies are under similar stress (Fig. 6.7.1 E). During EDC, the medium power with sporadic peaks indicated mild crisis-related pressures on Bahrain's economy through the US. Sh sharper power bands demonstrate the consequences of dynamic, short-term economic developments in shorter periods. During the Chinese crash and Brexit, the strong power zones are distinct, implying that the US indirectly impacts Bahrain's financial dynamics. Moreover, during COVID-19, leading power bands over medium to long durations show that the pandemic has implications on both economies and was coordinated, but with some delays (usually indicated by the direction of arrows). The Russian-Ukrainian war showed cross-wavelet power maxima and substantial interdependence, which might be attributed to global trade disruptions and geopolitical concerns affecting both nations. Studying the US-Bahrain wavelet correlation (Fig. 6.7.2 E) during GFC revealed that the shorter scales (4-16) show a moderate interconnectedness coordinated throughout this period. During EDC, the correlation eventually rises to larger scales (16-64), indicating long-term interconnectedness amid global investors' financial sentiments and Bahrain's sensitivity to foreign economic pressures. Moreover, in the Chinese crash and Brexit wavelet correlation increases significantly on medium-to-long scales, indicating coordinated market influences and their long-term implications and during COVID-19, correlation peaks at higher scales, indicating that the pandemic's effects were global and systemic, with long-term consequences for both the US and Bahrain's economy. Moreover, the Russia-Ukraine conflict revealed that the correlation is significant at greater scales, emphasizing the long-term global economic effects of geopolitical disputes.

Thus, based on the above XWT results, it can be stated that GFC, COVID-19, Russia-Ukraine crises, and coherence revealed that GFC and COVID-19 showed moderate co-movements among US-Bahrain. DCC-GJR-GARCH results also indicated that Bahrain was impacted only due to the Chinese-burst bubble (crisis origin-China) and Russia-Ukraine crises (crisis origin-Russia).

In studying US-Croatia stock markets during the GFC, high wavelet coherence showed higher periods at lower and top frequencies (Fig. 6.7.0 F). However, it demonstrated mixed coherence results, indicating that the long-term effect of the world crisis was accompanied by a much more drastic synchronization of the US and Croatian stock market models. During EDC at the lower level for intermediate high-frequency components (periods between 32 and 64), coherence is moderate to high. These presages from the regional crisis seem to transmit to the Croatian markets, which are carried by the positive detriment of the US market in the world. During the Chinese crash, sustained coherence from short to medium time scales implies a strong effect of global market shocks. Even the broader impacts of Brexit and the Chinese crash drive US markets, which then spillover into Croatian equities. During COVID-19, considerable coherence, particularly at medium- to long-run frequencies, reflects that the pandemic has synchronized the economic impacts across different countries. Consequently, the COVID-19 outbreak translated into a global response market reaction that similarly affected the US and Croatian markets. Moreover, during the Russia-Ukraine war, high coherence in the medium periods between the US and Croatian stock markets means that the geopolitical and economic impacts of the conflict are strongly correlated. Encircled arrows indicate periodic temporal deceleration; US elasticity is likely driving Croatian trajectories. On studying cross-wavelet transform (Fig. 6.7.1 F), US-Croatia stock markets showed significant co-movements during GFC, COVID-19, and the Russia-Ukraine war only.

Further, on studying wavelet correlation (Fig. 6.7.2 F) among US-Croatia, dynamics for the short-term (smaller scales) correlation, coefficients seem moderate (0.3–0.4), indicating that the GFC indeed influenced Croatia's economy. Still, the impact was somewhat slower than in the US, which demonstrates the behaviour of contagion effects, as correlation increases progressively, benefiting from Croatia being integrated into global markets, coupling with the US during the upturn via European trade and financial systems. On studying EDC, short-term linkage stayed relatively weak as Croatia is closer geographically and suffered pressure as a resident of the EU periphery. In contrast, the US suffered indirectly with regionally limited effects. Croatia was less exposed to China during the Chinese crash than the US markets. So, the correlation is growing higher as the world markets return from the aftershocks of the Chinese financial turbulence. BREXIT itself may directly affect Croatia less so initially than in terms of longer correlation with the US on the premise that the economic repercussions flow through other members of the EU and globally. Moreover, during the COVID-19 pandemic, a moderate correlation (0.4) exists despite differences in responses to the pandemic's immediate disruptions to healthcare, supply chains, and economies. There is a substantial increase in correlation (over 0.5), which indicates the pandemic has globally synchronized economic activity and recovery efforts across countries, which is also proved by wavelet coherence results. During the Russia-Ukraine war, Croatia, geographically and economically, was so close to the crisis that it could be the most affected. Croatian situation aligns with the global patterns (mainly led by the US) in energy markets, trade and geopolitics. A correlation exists at higher scales given the long-term trend of Croatia and the US halting energy dependence followed by market disruptions that went into a more synergetic economic trajectory.

Interestingly, the DCC-GJR-GARCH model results showed a financial contagion effect during GFC (as a country with a US crisis origin), indicating robust wavelet coherence model results. Moreover, Croatia has not demonstrated a contagion effect with all crises except EDC (PIIGS crisis origin), the Chinese burst bubble (China crisis origin), and the Russia-Ukraine war (Russia crisis origin).

In studying wavelet coherence in US-Kenya (Fig. 6.7.0 G), this study identified the least coherence as consistent co-movement identified during COVID-19 but showed uncommon co-movements during other crises. In studying cross-wavelet transform in

US-Kenya (Fig. 6.7.1 G), EDC and Chinese short-scale crash stock markets indicate volatility due to co-movement due to the investors' sentiments. On studying wavelet correlation in US-Kenya (Fig. 6.7.2 G), during GFC, the short, at smaller scales, correlation is weak and even slightly negative, consistent with Kenya's little direct exposure to the US dollar-dominated global financial system. In the longer term, as the global economic impact of the GFC structure through the rest of the world pushes down to Kenya and as Kenya's economy is more in line with global trends driven by the US, a positive correlation increases at a larger scale. EDC has shown limited direct effect in Kenya, which is more regionally vicariously in Africa, given the transient immediacy of the EDC on Kenya's economy. Here are two reasons for this. At smaller scales, this is evident in weak or slightly negative correlations. Moreover, in the long-term trends, the dynamics in the EU economy and trade will likely lead to increased correlation over the long term; some moderation is expected in the correlation, given Kenya's lesser integration in the EU financial systems. During the Chinese Crash, Kenya's economic relationship with China (through trade and infrastructure projects) will likely have little impact on short-term co-movements with the US. In the long-term: The broader impacts of the Chinese crash on global markets allow for increased alignment with US trends and, consequently, a gradual increase in positive correlation at larger scales. Moreover, during Brexit, Kenya's trade and economic connections to the UK and EU were indirect and sectoral, particularly in agriculture. The short-term correlation is tenuous because Brexit's immediate impacts are muted in Kenya. Global uncertainties on Brexit slowly trickle into effect and raise long-run correlation with the US a bit. During COVID-19, in the short term, direct responses to the pandemic differ significantly in the US and Kenya due to structural disparities (healthcare systems, economic dependencies) with low or no correlation. Moreover, in the long-term, global COVID-19 impacts (supply chain disruptions, trade shocks, etc.) sync domestic impacts, placing them more positively correlated at a larger scale, indicating robust results as co-movements indicated by wavelet coherence over medium to longer scale. In the case of the Russia-Ukraine war, Kenya's reliance on world energy and food markets indirectly connects its economy to the geopolitical and economic shocks unleashed. This correlates with US (bigger scales) combined supply shocks and inflationary pressures on both economies.

Interestingly, US-Kenya has not shown co-movements as per wavelet coherence. Moreover, the DCC-GJR-GARCH model has proved no contagion effect from any country of crisis origin (GFC-US and other crisis countries) to the Kenya stock market. However, due to temporal changes, co-movement was identified in EDC and COVID-19.

On studying wavelet coherence in US-Jordon (Fig. 6.7.0 H), a weak interrelationship was identified between both stock markets. It indicates weak co-movements identified among both countries in all the crises. Moreover, the cross-wavelet transform (Fig. 6.7.1 H) revealed co-movements during the GFC, COVID-19, and Russia-Ukraine crises. Furthermore, wavelet correlation revealed (Fig. 6.7.2 H) during GFC short-term dynamics indicates the correlation begins slightly negative or near zero. Jordan has limited direct exposure to the GFC as its economy is not as integrated with the US-dominated global financial market. In long-run trends (on larger scales), correlation increases and strengthens as Jordan's economy adjusts to the trending worldwide market and the US-led recovery effort strengthens. In EDC, the short-term impact revealed limited or slightly negative numbers, indicating Jordan has little direct regional impact or concerns about the EU debt crisis. In the long run, the relationship becomes positive, suggesting that adverse shocks get transmitted globally through global trade and investment links impacted by the US and EU economies. Moreover, the Chinese Crash also showed a low correlation owing to the lack of direct links between Jordan's economy and China.

In the US, however, markets react more strongly, resulting in less co-movement of the two economies. In the long term, the US shaped the gradual adjustment of Jordan's economy to the global economy after the global effects of the Chinese crash. Hence, there is a moderate positive correlation. During Brexit, Jordan was regionally concentrated in the short run, with little exposure to UK-related economic shocks, keeping the correlation at infinitesimals. Moreover, in the long term, the Brexit surrounding global uncertainty places Jordan and the US adjustments towards each other decisively, apparent by the low and increasing positive correlation. During the COVID-19 Pandemic, weak/near-zero correlation at small scales reflects more immediate pandemic impacts on Jordan's and the US's economies may differ because of structural differences. As time passes and both economies careen from one shared global challenge to another (supply chain breakdowns, inflation, policy measures), the correlation becomes positive (but not strong), highlighting growing interdependence. The Russia-Ukraine crisis revealed initial disruptions, as indicated in the initial impact on the Jordanian economy, primarily through the energy and food markets, which will differ from that of the US economy. Hence, there is a low correlation of adverse effects at small scales.

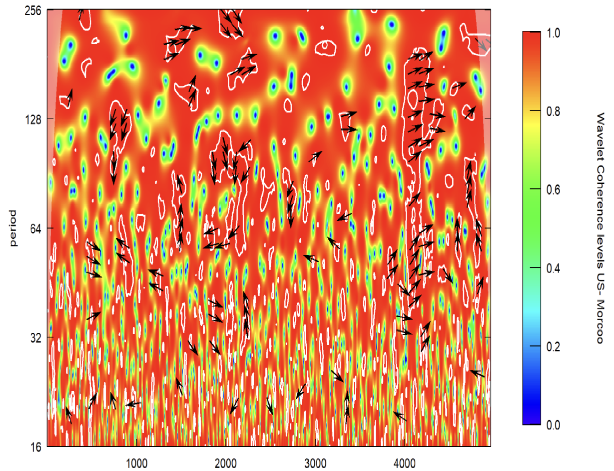
Interestingly, the US-Jordon has not shown consistent co-movement, which indicates that, among frontier countries, Jordon doesn't consistently follow the US. Moreover, DCC-GJR-GARCH results also proved no contagion effect from the US to Jordon during GFC. Only the Chinese crash and Russia-Ukraine crises have shown contagion effects to Jordon as a country of crisis origin.

In studying wavelet coherence in US-Bulgaria (Fig. 6.7.0 I), this study identified the least coherence as consistent co-movement identified during GFC and EDC (lower to medium scale) but showed uncommon co-movements during other crises. Interestingly, the Chinese crash demonstrated a reverse relationship as Bulgaria's stock markets led the US market for a short period. However, during Brexit, no major co-movement was identified. A major co-movement was identified in COVID-19, which further, during the Russia-Ukraine war, also showed volatility to certain levels only. Minor co-movements during GFC as a consistent lead-lag relationship are established in studying cross-wavelet transform US-Bulgaria (Fig. 6.7.1 I). Moreover, some medium-scale co-movement was identified during EDC (32-64). There was no such major co-movement in other crises, except during COVID-19 and Russia-Ukraine crises, as major co-movement was identified.

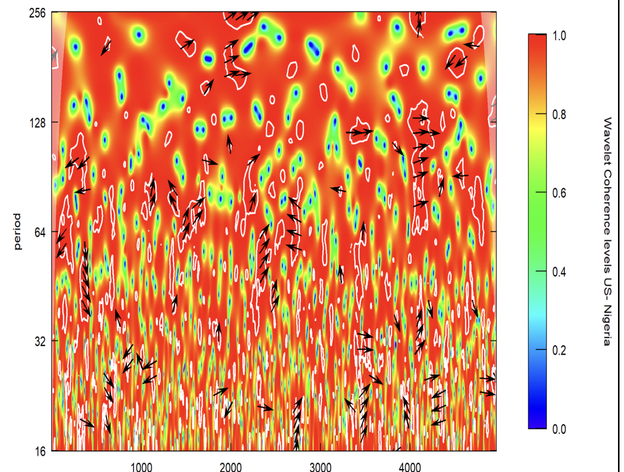
On studying wavelet correlation US-Bulgaria (Fig. 6.7.1 I), during GFC short-term behaviour, the correlation is slightly negative or near zero for small scales, which reflects Bulgaria's lag (due to smaller and less integrated financial markets) in being affected by the crisis, and in long-term, Bulgaria is moving in sync with trends promoting a positive correlation, at larger scales globally as its economy equalizes with the US influenced global economic downturn and recovery. During the EDC, in the short term, there was no significant way that Bulgaria (EU) directly interacted with the debt crisis in the US. However, the correlation between the two (US - EU) is still either weakly positively or moderately positively interdependent. Moreover, with the stabilization of the global economy, the positive correlation increased due to well-established financial and trade relations between Bulgaria and the EU and between Bulgaria and the US. During the Chinese crash also, limited correlation at narrower scales showed Bulgaria's indirect exposure to China via the global trade network, which increased in the long-term trends with the increases in correlation as Bulgaria's economy integrated more with global economic recovery and the more significant market trends dominated by the US. During Brexit, the short-term effects were identified with limited short-term correlation due to a regional focus and few direct links with the UK economy. The long-term effects of global uncertainty stem from Brexit-related scenarios, creating an incremental trend of increasing long-term convergence from Bulgaria to the US on trade and financial flows. During the COVID-19 Pandemic in the short term, correlation is weak at small magnitudes, having differing pandemic responses and management also across regions, while in the long-term tendencies, the global economic disruptions from the pandemic (e.g., supply chain breakdowns, inflation) create synchronized effects that lead to a higher positive correlation at larger scales, which indicate wavelet coherence results are robust. During the Russia-Ukraine crisis, localised effects created a weak correlation to the US as the crisis drove energy prices, inflation and trade patterns to converge; Bulgaria and the US became increasingly correlated, with correlation matching uniform approaches to positive values.

Interestingly, as per DCC-GJR-GARCH results, Bulgarian contagion has also not shown any strong co-movements or financial contagion in any crisis's origin country, as during GFC (US crises origin country) wavelet coherence has not demonstrated significant co-movement with US stock markets; thus, it proved DCC-GJR-GARCH has robust results.

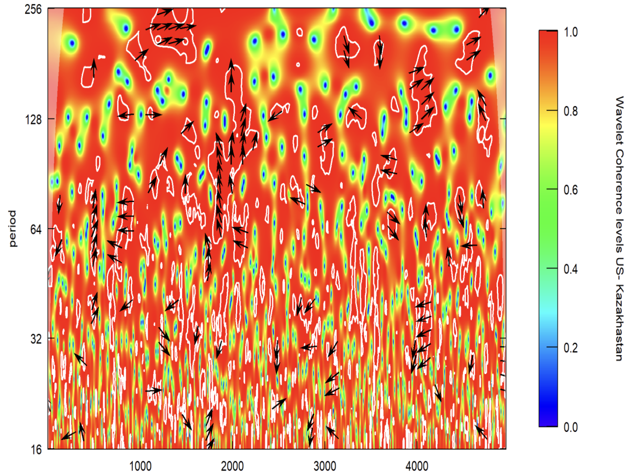
Frontier Countries- EMEA



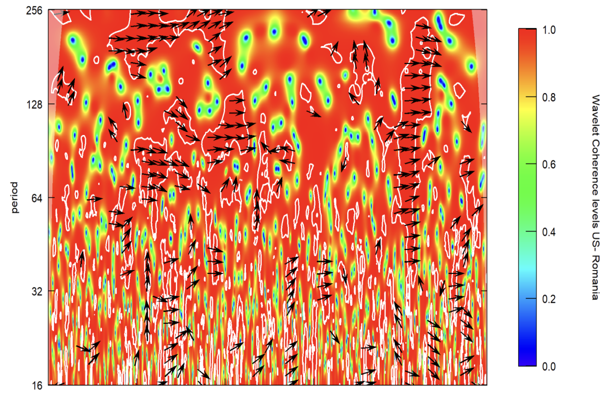
A) Wavelet Coherence US-Morocco (Market Capitalisation Ranking- 36).



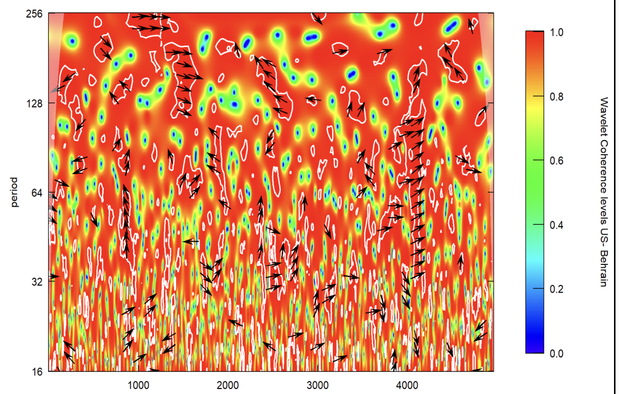
B)Wavelet Coherence US-Nigeria (Market Capitalisation Ranking- 37).



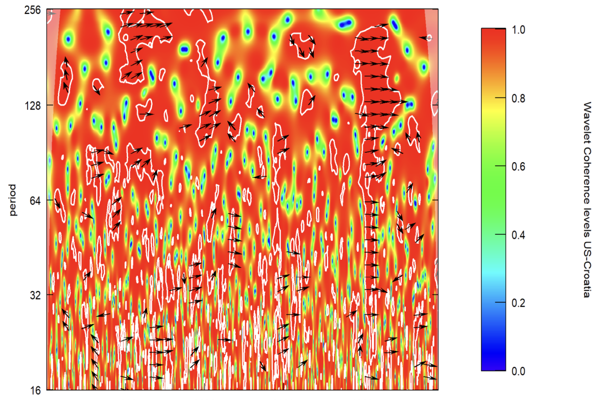
C) Wavelet Coherence US-Kazakhstan (Market Capitalisation Ranking- 40).



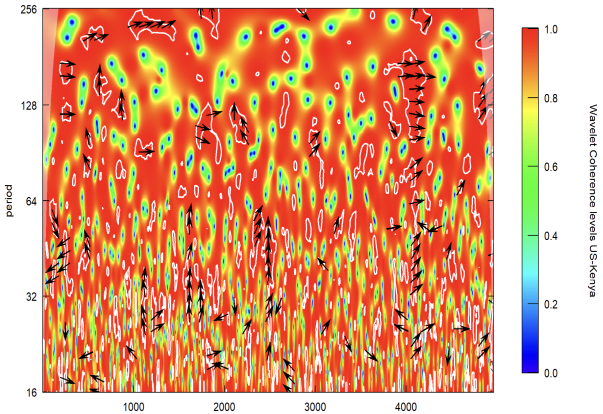
D) Wavelet Coherence US-Romania (Market Capitalisation Ranking- 44).



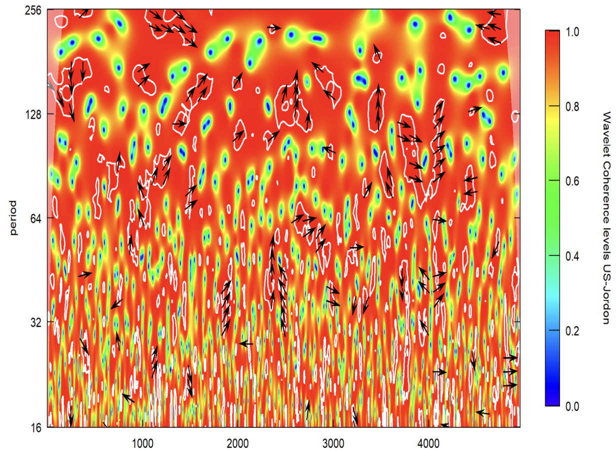
E) Wavelet Coherence US-Bahrain (Market Capitalisation Ranking- 45).



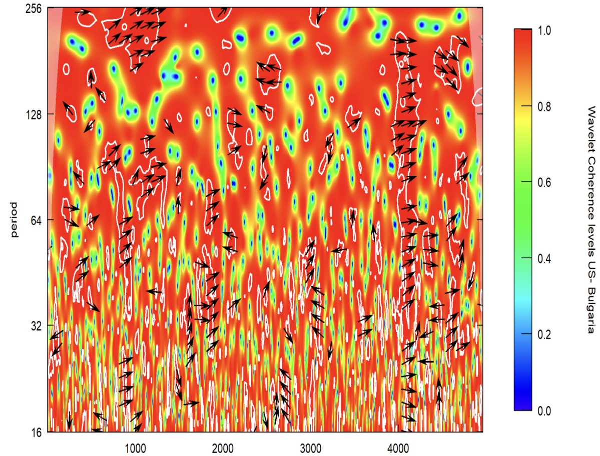
F) Wavelet Coherence US-Croatia (Market Capitalisation Ranking- 46).



G) Wavelet Coherence US-Kenya (Market Capitalisation Ranking- 47).

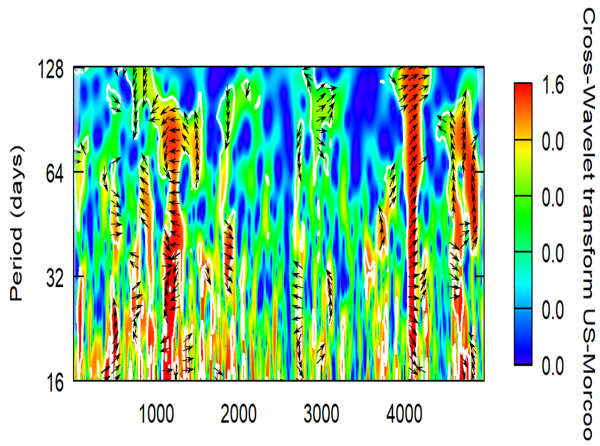


H) Wavelet Coherence US-Jordon (Market Capitalisation Ranking- 14).

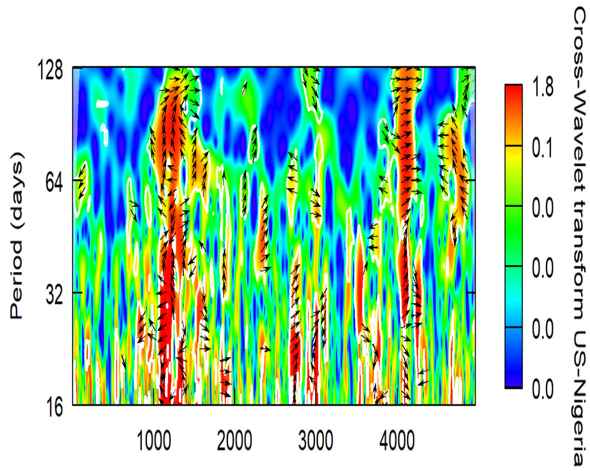


I) Wavelet Coherence US-Bulgaria (Market Capitalisation Ranking- 49).

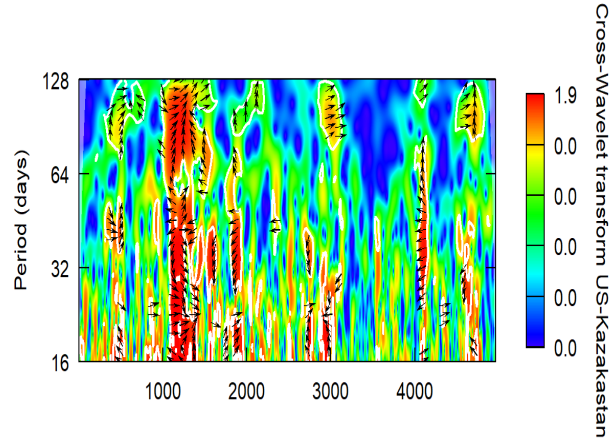
Fig. 6.7.0: Wavelet Coherence in the developed countries of the American region.



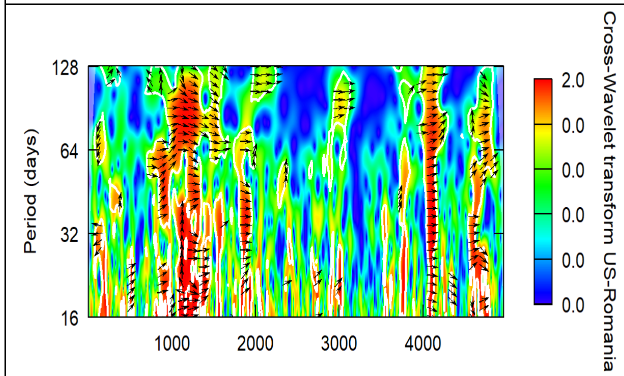
A) Cross-Wavelet Transform (XWT) US-Morocco (Market Capitalisation Ranking- 36).



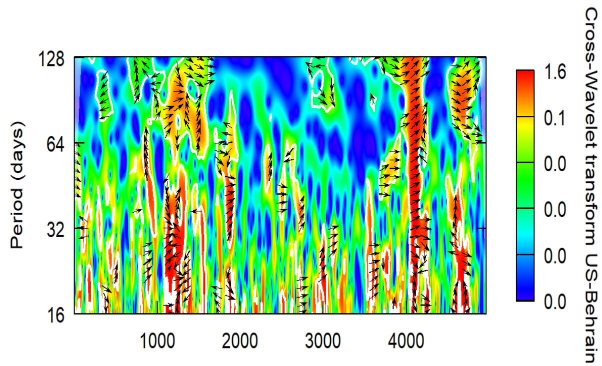
B) Cross-Wavelet Transform (XWT) US-Nigeria (Market Capitalisation Ranking- 37).



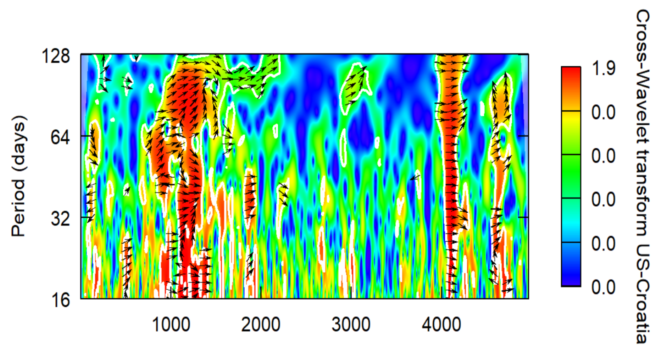
C) Cross-Wavelet Transform (XWT) US-Kazakhstan (Market Capitalisation Ranking- 40).



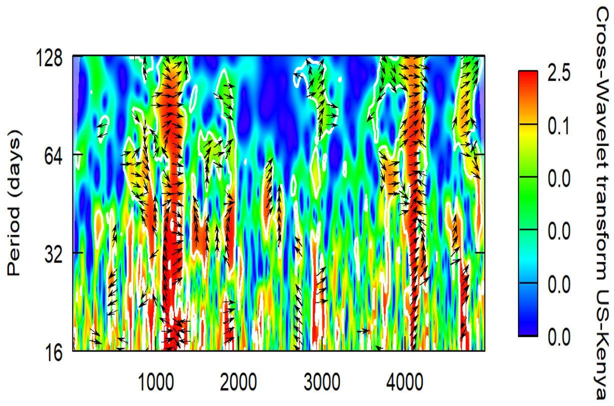
D) Cross-Wavelet Transform (XWT) US-Romania (Market Capitalisation Ranking- 44).



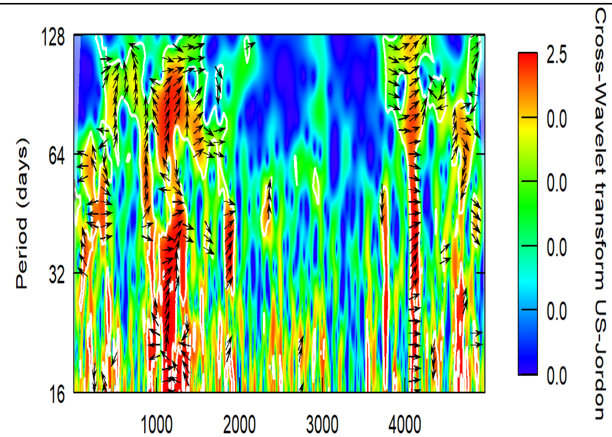
E) Cross-Wavelet Transform (XWT) US-Bahrain (Market Capitalisation Ranking- 45).



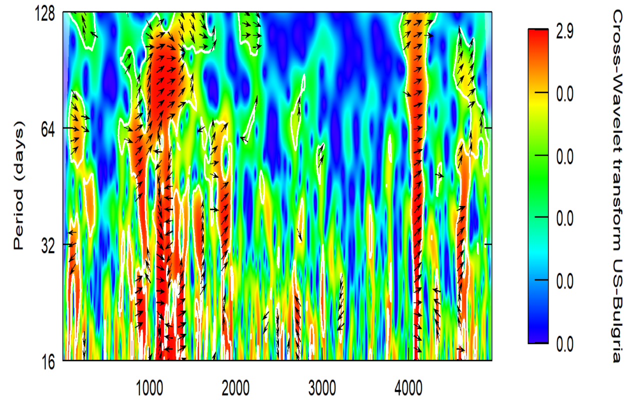
F) Cross-Wavelet Transform (XWT) US-Croatia (Market Capitalisation Ranking- 46).



G) Cross-Wavelet Transform (XWT) US-Kenya (Market Capitalisation Ranking- 47).

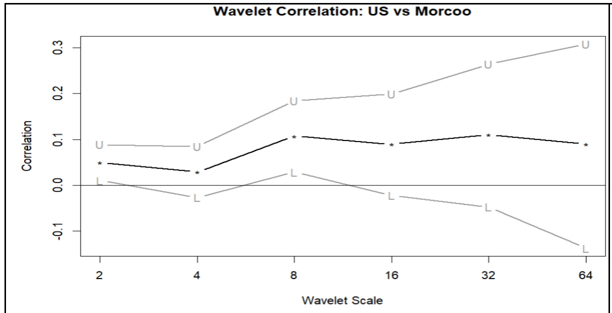


H) Cross-Wavelet Transform (XWT) US-Jordon (Market Capitalisation Ranking- 14).

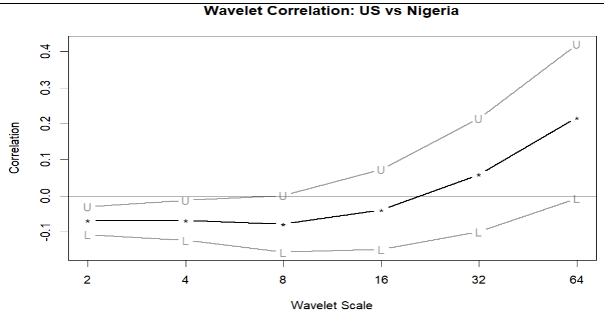


I) Cross-Wavelet Transform (XWT) among US-Bulgaria (Market Capitalisation Ranking-49).

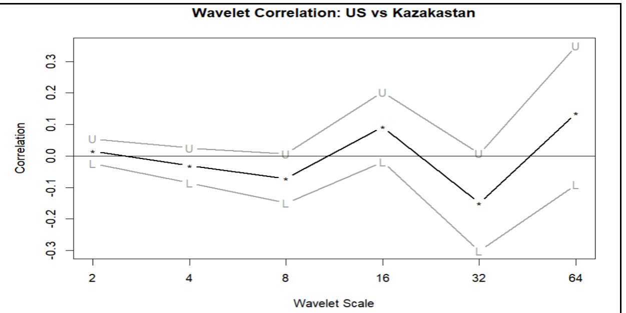
Fig.6.7.1: Cross-Wavelet Transforms (XWT) in the developed countries of the American region.



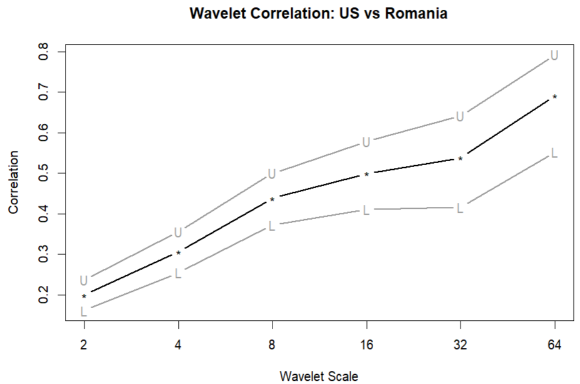
A) Wavelet Correlation US-Morocco (Market Capitalisation Ranking- 36).



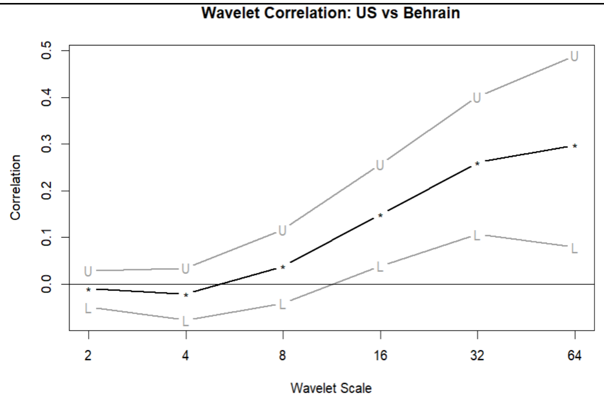
B) Wavelet Correlation US-Nigeria (Market Capitalisation Ranking- 37).



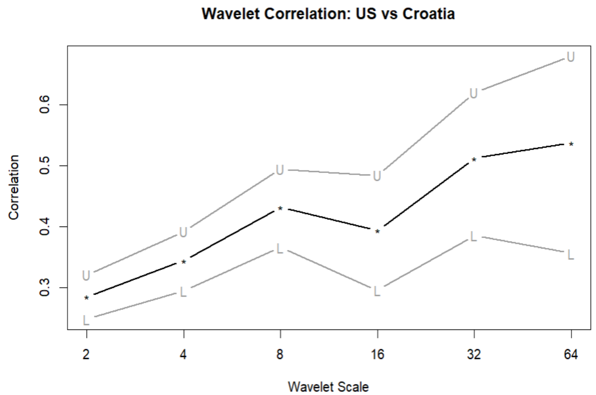
C) Wavelet Correlation US-Kazakhstan (Market Capitalisation Ranking- 40).



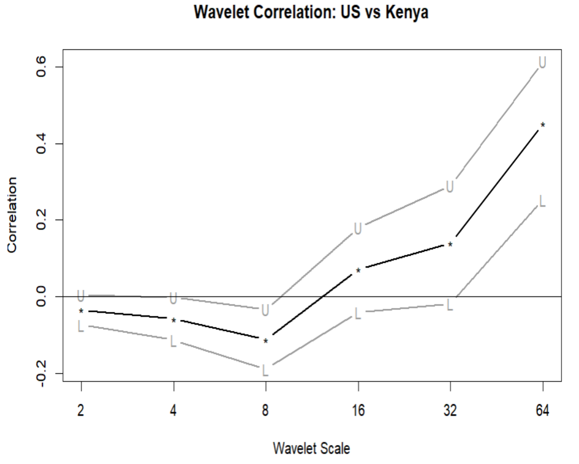
D) Wavelet correlation US-Romania (Market capitalisation Ranking-44).



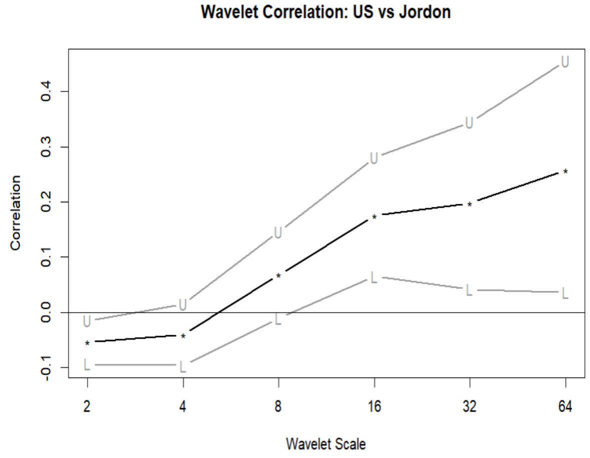
E) Wavelet Correlation US-Bahrain (Market Capitalisation Ranking- 45).



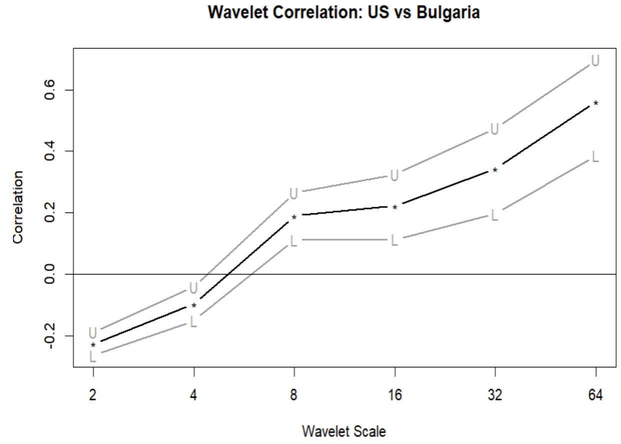
F) Wavelet Correlation US-Croatia (Market Capitalisation Ranking- 46).



G) Wavelet Correlation US-Kenya (Market Capitalisation Ranking-47).



H) Wavelet Correlation US-Jordon (Market Capitalisation Ranking- 14).



I) Wavelet correlation US-Bulgaria (Market Capitalisation Ranking -49)

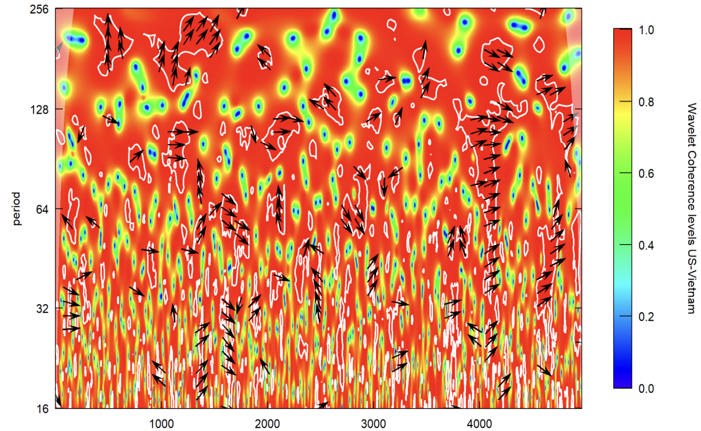
Fig.6.7.2: Wavelet correlation among US-Frontier stock market.

6.2.3.2 APAC Region

Studying wavelet coherence (Fig. 6.8.0 A) among frontier countries in the APAC region, i.e. Vietnam-US during GFC, from medium to long intervals (64-256 days) revealed high coherence. The rightward arrows indicated a positive correlation between the US and Vietnam markets, suggesting that global financial turmoil led to a coordinated market response throughout the global economy. In the EDC during the longer periods (128-256 days), medium-to-high harmony, but an increasingly essential weight that appears to have been deferred until now, indicating superior and more severe systemic effects in Vietnam because of European financial fear. CBB has shown mixed results, as in the short-term (16-64 days) lead-lag effects (arrows pointing right or up signify synchronization or the US dominant influence in Vietnam) are also shown to be considerable, with high coherence indicating that market volatility is transferred quickly from the US, possibly via a regional spillover effect. During Brexit, the coherence of Vietnam's indirect exposure (right vs slanted arrow directions as a double indication for overall lead/lag relationship; some responses in Vietnam were less straightforward) to global uncertainty because of Brexit is demonstrated moderately over the medium-term (32-128 days). Moreover, COVID-19 demonstrated unexpected consistency across time scales of interest (most right-pointing arrows indicate that the markets were in a phase, reflecting how the epidemic influenced global economic activity), particularly over longer durations (128-256 days), implying parallel global economic shocks affecting the US and Vietnamese markets that occurred in a coordinated process. Moreover, the Russia-Ukraine war has shown substantial consistency at medium time scales (32-128 days), implying that Vietnam's commercial links and exposure to international energy markets have geopolitical and economic spillover effects in her market.

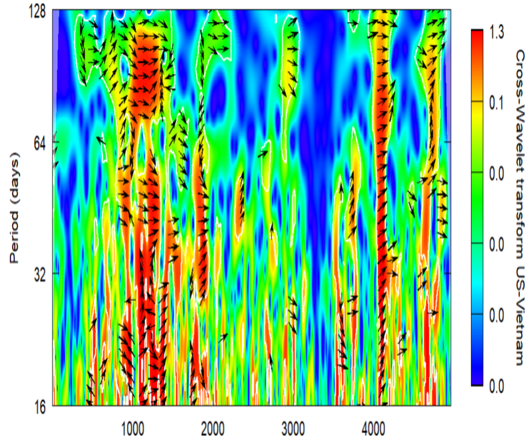
Furthermore, cross-wavelet transform (Fig. 6.8.0 B) has also shown significant results among US-Vietnam, strong positive lead-lag relationship during the COVID-19, but in GFC, it impacted in the longer period. The Russia-Ukraine war has shown co-movement for a short period and with moderate levels in other crises, revealing that wavelet coherence results are robust. Moreover, on studying wavelet correlation (Fig. 6.8.0 C), Vietnam showed a short-term tie with US markets that was comparatively weaker during the GFC. Still, their independence was ensured by the long-run relationship, which eventually entered the EDC period, with no significant disturbance in GFC. During EDC, an ordinary correlation grows from mid- to long-term (16-64). It indicates that Vietnam indirectly shows interconnectedness through the global economy, so the next medium to long-term trend will be towards the US; during the CBB, wavelet correlation showed a rising positive tendency throughout scales, with stronger correlation at shorter scales. This is an instantaneous and significant reaction to the Chinese market meltdown, particularly for Vietnam, which is likely owing to its geographical and economic proximity. During BREXIT, wavelet correlation gradually increases across all stages, particularly the intermediate scales (16-32). It implied that Vietnam's market reacted to global uncertainty with less intensity than the GFC or the Chinese crash. The slower development in correlation may reflect Vietnam's reduced direct exposure to the economic shock of Brexit. During COVID-19, the wavelet correlation increased dramatically across all scales, finishing at longer ones (32-64). It stressed an interconnected worldwide economic response since both markets reflected the pandemic's widespread destruction. The link across scales demonstrated Vietnam's exposure to global trends during this unusual occurrence. The association increased gradually, although it remains reasonably significant even at larger sizes (16-64). Thus, while the conflict's immediate impact did not appear to be as substantial on Vietnam as it was on others, the long-term consequences (e.g., oil costs supply chain interruptions) pulled Vietnam closer to the US side in terms of markets.

But, interestingly, as per DCC-GJR-GARCH results, Vietnam showed contagion effect from the US in all the crises except GFC (as shown less co-movements (lead-lag relationship) in the short to more extended period identified), which revealed Vietnam was impacted by US disturbances in long-term (wavelet methods has also shown least co-movement in EDC).



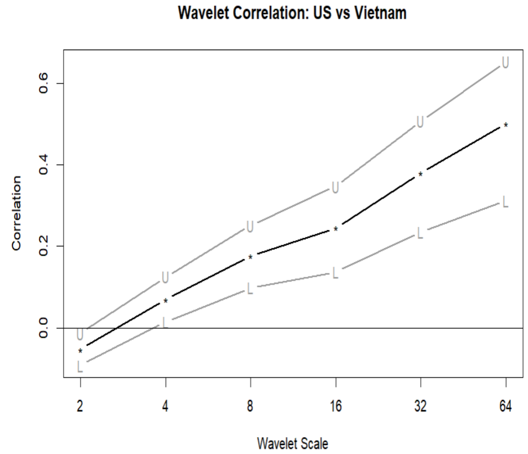
A) Wavelet Coherence US-Vietnam

(Market Capitalisation Ranking- 26).



B) Cross-wavelet transform US- Vietnam

(Market Capitalisation Ranking- 26).



C) Wavelet Correlation US- Vietnam

(Market Capitalisation Ranking- 26).

Fig. 6.8.0: Wavelet Coherence in the frontier countries of the APAC region.

6.3 Conclusion

During GFC (807 to 1431 observation) among developed countries, Japan, Australia (lower to top), the UK, Canada, and Switzerland are strong Germany Singapore in-fluctuations (medium, top level). Spain, Hong Kong, Russia, Australia, Brazil, and Mexico seem to have the least impact (lower to medium). Among emerging countries, Brazil, Mexico, and South Korea are strongly connected (low to high), Saudi Arabia, South Africa, India, Indonesia (medium to high), China, Malaysia, and Thailand are also the least impacted, and among frontier countries, Vietnam, Bulgaria, Croatia, and Romania positively correlated. However, higher co-moments were identified in the more extended period: Morocco, Nigeria, Bahrain, Kenya, Jordan, and Kazakhstan were the least impacted.

During the European debt crises (EDC) (1518 to 2328 observation) among developed countries, Russia (low to medium), the UK (low to high) in the longer term positively Switzerland, Germany, least impacted (medium to longer), Spain, Japan, Singapore (medium), Hong-Kong, Canada, Australia, less impacts. Among emerging countries, Brazil and Saudi Arabia showed some low and high-frequency co-moment, Mexico (at low-level period), South Africa (low to high), China and India least impacted, South Korea, Malaysia medium level, Thailand medium to high, Indonesia low to high. Among frontier countries, Morocco showed positive and negative significant impacts on the medium level, Kazakhstan at the upper medium scale, Bahrain at the top level, Romania at the all level, Nigeria, Kenya, Jordon as at the least impacted, Croatia (low and high level), Vietnam, (higher at low level), and Bulgaria (in longer period).

During the Chinese crash (2852 to 2996 observations), among developed countries, Japan (low to high), Hong Kong (low to medium), Australia, Canada (Medium), Russia were the least impacted, Singapore, Spain, Germany, Switzerland, UK on the lower level. Among frontier countries, Bulgaria, Vietnam, Morocco, and Kenya are least affected by Nigeria (in starting a few days), Kazakhstan scattered not linear moment, Romania (low to high), Bharain (low to middle), Croatia (low level) and Jordon (medium level) shown co-moment. Among emerging countries, South Korea, Brazil, Mexico, Saudi Arabia, Thailand, Indonesia, Malaysia, and China are the least impacted. However, up to certain limits, South Africa and India have shown co-moment.

During the Brexit crisis (3122 to 3453 observations), among developed countries, Singapore, Germany, and Switzerland made minor comments at a low level, Australia on the top level, Russia, Japan, Hong Kong, Spain, the UK, and Canada were least impacted. Indonesia, Malaysia, Thailand, Brazil, Mexico, Saudi Arabia, South Africa, China, and India were the least affected among emerging countries. South Korea indicated that co-movement went from a low to medium level. Among frontier countries, Vietnam, Bulgaria, Morocco, Nigeria, Kazakhstan, Romania, Bahrain, Croatia, and Kenya have slight co-movement at a low level and are the least impacted. Jordon indicated that the co-movement should be from medium to a high level.

During the COVID-19 crisis (4601 to 4963 observations), strong positive co-movements were identified with the US among all the countries. Among developed countries the UK, Spain (medium to high), Canada, Germany, Switzerland, Japan, Hong Kong, Australia, and Singapore (low to high). Among emerging countries are Mexico, Saudi Arabia, South Korea, Thailand, India, South Africa (low to high), Indonesia, Thailand, Malaysia, and Brazil (low to medium). Among the frontier countries, Kazakhstan, Nigeria, Morocco, Kenya, and Jordon showed the least co-moment, but Bahrain (medium period), Romania, Croatia (medium to long), Vietnam and Bulgaria (low to above medium period) had positive co-moment.

Strong co-movement was identified during the Russia-Ukraine crisis (4601 to 4963 observations) among developed countries, the UK, Canada, and Spain (low to medium period). In the emerging countries of South Africa and Malaysia, up to some limit, South Korea and India (medium) have demonstrated positive co-movement with the US. In the frontier, countries were less co-movement with the US in all the crises than in developed and emerging countries. Compared to other crises during COVID-19, a significant positive co-movement was identified among all the countries. During the Russia-Ukraine crises, Bulgaria, Romania and, up to some limit in the medium period, Croatia and Morocco showed significant co-movement in the frontier countries.

CHAPTER -7

CONCLUSION, LIMITATIONS, IMPLICATION, AND FUTURE RESEARCH AGENDA

CHAPTER -7

CONCLUSION, LIMITATIONS, IMPLICATION, AND FUTURE RESEARCH AGENDA

7.1 Study Conclusion

7.1.1 Major findings from the financial contagion among global stock markets –

- During global financial crises (GFC-2007 to 2009), Russia, Switzerland, Germany, Singapore, and Canada among developed countries; Mexico, Brazil, Thailand, South Africa, Indonesia, and Malaysia among emerging countries; and Croatia and Romania among frontier countries reported significant contagion effect among all the frontier countries on taking the US as the origin of crises during GFC. On analyzing correlation (developed markets have a strong connection with the US, whereas emerging and frontier markets have a low correlation) among all the countries taking the US as crises origin (using DCC-GJR-GARCH results) indicated Brazil, Mexico, Canada as highly integrated countries, in which India acted as connected contagion channel among all the countries, although due to different factors such as financial stability, financial innovation, and irrational behaviour (different sentiments) of investors may impact these contagion channels.

- Similarly, during EDC (May 2010- June 2013), Russia, Spain, Australia, Hong Kong, and Singapore among developed countries; Brazil, China, Saudi Arabia, South Korea, and Thailand among emerging countries; Croatia, Romania, Vietnam were identified as significantly impacted from financial contagion This might be owing to the U.S. losing economic supremacy because of the crisis, as well as China emerging as an economic powerhouse and improving trade and economic relations with other markets.

- Chinese burst bubble (June 2015 to Dec 2015) Singapore, Hong Kong, Australia, Japan, US, Germany, and Canada among developed countries; South Africa, Thailand, South Korea, Indonesia, India, Saudi Arabia, Malaysia, and

Brazil among emerging countries; Vietnam, Croatia, Jordon, Bahrain, Romania, Morocco, and Kazakhstan among frontier countries.

- During the BREXIT (June 2016 to Sept. 2017) event, emerging countries didn't show any contagion, but only Spain, Hong Kong, and Australia among developed countries; Vietnam, Bulgaria, and Nigeria among frontier countries had significant contagion.

- During the world health crisis, i.e. COVID-19 (Jan 2020 to April 2021), only Spain and Russia were among the developed countries; Bulgaria, Nigeria, and Kenya, among frontier countries, did not show significant contagion. The rest of the countries show considerable contagion.

- In geopolitical crises, i.e., the Russia-Ukraine crises (Feb 2022 to Feb 2023), all selected developed and emerging countries showed no contagion impact. Still, some volatility may occur among different countries or economic blocs during this period. Among all the frontier countries except Bulgaria, Kenya, and Romania, the rest of the countries were impacted due to contagion, which indicates frontier countries showed more contagious effects than other countries.

7.1.2 Major findings from the volatility spillover among the global stock markets –

- Before or pre-GFC, 73.68% volatility spillover was generated; Brazil, Switzerland, Germany, and Canada were major transmitters; Morocco, Spain and Croatia were major net receptors of the volatility spillover and weak integration identified during this period, indicating it as stable. During GFC, 84.37% volatility spillover was generated, suggesting a turbulent period. During this period, the US, Mexico, and Canada were identified as the major transmitters; Australia, Spain, and Nigeria were identified as the major receptors of the spillover. Moreover, minor impact in short period frequency (8.13%) and medium (72.77%), but a major impact in full period (80.91%) frequencies.

- During Pre-EDC, this study identified high volatility spillover, i.e. 83.54%, which indicates PIIGS, Morocco, and Saudi Arabia as major receptors, Kenya, Spain and the US as major transmitters of the spillover. During EDC, 76.47% volatility spillover was generated in the US, and Germany was the major transmitter. PIIGS and Kenya were the major receptors of the volatility spillover. It indicates that the US remains the epicentre of the spillover among all these countries. Less volatility spillover was generated during this period, possibly due to the pre-EDC period overlapping the GFC period, as EDC is a simulation crisis.

- During a pre-Chinese crash, 81.29% volatility spillover was generated in which the US (33.25%), Canada (25.1%), and Kenya (24.44%) were identified as the major net transmitter of the spillover. On analyzing developed countries, the US (33.24%), Canada (25.1%), and Russia (6.20%) were identified as major transmitters, and on the other side, Spain (-19.21%), Singapore (-15.94%), Japan (-7.66%) were identified as major net volatility spillover receiver.

- During the Chinese Crash, 91.45% volatility spillover was generated in which Canada (72.81%), Saudi Arabia (69.08%), and Nigeria (32.79%) are identified as the major transmitter; Singapore (-48.70%), Indonesia (-45.89%), Spain (-45.63%) are identified as the major receptor of the volatility spillover. Chinese crash generated 37.10% volatility spillover in short frequency, medium frequency generated 51.93%, and 89.03% in the full period as generated volatility spillover.

- During Pre-Brexit 92.94% volatility spillover and the reason may be due to oil crises; among developed countries, this study (indicated Japan (31.66%), Germany (30.90%), Hong Kong (20.97%) were the major net transmitter, and Australia (-47.92%), Spain (-39.47%), Switzerland (-36.56%) as major net receiver of the volatility spillover.

- During Brexit volatility spillover, 89.50% generated UK (35.44%), Switzerland (24.35%), Singapore (22.46%) were net transmitter; Canada (-41.29%), Hong-Kong (-6.34%), Singapore (-5.97) was major net receptor.

- ❖ During pre-COVID-19, no such interconnectedness was identified as it acted as a regular period, but it still generated an 84.64% volatility spillover among the selected stock market. South Africa (30.35%), Germany (28.22%), and Hong Kong (25.39%) were the major transmitters; Romania (-43.30%), Morocco (-34.93%), and Russia (-26.83%) were major receptor of the spillover.
- ❖ During COVID-19, 88.63% volatility spillover generated by the US (54.42%), Switzerland (33.40%), and Mexico (48.66%) were major transmitters; Kenya (-36.79%), Nigeria (-36.02%), and Japan (-34.68%) were major receptor of the spillover. On testing, different frequencies also showed low impact (35.73%), as compared to the medium (52.22%) and whole period (87.95%).
- ❖ During the Pre-Russia-Ukraine crises, volatility spillover among the developed countries indicates Russia (54.4%), Germany (49.09%), Spain (48.41%) as a major net transmitter; Singapore (-53.90%), Hong Kong (-52.87%), Japan (-52.60%) identified as the major net receiver.

On analyzing major net volatility spillover during Russia-Ukraine crises Germany (39.74%), Switzerland (29.52%), Japan (8.16%) among developed countries are major transmitter; India (31.89%), South Africa (30.66%), Thailand (22.24%) among emerging countries; Bahrain (33.65%), Romania (31.82%), Croatia (20.25%) among frontier countries. On analyzing the volatility spillover on the different frequency domains, this study found short frequency (27.49%), high spillover in just starting, medium frequency (56.11%), and total frequency (83.60%). TVP-VAR-BK Model results indicated that in just four days, 27.49% volatility spillover was generated, 56.11% was in the medium term, and 83.60% was in the longer term.

7.1.3 Major findings from the co-movement among the global stock markets –

- ➢ During GFC (807 to 1431 observation) among developed countries, Japan, Australia (lower to top), the UK, Canada, and Switzerland are strong Germany Singapore in-fluctuations (medium, top level). Spain, Hong Kong, Russia, Australia, Brazil, and Mexico seem to have the least impact (lower to medium). Among emerging countries, Brazil, Mexico, and South Korea are strongly connected (low to high), Saudi Arabia, South Africa, India, Indonesia (medium to high), China, Malaysia, and Thailand are also the least impacted, and among frontier countries, Vietnam, Bulgaria, Croatia, and Romania positively correlated. However, higher co-moments were identified in Morocco, Nigeria, Bahrain, Kenya, Jordan, and Kazakhstan as least impacted in the more extended period.

- During the European debt crises (EDC) (1518 to 2328 observation) among developed countries, Russia (low to medium), the UK (low to high) in the longer term positively Switzerland, Germany, least impacted (medium to longer), Spain, Japan, Singapore (medium), Hong-Kong, Canada, Australia, less impacts. Among emerging countries, Brazil and Saudi Arabia showed some low and high-frequency co-moment, Mexico (at low-level period), South Africa (low to high), China and India least impacted, South Korea, Malaysia medium level, Thailand medium to high, Indonesia low to high. Among frontier countries, Morocco showed positive and negative significant impacts on the medium level, Kazakhstan at the upper medium scale, Bahrain at the top level, Romania at all levels, Nigeria, Kenya, and Jordon as at the least impacted, Croatia (low and high level), Vietnam, (higher at low level), and Bulgaria (in longer period).

- During the Chinese crash (2852 to 2996 observations), among developed countries, Japan (low to high), Hong Kong (low to medium), Australia, Canada (Medium), Russia were the least impacted, Singapore, Spain, Germany, Switzerland, UK on the lower level. Among frontier countries, Bulgaria, Vietnam, Morocco, and Kenya are least affected by Nigeria (in starting a few days), Kazakhstan scattered not linear moment, Romania (low to high), Bharain (low to middle), Croatia (low level) and Jordon (medium level) shown co-moment. Among emerging countries, South Korea, Brazil, Mexico, Saudi Arabia, Thailand, Indonesia, Malaysia, and China are the least impacted. However, up to certain limits, South Africa and India have shown co-moment.

- During the Brexit crisis (3122 to 3453 observations), among developed countries, Singapore, Germany, and Switzerland made minor comments at a low level, Australia on the top level, Russia, Japan, Hong Kong, Spain, the UK, and Canada were least impacted. Indonesia, Malaysia, Thailand, Brazil, Mexico, Saudi Arabia, South Africa, China, and India were the least affected among emerging countries. South Korea indicated that co-movement is from a low to medium level. Among frontier countries, Vietnam, Bulgaria, Morocco, Nigeria, Kazakhstan, Romania, Bahrain, Croatia, and Kenya have slight co-movement at a low level and are the least impacted. Jordon indicated that the co-movement should be from medium to high level.

- During the COVID-19 crisis (4601 to 4963 observations), a strong positive co-movement was identified among the US countries. Among developed countries the UK, Spain (medium to high), Canada, Germany, Switzerland, Japan, Hong Kong, Australia, and Singapore (low to high). Among emerging countries are Mexico, Saudi Arabia, South Korea, Thailand, India, South Africa (low to high), Indonesia, Thailand, Malaysia, and Brazil (low to medium). Among the frontier countries, Kazakhstan, Nigeria, Morocco, Kenya, and Jordon showed the least co-moment, but Bahrain (medium period), Romania, Croatia (medium to long), Vietnam and Bulgaria (low to above medium period) had positive co-moment.

- During the Russia-Ukraine crisis (4601 to 4963 observations) among developed countries, the UK, Canada, and Spain (low to medium period), another strong co-movement was identified. In the emerging nations of South Africa and Malaysia, up to some limit, South Korea and India (medium) have shown positive co-movement with the US. In the frontier, countries were less co-movement with the US in all the crises than in developed and emerging countries.

Different results indicated that significant changes were established in the selected stock markets during all the crises based on the time frame and origin of the crises. As on analyzing the volatility spillover among all the selected countries, Pre-Brexit (92.94%)(as in the same time frame, oil crash also occurred), Pre Russia-Ukraine crises (91.62%) (as still in the more extended period COVID-19 impacts are observed), Chinese crash (91.45%), Brexit (89.50%), Covid -19 (88.64%), Russia-

Ukraine crises (85.80%), Pre-Covid (84.64%), GFC (84.37%), Pre-EDC (83.54%), Pre-Chinese (81.29), Pre-GFC Crises (73.68%), EDC Crises (76.47%), were the major impacted crises among all the selected countries.

Analyzing financial contagion identified that significant countries affected by the crisis origin, such as COVID-19 and GFC, were the most impacted by crises.

Among all the crises, different levels of co-movement were identified with the selected stock market in the US based on the various intensities of the crises. However, during GFC and COVID-19, high co-movement identified among all these countries, especially developed and emerging countries, showed a higher movement level but low co-movement identified among the frontier countries, which can act as for the hedging perspective.

7.2 Results of the Hypothesis

H_{01} = There is an impact of volatility spillover in the selected stock markets during global crises.

Accepted!

Significant volatility spillover was generated among the selected stock market during the different crises, although different intensities and magnitudes were identified in the various crisis periods.

H_{02} = There is financial contagion across the selected stock markets during global crises.

Accepted!

Financial contagion significantly impacts the selected stock market during different crises, although different intensities and magnitudes were identified in the various crisis periods.

H_{03} = There is time-frequency co-movement between the selected stock markets during the crises.

Accepted!

There is a significant impact on the time-frequency co-movement in the selected stock market. However, it varied in intensity in different periods, i.e. short, medium and long periods. High co-movement with the US was identified during the GFC and COVID-19 in the brief period.

7.3 Suggestions for the Portfolio

The empirical results of this study may have an impact on the decisions made by domestic and foreign investors, brokers/agents, fund managers, institutional investors, policymakers, regulators, and the regulatory authority of the national stock markets concerning the creation and modification of new asset allocation strategies for the current and upcoming crisis periods. Corporate management can make significant inferences from the study's findings or choose to raise additional funds through ADRs or GDRs or from outside markets in their local markets. By consulting this study, multinational financial institutions and trading partners may be able to develop more successful risk-diversification strategies shortly.

The results of this study can assist leverage traders, like hedge fund managers, in picking the markets with the highest volatility so they can make more money down the road. The majority of retail investors concentrate on low-risk markets. As a result, the findings of this thesis give domestic retail investors more reasons to be optimistic about international investments. Two primary approaches for global investments and portfolio diversification are prioritised: investing in various markets with solid correlations or few interconnections. The impact of a shock in one market may not be readily felt by other markets' results if there are relatively few interlinkages between various asset classes or markets. Alternatively, it may be useful to ascertain the potential for investor losses if the correlation between the asset markets has been stable over the previous period. For future reference, a better perspective of the integration of the global financial markets might be obtained from the results of the conditional correlation analysis conducted during the crisis era.

Moreover, specific recommendations are as follows -

From the analysis of the volatility spillovers between stocks during various financial crisis periods, the following portfolio-based suggestions and implications can be derived:

- Low-Correlation Markets Diversification:

High market interconnectedness during periods of high volatility spillover (like GFC, Chinese Crash, Brexit) Investors can reduce portfolio risk by diversifying into less integrated markets with weak spillover effects (e.g., Morocco, Croatia, Kenya, etc.). Short-frequency integrated periods, like pre-GFC or pre-COVID-19, are better for investments because they are more stable. Such periods can be a source of sustainable returns for investors, signalling to focus on regions with lower volatility transmission, exemplified by Morocco and Spain Pre-GFC.

- Strategic Hedging in the Age of Turbulence:

During turbulent times like the GFC, the Chinese Crash, and COVID-19, investors should closely follow the major volatility transmitters such as the US, Canada, and Germany. In hedging, investors can hedge their position with risk about these derivatives, like options and futures, to mitigate risk in these markets.

- Short-Term Tactical Shifts:

During events such as the Russia-Ukraine crisis, high volatility spillover is observed in the short run as per the TVP-VAR-BK Model. Investors must be nimble and employ tactical asset allocation strategies to minimise those near-term risks.

- Diversification by Sector and by Asset Class:

In particular, crises (e.g., pre-Brexit) can be sector-specific spillovers. This is why the risk of diversification across asset classes (commodity, equities, bonds) and sectors is essential to reduce sector risk in the whole portfolio.

- Invest in Emerging Markets and Frontier Markets

Emerging markets such as India and South Africa and frontier markets such as Bahrain and Romania have proven resilient or have been dominant spillover receptors in past turmoil. A portion of the portfolio can be allocated to contain exposure to these markets while prospects for growth. Still, the investors must keep in mind the volume of trade, especially concerning the country in crisis origin.

- Frequency-specific risk management

Different frequencies of volatility spillovers reflect different time lengths for the impact duration. For instance, the observation of higher medium and full-period spillovers for the COVID-19 crisis indicates a need for medium-to-long-term mitigating strategies for financial contagion. In contrast, spillovers in the short-run for the Russia-Ukraine crisis underscore the need for swift response mechanisms.

- Portfolio Implications:

1.) The effect of crisis events on regional markets hides the impact of crisis events on global markets. Crisis creates an environment of closer global market integration and lends greater systemic risk than is the norm. In turbulent times, portfolio managers need to account for the interconnectivity of international markets as they build portfolios. Economies such as the US, Germany, and Canada are persistent transmitters. Global portfolios are also swayed by market conditions in regions like North America, Europe, and Asia, which makes it essential to keep looking at their economic indicators and policies. Investor awareness of emerging risks, such as geopolitical tensions and economic disruptions, can cause significant volatility spillovers to globally linked markets. In short, based on the results of this study, investors can shift their portfolios to the least connected markets based on the behaviours of crises.

2.) Moreover, regarding financial contagion based on DCC-GJR-GARCH results, the portfolio of non-contagious countries from crisis origin in such countries can be shifted if investors are looking for long-term investment strategies. However, for short-term investment or earning from short-term volatility, TVP-VAR-BK results can help portfolio investors build strong portfolios.

3) The practical implication of DCC-GJR-GARCH results suggests that investors have to make decisions based on the country of crisis origin as the results vary from

country to country based on crisis origin. Thus, investors can hedge risk by shifting their portfolio to other investment sources or countries with non-contagious behaviour if they are looking for long-term investment options.

4) Different investment strategies can be created by understanding wavelet model results, as this study identified the least co-movement despite crises in many frontier countries; still, I suggest investors should look at least reactive or co-movement countries that don't follow US stock markets. Among the global stock markets, frontier countries revealed less co-movement with the US, especially Nigeria, Kazakhstan, and Jordon stock markets, which show the least co-movements with the US. Thus, this study suggests that in case of instability in the US, investors may hedge risk by shifting to frontier countries.

In short, based on this study, it can be stated that in times of crisis, portfolio strategies can be framed by shifting portfolios to emerging or frontier countries as a better option to keep funds on the safer side, which also caused the least contagion, spillover and co-movement in regional or global stock markets.

4. Crises-specific implication in this study from the TVP-VAR model based on the market capitalisation least impacted countries among developed, emerging, and frontier countries.

- During GFC-like crises, South Africa (-1.39 %) and Switzerland (-1.76 %) can act as a haven, as the least impacted, despite the considerable crash and global recession.
- During EDC, Hong Kong (2.59 %) and Jordon (-4.49%) can act from a hedging perspective as the least impacted among the selected countries.
- During the Chinese Brust Bubble, Japan (-4.77%) and Bahrain (1.95%) can be hedged as the least generated shocks.
- During the BREXIT crisis, Germany (1%) and China (-2.9 %) can be hedged as the least generated shocks.

- During the Covid-19 crisis, Spain (0.07 %) and Hong Kong (1.57%) can act as hedges as the least generated shocks.
- During the Russia-Ukraine crisis, Russia (-1.41 %) and Jordon (-2.29 %) can act as a hedge, as shown in the net least.

Moreover, the investor has to keep track before taking a final investment decision making based on variable sections impacts of the following battery of macro variables and country characteristics i.e., market capitalization, financial claim, risk, other macro variables (such as corruption, FDI, FII, export-import to GDP), Volatility Index (VIX), market sentiments indicators, economic indicators, sector Performance and other indicators such as Price to Earning ratio (P/E ratio), Dividend Yield, Earning per share (EPS), Beta, Debt-to- equity ratio (D/E), Price-to-Book Ratio (P/B Ratio), Return on Equity (ROE), & Return on Investment (ROI).

7.4 Limitations of the Study

I. The limitations of the econometric analysis of time series data are applicable in this study, as panel data with macro variables can clarify regional contagion or spillover more.

II. This study is limited to only highly market-capitalized (top ten) developed, emerging, and frontier countries.

III. This study is limited to the daily closing price as a variable only. Thus, there is a time lag between information generation and transmission to other markets during crises. The study of financial contagion may be limited because end-point data only captures the overall impact of the day.

IV. This study is limited to the six major crises only, i.e., the GFC, EDC, Chinese burst bubble, Brexit, COVID-19, and Russia-Ukraine crises. There could be numerous events, and these were major events that this study identified based on the different literature. By studying major crises, some portfolio managing strategies can be framed.

V. Stock market indices reflect each country's economic activity. The fundamentals of these countries may also have a significant impact on results.

Moreover, the interconnectedness of global financial markets has greater relevance in a turbulent world with interconnected economies; therefore, understanding the spillover effect is crucial for investors, policymakers, and the public. Analysis of stock market spillover, contagion effects, and co-movements is vital for promoting economic growth and financial resilience, fostering cooperation among global stock markets through different regional blocs or forums, and the various countries' inter-trade or bilateral trade partnerships. By disseminating knowledge about these dynamics, this research serves the public interest by contributing to a more stable and secure financial portfolio for individuals. This can help the investor make more informed decisions, manage risk and diversify their portfolio effectively in the relationship of the different crises by understanding its impact severally on the type of country, i.e., developed, emerging, and frontier economies, as different sentiments can be generated from these source of information. This study also reminds us of the importance of considering major events and crises when studying how markets are connected.

7.5 Future Scope of the Study

Finally, based on our review of the studies discussed in this study and concerning the identified gaps in the existing literature, this study suggests the following future research agenda.

I. High-frequency data (higher than daily) has not been widely used in the contagion literature. However, given the nature of return and volatility transmission relationships that occur in the geographical sequences of markets trading in intra-daily time intervals, based on the review, it can be believed that this is an area where various contributions can still be made.[20] In particular, the

[20] Lyócsa et al., (2021) considered daily, low-frequency volatility estimators based on open, high, low, and close daily prices.As the forecast horizon increases (up to one month), the difference in forecast accuracy becomes statistically indistinguishable for most market indices. On studying a simple asset allocation problem. the results reveal that asset allocation based on high-frequency volatility model forecasts does not outperform asset allocation based on low-frequency volatility model forecasts. But still it could be studied whether results varies based on different set countries or not.

current scenarios of political strikes, such as the Israel-Hamas attack, and systemic risks, such as SVB collapse.

II. Although it is a relatively new area of research in international information flow studies, futures contract data has not received full attention from previous literature. This is a field also for futures to act as directly investable instruments and not, for instance, the underlying stock indices. In my view, making trading volume part of the equation to shed light on return and volatility transmission relationships is another untapped field that could be addressed.

III. The novel Cryptocurrency Uncertainty Index of Lucey et al. (2021), or the overall impact of uncertainty (OIU) measure of Szczygielski et al. (2022), should be more extensively used as well, along with the latest models. High Frequency data should tested, which can give impactful results for the intra-traders, with contagion and volatility spillover effects.

IV. Research on return and volatility transmission should take a broader approach to incorporate investors' emotional or sentimental behaviour with the other behavioural finance elements. Further examination of the media, news, and the effects of announcements on the dynamic links between financial markets should be carried out in the contagion literature since emotional contagion and shifts in investment sentiments are significant factors in the financial contagion process.

V. Certainly, the repercussions of earlier pandemics, the recent Silicon Valley Bank crash, and the impacts of Middle Eastern volatility, i.e., the Israel-Hamas conflict, could be investigated through the lens of stock market interconnectedness, including its nature and magnitude. Further analyses that elucidate how emergencies or instabilities have altered the channels for spillovers and contagion are particularly significant, especially on a global scale that connects international stock markets with any segment of the broader financial markets, including the correlations between the stock market and other sectors of the larger economic market.

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APPENDICES 1

DESCRIPTIVE STATISTICS OF RETURNS SERIES (FULL DATASET).

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Sum	Sum Sq. Dev.	Observations	ADF	JB & ADF-P-Values
Australia	0.000145	0.000579	0.04755	-0.056	0.00716	-0.5759	9.23126	8303.72	0.71811	0.25432	4963	-4.728	0.01
Bahrain	0.000053	0	0.02711	-0.0462	0.00424	-0.99	14.7907	29559.1	0.26314	0.08915	4963	-5.952	0.01
Brazil	0.000346	0.000499	0.08261	-0.1173	0.01141	-0.3894	10.0133	10296.8	1.71735	0.64567	4963	-5.667	0.01
Bulgaria	0.000054	6.59E-05	0.06165	-0.0959	0.00794	-1.1366	18.4886	50677	0.26815	0.31313	4963	-5.535	0.01
Canada	0.000175	0.000576	0.07723	-0.0875	0.00734	-0.9259	18.6364	51268.9	0.86978	0.2671	4963	-6.381	0.01
China	0.000162	0.000024	0.08229	-0.0843	0.01047	-0.4156	8.16815	5666.26	0.80279	0.54383	4963	-5.865	0.01
Croatia	0.000145	0.0003	0.1097	-0.0926	0.00762	-0.6851	27.0009	119509	0.71774	0.28784	4963	-5.271	0.01
Germany	0.000284	0.000776	0.06595	-0.0649	0.00923	-0.4483	8.53112	6492.7	1.4074	0.42292	4963	-5.345	0.01
Hong_Kong	9.19E-05	0.00035	0.0771	-0.1099	0.00999	-0.2463	10.6783	12242	0.45621	0.49533	4963	-4.524	0.01
India	0.000518	0.000966	0.0913	-0.079	0.00953	-0.4571	12.0853	17241.8	2.57261	0.45051	4963	-6.547	0.01
Indonesia	0.000441	0.000647	0.071	-0.0684	0.0089	-0.7219	11.9446	16975.7	2.18834	0.39302	4963	-6.327	0.01
Japan	0.00021	0.000468	0.08518	-0.0866	0.00969	-0.4236	11.5877	15398.9	1.04164	0.46628	4963	-5.973	0.01
Jordon	3.96E-05	0	0.04446	-0.0566	0.00606	-0.7559	14.3965	27330.7	0.19635	0.1822	4963	-5.685	0.01
Kazakastan	0.000588	0.000291	0.1379	-0.0897	0.01247	0.71721	17.7253	45265.1	2.92032	0.77141	4963	-6.505	0.01
Malaysia	0.0001	0.00017	0.02632	-0.0515	0.00523	-0.742	10.7903	13005.3	0.50143	0.13556	4963	-5.462	0.01
Kenya	-9.70E+00	0	0.06588	-0.053	0.00647	0.32444	15.4167	31968.9	-0.4816	0.20742	4963	-5.798	0.01
Mexico	0.00033	0.00056	0.06248	-0.0637	0.00846	-0.1604	8.19718	5606.87	1.67265	0.35473	4963	-5.510	0.01
Morcoo	0.000146	0.00015	0.03611	-0.0844	0.00611	-1.2725	19.9656	60860.8	0.72629	0.18514	4963	-5.866	0.01
Nigeria	0.00016	0	0.06052	-0.0479	0.00832	0.09217	8.68574	6692.11	0.80635	0.34316	4963	-5.318	0.01
Romania	0.000281	0.00044	0.09164	-0.086	0.01032	-0.6993	13.0726	21385.1	1.39573	0.52807	4963	-5.203	0.01
Russia	0.000347	0.000625	0.15557	-0.182	0.01342	-1.0271	28.0174	130297	1.72279	0.89359	4963	-5.227	0.01
Saudi_Arabia	0.00014	2.78E-05	0.08639	-0.105	0.01034	-1.5433	18.4189	51133.5	0.69269	0.53009	4963	-4.239	0.01
South_Korea	0.00025	0.000526	0.06942	-0.0939	0.00846	-0.7721	13.104	21604.7	1.23877	0.35494	4963	-5.382	0.01
Singapore	0.00011	0.000287	0.0575	-0.0639	0.00721	-0.256	10.6692	12217.1	0.58618	0.25792	4963	-3.993	0.01
South_Africa	0.00041	0.00077	0.06454	-0.055	0.00902	-0.1706	7.36242	3959.47	2.06545	0.40373	4963	-5.789	0.01
Spain	3.27E+00	0.000539	0.06272	-0.0773	0.0099	-0.4423	8.87232	7292.81	0.16229	0.4864	4963	-3.929	0.01
Switzerland	0.00013	0.00057	0.07768	-0.0767	0.00747	-0.7496	13.6305	23833.7	0.6888	0.27709	4963	-5.794	0.01
Thailand	0.00016	0.00039	0.05125	-0.0906	0.00802	-1.0277	14.0246	26007.3	0.82804	0.31946	4963	-5.565	0.01
US	0.0002	0.000692	0.06204	-0.0741	0.00796	-0.6973	11.4313	15102.4	1.39632	0.31446	4963	-5.227	0.01
Vietnam	0.00031	0.00058	0.04636	-0.0515	0.01057	-0.3358	6.11486	2099.61	1.55548	0.55458	4963	-4.958	0.01

Note: All the selected stock markets are stationary at first difference.

APPENDICES 2

DESCRIPTIVE STATISTICS OF VOLATILITY SERIES (FULL DATASET).

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Sum	Sum Sq. Dev.	Observations	ADF	ADF & JB p-value	ARCH LM Statistic.Chi-squared	p-value.Chi-squared
Australia	0.006428	0.005514	0.031909	0.002995	0.003287	3.183179	18.27997	56662.58	31.90462	0.053603	4963	-7.83084	0.01	306.513733	3.98E-64
Bahrain	0.002805	0.002503	0.014125	0.001662	0.001086	3.521271	23.63757	98330.82	13.92225	0.005853	4963	-8.88186	0.01	0.40640988	0.995151202
Brazil	0.010421	0.009406	0.053829	0.006397	0.004129	4.516188	33.19034	205352.5	51.71942	0.084587	4963	-7.95797	0.01	410.185603	1.89E-86
Bulgaria	0.004608	0.003678	0.038468	0.002273	0.002978	4.028613	27.26363	135167.8	22.87197	0.044019	4963	-9.32333	0.01	92.7804334	1.75E-18
Canada	0.006187	0.004998	0.052534	0.002366	0.004252	3.980238	26.40439	126377.6	30.70549	0.089703	4963	-7.43416	0.01	556.248308	5.72E-118
China	0.009561	0.008071	0.043928	0.003523	0.00478	1.902897	8.276735	8753.077	47.45231	0.113352	4963	-6.51012	0.01	105.344577	3.94E-21
Croatia	0.004285	0.003271	0.033943	0.001956	0.003008	3.78351	23.588	99492.71	21.267	0.044895	4963	-6.92155	0.01	162.272436	3.24E-33
Germany	0.008334	0.007075	0.050979	0.00385	0.004482	2.95585	16.42873	44517.92	41.36078	0.099665	4963	-8.14173	0.01	312.766122	1.80E-65
Hong_Kong	0.008987	0.007796	0.055314	0.004204	0.004387	3.225865	21.09131	76289.64	44.60274	0.095489	4963	-6.53672	0.01	197.00808	1.24E-40
India	0.008397	0.006958	0.05229	0.003509	0.004865	3.176114	17.87558	54103.68	41.6719	0.117459	4963	-7.70608	0.01	18.8617098	0.002039522
Japan	0.008716	0.007584	0.061618	0.004591	0.004403	4.452973	35.81914	239136.3	43.25987	0.09618	4963	-8.87777	0.01	245.711776	4.57E-51
Indonesia	0.007802	0.006428	0.051746	0.00351	0.004646	3.369913	20.15178	70228.24	38.72041	0.107099	4963	-9.4473	0.01	466.134907	1.62E-98
Jordon	0.00356	0.002805	0.01449	0.001526	0.002119	2.158546	8.308674	9681.842	17.66863	0.022278	4963	-5.06964	0.01	4.09665905	0.535585101
Kenya	0.00547	0.004239	0.053104	0.002788	0.003874	4.325607	31.58588	184457.4	27.15009	0.074457	4963	-7.36722	0.01	180.556052	4.07E-37
Kazakhstan	0.010347	0.007791	0.079073	0.003422	0.007479	2.624574	13.62675	29050.37	51.35421	0.277583	4963	-11.2674	0.01	853.989424	2.41E-182
Malaysia	0.003296	0.002892	0.015395	0.001575	0.001475	2.811295	15.86255	40750.11	16.35656	0.0108	4963	-7.41866	0.01	6.65175098	0.247854651
Morocco	0.003567	0.003091	0.022403	0.001925	0.001605	3.525645	25.14408	111684.2	17.70245	0.012776	4963	-7.98097	0.01	336.766189	1.24E-70
Mexico	0.007618	0.006539	0.046177	0.003832	0.003798	3.294701	20.86277	74961.71	37.80843	0.071559	4963	-9.58897	0.01	214.359125	2.40E-44
Nigeria	0.007169	0.005404	0.054442	0.003423	0.004953	2.879727	14.39966	33732.59	35.58012	0.121719	4963	-10.9452	0.01	338.416768	5.45E-71
Romania	0.008718	0.006623	0.068996	0.003874	0.006258	3.278049	18.04803	55714.95	43.26574	0.194297	4963	-9.05709	0.01	214.64379	2.09E-44
Russia	0.010878	0.008488	0.097823	0.004748	0.00779	4.650712	35.4265	235327.8	53.9887	0.301144	4963	-7.04833	0.01	84.2557503	1.08E-16
Saudi-Arabia	0.008835	0.006843	0.055751	0.003403	0.006208	3.045067	15.76076	41343.15	43.85033	0.191262	4963	-7.68466	0.01	289.156221	2.15E-60
Singapore	0.006272	0.005147	0.040246	0.002767	0.003605	3.088698	17.14384	49259.53	31.12954	0.064493	4963	-6.99766	0.01	132.346875	7.56E-27
South-Africa	0.008233	0.007228	0.036755	0.004091	0.003723	2.912573	15.76856	40731.46	40.86174	0.068786	4963	-7.17961	0.01	188.495839	8.19E-39
South-Korea	0.007513	0.006464	0.054002	0.003395	0.004027	3.897428	28.74863	149665.8	37.28676	0.080454	4963	-7.92706	0.01	469.544256	2.98E-99
Spain	0.008918	0.007445	0.053502	0.004134	0.004874	2.894936	16.09353	42384.65	44.26164	0.117898	4963	-8.72139	0.01	458.904848	5.89E-97
Switzerland	0.006617	0.00558	0.051158	0.003265	0.003716	3.887348	27.51744	136803.2	32.83948	0.068532	4963	-8.95256	0.01	657.799469	6.53E-140
Thailand	0.00723	0.006178	0.043838	0.003604	0.003695	3.645156	23.92235	101512.6	35.8809	0.067759	4963	-8.52669	0.01	22.863711	0.000358429
US	0.006868	0.005562	0.045819	0.00259	0.004452	3.157202	18.30082	56658.15	34.08494	0.098347	4963	-6.99062	0.01	224.762846	1.42E-46
Vietnam	0.009491	0.007617	0.038372	0.003809	0.005532	1.767211	6.378857	4944.145	47.1025	0.151838	4963	-8.33609	0.01	267.139875	1.15E-55

Note: Only Bahrain, Malaysia, and Indonesia have not shown the Arch Effect; all the selected stock markets are stationary in the first difference.

APPENDICES -3

LIST OF PUBLICATION AND CONFERENCE ARTICLES.

S. No.	Title of Paper	Name of Journal (ISSN)	Year of Publication	ABDC Ranking	Publisher	Indexing
1	Novel evidence from APEC countries on stock market integration and volatility spillover: A Diebold and Yilmaz approach	Cogent Economics and Finance (E-ISSN:2332-2039)	2023	B	Taylor and Francis	Scopus (Q2) and WOS
2	Exploring crisis-driven return spillovers in APEC stock markets: a frequency dynamics analysis.	The Journal of Economic Asymmetries (ISSN 1703-4949)	2024	B	Elsevier	Scopus (Q1) and WoS
3	Financial contagion and volatility spillover financial stock market: a statistical review of the literature	International Journal of Financial Services Management (ISSN online 1741-8062)	2023	C	Inderscience	UGC
Conferences						
S. No.	Title of Paper	Conference	Year	Organiser		
1	Financial Contagion and Volatility Spillover: An Analysis of Emerging Stock Market	2nd Research Clinic and Doctoral Consortium	2021	Fortune Institute of International Business, New Delhi, India		
2	Financial Contagion and Volatility Spillover in Financial Stock Market: a review of empirical study.	International Conference on Commerce, Management and Interdisciplinary Subjects	2021	Central University of Kerala		
3	Financial Contagion and Volatility Spillover: The Analysis of Global Stock Market	Industry 5. O: Human Touch, Innovation and Efficiency	2022	Mittal School of Business, LPU		
4	A novel evidence from APEC nations on volatility spillover effect and stock market connectedness during the GFC, COVID-19, Russia–Ukraine Conflict: A Diebold And Yilmaz Approach	MERC 2023	2023	IIM Kashipur, UK, India		
5	Hedging Strategies Amidst the COVID – 19 Crisis: An Investigation of Financial Contagion among Developed, Emerging, and Frontier Countries	ICMSAAI-24	2024	SRM University, Haryana, India		