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SENTIMENT-DRIVEN SPILLOVERS: INVESTOR BEHAVIOR AND MARKET CONNECTIVITY IN FINANCIAL MARKETS

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Abstract

Purpose: *The study analyzes Connectedness and Volatility Spillover among investor sentiments and Asian stock markets. The study identified market risk based on market circumstances while investigating Asian stock marketing strategy. It has explored the financial inter-connectedness among Asian stock markets and investor sentiments. In additionally identified the early warning for customers.*

Method: *The Data were collected from the Asian stock markets, and the hypotheses were tested by using E-Views and R, R studio software. Moreover, the daily data is collected from the 11 Asian stock markets. Furthermore, the time series data has been collected to the analysis the connectedness and spillover among Asian stock markets and investor sentiments.*

Results: *The result of this is the increasing amount of evidence, even if it still needs to be completed, about the interconnectedness of different marketplaces. Furthermore, the capital markets have seen a significant downturn because of the ongoing COVID-19 pandemic, which is widely considered the most severe health crisis in recorded history. Moreover, it is said to have profoundly altered the global economic or financial cycle. All the assets are significant conduits for transmitting and receiving shocks; hence we anticipate a substantial amount of volatility spillover among them.*

Conclusion: *This study contributes to the literature by analyzing the connectedness and spillover among Asian stock markets. In addition, the study's purpose is to give an early warning to investors, state holders, shareholders, portfolio managers, and the public to put their investments carefully and gain high returns. We proposed a paradigm for future researchers that exploited the frequency domain for data processing. However, increasing the frequency and length of data gathering may reveal fresh insights into the fluctuation patterns and transmission processes of data in financial markets.*

INTRODUCTION

Investor sentiment plays a crucial role in influencing stock market dynamics, particularly in the context of Asian markets. The volatility spillover between investor sentiments and stock markets has been a focal point of recent research, highlighting how variations in sentiment can impact market behavior. Literature has demonstrated the relationship between investor sentiment and various asset classes,

uncovering a complex web of relationships that are often marked by mixed and ambiguous findings (Abdollahi et al., 2024). These studies suggest that investor sentiment can lead to significant volatility spillover across markets, the direction and magnitude of these effects are not always clear-cut. Further, the literature highlights the importance of understanding market risk in different market situations. As indicated by Ahmed, (2020), the impact of investor sentiment on stock market volatility can vary depending on the prevailing market conditions, indicating a need for tailored investment strategies in Asian markets. Moreover, Anastasiou et al., (2022) emphasize the financial interconnectedness among Asian stock markets, suggesting that sentiment-driven volatility can spill over across borders, thereby influencing market returns in a regional context.

The objective of this study is to unpack the specific mechanisms through which investor sentiments affect financial markets in Asia. Understanding these mechanisms is vital for developing more effective investment strategies and managing market risks, especially in the face of the complex and interconnected nature of global financial markets.

In the late nineteenth century, there was a shift in emphasis on anticipating investor mood and stock market movements. In the 20th century, there was increasing attention to behavioral finance due to the limitations of the Efficient Market Hypothesis (EMH) in elucidating the excessive fluctuations in the market (Elgayar & A.H., 2021. Several studies by Frugier et al., (2016), and Bouri et al., (2022), have revealed how different financial markets and equities are affected by investor sentiments in terms of volatility and returns (Baker, Wurgler, and Yuan et al., 2012, Goodell et al., 2022).

Diebold and Yilmaz (2014) introduced an empirical model that incorporates both linkage and spillover assessments. Subsequent research by Antonakakis (2020) and Chatziantoniou, N., & Gabauer, D. (2020) employed sliding window vector autoregressions (VARs) to evaluate prediction errors and perform variance decomposition. According to Sarwar (2020), Yıldırım (2022), and Zhang and Giouvris (2022), investors' concerns can be thoroughly assessed by examining the projected volatility index (VIX) of the S&P 500. Additionally, Cheuathonghua et al. (2019) observed that fluctuations in the VIX had a notable impact on global stock markets, leading to an increase in the number of indices monitoring the spread of volatility.

The primary aim of the study was to explore the potential of volatility persistence indicators for future financial markets. Specifically, the study sought to generate new data by assessing market interconnectivity levels under both normal and crisis conditions. Diabold and Yilmaz, in their articles from 2009, 2012, and 2014, developed an empirical model for analyzing linkages and spillovers. Subsequent research by Antonakakis (2020) and Chatziantoniou, N., & Gabauer, D. (2020) employed sliding window vector auto regressions (VARs) to evaluate prediction errors and perform variance decomposition. The study's problem statement aims to examine investor sentiments and market connectivity across Asian stock markets using a Time-Varying Parameter Vector Auto Regression (TVP-VAR) model. It will cover the period from January 2, 2019, to June 16, 2023, and will include selected Asian markets. Despite the increasing interconnectedness and spillover effects observed globally, the interaction between investor sentiments and stock markets in the Asian region remains inadequately understood.

This research employs a Time-Varying Parameter Vector Autoregressive (TVP-VAR) model to evaluate investor sentiment and market interconnection across various Asian countries. The study aims to elucidate how investor sentiments are articulated and their impact on stock market movements within the Asian context. By exploring the relationship between stock characteristics and investor sentiments, the research seeks to offer comprehensive insights into financial market interconnection and risk management, thereby contributing significantly to existing literature. Similarly, Khan et al. (2020) investigated spillover effects in the energy, finance, and materials sectors on the Pakistan Stock Exchange and found that the financial sector plays a substantial role in transmitting spillovers to other sectors. Additionally, Chen et al. (2024) reported that fintech has a notable impact on spillovers across other markets, including bonds and stocks.

Recent studies by Wang et al. (2019) and Ahmad & B (2020) have highlighted that investor sentiments significantly affect asset pricing due to irrational investor behavior. While research has investigated spillovers and interconnectedness among various asset classes, findings have often been mixed and ambiguous, as seen in Ahmed et al. (2019). This study acknowledges certain limitations: it employs only a time-series domain model and suggests that future research should consider frequency domain approaches for data analysis. Additionally, the study focuses on data from eleven Asian stock markets and utilizes a Time-Varying Parameter Vector Autoregressive (TVP-VAR) model exclusively. The data used was collected daily over the past five years, but increasing the frequency and extending the duration of data collection could provide deeper insights into fluctuation patterns and data transmission mechanisms in financial markets.

Theoretical Framework

The presented study grounded under the established perceptive explains investor behavior. The Efficient Market Hypothesis (EMH) posits that investors face significant challenges in consistently outperforming the market because all relevant information is already reflected in asset prices (Fama, 1970). Peón et al. (2019) have analyzed and discussed EMH within the finance field, which has sparked considerable debate. Some researchers (e.g., Clarke et al., 2001; Ball & R., 2009; Naseer et al., 2015) argue that financial gains can be achieved by exploiting market anomalies or inefficiencies. Despite these discussions, the EMH continues to be a fundamental framework for understanding financial market behavior.

In contrast, economist Andrew Lo introduces the Adaptive Market Hypothesis (AMH) as a novel concept. Unlike the EMH, which asserts complete market efficiency, the AMH suggests that financial markets undergo alternating phases of efficiency and inefficiency. The AMH integrates elements from behavioral finance and evolutionary biology to explain market mechanisms. It proposes that market participants adjust their behavior based on historical performance and current trends, which can lead to market inefficiencies and deviations from fundamental principles.

AMH acknowledges that varying information, risk tolerance, and investment strategies among market participants influence decision-making and market volatility. Behavioral finance, as defined by Byme (2013), examines the cognitive and emotional factors affecting individuals' financial decision-making. This field studies how emotions, biases, and cognitive constraints impact investment choices and decision-making processes, offering a more nuanced understanding of financial behavior. Behavioral finance models are designed to address scenarios where traditional rational theories fall short in explaining investor behavior and market anomalies. Inspired by psychology and sociology, these models seek to enhance financial decision-making by incorporating both economic and psychological insights, as noted by Hede & P.D. (2012).

Review of literature

Akram et al. (2023) investigated the transmission of volatility between Pakistan and its primary trade partner. Their study aimed to analyze the correlation between Pakistan's main trade partners and the country's financial markets by examining return, volatility, spillover, and market connectivity. Using the Spillover Index technique, the research presented data in monthly, weekly, and daily formats from 1995 to 2019. The findings indicate that stock markets act as conduits for both volatility spillovers and market return transmission. Zaidi et al. (2023) focused on global factors and sector-specific indicators pertinent to Pakistan. Utilizing daily frequency data from 2002 to 2022, the study found that Pakistan ranks prominently in terms of sector-level and global factor influences. The energy and financial sectors were identified as primary initiators of market fluctuations, while indices such as the EPEUI, WTI, and MSCI played significant roles in absorbing these fluctuations through net directional volatility spillovers and linkages.

Maaz et al. (2023) examined risk transmission across various Asian stock markets, including those in Asia, Oceania, and South America, using two distinct spillover methodologies from 2012 and 2018. The results revealed substantial impacts on Asian stock markets from Taiwan and Southeast Asian countries, with capital flows between countries primarily driving the expansion of financial links among

developing Asian markets. Sheng et al. (2024) employed the Markov Switching Vector Autoregression (MS-VAR) approach to analyze how volatility spillover asymmetry affects the stock markets of the US, Hong Kong, and Shanghai. The study found temporal and regime-dependent shifts in volatility transmission among these markets, with evidence of negative asymmetry in their connections. Chen et al. (2024) assessed the influence of outside investors on the return volatility of SHSCP stocks, utilizing both Fama-Macbeth and difference-in-differences (DID) regression models based on portfolio characteristics. The research examined various strategies for mitigating stock market volatility's impact on mainland China investors, with robustness tests confirming the significance of the results even after accounting for endogenous factors.

Jreisa (2023) aimed to measure the dynamic interconnections and impacts among growing stock markets in Asia, the United States, and Europe, particularly in the context of the Ukraine situation. The study also analyzed volatility transmission and return dynamics during the COVID-19 pandemic, the Ukrainian crisis, and the 2008 financial crisis, using Diebold and Yilmaz's (2012) approach. Malik (2023) investigated the relationship among trade openness, economic growth, and R&D investment among SAARC member states, specifically Sri Lanka, India, and Pakistan. Utilizing a two-equation stimulus model, the study found a positive linkage between human and physical capital and public R&D expenditure, suggesting beneficial impacts. Khan (2023) conducted a comprehensive study on the transmission of volatility from the established American market to the emerging stock markets of South Asia. By segmenting the sample period into pre-crisis, crisis, and post-crisis phases, the research analyzed the impact of market shocks and the two-way transfer of volatility using a multivariate GARCH-BEKK model. The findings highlighted an increase in volatility transmission due to the global financial crisis. Huang et al. (2023) used bootstrap rolling window causality analysis to explore the dynamic causal link between the Chinese and ASEAN stock markets, particularly during the COVID-19 pandemic. Their results revealed a generally amicable relationship between these markets before the pandemic.

Soltani et al. (2023) examined the relationship between Chinese stock markets and investor sentiment using the ADCC-GARCH model, focusing on asymmetric volatility and time-varying correlations. The study aimed to assess the impact of COVID-19 on investor sentiment and stock prices, utilizing Diebold and Yilmaz's (2012, 2014) methods to analyze interrelationships. Patwarani et al. (2023) investigated the effect of hedging strategies on Asian stock markets' performance during favorable and unfavorable market conditions amid the COVID-19 pandemic. Analyzing data from January 2, 2023, to September 30, 2023, using the GARCH volatility model and cross-sectional absolute deviation (CSAD), the research found evidence of hedging behavior in China, Singapore, and Indonesia during the pandemic.

Li et al. (2023) explored how the COVID-19 vaccine affected market volatility transmission among major Asia-Pacific stock markets. Employing both quantity-based and means-based methods, the study examined the impact of catastrophic events on network connectivity. The results indicated that the COVID-19 vaccine played a crucial role in reducing risk transmission and stabilizing stock markets in the Asia-Pacific region.

Khan et al. (2023) studied Asian stock markets, including those in Pakistan, China, Indonesia, Hong Kong, Malaysia, India, the Philippines, South Korea, Taiwan, and Thailand, comparing two spillover approaches, Dy (2012) and BK (2018). Yadav et al. (2023) analyzed interactions between China and other developing countries using the DCC-GARCH model, finding a causal relationship between China and Indonesia.

Data Exploration

The stock markets of Pakistan, India, Japan, China, Thailand, Bangladesh, Sri Lanka, and Singapore, as well as the US Dollar, Gold, and VIX, were all included in the daily data analysis conducted in this paper. Daily stock and market data for this research study was sourced from investing.com and finance.yahoo.com. Years 2019–2023, inclusive, are included in the sample. The US dollar serves as the standard unit of measurement for all indices, and their growth rate and return calculations are derived

from this currency. Below mentioned Table 1 has shown the daily base stock market data

Table 1: Daily base stock market data

Daily Bases Stock Market Data			
Markets	**Data-Frequency**	**Time – Period**	**Funding-Source**
P S X	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com
NSEI	Daily	02-01-2019 To 14-06-2023	http://finance.yahoo.com
N225	Daily	02-01-2019 To 14-06-2023	http://finance.yahoo.com
SSEC	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com
SET	Daily	02-01-2019 To 14-06-2023	http://finance.yahoo.com
DSEX	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com
CSE	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com
SGXL	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com
USD $	Daily	02-01-2019 To 14-06-2023	http://finance.yahoo.com
GOLD	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com
VIX	Daily	02-01-2019 To 14-06-2023	http://www.Investing.com

Time-Varying Parameter Vector Auto-regression (TVP-VAR)

Estimations of stock markets return

Return estimation within the stock market is crucially encouraged by using the remaining prices. This observe makes use of log-returns of stock market prices to address the heterogeneity and non-stationarity gift in the data. The log returns for date t are calculated as follows:

$$Return_t = \log(p_t) - \log(p_{t-1})$$

To keep away from spurious outcomes, return values with equal costs on the previous days are replaced with infinitesimally small values to prevent the use of null values in prediction fashions.

Time-Varying Parameter Vector Auto-regression (TVP-VAR)

Empirical Model

This paper used TVP-VAR technique, introduced by (Antonakakis et al; 2020). The study's variance extension approach was built upon the work of (Antonakakis & Gabauer 2017) and (Diebold & Yilmaz 2009, 2012, and 2014). In addition to analyzing the Connectedness spillover for pairs of investor's sentiments with stock market, we use the TVP-VAR (Antonakakis et al; 2020). According to the technique developed by Diebold and Yilmaz in 2014. Equation (3–6) illustrates the World theorem, which serves as the foundation for the study transformer of TVP-VAR vector moving average (VMA). This transformation is accomplished by considering the subsequent manner: $\gamma_t =$

$k'(\tilde{N}_t(V_{t-2} + \Phi_{t-1}) + \Phi_t$ (3 =

$k'\left(\tilde{N}_t\left(\tilde{N}_t(V_{t-3} + \Phi_{t-2}) + \Phi_{t-2}\right)\Phi_t\right)$ (4

⋮ (5) =

$k'\left(\tilde{N}_t^{K-1}\tilde{V}_{t-K-1} + \sum_{l=0}^{\lambda}\tilde{N}_t^{l}\Phi_{t-l}\right)$ (6)

Finally, we are computed Net Pairwise Directional Connectedness (NPDC) using Equ (18) and examine the overall net directional connectedness to determine bidirectional linkages.

$$\text{NPDC}_{\text{ul}}\left(\tilde{H}\right) = \left(\tilde{\emptyset}_{\text{lut}}\left(\tilde{H}\right) - \tilde{\emptyset}_{\text{lut}}\left(\tilde{H}\right)\right) \times 100 \quad (18)$$

The variable l is referred to be variable i where the value of (NPDC) ul $\left(\tilde{H}\right)$ is less than zero. If (NPDC) ul $\left(\tilde{H}\right)$> 0, variable j is utilized as the denominator for variable u.

$$TO_{lt} = \sum_{u=1,u\neq l}^{N} \tilde{\phi}_{ul}^{g} \tilde{H} \quad (19)$$

$$FROM_{lt} = \sum_{u=1,u\neq l}^{N} \tilde{\phi}_{ul,t}^{g} \tilde{H} \quad (20)$$

$$NET_{lt} = TO_{lt} - FROM_{lt} \quad (21)$$

$$TCI_{t} = N^{-1} \sum_{l=1}^{N} TO_{lt} \equiv N^{-1} \sum_{l=1}^{N} FROM_{lt} \quad (22)$$

Equation (19) quantifies the entire directional connectedness from variable l to all different variables inside the network, at the same time as equation (20) quantifies the entire directional connectedness to variable l from all different variables inside the community. Equation (21) is derived as the distinction between equations (19) and (20), representing the internet overall course of connectedness associated with variable l. If NET_{lt} > 0, it shows that variable l acts as a net driver of the network with the aid of mainly transmitting shocks. Equation (22) serves as an aggregate degree of the total connectedness among all variables within the community, aiming to mirror the overall interconnectedness and marketplace hazard. A better Total Connectedness Index (TCI) shows that shocks in a specific variable extensively affect the network, leading to higher marketplace hazard. Conversely, a decrease in TCI implies a decrease in marketplace risk as shocks in one variable have much less effect on different variables within the network.

Data Analysis

After doing a stationarity test, the behavior of each series is examined using descriptive statistics to ascertain the characteristics of the data. Table (2) presents the closing rates of the Asian stock markets. Descriptive statistics analysis involves examining measures of dispersion, measures of location, and measures of data form. The abbreviation "i.e." is shown in Table (2) under the section titled "Four part." The average return refers to the mean value of the replies. The standard deviation represents the lowest and maximum average responses. The data distribution and dispersion of the daily closing Asian stock markets from January 2, 2019, to June 14, 2023, are used.

Table 2: Descriptive data analysis

Descriptive Analysis

	CSE	*DHAKA*	*GOLD*	*N225*	*NSEI*	*PSX*	*SET*	*SGXL*	*SSEC*	*USD*	*VIX*
Mean	0.000555	0.000121	0.000396	0.000455	0.000486	8.411606	-2.18389	-0.000174	0.000224	5.661895	-0.00041
Med	0.00053	0.000319	0.000505	0.00054	0.000939	0.00059	7.598972	0	0.000385	0	-0.00713
Max	0.069271	0.097984	0.056438	0.069582	0.08851	0.04684	0.76531	0.123481	0.058815	0.016389	0.375567
Mini	-0.84449	-0.06731	-0.06571	-0.05008	-0.11982	-0.07102	0.114282	-0.07295	-0.11166	-0.02139	-0.28886
Std-Dev	0.013955	0.009041	0.010729	0.01122	0.012799	0.011653	0.010872	0.012593	0.011299	0.004277	0.077684
Skew	0.673755	0.879819	-0.10729	-0.09572	-0.88049	-0.67309	-2.01428	0.834568	-0.81816	-0.10414	0.880197
Kurt	9.215531	21.80607	7.146238	6.023853	17.45975	7.659439	28.57955	16.69812	13.00158	5.199838	5.608041

Jrq-Bra	1853.895	16351.72	790.0449	420.7658	9725.12	1078.12	30733.21	8727.789	4707.503	223.7893	453.7896
Prob	0	0	0	0	0	0	0	0	0	0	0
Sum	0.610675	0.133275	0.435794	0.500889	0.534676	0.092528	-0.024023	-0.191711	0.246147	0.062281	-0.451155
Sum Sq-Dev.	0.213862	0.089827	0.11954	0.138357	0.180021	0.149246	0.129895	0.174276	0.140305	0.020101	6.632261
Obs.	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100

Note: "Mean, Median, Max-Maximum, Min-Minimum, Std. Dev-Standard Deviation, Kurt-Kurtosis, J-B-Jarque Bera test, Pro-Probability, Sum, Sum of Standard Deviation, total observation 1100 to indicate the level of significance.

The mean average return serves as a reliable metric for assessing the overall health of the Asian stock market. According to the statistics, the stock markets exhibit both positive and negative mean returns. The Pakistan stock market has the highest mean return of 8.41% among all stock markets, while the Thailand stock exchange has the lowest mean return of -2.18%. Moreover, it is a fact that all stock markets exhibit positive standard deviations. The standard deviation of stock returns in Thailand is 0.01%, which is the lowest among all countries. On the other hand, Pakistan has the greatest standard deviation of stock returns at 0.011%. According to the finance theory proposed by Ross et al. (1973), undertaking a significant risk is likely to result in a substantial gain. Contrary to other Asian stock markets, the stock market in Thailand exhibits lower levels of volatility. The figures show the minimum and maximum daily returns on stock markets. The presence of data skewness indicates its specificity. According to the statistics, the VIX has the highest level of skewness at 0.88%, whilst Thailand has the lowest level at -2.01%. Furthermore, Kurtosis has distinct effects on Dhaka, SGXL, SET, SSEC, and NSEI stock markets. Unlike VIX, CSE, USD, gold, and PSX, the stock markets do not possess an outer layer.

Stock Market Index Visualization

Figure 1: Sock Market Indices

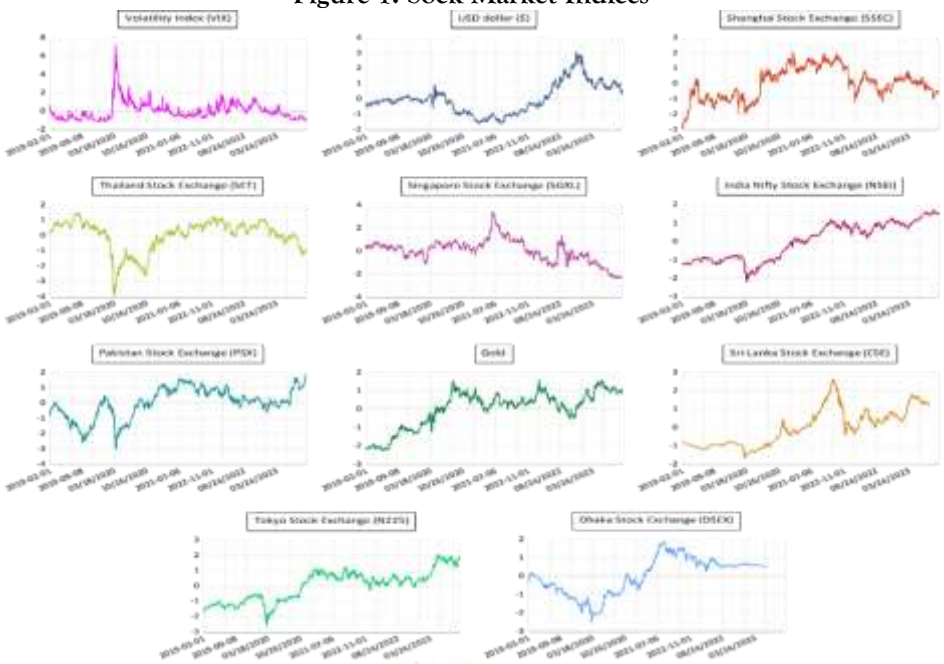


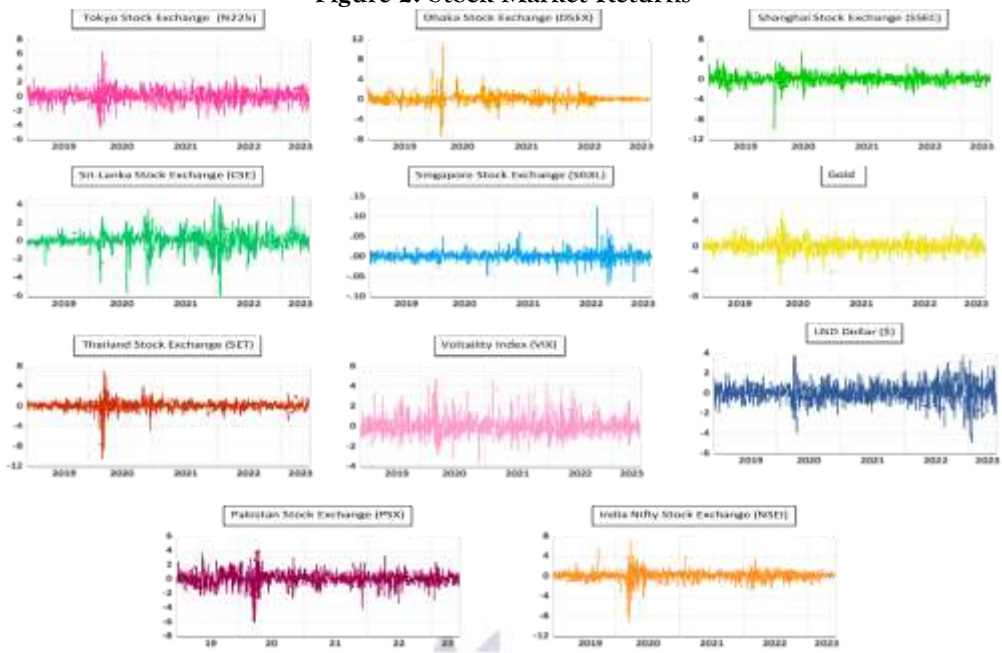
Figure (1) displays the time series analysis of the selected stock markets. In an ideal scenario, the series would exhibit consistent fluctuations throughout time, suggesting a lack of stationarity. Like other stock markets, the graph exhibited increased volatility throughout the period from 2019 to 2020. Furthermore, other markets such as CSE, Dhaka, NSEI, Gold, SET, SGXL, VIX, SSEC, and USD have seen substantial downward movements. Despite the upward trend in the PSX and N225 stock markets. Antonakakis et al. (2022) found that the time series data of the selected stock markets exhibited non-stationarity. The daily returns are computed by taking the first-order logarithmic difference, and the resulting values are as follows: The expression represents the difference between the natural logarithm of Xt and the natural logarithm of Xt-1. The variable l_n (Xt-1) represents the logarithm of the stock market returns at period t-1, whereas l_n (Xt) reflects the daily closing price of the stock market at time t.

Graphical Representation of Stock Markets Returns

The theory of stock market returns during the period of 2019 to 2023 in Asian stock markets may be defined by way of studying various factors that impact on stock markets prices and returns within the resign. These elements may additionally consist of economic signs, geopolitical activities, economic policy decisions, company income, investor sentiment, and global marketplace tendencies. During this era, the performance of Asian stock markets might also had been stimulated with the aid of factors such as trade tensions among foremost economies, central financial institution rules, technological improvements, demographic adjustments, and the effect of world occasions like the COVID-19 pandemic. During the period of 2019 to 2020 stocks fluctuated in the stock markets due to the COVID- 19 epidemic. From 2021 to 2023 markets smoothly working and it's graphically presenting the stationarity in data. There are no shocks and volatility spillover affection the stock markets during the 2021 to 2023. COVID- From 2021 to 2023 markets smoothly working and it's

graphically presenting the stationarity in data. There are no shocks and volatility spillovers affecting the stock markets during 2021 to 2023 as shown in fig 2.

Figure 2: Stock Market Returns



Empirical Evidence

This research has provided a concise overview of the data and sources used for this kind of analysis. This study used many stock market indicators, such as the dollar exchange rate, gold price, S&P 500 stock market, and others, to gather the necessary data. The inquiry primarily focused on data collected between January 2, 2019, and June 14, 2023. When the stock market's price declines then the number of potential buyers will decrease. However, fluctuations and uncertainties in the stock market are detrimental effects on the market's performance trajectory (Kearney & Lombra, 2009). Consequently, the economic cycle may cause instability in other related markets (Wang & Chueh, 2013). Interestingly, our findings on net spillover significantly diverge from the conclusions of Hussain et.at; (2019), while analyzing a comparable volatility spillover approach. The study examines the correlation and transmission of investor sentiments across Asian stock markets.

The study by Ando et al. (2020) apparently used the Time-Varying Parameter Vector Auto Regressive Approach (TVP-VAR). Examining the spillover interconnectedness in Equation (1) via the Time-Varying Parameter Vector Auto-regression (TVP-VAR) methodology. The metrics for connectedness spillover are computed using equations such as Equ (7), which represents the Total Connectedness Index (TCI), Equ (5), which represents the net directional "FROM," Equ (4), which represents the net directional "TO," and Equ (6), which represents the net connectedness. These calculations are performed under positive, negative, and neutral market conditions. This study highlighted the significant interdependence of many factors in the system during stable market times. The findings revealed that investor attitudes and all selected stock markets exhibited a Total Connectedness Index (TCI) of about 25.21 percent as shown in table 3.

Table 3: Dynamic Connectedness Table

TVP-VAR												
TO	PSX	NSEI	N225	SSE	USD	GOLD	VIX	SET	DHAKA	CSE	SGXL	FROM
PSX	75.26	2.32	2.39	2.05	2.25	3.71	2.56	2.78	2.28	2.24	2.17	24.74
NSEI	2.33	78.29	2.07	1.74	2.14	2.03	2.51	2.43	2.03	2.28	2.16	21.71
N225	1.91	1.89	75.53	3.94	1.71	2.83	2.11	3.47	1.53	2.8	2.29	24.47
SSE	2.09	1.73	4.55	75.82	2.24	2.62	2.64	2.07	1.73	2.22	2.29	24.18
USD	1.94	2.72	1.94	2.02	77.9	2.65	1.79	2.98	2.35	1.8	1.91	22.1
GOLD	2.21	1.75	2.73	2.62	2.56	76.63	4.87	1.27	1.54	2.49	1.34	23.37
VIX	1.81	2.62	2.32	1.91	1.91	5.17	75.58	1.83	1.74	2.32	2.78	24.42
SET	2.43	2.36	3.62	1.94	2.72	1.61	2.65	76.15	1.9	2.39	2.22	23.85
DHAKA	2.66	2.6	2.36	2.08	1.56	2.14	1.93	1.89	76.75	3.44	2.6	23.25
CSE	1.73	1.9	2.73	1.88	1.16	1.79	1.67	1.67	2.33	81.12	2.02	18.88
SGXL	2.18	1.94	2.28	2.02	1.59	1.88	2.7	2.09	2.18	2.26	78.87	21.13
TO	21.27	21.83	26.99	22.21	19.85	26.44	25.43	22.47	19.61	24.23	21.78	252.11
Inc. Own	96.53	100.12	102.52	98.04	97.75	103.06	101	98.62	96.36	105.34	100.65	TCI
NET	-3.47	0.12	2.52	-1.96	-2.25	3.06	1	-1.38	-3.64	5.34	0.65	25.21

Table 4: NET Pairwise Directional Connectedness Table

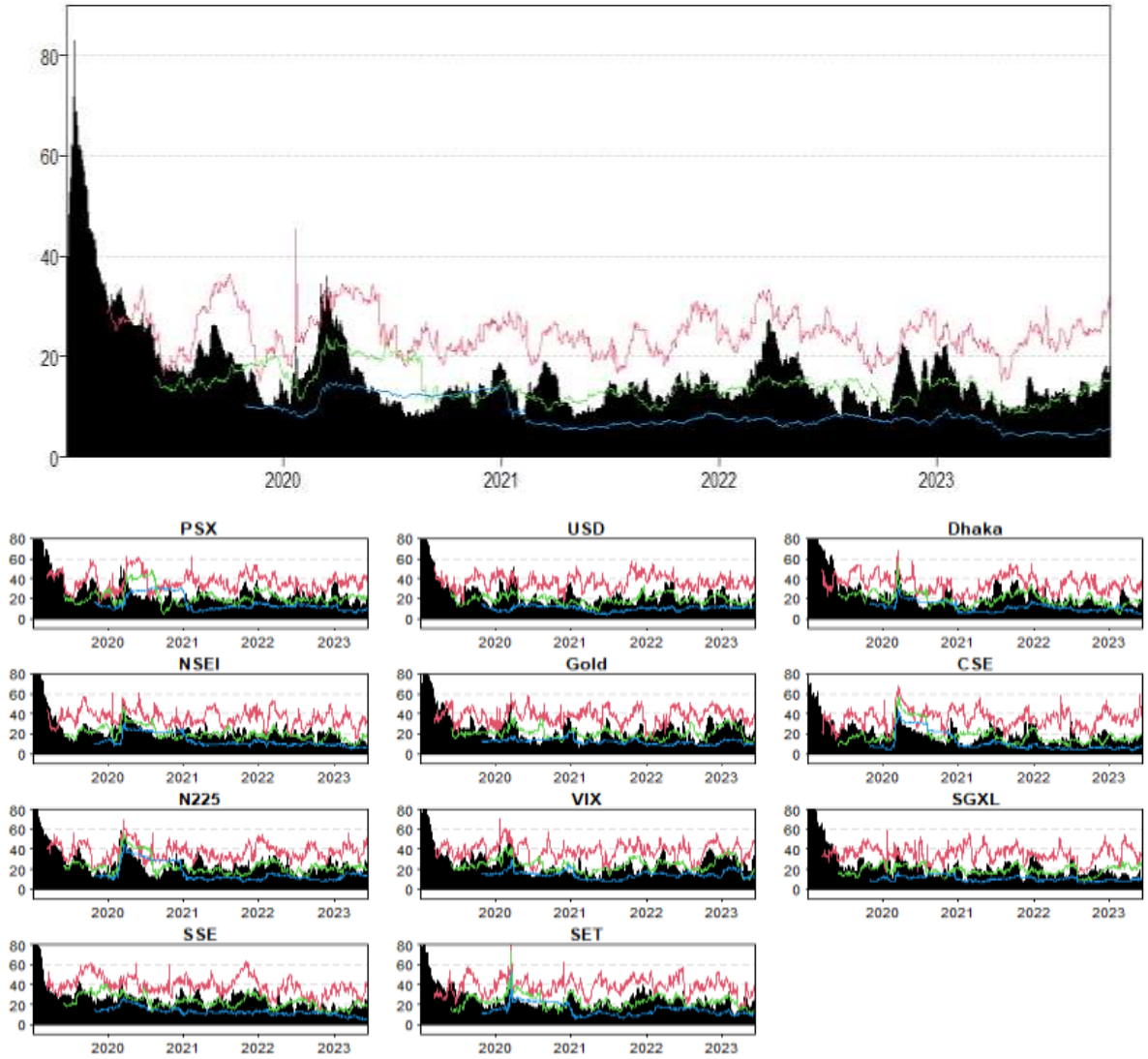
	NSEI	PSX	CSE	N225	VIX	USD	GOLD	DHAKA	SGXL	SET	SSEC
NSEI	0	0.01	0.38	0.39	-0.11	-0.58	0.28	-0.57	0.22	0.07	0.01
PSX		0	0.51	0.48	1.81	0.31	1.5	-0.38	-0.01	0.35	-0.04
CSE			0	-0.07	-0.65	-0.64	-0.42	-1.11	-0.24	-0.72	-0.34
N225				0	-0.21	-0.23	0.34	-0.83	0.01	0.85	-0.61
VIX					0	0.12	0.3	-0.19	0.08	-0.82	-0.73
USD						0	0.09	0.79	0.32	0.26	-0.22
GOLD							0	-0.6	-0.54	-0.34	0
DHAKA								0	0.42	-0.01	0.35
SGXL									0	-0.13	-0.27
SET										0	-0.13
SSEC											0

To estimate of the contribution on disruptions to variable j for the forecasting of error variance in variable i is shown in entry. Although all the off-diagonal elements provide spillover rates, the diagonal elements show self-inflicting spillover returns. These descriptive statistics provide essential insights that are crucial to word as we progress with the evaluation. Additionally, the non-stationarity distribution of the collection, alongside negative/wonderful skewness and high kurtosis values, suggests heavy-tailed distributions to the right or left with excess kurtosis. This indicates the presence of nonlinearity, structural breaks, and regime changes inside the series. Therefore, the usage of linear fashions, which rely upon constant parameter estimation, won't provide original and dependable effects for powerful coverage methods and investment decisions.

Total Connectedness Index

The TVP-VAR approach is applied on Total Connectedness Index (TCI) is obtained to analyzed volatility spillover returns among Asian stock markets. The TVP-VAR approach is shown by the prominent black spike on the TCI graph. The 50-day rolling window, 100-day window, and 200-day rolling window are all derived from the TVP model

Figure 3: Total connectedness Index.



TVP-VAR_ TCI Figure 4: Dynamic Connectedness from Others

Dynamic Connectedness "From" other Stock Markets

The study examines the investor sentiment and analyzes several stock markets to identify the transmission of risk. VIX experiences the bulk of its variation (24.42%) due to volatility in other markets. Among these markets, the Pakistan Stock Exchange (PSX) receives the most amount of directional volatility spillover (24.74%), followed by the Tokyo Stock Exchange (N225) at 24.47%, and gold at 24.18%. Out all the stock markets we examined, the Thailand Stock Exchange (SET) saw the lowest level of volatility spillover, measuring at 18.88%.

Amidst the prevailing atmosphere of uncertainty, investor pessimism has permeated all other stock markets, affecting a significant portion of 24.43 percent of them. In addition, the Tokyo Stock Exchange (N225) has a significant influence on other stock markets, such as Gold (26.44% of the time) and the Shanghai Stock Exchange (24.23% of the time), due to the transmission of high volatility. Among the selected stock markets, Dhaka's volatility spillover was the smallest at 19.61%.

Dynamic Connectedness "To" other Stock Markets

When compared to all other stock markets, the Shanghai Stock Exchange (CES) has the highest level of net connectedness, amounting to 5.34%. The Tokyo Stock market (2.52%), investor attitudes (1.00%), and gold (4.06%) transmitted extra net volatility effects to all other regional stock markets. Among the stock markets that were analyzed, the Indian Stock Exchange (NSEI) has the lowest net transmitter, which stands at 0.12%. Additionally, the findings demonstrate that, unlike other markets, the Singapore Stock Exchange (SGXL) functions as both a transmitter and receiver of shocks, rather than only one or the other.

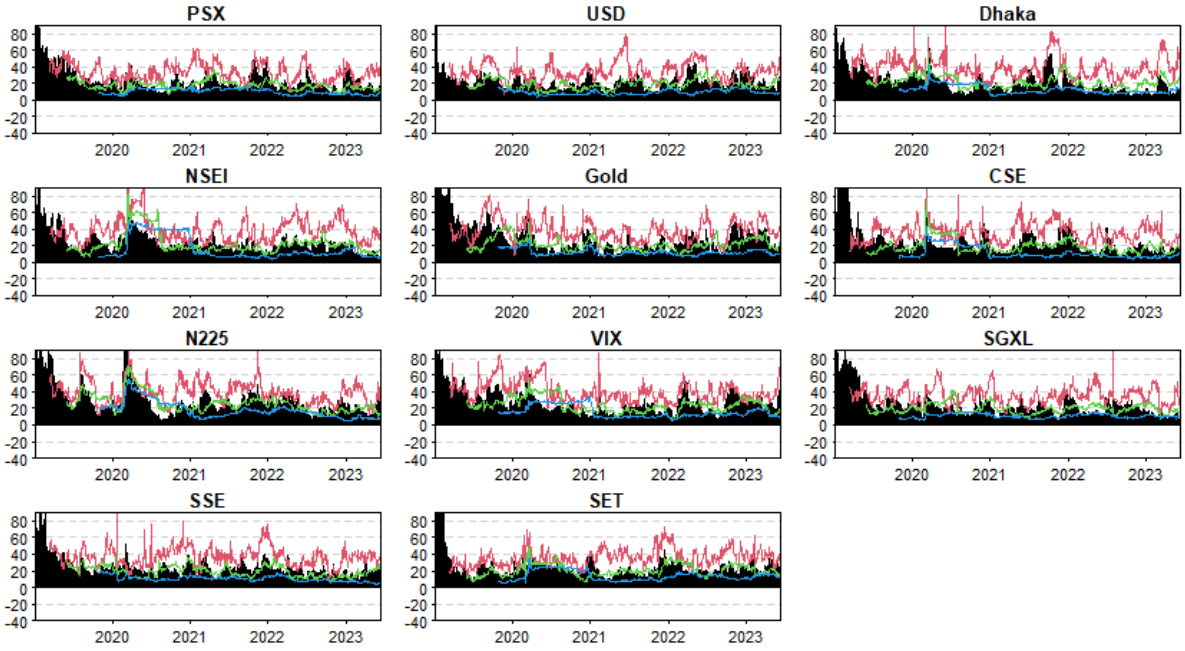


Figure 5: Dynamic Connectedness to Others

NET directional spillover

The net directional spillover values of Table 2 correspond to those shown in the NET spillover graph of Figure 3. According to Table 2, Sri Lanka (CSE) has the highest net transmission rate to all other stock markets, with a value of 5.34%. Results of the study are strongly aligned with the anticipated outcomes and corroborate the findings. Furthermore, the primary sources of spillover in the "Net Directional Index" to other Asian stock markets were Gold (3.06%), Tokyo (N225) (2.52%), and the Volatility Index (VIX) (1.00%).

Compared to other Asian stock markets, the Nikkei 50 (NESI) and the Singapore Stock Exchange (SGXL) have lower net transmission rates, at 0.12% and 0.65% respectively. This study exhibits many distinctions in comparison to (Zhang et al. 2020) & (Ji et al. 2020). (Antonakakis et. al.2020) state that the technique is robust against outliers and eliminates the need for a changeable rolling window size. Dhaka's equities market has the highest net directional spillover (-3.64%) compared to other markets, as seen in Table (2). Furthermore, among all the stock markets, the Pakistan Stock Exchange (PSX) had a decline of 3.47%, the US dollar depreciated by 2.25%, and the Shanghai Stock Exchange (SSE) saw an increase of 1.96%. Among the selected stock markets, the Thailand Stock Exchange (SET) has the most negative net receiver, with a value of -1.38%.

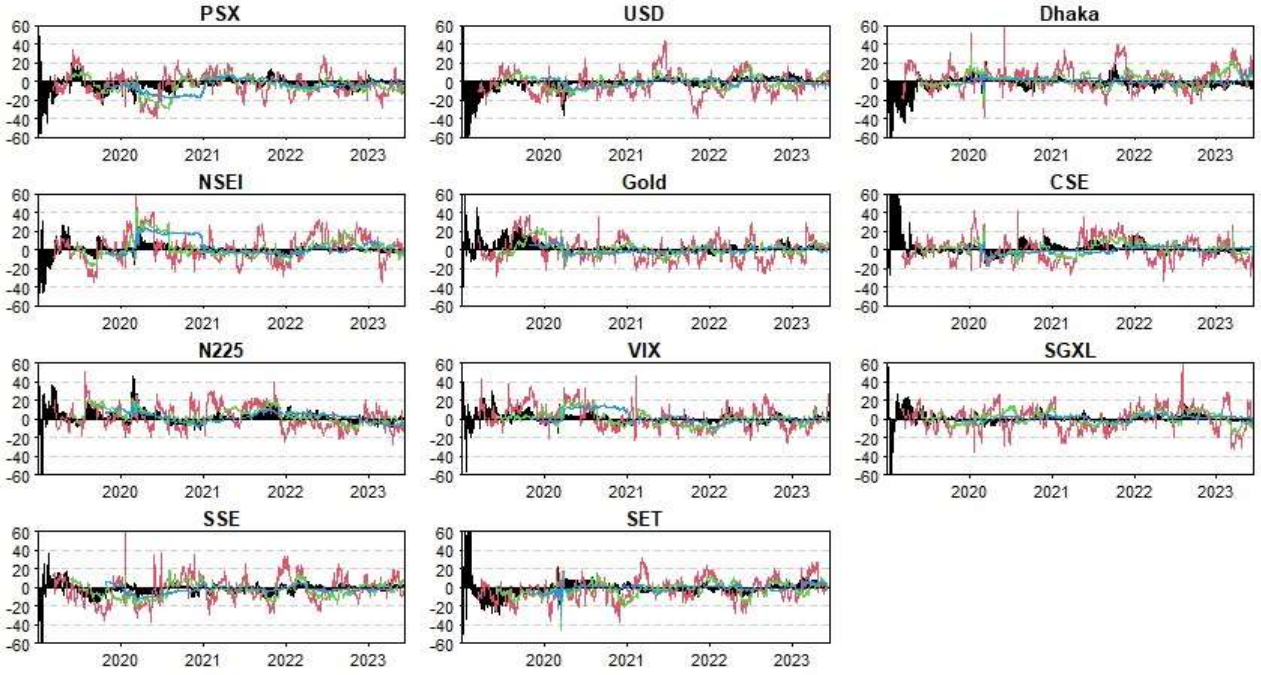
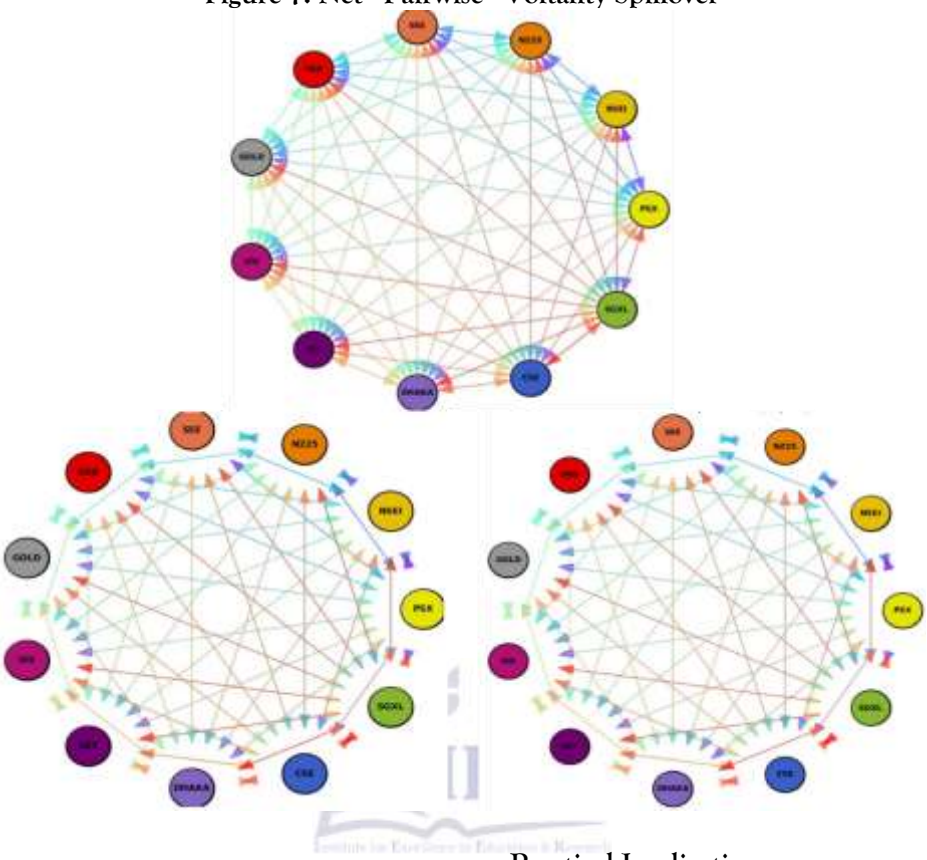


Figure 6: NET Connectedness Index

Figure (7) displays the sources of one-way spillover from different stock markets. PSX is the stock market that receives the greatest number of shocks when compared to other stock markets. From 2019 to 2020, there was a unidirectional spillover of N225, Dhaka, Gold, and CSE during the directional period. Moreover, over the timeframe spanning from 2019 to 2020, Asia had the most severe impact from both the Russia-Ukraine war and the COVID-19 epidemic. Empirical data suggests that the existence are fluctuated volatility spillover and stock markets returns, along with a significant correlation between extreme events, during the Russia-Ukraine war and the COVID-19 epidemic (Anyikwa, 2023). The N225 stock market has a very similar impact on the Dhaka, Gold, or CSE stock markets, but it has the least influence on the SET and SGXL stock markets. Additionally, it often responds within the specified time frame. Figure (7) The estimated contribution of Net pairwise volatility spillover for identification of net receiver, net transmitter according to pairwise effects of all Asian stock markets. Network exploration analysis of the net pairwise directional spillover and risk transmission among Asian stock markets. The finding conducted based on the TVP-VAR approach. Moreover, the visualization of net pairwise is given by the width of edge arrow.

Figure 7: Net "Pairwise" Voltality Spillover



Discussion

The study has aimed to analysis the connectedness and spillover among Asian Stock Markets included USD dollar ($), Gold, Volatility Index (VIX), Thailand Stock Exchange (SET), Dhaka Stock Exchange (DSEX), Sri-Lanka Stock Exchange (CSE), Singapore Stock Exchange (SGXL), Pakistan Stock Exchange (PSX), Indian Nifty 50 Stock Exchange (NSEI), Tokyo Stock Exchange Nikkei 225 (N225) and Shanghai Stock Exchange (SSEC). To analysis the connectedness at different time horizons (short, medium, and long term), the current study used the advanced connectedness approach of Antonakakis et al. (2020) and the frequency connectedness approach of Baruník and Křehlik (2018). To the best of our knowledge, this is the first study to do so in this specific context. In addition, previous study only the quantitative methodology used to measure the interconnected relationship between these stock markets.

Practical Implication

The results revealed the substantial policy implications. Policymakers and risk control specialists can also discover the findings of this especially relevant as they aim to realize the dangers related to stock markets. Examining the interactions among the returns and volatilities of various belongings can provide precious insights into financial contagion attributable to interconnected markets and spillover consequences. Furthermore, this analysis can offer guidance on effectively managing hazard-sharing and diversification inside a portfolio of interconnected assets.

The study's findings hold substantial implications for both policymakers and investors. For policymakers, the observed interconnectedness and volatility spillovers among Asian stock markets highlight the necessity for enhanced coordination and communication among regional financial authorities. Such measures are crucial for managing systemic risks and mitigating the potential for market

contagion. The study also highlights the critical role of early warning systems, which are essential for providing timely alerts regarding potential market disruptions, thereby enabling proactive intervention. Moreover, the influence of investor sentiment on market volatility suggests that policymakers should consider developing strategies to address the psychological and behavioral aspects of market participants, which could contribute to reducing volatility. The significant market downturns associated with the COVID-19 pandemic further emphasize the importance of crisis preparedness, with a call for policymakers to establish frameworks that bolster market resilience in the face of global crises.

For investors, the study recommends several strategic approaches. Diversification of portfolios across different regions and asset classes is crucial for mitigating risk and minimizing the impact of market shocks, particularly given the demonstrated volatility spillovers and market interconnectedness. Maintaining an informed perspective on market trends and sentimental indicators is also vital, as this knowledge can facilitate more informed decision-making, especially during periods of heightened uncertainty. The study's analysis of COVID-19's impact on market volatility suggests that investors should exercise caution during global crises, with an emphasis on reassessing portfolios and adopting defensive strategies to protect against substantial losses. Additionally, the utilization of advanced analytical tools, as employed in the study, offers investors valuable insights for making data-driven decisions in complex market environments. In conclusion, the study underscores the critical importance of recognizing the interconnectedness of global financial markets and the need for both proactive risk management and informed decision-making.

Limitations

The current study has few limitations. We have used only time domain models we have suggested for future researchers using frequency domain for data analysis. Firstly, we have used only eleven stock markets in Asian context data of stock markets. Secondly, we have applied connectedness and spillover based on the time varying auto regressive (TVP-VAR) by using only single model, if we used extended TVP-VAR and quintile approach then we can explore the new insights of the trends. In addition, the data used in this study was collected daily during the past five years. However, increasing the frequency and duration of data collection might unveil new understandings regarding the fluctuation patterns and mechanisms of transmitting data in financial markets. Thirdly, we have used daily data if we used monthly the trends of the stock markets are different. Fourthly, our study is based on cross-sectional. If we used longitudinal study, then we would be able to find deep insights into the stock markets.

Future directions

The current study also provides useful future directions for academics, first, we examined the connectedness among the eleven Asian stock markets by employing daily return-based measures. Thus, for future studies we suggest utilizing quantiles connectedness approaches among these markets, especially to uncover connectedness at the severe right and left tails of the distribution. Secondly, we also rely upon is on the volatility spillover transmission approaches like TVP-VAR, volatility spillover index (TVP-VAR) measures could also be helpful both in and out of the sample forecasting we have suggested for future they have used quintile and extended TVP-VAR model to examine the new trends of the stock markets. Most importantly, our investigation for spillover connectedness among these selected Asian stock markets is based on the (Antonakakis et al., 2020) TVP-VAR approach. Thirdly, we have used only Asian stock market we will suggest for Future researchers they will used ten-to-twenty-year data to explore the new trends of the stock markets. Fourthly, we have used only Asian stock markets then we will suggest for scholars to used G5 & G10 stock markets because they will be able to identify the various trends of stock markets.

Consent to Participation

All participants in this study provided informed consent before participating. They were informed about the study's objectives, procedures, potential risks, and their right to withdraw at any time without consequences. Participation was entirely voluntary,

and confidentiality was maintained throughout the study.

Ethics Declaration

All necessary precautions were taken to ensure ethical compliance. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. The study ensured the anonymity and confidentiality of participant responses in accordance with international ethical standards for research.

Competing Interests Declaration

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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