RETURNS AND VOLATILITY SPILLOVER IN ASIAN FRONTIER AND EMERGING MARKETS IN THE PRESENCE OF COVID-19 STRUCTURAL BREAK

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Received: June 10, 2021 / Revised: September 15, 2021 / Accepted: September 23, 2021

Abstract

The global integration of stock markets creates not only opportunities in market accessibility but also challenges in portfolio diversification. Therefore, it is crucial to discover less integrated markets for profit maximizing and risk reducing. In addition, it is also important to note that the existing pattern of global market integration and interrelation has been affected under the situation of Covid-19 pandemic. Hence, the study sets two important objectives as (1) to observe market integrating and exploring diversification opportunities by capturing returns and volatility spillovers among frontier markets (Bangladesh, Sri Lanka, and Vietnam) and emerging markets (China, India, and Thailand) in Asia; and (2) to identify the changes of returns and volatility spillovers among these markets in Covid-19 pandemic period. Time series analysis models, VAR (Vector Autoregressive) and BEKK GARCH (Baba-Engle-Kraft-Korner Generalized Autoregressive Conditional Heteroskedasticity), are employed to exhibit returns and volatility spillover effects. The numbers of data collected in each market are 1435 daily returns in normal period and 177 daily returns in pandemic period. The findings suggest that (1) there are significant return integration among most of frontier and emerging markets in the normal period; (2) the analysis of returns spillover in pandemic period observes no significant return relationship in all markets; (3) most of frontier and emerging markets express significant volatility spillovers in the normal period; (4) some frontier markets temporally halt volatility spillovers from emerging markets during pandemic time; and (5) Thailand is the most interconnected market among observed countries. In addition, the comprehensive analysis proposes long-term investment opportunities in selected frontier markets.

Keywords: Emerging and Frontier Markets, Diversification, Integration, Shock Transmission

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Introduction

Globalization, enormous digitalization and impressive deregulation pave the way to flow assets and information conveniently across the borders around the globe in current situation. This situation creates integration, interdependency and inter-connectedness among stock markets in the world which provide opportunities by promoting market accessibility as well as challenges by reducing diversification benefits for all investors. On the other hand, there are some headwinds to hinder international integration such as cultural background, natural endowments, institutional systems and legal tradition (Chiou, 2008). The modern portfolio theory also suggested that the potential benefits of a portfolio can be increased by searching the lesser correlations and diversification among the asset components (Markowitz, 1952). Although the opportunities of diversification were disturbed by increasing the level of integration among the international market, frontier markets may provide additional opportunity with low correlation to developed equity markets (Seth & Singhania, 2019). For this reason frontier markets, under the assumption of least integration to other markets, comes into the eyes of investors as the less risky arenas to expand their global portfolio. The geographical location of Asian frontier markets is the second reason to conduct this study because all of the markets are situated in India Ocean Region which is a rising geographical area to become a global economic hub in the near future. According to the Morgan Stanly Composite Index, Sri Lanka, Bangladesh, and Vietnam are three frontier markets in Asia while China, India and Thailand are listed under emerging market category (Morgan Stanly Composite Index [MSCI], 2020). Since some studies proved that researchers should not only investigate return causality linkages but also measure volatility spillover effects (Yildirim & Masih, 2018), Vector Autoregressive (VAR), a well-known return spillovers analysis model advocated by Sims (1980), together with Baba-Engle-Kraft-Korner Generalized Autoregressive Conditional Heteroskedasticity (BEKK GARCH) introduced by Kroner and Engle (1995) as a tool for capturing volatility and mean spillovers, are applied in this study to find insights and results. Collecting information on behavior of risk and return co-movement between the frontier markets and their neighborhood emerging markets in the COVID-19 pandemic times is the third reason for conducting this study. Because of the virus contagion, all of the global economy turned downward. On the other hand, there were significant active co-movements in financial markets all around the world including Asia (Malik et al., 2021; Naeem et al., 2021).

Objectives

The two objectives in this study are;

1. Observing market integrating and exploring diversification opportunities by capturing return and volatility spillovers among frontier and emerging stock market in Asia in normal period

2. Identifying the changes of return and volatility spillovers among these markets in COVID-19 pandemic period.

Literature Review

1. Frontier Markets

A group of researchers studied the changing role of emerging and frontier markets in global portfolio diversification in the presence of VAR BEKK GARCH model (Patari et al., 2019). The research indicated that there were more integration and co-movement between emerging and frontier markets and developed markets. Seth and Singhania (2019) conducted a study on volatility in frontier markets by using multivariate DCC (Dynamic Conditional Correlation) and BEKK GARCH analysis. The study approved that the association of co-integration and volatility spillover was negative among 21 frontier markets in the world. A Vietnamese researcher applied VAR BEKK GARCH model to capture return and volatility spillover across equity markets between China and Southeast Asian countries (Hung, 2019). This research showed the result of Vietnam, Thailand, Singapore, and Malaysia financial markets had significant impact of volatility in China market. Shamiri and Isa (2010) conducted a research on volatility transmission in Asia-Pacific markets. VAR BEKK GARCH model was an analysis model in their research. They found US market has been influencing the Asia-Pacific markets for the recent years. They also suggested international investors to pay attention on US market directly if they would like to get profit in Asia-Pacific markets. A group of researchers completed a research on looking at new markets for international diversification in frontier markets compared with US and Australia stock markets (Sukumaran et al., 2015). The result pointed out that diversifying into frontier markets could deliver significant benefits for the US investors than Australian.

2. Emerging Markets

Kumar and Dhankar (2017) explored the study on financial instability, integration, and volatility of emerging South Asian stock markets by using GARCH (1,1) and TGARCH. The study of financial integration and diversification benefits between China and four ASEAN emerging countries (Indonesia, Malaysia, Philippines, and Thailand) provided the empirical facts that there would be diversification benefits for investors from a cross-industry investment within the region (Nguyen & Elisabeta, 2016). Ameer (2006) also described the co-movement of Asian emerging financial markets like India, Indonesia, Malaysia, South Korea, and Thailand with global financial markets and indicated the global volatility spillover effects on these markets.

3. VAR BEKK GARCH

Vardar and Aydogan (2019) conducted a research of return and volatility spillover between Bitcoin and other asset classes in Turkey by employing VAR BEKK GARCH analysis. The results concluded that there was a positive unilateral return spillover between the bond markets and Bitcoin market. Pandey and Vipul (2018) applied CCC

(Constant Conditional Correlation), DCC, EGARCH and BEKK GARCH to study volatility spillover from crude oil and gold to equity markets in Brazil, Russia, India, China, and South Africa (BRICS). The finding showed that there were volatility spillover effects of crude oil and gold to equity markets in BRICS countries. Ghorbel and Boujelbene (2013) have touched the contagion effect of the oil shock and US financial crisis on the Gulf Corporation Council (GCC) and BRIC countries under the framework of GARCH class models including BEKK GARCH. A high degree of volatility in the oil and stock markets had been found in the analysis. The approach of structural VAR GARCH model was connected to a research on spillover effect in Asian financial markets. While China linked with other markets in lesser degrees, United States was a main source of fluctuations in Asian financial markets (Wang & Liu, 2016). The finding of a research indicated the substantial volatility spillover effects between Chinese stock market and E7 (Emerging 7) and G7 (Group of 7) markets in the application of VAR GARCH model (Uludag & Khurshid, 2019). This study also pointed the stock co-movement along with the geographical location.

Methodology

1. Data Profile

Daily stock market indices are collected from three frontier markets Sri Lanka, Bangladesh, and Vietnam, and from three neighboring emerging markets such as Thailand, India, and China. There are two analysis periods. The first period, the time between Global Financial Crisis and COVID-19, starts from 1st January 2013 to 31st December 2019. It is a 7 years long period. The second period, the COVID-19 pandemic time, starts at the beginning of January to the last day of December 2020. In this study, the daily index figures of Bangladesh and Sri Lanka are describes as MILK and MIBD by using Morgan Stanly Composite Index (MSCI). The daily return of Ho Chi Minh Stock Exchange is a source of Vietnam Index (VNI). Shanghai Composite Index (SSEC) is as a source for China financial market. SET and S&P BSE 100 index are used to represent Thailand Stock Exchange and Bombay Stock Exchange. The study, by converting the daily closed price with a formula, employs return value as a basic data in each index. The index prices on non-overlapping open days are removed for the purpose of synchronizing in all data series. The numbers of data collected in each market are 1435 returns in normal period and 177 returns in pandemic period.

2. Methodology

2.1 Return Analysis

The formula to capture the daily return in a financial market is

$$R_t = \ln(P_t / P_{t-1}) \times 100,$$

Where R_t is the return of the index; P represents the closing price index and t and $t-1$ are the time periods.

2.2 Descriptive Statistics

Pearson correlation matrix is applied to identify the relationship pattern and directions in between financial markets under the study. The descriptive statistics of

median, mean, maximum and minimum, and standard deviation in each financial index series are also illustrated. Skewness, kurtosis and Jarque-Bera normality tests are operated to identify the pattern of return distribution.

2.3 Stationary Test

The stationary tests are most important in proceeding BEEK GARCH model because they can identify the existence of unit root in studied data series. Unit root tests like Augmented Dickey-Fuller (ADF) test and Philips-Perron (PP) test are employed to examine stationarity in each returns data series before continuing the time series analysis methods for further process.

2.4 Vector Autoregressive (VAR)

VAR model is applied to find the return spillover effect between the stock market returns which are sorted in paired as (X,Y).

$$r_{y,t} = a + b_1 r_{y,t-1} + c_1 r_{x,t} + \varepsilon_t,$$

Where r_x and r_y are the stock index returns of each of variable in the paired data set. a is a vector constant, b_1 and c_1 are (2 x 2) matrix, and ε_t is an error term.

2.5 Baba-Engle-Kraft-Kroner GARCH

The effect of volatility spillover between the paired stock markets is captured by BEKK GARCH model. The model equation is

$$H_t = CC' + A\varepsilon_{t-1}\varepsilon'_{t-1}A' + BH_{t-1}B',$$

Where, is volatility at time period t and C is the triangular matrix with a 2 x 2 relationship. A and B are parameters with 2 x 2 matrix of ARCH and GARCH coefficient. ε is an error term. The ARCH coefficient captures own and cross-market shock transmission whilst GARCH coefficient is seeking the volatility persistence between particular paired markets.

Table 1 Descriptive Statistics

	BSE	MIBD	MILK	SET	SSEC	VNI
			A. Normal Period (2013-2019)			
Mean	0.0004	0.0003	0.0000	0.0002	0.0002	0.0007
Median	0.0007	0.0000	-0.0001	0.0004	0.0006	0.0012
Minimum	-0.0628	-0.0646	-0.0757	-0.0523	-0.0849	-0.0587
Maximum	0.0552	0.0580	0.0371	0.0459	0.0576	0.0385
S.D.	0.009	0.008	0.010	0.008	0.014	0.010
Kurtosis	3.3818	7.9771	7.0750	4.3984	6.6822	3.3945
Skewness	-0.2721	0.3131	-0.6446	-0.2772	-0.9582	-0.6474
JB test	701.5***	3828.2***	3092.3***	1175.1***	2889.4***	789.2***
PP	-35.14***	-37.8***	-30.7***	-37.5***	-35.3***	-37.7***
ADF	-11.50***	-10.13***	-11.48***	-11.4***	-11.0***	-10.5***
Count	1435	1435	1435	1435	1435	1435

Table 1 Descriptive Statistics (Cont.)

	BSE	MIBD	MILK	SET	SSEC	VNI
			B. Covid-19 Period (2020)			
Mean	0.0014	0.0019	0.0001	-0.0004	0.0008	0.0006
Median	0.0023	0.0000	0.0004	-0.0003	0.0011	0.0017
Minimum	-0.0827	-0.0335	-0.1069	-0.1080	-0.0772	-0.0519
Maximum	0.0554	0.0805	0.0983	0.0795	0.0315	0.0284
S.D.	0.014	0.012	0.022	0.017	0.013	0.011
Kurtosis	9.0904	13.9375	7.5418	12.9281	8.5841	4.1948
Skewness	-1.3539	2.3703	-0.6501	-1.2031	-1.5565	-1.4639
JB test	663.5***	1598.4***	431.9***	1275.3***	614.9***	192.9***
PP	-13.1***	-12.5***	-8.6***	-12.8***	-14.1***	-12.5***
ADF	-6.61***	-5.24***	-5.247***	-5.604***	-6.5***	-5.44***
Count	177	177	177	177	177	177

Note: Source from author's calculation. SD, PP, ADF, and JB represent Standard Deviation, Phillips-Perron test, the augmented Dickey-Fuller test and Jarque-Bera statistics. The significant levels in each test are de fined as "*", "**", "***" for 10%, 5%, and 1% respectively.

Table 2 Correlation Matrix

	BSE	MIBD	MILK	SET	SSEC
		A. Normal Period (2013-2019)			
MIBD	0.0250				
MILK	0.1000***	0.0848***			
SET	0.3829***	0.0192	0.1072***		
SSEC	0.1950***	0.015	0.1113***	0.2161***	
VNI	0.1541***	0.0369	0.1078***	0.1828***	0.1838***
		B. COVID-19 Period (2020)			
MIBD	0.0994				
MILK	0.0263	0.0858			
SET	0.6857***	0.1874**	-0.0318		
SSEC	0.2262***	0.0057	-0.0015	0.2744***	
VNI	0.3201***	0.0936	0.1819**	0.3665***	0.2496***

Note: Source from author's calculation. The significant levels in each test are defined as "*", "**", "***" for 10%, 5%, and 1% respectively.

Table 3 Vector Autoregressive Analysis Result

	Normal Period (2013-2019)		COVID-19 Period (2020)	
	$\nu 12$	$\nu 21$	$\nu 12$	$\nu 21$
BSE_MIBD	-0.04 [-1.50]	-0.00 [-0.03]	-0.03 [-0.36]	0.04 [0.65]
BSE_MILK	-0.06 [-2.39]**	0.10 [3.75]***	-0.05 [-1.11]	-0.11 [-1.06]
BSE_SET	-0.02 [-0.71]	0.03 [1.17]	-0.02 [-0.29]	0.14 [1.11]
BSE_SSEC	-0.03 [-1.81]*	0.09 [2.21]**	-0.06 [-0.71]	0.10 [1.45]
BSE_VNI	-0.08 [-3.18]***	0.07 [2.32]**	-0.02 [-0.22]	0.02 [0.24]
MIBD_MILK	-0.01 [-0.54]	0.01 [0.17]	-0.01 [-0.15]	0.10 [0.79]
MIBD_SET	0.06 [2.21]**	-0.05 [-1.86]*	0.01 [0.09]	-0.11 [-0.97]
MIBD_SSEC	0.01 [0.67]	0.09 [2.04]**	0.08 [1.18]	-0.01 [-0.16]
MIBD_VNI	0.00 [0.05]	0.03 [1.04]	0.14 [1.80]*	0.07 [0.93]
MILK_SET	0.08 [2.66]***	-0.03 [-1.28]	0.01 [0.07]	-0.073 [-1.27]
MILK_SSEC	0.02 [0.89]	0.11 [2.85]***	0.04 [0.38]	-0.05 [-1.03]
MILK_VNI	0.06 [2.55]**	0.05 [1.89]*	0.10 [0.73]	-0.03 [-0.85]
SET_SSEC	-0.01 [-0.40]	-0.01 [-0.22]	0.03 [0.25]	0.01 [0.18]
SET_VNI	0.00 [0.15]	0.05 [1.48]	0.06 [0.49]	0.08 [1.53]
SSEC_VNI	0.04 [1.13]	0.01 [0.30]	-0.06 [-0.66]	0.09 [1.33]

Note: Source from author's calculation. T-statistics values are described in [ ]. $\nu 12$, $\nu 21$ are the VAR coefficients with 1-day lagged returns turnover of specific stock markets. $\nu 12$ is the cross market return spillover from market 1 to 2 while $\nu 21$ tells the return turnover from market 2 to 1. The significant level are defined as "*", "**", "***" for 10%, 5% and 1% respectively.

2.6 Maximum Likelihood Estimation

To estimate the parameters and assuming the normal distribution error in BEKK GARCH, a Maximum Likelihood model known as Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm, is applied in this study.

$$L(\theta) = -T\log(2\pi) - 1/2\sum_{t=1}^{T}(log|H_t| + \varepsilon_t' H_t^{-1}\varepsilon_t) ,$$

Where T is the number of observations and θ is the vector of parameters to be estimated. H_t is volatility and ε_t is an error term.

Results

1. General Descriptive Statistics

It is important to note that the country and its particular symbol illustrated in all tables are India (BSE), Bangladesh (MIBD), Sri Lanka (MILK), Thailand (SET), China (SSEC), and Vietnam (VNI). The descriptive statistics of studied return series are exhibited in Table 1. In normal period, the Vietnam possesses highest mean and Sri Lanka shows the lowest mean. Bangladesh is the highest in return mean and Sri Lanka describes the

lowest return in pandemic period. Moreover, the average means of India, Bangladesh and China are significantly increased in the pandemic period. Thailand owns the only negative mean in pandemic period. From the perspective of standard deviation, a useful measurement of volatility, China is the most deviated and Bangladesh and Thailand are the least ones in the normal period. In the pandemic situation, Sri Lanka expresses the highest and Vietnam is the lowest value of standard deviation. In addition, all of the markets present higher fluctuation in their specific own market except China and Vietnam in this situation. All of the return series are not highly skewed in normal period. In the pandemic period, however, Bangladesh describes obvious skewness in its returns. Moreover the positive skewness, in both studied periods, is found only in Bangladesh while negative skewness is shown in all other markets. The leptokurtic characteristics shown in the descriptive statistics that means the value of Kurtosis for all markets is greater than the standard value. Moreover, the results in Jarque-Bera test are the noticeably significant. These evidences reject the normal distribution in all return series for both periods.

2. Correlation Matrix

The correlations between financial markets in normal and COVID-19 period are presented in panel A and B of Table 2. The degrees of correlation between financial markets are illustrated in digit with specific significant level. All of the financial markets except Bangladesh are highly correlated each other in normal period. Later, Thailand becomes the only one market correlates Bangladesh in the COVID-19 period. The non-existence of significant negative correlation among observed markets is a similar character in both periods.

3. Stationary Tests

The 1% significant results of Phillips-Perron (PP) and augmented Dickey-Fuller (ADF) tests, in Table 1, confirm the stationarity of all time series in both study periods to follow the further analysis methods VAR and BEKK GARCH.

4. Results on Return Spillover

Vector autoregressive model (VAR) is applied to study the return spillover effect. The results on return spillover are shown in Table 3. The highly significant level are considered as "**" and "***" for 5% and 1% respectively. In the normal period, the previous daily return is significantly influence between India and Vietnam where the coefficients are significant 1% and 5%. This influence also transmits from Bangladesh to Thailand (5% significance) and from Sri Lanka to Thailand (1% significance) and to Vietnam (5% significance). Furthermore, there is a unidirectional return linkage from China to India, Bangladesh (5% significance) and Sri Lanka (1% significance). The return integration in Thailand and China to frontier markets like Bangladesh and Sri Lanka is against the results of Thomas, Kashiramka and Yadav (2017). Nevertheless, there is no any statistically significant return spillover between the other paired markets in this

period. This finding is inconsistence with the finding of Hung (2019) which describes the existence return transmission from China to Thailand and Vietnam. Some markets such as India and China present own market return spillover effect in the normal period while Sri Lanka displays this spillover effect in both studied periods. The figures in Covid-19 do not describe the same result as there is no significant return series in this period.

Table 4 Volatility spillover Analysis Result (2013-2019)

	BSE_MIBD	BSE_MILK	BSE_SET	BSE_SSEC	BSE_VNI
α_{12}	0.32 [8.16]***	0.04 [1.05]	-0.15 [-10.1]***	-0.05 [-1.59]	0.19 [1.29]
α_{21}	-0.05 [-0.60]	0.13 [3.39]***	0.04 [0.58]	0.21 [5.68]***	0.15 [2.97]***
β_{11}	-0.03 [-0.73]	-0.04 [-0.99]	0.03 [0.51]	0.02 [0.53]	0.20 [1.08]
β_{12}	0.00 [0.16]	0.31 [2.46]**	0.01 [0.17]	-0.21 [-4.39]***	0.35 [4.54]***
β_{21}	-1.03 [-10.6]***	-0.05 [-0.84]	0.36 [0.61]	-0.06 [-2.64]***	-0.70 [-20.9]***
β_{22}	0.03 [0.75]	0.45 [6.68]***	0.14 [0.75]	-0.88 [-77.5]***	0.00 [0.04]
	MIBD_MILK	MIBD_SET	MIBD_SSEC	MIBD_VNI	MILK_SET
α_{12}	0.02 [0.45]	-0.17 [-3.81]***	-0.13 [-1.52]	-0.43 [-10.6]***	-0.12 [-2.12]**
α_{21}	0.09 [2.03]**	-0.12 [-2.59]***	-0.4 [-120.2]***	-0.037 [-1.00]	0.18 [3.35]***
β_{11}	0.01 [0.26]	-0.14 [-5.31]***	0.22 [3.62]***	0.01 [0.19]	0.29 [1.33]
β_{12}	0.07 [0.44]	-0.03 [-3.93]***	1.32 [24.20]***	-0.02 [-1.96]*	0.04 [1.45]
β_{21}	0.09 [1.15]	0.95 [34.22]***	-0.37 [-10.2]***	-0.79 [-33.2]***	-0.88 [-6.41]***
β_{22}	0.45 [7.81]***	0.15 [13.71]***	0.11 [4.00]***	-0.01 [-0.19]	-0.10 [-1.34]
	MILK_SSEC	MILK_VNI	SET_SSEC	SET_VNI	SSEC_VNI
α_{12}	-0.01 [-0.19]	0.06 [1.36]	0.06 [1.5391]	0.40 [3.71]***	-0.22 [-5.39]***
α_{21}	0.04 [1.13]	0.04 [0.93]	0.25 [10.3]***	-0.00 [-0.10]	0.21 [3.38]***
β_{11}	0.40 [5.51]***	-0.01 [-0.34]	-0.56 [-9.86]***	-0.58 [-1.76]*	0.77 [21.01]***
β_{12}	-0.04 [-2.74]***	-0.02 [-0.26]	-0.17 [-5.03]***	0.09 [1.29]	0.31 [12.79]***
β_{21}	0.02 [1.11]	-0.04 [-0.85]	0.00 [0.30]	-0.52 [-1.75]*	-0.72 [-18.9]***
β_{22}	0.91 [483.4]***	-0.75 [-21.0]***	-0.90 [-99.7]***	-0.21 [-2.62]***	0.49 [6.29]***

Note: Source from author's calculation. T-statistics values are described in [ ]. α represents the ARCH effect and β is the GARCH coefficient in each of paired markets. The significant level are defined as "*", "**", "***" for 10%, 5%, and 1% respectively.

Table 5 Volatility spillover Analysis Result (2020)

	BSE_MIBD	BSE_MILK	BSE_SET	BSE_SSEC	BSE_VNI
$\alpha 12$	-0.03 [-0.29]	1.18 [9.43]***	0.06 [0.35]	-0.00 [-0.03]	-0.01 [-0.13]
$\alpha 21$	-1.15 [-7.92]***	0.02 [0.53]	-0.05 [-0.40]	-0.37 [-2.27]**	-0.56 [-4.9]***
$\beta 11$	-0.07 [-0.97]	-0.27 [-7.0]***	-0.84 [-7.9]***	0.01 [0.27]	-0.00 [-0.08]
$\beta 12$	0.64 [11.37]***	0.26 [2.73]***	-1.30 [-11.4]***	-0.12 [-0.47]	-0.00 [-0.08]
$\beta 21$	-0.02 [-1.26]	-0.29 [-4.00]***	0.53 [4.0]***	-0.06 [-0.50]	0.00 [0.07]
$\beta 22$	0.03 [0.44]	0.27 [8.67]***	0.83 [7.8]***	0.74 [19.03]***	-0.00 [-0.02]
	MIBD_MILK	MIBD_SET	MIBD_SSEC	MIBD_VNI	MILK_SET
$\alpha 12$	0.24 [1.49]	1.17 [6.43]***	1.02 [7.87]***	0.31 [2.45]**	0.43 [4.54]***
$\alpha 21$	-0.00 [-0.02]	0.14 [2.03]**	0.03 [0.42]	0.12 [2.75]***	-0.11 [-0.96]
$\beta 11$	-0.73 [-24.4]***	0.43 [4.48]***	0.12 [1.55]	-0.73 [-18.0]***	0.34 [4.64]***
$\beta 12$	0.02 [0.45]	-0.25 [-2.66]***	-0.26 [-3.32]***	-0.01 [-0.15]	0.16 [2.31]**
$\beta 21$	0.00 [0.10]	0.35 [5.74]***	-0.67 [-10.4]***	-0.22 [-2.00]**	-0.69 [-9.13]***
$\beta 22$	-0.35 [-4.51]***	0.09 [1.27]	-0.17 [-2.23]**	-0.00 [-0.18]	-0.33 [-4.50]***
	MILK_SSEC	MILK_VNI	SET_SSEC	SET_VNI	SSEC_VNI
$\alpha 12$	-0.03 [-0.50]	0.09 [1.58]	0.27 [2.17]**	0.21 [2.54]**	0.00 [0.03]
$\alpha 21$	-0.00 [-0.05]	-0.27 [-1.83]*	-0.02 [-0.08]	1.04 [6.63]***	0.06 [0.53]
$\beta 11$	-0.41 [-4.84]***	0.66 [15.03]***	0.38 [1.83]*	-0.10 [-1.23]	-0.00 [-0.02]
$\beta 12$	-0.02 [-0.41]	0.26 [2.26]**	0.13 [0.78]	0.01 [0.37]	-0.00 [-0.01]
$\beta 21$	0.05 [0.24]	-0.48 [-1.44]	-1.03 [-4.81]***	-0.78 [-6.51]***	0.00 [0.00]
$\beta 22$	0.00 [0.15]	-0.19 [-2.88]***	-0.37 [-1.76]*	0.091 [1.08]	0.00 [0.02]

Note: Source from author's calculation.T-statistics values are described in [ ]. α represents the ARCH effect and β is the GARCH coefficient in each of paired markets. The significant level are defined as "*", "**", "***" for 10%, 5%, and 1% respectively.

5. Results on Volatility Spillover

BEKK GARCH is the key analysis model to capture short-term volatility (shock) and long-term volatility spillover effects in between the paired time-series in this study. Table 4 and 5 display the detail results on volatility spillover effect in normal (2013-2019) and COVID-19 period (2020). The mutual volatility spillover effect is significant in the pair India-Sri Lanka, India-Thailand, Bangladesh-Thailand, Bangladesh-China, and Sri Lanka-Thailand which illustrates the persistence of long-term memory effect between each pair in the pandemic period. Likewise, the pair of Bangladesh-Vietnam and Thailand-Vietnam transmits bidirectional long-term volatility between each other in this period. The opposite direction of volatility spillover between short and long-term transmission happens in India-Bangladesh and Thailand-China. Furthermore, the short-term and unidirectional shock is transmitted from China and Vietnam to India in the pandemic time. This conclusion is supported by the

findings of a study (Naeem et al., 2021) that indicates the reason occurring the return connectedness in conventional stock markets is short-term spillover. Moreover, the fact that the own-market volatility in China is higher than India is recommended by a study (Malik et al., 2021). The crossvolatility spillover effect with 1% significant coefficients is observed in Bangladesh-Thailand and Bangladesh-China in both normal and pandemic period. It shows that the two markets in these pairs are closely related along with shocks and long memories in each market influence the other's movement reciprocally. The most considerable difference in volatility spillover effect between the normal and pandemic period occurs in between China and Vietnam. Although there is a highly significant (1% significant level) cross-volatility spillover effect between China and Vietnam in normal period, no significant coefficient is observed and there is no any volatility transmission among these countries in the pandemic time. The other divergence between the normal and pandemic situation is that the nature of volatility spillover from Sri Lanka to Bangladesh and China. In the normal period, Sri Lanka transmits short-term volatility spillover to Bangladesh and long-term volatility to China. Conversely, there is no any significant spillover effect between these markets in the COVID-19 period.

Discussion

Exploring opportunities and risk evaluation are critical factors to maximized profit and minimize damage in International investment decision through portfolio diversification especially in global pandemic situation. Examining the return transmission and volatility transmission can illustrate integration and co-movement patterns among stock markets to provide useful information in calculating these critical factors. Vector Autoregressive model (VAR) is a strong tool and widely apply to deal with return transmission. BEKK GARCH is a mechanism for observing shock and long-term volatility interrelation. Therefore, seeking the opportunities in frontier markets in Asia by comparing and contrasting geographically connected emerging markets in both normal and pandemic situation, applying VAR and BEKK GARCH, is implemented by reason of cross-border economy and financial integration. The other reason is the effect of Covid-19 on financial markets by spreading across the border line of particular country.

According to the observation in the normal timeframe (2013-2019), India stock market is integrated to other markets especially China, Vietnam and Sri Lanka. Bangladesh is well integrated market with China and Thailand. Sri Lanka, according to the findings, is integrated to emerging markets but it has limitations to connect with other frontier markets. The return linkage of Thailand only appears in Bangladesh and Sri Lanka. The country also presents the volatility spillover effect for all other stock markets while Bangladesh is the closest relationship with an exclusive mutual volatility spillover. China also serves as a transmitter as

well as a receiver of volatility spillover for all other countries. The Vietnam market displays the lack of return integration with Bangladesh, Thailand and China. It exchanges volatility spillover in all of the observed markets; however, there is no considerable spillover with Sri Lanka. During the pandemic period, the analysis results suggest that no return linkage is observed among all studied markets. This figure exhibits the effect of lock down can reduce the return integration in this period. There is a strong volatility spillover between Thailand and India and Thailand increase its bi-directional volatility spillover transmissions in India and Sri Lanka addition to Bangladesh. Moreover, Thailand is the only country which possesses the strongest volatility relationships to all markets in both pandemic and normal time. Hence Thailand stock market exhibits the most inter connectedness not only to other emerging markets but also to frontier markets under the study. Frontier countries, Vietnam and Sri Lanka, leave China in their volatility spillover affected countries list in COVID-19 period.

Conclusion

Bring to a close, frontier markets are significantly integrated to emerging ones, on the other hand, they are not strongly integrated in between each other during normal period. In pandemic situation Bangladesh, among frontier markets, maintains its integration with emerging markets while Vietnam and Sri Lanka present significant reducing in integration with emerging ones. Thailand is the most active country in transmission and receiving shock and long-term volatility spillovers among emerging markets in both periods since China and India break their bilateral volatility relationship in pandemic time. The results suggest that the frontier markets in Asia are highly integrated to emerging markets. It reduces the effectiveness of portfolio diversification for all types of investors. However, investors may enjoy the diversification benefit by long term investing in Vietnam because this market offers higher returns and less fluctuation than its frontier counterparts, Bangladesh and Sri Lank in the normal situation. Besides, the market offers moderate return with least market fluctuation with neither of return and volatility spillover comes from China during the pandemic situation.

Although there are some methodological, periodical, positional limitations, this study offers various future research options. As a methodological limitation, BEKK GARCH leaves a room to capture the natures of volatility to identify whether symmetry or asymmetry cluster for other analysis models. The study in nature of volatility clusters may become a future research topic. The researchers may also estimate the return and volatility spillovers either by applying different analysis models including GARCH family models in the same region or by exploring different regions under existing models, VAR BEKK GARCH. Since this research covers 1st January 2020 to 31st December 2020, the duration of pandemic itself becomes the periodical limitation for

the study because the beginning of pandemic in each country under the study is different and the period is still happening even after the year 2020. The future papers can offer the additional results by conducting the analysis in longer COVID-19 pandemic period focus on the same or different financial markets. The positional limitation can be considered into two types. The first type is that this study totally concentrates on frontier markets and neighboring emerging markets although there are many emerging markets in Asia. The other positional limitation is that the scope of this study covers stock markets for the analysis of spillover effects, however, the return and volatility spillovers can occurs among the other asset classes like bonds, crypto currency and commodities.

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