IMPACT OF COVID-19 ON LONG RUN AND SHORT RUN FINANCIAL INTEGRATION AMONG EMERGING ASIAN STOCK MARKETS

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Abstract. *Purpose –*The study aims at exposing any possible impact of COVID-19 on short-run and long-run financial integration among five emerging Asian economies viz., China, South Korea, India, Indonesia and Taiwan.

Research methodology – Daily closing indices of selected countries have been analyzed from January 2010 – September 2021. The integration among the selected economies has been examined for long-run and short-run through Johansan co-integration and Granger causality tests respectively.

Findings – The analysis revealed that coronavirus weakened integration among nations. The absence of long-run integration was observed after the onset of COVID-19. During pre-covid period, unidirectional as well as bi-directional causal relations were present, but after the outbreak of COVID-19, only South Korea and China reported short-term linkage.

Research limitations – The results are subject to the limitation of limited data and reference period. Further, daily returns of different stock markets are subject to domestic shock which has not been analyzed in the present study.

Practical implications – Since the absence of integration indicates an ample opportunity for risk minimization through international diversification of the portfolio, the results are expected to be very useful for investors, researchers and regulators.

Originality/Value – In present times, researchers are showing keen interest to know the possible impact of COVID-19 on linkages of international financial markets. However in spite of being rapidly growing economies, countries selected in the present study have not been explored much. The present study aims to bridge this research gap.

Keywords: COVID-19, emerging Asian countries, financial integration and stock markets.

JEL Classification: G15.

Introduction

With the advent of economic and financial reforms during 1990s Indian economy paved the door for globalization. The concept of liberalization and globalization heralded integration

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of Indian stock market with global stock markets. Broadly, financial market integration occurs in three dimensions, nationally, regionally and globally (Raj & Dhal, 2006). The present study considers the global form of financial market integration that refers to the opening of domestic markets for cross border flow of capital. The integration of stock market delineated a steady growth. The concept of global financial integration was scant during 1970s due to the conservativeness of stock markets. However, with an advent of technological developments and financial liberalization, the financial markets, especially the stock markets, for developing and developed markets have now become more closely interlinked (Chattopadhyay & Behera, 2006). In context of India, initially the stock market integrated with few major capital markets but gradually it established integration with almost all other countries. The rising graph of cross border capital movements, foreign investments, international mergers and acquisition witness the same. Many researchers (Dhal, 2009; Mandal & Bhattacharjee, 2012; Ardliansyah, 2012; Bhunia & Ganguly, 2015; Verma & Rani, 2016) observed short run and long run interlinkages of Indian stock market with international stock markets.

It has already been substantiated that stock market integration can lead to several benefits to investors and has far reaching implications for policy makers. But the magnitude of possible return from financial integration depends upon the amount of correlation among financial markets. American economist Harry Markowitz in his pioneer work on Portfolio Selection adduced that diversification of portfolio in uncorrelated economies may lead to giant gains as low co-movement among stock prices will provide a cushion unsystematic risk of the economy. But at the same moment of time, it is imperative to mention that linkage of financial market can be a powerful media to spread the contagious risk of market failure and volatility spillover. Investors and policy makers have already witnessed the risk of contagion, information spillovers, disruption of economic activity and much more. Therefore, in present globalized world, it is essential to know the degree of linkage of a country with other developing and developed nations to reap the benefits of diversification as well as to initiate precautionary measures for risk management.

Recognizing the importance of financial market integration for investors and policy makers, many researchers made an attempt to establish/reject the integration between the markets in different time periods. In context of India, initially studies have been undertaken to explore the linkage of Indian stock market with developed and major global economies. But India's global ascendancy across the economic landscape of the world led to financial integration of Indian market with other developing and emerging nations also. Many studies (like Sehgal et al., 2019; Kumar & Aurora, 2020; Tripathy & Mishra, 2021) tried to explore the possibility of financial integration of Indian market with selected emerging markets. But unfortunately, researchers could not get any consensus. Some of the studies found good evidence to assume the correlation while some other rejected the possibility of any sort of market linkages. There are two prominent reasons that are responsible for such divergent conclusion viz., difference in time span of the study and difference in the sample i.e., the nations selected for the study. Further the impact of market shocks like crisis, pandemic also contributed to the irreconcilability of the findings of different studies.

In this reference, the present study aims at exploring the short run as well as long run integration of Indian stock market with four emerging economies of Asia viz., China, Taiwan,

Indonesia and South Korea. Further, since in recent past, the outbreak of Covid-19 changed the entire scenario of international trade and cross-capital flow, the present study will also examine the impact of Covid-19 over this integration. The study is expected to be very fruitful for the investors as well as policy makers.

1. Literature review

Investigation of inter-linkage among financial markets has always been a matter of great interest for researchers because financial integration of a country with other countries may seriously influence economic growth of the country. In context of India also researchers anatomized the possible integration and co-movement of Indian stock market with other countries. Till last decade the focus of many studies was to explore the integration if Indian market with developed nations like USA, Canada, Europe and Japan and little work has been done to investigate the inter-linkages between the nations from Asia. But last decade witnessed good number of studies aiming at investigation of market linkage with emerging and developing countries. Like Bodla and Sharma (2011) investigated inter-linkages between stock markets of Indian, Pakistan and Sri Lanka. The data over a period of seven years from January 2003 to June 2010 was analyzed through Granger casualty and VAR models. The study concluded the presence of unidirectional causality. The results reported that Indian market uni-directionally Granger causes the markets of Pakistan and Sri Lanka. In contrast of this the findings of study conducted by Iqbal et al. (2011), established no integration between India and Pakistan. The study covered a span of seven years from January 2003 – Dec 2009. The results of Granger Causality concluded that there is granger causality only from US stock market to Indian and Pakistani markets. The correlation and causal relation of Indian Stock Market with Major Asian economies namely Japan, Hong Kong, Indonesia, Malaysia and Korea were observed to be weak by Gupta and Aggarwal (2011). However, the financial integration in 10 emerging Asian markets using both quantity and price-based measures through GARCH model witnessed global integration (Park & Lee, 2011). The study recommended diversification to maximize investment gains and risk management.

Bhunia and Das (2012) found long-run and short-run association among China, Indonesia, Taiwan, South Korea, India, Singapore, Hong Kong and Malaysia. The study examined daily stock indices from 2002 to 2011 to explore co-integration and Granger causality among selected markets. Similarly, Patel (2012) investigated the interdependence of Indian stock market with some selected Asian markets including the markets of Pakistan, Korea, Malaysia, China, Taiwan, Singapore, Sri Lanka and Japan. Monthly data over a period from July 1997 to September 2012 was used. The study applied Johansen trace test, Granger causality test and vector error correction model for analysis. The results reveal that Indian stock market is positively correlated and is being affected by Pakistan, Sri Lanka, Malaysia, Korea and Singapore. Potharla (2012) also established the co-integration between Indian stock market and stock market off selected Asian economies (China, Indonesia, Japan, South Korea, Malaysia, Hong Kong). Monthly indices were taken from January 2000 to December 2010. The results of variance decomposition divulge low impact of Asia-Pacific stock markets on Indian stock market. The study of Kharka et al. (2012) analyzing the integration of Indian stock market

with South Asian markets (Bhutan, Pakistan, Nepal, Bangladesh) through weekly data from January 2006 to December 2011 found no such market integration in long run. The results were obtained through unit root test and Johansen trace test. The market linkages expose the volatility spillover among markets. Diebold and Yilmaz (2012) test for volatility spillover effects among selected markets and concluded that Singapore was the most dominant market based in terms of returns as well as volatility spillovers.

Palamalai et al. (2013) reported integration among stock markets of Asia-pacific economies, viz. India, Malaysia, Hong Kong, Singapore, South Korea, Taiwan, Japan, China and Indonesia. The results of Johansen co-integration test, variance decomposition analysis and granger casualty test established the integration among selected stock markets. The variance decomposition analysis also revealed stock market interdependencies. But Sharma et al. (2013) while exploring inter-linkages among BRICS nations over a period of five years from April 2005 to March 2010 suggested that though some countries have influence over others but in aggregate terms it is not much significant. The study recommends portfolio diversification among the stock exchange of BRICS. Similarly, Rajwani and Mukherjee (2013) reported that Indian stock market is not co-integrated with any of the selected Asian stock market in long run. The study analyzed the secondary data of China, Japan, Malaysia, South Korea, Indonesia and Taiwan and reported that diversification can minimize the portfolio risk. But the study of Bhunia and Ganguly (2015) conducted over a period of 22 years from 1991 to 2013 reported the long run integration and bi-directional causality among selected Asian stock market indices.

Babu et al. (2016) also examined inter-linkages among Asian pacific markets viz. India, Australian stock exchange, Shanghai, Tokyo and Hong Kong stock exchange by using daily data from April 2009 to March 2014. The findings suggest that there is only uni-directional relationship among the markets. The study of BRICS nations by Verma and Rani (2016) also reported that Brazilian market has a unidirectional relation with Indian stock market and Indian stock market has a uni-directional relation with South Korea. The results of variance decomposition mode revealed shocks emerging in other stock markets do no influence returns in Indian stock market. But Kumar and Dhankar (2017) found significant short run and long run spillover effects of international instability on stock returns of emerging South Asian stock market (India, Sri Lanka, Pakistan). The results were based on Generalized Autoregressive Conditional Heteroscedastic (GARCH) model and granger causality test. Bhowmik and Wang (2018) investigated volatility linkage among emerging Asian stock markets (India, China, Bangladesh, Malaysia, South Korea, Philippine) and developed stock markets (US, UK, Japan and Singapore). The results of GARCH, VAR model and Causality test confirmed the linkage among the returns as well as volatility of selected stock markets. But Narayan and Rehman (2018) while examining the possible benefits of portfolio diversification for a period spanning from 2000 to 2013 found Asian region as good investment destination. The study concluded that portfolio investment in Asian countries might lead to greater diversification gains than a portfolio without involvement of Asian countries. In the study of regional and global stock market integration in Asia, Caporale et al. (2019) concluded that Asian stock markets were integrated both globally and regionally. Analyzing the three big Asian economies Japan, China and India, Bhullar (2019) observed relationship between India and Japan

but no integration could be observed between India and China. Sehgal et al. (2019) also gave hybrid result while exploring stock market linkages among selected 12 Asian stock markets over a period Jan 2000 to June 2017. Results were given by employing GARCH model.

Since every financial activity is highly prone to market risks caused by random shocks, researchers have shown a great interest to investigate the impact of shocks over the co-integration and spillover of volatility among different nations. In this context, in recent last two years, the shock that has influenced each and every economic activity all over the world and has been proved as the most brutal pandemic of last few decades i.e., COVID-19 fetched the attention of researchers. The coronavirus has spread all over the world within no time and left no scope for the economies to isolate themselves from this pandemic. That is the reason why researchers probe into the possible consequences of this pandemic over the market integration. However, most of the research work has been conducted with reference to developed nations like Song et al. (2021) examined the volatility spillover between USA and China in pre-covid period and during covid crises. EGARCH results confirmed asymmetric volatility spillover effect from China to US.

Similarly, another study was conducted by Youssef et al. (2021) who concluded that stock markets of China, France, UK, US, Russia, Spain, Italy and Germany were connected during the entire period of covid-19 and there were volatility spillover effects to all selected stock markets except from Italy. Chaudhary et al. (2020) investigated influence of COVID-19 on volatility of stock market for top 10 countries on the basis of GDP. The results of GARCH model observed covid as an exogenous variable was found to be significant for all nations and volatility was high for all the selected economies. Ali et al. (2020) also tried to examine the volatility spillover effects from China to Europe and then to US. The results of ARCH and GARCH test confirms that earlier China was the epicenter but due to association between the nations in later stages as pandemic got transferred to Europe and then US causing a decline in the value of assets and stock markets. In contradiction to above mentioned studies Zhang et al., (2021a) by using TGARCH model concluded that China had volatility spillover effects to most advanced nation of the world (UK, Sweden, Netherlands, Switzerland) but no significant impact of Chinese stock market returns was observed on US stock market volatility. Gao et al. (2021) compared the impact of COVID-19 and volatility spillover between China and US. The results of wavelet approach concluded that both the markets responded to covid differently a loose interest rate policy of US suppressed volatility to a great extent. Pinglin et al. (2020) investigated impact of COVID-19 across different sectors of Chinese stock market. Results show that some sectors like transportation, mining, environmental industries, heating and electrical sectors were affected greatly. The study reported that on one hand the pandemic had a negative impact on stock prices of Shanghai stock exchange but at the same time it created an opportunity for development of high-tech industries. Similarly, Mazur et al. (2021) observed equities in petroleum, real estate, hospitality and entertainment fell drastically. However, health care, natural gas and software sectors have demonstrated positive returns.

Thus, we can say that while exploring the integration of Indian stock market with other developing and developed countries, different researchers have obtained different findings that are very much subject to specific time. However, we did not find much work to explore

the market integration during post-covid period. Further researchers unveil that market shocks may influence the degree integration among market for an instance global financial crisis affected market integration (Dhanaraj et al. 2013). Similarly other innovations/shocks may have their own implications over market integration. In recent two years the entire world experienced a novel shock in terms of emergence of COVID-19. The novel coronavirus has shaken the entire world. There is no single economy that could remain isolated during the turbulence caused by this deadly pandemic. In this context, the present study aims at investigating the impact of COVID-19 over the short run and long run linkages of Indian economy with other Asian countries.

2. Research design

2.1. Statement of problem

With ever increasing volatility spillovers across global markets, the understanding of stock market linkages became inevitable. Recent financial crises clearly demonstrate how a crisis emanating from one nation gets transferred to another nation leading to a situation of global crises. Now the novel coronavirus also caused great oscillations across the world. Some researchers found substantial evidence of significant impact of coronavirus on developed markets (Ali et al., 2020; Zhang et al., 2021b; Song et al., 2021; Youssef et al., 2021; Gao et al., 2021). But studies aimed at investigating the impact of covid-19 on the international linkages of Indian stock market with other countries are in dearth. In this context, the present study makes an attempt to analyze the integration among five emerging Asian countries viz., China, South Korea, India, Indonesia and Taiwan. The study is important due to two reasons. Firstly, only a few studies have been conducted to explore the market integration of Indian stock market with other countries during post-covid period. Secondly though as per the World Economic Outlook (International Monetary Fund [IMF], 2020), the selected countries are Asia's rapidly emerging and growing economies yet somehow have got less attention of the researchers. On this backdrop, the present study will tend to answer the following research questions:
  – Is there any long-run co-integration among the selected stock markets? If yes, whether the same has got influenced by COVID-19 or not.
  – Is there any unidirectional or bidirectional causal relation among selected markets in short run or not? If yes, whether the same has got influenced by COVID-19 or not.

2.2. Rationale of selected emerging economies

The present study aims at investigating impact of COVID-19 on the integration among five Asian countries viz., China, India, Indonesia, South Korea and Taiwan. Though these countries are rapidly growing economies of Asia-Pacific region in terms of GDP yet the linkage among these remain unattended in the previous studies. The present study relates two Asian giants i.e., Indian and China having a market capitalization of 3.6 USD trillion and 7.2 USD trillion respectively (IMF, 2020). Besides these two prominent Asian countries, three rapidly growing and emerging economies of Asia have also been included. Divecha et al. (1992) pointed out that there are three criterions to be fulfilled by a market in order to be eligible

to get recognized as an emerging market. These criterions are – firstly the country must have an organized market for trading securities and foreign investors should be allowed to invest in these economies. Secondly, the country or stock market should have a reliable source of database for its investors and lastly the country should not have the status of developed nation. To ensure the first and second condition we checked the online status of markets and for the last condition, the report of MSCI Emerging Markets Asia Index (MSCI, 2021) has been referred. Keeping in view of the pre-stated criterion, three counties i.e., Taiwan, Indonesia and South Korea have been included in the analysis. Taiwan with a market capitalization of 1.1 USD trillion is a major trading partner of Indian with a trade of 7 billion US dollars. South Korea is one of the biggest markets for exports of India and has a market capitalization of 2.3 USD trillion. Indonesian stock market is also regarded as one of the biggest equity markets in South East Asia. Further it is one of the largest trading partners in ASEAN group.

2.3. Objectives

The present study has following four objectives:
  – To investigate the long run market integration among selected countries.
  – To investigate the short run causality relation among selected countries.
  – To investigate the impact of covid-19 over long run market integration among selected countries.
  – To investigate the impact of covid-19 over the short run causality relation among selected countries.

3. Research methodology

3.1. Data

The paper attempts to investigate the short run and long run linkages among the financial markets of selected countries. To represent the financial markets, closing daily data of leading indices of respective countries have been taken for analysis. The selected stock indices are Shanghai SE Composite Index (China), S & P BSE Sensex (India), Jakarta Composite Index (Indonesia), KOSPI composite index (South Korea) and TSEC Weighted Index (Taiwan). Daily closing values of all indices have been taken from 1st January 2010 to 9th September 2021. In total 2430 observations for each index i.e., 12,150 observations have been analyzed. Further as the study aims at examining the impact of COVID-19 over short run and long run market integration, the entire time-period is segregated in two sub-periods viz., pre-covid period (1st January 2010 to 31st December 2019) and post-covid period (since 1st January 2020). The period has been sub-divided on the ground of first reported case of COVID-19 across the globe.

3.1.1. Descriptive statistics

At the outset, descriptive statistics related with all indices have been explored. But as the closing indices of different countries have been denominated in their local currency, the logarithmic returns have been computed from each index. These returns have been used for com-

paring the descriptive statistics about the market. Average, standard deviation, skewness and kurtosis have been computed for the purpose of comparative analysis. To explore the possible relationship among returns, correlation has been computed. The coefficient of provides an insight about the strength of association and magnitude of relationship between two countries.

3.1.2. Unit root test

Before proceeding for any statistical tool to draw inferences about market integration, it is pertinent to check the presence of unit root in the time series. The unit root test examines whether mean and variance of a time series are constant over the time or not. In order to be stationary (i.e., in case of absence of unit root), the data does not move away from the mean value rather it revolves around it's mean value. One of the most popular tests for checking unit root is Augmented Dickey Fuller (ADF) test and the same has been employed in this study. Since the study has been divided into sub-periods, following three null hypotheses have been framed:

- H_{01}: The individual time series i.e., India/China/Jakarta/South Korea/Taiwan does not have unit root i.e., the series is not stationary at level during total study period.
- H_{02}: The individual time series (i.e., India/China/Jakarta/South Korea/Taiwan) does not have unit root i.e., the series is not stationary at level during pre-covid period.
- H_{03}: The individual time series i.e., India/China/Jakarta/South Korea/Taiwan does not have unit root i.e., the series is not stationary at level during post-covid period.

3.1.3. Long-run integration among markets through Co-integration Test

The results of unit root test indicate the presence of unit root at level and reported that all series are integrated at first difference. In the light of this result, Johansen Cointegration test has been conducted for examining the long run association among the selected time series. If selected indices are found to be co-integrated there exists a long run equilibrium relation among the selected markets. Johansen Cointegration is based upon two test statistics viz., trace test and maximum Eigen value test. The results are based on a rule of thumb if test statistics is more than the critical value, null hypothesis of no co-integration is rejected. The null hypotheses for the test are as follows:

- H_{04}: There are no significant co-integrating equations among selected markets during total study period.
- H_{05}: There are no significant co-integrating equations among selected markets during pre-covid period.
- H_{06}: There are no significant co-integrating equations among selected markets during post-covid period.

3.1.4. Short-run integration between markets through Granger Causality test:

Granger causality test has been used to examine the possible short-term causal relation among the selected countries. The test was proposed by Clive Granger in 1969 to predict the values of one time series on the basis of prior values of another time series. Granger causality is an indicator of cause-and-effect relation between two time series. The presence of Granger causality indicates that any change in one series will bring change in another series. In contrast of correlation, Granger causality is a dynamic concept that considers the lag-lead

relationship. The presence of correlation simply implies that two time series are related with each other but causal relation enables us to predict the possible change in one series in future due to the current change in another series. In the present study, Granger causality has been used to test the following null hypotheses:

- H_{07}: There is no significant Granger Causal relation between markets during total period.
- H_{08}: There is no significant Granger Causal relation between markets during pre-covid period.
- H_{09}: There is no significant Granger Causal relation between markets during post-covid period.

4. Results and discussion

The selected stock markets experienced a turbulent time period during pandemic. The year 2020 witnessed a drastic dip in stock indices of all selected countries but by the mid of 2021 the indices gradually started to maintain resilience. To divulge whether this market fall is a repercussion of COVID-19 or not, the logarithmic returns of all selected markets have been analyzed for total period as well two sub-periods viz., January 2010 – December 2019 i.e., pre-covid period and January 2020 – September 2021, i.e., post-covid period. The use of logarithmic returns enables to compare the returns of different countries without having any possible dependence of changes in stock prices. The comparative analysis of returns reveals that during the entire study period, the average stock return observed to be highest in India (0.049) and lowest in China (0.005). During the pre-covid period, the returns revealed that Chinese stock market registered a negative return during 2015-16 that may be attributed to the stock bubble in China that burst out with the beginning of 2016. Till December 2019, the highest average returns accounted for Indonesia (0.043) followed by India at (0.042). But the brutal impact of COVID-19 on Indonesia turned the market returns to be negative during post-covid period. The country's stock market has also experienced downturn, with Jakarta Composite Index dropping at its lowest point on 23 March 2020, only 21 days after the first government officially confirmed COVID-19 cases (Utomo & Hanggraeni, 2021). The standard deviation of Taiwan and South Korea (0.011) indicates that these markets are less volatile in comparison to other selected markets when total time period is examined. The outbreak of COVID-19 enhanced the standard deviation of returns of India, Indonesia and South Korea. Table 1 depicts the descriptive statistics of these returns in percentage terms.

The descriptive statistics of stock returns reveals the skewness and kurtosis of stock returns. A normally distributed return series should have a zero value of skewness with a kurtosis value equal to three. However, in the present study, all returns have been observed to be negatively skewed during the total period. The skewness of stock returns is often used as a risk measurement tool and a negative skewness indicates high volatility accompanied with less returns. The negativity of skewness gesticulates the infusion of any shock into the stock market(s) and possible information spillovers among the selected nations. After the outbreak of covid-19 the positively skewed returns from Indian stock turned out to be negative. Here it is interesting to note that the return from Indonesia exhibited a distinct behaviour. The return from Indonesian stock market was negatively skewed during pre-covid period but transposed

Table 1. Descriptive statistics (source: author's calculation)

Particulars	Total Period					Pre-covid period					Post-Covid Period				
	China	India	Indo-nesia	South Korea	Taiwan	China	India	Indo-nesia	South Korea	Taiwan	China	India	Indo-nesia	South Korea	Taiwan
Average	0.005	0.049	0.035	0.025	0.031	-0.002	0.042	0.043	0.012	0.019	0.05	0.10	-0.01	0.10	0.10
Maximum	6.80	11.57	9.70	8.25	6.17	6.80	5.31	7.01	4.90	4.46	5.55	11.57	9.70	8.25	6.17
Minimum	-11.97	-14.10	-9.30	-8.77	-7.70	-8.87	-6.12	-9.30	-6.42	-6.42	-11.97	-14.10	-6.81	-8.77	-7.70
Standard Deviation	0.015	0.012	0.012	0.011	0.011	0.015	0.010	0.011	0.010	0.010	0.01	0.02	0.02	0.02	0.01
Skewness	-0.79	-0.57	-0.29	-0.30	-0.67	-0.655	0.008	-0.451	-0.444	-0.639	-1.82	-1.06	0.14	-0.15	-0.73
Kurtosis	9.70	18.68	10.43	10.40	8.60	8.31	5.59	9.26	6.66	7.10	22.04	17.98	10.22	9.31	8.89

Table 2. Correlation matrix (source: author's calculation)

Country	Total Period					Pre-Covid period					Post-Covid Period				
	India	China	Indo-nesia	South Korea	Taiwan	India	China	Indo-nesia	South Korea	Taiwan	India	China	Indo-nesia	South Korea	Taiwan
India	1					1					1				
China	0.25	1				0.25	1				0.40	1			
Indonesia	0.48	0.28	1			0.49	0.28	1			0.64	0.43	1		
South Korea	0.48	0.34	0.53	1		0.49	0.35	0.53	1		0.60	0.48	0.62	1	
Taiwan	0.47	0.37	0.51	0.72	1	0.48	0.38	0.52	0.73	1	0.57	0.52	0.57	0.76	1

to be a positively skewed return during pre-covid. The finding reiterates the observations of other researchers (Esteves & Sussman, 2020; Sugandi, 2020) claiming that Indonesia was less penalized during the Covid-19 pandemic as compared to the 2008 global financial crisis. The Kurtosis remained very high during both sub-periods so it can be said that the distribution is peak topped and follows leptokurtic distribution. High values of kurtosis of stock returns indicate the presence of outliers and manifest that during the study period investors were exposed to heavy oscillations. To examine how far the changes taking place in one market are associated with other markets, at the outset correlation between the selected markets has been examined (Table 2).

The outbreak of COVID-19 improved the correlation between the stock markets. The correlation coefficient of Indian return enhanced from 0.25 to 0.40, which is quite apparent form the fact that China was the largest trading partner of India during first half of 2020–2021. The correlation of Indian returns with Indonesian returns also increased from 0.49 to 0.64 that can be accounted to trade relation between India and Indonesia that reached to US$10.41 billion during 2020. Further in 2020 South Korea's foreign direct investment to India worth of $6.94 billion also made interrelation stronger during post-covid period as compared to previous time periods. The correlation between South Korea and Taiwan observed to be highest throughout the study period. This reflects the lesser possibility of risk minimization through portfolio diversification by a South Korean investor in Taiwan stock market and vice-versa. However, the correlation between China and India observed to be lowest which paves the way for risk minimization through portfolio diversification. The results are in confirmation to the findings of Younis et al. (2020). As the pre-condition of testing co-integration among stock indices is to examine whether all variables are stationary of same order or not, the stationarity of all indices has been checked through ADF unit root test. The test examines the null hypothesis that there is no unit root in the series and data is stationary. To test the null hypothesis, the probability of test statistics will be compared with 0.05. If the probability is more than 0.05, the null hypothesis cannot be rejected. However, if probability is less than 0.05, the null hypothesis will be rejected i.e., data will be presumed to be stationary. The test results have been reported in Table 3.

The results depict that at original level, null hypothesis cannot be rejected for any of the indices. In other words, all the stock indices are non-stationary at levels. But the probability after first differencing is less than 0.05, which indicates absence of unit root. In other words, all series are observed to be integrated of order 1. Now Johansen co-integration test has been applied at 1 lag length (as suggested by lag length criterions) to analyze possible long run co-integration among the selected economies. Johansen co-integration test gives estimates about Trace statistics and Max-Eigen Statistics. If these statistics are more than their respective critical values at 5% level of significance, the hypothesis cannot be rejected and vice-versa. Results of the same have been reported in Table 4.

During the total study period, the trace statistics and maximum Eigen statistics reject the possibility of no co-integrated equation as well at most 4 cointegrated equations among the selected indices at 5% level of significance. Thus, it can be concluded that there is a presence of long run co-integration among the stock indices and at most there can be three cointegrating equations. The presence of cointegrating equation indicates that selected stock markets

Table 3. Results of unit root test (source: author's calculation)

Particulars	Total Period				Pre-Covid Period				Post-Covid Period			
	Original Level		First Differencing		Original Level		First Differencing		Original Level		First Differencing	
	T-stat	Probability	T-stat	Probability	T-stat	Probability	T-stat	Probability	T-stat	Probability	T-stat	Probability
China	−2.13	0.232	−22.62	0.0000	−2.29	0.175	−20.38	0.0000	−1.30	0.6318	−18.3639	0.0000
India	1.51	0.999	−50.32	0.0001	0.23	0.974	−42.68	0.0000	0.3007	0.9781	−20.6853	0.0000
Jakarta	−2.16	0.222	−47.92	0.0001	−1.76	0.400	−29.24	0.0000	−1.3959	0.5847	−18.3521	0.0000
South Korea	−0.64	0.859	−49.04	0.0001	−2.58	0.097	−44.44	0.0001	−0.5698	0.8739	−19.3689	0.0000
Taiwan	1.13	0.998	−48.31	0.0001	−0.684	0.849	−43.43	0.0000	−0.2968	0.9224	−19.1964	0.0000

Table 4. Results of Johansen co-integration (source: author's calculation)

Hypothesized number of Cointegrated Equation(s)	Total Period		Pre-Covid Period		Post-Covid Period		Critical Values	
	Trace statistic	Max-Eigen statistic	Trace statistic	Max-Eigen statistic	Trace statistic	Max-Eigen statistic	Trace statistic	Max-Eigen statistic
None	78.86*	38.51*	84.87*	31.54	73.53	33.23	79.34	37.16
At most 1	40.36	19.69	53.33	24.38	40.30	20.91	55.25	30.82
At most 2	20.66	9.30	28.95	14.09	19.39	11.85	35.01	24.25
At most 3	11.37	6.45	14.86	10.98	7.54	6.16	18.40	17.15
At most 4	4.92*	4.92*	3.88*	3.88*	1.38	1.38	3.84	3.84

Note: *Hypothesis rejected at 5% level of significance.

follow a common trend in long run and are driven by some common force. The results are in confirmation to previous studies by Palamalai et al. (2013), Agarwal et al. (2021), Potharla (2012) that reported long-run integration among Asian economies. During the pre-period also, the possibility of at most four equations have been rejected by Trace statistics as well as Max Eigen statistics. Further, the hypothesis of absence of any cointegrating equation has also been rejected by Trace statistics. Thus, it can be concluded that at most there can be three cointegrating equation during pre-covid period. However, during the post-covid period, no hypothesis could be rejected. This kind of result is possible under two circumstances either the time period is not sufficient enough to comment upon the long run behaviour of the markets or there does not exist any long run relationship among the market indices. To examine the possible short-run relationship among sock markets, Granger causality test (1969) has been used. The test determines the direction of causation between the selected stock market. The null hypothesis is that country 'X' does not Granger cause Country 'Y' i.e. X ↛ Y. The null hypothesis will be accepted if the probability of F-statistics is more than 0.05. In such a case no causality will be assumed. However, if probability of F-statistics is less than 0.05, the null hypothesis will be rejected and it will be concluded that there is a causal relation between the two stock markets. Table 5 represents the results of granger Causality test.

Table 5. Results of Granger causality tests (source: author's calculations)

Null Hypotheses	Total Period		Pre-Covid Period		Post-Covid Period	
	F-Statistics	Result	F- Statistics	Result	F- Statistics	Result
China ↛ India	2.3	Accepted	3.9	Rejected	0.42	Accepted
China ↛ Indonesia	4.21	Rejected	4.77	Rejected	0.29	Accepted
China ↛ South Korea	0.7	Accepted	0.52	Accepted	0.26	Accepted
China ↛ Taiwan	4.56	Rejected	5.69	Rejected	0.13	Accepted
India ↛ China	3.99	Rejected	2.2	Accepted	2.52	Accepted
India ↛ Indonesia	8.35	Rejected	5.69	Rejected	2.24	Accepted
India ↛ South Korea	11.46	Rejected	14.33	Rejected	1.03	Accepted
India ↛ Taiwan	11.28	Rejected	14.76	Rejected	1.32	Accepted
Indonesia ↛ China	4.72	Rejected	3.74	Rejected	0.73	Accepted
Indonesia ↛ India	1.09	Accepted	0.76	Accepted	2.94	Accepted
Indonesia ↛ South Korea	3.93	Rejected	2.91	Accepted	0.93	Accepted
Indonesia ↛ Taiwan	2.13	Accepted	1.7	Accepted	0.5	Accepted
South Korea ↛ China	6.81	Rejected	3.67	Rejected	3.2	Rejected
South Korea ↛ India	3.32	Rejected	0.22	Accepted	2.21	Accepted
South Korea↛ Indonesia	2.64	Accepted	1.11	Accepted	2.44	Accepted
South Korea ↛ Taiwan	1.77	Accepted	3.99	Rejected	0.15	Accepted
Taiwan ↛ China	6.56	Rejected	3.67	Rejected	2.36	Accepted
Taiwan ↛ India	3.06	Rejected	0.4	Accepted	1.26	Accepted
Taiwan ↛ Indonesia	4.3	Rejected	0.94	Accepted	2.46	Accepted
Taiwan ↛ South Korea	5.1	Rejected	3.07	Rejected	1.41	Accepted

The results depict that when total time period is considered a unidirectional causal relation can be seen running from India to China, South Korea to China, Indonesia to India, Indonesia to South Korea and Taiwan to Indonesia. The unidirectional relation running from X country to Y country simply represents that crisis emanating from country X may transmit to country Y. Further, some bi-directional relations have been observed running from Indonesia to China, Taiwan and China and Taiwan and South Korea, which indicate that both the nations are associated with each other. In other words, any oscillation in one country will cause turbulence in other country also. Therefore, a risk averse investor should not choose the respective county to hedge risk through portfolio diversification in that country.

During pre-covid period, unidirectional causal relation was observed running from China to India. Babu et al. (2016) also noticed the uni-directional relation between India and Chinese market however, Bhullar (2019) concluded no casual relation exists between India and Chinese stock markets. Further unidirectional causal relation was observed running from South Korea to China; India to Indonesia; India to South Korea and India to Taiwan. However, no casual relation could be seen to flow between South Korea and Indonesia and Taiwan and Indonesia. Gupta and Aggarwal (2011) also observed very low casual relation among Indonesia, Malaysia, India and Korea. Narayan and Rehman (2018) also reported poor relationship among Asian economies leading to the immense opportunities for investors to diversify their portfolio and reduce risk. The absence of causal relationship suggests that during pre-covid period, investors could have diversified their portfolio to reap the benefits from diversification. The results indicate bi-directional causality between Indonesia and China; between Taiwan and China; between Taiwan and South Korea. Reddy (2010) and Rizwanullah et al. (2020) also reached at the same conclusion. The bi-directional causality between the nations has taken place on accounts of growing foreign trade relation during past few years. The presence of short-run causal relation reveals that for an investor exploring for some international stock markets to park the saving, the respective country may not prove to be a good choice.

Some varied and interesting results have been noticed in post-covid period where no causality was observed between India and China; Indonesia and India; India and South Korea; India and Taiwan whereas during pre-covid period there was unidirectional causality from China to India; India to Indonesia; India to South Korea; India to Taiwan respectively. Further no causality was observed between Indonesia and China; Taiwan and China; Taiwan and South Korea whereas during pre-covid period there was bidirectional causality between the same. The results illustrate that short-run causality between the nations has been highly influenced due to the outbreak of COVID-19. After the pandemic, unidirectional causality has been observed running from South Korea to China only. The study is expected to be fruitful for the policy makers and economic agents as it fills the research gap of dearth of studies aiming at exploring integration among selected nations viz., Taiwan, China, India, South Korea and Indonesia Further it is interesting to note that during post covid period no nation has causation with other nation except South Korea and China despite which paves the ways for diversification to investors.

Conclusions

This paper examines co-integration between Indian stock market and emerging Asian economies. The study is conducted for a time period spanning from January 2010 to September 2021. To examine the impact of Covid-19, the entire period was divided into two sub-periods viz., pre-covid period (1st January 2010 to 31st December 2019) and post-covid period (since 1st January 2020). Long run and Short-run inter-linkages have been investigated by using various econometric tools co-integration test and Granger causality test respectively. The analysis revealed that all stock market indices are stationary at first level and are integrated of order one. The results of co-integration conclude the presence of long run integration among all the selected emerging Asian economies. It could be said that all the markets are governed by a common trend and will converge to equilibrium in long run. Therefore, it could be said that the benefits of portfolio diversification among Asian nations may get limited. Further, Efficient market hypothesis (Fama, 1970) was also violated which concluded that financial market returns follow a random pattern and cannot be predicted. But the results show that markets are integrated in long run and the integration among markets can be used for forecasting purposes. With respect to short-run causality, it has been observed that few countries have bidirectional causality during pre-covid period (like between Indonesia and China; between Taiwan and China; between Taiwan and South Korea) but the same disappeared during post-covid period. Another important observation is that when causality for total time period was observed Chinese stock market does not granger caused Indian stock market but there was a uni-directional causality flowing from India to China. But when pre-covid period was examined, the relation was reversed. It was China that Granger caused Indian stock market. During post-covid period there was no causality between India and China. Also, there was no causal relation between any other stock markets during post-covid period. Therefore, it can be inferred that with the emergence and spread of covid financial markets limited themselves from being associated or affected by other selected stock markets. Only one unidirectional relation existed where South Korea had causation with China. Therefore, it can be concluded that short-run causality between the nations have been highly influenced due to the outbreak of COVID-19.

With the advent of globalization, better international relations ever increasing trade among nations, financial interdependence and association among countries have become very common. The linkages among different countries have increased the volatility of stock markets and posed a serious threat to potential investors. Major historical events like Sub-prime mortgage crises (2008), Chinese stock market bubble (2015); Asian crises (1997) are some examples of it. In this reference the present study made an attempt to analyze the linkages among few selected Asian countries during pre-covid as well as post-covid period. The results of present study are expected to be fruitful for investors intending to diversify their portfolio through international investments. Also the present study is expected to be fruitful for policy makers and regulatory bodies to better understand the interdependence among economies and to closely monitor the functioning of other stock market particularly during the time of any turbulence in one economy. In contemporary integrated global scenario, it becomes inevitable to identify those economies, which might have an immediate effect on functioning of domestic stock market. The findings of present study offer a line of thought with reference to possible integration

among selected countries so that respective regulatory bodies can design policies in order to safeguard the interest of foreign investors. Further, it highlights the possible destination points for international investments to reap the benefits from portfolio diversification.

However, it is pertinent to mention here, that the results are subject to the limitation of non-consideration of domestic shocks of different countries. In order to increase the scope and domain of the study, some macroeconomic variables like FDI, FII, GDP that influence the functioning of stock market may be considered in future studies.Further, the present paper examines only short-run causality and co-integration among selected emerging markets However, in future work, Variance decomposition analysis can be applied to see the degree of exogeneity and to what extent selected variables have influence on other set of variables. Also, the Impulse Responsive Function can be applied to measure sensitivity or reaction of selected variables in response to shocks.

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