Impact of Economic Crisis 2008 on Integration of Indian Stock Market with Emerging and Frontier Markets of Asia- A Study of Pre and During Crisis Period

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Abstract

The purpose of this paper is to study linkages between emerging and frontier markets of Asia. The impact of US financial crisis will be studied on the relationship of select markets. Daily data on closing prices of indices of India, Indonesia, Malaysia, Indonesia, Philippines, Sri Lanka and Pakistan is taken in local currency terms. Data spans from 2000 to 2010, and it is further sub divided in two parts – pre crisis (2000 to 2005) and During crisis (2006 to 2010). Johansen co- integration is applied, ADF and PP tests are applied to test stationary property of the time series. To understand short run linkages, Engle and Granger causality test is used. Results of Johansen test confirms the presence of long run relationship between the markets during crisis. Further, granger causality test confirms the presence of short run linkages between markets. Return and volatility spillovers are examined by GARCH model. This paper confirms significant changes in return and volatility spillovers in Pre and during crisis period.

Keywords: *stock market integration, volatility,spillover, unit root, GARCH, Granger causality, stationary, co- integration*

Introduction

Financial Integration

Events like crash of US stock market happened in 1987 has generated interest in researchers for the study of financial integration of global markets. Financial integration means the association between global financial markets in terms of asset prices and returns (Berben and Jensen, 2006). It lowers the benefit of diversification for investors, as shock from one market ripples to another market (Rajwani and Mukherjee,2013). The well-integrated markets tend to reduce the potential of earnings through portfolio diversification. The major channel for financial integration of market economies are national stock markets besides globalization, deregulation in markets and advances in information technology. Furthermore, data of last two decades on portfolio investors depicts manifold increase in the number of investors who hold cross border financial assets in their portfolio (Schindler, 2009). Although, developed markets are most preferred ones, but nowadays, investors are including emerging markets also for maximising returns. Hence, it becomes imperative to study such a dynamic relationship between stock markets, as stock market integration would lead to the reduction of arbitrage opportunity in financial markets (Perera,2012). Such studies also benefit in formulation of more efficient portfolio strategy and provides opportunity to minimise the risk (Paurer, 2005).

A plethora of work is available on integration of stock markets where linkages between developed markets namely, USA, Japan, Germany, UK, Australia were studied (Hamao et al., (1990); Campbell and Hamao,1992; Park & Fatemi1993; Friedman and Shachmurove, 1997;Masih and Masih,1997;) but the interest of researchers has shifted towards emerging markets with the occurrence of events like Asian crisis of 1997 (Wang et al.,2003). Further, the researchers have augmented their research interest on stock market integration towards frontier markets (Daugherty & Jithendranathan, 2015; Thomas et al., 2017). The reason is many emerging and frontier markets have experienced structural changes in the couple of decades (Nasser and Hajilee, 2016).

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Emerging markets

Divecha et al. (1992) has given following definition of an emerging market and it was further employed by Mobius (1996).

Emerging markets are one which have the following:

(i) trading of securities is facilitated;

(ii) the country is not a developed one;

And according to the Morgan Stanley Capital International Indices (MSCI) list or Financial Times Indices; an emerging market is one which is accessible for investment by foreign institutional investors and the it has an authentic source of data.

Frontier markets

Frontier markets are one which are relatively smaller in terms of market capitalization, are less liquid and have more investment restriction as compared to developed and emerging markets. Investment community perceives frontier markets as untapped market that has "growing potential for investment". Frontier markets can be defined as the smallest, least developed, least liquid countries among the developing markets. There are many risks associated with investing in frontier markets and political instability is one among them and it may become an inherent risk to investments. (Daugherty and Jithendrannathan,2015).

Hence, this paper aims to study the level of integration among emerging and frontier markets of Asia before and during economic crisis of 2008. During period of turmoil the markets possess the risk of volatility (Mensi, 2016) and linkages among financial markets can lead to contagion and associated disruption of economic activities which are transferred from one nation to another, that were evident during the Asian Crisis of late 1990s (Majid,2009).

Reasons for co integration among markets

Tripathi and Sethi (2010) suggested few factors for stock market integration namely inflation differential, bilateral trade relations, differences in interest rates and characteristics of stock markets like market capitalization, turnover, volatility. Regional trade agreements either bilateral or multilateral and intensified trade relations lead integration of financial markets to a greater extent (Goyal,2016). Trade openness and stock market capitalization are two major drivers of linkages among stock markets (Lane and Milesi-Ferretti, 2003) among the select markets, three are from ASEAN and three are from SAARC. India has a free trade agreement with ASEAN and is a member of SAARC.

Further more, main drivers of integration are fiscal position of economies, monetary policies, more liberalised financial markets, cross border capital flows, innovation in financial markets (Mukherjee & Mishra, 2009). A common trend was evidenced in the monetary policies of India, Indonesia, Malaysia, Philippines during turmoil period. For example, India and Indonesia, raised their policy rates by 175 and 125 basis points respectively, for combating the problem of high inflation, which was over 12% in mid of 2008. But, Malaysia kept the rates unchanged because of fears from downside risk, Interest rate spreads increased by approximately 500 basis points in India and the Philippines, and by 885 basis points in Indonesia. India, Indonesia, Philippines lowered down their reserve requirement ratios, for instance India decreased it's CRR by 4%, Indonesia lowered down the rupiah reserve by 4.1%, followed by Malaysia where 3% decrease was reported and in Philippines the reserve was lowered by 2%. The reductions in reserve requirements were made with an intent to lower down the borrowing costs and to give boost to liquidity in banking system. Hence, two factors responsible for the integration between the markets during the crisis period are synchronised movements in monetary policies and trade linkages. Rejeb and Arfaoui (2016) analyzed linkages in financial markets of Asian emerging markets and Latin America with developed markets of US and Japan. The study concluded that there is transfer of volatility from developed markets to developing markets. This is because of geographic proximity and trade linkages between markets.

So, the stock markets of Indonesia, Malaysia, Philippines, Sri Lanka, Pakistan along with India are taken in account for the current study. These markets have gain significant position among global financial markets. Daily data is taken for the analysis from August 2000 to December 2010. No developed market is considered for the present study as all the emerging and frontier markets are linked with developed markets but there is no study which focuses on the linkage of emerging and frontier markets only.

The remaining paper is organized as, section 2 literature review, Section 3 describes the data and empirical methodology, and Section 4 provides the details of

empirical results, Section 5 includes managerial implications and section 6 concludes the paper.

Review of literature

Sharma and Seth (2012) have defined financial markets integration as a situation where different markets tend to trend together. Although, the area of stock market integration is a topic of research since 1968 (Grubel,1968) but it has attained huge attention in recent years. The review comprises of studies on linkages which include methodology of co- integration, causality and return, volatility spillovers.

Hence, literature on financial integration comprises of diverse areas namely- study on integration of developed markets (Agmon, 1972; Hiliard, 1979; Eun and Shim, 1989; Hamao et al.,1990; Campbell and Hamao,1992; Park and Fatemi,1993; Friedman and Shachmurove,1997; Masih and Masih, 1997) , others studied linkages between developed and emerging markets (Cheung ,1992; Ghosh et al., 1999, Bekaert and Harvey ,2000) many researchers analysed the impact of economic crisis on integration of developed and emerging markets (Arshanapalli et al., 1995;Wang et al. ,2003; Syriopoulos, 2004; Majid et al.,2009), other studies focused on stock market integration among regional blocs (Phengpis and Apilado ,2004; Aggarwal and Kyaw,2005; Click and Plummer ,2005; Diamandis, 2009; Graham et al., 2012; Rajwani and Mukherjee , 2013) , and now the researchers are interested in understanding linkages of developed and frontier markets (Thomas et al., 2017).

Agmon (1972) made an attempt to study linkages between stock prices of Germany and US, Japan and US markets and concluded that US has strong linkages with both Japan and Germany, which reduces the positive implications of portfolio diversification. Hilliard(1979) examined the effect of economic crisis on the integration of ten developed markets and concluded with an evidence of strong linkages among sample markets. Eun and Shim (1989) concluded the dominance of US markets while investigating interactions between major stock markets of North America and Europe.

Hamao et al. (1990) studied the integration using spillover of price volatility from US and UK to Japanese stock markets and confirms the volatility spillover from US and UK markets to Japanese stock markets by using GARCH. Campbell and Hamao (1992) with the application of asset pricing models confirmed the presence of co movements between asset prices of US and Japan securities. Park and Fatemi (1993) applied VAR and concluded the presence of weak linkages between the pacific basin and US, UK and Japanese markets. Friedman and Shachmurove (1997) applied granger causality and concluded the presence of short run linkages between developed markets of Europe namely Germany, France, Belgium, spain, Italy.

Cheung (1992) concluded the presence of low degree of correlation among the eleven emerging Asian market group and the developed markets group. Ghosh et al. (1999) studied level of integration between nine countries in the Asia Pacific region with US and Japan and found that all the countries have different magnitude of linkage with select developed markets. Bekaert and Harvey (2000) employed asset pricing model for the examination of link ages between developed and emerging markets . he concluded with the presence of long run linkages between the studied markets. Arshanapalli et al. (1995) examined the financial integration between US and major six Asian stock markets and concluded the impact of October crisis (1987) in strengthening linkages among stock markets of select countries. Wang et al (2003) studied the impact of 1997 Asian crisis on integration of African stock markets and concluded that the integration between most of the African stock markets was weakened after the 1997-1998. Diamand is (2009) studied presence of linkage between US and Latin America and the results confirm the integration between the sample countries in post financial liberalization era. Nikkinen et al. (2011) investigated the impact of recent GFC(2008) on the financial integration of major European and Baltic countries. They concluded that after the crisis magnitude of correlation has increased, which further confirms the impact of crisis on the linkages of the countries.

Syriopoulos (2004) extended the sample of Central European stock markets and included Slovakia along with Poland, the Czech Republic and Hungary. He found one cointegrating vector among the equity prices of these markets and those of Germany and the US. Wang et al. (2005) studied the spillover effects from developed to emerging markets namely India, Japan, Pakistan, Sri Lanka and US. The results confirmed the presence of return spillovers from the US and Japan to all three markets, and volatility spillovers from the US to Sri Lanka and India, and from Japan to Pakistan. The spillover effects get intensified after the crisis.

Phengpis and Apilado (2004) test level of integration between members and non - members of European monetary union and concluded that member countries of European monetary union were strongly integrated than their non - member counterparts. Aggarwal and Kyaw (2005) compared magnitude of integration between NAFTA countries and concluded that the integration among countries have increased during NAFTA. Click and Plummer (2005) analysed linkages between ASEAN members and concluded the presence of one co integrating vector between the nations. This implied presence of long run relationship. Majid et al., (2009) analysed linkages between ASEAN-5 emerging stock markets and concluded that the degree of short run and long run linkages has increased after the financial crisis of 1997. Gee et al. (2010) examined the integration of Indonesia, Japan, Malaysia, the Philippines, Singapore, Thailand and US stock markets in terms of information transfers concluded that US had significant impact in terms of returns and volatility spillovers. Moreover, the markets are majorly influenced by their own past returns. Rajwani and Mukherjee (2013) studied integration of India with other Asian counterparts and concluded that there is no linkage between Asian countries and India.

Thomas et al. (2017) examined integration between developed, emerging and frontier markets of Asia Pacific region and concluded with a bidirectional correlation that emerging and frontier markets influence developed markets.

Rationale of the study

The above review makes it clear that all the studies have considered either developed markets with emerging markets or developed markets with frontier markets, but none has studied integration between emerging and frontier markets in isolation from developed markets. Hence, this paper attempts to study the same.

Data and methodology

Data

The stock markets considered for study consist of India and 5 other Asian markets. The period of the study spans from August 2000 to December 2010 . Data is collected from yahoofinance.com in their local currency terms. Further, the data is divided in two sub periods-sub period 1 from 1 July 2000 to 31 December 2005 and sub period II is from 1 January 2006 to 31 December 2010. Data consists of daily closing prices of the select indices and returns are calculated by taking natural logarithm of the ratio of current price(Pt) and previous day's closing price(Pt-1).

$$\text{Log returns} = \ln(Pt/Pt\text{-}1) \quad (1)$$

Asian countries other than India are selected on the basis of availability of data, efficiency, depth and turnover of the financial market.

Table I. list of stock markets with their leading index

Country	*India*	*Indonesia*	*Malaysia*	*Philippines*	*Sri Lanka*	*Pakistan*
Exchange	*BSE(Bombay Stock exchange)*	*Indonesia stock exchange*	*Kuala Lumpur stock exchange*	*Philippines stock exchange*	*CSE*	*KSE*
Year of establishment	*1875*	*1912*	*1986*	*1927*	*1896*	*1947*
Stock index	*SENSEX*	*IDX composite*	*KLCI*	*PSEi*	*CSE Milanka*	*KSE100*

Research Methodology

- Unit root test is applied to test the stationary property of time series. ADF and PP both are used to check the time series for the presence of unit root.
- Johansen test is applied when time series has unit root at levels and become stationary when differenced for once. If the data series becomes stationary after differencing, then it is inferred that it possess a long run linkage (Gujarati,2009).
- Engle and Granger test is used to find out the lead and lag relationship between sample markets. It also helps in analyses of short run linkages.
- Optimal lag length is chosen based on AIC and SIC criteria.
- GARCH model is applied to analyse return and volatility spillovers.

Data analysis and empirical results

Descriptive statistics

Table II provides summary of time series comprising of 6 markets for full sample period , pre - crisis and during crisis. It can be inferred from the following table that markets have given positive returns, as the mean value of daily closing prices of indices are positive in all periods of study. CSE has highest value of mean returns, followed by KSE and KLCI is the worst performer for full sample period. SENSEX has recorded highest volatility between 2000 to 2010, followed by Pakistan.

KLCI is the least volatile in all the sample periods, which means that risk in stock returns is less in Malaysia and is a stable avenue for investments. In pre -crisis period KSE has registered maximum mean return, PSE is the worst performer. CSE is most volatile among all followed by KSE. JKSE has given highest mean return in during crisis period followed by SENSEX. KSE has registered lowest average returns and experienced highest volatility. The returns of JKSE, KLCI, KSE, SENSEX are negatively skewed in all the sample periods but the returns of PSE and CSE are positively skewed. The value of kurtosis shows that return series have fat tails and is leptokurtic. JarqueBera statistics confirms that none of the time series is normally distributed. One interesting fact which can be inferred from the table is that economic crisis has impacted the volatility of the indices, as KSE has highest value of standard deviation in during crisis period (Seth and Sharma,2015).

Table II descriptive statistics

	CSE_R (all share)	JKSE_R (composite)	KLCI_R (Composite)	KSE(100)_R	PSE_R (Composite)	SENSEX_R
Mean	0.000944	0.000744	0.000238	0.00075	0.000402	0.000579
Median	0.00000	0.000403	.000768	0.000432	0.00000	0.000643
Maximum	0.182872	0.076231	0.045027	0.085071	0.161776	0.1599
Minimum	-0.139055	-0.11306	-0.099785	-0.077414	-0.130887	-0.118092
Std. Dev.	0.013069	0.014703	0.008744	0.014743	0.013834	0.016431
Skewness	0.209551	-0.693384	-0.984384	-0.245898	0.583484	-0.14132
Kurtosis	32.11471	10.02743	13.95563	5.920956	20.82764	10.36964
Jarque-Bera	96018.12	5810.619	14031.88	993.6379	36147.89	6159.838
Probability	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Observations	2718	2718	2718	2718	2718	2718
Sub period I						
Mean	0.000939	0.000612	.000848	0.00128	0.00028	0.000561
Median	0.0000	0.0000	0.0000	0.001	0.0000	0.000679
Maximum	0.182872	0.0485	0.045027	0.085071	0.161776	0.079311
Minimum	-0.139055	-0.109336	-0.063422	-0.077414	-0.061911	-0.118092
Std. Dev.	0.015022	0.01298	0.008506	0.014561	0.01271	0.013629
Skewness	0.136294	-0.775671	-0.565782	-0.121686	2.561249	-0.76835
Kurtosis	33.1577	9.213042	9.875402	6.33942	36.14243	9.276076
Jarque-Bera	53550.41	2414.379	2858.475	660.045	66214.39	2458.065
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1413	1413	1413	1413	1413	1413
			Sub period II			
Mean	0.001286	0.001663	0.000731	0.000144	0.001357	0.001477
Median	0.000778	0.001324	0.000643	0.000605	0.000944	0.002237
Maximum	0.072993	0.053223	0.015029	0.045734	0.047022	0.06667
Minimum	-0.042195	-0.065152	-0.020205	-0.060418	-0.040513	-0.070033
Std. Dev.	0.010388	0.012767	0.00511	0.017379	0.012145	0.016
Skewness	0.672032	-1.030984	-0.483727	-0.51158	0.050598	-0.453746
Kurtosis	13.95521	8.846591	5.346555	3.925132	5.225023	6.105056
Jarque-Bera	1319.752	416.372	69.79145	20.61284	53.74381	113.3699
Probability	0.0000000	0.0000000	0.0000000	0.0000330	0.0000000	0.0000000
Observations	260	260	260	260	260	260

Unit root test

ADF and PP are two popular unit root tests and the same are used for present study. Both assume null hypothesis of unit root in data. The test is applied on the model of intercept, as it can be seen in the Graphs that there is no evidence of trend in the time series of all sample periods (Graph 1, Graph2, Graph3)

ADF assumes that a series follows AR(p) process and controls higher order correlation by adding lagged differences of dependent variable (Chris and Brooks,2019)

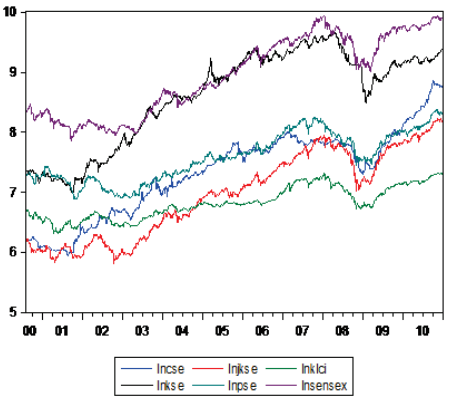
$$\Delta X_t=\alpha_1+\alpha_2\ t+\gamma X_{(t-1)}+\Sigma_{(i=1)}^{k}\ \Psi\Delta X_{(t-1)}+\varepsilon_t \quad (2)$$

PP test is less restrictive as compared to ADF and it also gives same results. Hence, null hypothesis is strongly rejected and it is confirmed that the series are having unit root at levels but become stationary at first difference. It also means that market returns are not random.

$$\Delta X_t = \alpha_1 + \alpha_2\ t + \gamma X_{(t-1)} + \varepsilon_t \quad (3)$$

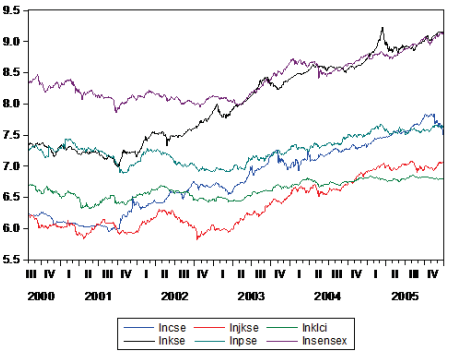
The results in table III show that all the series were non stationary or having unit root at levels and become stationary at first difference. It means that all are I(1) , this implies that their long run relationship is also stationary.

Graph 1- Full sample period



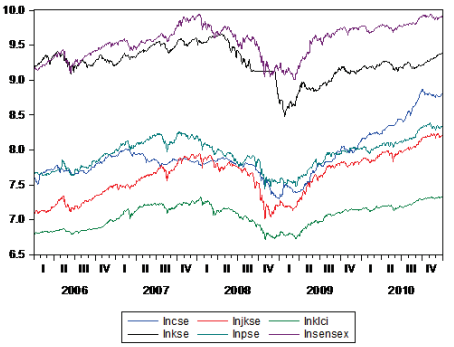
The above graph makes it clear that there is break in the index prices of all the sample markets between 2007-2009.

Graph 2- Sub period 1 (pre- crisis period)



In graph 2, there is a clear evidence of rising rally in stock markets of all the sample countries.

Grpah 3 – Sub period 2 (during crisis period)



Graph 3 shows a trough in all stock markets during 2007-09, which is the period of the global financialcris

Table III Unit root results

	ADF(Augmented Dickey Fuller test)						Phillips and Perron test					
	Total period		Sub Period I		Sub Period II		Total Period		Sub period I		Sub Period II	
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference	level	First Difference	Level	First Difference
SENSEX_R	0.936	0.0000	0.992	0.0000	0.486	0.0000	0.941	0.0000	0.994	0.0000	0.454	0.0000
KSE(100)_R	0.652	0.0000	0.993	0.0000	0.632	0.0000	0.663	0.0000	0.986	0.0000	0.589	0.0000
CSE_R(all share)	0.979	0.0000	0.938	0.0000	0.999	0.0000	0.974	0.0000	0.938	0.0000	0.997	0.0000
KLCI_R(Composite)	0.935	0.0000	0.705	0.0000	0.759	0.0000	0.926	0.0000	0.687	0.0000	0.762	0.0000
PSE_R(Composite)	0.918	0.0000	0.861	0.0000	0.713	0.0000	0.934	0.0000	0.880	0.0000	0.757	0.0000
JKSE_R(composite)	0.969	0.0000	0.979	0.0000	0.770	0.0000	0.972	0.0000	0.978	0.0000	0.788	0.0000
note :Exogeneous: constant; Lag length (Based on SIC 2); Max lag lengnth:22, Deterministic term: intercept												

Correlation

This time invariant analysis gives an insight of level of association between the markets taken for study. The results are compiled in table IV, and it is clear from the table that the correlation between the markets range from low to moderate. Correlation between JKSE and PSE is 33.54%, between JKSE and SENSEX is 40.4%. CSE has the lowest correlation with all other indices. In pre - crisis period the returns of CSE and KLCI, CSE and SENSEX and CSE and KSE are negatively correlated (though, degree is quite low) .But during crisis , the correlation between returns of SENSEX and JKSE (from 24.54% to 56.8%), SENSEX and PSE(from 11.4% to 31.05%) and SENSEX and KSE(from 8.08% to 24.37%) has increased. Further, the sign of correlation coefficient between PSE and CSE changed from negative to positive in pre- crisis to during crisis period. Increased in magnitude of correlation coefficient shows presence of short run linkages between markets which reduces the probable benefits of diversification for the investors.

Table IV correlation analysis

Markets						
	CSE_R(all share)	JKSE_R(composite)	KLCI_R(Composite)	KSE(100)_R	PSE_R(Composite)	SENSEX_R
CSE_R(all share)	_					
JKSE_R(composite	0.056811	_				
KLCI_R(Composite)	0.030582	0.071586	_			
KSE(100)_R	0.013028	0.084484	0.01175	_		
PSE_R(Composite)	0.051852	0.33549	0.144656	0.085701	_	
SENSEX_R	0.058104	0.404214	0.0374	0.106709	0.227247	_
(A) Sub period I and Sub period II						
Markets	CSE_R(all share)	JKSE_R(composite)	KLCI_R(Composite)	KSE(100)_R	PSE_R(Composite)	SENSEX_R
CSE_R(all share)	_	0.085898	***0.097008***	0.017223	***0.068497***	***0.0403186***
JKSE_R(composite	0.012933	_	-0.00785	***0.253028***	***0.376243***	***0.5689909***
KLCI_R(Composite)	-0.01026	0.058878	_	-0.08145	0.201026	0.06205754
KSE(100)_R	0.021569	0.04587	-0.00697	_	0.206037	***0.24376939***
PSE_R(Composite)	-0.00722	0.195865	0.072732	0.083862	_	***0.31055194***
SENSEX_R	-0.00079	0.245483	0.023754	0.080289	0.115411	_
The top diagonal consists of correlation coefficients during the crisis period and bottom diagonal shows result of correlation coefficient pre crisis period						

Lag selection

For cointegration test and granger causality test 2 lags are chosen on the basis of AIC and SIC criteria. It is important to choose an appropriate lag for the application of aforementioned tests.

Johansen Co- integration test

This test diagnoses the presence of long run linkages between the series. It test the null hypothesis of no co-integrating equations between the selected time series. The pre- requisite of this test is that the all series are I(1), which was proved by the application of ADF and PP. the results are based on values of two test statistics namely trace test and Max eigen value test.

Table V shows the result of the test for all three sample periods and it is clear from the table that there in no co-integrating equations in full and pre crisis period. But there is evidence of one co-integrating equation during the crisis period. Both trace and max eigen test confirm the same result.

$$\lambda\_trace=-T\sum\_(i=r+1)^k \left[ln (1-\lambda\_i^{\wedge\wedge}\right]) \quad (4)$$

$$\lambda\_max=-T ln (1-\lambda\_(r+1)^{\wedge\wedge}) \quad (5)$$

Table V

Results of co- integration test (no. of equations)			
Test	Total period	sub period I (Pre crisis)	Sub period II(During crisis)
Trace test	0	0	1
eigen value test	0	0	1

Granger causality test

This test is used to study causality between the markets in short run. If there are two variable Xtand Yt, and both are co – integrated then the null hypothesis is Xt doesn't granger cause Yt and Ytdoesn't granger cause Xt. a bivariate VAR model is specified to test granger causality relationship.

$Yt = \beta 0 + \beta 1Yi-1 + \bullet\bullet\bullet + \beta nYi-k + \delta 1Xi-1 + \bullet\bullet\bullet + \delta nXi-k + \varepsilon t,$ (6)

$Xt = \beta 0 + \beta 1Xi-1 + \bullet\bullet\bullet + \beta mXi-1 + \delta 1Xi-k + \bullet\bullet\bullet + \delta mXi-k + \mu t.$ (7)

The above two equations demonstrate that one country's stock price index (say India) doesn't granger cause another country's stock price index (say Indonesia) and the other equation estimates that one stock price index country (say Indonesia) doesn't granger cause another country's stock price (say India).

The results in table VI for full sample period indicates that there is unidirectional relationship between JKSE and CSE, SENSEX and CSE. Both JKSE and SENSEX leads to changes in CSE. KLCI is affected by KSE, PSE, SENSEX. There exists bidirectional relationship between CSE and KLCI, PSE and JKSE. SENSEX is the only market which is not granger caused by any other market. Further, there is no relationship between CSE and KSE, CSE and PSE, JKSE and PSE, KSE and PSE. Hence, it can be inferred that PSE is the most isolated market among all markets.

In pre - crisis period there is bidirectional relationship between KLCI and JKSE , PSE and JKSE. Further, KLCI is caused by PSE, SENSEX. and by CSE, KSE

During the crisis period CSE, JKSE, PSE ,KLCI are caused by SENSEX but there is no relationship between SENSEX and KSE. CSE is the most isolated index during pre- crisis period, as it has no relationship with any other index. During the crisis period PSE is caused by JKSE and causes KLCI.

SENSEX is the index which is causing changes in other indices but is not getting caused by any selected indices. This can be concluded that Indian stock market leads all other markets.

	Total period					
	CSE_R(all share)	**JKSE_R(composite)**	**KLCI_R(Composite)**	**KSE(100)_R**	**PSE_R(Composite)**	**SENSEX_R**
CSE_R(all share)	_					
JKSE_R(composite		_				
KLCI_R(Composite)			_			
KSE(100)_R	X	X		_		
PSE_R(Composite)	X			X	_	
SENSEX_R						_
Results for Subperiod I and Sub period II						
	CSE_R(all share)	**JKSE_R(composite)**	**KLCI_R(Composite)**	**KSE(100)_R**	**PSE_R(Composite)**	**SENSEX_R**
CSE_R(all share)	_	X		X	X	
JKSE_R(composite	X	_		X		
KLCI_R(Composite)	X		_			
KSE(100)_R	X	X	X	_	X	X
PSE_R(Composite)	X			X	_	
SENSEX_R	X	X	X			_

(Note: ⇧ indicates bi directional relationship, ⇩ or ⇧ indicates unidirectional relationship between markets, x indicates no correlation . the top diagnol indicates results of granger causality during crisis and the bottom diagnol indicates results of granger causality pre crisis).

GARCH Model

Developed by Bollerslev(1986) and it is widely used to model conditional volatility in time series data.

It has two equations – mean and variance . Mean equation has two components primarily i.e. lag value of return series and constant.

The variance equation has three terms – constant, ARCH (lag square of residuals) and GARCH term (last forecast variance).

Mean equation

$Ri,t=\lambda 0+\lambda 1Ri,t-1+\varepsilon t$(8)

Variance equation

$hi,t=\alpha 0+\alpha 1\varepsilon 2i,t-1+\beta 1hi,t-1$ (9)

the above equation follows:-

$\alpha 0>0,\ \alpha 1>0,\ \beta 1>0,\ \alpha 1+\beta 1<1$

Hence, next period forecast of variance depends on previous forecast and square of lagged residuals.

The above model is further expanded in two dimensions:-

(i) Return and volatility spillovers from other markets to India

(ii) Return and volatility spillovers from India to other markets.

(i) Return and volatility spillovers from other markets to India

To examine return and volatility spillovers between India and select markets, the basic GARCH model is modified as

follows. In the mean equation λ2 andλ3 represents returns and conditional volatilities of select Asian markets. In variance equation δ1 represents volatility of other Asian markets (Mukherjee and Mishra,2010). It is used as an exogenous variable in both mean and variance equation to test volatility spillover between India and its Asian counterparts. The model is based on daily returns and is contemporaneous.

Mean equation

$$Ri,t=\lambda 0+\lambda 1Ri,t-1+\lambda 2Rj,t+\lambda 3hj,t+\lambda 4h1/2i,t+\varepsilon t \quad (10)$$

Variance equation

$$hi,t=\alpha 0+\alpha 1\varepsilon 2i,t-1+\beta 1hi,t-1+\delta 1hj,t \quad (11)$$

i= Indian markets returns

j= Asian market returns

Table VII- Return and Volatility spillover from Asian markets to India(Pre – crisis)

Markets	λ_1	α_0	α_1	β_1	δ_1
Sri Lanka	(.0920)	(.0043)	(.1515)	(.7739)	(.0006)
	.0000	.0000	.0000	.0000	.0000
Pakistan	(.0942)	(.0021)	(.1477)	(.7716)	(-.0003)
	.0018	.0000	.0000	.0000	.0000
Indonesia	(.0811)	(.0011)	(.132)	(.769)	(-.0004)
	.0051	.0000	.0000	.0000	.0000
Malaysia	(.0961)	(.0030)	(.1521)	(.7621)	(-.0008)
	.0014	.0000	.0000	.0000	.0000
Philippines	(.084)	(.0054)	(.1514)	(.7712)	
	.0000	.0000	.0000	.0000	

*(note: value in parenthesis is the coefficient's value; ** significant at 5% ; Table includes only those c oefficients which are significant (non -significant coefficients are eliminated from the table))*

The results in table VII signifies that Indian stock index returns are dependent on its own lag returns, as none other variable is significant in the mean equation. In variance equation the constant term, ARCH, GARCH are positively significant but magnitude of GARCH term is more than ARCH term, hence it can be concluded that variance of index returns are more influenced by forecasted variance of previous term. Except, Philippines, volatility in all other index returns cause volatility in Indian index returns. Further, the volatilities in Pakistan, Indonesian and Malaysian index returns negatively influence volatility in Indian index returns. Hence, it confirms volatility spillover from these markets to Indian markets.

Table VIII Return and Volatility spillover from Asian markets to India(during crisis)

Markets	λ_1	λ_2	λ_3	α_0	α_1	β_1	δ_1
Sri Lanka	(.0610)		(.4310)	(.0121)	(.0371)	(.9550)	
	.0000		.0000	.0000	.0000	.0000	
Pakistan	(.0625)			(.0213)	(.0361)	(.9560)	
	.0000			.0000	.0000	.0000	
Malaysia	(.0601)			(.0342)	(.0310)	(.9471)	(-.0004)
	.0000			.0000	.0000	.0000	.0000
Indonesia		(2.121)	(-1.781)	(.0432)	(.0411)	(.9411)	(-.0002)
		.0000	.0000	.0000	.0000	.0000	.0000
Philippines				(.0113)	(.0411)	(.9451)	(-.0002)
				.0000	.0000	.0000	.0000

*(note: value in parenthesis is the coefficient's value; ** significant at 5% ; Table includes only those coefficients which are significant (non -significant coefficients are eliminated from the table))*

Table VIII represents the results of return and volatility spillover from other markets to Asian markets during the crisis period. Indonesian index returns and volatility cause spillover in Indian index returns. It is important to note that Volatility in Malaysia , Indonesia, Philippines index returns are negatively significant The constant term, ARCH, GARCH are positively significant but magnitude of GARCH term is more than ARCH term, hence it can be concluded that variance of index returns are more influenced by forecasted variance of previous term.

(ii) Return and volatility spillovers from India to other markets.

Mean equation

$$Ri,t=\lambda 0+\lambda 1Ri,t-1+\lambda 2Rj,t+\lambda 3hj,t+ +\lambda 4h1/2i,t+\varepsilon t \quad (12)$$

Variance equation

$$hi,t= \alpha 0+ \alpha 1\varepsilon 2i,t-1+ \beta 1hi,t-1+ \delta 1hj,t \quad (13)$$

j= Indian markets returns

i= Asian market returns

Table IX - Return and Volatility spillover from India to Asian Markets (pre– crisis)

Markets	λ_1	λ_2	λ_3	α_0	α_1	β_1	δ_1
Sri Lanka	(.2501)	(.3131)	(-.3096)	(.0041)	(.3811)	(.3431)	(.0026)
	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Pakistan		(.5315)		(.0032)	(.1413)	(.8152)	(-.00007)
		.0000		.0000	.0000	.0000	.0000
Indonesia	(.1361)			(.0045	(.0910)	(.8051)	(-.00006)
	.0000			.0000	.0000	.0000	.0000
Malaysia	(.1751)	(.8698)	(-.8571)	(.0076)	(.0536)	(.9371)	(.0031)
	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Philippines	(.1781)	(.9254)	(-.7763)	(.0021)	(.0991)	(.5201)	(.0021)
	.0000	.0000	.0000	.0000	.0000	.0000	.0000

*(note: value in parenthesis is the coefficient's value; ** significant at 5% ; Table includes only those coefficients which are significant (non -significant coefficients are eliminated from the table))*

Table IX represents results of return and volatility spillover from India to other markets. There is spillover effect from mean index returns of Indian markets to returns of Sri Lanka, Indonesia, Malaysia, the Philippines.

The variance in Indian index return effects returns of Sri Lanka, Malaysia, the Philippines positively and to returns of Pakistan and Indonesia negatively. The constant term, ARCH, GARCH are positively significant but magnitude of GARCH term is more than ARCH term, hence it can be concluded that variance of index returns are more influenced by forecasted variance of previous term.

Table X -Return and Volatility spillover from India to Asian Markets (During– crisis)

Markets	λ_0	λ_1	λ_2	λ_3	α_0	α_1	β_1	δ_1
Sri Lanka		(.1834)	(.4042)	(-.3651)	(.0000)	(.115)	(.870)	(-.0001)
		.0000	.0000	.0000	.0000	.0000	.0000	.0000
Pakistan		(.1741)	(.9721)	(-.8775)	(.0001)	(.114)	(.830)	(-.0003)
		.0000	.0000	.0000	.0000	.0000	.0000	.0000
Indonesia			(1.1.58)	(-.7651)	(.0002)	(.0791)	(.8961)	(-.0004)
			.0000	.0000	.0000	.0000	.0000	.0000
Malaysia	(.0001)	(.0816)	(2.213	(2.222)	(.0004)	(.0832)	(.8897)	(-.0001)
	.0000	.0000	.0000)	.0000	.0000	.0000	.0000	.0000
Philippines	(.0016)		(3.044)	(-2.812)	(.0002)	(.088)	(.8571)	(-.00057)
	.0000		.0000	.0000	.0000	.0000	.0000	.0000

*(note: value in parenthesis is the coefficient's value; ** significant at 5% ; Table includes only those coefficients which are significant (non -significant coefficients are eliminated from the table))*

It is clear from table X that volatility in Indian stock index returns cause negative but significant spillover effect on its Asian counterparts. The constant term, ARCH, GARCH are positively significant but magnitude of GARCH term is more than ARCH term, hence it can be concluded that variance of index returns are more influenced by forecasted variance of previous term. The coefficients of mean equation confirms the return and volatility spillover from Indian index return to returns of other stock markets.

Managerial implications

As of now, it was assumed that emerging and frontier markets are not that matured to have linkage between them in isolation of developed markets. But the results of this study compel one to give a second thought to this pre assumed notion. Events like economic crisis can change the linkage pattern of the stock markets; including emerging and frontier markets simultaneously in a portfolio with a motive of fetching benefits of diversification, may go in vain. Hence, this study will help portfolio investors in designing their optimal portfolio strategy. For instance, they can include either Sri Lanka or Philippines in their portfolio, as both the markets exhibited relatively low level of association with other markets. Apart from investors, this study has implications for corporate managers and policy makers as it helps them to hedge their respective positions in international stock markets.

Concluding Remarks

This study has made an attempt to study the linkages between Asian emerging and frontier markets with the application of Johansen methodology granger causality and GARCH modelling. The Indian stock markets found to be the riskiest in the total sample period and Sri Lankan market has outperformed other markets taken in sample in the total period. In pre- crisis period Pakistan market is the best performer in terms of returns but during the crisis period Indonesian market has given highest returns. The returns are negatively skewed for all sample periods except Sri Lanka and the Philippines.

The results of correlation coefficient makes it clear that there is a change in the dynamics of relationship between selected markets, as magnitude of correlation coefficient differs significantly from pre -crisis to during crisis period. Furthermore, the results of Johansen co integration also confirms the presence of long run linkage between the markets during the crisis period. The presence of integration during crisis period decreases the opportunity for diversification.

To gauge short run linkages between India and its Asian counter parts, granger causality test is applied. The results of the test confirm changes in the causality relationship between the markets. As, there was no relationship between India and Sri Lanka, Indonesia, Malaysia; but during the crisis period there is unidirectional causality from India to Indonesia, Philippines, Sri Lanka, Malaysia. But there is no causal relationship between India and Pakistan during the crisis period, which was evident in pre-crisis period. India has strengthened its linkages between Indonesia, Malaysia and Philippines. It is because of common trends in macro-economic policies of select markets. Also, linkages between Indonesia, Malaysia and the Philippines has intensified in during crisis.

Then, GARCH (1,1) model was applied to examine the impact of economic crisis on the return and volatility spillovers of between India and its Asian counterparts. In pre-crisis period there is significant flow of information in terms of volatility from Sri Lanka, Indonesia, Philippines, Pakistan to India and in during crisis period there is significant flow of information in terms of volatility from Indonesia, Malaysia and Philippines to India. There is significant flow of information in terms of return and volatility from India to other markets in pre and during crisis. Hence, it can be concluded that there is shift in the linkage pattern of India with its counterparts and Indian stock market is the major source of information transfer (in terms of return as well as volatility) to other markets.

References

1. *Aggarwal, R., &Kyaw, N. A. (2005). Equity market integration in the NAFTA region: Evidence from unit root and cointegration tests. International Review of Financial Analysis, 14(4), 393-406.*
2. *Agmon, T. (1972). The relations among equity markets: a study of share price co-movements in the United States, United Kingdom, Germany and Japan. The Journal of Finance, 27(4), 839-855.*
3. *Al Nasser, O. M., &Hajilee, M. (2016). Integration of emerging stock markets with global stock markets. Research in International Business and Finance, 36, 1-12.*
4. *Arshanapalli, B., Doukas, J., & Lang, L. H. (1995). Pre and post-October 1987 stock market linkages between US and Asian markets. Pacific-Basin Finance Journal, 3(1), 57-73.*
5. *Bekaert, G., & Harvey, C. R. (2000). Foreign speculators and emerging equity markets. The Journal of Finance, 55(2), 565-613.*
6. *Berben, R. P., & Jos Jansen, W. (2009). Bond market and stock market integration in Europe: a smooth transition approach. Applied Economics, 41(24), 3067-3080.*

7. *Bollerslev T. Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 1986, 31(3): 307–327.*
8. *Brooks, C. (2019). Introductory econometrics for finance. Cambridge university press.*
9. *Campbell, J. Y., &Hamao, Y. (1992). Predictable stock returns in the United States and Japan: A study of long-term capital market integration. The Journal of Finance, 47(1), 43-69.*
10. *Cheung, Y.-L., Mak, S., 1992. The international transmission of stock market fluctuations between the developed markets and the Asian–Pacific markets. Applied Financial Economics 2, 43–47*
11. *Click, R. W., & Plummer, M. G. (2005). Stock market integration in ASEAN after the Asian financial crisis. Journal of Asian Economics, 16(1), 5-28.*
12. *Daugherty, M. S., &Jithendranathan, T. (2015). A study of linkages between frontier markets and the US equity markets using multivariate GARCH and transfer entropy. Journal of Multinational Financial Management, 32, 95-115.*
13. *Diamandis, P. F. (2009). International stock market linkages: evidence from Latin America. Global Finance Journal, 20(1), 13-30.*
14. *Divecha, A., Drach, J. and Stefek, D. (1992). `Emerging markets: a quantitative perspective', Journal of Portfolio Management, Fall, 41±50.*
15. *Eun, C. S., & Shim, S. (1989). International transmission of stock market movements. Journal of financial and quantitative Analysis, 24(2), 241-256.*
16. *Friedman, J., &Shachmurove, Y. (1997). Co-movements of major European community stock markets: A vector autoregression analysis. Global Finance Journal, 8(2), 257-277.long-term capital market integration. The Journal of Finance, 47(1), 43-69.*
17. *Ghosh, A., Saidi, R., & Johnson, K. H. (1999). Who moves the Asia-Pacific stock markets—US or Japan? Empirical evidence based on the theory of cointegration. Financial review, 34(1), 159-169.*
18. *Goyal, K. (2016). Globalization and its impact on transforming India's economy. International Journal of Research in Management and Business Studies, 3(4).*
19. *Graham, M., Kiviaho, J., &Nikkinen, J. (2012). Integration of 22 emerging stock markets: A three-dimensional analysis. Global Finance Journal, 23(1), 34-47.*
20. *Grubel, H. G. (1968). Internationally diversified portfolios: welfare gains and capital flows. The American Economic Review, 58(5), 1299-1314.*
21. *Gujarati, D. N. (2009). Basic econometrics. Tata McGraw-Hill Education.*
22. *Hamao, Y., Masulis, R. W., & Ng, V. (1990). Correlations in price changes and volatility across international stock markets. The review of financial studies, 3(2), 281-307.*
23. *Hilliard, J. E. (1979). The relationship between equity indices on world exchanges. The Journal of Finance, 34(1), 103-114.*
24. *Lane, P. R., &Milesi-Ferretti, G. M. (2003). International financial integration. IMF Staff Papers, 50(1), 82-113.*
25. *Masih, A. M., &Masih, R. (1997). Dynamic linkages and the propagation mechanism driving major international stock markets: an analysis of the pre- and post-crash eras. The Quarterly Review of Economics and Finance, 37(4), 859-885.*
26. *Mensi, W., Hammoudeh, S., Nguyen, D. K., & Kang, S. H. (2016). Global financial crisis and spillover effects among the US and BRICS stock markets. International Review of Economics & Finance, 42, 257-276.*
27. *Mobius, Mark J., 1996, Mobius on Emerging Markets, FT Pitman Publishing.*
28. *Nath Mukherjee, K., & Mishra, R. K. (2010). Stock market integration and volatility spillover: India and its major Asian counterparts. Research in International Business and Finance, 24(2), 235-251.*
29. *Park, J., &Fatemi, A. M. (1993). The linkages between the equity markets of Pacific-Basin countries and those of the US, UK, and Japan: A vector autoregression analysis. Global Finance Journal, 4(1), 49-64.*
30. *Pauer, F. (2005). Financial market integration and financial stability. Monetary Policy.*
31. *Perera, A., &Wickramanayake, J. (2012). Financial integration in selected South Asian countries. South Asian Journal of Global Business Research, 1(2), 210-237.*
32. *Phengpis, C., &Apilado, V. P. (2004). Economic interdependence and common stochastic trends: A comparative analysis between EMU and non-EMU stock markets. International Review of Financial Analysis, 13(3), 245-263.*
33. *Rajwani, S., & Mukherjee, J. (2013). Is the Indian stock market cointegrated with other Asian markets?. Management Research Review, 36(9), 899-918.*
34. *Rejeb, A. B., &Arfaoui, M. (2016). Financial market interdependencies: A quantile regression analysis of*

volatility spillover. Research in International Business and Finance, 36, 140-157

35. *Schindler, M. (2009). Measuring financial integration: A new data set. IMF Staff papers, 56(1), 222-238.*
36. *ShabriAbd. Majid, M., KameelMydinMeera, A., Azmi Omar, M., & Abdul Aziz, H. (2009). Dynamic linkages among ASEAN-5 emerging stock markets. International Journal of Emerging Markets, 4(2), 160-184.*
37. *Sok-Gee, C., Karim, M. A., & Karim, M. A. (2010). Volatility spillovers of the major stock markets in ASEAN-5 with the US and Japanese stock markets. International Research Journal of Finance and Economics, 44, 161-72.*
38. *Syriopoulos, T. (2004). International portfolio diversification to Central European stock markets. Applied Financial Economics, 14(17), 1253-1268.*
39. *Thomas, N. M., Kashiramka, S., & Yadav, S. S. (2017). Dynamic linkages among developed, emerging and frontier capital markets of Asia-Pacific region. Journal of Advances in Management Research, 14(3), 332-351.*
40. *Tripathi, V., &Sethi, S. (2010). Integration of Indian stock market with World stock markets. Asian Journal of Business and Accounting, 3(1), 117-134.*
41. *Wang, Y., Gunasekarage, A., & Power, D. M. (2005). Return and volatility spillovers from developed to emerging capital markets: the case of South Asia. In Asia Pacific Financial Markets in Comparative Perspective: Issues and Implications for the 21st Century (pp. 139-166). Emerald Group Publishing Limited.*
42. *Wang, Z., Yang, J., &Bessler, D. A. (2003). Financial crisis and African stock market integration. Applied Economics Letters, 10(9), 527-533.*