GLOBAL EQUITY MARKET LINKAGES & ITS IMPACT ON INDIA

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ABSTRACT

Stock markets today are getting more and more complex with passing every dawn. From the open outcry set up under a banyan tree to computer aided algorithm trades fired in a split of a second we have come a long way since the evolution of trading on stock exchanges. The study tries to examine the cross border linkages and impact among three global regions namely the United States of America represented by the equity indices of Dow Jones Industrial average and the S&P 500 index, the European region represented by the CAC 40 index, the DAX, FTSE 100 and Asia Pacific region represented by Hang Seng Index, Kospi index, Nikkei Index and the Straits time index have on the movement of Nifty (India). The cross border relationship among different economies have assumed significant importance given the variability and volatility in returns that one equity market can cause on another mainly influenced due to various fundamentals factor variations that a nation is prone to and can have catastrophic effects on multiple nations especially the emerging economies.

INTRODUCTION

Stock prices movements never follow a particular trend, they are often correlated by the movements of fundamental indicators such as Gross domestic product change, Index of industrial production, Currency valuation, Inflation rate amongst others macro-economic variables on a domestic perspective, however no economy can function solely in isolation, they are often mapped with other global fundamental indicators of other economies. These could include the trade data of trading partner, currency valuation of our trading partner, Gross domestic product growth among a set of regions such as ASEAN, EMEA to name a few. The economic linkages of global stock markets has become important on the onset of globalization. Increased trade flow, capital formation and tremendous development on the technological frontier have boosted the globalization process. Emerging markets in general are more prone to external shocks than developed economies, however during bullish trends these markets are flushed with excess funds from developed economies. With the onset of financial liberalization India was witnessed a spurt in growth of foreign capital inflows during the last two decades, coupled with increased volatility in the equity markets. Numerous studies have been conducted to analyse the existence of financial linkages and correlation of how news or events in global equity markets influences the performance of a different set of equity markets.

Volatility spill over, is also referred to as contagion and arises due to the inter linkages between global economies. This means that any shocks arising in one country can be

be transmitted due to cross border relationships or due to economic integration among countries, it may be caused by local or global factors that have a significant bearing on other countries. These mostly include adversities in macro-economic fundamentals that may create a ripple effect across other financial markets. Financial crisis in an economy can have multiplier effects on other countries that share a significant trade link through currency fluctuations. Any country having considerable trade links with a crisis hit country could witness significant slump in exports and thereby a drop in trade which could provoke investors to pull out their funds from the country.

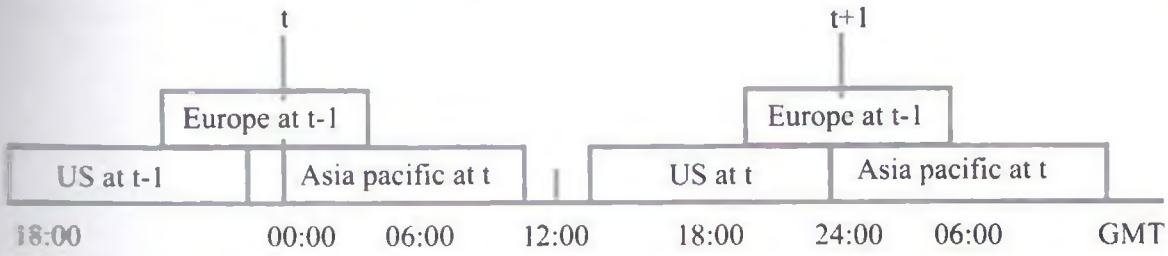
The extent of crisis is also dependent upon the on the magnitude of financial market linkages, if the countries are closely associated and integrated with the global financial markets, than the economic asset prices, macro-economic variables will move in tandem. Many economies have their assets being traded in other countries in the form of sovereign bonds, asset backed instruments or through structured products and whose financial markets are highly liquid are more prone to financial contagion. In the long run it is nearly impossible to decipher a particular trend in which market will fluctuate. Various presumptions have been framed on volatility with divergent views and opinions. Economists argue that volatility in equity markets may be substantiated by information leadership prevalent specially in the developed economies, however other contradict by putting forth that economic of external factors have no bearing on market volatility and is mainly due to investor reaction, perception and psychological beliefs.

Various financial intermediaries today decimate volatility information through specially constructed volatility indices such as the India Volatility Index, CBOE NASDAQ volatility Index, CBOE S&P 500 Volatility Index and are effectively used for hedging purposes against other indices. Stock exchanges have also innovated trading in Volatility through specially constructed Volatility F&O contracts. India today shares a very important trade relationships with China, the United States, European region in such scenarios the probability of financial disturbances in these regions effecting Indian markets is very high.

Global stock indices trading hours

Index	Trading hours	Index	Trading hours
S&P 500	9:30 to 16:00	Nifty	9:15 to 15:30
DJIA	9:30 to 16:00	Straits times	9:00 to 17:00
FTSE 100	8:00 to 16:30	NIKKEI	9:00 to 17:00
DAX	9:00 to 17:30	KOSPI	9:00 to 17:00
CAC 40	9:00 to 17:30	Hang Seng	9:20 to 16:00

Time gap across global stock exchanges



Review of literature

The study assumes considerable significance from studies carried in the areas of financial contagion across various markets and to study its counter effects. The review of literature pertains to different studies done in the area of volatility spill over so as to differentiate the present study, numerous articles, publications and works of research done in the field of volatility spill over have been referred.

Click and Plummer (2005) tried to understand the stock market integration in ASEAN countries after the Asian financial crisis using co integration test to extract long run relations. The empirical results suggested that the markets are not fully co-integrated; therefore the benefits of international portfolio diversification across the markets are not eliminated but reduced. Choudhry and Peng (2007) empirically investigated that there existed long run relationship among stock markets of the Far East countries around the Asian financial crisis of 1997 and also found that USA and Japanese had a significant influence on the relationship.

Dufrénot et al. (2011) studied if the volatility changes in stock markets of Latin American countries in the after math of 2007-08 crises could be attributed to the worsening environment of US financial markets. The study uses time varying transition probability Markov-switching model for a period covering January 2004 to April 2009 and concluded that the financial stress from US markets is transmitted to the LACs stock markets creating volatility, especially in Mexico. On the contrary, Xu and Hamori (2012) studies the impact of US financial crisis of 2008 on dynamic linkages between the BRIC countries in the mean and variance of stock prices for the period August 2004 till April 2010. Results showed that the transmission effects from US market to BRIC markets weakened both in the mean and the variance after the 2008-09 crises.

Similarly, Sensoy and Sobaci (2014) using the data period from September 2004 till April 2013 investigated the relationship dynamics between major European countries and Turkey during the global financial crisis (Subprime crisis and Euro zone crisis). The results proved the existence of integration between Turkey and the major European economies in terms of risk perception, thereby restricting the diversification benefits for global investors.

Koutmos and Booth (1995) observed that market players, trade not only on domestically available information but also gain cues from a global perspective. Such actions substantiates the concept of efficient market hypothesis, given that the global news is in line

with the activities of the domestic trader. The last few decades have been characterized by tremendous development in technology, free flow of capital across nations. Understanding these intricacies of globalisation has helped investors in better investing and efficient hedging.

In a similar approach Ng (2002)highlighted that the correlation among equity indices in the ASEAN markets has increased, subsequent to the period of equity market liberalization. He further states that there exist a close linkage between Asian equity markets in Indonesia, Philippines, Thailand and that of Singapore. Susmel and Engle (1994) studied the price and volatility spill over effect between the New York and London markets using hourly returns and concluded that the prevalent spillovers were of short and small durations.

Yanan Li and David E Giles (2013) analysed the linkages in equity markets across the United States, Japan and Asian developing economies of India, Indonesia, Malaysia, Philippines and Thailand. They further conclude that there exist significant volatility spill over from the US to the Japanese and Asian emerging markets.

Puja Padhi and Lagesh. M.A. (2012) analysed the presence of transmission mechanism prevalent between returns and volatility. The volatility spill over effects and consolidation in market movements occur in higher proportion during periods of high volatility. The degree of correlation among financial assets is of utmost importance to global investment companies, however at the same time increased correlation will decrease the impact of diversification in an investment portfolio. Suk-Joong Kim(2005) analysed the prevalent linkages among the advanced Asia pacific equity markets of Australia, Hong Kong, Japan, Singapore and US. The analysis points out to a strong degree of correlation in equity market returns, and considerable higher correlation post 1997 crisis. The granger causality test concluded a Uni-directional causality flowing from the US markets to the Asia-Pacific markets. Aggaraval et al. (1999) found that periods of high volatility in these emerging markets are associated with important events in each country rather than global events.

Data and Research methodology

This study depends on available secondary data and established set of statistical techniques that help in understanding and analysing financial contagion. The study has relied upon the historical closing prices of ten indices across the United States, European region and the Asia pacific region. The entire data set is sourced through secondary medium namely Bloomberg professional terminal. The study has been carried out for a period of 14 years starting from 1st January 2000 to 31st December 2014, which covers 3902 data points across each index. The main indexes that have been considered are mentioned in table 1.

Table 1: Data Description

United states of America	European region	Asia – Pacific region
DJIA	CAC 40	Nifty 50
S&P 500 index	DAX	KOSPI
	FTSE 100 Index	NIKKEI
		Straits times Index

The daily natural logarithmic returns of each index over a period of 14 years have been calculated and the same data points have been used throughout the study. Where in the daily logarithmic returns are given by $R_t = \text{Log}\,(P_t/P_{t-1}) * 100$

Where: R_t = Logarithmic returns for period t

P_t = Index value on day t

P_t-1 = Index value on day t-1

Log = Natural Log

Unit root test

A unit root test helps in determining whether a time series data variable is stationary. The Augmented Dickey Fuller test (ADF Test) is a well – known test that is used to check if the data points are stationary and as such has been used on the closing prices of all the indexes. The data points were found to be stationary at first difference. This helps to ensure that the data series are integrated and hence does not exhibit unit root property.

Johansen test for co-integration

Time series data usually follow a random stochastic movement in prices, it is however possible for two data series to move in a co-integrated and synchronised trend. If there exist any linear relationship between these stationery data series, then they are said to be co-integrated. Co-integration signifies when time series data points exhibit a similar or common stochastic drift. Johansen test for co-integration is used for testing the long run co-integrating relationship between Indian and other global equity markets.

Vector error correction model

The Johansen test for co-integration helps us in establishing a long term equilibrium relationship, through co-integration and hence it is necessary to study the short run behaviour among the prices of the indices. Two data sets may move together in a synchronised trend in the long run, however in the short run one data series might deviate from equilibrium. The error correction mechanism prevalent among the data series that keeps bringing them back to equilibrium at regular intervals and hence the vector error correction model is used to study the short run causality prevalent among the Indian markets and across sets of other global equity markets. The following equation defines the vector error correction model.

$$\Delta n = \alpha_n + \beta_n\, e_{t-1} + \sum \gamma_{n,i}\, \Delta n_{t-1} + \sum \omega_{m,i}\, \Delta m_{t-1} + \epsilon_{nt} \ldots\ldots(1)$$

In the above equation βn represents the long term error correction coefficients and hence establish the presence of long run equilibrium relationship. ω represents the short run influence of market on another. The lag length is identified based on Schwarz Information Criteria (SIC). Further Wald F-test is used to check for the joint significance of the variables.

Volatility modelling using EGARCH (1, 1)

Numerous studies have been conducted that try to analyse and study time varying conditional volatility spill overs across different market sets. As is the case with equity index movements, volatility also exhibit a similar characteristic wherein different periods can be found characterized by high volatility and vice versa. The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models conceptualised byBollerslev's (1986) are one of the most frequently used models to capture time varying volatility across different global markets. The study has relied on EGARCH to avoid inherent limitations prevalent across other GARCH models. EGARCH model also allows to capture the asymmetric relationship between returns and volatility. The following equation constitutes the EGARCH (1, 1) model.

$$\ln(\sigma^2_{N,t}) = \omega_N + \beta_N \left[\left| \frac{e_{M,t-1}}{\sigma_{M,t-1}} \right| - E \left| \frac{M_{t-1}}{M_{t-1}} \right| \right] + \gamma_N \left[\frac{eN_{t-1}}{\sigma_{t-1}} \right] + \theta_f \ln(\sigma^2_{N,t-1}) \quad \ldots(2)$$

The above equation represents time varying volatilities among of Nifty and other global equity markets. γ signifies the volatility spill over effect prevalent across other equity markets on India. Θ denotes the leverage effect or the severity in volatility due to any bad news or good news. β represents the volatility persistence or the duration taken for volatility decay subsequent to impact of any new information.

Garman and Klass Volatility Model

The first advanced volatility estimator was created by Parkinson in 1980, and it uses the high and low prices of the security, the Garman and Klass volatility model is an extension of Parkinson model but also includes opening and closing prices and is defined by the formula:

$$\sigma = \sqrt{\frac{1}{2}[\log\left(\frac{H}{L}\right)]^2 - [2\log(2) - 1][\log\left(\frac{C}{O}\right)]^2}$$

Where:
H = High price of the security for the day
L = Low price of the security for the day
O = Opening price for the security for the day
C = Closing price of the security for the day

Data Analysis

A summary of descriptive statistics of the ten global indices is given in table 2.The daily log normal returns are used for depicting the descriptive statistics.

Table 2 : Descriptive Statistics

	CAC	DAX	DJIA	FTSE 100	HSI	KOSPI	NIFTY	NIKKIE	S&P 500	STI
Mean	-0.008	0.009	0.011	7.57E-05	0.007	0.01	0.042	-0.001	0.008	0.006
Median	0.021	0.073	0.045	0.033	0.019	0.06	0.10	0.02	0.053	0.030
Maximum	10.59	10.79	10.50	9.38	13.40	11.28	16.33	13.29	10.95	12.06
Minimum	-9.47	-8.87	-8.97	-9.26	-14.51	-12.80	-15.04	-12.11	-9.47	-8.69
Std. Dev.	1.51	1.56	1.21	1.24	1.60	1.68	1.68	1.60	1.29	1.25
Skewness	0.039	-0.02	-0.14	-0.11	-0.21	-0.44	-0.30	-0.25	-0.23	-0.02
Kurtosis	7.60	7.23	11.05	9.04	11.61	8.67	11.37	9.23	10.77	10.91
Jarque-Bera	3447	2909	1055	5954	12092	5356	11474	6353	9863	10190
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 2 describes the summary statistics for all the ten indices. Apart from other indices CAC and Nikkei have given a negative rate of return in the long run. The Indian and the Korean market are more volatile as compared to other markets which can be seen from the higher standard deviation in both the markets. Skew-ness checks if the data points are normally distributed, none of the indices are symmetric. Any index having skew-ness from +/- 1 are considered moderately skewed. The measure of kurtosis for all data series is above 3 which indicates leptokurtic behaviour of all the data points indicating sharper peaks with longer and fatter tails. Jarque- Bera test is used to test the normality of the data series, in the above table the Null hypothesis for J-B test is that the data is normally distributed. From the above table it can be observed that the established null hypothesis is rejected for all the data series, hence it can be inferred that none of the data series are normally distributed.

Unit root test

In order to ensure that the data points for each of the index were stationery, they were tested for unit root at level as well as first difference. The results of which are summarized in table 3

Table 3: Unit root test results		
Index	**ADF test statistic**	
	Level	**First Difference**
Dow Jones Industrial Average	-0.2723	-70.1504*
S&P 500	-0.2010	-70.4689*
CAC	-2.1587	-66.6674*
DAX	-0.8036	-64.7827*
FTSE 100	-1.9182	-40.2717*
Hang Seng	-1.4245	-69.5148*
KOSPI	-0.9038	-66.3298*
Nifty	0.3188	-68.3848*
Nikkei	-1.9769	-69.3864*
Straits times Index	-0.9365	-65.9502*

Note: The Null hypothesis for the ADF test is that there exist unit root. * denotes 5 percent significance level and hence rejection of null hypothesis.

From the above table it can be observed that there exist unit root at level, however at first difference they exhibit a stationary behaviour, which implies that though the prices of indices may be non-stationary their daily returns exhibit a stationary characteristic and as such it is possible to check for co-integrating relationship of Nifty along with other global indices.

Johansen test for Co-integration

A set of time series data may move in an upward or downward trend, exhibiting a non-stationary movement. A data set is said to be co integrated if there exist a linear combination of the two non- stationary data sets. Co- integration tries to establish long term equilibrium relationship between both the variables.

The test tries to identify the number of hypothesized co-integrating equation based upon the number of indices we are checking for co-integration. The null hypothesis while checking for co-integration is that there is no co-integration among the different sets of global indices. The Johansen test for co-integration is used to check for long term co-integrating

relationship between Nifty and the American equity markets, Nifty and the European equity markets and Nifty and the Asia Pacific equity markets. The number of co –integrating equations depends upon the number of indices under each category of global equity market sets. The null hypothesis for Johansen test for co-integration is that there exist no long term co-integrating relationship among different global equity markets.

Table 4: Johansen test for Co-integration results			
Indian and American markets.			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical value
None *	0.212112	2379.694	29.79707
At most 1 *	0.177031	1450.893	15.49471
At most 2 *	0.162697	691.8079	3.841466
Indian and European markets			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value at 5 percent
None *	0.226000	3443.919	47.85613
At most 1 *	0.212337	2445.827	29.79707
At most 2 *	0.195077	1515.911	15.49471
At most 3 *	0.158093	670.4454	3.841466
Indian and Asia Pacific markets			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value at 5 percent
None *	0.218954	3971.595	69.81889
At most 1 *	0.200600	3008.810	47.85613
At most 2 *	0.184274	2136.520	29.79707
At most 3 *	0.166912	1342.997	15.49471
At most 4 *	0.149640	631.5231	3.841466

It can be observed that the established hypothesis of no existence of co-integrating relationship among different global equity market indices fails within each of the market sets. It is further seen that each of the hypothesized equation among different market sets is significant indicating that all the global indices within each pair of American, European and Asia Pacific markets are co-integrated and hence exhibit a strong synchronized equilibrium relationship. Irrespective of an upward or a downward trend it indicates that in the long run each of the indices move together in a similar trend. This is a very important property when analysing global equity market linkages and volatility spill over effect. If the movement in any of the equity market is dis-oriented the purpose of analysing equity market linkages and volatility spill over fails. It also helps in establishing a causal relationship between Indian and American, European and Asia Pacific markets.

Vector Error correction model

The Johansen test for co-integration determined the presence of long term co-integrating relationship between the Indian and American, European and Asia Pacific markets. The short run causality between each of these market sets can be analysed using the Vector error correction model. The VECM model helps in identifying how the returns within each markets are correlated. It also explains the trend and significance on long term causality between the variables and the prevalence of short run influence among each other. The VECM parameters are estimated using equation 1.

Table 5: Estimates of Vector error correction model

Panel A: Indian and American markets.

Coefficient	Value	Standard error	t - statistic
Nifty (-1)	-0.300716*	0.021511	-13.97941
Nifty (-2)	-0.157081*	0.015519	-10.12211
DJIA (-1)	0.086037	0.077758	1.106476
DJIA (-2)	0.006134	0.077028	0.079640
S&P 500 (-1)	-0.648596*	0.081769	-7.932010
S&P 500 (-2)	-0.226966*	0.074445	-3.048786
Wald F-statistic			52.8172*

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DJIA (-2)	0.006134	0.077028	0.079640
S&P 500 (-1)	-0.648596*	0.081769	-7.932010
S&P 500 (-2)	-0.226966*	0.074445	-3.048786
		Wald F-statistic	52.8172*

Panel B: Indian and European markets			
Coefficient	Value	Standard error	t - statistic
Nifty (-1)	-0.615475*	0.019346	-31.81330
Nifty (-2)	-0.302448*	0.016102	-18.78284
CAC 40 (-1)	-0.233901*	0.048102	-4.862584
CAC 40 (-2)	-0.042799	0.044472	-0.962366
DAX (-1)	0.321325*	0.038802	8.281184
DAX (-2)	0.105188*	0.034843	3.018904
FTSE 100 (-1)	-0.286307*	0.050786	-5.637470
FTSE 100 (-2)	-0.107720*	0.043178	-2.494775
		Wald F-statistic	187.4360*

Panel C: Indian and Asia Pacific markets			
Coefficient	Value	Standard error	t - statistic
Nifty (-1)	-0.442230*	0.024997	-17.69141
Nifty (-2)	-0.195183*	0.018722	-10.42506
HSI (-1)	-0.396307*	0.031872	-12.43449
HSI (-2)	-0.158922*	0.023480	-6.768520
KOSPI (-1)	0.014803	0.018810	0.786939
KOSPI (-2)	-0.014367	0.018713	-0.767750
NIKKEI (-1)	-0.204317*	0.022180	-9.211847
NIKKEI (-2)	-0.137725*	0.019644	-7.010963
STI (-1)	0.325910*	0.030260	10.77041
STI (-2)	0.158022*	0.026799	5.896523
		Wald F-statistic	133.5868*

The above table indicates Nifty as the dependant variable with other global indices within each set as independent or explanatory variables. Nifty (-1) and Nifty (-2) indicate that present day Nifty value is effected by one day and two day lag values of Nifty. Panel A identifies the causal relationship between the Indian and American markets. It can be seen that there exist a uni-directional causality between Nifty and Nifty one day, two day lag and S&P 500 one day, two day lag. It can also be observed that Dow Jones one day lag and two day lag are statistically insignificant indicating no short run causal relationship between DJIA and Nifty. It can also be inferred that the causal relationship between S&P 500 two day lag and Nifty is stronger among other variables. The combined causal relationship between Nifty one day, two day lag and S&P 500 one day, two day lag is confirmed by the Wald test that checks for joint significance of coefficients and is statistically significant in this case. Panel B captures the short run causality between Indian and European markets, it can be observed that Nifty one day, two day lag, CAC one day lag, DAX one day, two day lag and FTSE 100 one day, two day lag are statistically significant indicating a short run uni-directional causal relationship between Nifty and the above significant coefficients. CAC two day lag is statistically insignificant indicating an absence of short run causal relationship between nifty and CAC (-2). The Wald test in this case is statistically significant indicating a joint significance of the coefficients. Panel C depicts the causal relationship between Indian and Asia pacific markets. With the exception of Kospi one day, two day lag all other variables are statistically significant indicating a short run causality flow from the Asia Pacific markets to the Indian markets. The statistical significance of Wald test further indicates that all the significant variables jointly effect the Indian markets.

With the exception of a few markets it can be summarized that there exist a short run uni-directional causality flow from the American, European and Asia Pacific markets to the Indian markets. It can be said that the global indices of developed economies price in any available information and then pass on the same to emerging economies like India. Hence it can be summarized that there exist a uni-directional causality between S&P 500, CAC, DAX, FTSE 100, Hang Seng, Nikkei, Straits times Index and the Indian markets.

Exponential GARCH (1, 1)

The relationship in volatilities among different global equity markets is analysed using Exponential GARCH (1, 1) model.

The exponential or EGARCH model introduced by Nelson (1991) addresses the problem of ensuring that the variance is positive not by imposing constraints on the coefficients but by formulating the conditional variance equation in terms of the log of the variance.

Table 6: Estimates of pairwise EGARCH

	CAC on Nifty		DAX on Nifty		DJIA on Nifty	
	Coefficient	Z-statistic	Coefficient	Z-statistic	Coefficient	Z-statistic
ω	-0.18	-17.49	-0.18	-17.20	-0.18	-17.54
β	0.96	275.82	0.96	273.45	0.96	267.69
γ	0.27	19.69	0.27	19.46	0.27	19.85
θ	-0.08	-8.49	-0.08	-8.14	-0.09	-10.11
λ	-0.03	-5.72	-0.03	-5.87	-0.04	-4.66

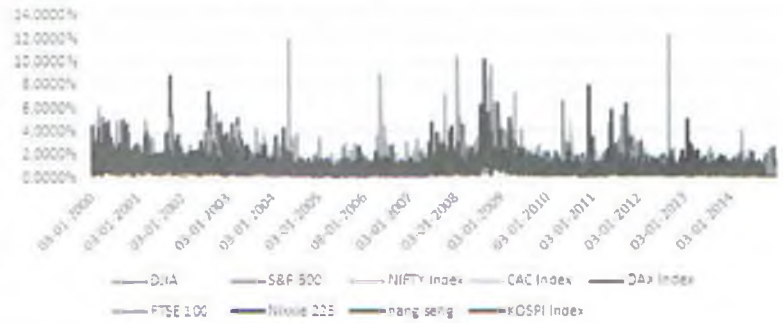
	FTSE 100 on Nifty		Hang Seng on Nifty		Kospi on Nifty	
	Coefficient	Z-statistic	Coefficient	Z-statistic	Coefficient	Z-statistic
ω	-0.18	-17.61	-0.18	-18.03	-0.18	-16.95
β	0.96	254.81	0.96	261.54	0.96	264.72
γ	0.27	19.89	0.28	20.24	0.27	19.05
θ	-0.08	-8.13	-0.09	-8.22	-0.07	-7.02
λ	-0.05	-6.87	-0.02	-4.80	-0.04	-6.93
	Nikkei on Nifty		**S&P 500 on Nifty**		**Straits time on Nifty**	
	Coefficient	Z-statistic	Coefficient	Z-statistic	Coefficient	Z-statistic
ω	-0.18	-17.52	-0.18	-17.41	-0.19	-17.83
β	0.96	253.63	0.96	268.41	0.96	239.76
γ	0.28	19.90	0.27	19.67	0.28	20.26
θ	-0.09	-9.33	-0.09	-9.83	-0.08	-7.39
λ	-0.03	-5.26	-0.04	-5.24	-0.04	-6.43

The GARCH parameter ω signifies the EGARCH constant.
Volatility persistence is captured by β. The absolute values of the coefficients indicate the presence of volatility persistence. The β values in table 18 and 19 indicate a strong presence of volatility persistence in each of pair wise estimates. At the same time it can be inferred that any information available in the market on present day, impacts the present day volatility and the volatility in the subsequent days. Hence it can be concluded that any impact created by information penetration in the market would cause the volatility to stay for a longer duration. The GARCH parameter θ captures and indicates the asymmetric volatility effect or leverage effect. It can be observed from table 6 that θ values for all the variables are statistically significant, which indicates a leverage effect. Hence it can be concluded that the impact of bad news on volatility is substantial as compared to good news. The GARCH parameter γ indicates the volatility spill over among each of the market. It can be observed that there is pairwise volatility spill over from global indices to India as γ is statistically significant in each of the pairs. However based on the coefficients it can be inferred that the magnitude of spill over is similar throughout each of the market pairs. The impact of external index variable is indicated by λ, in each pair it signifies how a global index has an impact on the volatility of Nifty. In each of the pairs λ would be represented by the global index. The coefficients are negative and statistically significant which indicates that there any movement in global indices causes a significant impact in Indian markets.

Garman and Klass Volatility model

The following graphs depict the long term and short term volatility clustering which is computed using the Garman and Klass Volatility model. Above graph displays the intraday volatility clustering which shows that there exist a strong correlation among the volatilities and their spill over in the long run.

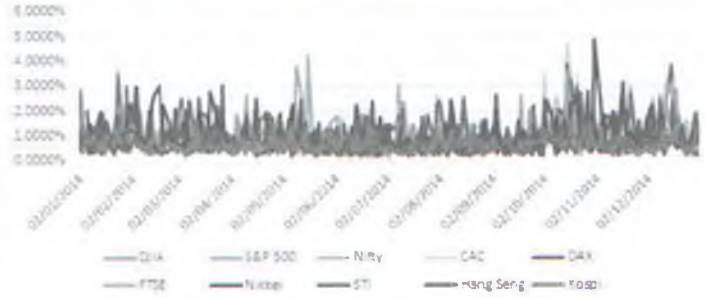
Figure 5: Intraday Volatility Clustering



Source: Authors compilation

Above graph displays the intraday volatility clustering which shows that there exist a strong correlation among the volatilities and their spill over in the long run.

Figure 6: Short term Intra day Volatility clustering



Source: Authors Compilation

The above graph shows short run stochastic co integration in movement of volatilities among the global indices. The graphs are plotted using intraday volatilities for each index calculated under the Garman and Klass volatility model.

Conclusion

The paper has tried to examine the long run and short run global equity market linkages that persist in the global financial system. With the global financial market consolidation emerging economies apart from developed economies has assumed significant importance. Economists and financial investors today pay equal attention to developed as well as emerging economies. Global equity market linkages prove significant implications to international portfolio investors. For instance an Indian investor has to close monitor the performance of Indian economy and at the same time focus on the performance of global Marco economic variables of the US and key Asia – pacific regions.

In this paper close to close returns of ten indices has been analysed to study for the long run stochastic co integration among the indices. The paper has used the Johansen co-integration test to study the long run co-integration and linkages among the equity markets. It is found that in the long run there exist strong linkages and stochastic co integration within the US, European and Asia Pacific markets. However in the short run any linkages between Kospi and Nifty could not be established. Considerable amount of volatility in an Index is caused by its own previous shocks, similarly it can also be substantiated that there exist pair wise volatility spill over from different global markets towards India. Information leadership is another important factor that causes and impacts the volatility in an equity market. Several studies have confirmed the significance of information leadership and its impact on volatility in equity markets. From our study it can be concluded that global equity markets are quickly accessible to any incoming news and adjust accordingly.

Trade balances and linkages is another factor that can be attributed to global equity market linkages and volatility spill over. Majority of the developed economies share a considerable amount of imports and exports with emerging economies, any distortion in the macro economic factors of these developed economies could seriously affect the trade balances and currency valuation of the emerging economies, which in turn would be reflected through

equity markets. Indian shares a significant trade relationship with many developed and emerging economies. China accounts for the largest trade partner with India, the United States of America further accounts to be the largest trade partner with China, any distortion in the US economy would cause ripples in the Chinese economy which would further pass on to the Indian economy.

The Garman and Klass Volatility model has been used in calculating the intraday volatilities among each of the indices based upon which significant inferences can be drawn towards volatility clustering prevalent in the long and the short run.

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