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DYNAMIC LINKAGES BETWEEN US AND INDIAN EQUITY MARKETS: AN EMPIRICAL STUDY

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ABSTRACT

In this study, we attempt to investigate the dynamic linkages between US and Indian equity market particularly after the Global Financial Crisis. The daily closing value of total return indices from both the equity markets is examined for a period of more than 15 years ending March 2019. These indices are not found to be cointegrated. An analysis of returns from these equity markets using ADCC-GARCH model reveals the linkage between the volatilities of the two markets. However, the degree of these association between the volatilities are time-varying and has been found to have reduced for past three years paving the way for equity investors of both the markets for seeking the advantage of international diversification.

Keywords: Volatility Spillover, Equity Market, Multi-Variate GARCH

INTRODUCTION

Over the last two decades, financial integration has increased vastly through reforms of the financial system and liberalisation of capital movements. This trend is evident in both domestically and internationally. In recent years of liberalisation, technological progress and information processing, more and more countries providing access to investors in their market, several opportunities come up for investment in their domestic and foreign markets. Foreign investors are increasingly investing in emerging markets. Development in stock markets of different countries provides lucrative opportunities for investors to invest in the international diversified

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portfolio. The stock market is considered as an important part of the economy and has often said as the mirror of the economy. The Indian stock market has come of age and has appreciably aligned itself with the international order. Over the last decades, several developments have made the Indian stock markets almost on par with the global markets.

With the integration of national and international markets, the Indian stock market has witnessed a phase of exponential growth and expansion post-globalization, which has been continuing since then. Now, globalisation allowed information to be transmitted across global financial markets more freely which facilitates the investors to make an international diversified portfolio. Therefore, the linkages or integration between the stock markets of different countries has grown stronger. Different markets are said to be integrated when the assets with identical risk command the same expected return irrespective of their domicile, through market efficiency.

Previous works in this area, especially in the context of emerging Asian markets, focused on the impact of developed markets on emerging Asian markets, inter- or intra-regional interdependencies between emerging markets, while controlling for the impact of developed markets.

However, in the current scenario, there may have renewed interdependency between US and Indian Equity markets particularly after the advent of the global financial crisis. In this study, we attempt to examine this renewed dynamic linkage between US and Indian stock market. To achieve this objective, we must check whether the volatility of one country can be transmitted to other country's equity market.

This paper is organized as follows: Section I that is the present section gives a brief introduction. Section II presents a brief literature review; Section III Research objectives and Hypotheses; Section IV discusses the data and methodology used in the paper; Section V explains the findings and empirical analysis; Section VI provides conclusions of the study.

REVIEW OF LITERATURE

Many studies have been conducted to investigate information transmission across markets. A lot of studies focus on how financial market shocks were transmitted across Asian countries and developed economies. A collection of important empirical studies related to the interdependence among developed and emerging markets particularly the Indian stock market has been brought out here:

Aggrawal and Inclan et al. (1999) examined the events which cause larger shifts in the volatility of emerging stock markets using daily closing values from May 1885 and April 1995. They have used iterated cumulative sums of square (ICSS) algorithm and GARCH Model and found that the large volatility seems to relate to country's specific political, social and economic events and these events includes the Mexico Peso crisis, period of hyperinflation in Latin America, the Marcos-Aquino conflict in the Philippines, and the stock market scandal in India. Kumar and Mukhopadyay (2002) investigated the short run dynamic interlinkage between the US and Indian stock markets, using daytime and overnight returns from 1 st July 1999 to 30th June 2001. They applied Two-stage GARCH model and ARMA-GARCH model to capture the inter-linkages and found that unidirectional Granger causality running from the US markets (both NASDAQ Composite and S&P 500) to the Indian stock market. Further, the previous day's daytime returns of both NASDAQ Composite and NSE Nifty have a significant impact on the NSE Nifty overnight return of the following day. Mukherjee and Mishra (2006) investigated the volatility spillover of Indian stock market with 12 other developed and emerging Asian countries over a period of 10 years using daily opening and closing prices from November 1995 to May 2005. They have used GARCH model and found that the intraday return spillover among India and almost all the sample countries were positive and significant. Bhar and Nikolova (2007) explored the degree of integration of the BRIC countries on a regional and global basis since their liberalization using daily closing stock market indices for BRIC countries for the period from January 1995 to December 2004. They used the GARCH and concluded that a high degree of integration exists between the BRIC countries and their respective regions and a lesser degree of integration exists

between BRIC countries and the rest of the world. The world index returns, and most likely the U.S. equity market returns, had a significant influence upon the variance of returns seen across Brazil, Russia, India and China. China was the only country where there exists a negative relationship between volatility spillover effects on a regional and global basis. Mukherjee and Bose (2008) examined the linkages of Indian stock market with the other markets in Asia and the US using daily data from Jan 1999 to June 2005. They have applied VAR, VECM based causality test and found bidirectional causality between the US and most of the Asian markets. They have also concluded that the Indian stock market was guided by the volatility of the US, Japan and other Asian markets such as Hong-Kong, South Korea and Singapore. Singh, Kumar and Pandey (2008) examined the interdependence across North American, European and Asian stock markets including the Indian stock market in terms of return and volatility spillover using daily opening and closing prices from 1st Jan 2000 to 22nd Feb 2008. They have applied cointegration, Granger Causality, AR-GARCH, bivariate VAR and multivariate GARCH (BEKK) model and found that there was greater regional influence among the Asian market than with European and US, Japanese market. The Indian market was not cointegrated with the rest of the world except Indonesia. Further, the study also concluded that there was significant positive volatility spillover from other markets to the Indian market, mainly from Hong Kong, Korea, Japan, Singapore and the US market. Mukherjee (2011) examined the volatility across the Indian equity market and developed countries equity market using the daily closing value from 1st January 1999 to 15th February 2008. She used VAR and combined VAR with multivariate GARCH model to explore the possibility of volatility transmission to India from markets like Japan, the United Kingdom and the United States, as well as emerging markets like Singapore, the Republic of Korea and Hong Kong, China and concluded that Indian market return was significantly influenced by the past return of its own and Republic of Korea and of U.S. positively and that of Hong Kong, China negatively. Further, there was evidence that the past return of the Indian stock market has also significantly impacted the return of Japan, the Republic of Korea, Singapore and Hong Kong, China. Kaur (2011) examined the time-varying volatility in daily return on Sensex

and nifty and, day of the week, weekend effect, month effect and also investigated the return and volatility spillover across the Indian and US stock market using daily prices from January 1993 to March 2003. He applied GARCH, EGARCH and TGARCH and found mixed evidence of return and volatility spillover between the US and India. Further, he also found the presence of intra-week and intra- year seasonality. Pandey and Kumar (2011) investigated the volatility spillover of developed and developing economies on Indian stock exchanges using daily index return data from 4 Jan 2000 to 17 July 2009.They have applied Johansen's cointegration and GARCH model and found the evidence of the increasing impact of several international indices on returns and volatility levels of the BSE Sensex. Further, the volatility of the Indian stock market is dependent on its lagged value and the volatility of the UK, Japan, China and the Indonesian stock market. Li and Giles (2013) examined the linkages of the stock market across the U.S., Japan and Six Asian developing countries namely China, India, Indonesia, Malaysia, and Philippines and Thailand using daily data from 1st January 1993 to 31st December 2012. They have applied VAR and MGARCH model and found significant unidirectional shocks and volatility spillover from the U.S. market to both the Japanese and the Asian emerging market and the volatility spillovers between the U.S. market and the Asian markets were stronger and bidirectional during the financial crisis. Dasgupta (2013) investigated the dynamic linkage between BRIC and the U.S. stock market both in short and long run using daily closing values of the stock indices from 1 st January 1998 to 31 st December 2012. He had applied VAR, cointegration and Granger causality test and concluded that the short run interrelationship and integration has been in one direction from the Brazilian stock market to the Indian stock market. The study found that the Indian stock market has a strong impact on Brazilian and Russian markets and the interdependencies and dynamic linkage were also evident in the BRIC stock markets mainly between India and China. The study also found that the BRIC stock market was the most favourable destination for global investors in the coming future and among the BRIC stock market, the particularly the Chinese market has dominance. Gahlot (2013) examined the impact of the recession on the nature of volatility and its spillover among South Asian countries using daily closing prices

from April 2006 to March 2011. She has applied Granger Causality and MGARCH and found bidirectional causality between US and Indian stock market which is not affected by the recession. She also found an unstable volatility spillover effect over time. Beire, Corporate at al. (2013) examined the volatility spillover from mature to emerging equity markets using the weekly return from September 1993 to mid-March, 2008.They have applied BEKK GARCH and found that volatility spillover from mature market does influence the dynamic of conditional variance of return in many local and regional emerging stock market. And, furthermore, the conditional correlation between the local and mature markets has increased during the turbulent period. Rajeb and Boughrara (2015) examined the volatility relationship between emerging and developed countries using daily data from Jan 1976 to Dec 2008. Using VAR, they found the volatility transmission across emerging markets and between emerging and developed markets and the importance of geographical proximity in volatility transmission. Bahadur and Kothari (2016) investigated the transmission of volatility from the global stock market to Indian stock market using daily data from Jan 2005 to Dec 2015. They have applied Granger causality and ARDL and found cointegration of Indian stock market with the UK, US and Japanese market. Further, India and UK have bi-directional causality. They have also concluded that the past one day's volatility in the foreign market has the greatest influence in the volatility of the Indian stock market.

Regardless of the extensive research in this field, relatively few researches have been conducted mainly on India, and fewer on its linkage with the US equity market only. In summary, these studies open a renewed interest to explore the linkages between US and Indian equity market particularly after the conclusion of the global financial crisis.

DATA AND RESEARCH METHODOLOGY

For achieving the objectives of the study, this paper analyses the equity market returns in the emerging economy of India and that of the developed economy of the USA. As the investors of the equity markets are concerned about the returns in the equity market, including dividend yields, the equity market movements are

measured by the movements in the Total Return Indices of the major indices in both the economies. The Indian equity market is proxied by NIFTY 50 which is constituting 50 stocks belonging to 13 sectors of the Indian economy representing 66.8% of the free float market capitalization of the stocks listed on National Stock Exchange of India Ltd. for the financial year ending 2018-19. NASDAQ Composite Index measures the movements of US and international based equity type stocks listed on the NASDAQ Stock Market. This index has more than 2500 equity shares and similar scrips. Both these indices are also released in their total return versions which includes dividend yields otherwise ignored in the price based versions.

The data for NIFTY 50 Total Return index was sourced from CMIE ProwessIQ corporate database for Indian economy. The data for NASDAQ Composite Total Return was sourced from online database Quandl. The later data could only be sourced since 25th September 2003, and therefore this study uses the daily closing index values spanning Sep. 25, 2003 to Mar. 29, 2019.

The study employs the time series tools of stationarity, Granger Causality, Engle-Granger Cointegration, and Asymmetric Dynamic Conditional Correlation (ADCC) – Generalised Auto-Regressive Conditional Heteroscedasticity (GARCH) model for analysing the data.

RESULTS AND ANALYSIS

This section reports the results of the analyses of the dataset mentioned in the previous section. The descriptive statistics of the equity returns to the investors of both the markets are presented below.

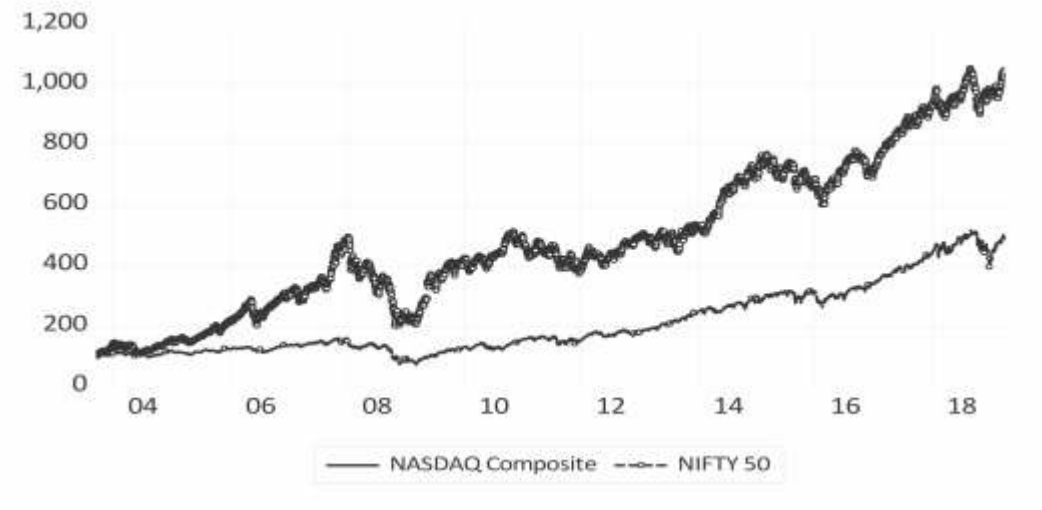
Table-1: Descriptive Statistics of the Total Return Indices

	NASDAQ COMPOSITE	NIFTY50
Mean	3858.839	7465.033
Median	2864.750	6820.250

Maximum	9388.220	16220.45
Minimum	1319.830	1542.170
Std. Dev.	2084.477	3803.706
Coefficient of Variation	54.01824	50.95364
Skewness	1.039607	0.440357
Kurtosis	2.925327	2.285741
Jarque-Bera	704.1359	206.6424
Probability	0.000000	0.000000
Observations	3904	3857

It is evident from the above table-1 that the NIFTY 50 has been scaled higher during the study period. Both the series are positively skewed and observe higher kurtosis, resulting in a non-normal distribution of value as evidenced by the Jarque-Bera statistics. The coefficient of variation shows that higher variation in NASDAQ Composite relative to NIFTY 50, though the standard deviation been otherwise. A chart of common starting value of both the series is presented below. The common base value at the start of the study period is pegged at 100.

Chart-1, Total Return Indices with the same base value



The above chart-1 shows that NIFTY 50 has relatively higher values with higher variation in its values. This implies that Indian markets offer relatively higher equity returns with higher risk.

The total return index series (unscaled to common base) are further tested for stationarity after transforming into logarithmic version to ease interpretation of further differencing. The results of the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests of unit root are presented in the following table.

Table-2, Test statistics of Unit Root Tests of the Log of Return Indices

	Log (NASDAQ)	Log (Nifty)
Augmented Dickey-Fuller (ADF)	-0.0196	-1.7914
Phillips-Perron (PP)	-0.0460	-1.7964
Kwiatkowski-Phillips-Schmidt-Shin (KPSS)	7.1565	7.0588

The above table-2 shows the statistical evidence against the hypothesis that the individual series is stationary. Hence, the equity market return series are obtained by differencing the series of log-transformed total return indices. The table below shows that these series are observed to be stationary.

Table-3, Test statistics of Unit Root Tests of the returns

	Log (NASDAQ)	Log (Nifty)
Augmented Dickey-Fuller (ADF)	-45.7308	-56.7394
Phillips-Perron (PP)	-64.7848	-56.6967
Kwiatkowski-Phillips-Schmidt-Shin (KPSS)	0.1006	0.1814

The above table-3 also indicates the order of integration of the original Total Return Indices is one, i.e. I(1). A further investigation of the linear combination of these I(1)

series is carried out to check any possibility of cointegration of the return indices. Such a relationship may provide opportunities to the investors to earn arbitrage opportunities arising owing to the disequilibrium from such relation. A test of possible cointegration among these return indices is carried as follows.

A preliminary assessment of the Granger Causality test of the common sample of log-transformed total return indices is presented in the table below.

Table-4, Granger Causality Tests with Lag 2

Null Hypothesis:	Obs	F-Statistic	Prob.
Log(NIFTY) does not Granger Cause Log(NASDAQ)	3158	0.44765	0.6392
Log(NASDAQ) does not Granger Cause Log(NIFTY)		97.4910	8.E-42

The above table-4 shows a potential unidirectional impact of US market to the Indian market. However, any stable long term relation can only be implied by the cointegrating equation. Engle-Granger testing procedure of the cointegrating relationship is presented below.

Table-5, Linear Regression of Log of NIFTY Index on Log of NASDAQ Index

Dependent Variable: Log(NIFTY)			R-squared	0.779772
Method: Least Squares			Adjusted R-squared	0.779713
Sample: 9/25/2003 3/29/2019			F-statistic	13182.20
Included observations: 3725			Prob(F-statistic)	0.000000
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.274802	0.074105	3.708258	0.0002
Log(NASDAQ)	1.044828	0.009100	114.8138	0.0000

The results of the above table-5 were used to compute the residuals of the regression

for further testing of its stationarity. The results of the stationarity are reported below

Table-6, Test statistics of Unit Root Tests of the Residuals of Regression

	Residual
Augmented Dickey-Fuller (ADF)	-1.2989
Phillips-Perron (PP)	-1.9920
Kwiatkowski-Phillips-Schmidt-Shin (KPSS)	2.0946

The above table-6 shows the statistical evidence against the hypothesis that the residual series is stationary. Thus, the Engle-Granger procedure concludes that the Total Return Indices of major equity markets in India and US is not cointegrated. Resultantly, the relationship between these Indices will prove to be spurious. Therefore an association in terms of the returns, rather than their indices, is sought in order to establish the possibility of dynamic linkages between the equity markets of the two economies. The table below describes the common dataset of returns from the two equity markets.

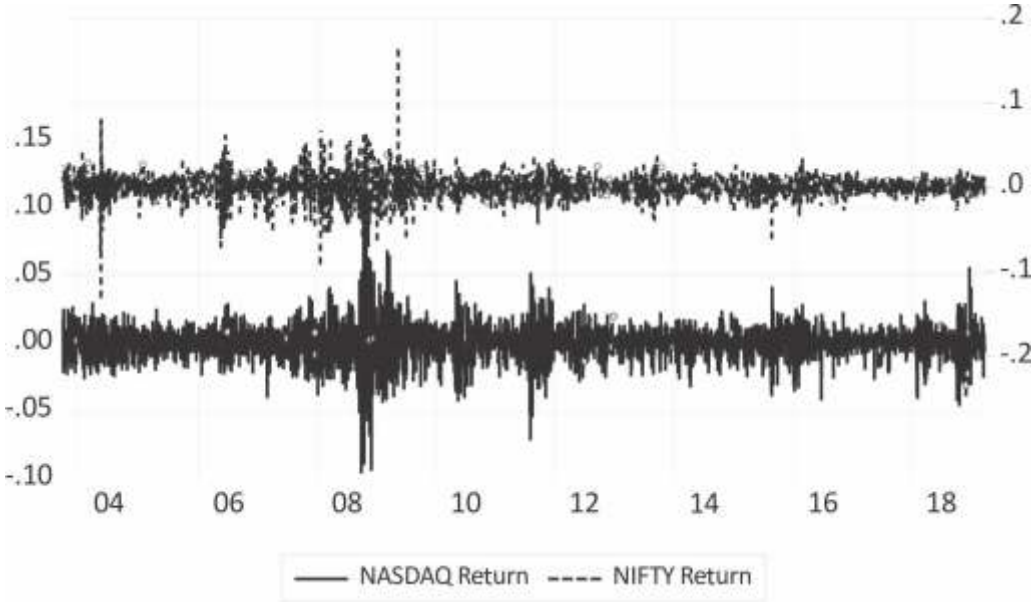
Table-7, Descriptive Statistics of the Returns from NASDAQ & NIFTY

	NASDAQ Return	NIFTYReturn
Mean	0.000352	0.000557
Median	0.000863	0.000797
Maximum	0.111592	0.163350
Minimum	-0.095861	-0.130551
Std. Dev.	0.012668	0.014074
Skewness	-0.292143	-0.180519
Kurtosis	10.50469	15.21550
Jarque-Bera	8109.708	21375.54

Q-statistic (Lag 1)	12.445	8.4409
Q-statistic of Squared mean deviations (Lag 1)	200.70	169.53
ARCH Heteroscedasticity test statistic	207.9429	176.7485
Observations	3435	3435

The above table-7 shows the non-normal nature of the return distributions with autoregressive nature of the series exhibiting heteroscedasticity. The chart below also suggests the suitability of GARCH family-based models to describe the interrelationship between the series.

Chart-2, Equity Market Returns over time



Thus, this study uses the Asymmetric Dynamic Conditional Correlation (ADCC) – Generalised Auto-Regressive Conditional Heteroscedasticity (GARCH) model to study the dynamic linkages between the two markets as suggested by Cappiello, Engle & Sheppard (2006). The results of the model are presented below.

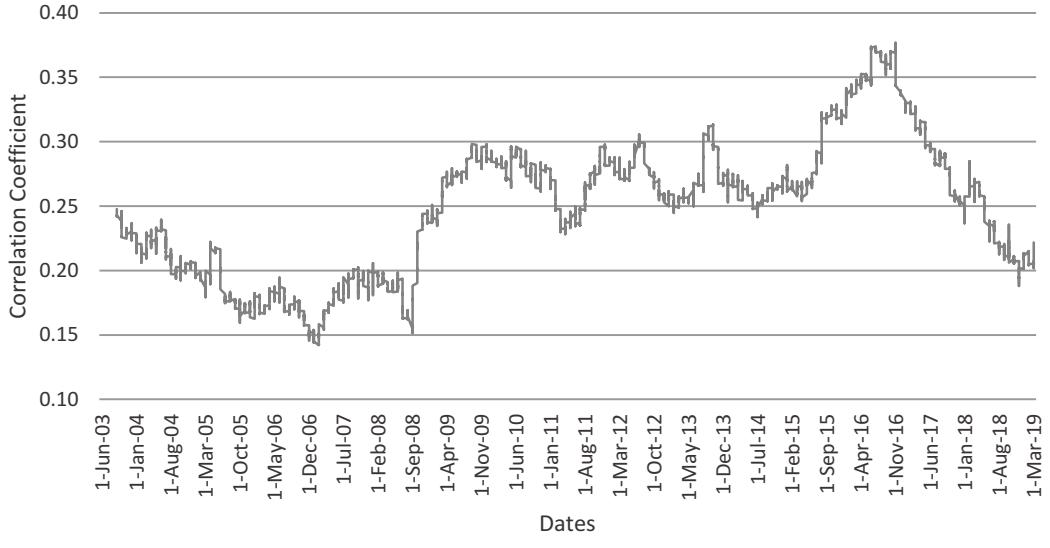
Table-8, ADCC – GARCH Regression of returns from NIFTY and NASDAQ

Distribution	: MVNORM			
Model	: DCC(1,1)			
No. Parameters	: 15		Akaike IC	6.1044
No. Series	: 2		Bayes IC	6.1294
No. Obs.	: 3724		Shibata IC	6.1044
Log-Likelihood	: -11351.36		Hannan-Quinn	6.1133
Parameters	Coefficient	Std. Error	t-Statistic	Prob.
[Nifty50].mu	0.0982	0.0189	5.1965	0.0000
[Nifty50].ar1	-0.2323	0.2960	-0.7850	0.4325
[Nifty50].ma1	0.3080	0.2888	1.0665	0.2862
[Nifty50].omega	0.0185	0.0070	2.6544	0.0079
[Nifty50].alpha1	0.1023	0.0205	4.9844	0.0000
[Nifty50].beta1	0.8932	0.0187	47.8330	0.0000
[NASDAQ Composite].mu	0.0788	0.0026	29.9460	0.0000
[NASDAQ Composite].ar1	0.9626	0.0055	176.3	0.0000
[NASDAQ Composite].ma1	-0.9802	0.0001	-10700.0	0.0000
[NASDAQ Composite].omega	0.0322	0.0075	4.2693	0.0000
[NASDAQ Composite].alpha1	0.0947	0.0126	7.5396	0.0000
[NASDAQ Composite].beta1	0.8824	0.0144	61.3780	0.0000
[Joint]dcca1	0.0029	0.0013	2.2754	0.0229
[Joint]dccb1	0.9965	0.0018	544.53	0.0000

The above table-8 shows that the statistically significant values of the coefficients of dcca1 and dccb1 depicting the inter-linkages of the two markets at 5% level of significance. Thus, there exists a spillover of volatilities across the markets. A hike in the volatility in one market affects the volatility level of the other market. The strength of such impact varies across time. The following chart presents the time-varying conditional correlations between the two equity markets which are extra

sensitive towards the fall in the indices.

Chart-3, Correlations between NIFTY and NASDAQ returns



The above chart-3 shows that the conditional correlations between the equity market return indices started rising after the advent of the Global Financial Crisis from its lowest levels in February 2007. After the Global Financial Crisis, these correlations stabilized for six years. After which, these stock market returns have been experiencing a consistent reduction in the correlations from its highest level in November 2016. Thus, it can be deduced that they do exhibit spillover of volatilities, however, the strength of such spillover is varying across the different time period. The next section provides the overall conclusions.

CONCLUSIONS

This study aims to assess the renewed interest in the dynamic interlinkages between the emergent Indian equity market and matured equity market of the US, particularly after the Global Financial Crisis. For the purpose of this study, daily values of Total Return Index of NIFTY 50 for the Indian equity market and Total Return Index of

NASDAQ Composite of US equity market are analysed for more than 15 years starting from Sep 2003 to Mar 2019. The study found these indices to be integrated of order one and exhibited an absence of cointegration between them possibly due to lower economic interlinkage for the US market. This result turned our analysis from the index level to the return level. Given the peculiar nature of equity markets around the world, these returns were analysed using Multi-variate model of GARCH family of models accounting for the time-varying nature of conditional correlations asymmetric to the impact of good news and bad news. The results show that both markets are affected by the volatilities in the other market. However, the degree of such impact varies across time. During the past three years, such correlations are consistently going down. This may result in better diversification of the portfolios held by the investors of both the equity markets.

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