



## **Integration and Linkages between Indian and Chinese Stock Markets on the prospect of diversification opportunities**

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### **Abstract**

Diversification is the key to the management of portfolio risk without adversely affecting return. International investing offers potential return opportunities and risk reduction through international portfolio diversification, to investigate its linkages and integration among stock markets have a major role. The study checks the possible diversification opportunities between Indian and Chinese Stock market and tried to detect integration and linkages between these stock markets taking sample of Nifty 50 Index (India) and Shanghai Composite Index (China) spanning from the year 1995 till 2016. Accounting Structural break due to GFC 2007-08, analysis conducted for pre and post GFC and also incorporated dummy exogenous in some aspect. The model does not identify any long run integration between these pair of markets, but evidenced some short run linkages. Frequency domain analysis (Breitung and Candelon (2006)) captured the range of causality and bandwidth ranges of corresponding time periods.

**Key Words:** Diversification, Stock Market, Integration, Integration, GFC (Global Financial Crisis), Shanghai Composite, Nifty.

### **Introduction**

The study on investment is crucial than ever in the twenty-first century as individual investors have swarmed into the financial market seeking higher returns than those available from financial avenues. However, Investment returns are associated with the risk, which in common arise out of variability, and connected with the dispersion in the likely outcome. There are so many factors that influence the risk the important among them is a market fluctuation, i.e., over the period of time the price of an investment may change rapidly and sometimes dramatically, in stock market it is widely known as volatility. It poses the major investment risk in the short term. However, the chances are there to reduce or eliminate risk if the portfolio is diversified. Therefore the riskiness of the investment declines as more stocks are added, in fact, diversification is the key to the management of portfolio risk without adversely affecting return. International investing also offers potential return opportunities and risk reduction through international portfolio diversification.

It is generally believed that international stock market have become more closely related in recent days, and the causes for this increased linkages are due to speedy transmission of prices and shocks between markets. There are so many factors that strengthen the linkages among the stock markets such as increased importance of capital flow, free floating prices or otherwise market determined prices in which the pressures are transmitted to another market due to lack of government intervention. Technological advancement would be another cause for it as there is a speedy international financial transaction, increased flow of information, 24 hrs trading as a result of low transaction costs. Also performances of a particular share become



a global even as there is an increasing trend of cross listing of multinational shares. Increasing International trade as a result of globalisation also contributing towards the strengthening the stock market linkages.

The Increased stock market linkages have a major impact on international portfolio diversification. The asset return in a portfolio have a correlation less than unity or have a negative correlation then diversification can reduce or eliminate risk entirely. Perhaps there is a strong linkage and greater co-movement among the international markets, then there will be no benefits of diversification.

When the stock markets have no tendency to move together in the long-term and causal effects become weak in the short-term then the markets are segmented and provide ample room for diversification of investments.

## I. Literature review

Researchers across the globe also studied diversification on various dimensions of stock market linkages and integration; **Kasa (1992)** **Arshanapali and Doukas (1993)** **Kotumos (1996)** taking developed economy for their analysis and found that the factors strengthen the linkages includes international news, especially unfavorable, stemming from the other markets. **Lamba (2002)** examined the influence of developed equity markets on Indian markets and found that Indian stock market is not integrated with the world markets, but some short-term sentiments in the world market do have an impact on the Indian market. **Ahmad et.al (2005)** revealed no long-term relationship of the Indian equity market with that of the US and Japanese markets. **Tripathi & Sethi (2010)** examined the integration of the Indian stock market with the stock market of Japan, UK, US and China and found Indian stock market has no integration with any of these markets except the US. However, short-run causality was found in most cases. In the same way, European stock market integration was studied by **Fratzscher, M. (2002)** and observed that a strong degree of co integration South Asian market integration was examined by **Nath and Verma (2003)** and no co-integration was found with no long-run equilibrium. Integration of Far East Countries was studied by **Chaudhary et.al. (2007)** and found long-run relationships among stock markets.

Most of the Studies measured stock market integration in the time domain whereas in recent days it is proved by authors that analysis in frequency domain provides more information and are useful for major decisions as well. Traditional time domain analysis focuses only on the time. And indicates, when certain variation happens whereas frequency domain analysis measures the degree of certain variations by showings how much of the signal lies within each given frequency band over a range of frequencies.

Thus integration and linkages in the perspective of frequency domain have been reviewed and found only a few studies available, among which was the study done by **Tiwari, A. K et al (2015)**. They investigated the causality in frequency domain taking stock prices and economic variables, in order to identify the direction of the causality at different frequencies. The framework of **Geweke (1982)** and **Hosoya (1991)** was adopted to construct a simple test for causality in the frequency domain, which can also be applied to co integrated systems. The study evidenced unidirectional causal relationship between stock prices and industrial production in the long-run, running from stock prices to industrial production. The study concluded that the stock prices are a leading indicator of growth in the industrial production in India. In recent times **Joseph, A., Sisodia, G., & Tiwari, A. K. (2014)** examined the direction, strength, and extent of the causal relationship between futures and spot prices of

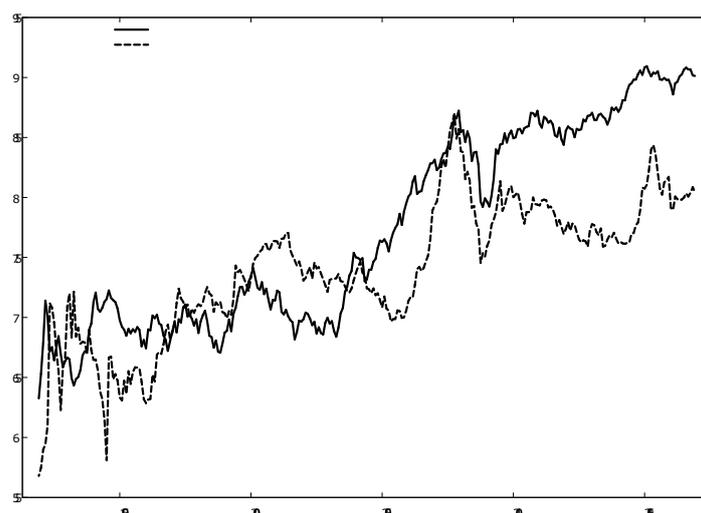
Indian commodity markets using frequency domain approach of **Breitung and Candelon (2006)** based on the bivariate spectral density matrix, and the same measure has also used in the present study to capture causality in the frequency domain.

## II. Data Methodology and empirical results

In this paper, we examine the long and short run integration between Indian and Chinese Stock markets. In order to compute the linkages we use monthly data of Nifty (India) and Shanghai Composite Index (China). Data together for both the market were available from 1991M10, however the Chinese market trend line had deep downward movement during 1993M03 and lasted till 1994M10 due to 'tequila crisis'<sup>1</sup> (see graph 1). Therefore the study used data from 1995 onwards, i.e. the monthly data of Nifty (India) and Shanghai Composite Index (China) spanning from 1995M01 to 2016M02 are considered for the analysis. (See Graph 2) In addition both the stock market were showing structural break of Global financial crisis<sup>2</sup> from 2007M10 to 2009M02. Thus accounting for the break, separate analysis has been done for Pre and post global financial crisis by converting price in to log.

Preliminary analysis is done with the help of summary statistics and line graph. ADF and PP test are applied to check the stationary properties of the variables. Also Johansen's Co-integration model has been used to estimate the long term relationship between the markets. Short term causal relationship measured through Pair wise Granger causality test. Moreover, conventional time domain measure which in turn failed to throw appropriate light in capturing the causality dates, therefore attempt is made in this paper to fill the gap and causality besides studied through frequency domain approach of **Breitung and Candelon (2006)**.

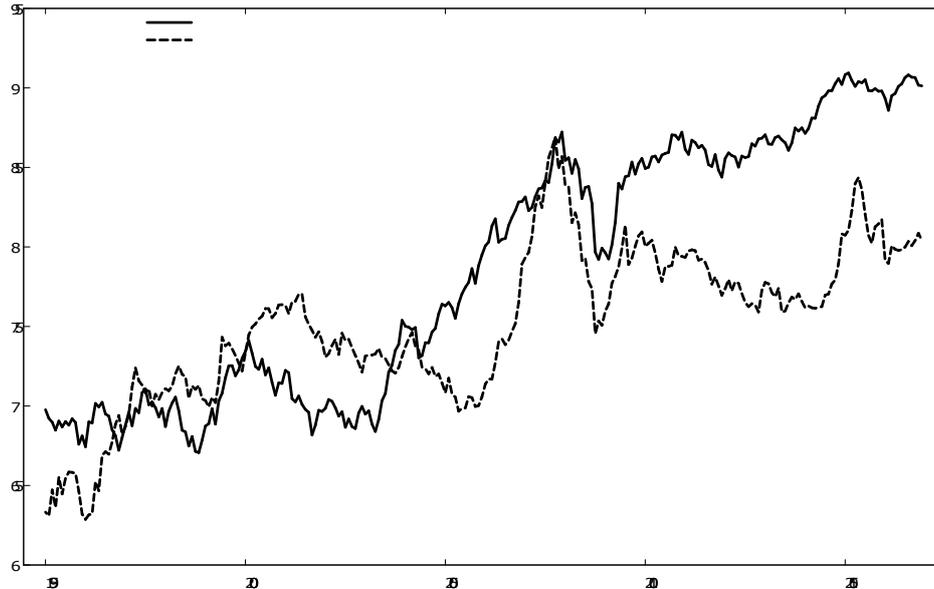
**Graph 1**  
**Trend line of Nifty and Shanghai composite for available period 1991M10 to 2016M12**



<sup>1</sup> Tequila crisis otherwise the **Mexican peso crisis** was a currency crisis sparked by the Mexican government's sudden devaluation of the peso against the U.S. dollar in December 1994, which became one of the first international financial crises ignited by capital flight.

<sup>2</sup> The financial crisis of 2007–2008, also known as the global financial crisis and the 2008 financial crisis, is considered by many economists to have been the worst financial crisis since the Great Depression of the 1930s.

**Graph 2**  
**Trend line of Nifty and Shanghai composite from 1995M01 to 2016M12**



### III. Descriptive Statistics

This section discusses the descriptive statistics of variables included in the study Table 1 shows the summary statistics of Nifty and Shanghai Composite Index for pre and post global financial crisis. Pre-crisis period for both the market had low return (low mean) with high risk (high Standard deviation), however both the market picked up in post crisis period offer added return for low risk and comparatively Shanghai composite reported high mean with less risk. It is observed from the table that the series of Shanghai is positively skewed for pre and post crisis period. Nifty is negatively skewed for the post-crisis, and for pre-crisis shows positive skewness value. Kurtosis is slightly more than the limit during all the periods, for Shanghai composite index, however Nifty is close to the criterion limit.

Table: 1  
 Descriptive statistics

	Nifty			Shanghai Composite		
	Whole Period	Pre-Crisis	Post-Crisis	Whole Period	Pre-Crisis	Post-Crisis
Mean	7.855294	7.282115	7.879134	7.512522	7.24834	8.721698
Median	7.922758	7.055615	7.884448	7.557594	7.242243	8.676366
Maximum	9.094014	8.682818	8.436361	8.691947	8.691947	9.094014
Minimum	6.706557	6.706557	7.590451	6.28665	6.28665	7.924308
Std. Dev.	0.802415	0.494294	0.193331	0.489202	0.451906	0.242498
Skewness	0.041237	1.147262	0.493031	-	0.462152	-0.40548

				0.287765		
Kurtosis	1.388312	3.199726	2.855948	2.920972	4.451005	3.387731

#### IV. Unit Root test results

Prior to the co-integration model, the properties of the data series needs to be examined whether the series are non-stationary or contain unit root. Unit root test involves examining whether the series are stationary or not at level and subsequently finding the order in which they are integrated if the series are non-stationary. This study employs Augmented Dickey-Fuller (ADF) test to determine the unit root property of the stock market indices.

The following hypotheses are tested:

Ho:  $\gamma = 0$  (series contain a unit root)

H1:  $\gamma \neq 0$  (series is stationary)

The test statistics known as the tau statistics are checked against the critical values w tabulated by Dickey and Fuller on the basis of Monte Carlo simulations<sup>3</sup>. The null hypothesis of series contain a unit root is rejected if t-statistics is smaller (more negative) than the critical value respectively. After getting the order of integration using ADF test, the presence of co-movement between the stock market indices is tested using co-integration test.

The results of the ADF (at 5% level of significance) for the series of Nifty and Shanghai Composite are shown in Table 1. The results revealed there are unit root in the series at level I (o) and become stationary by first difference I (1).

#### Results of ADF and PP test (for whole study period)

Table xxx ADF & PP unit root test of stock indices for the study period based on SIC at level and difference.

Country	Index	ADF Test		PP Test	
		Level	1 <sup>st</sup> diff	Level	1 <sup>st</sup> diff
India	Nifty 50	-0.400514	-16.14942***	-0.448772	-16.16411***
China	Shanghai CI	-2.243748	-15.20576***	-2.38621	-15.44406***

\*\*\*Significant at the 1% level.

#### Results of ADF and PP test (for pre and post crisis period)

Table xxx ADF & PP unit root test of stock indices for Pre- Crisis Period based on SIC at level and difference.

Country	Index	ADF Test		PP Test	
		Level	1 <sup>st</sup> diff	Level	1 <sup>st</sup> diff
<i>Pre-Crisis</i>					
India	Nifty 50	1.1970	-12.6504***	1.23674	-12.6503***
China	Shanghai CI	-0.3120	-11.3791***	-0.53828	-11.4677***
<i>Post-Crisis</i>					
India	Nifty 50	-2.0815	-10.1384***	-3.37665	-9.62284***
China	Shanghai CI	-2.0457	-8.58598***	-2.04568	-8.54203***

\*\*\*Significant at the 1% level.

<sup>3</sup> D. A. Dickey and W. A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, vol. 74, 1979, pp. 427-431.

After seeing the graphical representation of common trend, and stationary properties it is confirmed that the presence of co-movement between the stock market indices can be tested using co-integration test.

**V. Co-integration and causality in Time Domain**

Co integration tests expose whether the stock markets move together over a longer time period. There are several methods to test for co integration such as Engle and Granger, 1987, which is applied to perform pair wise analysis of the stock indices and it allows only for one endogenous and one exogenous variable. However, Johansen method is widely used multivariate method and it improves some of the drawbacks with the Engle-Granger method (Brooks, 2008), as it allows for all variables to be endogenous and makes it possible to determine all co-integrating relationships between the stock markets. Although the Johansen method is best known as a multivariate approach to co integration testing, it can also be used to test for co integration between a pair of variables (Johansen, 1991). The present study applies Johansen method to test co-integration in a system of two or more variables.

Co integration provides existence of a long-run relationship; the Granger Causality test is conducted to investigate direction of causality between variables. To understand the causality between Indian and Chinese stock market return, Pair wise Granger causality test is conducted. The results can be found out from table xxxx.

The null hypothesis tested for the study:

$H_0^1$ : Shanghai composite does not Granger Cause Nifty for pre and post-crisis periods.

$H_0^2$ : nifty does not Granger Cause Shanghai composite for pre and post-crisis periods.

**VI. No co integration but Unidirectional causality between Indian and Chinese Stock Markets**

The study found no co-movement or co-integration between Indian and Chinese markets, even if GFC 2008 is accounted or ignored, yet some evidence of short-run cause and effect relationships exist between these two markets. For pre-crisis period Short run causality is bidirectional between Indian and Chinese market whereas post-crisis period evidenced unidirectional causality, running from Nifty to Shanghai Composite. In other words, Chinese market has no effect on the Indian market whereas Indian market has an impact on the Chinese market for the post-financial crisis.

Since there is no long run relationship the study do not continue to the next model, i.e., short term equilibrium otherwise speed of adjustment.

Table xxx: Johansen Co-integration test Results not accounting GFC

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
<b>Unrestricted Cointegration Rank Test (Trace)</b>				
None	0.039181	10.59545	15.49471	0.2377
At most 1	0.000471	0.123562	3.841466	0.7252
<b>Unrestricted Cointegration Rank Test (Maximum Eigen</b>				

value)

None	0.039181	10.47189	14.2646	0.1828
At most 1	0.000471	0.123562	3.841466	0.7252

\*denotes rejection of the hypothesis at 5% significance level

Table xxx: Johansen Co-integration test Results accounting GFC: Exogenous Series: Dummy

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
<b>Unrestricted Co-integration Rank Test (Trace)</b>				
None	0.02368	6.281693	15.49471	0.6622
At most 1	1.13E-05	0.00297	3.841466	0.955
<b>Unrestricted Co-integration Rank Test (Maximum Eigenvalue)</b>				
None	0.02368	6.278723	14.2646	0.5777
At most 1	1.13E-05	0.00297	3.841466	0.955

\*denotes rejection of the hypothesis at 5% significance level

Even when the variables are not co integrated in the long-run, they might still be related in the short-run. In order to understand short-run interdependence among stock markets, Granger causality tests will be performed.

The result reveals that for pre crisis period bidirectional causality run between Nifty and Shanghai, (Null hypothesis rejected) whereas for the post crisis period the causality runs from Shanghai composite to Nifty. The study also agrees with the views the direction of causality will differ according to the economic conditions. As in the post crisis period Shanghai causes Nifty which evidenced unidirectional causality.

#### Results of Pair wise Granger Causality Tests

Period	Null Hypothesis:	F-Statistic	Prob.
Pre-crisis	SCI does not Granger Cause Nifty	5.82531	0.0037
	Nifty does not Granger Cause SCI	3.06911	0.0495
Post-crisis	SCI does not Granger Cause Nifty	1.38247	0.2328
	Nifty does not Granger Cause SCI	2.57441	0.0254

#### VII. Frequency domain causality

In statistics, frequency domain is a term used to describe the domain for analysis of mathematical functions or signals with respect to frequencies, rather than time. In the frequency domain, a stationary process can be expressed as a weighted sum of sinusoidal components with a certain frequency ( $\omega$ ). However, in the frequency domain, a very similar



definition holds for the Granger causality, as in the time domain<sup>4</sup>. Non-technically a time domain shows how a signal changes over time, whereas a frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies. In very simple terms, “time” means the ability of indicating when a certain variation happens, whereas “frequency” is a component that measures the degree of a certain variation. Though there are other approaches, such as the Partial Directed Coherence (PDC) measures for testing of Granger-causality in frequency domain however, we focus on a slightly different approach of Granger causality, refined by Geweke (1982) and later by Breitung and Candelon (2006). This approach provides an elegant interpretation of the frequency domain Granger causality as a decomposition of the total spectral interdependence between the two series (based on the bivariate spectral density matrix, and directly related to the coherence<sup>5</sup>) into a sum of “instantaneous”, “feed forward” and “feedback” causality terms.

This FD causality figures reports the causality measure between Nifty and SSE composite index returns in the interval  $\omega \in (0, \pi)$  along with their 5% critical values (broken lines (5.99)) for all the frequencies for pre and post financial crisis (2007-08). Null Hypotheses tested are as below  
Ho<sub>1</sub>: Indian Market does not cause Chinese market at frequency  $\omega$  during pre and post crisis period.

Ho<sub>2</sub>: Chinese market do not cause Indian market at frequency  $\omega$  during pre and post crisis period.

#### VIII. FD Causality :Pre and Post crisis period

The results of the causality tests in the frequency domain are presented in Fig: xxxx & xxx. Figure xxx presents the frequency domain causality measure from Nifty to Shanghai composite for pre financial crisis. (Ho: Nifty returns do not cause Shanghai Composite returns @ frequency  $\omega$ ). It turns out that the null hypothesis of no predictability is rejected in the range  $\omega \in [0.82, 1.39]$  corresponding to the cycle length between 1996 M7 and 1997 M10. We also find the predictability between the range  $\omega \in [2.37, 2.82]$  which corresponds to the (business cycle) frequencies with a wave length between 1999 M10 and 2000 M09. (Ho of no causality rejected). There is a causality running from Nifty to Shanghai Composite, in other words the changes in Nifty affect the changes of Shanghai Composite in pre crisis period.

The second graph reveals the causality in frequency domain direction from SSE Composite to Nifty, (Ho: SSE Composite returns does not cause Nifty @ frequency  $\omega$ ) and it reveals that the null hypothesis no causality is rejected between the frequency range  $\omega [1.18, 1.92]$  corresponding to business cycle between 1997 M05 and 1998 M11. Also the null hypothesis of no causality is rejected when  $\omega > 2.53$ , corresponding to business cycle 2000 M02. Therefore the impact of SSE Composite on CNX nifty is also present over the range of frequency. The impact of Nifty on SSE composite and the impact of SSE composite on nifty during frequency

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<sup>4</sup> It is important to mention that the Granger (1969) approach to the question of whether X causes Y is to determine how much of the current Y can be explained by past values of Y, and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X if X helps in the prediction of Y, or if the coefficients of the lagged Xs are statistically significant. It is important to note that the statement “X Granger causes Y” does not imply that Y is the effect or the result of X. Granger causality measures precedence and information content but does not of itself indicate causality in the more common use of the term.

<sup>5</sup> Nicolas Ronderos' speccaus Add-in computes a frequency domain Granger causality test in the context of VAR models, as given in Breitung and Candelon (2006).

point  $\omega$  [1.18, 1.39, 1.92], which are corresponding to the business cycle from the mid of 1997 Mo5, Mo7, M10] in which there was a time of Asian contagion.<sup>6</sup>

Figure 2 shows the frequency domain causality measure between nifty and SSE composite for post financial crisis period. The figure on the top explains causality from SSE Composite to Nifty in which the null hypothesis of no causality is not rejected and proved that there is no causality running from SSE to Nifty. The second graph shows direction causality from Nifty to Shanghai composite in which the null hypothesis of no causality is rejected in the range  $\omega$  E [1.14, 1.59] which are corresponding to the months 2010 Mo4 and 2010 M10. Therefore the SSE composite has no effect on the CNX Nifty composite whereas Nifty composite has an impact on SSE composite for post financial crisis. Thus results of pre and post crisis period prove the results of time domain causality approach.

Figure 2 FD Causality for the pre crisis period 1995 Mo1 to 2007 M10

Causality in the frequency domain | H0: There is not causality at frequency Omega | P-value D.F. (2, 138) | Selected lag: 5 | Exogenous variables: c

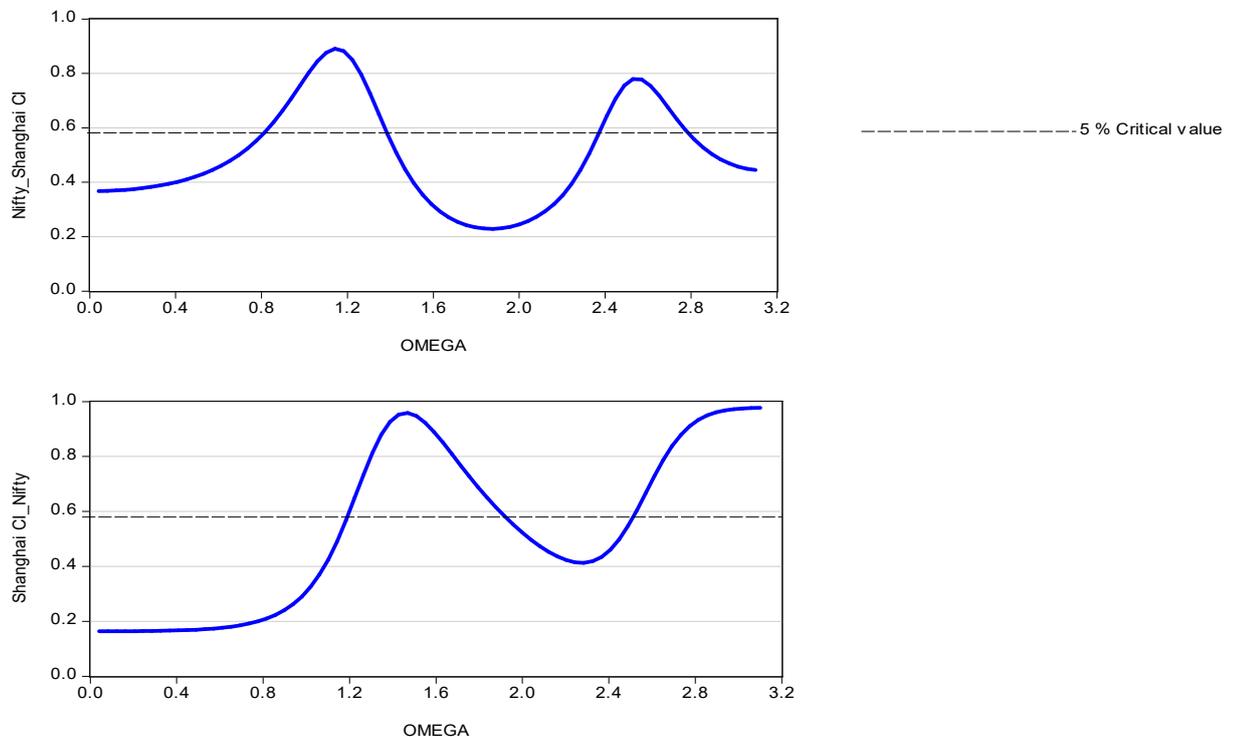
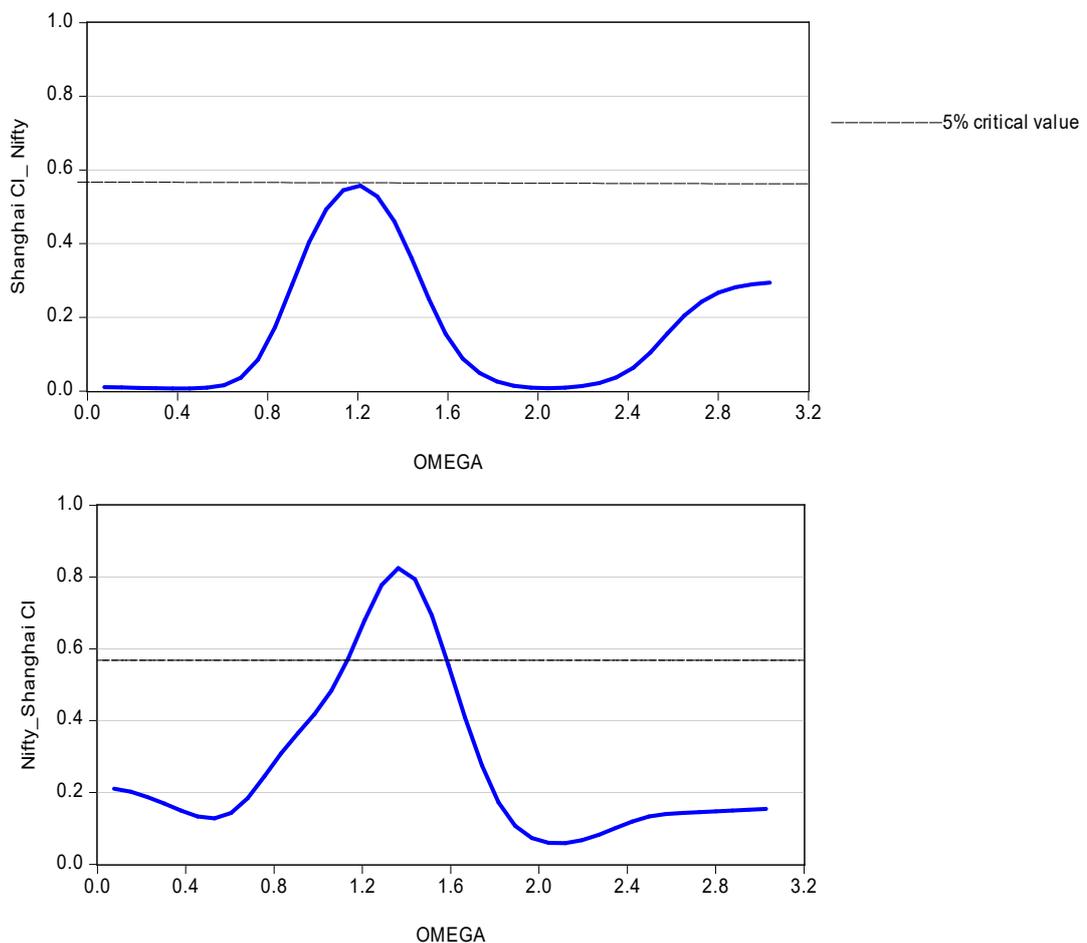


Fig: xxxx FD Causality for the post crisis period 2007 M11 to 2016 M12

<sup>6</sup>Asian contagion was a series of currency devaluations that spread through many Asian markets beginning in the summer of 1997. The currency markets first failed in Thailand as the result of the government's decision to no longer peg the local currency to the U.S. dollar (USD). Currency declines spread rapidly throughout South Asia, in turn causing stock market declines, reduced import revenues and government upheaval.

Causality in the frequency domain | H0: There is not causality at frequency Omega | P-value D.F. (2,61) | Selected lag: 7 | Exogenous variables: c



## IX. Conclusion

The study investigated the integration and linkages between Indian and Chinese stock market. It can be concluded that there is no integration between these pair of stock markets. Structural break has no impact on the co-movement as the study does not detect any co integrating relation even if structural break is accounted. Study would suggest for long term diversification between Indian and Chinese markets.

There is a possibility of short term diversification or speculative activities between Indian and Chinese markets, as cause and effect in short run is evidenced between these markets which are revealed by pair wise Granger Causality test. Also the Breitung and Candelon (2006) approach to Frequency domain proved same. The study also confirms that causality is running between the markets only in connection with major economic slowdown events like Asian contagion, European debt crisis etc. Therefore investors need not worry until unless any special event takes place.

The investors could theoretically diversify their portfolios and achieve gains from diversification by investing in these pairs of stock markets, however for short term Nifty could be a better platform for investors between these two markets, since Nifty is not affected by Shanghai CI<sup>7</sup>.

<sup>7</sup> In post crisis period there is only unidirectional causality from Nifty to Shanghai CI



- In the prospect of risk diversification, there are possibilities of long-term diversification between Indian and Chinese Markets.
- However, short-term diversification or speculative activities between Indian and Chinese Markets are possible only in normal situations, provided market is not affected by major economic events.

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