

INTER-LINKAGES BETWEEN INDIA AND WORLD STOCK MARKETS AND EUROPEAN DEBT CRISIS

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Abstract This paper examines the inter-linkages and long run cointegration of Indian economy with other economies of the world (US, Europe, Other Emerging markets, and World economy) using standard indices of MSCI over the period April, 2001 to March, 2013. We also investigate Indian economy's response to recent global turbulence European Debt crisis (EDC). We use Granger causality test, Johansen co-integration test and Impulse response analysis of Vector auto-regression framework to test various hypotheses. There is no contagious effect of EDC on Indian economy. During post-EDC, the Indian economy is granger caused by US and world economies. Further during the pre as well as post-EDC period, no cointegrating relationship has been found. This low level of co integration, despite presence of short run causal relationship, shows that global shocks might destabilize Indian economy in long run. Especially, Impulse response analysis revealed that Indian economy seems to be affected from the shocks created in the European markets and such shock persists in Indian economy for more than 10 months. These results have important policy implications. The policy makers need to understand that although there is no contagious effect of EDC on Indian economy but interdependency can destabilize Indian economy for much longer period.

Keyword: Global Financial Crisis, Inter-Linkages, Granger Causality, Johansen Co-Integration Test, Impulse Response Analysis, European Debt Crisis

JEL Classification: G10, G11, G14, G15

INTRODUCTION

As global credit crisis of 2007-08 morphed into the sovereign debt crisis of 2010-11, the outlook of world economies became weaker and situation went worsened. A working paper series by Political Economy Research Institute, University of Massachusetts Amherst studies the causes and root of EDC (Panico, 2010). It has been found that during 2010 the government debts of Greece, Spain, Portugal, Ireland, and Italy have undergone speculative attacks (Fig. 1). In July and August, the interest rate on the 10-year government bonds of Greece, the most affected country, has moved around 10.3%, a level considered unsustainable. The factors that allow the launch of a speculative attack are always multiple. In the case here considered, these can be found in some simultaneous events (e.g. the regional German elections of the 9th of May 2010), in some previous faulty behaviours of the governments under attack, and in some defects of the institutional organisation of the European Monetary Union (EMU).

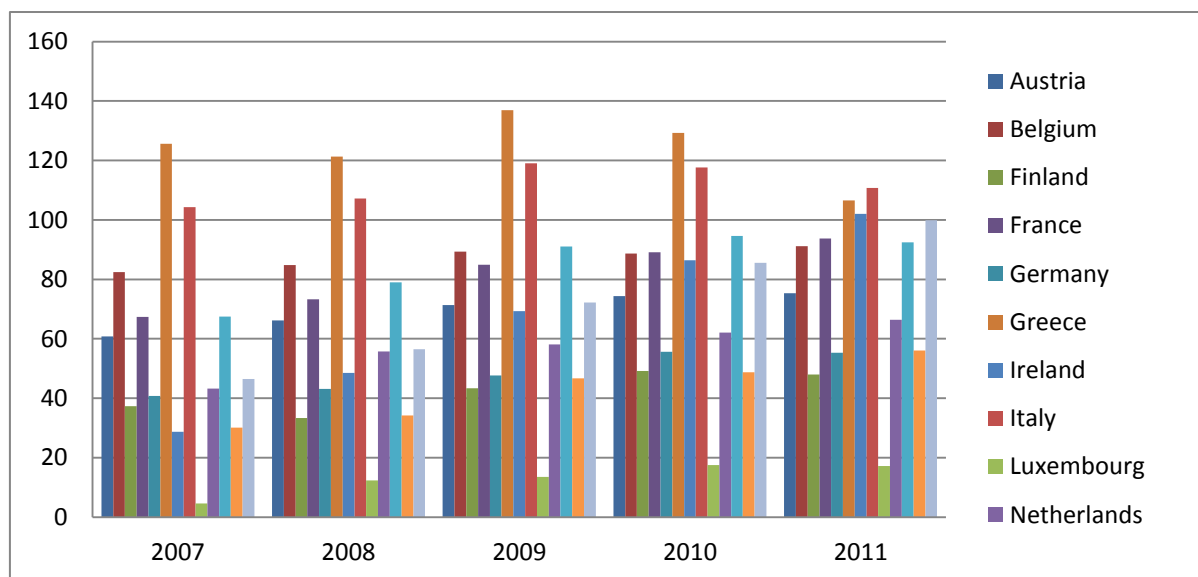
In today's integrated world economies, traditional trade remains the central transmission mechanism. However, financial spillover is being evolved more pronounced as the rising correlation of global equity prices and the potential for

sudden capital flow reversal mean that shocks at the core can be transmitted rapidly throughout the entire global financial system. The degree and intensity of contagion vary from country to country based on its financial system and markets.

According to World Bank estimates, India achieved growth rate of 9% percent and 10.1% percent respectively in 2009-10 and 2010-11. However, with the economy exhibiting inflationary tendencies, the Reserve Bank of India (RBI) started raising policy rates in March 2010. High rates as well as policy constraints adversely affected investment, and in the subsequent two years viz. 2011-12 and 2012-13, the growth rate slowed to 6.3 percent and 3.2 percent respectively. The causes are *first*, monetary and fiscal stimulus following the crisis (US subprime crisis) was large. *Secondly*, corporate and infrastructure investment started slowing because of both investment bottlenecks as well as the tighter monetary policy. *Thirdly*, even as the economy slowed, it was hit by two additional shocks: a slowing global economy, weighed down by the crisis in the Euro area and uncertainties about fiscal policy in the United States, and a weak monsoon, at least in its initial phase.

In this paper, we examine the inter-linkages and long run integration of Indian economy with other economies of the world. We also investigate Indian economy's response to recent global turbulence caused by European Debt Crisis (EDC).

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Fig. 1: Debt to GDP Ratio of Major Countries of European Union

Source: World Economic Indicators, World Bank (<http://data.worldbank.org/>)

The rest of the paper is arranged as follows. In second section we present a brief review of literature. Third section presents research objectives and hypotheses. Data and methodology are described in fourth section. Empirical results are discussed in fifth section and finally sixth section provides the conclusion and implications of research findings.

LITERATURE REVIEW

The spread of financial crisis or contagion evolved as mature concept after the lethal US subprime crisis in 2007-2008. Pericoli and Sbracia (2003) consider five definitions of contagion including “Contagion is significant increase in co-movements of prices and quantities across the markets, conditional on a crisis occurring in one market or group of market.”

The transmission and intensity of contagion in a particular economy is depends on health of macro fundamentals of an economy. Marcel, Pereira, Martin, Nakamura and Monteiro (2010) concluded that Asian economies were immune in times of Latin America crisis (1999). At that time Asian economies were recovering from the East Asian crisis (1997) with strong macroeconomic fundamentals. Also it has been concluded that negative surprise in US stock markets made Latin America in vulnerable position but kept Asian market immune to subprime crisis.

According to Kannan and Koebler-Geib (2009), “the strong variation in uncertainty across countries points to systematic differences that are accounted for through country fixed effects. Also quality and quantity of information are drivers

of determining the uncertainty in the economy. Both surprise crisis and anticipated crisis prompt stronger effects on uncertainty in emerging market that in all countries. This finding might reflect higher costs of information gathering in emerging markets that are, on average, less transparent than advanced countries”.

The research in this field started in 1960s. Grubel (1968), Agmon (1972) and Hilliard (1979) are some of the earlier studies which focused on finding the relationship between the then developed markets using the basic techniques. As more stock markets started emerging, research using new techniques too starting spreading in those areas, resulting into plethora of literature. Broadly, the research in this area can be divided into three categories. In the first category, exist the studies undertaken with the objective of finding the short run and the long run inter-linkages, whereas, others focus on empirically exemplifying the plausible reasons behind the inter-linkages. The third category caters to analysing the impact of some important events (e.g. OPEC oil crisis, South East Asian crisis, etc.) on the inter-linkages between the markets considered.

In the first category, some studies are undertaken to check the inter-linkages between the developed markets, whereas others focus on finding the relationship among the stock markets of a particular region (e.g. Asian region, American region, etc.). United States of America, considered the dominant and most influential economy of the world also occupies a dominant position in the research. Many studies focus on analysing the impact of US stock market on the others or on a region as a group. Literature also exists in the area of emerging markets. Eun and Shim (1989) investigated the

transmission of stock market movements among nine largest stock markets of the world (in terms of capitalisation value in 1985) viz. Australia, Canada, France, Germany, Hong Kong, Japan, Switzerland, the United Kingdom, and the United States. Multilateral interactions of significant amount among the stock markets were observed. On an average 26 percent of the error variance of a national stock market was attributed to collective innovations in the foreign stock markets. It was also discovered that innovations in the US stock market are rapidly transmitted to other stock markets in an identifiable pattern. All respond to the shock most dramatically on the first day i.e. with a lag of one day (except UK and Canada which react the same day) and after that the responses narrow down. The speed with which the transmission happens from the US market to others indicates that the informational efficiency of the international stock markets.

The Indian stock market too has been analyzed by researchers (Lamba, 2004; Mukherjee & Mishra, 2005, 2007) in the recent years. The inter-linkages has been checked with many stocks markets of both developed and the developing nations. Mixed evidences have been found. Tripathi and Sethi (2010) examined the integration of the Indian stock market with those of three developed economies viz. United States of America, Japan and United Kingdom and the emerging economy of China over the period of 10 years (1st January 1998 to 31st October 2008). Positive and significant correlation was observed between the Indian stock market and the others studied. It was highly correlated with USA and least with Japan.

Tripathi and Sethi (2012) examine the short run and long run inter-linkages of the Indian stock market with those of advanced emerging markets viz. Brazil, Hungary, Taiwan, Mexico, Poland, and South Africa over the period ranging from 1 January 1992 to 31 December 2009. The analysis of daily data shows that the short run and long run inter-linkages of the Indian stock market with these markets has increased over the study period. Unidirectional causality is found in most cases.

Tripathi, Seth and Kumar (2013) examined the inter-linkages and long run integration of Indian economy with other economies of the world i.e. US, Europe, other emerging markets and world economy) and also investigated Indian economy's response to recent global turbulence (i.e. US subprime crisis and European debt crisis) and its preparedness to counter global shocks. Study revealed that Indian economy seems to be immune from the shocks created in the other economies of the world for atleast first two months and negative effects appear after that only.

RESEARCH OBJECTIVES

In this research work, an attempt has been made:

- To examine inter-linkages and causal relations of Indian economy with US, European, other emerging markets, and world economy.
- To investigate if there is any long-term co-integrating relation between India & US, India & Europe, India & other Emerging Markets, and India & World Economy.
- To examine India's response to the turbulence created in the global markets by conducting Impulse Response Analysis.

RESEARCH HYPOTHESES

Based on the above mentioned research objectives, the following Null Hypotheses have been tested:

- H_{01} : There are no significant inter-linkages and causal relations of Indian economy with US, European, other Emerging markets, and World economy.
- H_{02} : There is no significant long-term co-integrating relation between India & US, India & Europe, India & other Emerging Markets, and India & World Economy.
- H_{03} : Indian economy is immune to Global turbulence.

All the research hypotheses have been tested for examining the impact of recent *EDC* that began in January 2010 on Indian economy. Accordingly, we have divided the entire study period into two sub-periods, one before the start of each crisis and the second sub-period is after the start of crisis situation.

DATA AND METHODOLOGY

We have used secondary data to represent India, US, Europe, Asia, and the entire world. Data have been collected from Morgan Stanley Composite Index (MSCI) database. The Indices are India Standard, US standard, Europe Standard, Asia Standard and All Country World Index (ACWI) standard. The MSCI Index is a free float-adjusted market capitalisation weighted index that is designed to measure the equity market performance of developed and emerging markets. Further The MSCI ACWI¹ consists of 44 country

¹ The **MSCI ACWI** consists of 44 country indices comprising 23 developed and 21 emerging market country indices. The developed market country indices included are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom and the United States. The emerging market country indices included are: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand, and Turkey.

indices comprising 23 developed and 21 emerging market country indices. We have assumed that equity market performance is a reflection of the state of an economy.

The period of study is 12 years from April 1, 2001 to March 31, 2013. We have used monthly data for the purpose of analysis. In addition, entire study period is divided as pre crisis period and post period crisis for EDC. Pre EDC period and post crisis period are from April 1, 2001 to December 31, 2010 and from January 1, 2010 to March 31, 2013 respectively. All data covering the period 2001 to 2013 were used in natural logarithms to calculate monthly returns. Besides the usual descriptive statistics, correlation analysis, ADF and PP Unit root tests, we have used the following statistical and econometric techniques to analyse the data:

Granger Causality Test

In order to check the short term causal relationship between Indian economy and other economies, Granger causality test is used. This test states that, if past values of a variable X significantly contribute to forecast the value of another variable Y, then X is said to Granger cause Y and vice versa.

The test is based on the following two regressions equations. These equations can be used to show the direction of causality between Indian economy and other economies used in the study.

$$X_t = \alpha_1 + \sum_{k=1}^m \beta_{1k} X_{t-k} + \sum_{k=1}^m \gamma_{1k} Y_{t-k} + e_{1t} \quad \dots\dots\dots (1)$$

$$Y_t = \alpha_2 + \sum_{k=1}^m \beta_{2k} Y_{t-k} + \sum_{k=1}^m \gamma_{2k} X_{t-k} + e_{2t} \quad \dots\dots\dots (2)$$

where, Y_t and X_t are the variables to be tested, e_{1t} and e_{2t} are mutually uncorrelated white noise errors, t denotes the time period, k is the number of lags and m is the maximum number of lagged observations included in the model. The null hypothesis is $\gamma_1 = \gamma_2 = 0$ for all k 's versus $\gamma_1 \neq \gamma_2 \neq 0$ for at least some k 's. If the coefficients γ_1 is significantly significant but γ_2 is not, then Y granger causes X. However, in the reverse case, X granger causes Y. And, if both γ_1 and γ_2 are significant then causality runs in both directions. Finally, if both γ_1 and γ_2 are not statistically different from zero, then X and Y will be independent.

Johansen Co-integration Test

Using non-stationary series, Co-integration analysis has been used to examine whether there is any long run equilibrium relationship between Indian economy and other economies of the world. Co-integration means that despite being individually non-stationary, a linear combination of two or more time series can be stationary.

The Johansen method applies the maximum likelihood procedure to determine the presence of co-integrating vectors in non-stationary time series as a vector autoregressive (VAR). Consider a VAR of order k

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots \dots + A_k Y_{t-k} + BX_t + \epsilon_t \quad (3)$$

Where Y_t is a k -vector of non-stationary $I(1)$ variables, X_t is a the vector of deterministic variables, k is the number of lags and ϵ_t is a vector of innovations or error terms. We can rewrite the VAR as:

$$\Delta Y_t = \pi Y_{t-1} + \sum_{i=1}^{k-1} \tau_i \Delta Y_{t-i} + BX_t + \epsilon_t \quad (4)$$

where,

$$\pi = \left(\sum_{i=1}^k A_i \right) - 1 \quad (5)$$

$$\tau_i = - \sum_{i=1}^k A_i \quad (6)$$

Here Y_t is a vector of non-stationary variables. The information on the coefficient matrix between the levels of the series Π is decomposed as $\Pi = \alpha\beta'$ where the relevant elements of α matrix are adjustment coefficients and the β matrix contains the co-integrating vectors. Johansen and Juselius (1990) specify two likelihood ratio test statistics to test for the number of co-integrating vectors. The first likelihood ratio statistics for the null of exactly r co-integrating vectors against the alternative of $r+1$ vectors is the maximum Eigenvalue statistic. The second statistic for the hypothesis of at most r co-integrating vectors against the alternative is the Trace statistic. If the hypothesis of no co-integration is rejected, then a stable long run relationship between Indian economy and other economies of the world does exist.

AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion) criterions have been used to determine the optimal lag length structure.

Impulse Response Analysis

As a univariate AR model can be represented as an infinite order MA process, similarly a stable VAR model of order k can be represented as an infinite order vector moving average (VMA) process. This representation serves as the key to study the impulse response function (IRF). An IRF allows one to trace the time path of the impact of a shock in one variable on all the variables included in the VAR model. Here we have used Cholesky decomposition method which is one of the popular methods for this purpose.

Impulse Response Analysis has been performed to check the response of Indian economy to shocks created in the other economies of the world with the help of graphs.

EMPIRICAL RESULTS

All the research hypotheses have been tested for examining the impact EDC that began in January 2010 on Indian economy. Accordingly, we have divided the entire study period into two sub-periods, one before the start of each crisis and the second sub-period is after the start of crisis situation. The result of two sub-periods has been compared to see whether any significant change has happened because of the crisis.

Descriptive and Correlation Analysis

Table 1 shows descriptive statistics and correlation analysis with respect to EDC. Volatility in returns has been lower in post-crisis period in Indian, Asian and ACWI markets. European market has increased variance while US market has almost no change in post crisis period from pre-crisis period of EDC. Market return has increased in US market and in the overall world but declined in India, Europe, and Asia. On the point of skewness of returns, they are negatively skewed in both pre and post-crisis period for all markets except Indian market. Skewness is a measure of asymmetry of the distribution of the series around its mean. The skewness of a normal distribution is zero. From the skewness measure we found that all the indices are negatively skewed both in the pre and post – crisis period. In post-period, Indian market returns have shown positively skewed distribution. This might be due to investor's under reaction to EDC.

The market monthly log return of India was negative in post crisis period. It decreased from 1.5% to -0.7%. In contrast, market returns of US and world market have shown some improvement from pre to post period of EDC. US return increased from -0.04% to 0.9% in post-crisis period. In addition, the world market return increased from 0.2% to 0.4% in post-crisis period. The reasons for these improvements may be some recovery in US market and the impact of measures taken by US Federal bank like quantitative easing etc.

The shapes of the distributions or return curves of each market show different characteristics in pre-crisis and post-crisis period of the crisis. India's market return was asymmetry where most of the observations vary towards the lower values of the return and distribution was platykurtic. In post-crisis period, returns were positively skewed and distribution was platykurtic. The returns of all other markets were negatively skewed in both pre-crisis and post-crisis period of EDC. However, the distributions of return in pre-crisis period for Europe and world markets were close to normal or mesokurtic. These distributions were platykurtic in post-period. Table 1 presents descriptive statistics of the monthly aggregate stock market returns for each of the five indices in the sample of pre and post-European Debt crisis from period April 1, 2001 to March 31 2013. Pre-crisis period is from April 1, 2001 to December 31, 2009 and post-crisis period is from January 1, 2010 to March 31, 2013.

Kurtosis values of all variables show that the data is not normally distributed because values of kurtosis are deviated from 3, except for USA and World which seems to be

Table1: Descriptive Statistics and Correlation Analysis – European Debt Crisis

Descriptive statistics	INDIA		USA		EUROPE		ASIA		ACWI	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	0.015	-0.007	-0.0004	0.009	0.002	0.001	0.003	0.002	0.002	0.004
Median	0.025	-0.009	0.008	0.014	0.009	-0.006	0.007	0.004	0.009	0.007
Std. Deviation	0.092	0.078	0.047	0.042	0.059	0.063	0.055	0.043	0.05	0.047
Variance	0.009	0.006	0.002	0.002	0.003	0.004	0.003	0.002	0.003	0.002
Kurtosis	2.125	0.147	2.12	0.012	3.062	-0.058	1.547	0.414	3.303	0.289
Skewness	-0.643	0.256	-0.991	-0.281	-1.147	-0.396	-0.758	-0.66	-1.217	-0.383
Count	105	39	105	39	105	39	105	39	105	39
Coefficient of Correlation										
INDIA	1	1								
USA	0.66	0.585	1	1						
EUROPE	0.707	0.648	0.903	0.886	1	1				
ASIA	0.785	0.774	0.726	0.814	0.798	0.862	1	1		
ACWI	0.743	0.682	0.963	0.963	0.972	0.966	0.845	0.908	1	1

Source: Author's Calculations

Table 2: Correlation Index - US Subprime Crisis

	India	USA	Europe	Asia	ACWI
India	100				
USA	88.64	100			
Europe	91.65	98.12	100		
Asia	98.60	112.12	108.02	100	
ACWI	91.79	100	99.38	107.46	100

Source: Author's Calculations

normally distributed in the pre-crisis period. All indices have kurtosis value greater than 3, implying that their distribution is Leptokurtic or fat-tailed and sharply peaked about the mean when compared with the normal distribution.

The market returns of Indian and European market have fallen in post-crisis period but correlations between the India and other markets have not been changed in post-crisis period. Even correlations among other markets also have not changed in post crisis period. In Table 1, Correlation index shows that there was virtually no contagion effect of EDC outside the European countries. The intensity of change in correlation between India and other markets can be shown in Table 2 by correlation index.

Correlation index (CI) shows the relative change in coefficients of correlation. The base value of all variables is 100.

The correlation between India and other markets has been decreased in post crisis period. Although, correlation coefficients between Asia & Europe, Asia & USA and Asia & ACWI have marginally increased in post crisis period, but it cannot be considered as contagion; effect of EDC. Table 2 represent correlation index among the India and other markets.

The Results of Unit Root Tests

The properties of the variables need to be investigated to avoid the possibility of spurious regressions. To assess the stationarity properties of the variables employed, the study utilizes two different unit root tests, Augmented Dickey and fuller (ADF) and Phillips and Perron test. Table 3 reports the result of unit root tests, indicating that all the variables in both pre period and post period of EDC are stationary at first differences. All variables are in natural logs, while the lag lengths are determined via the Akaike information criterion (AIC) and are in parentheses. Subscripts a, b and c represent significance at 1%, 5% and 10% respectively. Both unit root tests employed in our study have a null hypothesis that the series has a unit root against the alternative of stationary.

Results of Granger Causality Test

Granger causality test has been used to analyze short term causal relationships between India and USA, India and Europe, India and Asia, and India and World. Before applying the Granger causality test, we have used Akaike Information Criterion (AIC) and Schwarz Information Criterion (SC) to ascertain the optimum lag length, which has come out to be upto three. So, we have performed the whole analysis at one, two and three lag lengths. Table 4 reports the results of the Granger causality test. In the table, results shows that in EDC, pre-crisis period there is unidirectional causality from US to India and from world to India. Further there was

Table 3: Results of Unit Root Tests

	ADF				PP			
	Level		First Differences		Level		First Differences	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
India	-0.86439(1)	-1.98651(0)	-8.16050(0)a	-6.10039(1)a	-0.84762	-1.9027	-8.27226a	-6.87562a
USA	-2.30262(4)	-0.81039(0)	-7.77379(0)a	-6.34498(0)a	-1.8636	-0.81039	-7.89804a	-6.34498a
Europe	-1.53832(1)	-2.39669(0)	-7.25555(0)a	-6.53933(0)a	-1.57936	-2.44227	-7.43218a	-6.53933a
Asia	-1.32274(1)	-2.11645(0)	-7.38796(0)a	-6.15222(0)a	-1.38554	-2.26904	-7.57439a	-6.15829a
ACWI	-1.43528(1)	-1.78035(0)	-7.21239(0)a	-6.58502(0)a	-1.48992	-1.757	-7.37721a	-6.58502a

Source: Author's Calculations

Table 4: Granger Causality Results

Direction of Causality	Pre			Post		
	1 lag	2 lag	3 lag	1 lag	2 lag	3 lag
From Ind to US	0.00566	1.24169	0.5096	0.8385	1.04683	0.80227
	[0.9402]	[0.2934]	[0.6766]	[0.3661]	[0.3628]	[0.5028]
From US to Ind	6.40607*	3.49624*	2.19356**	3.4068**	1.86434	1.45395
	[0.0129]	[0.0341]	[0.0939]	[0.0734]	[0.1714]	[0.2476]
From Ind to Eur	0.85456	2.3963**	1.44211	2.3071	1.72438	1.13581
	[0.3575]	[0.0964]	[0.2354]	[0.1378]	[0.1944]	[0.351]
From Eur to Ind	8.42834*	4.10316*	2.51782**	2.4716	2.40226	2.11125
	[0.0045]	[0.0194]	[0.0628]	[0.1249]	[0.1067]	[0.1205]
From Ind to Asia	0.55644	0.75118	0.44511	1.0182	0.80622	0.34823
	[0.4574]	[0.4745]	[0.7213]	[0.3199]	[0.4554]	[0.7907]
From Asia to Ind	2.49603	1.31075	0.9607	1.4815	0.64388	0.42535
	[0.1173]	[0.2743]	[0.4147]	[0.2317]	[0.5319]	[0.7363]
From Ind to ACWI	0.87884	2.09671	1.13119	1.9642	1.5998	1.03706
	[0.3508]	[0.1283]	[0.3405]	[0.1699]	[0.2177]	[0.3908]
From ACWI to Ind	7.68664*	3.84463*	2.35976**	3.1451**	2.1975	1.6851
	[0.0066]	[0.0247]	[0.0764]	[0.0849]	[0.1276]	[0.192]

Source: Author’s Calculations

bidirectional causality between India and European market. F statistics and p-values [], Single asterisk (*) and double asterisk (**) indicate 5% and 10% levels of significance respectively.

In post-crisis period causality from European market on India has been disappeared but unidirectional causalities from US and ACWI were still present.

Table 5: Cointegration Analysis

Hypotheses	Null	Trace test		Maximum Eigen Value		Co-integrating Relationship		Number of Co-integrating relationships	
		Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis	Pre-crisis	Post-crisis
No co-integration between India & US	r = 0	6.363119	7.964152	5.451809	7.868063	No	No	0	0
	r ≤ 1	0.91131	0.096089	0.91131	0.096089				
No co-integration between India & Europe	r = 0	6.352434	11.33442	5.532452	10.48261	No	No	0	0
	r ≤ 1	0.819982	0.851806	0.819982	0.851806				
No co-integration between India & Asia	r = 0	6.940189	8.931347	6.11707	6.598621	No	No	0	0
	r ≤ 1	0.823119	2.332726	0.823119	2.332726				
No co-integration between India & World	r = 0	6.129607	5.582405	5.499837	5.068406	No	No	0	0
	r ≤ 1	0.62977	0.513999	0.62977	0.513999				

Source: Author’s Calculations

Johansen Co-integration Test Results

Johansen co-integration test is employed to examine the long term causal relation between Indian market and other markets of the world. We have performed both Bi-variate and Multi-variate Johansen’s co-integration tests.

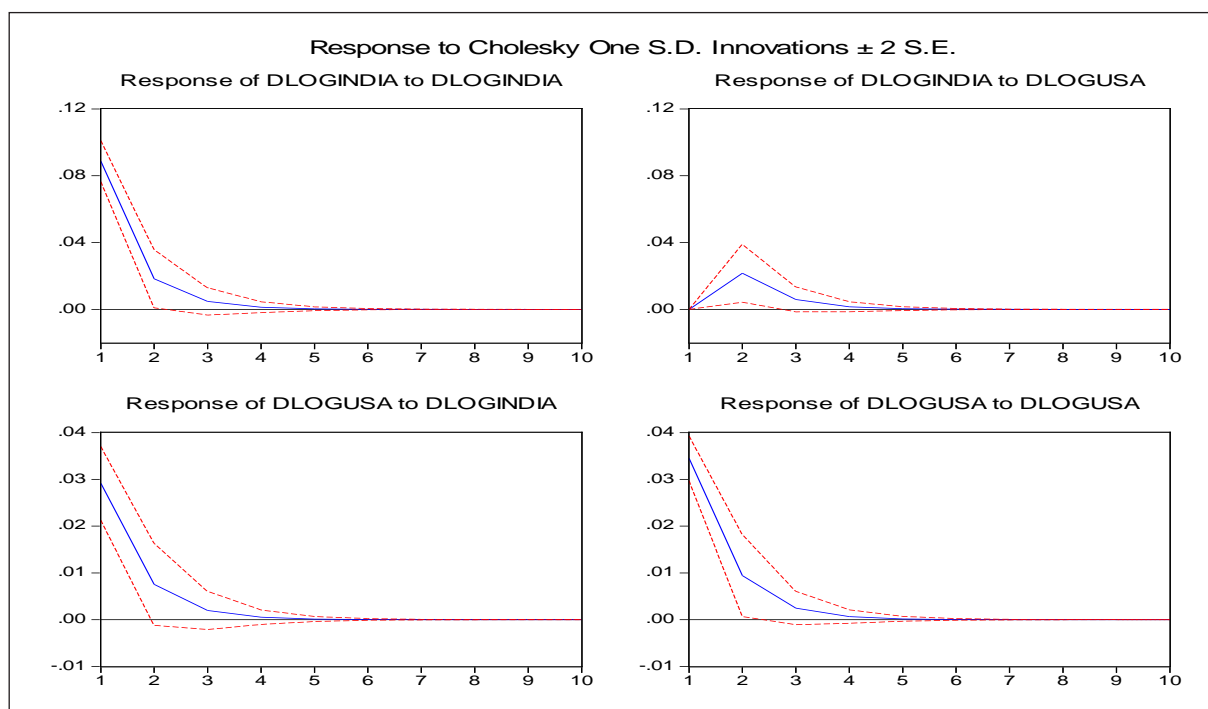
We used Johansen co integration test after following the selection of the optimal number of lagged periods to examine the co-integration relationships among the variables. Table 5 shows the results of Johansen co-integration analysis. In the entire sample period, both in pre-crisis period and post crisis period of European crisis, there were no co-integrating relationships among the problem. Single asterisk (*) and double asterisk (**) indicate 5% and 10% levels of significance.

Results of Impulse Response Analysis

Co-integration and Granger Causality tests are used way to examine the relationship among the series. However, test results do not consider how variables in general respond to innovations in other variables. In order to examine how a shock to one variable affects another variable and how long the effect lasts in short run, we utilise impulse response analysis. Impulse Response Analysis has been performed to check the response of Indian market to shocks created in the other economies namely, other emerging markets, European market, US economy, and overall world economy. The impulse response analysis results of EDC are plotted in Fig.2 (a) to (h).

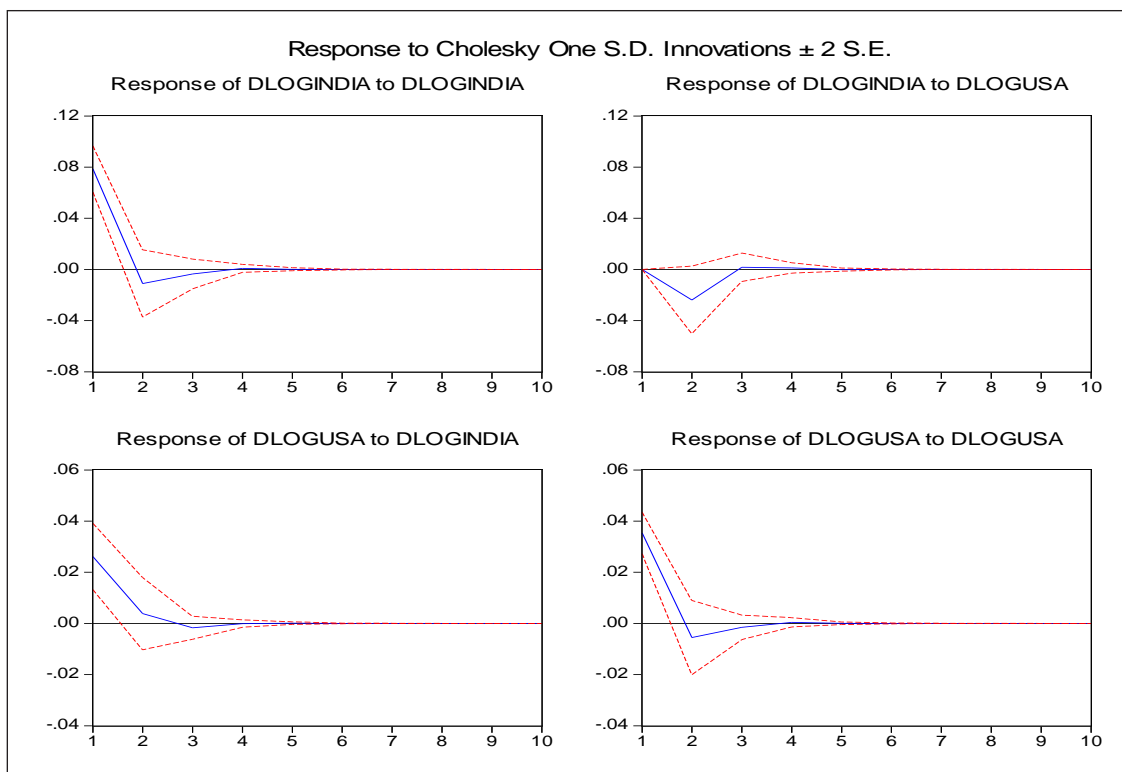
Source: Author’s Calculations

Fig. 2(a): Result of Impulse Response Analysis - USA- Pre



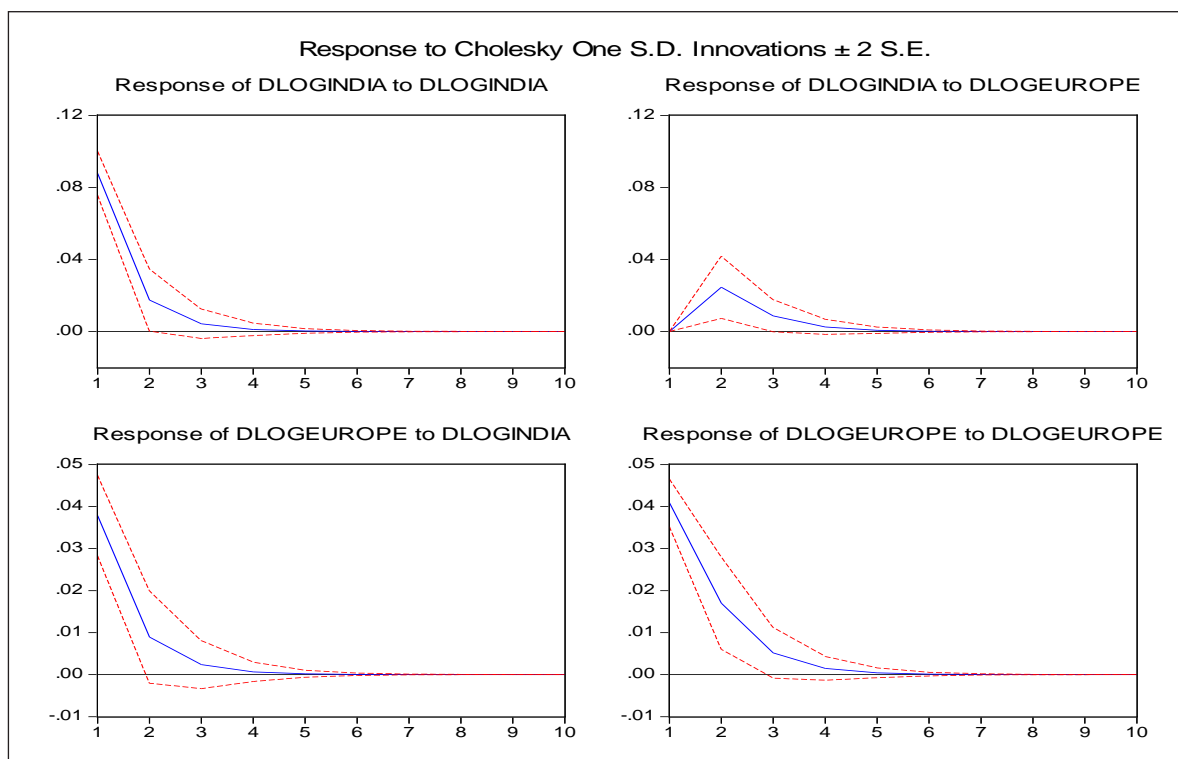
Source: Author’s Calculations

Fig. 2 (b): Result of Impulse Response Analysis - USA – Post



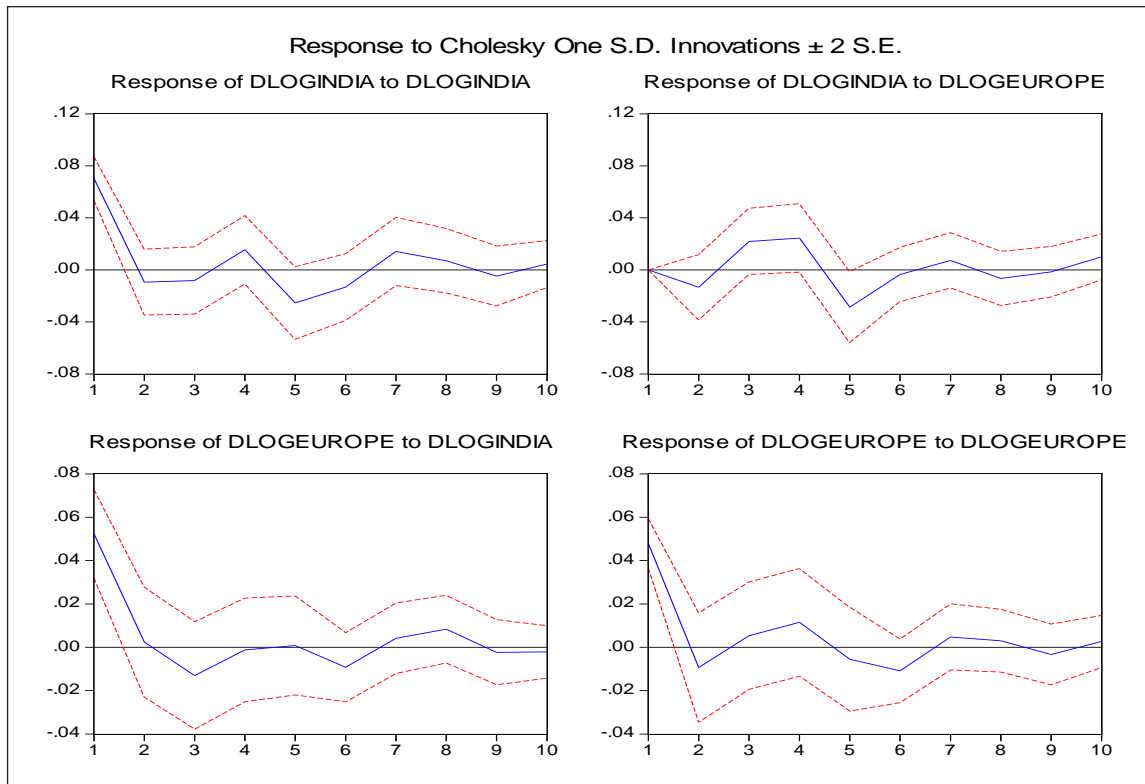
Source: Author's Calculations

Fig. 2 (c): Result of Impulse Response Analysis - EUROPE-Pre



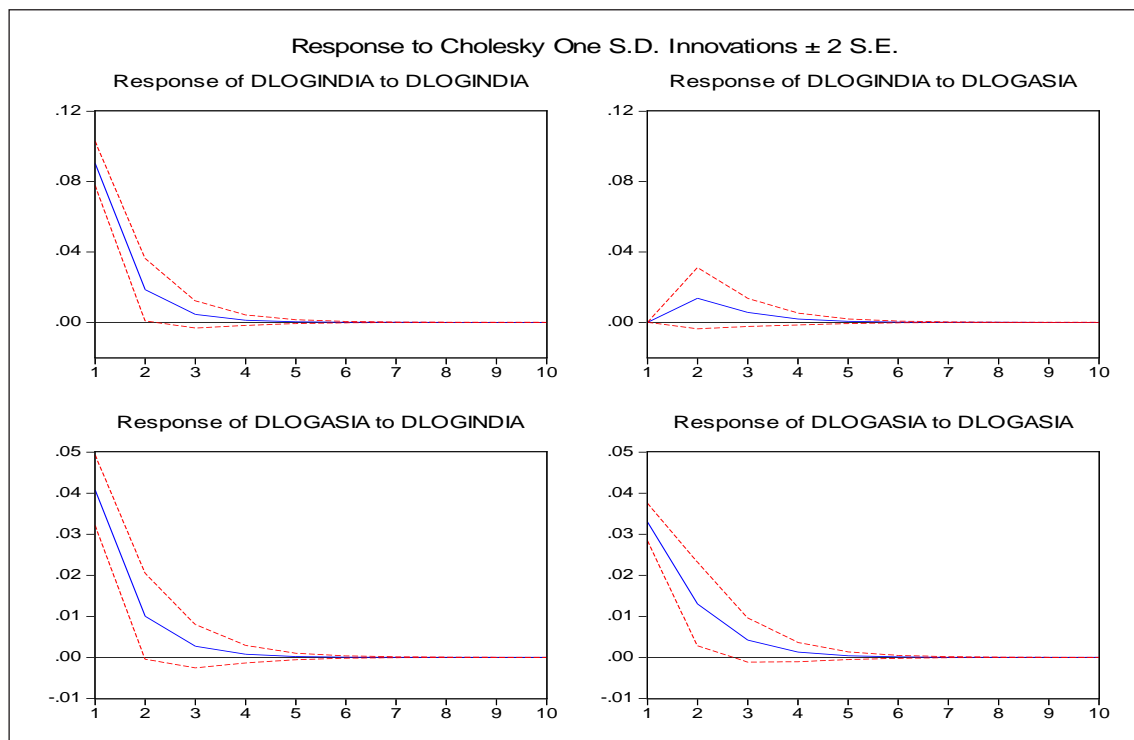
Source: Author's Calculations

Fig. 2 (d) : Result of Impulse Response Analysis - EUROPE- Post



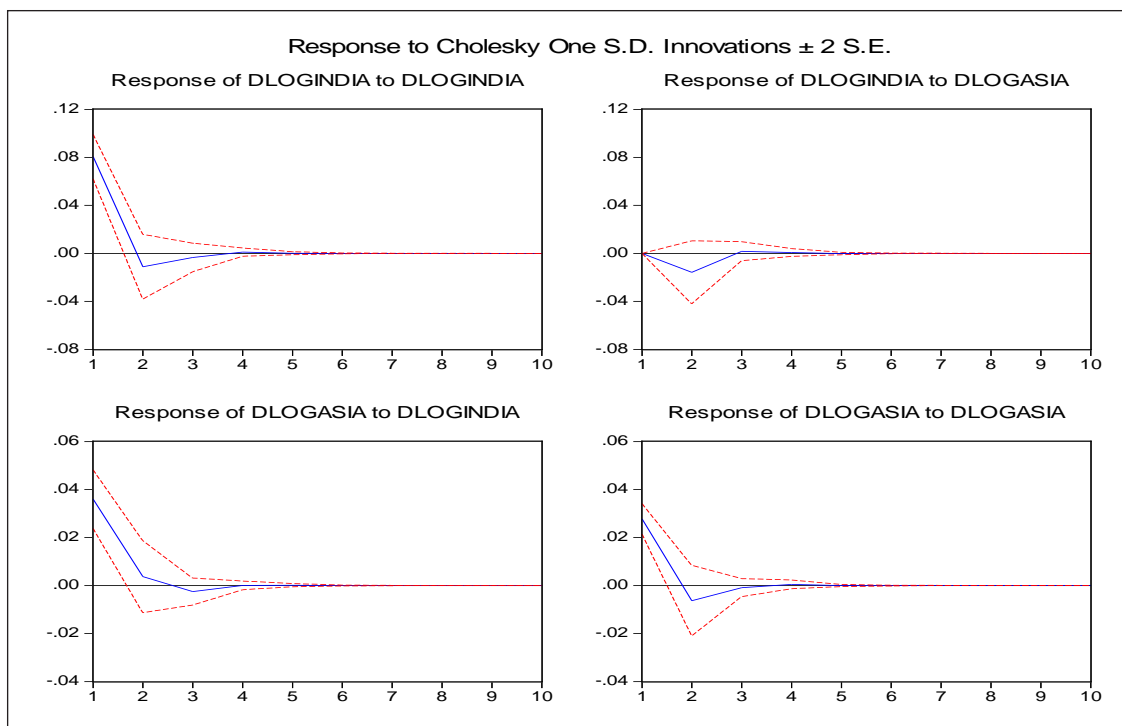
Source: Author's Calculations

Fig. 2 (e): Result of Impulse Response Analysis - ASIA- Pre



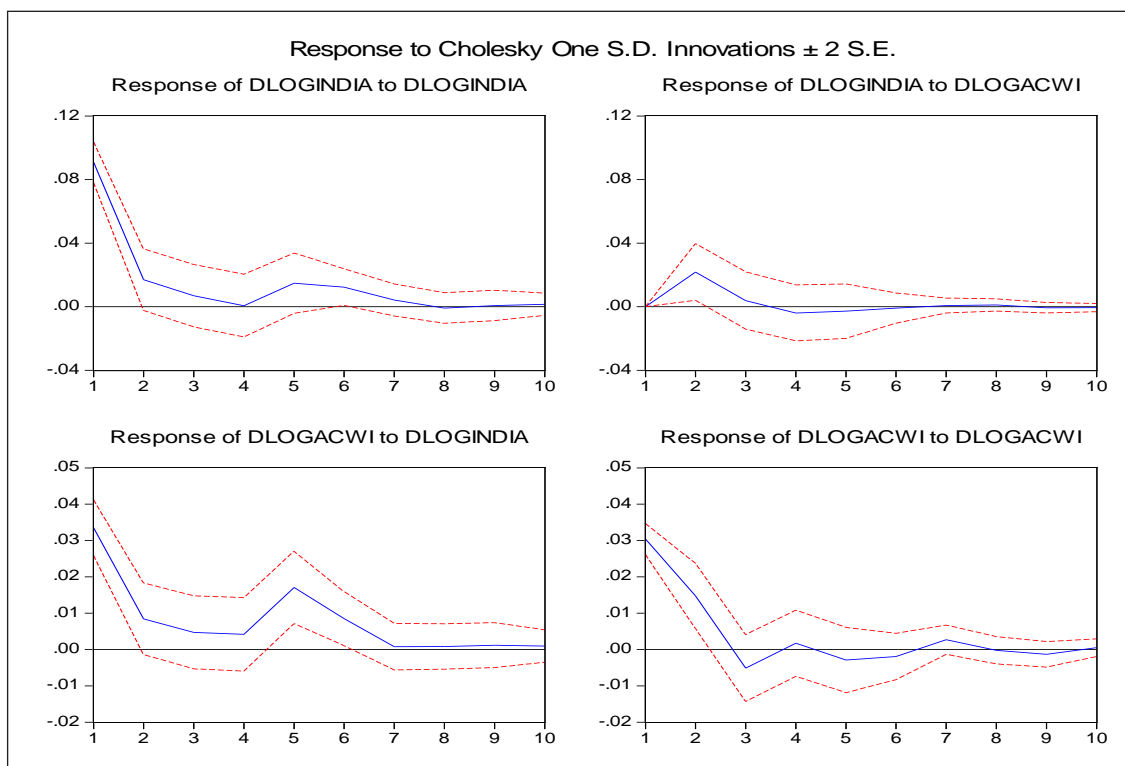
Source: Author's Calculations

Fig. 2 (f): Result of Impulse Response Analysis - ASIA- Post

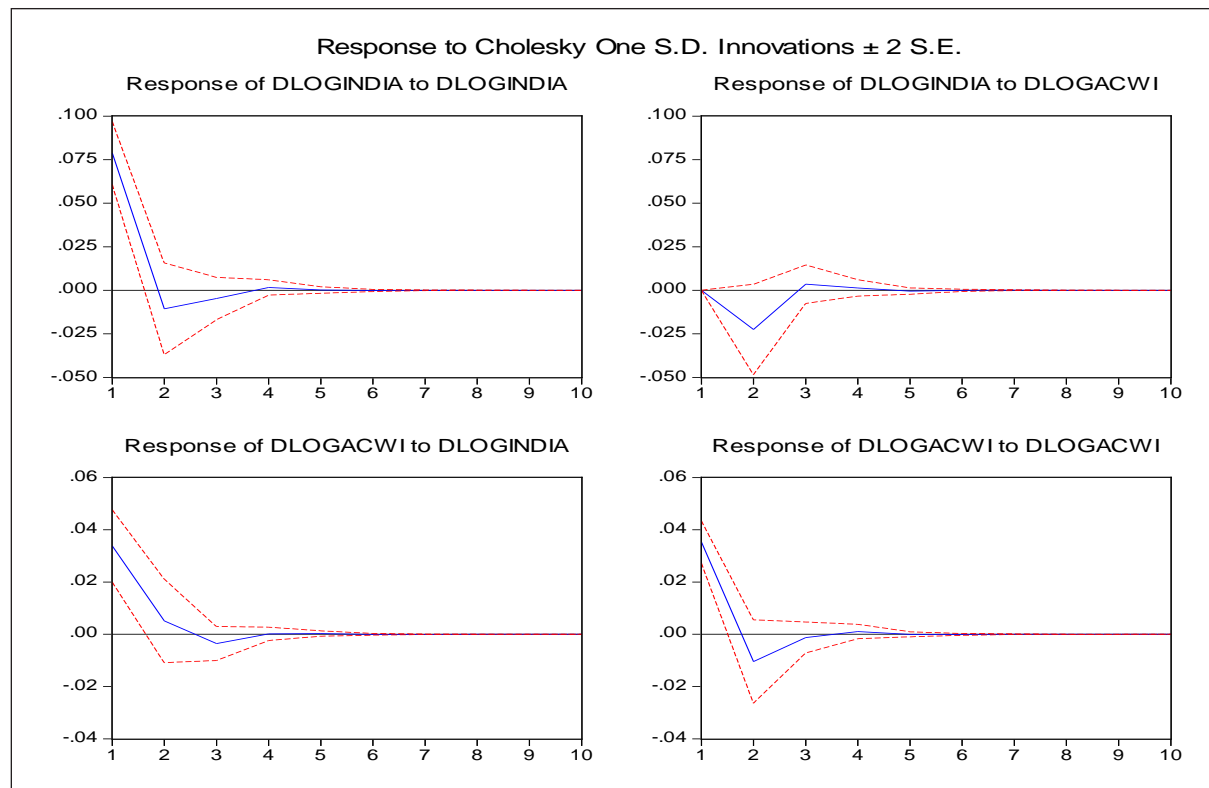


Source: Author's Calculations

Fig. 2 (g): Result of Impulse Response Analysis - ACWI- Pre



Source: Author's Calculations

Fig. 2 (h): Result of Impulse Response Analysis - ACWI-Post

The responses of Indian stock market to innovation in world stock markets can be seen in Fig. 2 (a) to (h). The responses are further divided into pre-crisis and post-crisis for comparison purposes. In pre-crisis period, Indian market responded positively to shock in US market and it lasted for 3-4 months. In other words, innovation in US market positively affected Indian economy and effect persisted for 3-4 months. The shock created in Europe and Asian markets are providing similar result as in case of US market. Innovation in both markets led Indian market to respond positively and shocks persisted in Indian economy for 5-6 months in case of both the markets. However, world market compelled Indian market to respond very differently. The innovation in world market led Indian market to respond positively for 3-4 months and after that it went negative and persisted for another 2-3 months.

In post-crisis period India responded negatively to a shock in US market, which had a life span of 3- 4 months. However, in post-crisis period life span of effect has increased to more than 10 months and has been erratic. Indian – Asian market also changed from positive in pre-crisis period to negative effect in post European crisis period. An interesting relationship between India and world market was that in post-crisis period. During post-crisis period, Indian market responded negatively immediately after the innovation in world market. Indian economy got recovered after 2-3 months

but shock persisted in market for more than 4-5 months. In short, Indian market became negative in post-crisis period with reduced life span from more than 10 to 4-5 months.

CONCLUSION

In this paper we examined the inter-linkages and long run integration of Indian economy with other economies of the world (US, Europe, other emerging markets, and world economy) using standard indices of MSCI over the period April 1,2001 to March 31,2013. We also investigated Indian economy's response to recent global turbulence i.e. EDC. Beside the main models, we have used Augmented Dickey Fuller (ADF) and Phillips and Perron(PP) unit root tests. In addition, we used Granger Causality, Johansen Co-integration test and Impulse response analysis of Vector auto regression framework to test various hypotheses.

The market returns of Indian and European markets have fallen in post crisis period but correlations between the India and other markets have not been changed in post-crisis period. Even correlations among other markets also have not changed in post crisis period. As per the definitions that we have taken to explaining the financial contagion, we found that there is a no contagious effect during the EDC as shown by correlation. Correlation coefficient has increased by more than 35% from pre to post US subprime crisis.

We found that all indices were stationary at first differences. The results of Granger causality established a short run relationship among the variables. In EDC, during pre-crisis period there is unidirectional causality from US to India and from world to India. Further there was bidirectional causality between India and European market. In post-crisis period causality from European Market on India has disappeared but unidirectional causalities from US and ACWI were still present.

Johansen Co-integration test provides evidences that in the entire sample period, both in pre-crisis period and post-crisis period of European crisis, there were no co-integrating relationships among the variables

Indian economy has responded negatively in post crisis periods to the shocks created in all other markets. However, the life span of shock has increased from 3 months to 10 months in post-crisis shock in European market.

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