INTER-LINKAGES BETWEEN INDIAN AND MAJOR EQUITY MARKETS - IMPACT OF GLOBAL FINANCIAL CRISIS

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ABSTRACT

This paper examined the short and long run correlating, causal and co-integrating relationship between Indian and other major developed [Australia, Canada, France, Germany, Japan, United Kingdom (UK) and United States of America (USA)] and developing [Argentina, Brazil, China, Mexico, Russia, and South Africa (SA)] markets for the period from April 2003 to December 2014 which was further subdivided in two sub periods: a Pre-crisis period (April 2003 to August 2007) and a Post-crisis period (August 2007 to December 2014). We applied correlation analysis, short and long run granger causality and Johansen Co-integration techniques on the monthly adjusted closing indices values of representative market indices.

Overall, results show that India had high correlating, causal and co-integrating relationship with Brazil, China, Russia and South Africa from the developing block and with Australia and Canada amongst the developed economies. This could be due to large bi-lateral trade and/or close political and cultural ties between these countries like the official BRICS group. Also, while the correlations significantly reduce post crisis, causal and co-integrating relationships increase post crisis. So, the nature of relationship between these markets has shifted from being contemporaneous to more of lead-lag nature. Thus, we find evidence for increase in contagion post crisis.

This has important implications for all stakeholders. Policy makers and stock market regulators need to be vigilant and take steps to insulate domestic markets as crisis is evidenced to greatly accentuate contagion. Investors can work out possible arbitrage opportunities as we find evidence of several lead-lag relationships among these markets. International investors can breathe easy regarding their international portfolio diversification as we find support for declining correlations among these markets.

KEYWORDS: *Stock Market Inter-linkages, Global Financial Crisis, Short and Long Run Causality, Co integration.*

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1. INTRODUCTION

The role of stock markets in an emerging economy like India is indispensible as they perform the crucial function of channelizing scarce financial resources from fund surplus units like investors to fund deficit units like businesses. They also perform other vital functions of price discovery, providing liquidity and risk management services. All these they do while lowering transaction cost and time and improving transparency. No wonder, they are considered important in sustaining economic growth of a nation in the long run.

Post globalization, there has been an exponential increase in international flow of human resources, capital, technology, goods and services. Nations and economies have become more interlinked and interdependent on each other such that any major event in one part of the world generates ripples that can be felt all across the globe. We know have one 'Global Village" and no country or group of countries can afford political, economic and social isolation.

In the financial context, this means that the economic and financial systems and markets are witnessing more and more interdependencies and interlinkages. Two markets are perfectly integrated, if investors can pass from one market to another without paying any extra costs and if there are possibilities of arbitration which ensures the equivalence of prices in both markets. Stock markets are interlinked or integrated if they move together and show similar returns when adjusted for non common risk factors.

Today, the stock markets around the world experience related price and volume movements due to globalisation, financial sector reforms, higher bilateral trade, transparency and technological advancements in stock trading. This supports the view that capital markets are becoming increasingly integrated across countries. Growing inter-linkages have manifested mainly through foreign portfolio investments and foreign listing of MNCs. However, there are also some barriers to investment like exchange rate risk, legal and tax differences, information availability, foreign ownership restrictions that can prevent markets from integrating. The complete elimination of barriers to financial integration allows firms to choose the most efficient sources of funds, allows allocation of capital to the most productive uses and provides investors with a wide range of alternatives markets to choose from.

In the Indian context, stock market interlinkages got major boost post the 1991 market reforms. We often come across reports that benchmark Indian indices like Nifty or Sensex rise or fall owing to global cues from other markets. Foreign Portfolio Investments (FPI), listing of Indian companies abroad and issue of ADRs/GDRs by Indian firms are major channels of transmission of these interlinkages from Global to Indian markets and vice

versa.

The recent global financial crisis of 2007-08 which had its roots in US sub-prime mortgage crisis, wrecked havoc on financial markets across the globe. Stock prices in many markets halved. Indian economy was relatively insulated because it is more dependent on domestic demand and investments. But stock markets saw significant declines in valuations. International linkage of markets has major implications for international diversification & for domestic economic policies. Weak market linkage offers potential gains from international diversifications whereas strong linkage reduces the insulation of domestic market from any global shock. As regards domestic economic policies, in an emerging economy like India there are always concerns regarding negative impact of any global contagion on domestic economy. In this context, it would be interesting to see if this crisis had any major ramifications on interlinkages between Indian and other global counterparts

The objective of this paper is to establish short and long run correlating, causal and cointegrating relationship between Indian and major equity markets in light of the recent global financial crisis.

The remaining paper is structured like this: Section 2 gives an outline of concerned literature. Section 3 elucidates the data and methodology used. Section 4 discusses the empirical results. The conclusions and inferences of the study are provided in Section 5.

2. REVIEW OF LITERATURE

Though most of the studies had initially been conducted for the developed markets like the US, European countries and Japan, recently (post-Asian crisis), the literature has started focusing on emerging Asian markets as well. Quite a few papers address the issue of capital markets integration in emerging economies in the Asia-Pacific basin, with evidences of mixed results, depending on the methodology, data, time period and/or framework used.

Nath & Verma (2003) established absence of any significant causal or long term equilibrium relationship between equity markets of India, Singapore and Taiwan for data from Jan.1994 to Nov.2002 using Granger causality and Johansen cointegration test.

Wong et al. (2005) reported that Indian market is unilaterally granger caused by USA and Japan and there is long run equilibrium relationship between these markets in a study period ranging from Jan.1991 to Dec. 2003 using Granger causality and Johansen Cointegrtaion test.

Chittedi (2010) testified that Indian and five developed markets, viz., Australia, France, Japan, USA and UK have long term cointegration by applying causality and cointegration techniques for a ten year period from

Oct., 1997 – Oct., 2007.

Tripathi & Sethi (2010) studied India, China, USA, UK and Japanese markets for causality and cointegration over the period Jan.1998-Oct.2008 using daily data. They reported unidirectional causality from UK, Japan and USA to India. Indian market was found to be cointegrated with the USA market.

Gupta & Guidi (2012) investigated short run and long run interlinkages between India and stock markets of Japan, Singapore and Honk Kong by employing Engel-Granger and Johansen cointegration for a period from 1999 to 2009. They found short run linkages but established absence of any strong long run relationship between these markets.

Mandal & Bhattacharjee (2012) scrutinized the impact of global financial crisis on comovement and interlinkages between India and major stock markets for a study period of Jan.2002 – July 2010 which was subclassified in pre and post recession periods. Their results indicate a significant increase in comovements of these stock markets in the post recession period.

Saha & Bhunia (2012) seeked to establish cusal and cointegrating relationship between Indian and US stock market in light of recent US sub-prime crisis. They found bidirectional causality and long run equilibrium relationship between these markets in a study period ranging from Jan.2008 to Feb. 2012 using Granger causality and Johansen Cointegrtaion test.

Tripathi & Sethi (2012) probed whether Indian market has any short and long run linkages with other emerging markets viz. Brazil, Hungary, Taiwan, Mexico, Poland and South Africa using Granger causality and Johansen cointegration test for the period from Jan., 1992 – Dec.2009 which was divided in multiple sub periods. They evidenced that India's short and long run inter-linkages with these emerging markets has increased over time.

Sharma et. al (2013) studied the interlinkages between BRICS markets from April 2005 to March 2010 using daily data. They applied Regression, Granger's causality in Vector Auto Regression (VAR) framework, Variance Decomposition and Impulse Response to conclude that these stock markets are not influenced by each other to a large extent.

Dasgupta (2014) probed inter-linkages and integration between BRIC markets from Jan. 2003 to Dec. 2012 and found bidirectional causality between Brazil and India. There was no long term equilibrium relationship between these markets.

Majority of the studies suggested that market integration has increased significantly over the years, within an international context. There are, however, a number of studies that did not detect any signs of integration.

Despite the small number of studies indicating the absence of market integration, there is considerable evidence that the stock market interdependencies exist and become increasingly important as the degree of economic interaction among countries gets higher. So, a comprehensive examination of this relationship between Indian and major equity markets, incorporating the impact of financial crisis is warranted.

3. DATA AND METHODOLOGY

3.1. Data

The time period for the present study is from April 2003 to December 2014. This has been divided further in two sub periods: a Pre-crisis period (April 2003 to August 2007) and a Post-crisis period (August 2007 to December 2014). August 2007 has been taken as the cut off month for crisis because its active phase in form of a liquidity crisis began on August 9, 2007 when BNP Paribas blocked withdrawals from three hedge funds citing "a complete evaporation of liquidity".

The data comprises of monthly adjusted closing indices values of representative market indices of major developed and developing economies. We have considered seven prominent advanced markets [Australia, Canada, France, Germany, Japan, United Kingdom (UK) and United States of America (USA)] and seven important emerging markets [Argentina, Brazil, China, India, Mexico, Russia, and South Africa (SA)]. Table 1 below provides a snapshot of stock exchanges and representative market indices chosen for each country.

Table 1: List of Countries, Stock Exchanges and Market Indices used

S.No.	Country	Stock Exchange	Index
1.	Argentina	Buenos Aires	MERVAL
2.	Australia	Australian Stock Exchange	ASX ALL ORDINARIES
3.	Brazil	BM&FBOVESPA	BRAZIL IBOVESPA
4.	Canada	Toronto Stock Exchange	S&P/TSX COMPOSITE I
5.	China	Shanghai Stock Exchange	S SE COMPOSITE
6.	France	Paris Stock Exchange	FRANCE CAC 40
7.	Germany	Frankfurt Stock Exchange	DAX 30 PERFORMANCE
8.	India	Bombay Stock Exchange	S&P BSE SENSEX
9.	Japan	Tokyo Stock Exchange	NIKKEI 225 STOCK AVERAGE
10.	Mexico	Bolsa Mexicana de Valores	MEXICO IPC
11.	Russia	Moscow Stock Exchange	RUSSIA RTSI INDEX
12.	SA	Johannesburg Stock Exchange	FTSE/JSE ALL SHARE
13.	UK	London Stock Exchange	FTSE 100
14.	USA	New York Stock Exchange	S&P500 COMPOSITE

3.2. Methodology

3.2.1 Unit Root Test

If the mean, variance and auto-covariance of a time series data does not vary over time or is time invariant, it is said to be stationary. Stationarity of a data is a prerequisite for applying most advanced econometric techniques. Augmented Dickey Fuller (ADF) unit root test has been used to test for presence of unit root.

3.2.2 Correlation Analysis

Correlation here has been used to measure the nature and magnitude of short term relation between the stock indices of two countries. A comparative bi-variate correlation index has been constructed by dividing the post-crisis bi-variate correlations with their pre-crisis values for each pair of countries. A value more than 1 indicates an increase in the bi-variate correlation coefficient post-crisis as compared to pre-crisis.

3.2.3 Granger Causality Test

Granger causality has been used in this study to test for any causal relationship between stock markets. The time series Y is granger-caused by X if the lagged values of X along with the lagged values of Y provide statistically significant information about the values of Y in the next period. The test is based on the following regressions:

$$Y_t = \beta_0 + \sum_{i=1}^{N} \beta_k Y_{t-k} + \sum_{j=1}^{N} \alpha_i X_{t-i} + u_t$$

$$X_t = \gamma_0 + \sum_{i=1}^{N} \gamma_k X_{t-k} + \sum_{j=1}^{N} \delta t Y_{t-i} + v_t$$

Where, the two variables are Y_t and X_t. Error terms are u_t and v_t. and the number of lags is denoted by "I" whereas time period is denoted by t. N is optimal number of lags. H_0 (X does not granger cause Y) is $\alpha_i = \Delta_i = 0$ for all i's versus the alternative hypothesis that $\alpha_i \neq 0$ and $\delta t \neq 0$ (X granger cause Y) for at least some i's. Granger causality test establishes short run causality if we take stationary values. Causality tests by the level VAR (non-stationary) can complement the result of the co-integration tests in terms of long-run information [Worthington & Higgs, 2007].

3.2.4 Johansen Co-integration Test

Johansen cointegration test is applied to test the long run cointegrating or equilibrium relationship between Indian and Global equity markets. Cointegration means despite being individually non-stationary, a linear

combination of two or more time series can be stationary. Cointegration of two or more time series suggests that there is a long run or equilibrium relationship between them.

Johansen cointegration test named after Søren Johansen is a procedure for testing cointegration of several time series. Two different likelihood ratio tests were developed by Johansen. They are:

1. Trace test: $\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1-\lambda_i)$

The null hypothesis of the trace statistics tests is no co-integration H_0: r = 0 against the alternative of more than 0 co-integration vector H_1: r > 0.

2. Maximum eigen value test statistics given by:

$\lambda_{ex}(r, r+1) = T \ln(1-\lambda)_{i+1}$

Null hypothesis is the r co-integrating vectors against the alternative of r + 1 co-integrating vectors.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1 ADF Unit Root Test Results

Time series index values of all the countries are non-stationary at level for all the three study periods. Thus, they are fit for long run causality and cointegration analysis. The first differenced logarithmic values of stock indices of all the countries are stationary in all the three time periods and hence can be used for short run econometric analysis.

4.2 Bi-Variate Correlation Results

Table 2 below provides the bi-variate correlation coefficient between India and other major equity markets in all the three periods. We see that barring a couple of exceptions, all bi-variate correlation coefficients are significant at 5%. We find that Indian stock market has very high significant correlation (0.9 & above) with German, Mexican and South African markets in the total period. Whereas, in the pre-crisis period, India has very high correlation with all markets except China. But in the post crisis period we do not find any very high correlations between Indian and other markets. The post/pre relative correlation index confirms this trend as no correlation in the post crisis period is higher than its pre crisis coefficient. All the correlations have declined post crisis, but the most drastic declines is noticed with Brazil, China & Russian markets. This indicates that post crisis, these markets have taken their own independent routes and are no more moving together.

Table 2: Bi-Variate Correlation (All Periods) & Post/Pre Crisis Correlation Index

Country	Total Period	Pre Crisis	Post Crisis	Post/Pre
India – Argentina	0.79	0.95	0.86	0.91
India – Australia	0.66	0.98	0.58	0.59
India – Brazil	0.84	0.98	0.26	0.27
India – Canada	0.87	0.98	0.79	0.81
India – China	0.52	0.69	0.01	0.01
India – France	0.17	0.99	0.41	0.41
India – Germany	0.91	0.98	0.87	0.89
India – Japan	0.24	0.96	0.64	0.67
India – Mexico	0.95	0.98	0.82	0.84
India – Russia	0.60	0.98	0.16	0.16
India – SA	0.95	0.99	0.87	0.88
India – UK	0.78	0.98	0.83	0.85
India – USA	0.73	0.97	0.86	0.89

Bi-Variate Correlations in bold are significant at 5%.

4.3 Short Run Granger Causality Test Results

Next, before applying Granger Causality test, we use the Vector Auto Regression (VAR) framework to determine the optimal lag and use the Akaike information criterion (AIC). Now, we apply Granger Causality Test to determine the short run causal relationship between India and Major equity markets. In the total period, we find one-way causality from India → Canada, India → Russia and India → South Africa. India is not granger caused by any country in this period. In pre crisis period, we report that while India is not granger caused by any other market, it granger causes Canada & South Africa. In the post crisis period, we discover that India has bi-directional causality, i.e., India ↔ Canada, India↔Russia and India ↔ South Africa. There is also unidirectional causality running from India → Australia, India→ Brazil, and China → India.

Table 3: Short Run Granger Causality Test Results

Null Hypothesis	Total Period	Pre Crisis	Post Crisis
DLOG(ARG) does not Granger Cause DLOG (IND)	0.66	0.07	1.39
DLOG(IND) does not Granger Cause DLOG (ARG)	1.22	2.60	2.38
DLOG(AUS) does not Granger Cause DLOG(IND)	1.33	0.93	1.37
DLOG(IND) does not Granger Cause DLOG(AUS)	1.36	0.72	**2.61**
DLOG(BRA) does not Granger Cause DLOG(IND)	1.07	0.50	2.17
DLOG(IND) does not Granger Cause DLOG(BRA)	1.09	1.35	**2.50**
DLOG(CAN) does not Granger Cause DLOG(IND)	1.73	0.04	**2.63**
DLOG(IND) does not Granger Cause DLOG(CAN)	**2.73**	**3.93**	**4.85**
DLOG(CHI) does not Granger Cause DLOG(IND)	1.65	2.66	**4.48**
DLOG(IND) does not Granger Cause DLOG(CHI)	1.06	0.54	0.57
DLOG(FRA) does not Granger Cause DLOG(IND)	1.52	0.31	0.35
DLOG(IND) does not Granger Cause DLOG(FRA)	0.85	0.89	1.22
DLOG(GER) does not Granger Cause DLOG(IND)	1.08	0.93	0.27
DLOG(IND) does not Granger Cause DLOG(GER)	1.13	1.29	0.94
DLOG(JAP) does not Granger Cause DLOG(IND)	1.31	0.94	0.85
DLOG(IND) does not Granger Cause DLOG(JAP)	1.09	0.32	1.23
DLOG(MEX) does not Granger Cause DLOG(IND)	0.74	0.12	0.56
DLOG(IND) does not Granger Cause DLOG(MEX)	1.09	1.05	1.78
DLOG(RUS) does not Granger Cause DLOG(IND)	1.73	1.01	**5.89**
DLOG(IND) does not Granger Cause DLOG(RUS)	**2.44**	2.88	**3.37**
DLOG(SA) does not Granger Cause DLOG(IND)	1.89	0.34	**2.81**
DLOG(IND) does not Granger Cause DLOG(SA)	**2.10**	**3.93**	**4.11**
DLOG(UK) does not Granger Cause DLOG(IND)	0.37	0.08	0.22
DLOG(IND) does not Granger Cause DLOG(UK)	1.12	0.87	2.47
DLOG(USA) does not Granger Cause DLOG(IND)	1.51	0.31	0.52
DLOG(IND) does not Granger Cause DLOG(USA)	0.78	1.99	1.37

Values are F-statistics corresponding to null hypothesis of Granger Causality test.
Figure in bold are significant at 5% level.

4.4 Long Run Granger Causality Test Results

As explained in the methodology section, we test for long run granger causality by taking non-stationary or level VAR. The results are provided in Table 4 below. In the total period, we find bi-directional causality, i.e., India ↔ Russia and India ↔ South Africa. India granger causes Brazil and Canada and India is granger caused by China. Whereas, in the pre crisis period, we find India granger causing China and Russia and being granger caused by South Africa. There is no bidirectional causality in this period. In post crisis period, we report that Brazil, China, Russia and South Africa are granger causing India. There is a bi-directional causality between India and Canada.

Table 4: Long Run Causality Test (Level VAR) Results

Null Hypothesis	Total Period	Pre Crisis	Post Crisis
ARG does not Granger Cause IND	1.43	0.19	2.47
IND does not Granger Cause ARG	1.35	2.73	1.88
AUS does not Granger Cause IND	0.79	1.72	2.37
IND does not Granger Cause AUS	1.48	0.29	2.00
BRA does not Granger Cause IND	1.89	0.30	**4.66**
IND does not Granger Cause BRA	**2.09**	1.39	0.83
CAN does not Granger Cause IND	1.78	0.65	**4.98**
IND does not Granger Cause CAN	**2.37**	0.73	**5.61**
CHI does not Granger Cause IND	**4.06**	0.04	**5.65**
IND does not Granger Cause CHI	0.91	**4.79**	0.84
FRA does not Granger Cause IND	0.49	1.26	1.89
IND does not Granger Cause FRA	1.25	0.34	1.22
GER does not Granger Cause IND	0.59	1.24	0.06
IND does not Granger Cause GER	1.24	1.20	0.74
JAP does not Granger Cause IND	0.69	0.08	0.53
IND does not Granger Cause JAP	1.23	0.81	1.15
MEX does not Granger Cause IND	0.64	1.50	0.36
IND does not Granger Cause MEX	1.25	0.86	1.17

RUS does not Granger Cause IND	**2.91**	0.31	**11.61**
IND does not Granger Cause RUS	**2.20**	**4.42**	1.66
SA does not Granger Cause IND	**2.95**	**4.97**	**2.65**
IND does not Granger Cause SA	**3.02**	0.25	1.01
UK does not Granger Cause IND	0.31	1.88	0.62
IND does not Granger Cause UK	1.14	0.24	2.36
USA does not Granger Cause IND	0.59	0.04	0.21
IND does not Granger Cause USA	1.02	2.22	0.80

Values are F-statistics corresponding to null hypothesis of Granger Causality test. Figure in bold are significant at 5% level.

4.5 Johansen Co-integration Test Results

Finally, we also apply Johansen cointegration test to check whether there is any long term cointegration between India and other major equity markets. Table 5 and Table 6 provide results of Johansen Unrestricted Cointegration Rank Test based on Trace and Maximum Eigenvalue respectively. Results of both the test are same. Both tests reveal that the Indian stock market is not cointegrated with any other market in the total period. In the pre crisis, there is one cointegrating equation which binds India with China and South Africa. In the post crisis period, India is cointegrated with Australia, Canada, China, France and Russia.

Table 5: Johansen Co-integration Rank Test (Trace)

Variables	Hypothesized No. of CE(s)	Total Period	Pre Crisis	Post Crisis
IND-ARG	None	7.28	6.73	7.73
	At most 1	2.87	0.25	0.00
IND-AUS	None	7.22	7.08	**17.68**
	At most 1	0.02	0.50	0.10
IND-BRA	None	8.10	7.44	11.79
	At most 1	2.66	0.37	1.28
IND-CAN	None	9.43	5.97	**26.39**
	At most 1	0.08	0.01	0.40
IND-CHI	None	11.32	**18.98**	**31.17**
	At most 1	0.12	0.01	0.004

IND-FRA	None	7.31	8.05	**15.80**
	At most 1	0.16	0.02	0.45
IND-GER	None	7.67	11.30	5.44
	At most 1	0.86	0.15	0.03
IND-JAP	None	4.41	5.56	8.86
	At most 1	0.94	0.03	0.40
IND-MEX	None	7.40	10.37	2.78
	At most 1	2.53	2.43	0.17
IND-RUS	None	8.37	14.23	**25.16**
	At most 1	1.36	0.32	0.01
IND-SA	None	9.78	**18.38**	4.95
	At most 1	0.20	3.26	0.18
IND-UK	None	7.22	5.27	11.92
	At most 1	0.72	0.48	0.10
IND-USA	None	3.50	7.77	8.61
	At most 1	0.18	0.21	0.01

Values are Trace statistics corresponding to Johansen Co-integration Rank Test (Trace based).

Figure in bold are significant at 5% level.

Table 6: Johansen Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Variables	Hypothesized No. of CE(s)	Total Period	Pre Crisis	Post Crisis
IND-ARG	None	4.41	6.48	7.73
	At most 1	2.87	0.25	0.00
IND-AUS	None	7.20	6.58	**17.58**
	At most 1	0.02	0.50	0.10
IND-BRA	None	5.44	7.07	10.51
	At most 1	2.66	0.37	1.28
IND-CAN	None	9.36	5.96	**25.99**
	At most 1	0.08	0.01	0.40
IND-CHI	None	11.20	**18.97**	**31.17**
	At most 1	0.12	0.01	0.004
IND-FRA	None	7.15	8.03	**15.35**
	At most 1	0.16	0.02	0.45
IND-GER	None	6.82	11.16	5.40
	At most 1	0.86	0.15	0.03
IND-JAP	None	3.48	5.53	8.46
	At most 1	0.94	0.03	0.40

Variables	Hypothesized No. of CE(s)	Total Period	Pre Crisis	Post Crisis
IND-MEX	None	4.87	7.93	2.61
IND-MEX	At most 1	2.53	2.43	0.17
IND-RUS	None	7.01	13.92	**25.15**
IND-RUS	At most 1	1.36	0.32	0.01
IND-SA	None	9.58	**15.13**	4.76
IND-SA	At most 1	0.20	3.26	0.18
IND-UK	None	6.51	4.79	11.82
IND-UK	At most 1	0.72	0.48	0.10
IND-USA	None	3.32	7.55	8.60
IND-USA	At most 1	0.18	0.21	0.01

Values are Max-Eigen statistic for Johansen Co-integration Rank Test (Max Eigen value based).

Figure in bold are significant at 5% level.

5. CONCLUSION AND IMPLICATIONS

This paper examined the short and long run correlating, causal and cointegrating relationship between Indian and other major developed [Australia, Canada, France, Germany, Japan, United Kingdom (UK) and United States of America (USA)] and developing [Argentina, Brazil, China, India, Mexico, Russia, and South Africa (SA)] markets for the period from April 2003 to December 2014. This has been divided further in two sub periods: a Pre-crisis period (April 2003 to August 2007) and a Post-crisis period (August 2007 to December 2014). The data comprised of monthly adjusted closing indices values of representative market indices. We applied correlation analysis, short and long run granger causality and Johansen Cointegration techniques.

Correlation analysis results reveal that while the correlation between Indian and other markets was very high in the pre crisis period, there was a significant decline in correlations in the post crisis period. Short run causality analysis reveals unidirectional causality from India to Canada, Russia and South Africa in pre crisis period and bidirectional causality with these countries in the post crisis period. Long run causal relation results show that the direction of unidirectional causality was from India to China & Russia in the pre crisis period but it reversed in the post crisis period. We do not find any cointegration between Indian and other markets in the total period, but India was cointegrated with China, Russia, Canada & Australia in post crisis.

Overall, results show that out of seven developed and six emerging markets

considered, India had high correlating, causal and cointegrating relationship with Brazil, China, Russia and South Africa from the developing block and with Australia and Canada amongst the developed economies. This could be due to large bi-lateral trade and/or close political and cultural ties between these countries like the official BRICS group. Also, while the correlations significantly reduce post crisis, causal and cointegrating relationships increase post crisis. So, the nature of relationship between these markets has shifted from being contemporaneous to more of lead-lag nature. Thus, we find evidence for increase in contagion post crisis.

This has important implications for all stakeholders. Policy makers and stock market regulators need to be vigilant and take steps to insulate domestic markets as crisis is evidenced to greatly accentuate contagion. Investors can work out possible arbitrage opportunities as we find evidence of several lead-lag relationships among these markets. International investors can breathe easy regarding their international portfolio diversification as we find support for declining correlations among these markets.

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