Foreign Currency Exposure of Indian Multinational Companies around the Financial Crisis Period of 2008-2009

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Abstract: In the modern era of globalization, Multi-National Corporations (MNCs) play a key role in the economic growth of a country. They contribute to the economy through Foreign Direct Investments and Foreign Portfolio Investments. India being an emerging economy has also been impacted by the presence of MNCs. The performance of MNCs is influenced by myriad of factors, both domestic and global. One of these factors is inevitably the foreign exchange rate. The performance of MNCs, in terms of economic as well as transaction exposure, depends to a great extent on exchange rate fluctuation. Thus the performance, explicitly replicated by the stock return of MNCs, should not be viewed in isolation. The association between the two markets, with its changing nature is particularly relevant in the present era of strong global financial market integration.The presence of dynamic linkages between the stock market and foreign exchange market has been abundantly evidenced in the literature. However the Sensex is a representation of the Indian Stock Market and includes many companies which operate solely within the National Territory. In order to have a more defined view, the MNC index constituted by global players, has been considered in the present study. Focusing on the recent global financial turmoil of 2007-2008, this paper tries to find the pattern of inter-linkages, specifically the volatility dynamics between the stock return of multi-national firms and foreign exchange rates viz. INR/USD and INR/Euro with respect to India before starting of the global turmoil, during the period of it, and aftermath. Volatility spillover between financial markets has direct implications not only for financial hedging, portfolio management and asset allocation, but also to policy makers and regulators of a country. Based on the volatility dynamics, this study helps the MNCs to manage its currency exposures.

Key-words: Translation exposure, economic exposure, transaction exposure, operating exposure.

1. Introduction

Theoretical background of exchange rate exposure of a firm is enormous. Following a textbook treatment, the foreign exchange exposures of the firm are of two types' viz., Accounting or Translation Exposure, and Economic Exposure. The basic difference between the two is that the accounting exposure is derived from the consolidated financial statement of the parent company and it does not influence the cash flow. Economic exposure, on the contrary, is the result of the altered cash flow of a company. The economic exposure is further divided into Transaction Exposure and Real Operating Exposure.

Transaction Exposure deals with the changes in cash flows that result from existing contractual obligations denominated in foreign currency. It refers to the risk associated with the change in the exchange rate between the time an enterprise initiates a transaction and settles it.

Operating exposure relates to the effect of unexpected exchange rates on the future operating cash flows of the company. In financial management, a firm is valued by the net present value of the future cash flows. A change in the exchange rate may bring about changes in the cash flows of the company directly by affecting its revenues and costs and indirectly by affecting its competitiveness by the action of its consumers and competitors. As a result, the net present value may differ from the one anticipated.

Finally, Translation Exposure (or Accounting Exposure) arises when the enterprises has subsidiaries abroad. In many countries, multinational companies are required to consolidate the assets and liabilities of the subsidiaries with those of the parent company and present consolidated financial statements. The functional currency used is important because it determines the translation process. If the local currency is used, all assets and liabilities are translated at the current rate of exchange. Moreover, translation gain or losses are not reflected in the income statement but rather are recognized in owner's equity as a translation adjustment. The fact that such adjustments do not affect accounting income is appealing to many companies. Translation exposure should have no effect on the price of a firm's stock with a notion that investors price stocks according to expected future cash flow.

Even a domestic firm with no foreign activities may be exposed to exchange-rate risk for two reasons. Firstly, depreciation or appreciation in the domestic currency has an impact on the earnings of the domestic firms leading to increase or decrease in the value of the firms having foreign competitors. Secondly, the volatility of exchange rate also affects the firms having no foreign competitors, due to the fact that change in exchange rate may affect the input price. For example, depreciation of domestic currency resulting in higher demand for inputs by the export oriented companies leading to increase in the input prices. The firms belong to protected industry also share the same source of input. Thus the rise in input price negatively impact the profitability of those firms. In other words, the depreciation of the exchange rate has a negative impact on the cash flows of the firm. So, it can be said that performance of multinational or domestic firms alike are affected to a large extent by exchange rate fluctuations.

2. Review of Literature

Former studies in the empirical exposure literature have predominantly focused on the amount of exposure and its consistency with the theoretical determinants of exposure. Jorion (1990) in his study finds that only 5% of sample of 287 large U.S. multinational firms have significant exchange rate exposure. However, Amihud (1993), Bartov and Bodnar (1994) and Choi and Prasad (1995) find no such evidence of contemporaneous exposure for U.S. multinationals, although Bartov and Bodnar do find that U.S. firms respond to past quarterly exchange rate movements. Related global studies that explore numerous countries, such as Bodnar and Gentry (1993), Dominguez and Tesar (2001) and Doidge, Griffin and Williamson (2002), also find an astonishingly low number of firms that exhibit significant sensitivity to exchange-rate movements. Bodnar and Gentry (1993) examine exchange-rate exposure at industry level for Canada, Japan and the US over 1979-1988. For the US and Canada they find that respectively 11 out of 39 industries (28%) and 4 out of 19 (21%) have significant exchange-rate exposures. In contrast, the results for Japan indicate that 7 out of 20 industries (35%) are significantly exposed at the 10%-level. Bodnar and Gentry (1993) also test the hypothesis that small and open economies are more sensitive to exchange-rate exposure by investigating the inter-industry variance of the exposure coefficients. They find that the variance of the exposure coefficients is smaller for the US than for Canada and Japan. As the US is the largest and least open economy of the three countries, the results suggest that industries in smaller and more open economies are likely to be more exposed to exchange-rate fluctuations.

Studies on Japanese firms by Bodnar and Gentry (1993) at the industry portfolio level, by He and Ng (1998) at the firm level for several industries and Williamson (2001) at the firm level for the automotive industry, do report significant exchange rate exposure. However, Griffin and Stulz (2001) in their study on the economic magnitude of exchange rate exposure suggest that the extremely high exposure exhibited by the Japanese industries, particularly the automotive industry, is not the norm. Two studies with a large set of international firms are Dominguez and Tesar (2001) and Doidge, Griffin and Williamson (2002). The latter study is the most comprehensive international study on exchange-rate exposure. Using individual firm data from over 27,000 stocks in 21 developed and 29 emerging markets, they still find surprisingly low exchange-rate sensitivity levels. Moreover, they detect quite some cross-sectional variation that cannot be explained fully by exchange-rate determinants. Interestingly, they find that exchange rates affect firm value mainly in periods of large exchange-rate changes. Dominguez and Tesar (2001) study over 2000 firms in 8 countries. The authors use a trade-weighted exchange-rate index, the US dollar and the currency of the largest trading partner. The results show that the trade weighted exchange-rate index understates the exposure. Recent studies, however, show that derivatives usage reduces foreign-exchange exposure. Despite these efforts, the low exposures remain a puzzling phenomenon. The aforementioned studies typically use a trade-weighted exchange-rate index as a proxy for a firm's exposure to individual exchange rates. Ideally, we would like to have information on the relevant exchange rates for each firm. While some studies (Dominguez and Tesar, 2001) use individual exchange rates, the selection is not based on firm-specific information. Ihrig (2001) constructs a company-specific exchange-rate index using the number and location of each multinational's subsidiaries. Using this company specific exchange-rate index, she finds 16% of the firms to be significantly exposed to exchange-rate risk versus 10% when using a trade-weighted exchange-rate index. More importantly, as we discuss below, our approach differs substantially from prior studies.

One problem in modeling the relation between exchange rates and firm value is that perhaps it is too simplistic to assume that exchange rate changes have a linear and constant impact on firm value. Only in simplified situations does the theoretical literature predict a linear relation and these methodological issues may mask exposure {Dewenter, Higgins, and Simin (2002)}. Even if the exposure-return relation is linear, but varies through time (Allayannis,1997), an exposure regression will be misspecified if an imperfect proxy is used to capture the time-variation in exposure. To address these concerns, in addition to tabulating results based on standard regression approaches, we propose a different method to examine exposure.

3. Data and Methodology

Daily closing data of stock price and exchange rates from January 2, 2006 to December 31, 2013 has been considered for this study. The sample is divided into three sub-periods based on the price movements in S & P CNX Nifty:

i) Period 1 (Pre-crisis period): January 2, 2006 to January 17, 2008

ii) Period 2 (In-crisis period) : January 18, 2008 to July 20, 2009

iii) Period 3 (Post-crisis period) :July 21, 2009 to December 31, 2013

At micro level, we further consider the individual stock return of 11 different MNCs, constituents of the CNX MNC indices and two different exchange rates namely, INR/USD and INR/Euro Exchange Rate for this study, based on the assumption that firms within an industry need not be homogeneous. It may be that industry-wide exposure is actually high but that individual firms within the industry are exposed in opposite ways. An aggregation of their returns will therefore average out the individual exposure effects.

To segregate the time period into three sub-periods, the Modified Identification of multiple structural breaks in variance (Modified ICSS Test) proposed by Sans et al. (2003) has been used.

To test the stationarity, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) has been used. The study of volatility spillover provides useful insights into how information is transmitted from foreign exchange market to individual stock return. Multivariate Asymmetric GARCH (Diagonal VECH) model is used to capture the contagion and asymmetric effect of different foreign exchange on stock return of different selected companies. To explore the presence and nature of the volatility spill-over between the two markets, the study makes use of multivariate GARCH model. We are, in this paper, following the same methodology on Multivariate Asymmetric GARCH (Diagonal VECH) model, used by us, i.e., Saha and Chakrabarti (2011) in one of our paper. Earlier studies have made extensive use of Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized ARCH (GARCH) type models that take into account the time-varying variances. Suitable surveys of ARCH modeling in general and its widespread use in finance applications may be found in Higgins and Bera (1993) and Bollerslev et al. (1988) respectively. Discussion on recent developments in this expanding literature could be found in Pagan (1996). More recently, the univariate GARCH model has been extended to the multivariate GARCH (MGARCH) case, with the recognition that MGARCH models are potentially useful developments regarding the parameterization of conditional cross-moments. Bollerslev (1986, 1990) used a MGARCH approach to examine the coherence in short-run nominal exchange rates, while Karolyi (1995) employed a similar model to examine the international transmission of stock returns between the United States and Canada. Dunne (1999) also employed a MGARCH model, though in the context of accommodating time variation in the systematic market-risk of the traditional capital asset pricing model. Kearney and Patton (2000) used a series of 3-, 4- and 5- variable MGARCH models to study the transmission of exchange rate volatility across European Monetary System (EMS) currencies prior to the introduction of the single currency. However, while the popularity of models such as these has increased in recent years, "…the number of reported studies of multivariate GARCH models remains small relative to the number of univariate studies" (Kearney and Patton, 2000).

The daily returns for the individual series are calculated based on the logged difference as below:

$R_{it} = [\text{Ln}\ (P_{it}) - \text{Ln}(P_{it-1})]$ Equation…..(1)

The diagonal VECH model chosen in this study is of particular interest as it allows the conditional variance covariance matrix of stock market returns to vary over time and is more flexible compared to BEKK model if there are more than two variables in the conditional variance covariance matrix (Scherrer and Ribarits, 2007). Empirical implementation of the VECH model is, however, limited due to the difficulty of guaranteeing a positive semi-definite conditional variance covariance matrix (Engle and Kroner (1993), Kroner and Ng (1998), Brooks and Henry (2000)). This study uses the unconditional residual variance as the pre-sample conditional variance to overcome this problem thus guaranteeing the positive semi-definite of conditional variance covariance matrix of the diagonal VECH model. The conditional variance-covariance matrix (H_t) has four dimensions with the diagonal and non-diagonal elements representing the variance and the covariance terms, respectively. In matrix notation, H_t can be written as:

$$H_t = \begin{bmatrix} h_{11t} & \cdots & h_{1nt} \\ \vdots & \ddots & \vdots \\ h_{n1t} & \cdots & h_{nnt} \end{bmatrix} \qquad (2)$$

Where h_{iit} is a conditional variance at time t of the stock return of country i and h_{ijt} denotes the conditional covariance between the stock returns of country i and country j (where $i \neq j$) at time t.

Although there are different ways of specifying the MGARCH model, this study uses the diagonal VECH model of Bollerslev et al. (1988) as the model is more flexible when Ht contains more than two variables (Scherrer and Ribarits, 2007). The diagonal VECH representation is based on the assumption that the conditional variance depends on squared lagged residuals and the conditional covariance depends on the cross-lagged residuals and lagged covariances of other series (Harris and Sollis, 2003). The diagonal VECH model can be written as follows:

$$Vech(H_t) = C + Avech(\varepsilon_{t-1}\varepsilon'_{t-1}) + Bvech(H_{t-1}) \qquad (3)$$

Where, A and B are $\frac{N(N+1)}{2} \times \frac{N(N+1)}{2}$ parameter matrices and C is a $\frac{N(N+1)}{2} \times 1$ vector of constants. The diagonal elements of matrix A (a_{11}, a_{22}, a_{33} and a_{44}) measures the influences from past squared innovations on the current volatility (i.e. own-volatility shocks) while non-diagonal elements (a_{ij} where, $i \neq j$) determine the cross product effects of the lagged innovations on the current volatility (i.e. cross-volatility shocks). Similarly, the diagonal elements of matrix B (b_{11}, b_{22}, b_{33} and b_{44}) determine the influences from past squared volatilities on the current volatility (i.e. own-volatility spillovers) and non-diagonal elements (b_{ij} where, $i \neq j$) measure the cross product effects of the lagged co-volatilities on the current co-volatility (i.e. cross-volatility spillovers).

The study has incorporated a threshold term in the variance-covariance equation to capture asymmetric volatility spill-over. Volatility responses are said to be asymmetric when volatility changes dissimilarly with good and bad news in any market. In presence of asymmetric volatility spill over, volatility responses of any market towards good or bad news in any other markets will be different. The model used in this study could be represented as:

$$VECH(H_t) = C + A.VECH(\epsilon_1(t-1)\,\epsilon_1(t-1)^{\intercal}) + B.VECH(H_{t-1}) + D.VECH((\epsilon_1(t-1)\,\epsilon_1(t-1)^{\intercal\prime}) < 0] *((\epsilon_1(t-1)\,\epsilon_1(t-1)^{\intercal\prime}) < 0]]\ 'D*VECH((\epsilon_1(t-1)\,\epsilon_1(t-1)^{\intercal\prime}) < 0] *((\epsilon_1(t-1)\,\epsilon_1(t-1)^{\intercal\prime}) < 0]] \quad (4)$$

A, D and B are $\frac{N(N+1)}{2} x \frac{N(N+1)}{2}$ parameter matrices. C is $\frac{N(N+1)}{2}$ vector of constant. a_{ii} in matrix A, that is the diagonal elements show the own innovation impact and the cross diagonal terms (a_{ij}, $i \neq j$) show the cross innovation impact. Similarly, b_{ii} in matrix B shows the own volatility impact and b_{ij} shows the cross volatility impact. d_{ii} shows the volatility spillover with asymmetry from the i'th market to itself. d_{ij} shows the volatility spill over with asymmetric response from the i'th market to the j'th market.

Karunanayake et al.(2008) emphasize that in estimation of a diagonal VECH model the number of parameters to be estimated are crucial. Bollerslev et al. (1988) and Goeij and Marquering (2004) suggested use of a diagonal form of A and B. Moreover, in the estimation process, one has to ensure the positive semi-definiteness of the variance covariance matrix. The condition is satisfied if all of the parameters are positive with a positive initial conditional variance covariance matrix (Bauwens et al., (2006)). Bollerslev et al. (1988) suggested some restrictions to be used in the estimation process that were duly followed by Karunanayake et al. (2008). They used maximum likelihood function to generate these parameter estimates by imposing some restriction on the initial value.

Prior to implement the Asymmetric MGARCH model on the selected data series, the descriptive statistics of the raw return, particularly measures of skewness, kurtosis and Jarque-Bera Statistics are calculated to explore the nature of the selected return series.

4. Results

4.1. Stationarity Test and Descriptive Statistics

The descriptive statistics and unit root test results for eleven different multinational firms, two foreign exchange rates and NSE as a proxy for market index for the pre-crisis period has been shown in Table 1 to Table 4. For bilateral exchange rates, USD has negative means (-0.00023), indicating that the rupee was appreciating on average against those two currencies during the sample period. However, it is positive for euro (0.000174), suggesting that rupee was depreciating against euro during the sample period. All the return series for pre-crisis period showed in Table 1 to Table 4 of the selected companies under different industries, two foreign exchange rates and NSE NIFTY under ADF and PP test found stationary at level. All the series were non normal, skewed and had kurtosis values greater than three.

Table 1: Descriptive Statistics for pre-crisis period

SL NO.	Name of the Company	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
	ABB	-0.00066	0.00162	0.072036	-19.1239	405.589	3393471	0
	CUMMINSIND	0.00159	-0.00059	0.026948	0.381328	4.614036	66.1252	0
	GLAXO	-0.00028	-0.0012	0.02138	0.01136	5.58222	138.3688	0
	GUJAMBCEM	0.000831	0.000683	0.021955	-0.0717	6.127067	203.3315	0
	HINDLEVER	3.23E-05	-0.00112	0.021826	0.345812	4.932389	87.40873	0
	IFLEX	0.000342	-0.00052	0.02657	0.186795	8.548747	641.7594	0
	MARUTI	0.000369	-0.00043	0.024075	-0.00505	5.996438	186.3089	0
	MICO	0.001083	-0.00045	0.022557	1.547826	11.02499	1535.158	0
	SESAGOA	0.002125	-1.17E-05	0.031856	0.124724	5.852552	170.135	0
	SIMENS	-0.00125	0.000487	0.079643	-18.2927	382.8572	3021822	0
	STER	-0.00043	0.001555	0.079219	-15.7509	313.2101	2017370	0

Table 2: Stationarity Test for pre-crisis period

SL NO.	Name of the Company	ADF	PP	Bandwidth
	ABB	-22.787*	-22.7914*	2
	CUMMINSIND	-23.9879*	-24.0738*	6
	GLAXO	-18.7657*	-23.885*	5
	GUJAMBCEM	-18.2545*	-22.8198*	1
	HINDLEVER	-21.8079*	-21.8077*	3
	IFLEX	-22.4695*	-22.4789*	7
	MARUTI	-23.0846*	-23.1955*	9
	MICO	-24.5356*	-24.6125*	5
	SESAGOA	-20.8099*	-20.7829*	9
	SIMENS	-21.5158*	-21.5024*	2
	STER	-21.8802*	-21.8765*	6

* Implies that significance at 1% level of significance

Table 3: Descriptive Statistics for pre-crisis period of Exchange Rates and NSE

SL no.	Name	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
1	USD	-0.00023	-7.45E-05	0.003403	-0.06127	8.034441	526.2326	0
2	EURO	0.000174	0.000408	0.004915	0.038077	3.831755	14.47553	0.000719
3	NSE	0.001417	0.001668	0.016132	-0.3781	5.040258	98.24037	0

Table 4: Stationarity Test for pre-crisis period of Exchange Rates and NSE

SL no.	Name of the Company	ADF	Lag	PP	Bandwidth
1	USD	-24.45335	0*	-24.43563	6*
2	EURO	-24.40661	0*	-24.40598	1*
3	NSE	-21.59442	0*	-21.59529	1*

* Implies that significance at 1% level of significance

Table 5 to 8 showed the descriptive statistics and unit root test results for eleven different multinational firms, two foreign exchange rates and NSE as a proxy for market index for crisis period. Most of the multinational companies had negative mean return with a high standard deviation as compared to the pre-crisis period. For bilateral exchange rates, all currencies, USD and euro have positive means (0.00075 and 0.000754 respectively), indicating that the rupee was depreciating on average against those currencies during the sample period. All the series were stationary under ADF and PP test, non-normal, skewed and had kurtosis values greater than three.

Table 5: Descriptive Statistics for crisis period

SL NO.	Name of the Company	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
	ABB	-0.00185	-0.00089	0.033277	-0.494	5.334846	95.61099	0
	CUMMINSIND	-0.00142	-0.00074	0.030171	-0.31627	6.504375	188.6261	0
	GLAXO	0.000729	0.001364	0.018606	-0.49857	6.320682	178.8159	0
	GUJAMBCEM	-0.00085	-0.00123	0.033988	0.025107	4.191447	21.15324	0.000026
	HINDLEVER	0.000529	-0.00077	0.024178	-0.13138	4.134307	20.166	0.000042
	IFLEX	0.000108	-0.00204	0.044301	-0.06024	4.900309	53.93212	0
	MARUTI	0.000919	0.001295	0.029623	-0.2702	3.507751	8.178883	0.016749
	MICO	-0.0008	-0.00082	0.022309	0.791334	20.88632	4796.076	0
	SESAGOA	-0.00721	-4.50E-05	0.161944	-16.6096	300.8125	1335713	0
	SIMENS	-0.00427	-0.00364	0.056336	-6.2662	83.01385	97569.26	0
	STER	-0.0013	0.001359	0.047968	-0.00646	3.760322	8.601563	0.013558

Table 6: Stationarity Test for crisis period

SL NO.	Name of the Company	ADF	PP	Bandwidth
	ABB	-17.6695*	-17.6325*	12
	CUMMINSIND	-19.4168*	-19.4168*	0
	GLAXO	-16.3932*	-16.368*	2
	GUJAMBCEM	-19.6163*	-19.6166*	1
	HINDLEVER	-20.8471*	-22.2189*	18
	IFLEX	-17.9074*	-18.0064*	7
	MARUTI	-16.8799*	-16.8336*	10
	MICO	-17.1084*	-17.1656*	14
	SESAGOA	-18.8872*	-18.8873*	1
	SIMENS	-17.3138*	-17.3127*	3
	STER	-14.7923*	-17.536*	10

* Implies that significance at 1% level of significance

Table 7: Descriptive Statistics for crisis period of Exchange Rates and NSE

SL no.	Name	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
1	USD	0.00075	0.000598	0.007081	-0.02057	7.692697	327.5935	0
2	EURO	0.000754	0.000691	0.0096	-0.01703	4.142552	19.43547	0.00006
3	NSE	-0.000931	0.000491	0.026595	-0.33051	4.433139	37.05118	0

Table 8: Stationarity Test for crisis period of Exchange Rates and NSE

SL no.	Name of the Company	ADF	Lag	PP	Bandwidth
1	USD	-19.04446	0*	-19.05061	4*
2	EURO	-21.04170	0*	-21.04170	0*
3	NSE	-17.93144	0*	-17.92843	15*

* Implies that significance at 1% level of significance

Table 9 to 12 showed the descriptive statistics and unit root test results for eleven different multinational firms, two foreign exchange rates and NSE as a proxy for market index for post-crisis period. Most of the multinational companies had positive mean return and less standard deviation as compared to the crisis period. For bilateral exchange rates, all currencies, USD and euro have positive means (0.000125 and 3.83E-05 respectively), indicating that the rupee was depreciating on average against those currencies during the sample period. All the series were stationary under ADF and PP test, non-normal, skewed and had kurtosis values greater than three. These justified the use of GARCH family models in the selected data set.

Table 9: Descriptive Statistics for post-crisis period

SL NO.	Name of the Company	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
	ABB	-0.00016	0.000176	0.019604	2.042043	26.39164	12616.11	0
	CUMMINSIND	0.000818	0.000295	0.02326	-6.2393	101.6484	221226.7	0
	GLAXO	0.000881	0.000574	0.0131	0.181704	5.337967	125.2587	0
	GUJAMBCEM	0.000791	0.000833	0.020544	0.28	4.338307	47.09194	0
	HINDLEVER	0.000509	0	0.016392	-0.13052	4.574724	57.00913	0
	IFLEX	0.000452	-0.00063	0.017798	0.815104	6.704956	366.5982	0
	MARUTI	-0.0002	-0.00074	0.019437	-0.25453	7.186423	397.9454	0
	MICO	0.001209	-0.00036	0.012896	1.278164	8.263218	766.0367	0
	SESAGOA	-0.00044	-0.00046	0.027525	-0.01478	5.639755	155.9354	0
	SIMENS	0.00097	0.000342	0.018288	1.143846	14.05078	2849.53	0
	STER	-0.0032	-0.00023	0.06141	-18.0144	384.2271	3280895	0

Table 10: Stationarity Test for post-crisis period

SL NO.	Name of the Company	ADF	PP	Bandwidth
	ABB	-22.9094*	-22.9533*	7
	CUMMINSIND	-24.471*	-24.4449*	5
	GLAXO	-22.5674*	-22.5931*	5
	GUJAMBCEM	-25.0564*	-25.0133*	6
	HINDLEVER	-22.2097*	-22.2369*	9
	IFLEX	-21.0048*	-20.999*	2
	MARUTI	-21.3588*	-21.3518*	11
	MICO	-18.1207*	-22.6219*	3
	SESAGOA	-22.9667*	-22.9656*	2
	SIMENS	-25.1781*	-25.2495*	0
	STER	-22.1968*	-22.1833*	5

* Implies that significance at 1% level of significance

Table 11: Descriptive Statistics for post-crisis period of Exchange Rates and NSE

SL no.	Name	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
1	USD	0.000125	-0.00016	0.004723	0.419366	4.245121	50.42867	0
2	EURO	3.83E-05	0.00013	0.006289	0.248659	3.549042	12.27878	0.002156
3	NSE	0.000118	0.000244	0.011811	-0.08955	3.56048	7.746514	0.020791

Table 12: Stationarity Test for post-crisis period of Exchange Rates and NSE

SL no.	Name of the Company	ADF	Lag	PP	Bandwidth
1	USD	-22.50621	0*	-22.52505	6*
2	EURO	-23.33534	0*	-23.37333	7*
3	NSE	-21.56168	0*	-21.51955	6*

* Implies that significance at 1% level of significance

4.2 Results of applying MGARCH

4.2.1 Pre-Crisis Period

The results of contagion effect are shown in Table: 13. In the pre-crisis period, the effect of own lagged innovation (a_{ij}, where i=j) were significant at five percent level of significance for 8 out of the 11 selected MNCs, indicating the presence of ARCH effect. Amongst eleven MNCs, the own lagged innovation impact was highest for Sesa Goa. Siemens India and Hindustan Unilever Ltd. are less impacted by own lagged innovation as compared to all other selected multinational companies in this segment. Based on the magnitude of the estimated cross innovation coefficients (a_{ij}: where $i \neq j$), it was observed that cross innovation impact emanating from two foreign exchange rates was not statistically significant for any of these selected companies in this segment. The cross innovation impact originating from NSE NIFTY was positive and significant at five percent level for 5/11 MNCs and the impact was highest for Cummins India ltd.

Table 13: Results for applying MGARCH (Diagonal VECH)

Pre-Crisis Period

	aij	company	usd	euro	nse
1	ABB	-0.00312	0.005095	0.010768	0.036209*
2	CUMMINSIND	0.138313*	0.019669	-0.00625	0.103854*
3	GLAXO	0.1245*	-0.00127	-0.0425	0.072719*
4	GUJAMBCEM	0.035351	0.027589	0.000846	0.00749
5	HINDLEVER	0.066821*	0.023411	0.020331	0.020331
6	IFLEX	0.117111*	-0.00252	-0.01743	0.039164
7	MARUTI	0.067867*	0.017309	0.042227	0.045026*
8	MICO	0.093278*	0.021005	-0.03845	0.064135
9	SESAGOA	0.148554*	0.014881	0.036733	0.051999
10	SIMENS	1.75E-01*	8.46E-02	-0.07589	-0.10736*
11	STER	-3.07E-03	1.39E-02	0.005017	0.062119

	dij	company	usd	euro	nse
1	ABB	8.28E-08	2.85E-07	2.87E-07	2.90E-07
2	CUMMINSIND	2.01E-06	2.61E-06	2.07E-07	3.15E-06
3	GLAXO	0.001709	0.000792	-0.00042	0.001813
4	GUJAMBCEM	0.092077*	-0.02811	-0.02457	0.058088*
5	HINDLEVER	0.180989*	-0.02845	0.007438	0.103974*
6	IFLEX	0.006969	-0.00039	-0.00068	0.01931
7	MARUTI	0.007166	0.006968	0.003128	0.017966
8	MICO	5.56E-05	3.30E-06	1.95E-06	7.48E-05
9	SESAGOA	0.099923	-0.02458	-0.0079	0.142945*
10	SIMENS	2.579103*	0.174004	-0.0171	1.122692*
11	STER	1.16E-06	1.08E-06	1.05E-06	1.12E-06

	bij	company	usd	euro	nse
1	ABB	1.00507*	0.927428*	0.943108*	0.918562*
2	CUMMINSIND	0.718451*	0.744747	0.745792	0.76387*
3	GLAXO	0.740504*	0.803746	0.76757*	0.846735*
4	GUJAMBCEM	0.828222*	0.587623	0.803793*	0.932297*

5	HINDLEVER	0.637664*	0.916942*	0.593386	0.840002*
6	IFLEX	0.858667*	0.989228*	1.013245*	0.91836*
7	MARUTI	0.866925*	0.86051*	-0.28589	0.895503*
8	MICO	0.815132*	0.833112*	0.859932*	0.793572*
9	SESAGOA	0.706779*	0.736745*	0.814619	0.7408*
10	SIMENS	0.586192	0.045044	0.572651	0.377285
11	STER	0.592379	0.716607	0.728521	0.705147

*indicates significance at 5% level

No asymmetric volatility spillover effect, however, was significant during the pre-crisis period amongst two foreign exchange rates and the selected multinational companies.

The values of b_{ij} (where i=j) coefficients were positive and significant at 5% level of significance, indicating the presence of GARCH effect, for 9/11multinational companies. Own past volatility impact was highest for ABB ltd. (1.00507) amongst the selected multinational companies. Moreover, the cross volatility impact emanating from two foreign exchange rates was positively significant at 5% level for 3/11 selected multinational companies while 9/11 multinational companies had positive and significant impact from NSE NIFTY. Only 6/11 multinational companies were exposed to USD, 10/15 multinational companies were exposed to yen, 8/15 multinational companies were exposed to euro and only 9/11 were exposed to NSE. The average cross volatility impact was more as compared to the own past volatility impact. ARCH-LM test suggested no remaining ARCH effect in the residuals.

4.2.2. Crisis Period

Results for crisis period were presented in Table 14. In the crisis period, the effect of own lagged innovation (a_{ij}, where i=j) were significant at five percent level of significance for 5/11 selected multinational companies indicating the presence of ARCH effect. Amongst eleven multinational companies, the own lagged innovation impact was highest for GlaxoSmithKline Pharmaceuticals Limited (0.177393) while ABB ltd. was less impacted by own lagged innovation. Based on the magnitudes of the estimated cross innovation coefficients (a_{ij}: where $i \neq j$), it was observed that no companies effected by cross innovation impact emanating from two foreign exchange rates. Cross innovation impact was positive and significant between USD and ABB ltd. while the exposure was negative and significant between USD and GlaxoSmithKline Pharmaceuticals

Limited. HUL was the only MNC which exposed to euro and impact was negative and statistically significant. Moreover, only 1/11multinational companies effected from the positive and significant cross volatility impact emanating from NSE NIFTY while the same was negative for MICO.

Table 14: Results for applying MGARCH (Diagonal VECH)

Crisis Period

	aij	company	usd	euro	nse
1	ABB	0.099938*	0.077107*	-0.0302	0.022732
2	CUMMINSIND	0.149984*	0.087932	0.018244	0.009314
3	GLAXO	0.177393*	-0.0376*	-0.01534	0.05166
4	GUJAMBCEM	0.108404*	0.002263	-0.00494	0.085277*
5	HINDLEVER	0.167476*	0.028045	-0.02674*	0.038897
6	IFLEX	-0.0122	-0.00281	-0.03625	-0.01882
7	MARUTI	0.022035	0.023392	-0.00889	-0.00538
8	MICO	0.066317	-0.02874	-0.01072	-0.14487*
9	SESAGOA	-0.00397	0.010168	0.015078	0.022422
10	SIMENS	-0.00192	0.010513	-0.00766	0.056178
11	STER	0.050509	0.004575	0.001424	0.01328

	dij	company	usd	euro	nse
1	ABB	0.031015	-0.00832	-0.00392	0.051648
2	CUMMINSIND	2.62E-05	1.90E-05	5.24E-05	0.00012
3	GLAXO	4.45E-04	1.16E-04	1.83E-04	0.001304
4	GUJAMBCEM	4.41E-03	8.67E-04	3.85E-04	-0.01452
5	HINDLEVER	1.03E-01	5.07E-03	3.06E-03	0.093571*
6	IFLEX	6.50E-02	-1.19E-02	-6.77E-03	0.078015*
7	MARUTI	4.81E-02	3.71E-03	7.60E-03	0.073491*
8	MICO	5.68E-01*	-4.10E-02	-3.66E-02	0.276665*
9	SESAGOA	9.64E-07	9.68E-07	9.80E-07	9.85E-07
10	SIMENS	1.33E-06	6.22E-07	1.09E-06	1.47E-06
11	STER	0.047337	0.004058	0.015863	0.066028*

	bij	company	usd	euro	nse
1	ABB	0.827672*	-0.83622*	0.8726*	0.874706*
2	CUMMINSIND	0.358196*	0.310164	0.532267	0.892903*
3	GLAXO	0.750562*	1.012146*	0.765651	0.844428*
4	GUJAMBCEM	0.852824*	0.929265*	0.832315	0.86702*
5	HINDLEVER	0.643634*	0.890606*	1.015599*	0.774025*
6	IFLEX	0.841182*	0.911146*	0.909388*	0.868634*
7	MARUTI	0.904629*	0.907493*	0.990132*	0.854101*

8	MICO	0.617541*	0.807375*	0.782292	0.838416*
9	SESAGOA	0.591557	0.760066	0.745754	0.706222
10	SIMENS	0.845581*	0.910959*	0.887424	0.812131*
11	STER	0.864778*	0.926185*	0.86731*	0.891421*

*indicates significance at 5% level

No asymmetric volatility spillover effect, however, was significant during the crisis period amongst two foreign exchange rates and the selected multinational companies.

The values of all b_{ij} (where i=j) coefficients were positive and significant at 5% level of significance, indicating the presence of GARCH effect, for 10/11 multinational companies. Own past volatility impact was highest for Maruti Suzuki India Ltd. (0.904629) amongst the selected multinational companies. Moreover, the cross volatility impact was positively significant at 5% level for 5/11 selected multinational companies while all 10/11 multinational companies had positive and significant impact from NSE NIFTY. The average cross volatility impact emanating from foreign exchange rates and NSE NIFTY was more as compare to the own past volatility impact for all selected companies. 9/11multinational companies were exposed to USD, 5/11multinational companies were exposed to euro. ARCH-LM test suggested no remaining ARCH effect in the residuals.

4.2.3. Post-Crisis Period

Results for post-crisis period are presented in Table 15. In the post-crisis period, the effect of own lagged innovation (a_{ij}, where i=j) were positive and significant at five percent level of significance for 7/11 selected multinational companies indicating the presence of ARCH effect. Amongst eleven multinational companies, the own lagged innovation impact was highest for HUL (0.269435). Maruti and Sesa Goa were less impacted by own lagged innovation as compared to the other multinational companies in this segment. Based on the magnitudes of the estimated cross innovation coefficients (a_{ij}: where $i \neq j$), it was observed that only one multinational company got impacted by US dollar and 3 MNC impacted by euro. Moreover, only 3/11 was affected from the positive and significant cross volatility impact emanating from NSE NIFTY.

Table 15: Results for applying MGARCH (Diagonal VECH)

Post-Crisis Period

	aij	company	usd	euro	nse
1	ABB	0.163944*	0.023533	-0.07569*	-0.05917*
2	CUMMINSIND	0.921444	0.019343	0.074647	0.11991*
3	GLAXO	0.025736	-0.00981	-0.00302	-0.01498
4	GUJAMBCEM	0.038493	0.014826	0.081142*	-0.03063
5	HINDLEVER	0.269435*	0.088045*	0.008228	0.117671*
6	IFLEX	0.046127*	0.013068	-0.00826	0.023877
7	MARUTI	-0.01471*	0.019401	0.039798*	-0.00067
8	MICO	0.171696*	-0.02873	0.043778	-0.01786
9	SESAGOA	0.069736*	0.009508	-0.05102	0.010614
10	SIMENS	0.320596*	-0.02207	0.070789	0.050072
11	STER	-0.00216	0.005381	0.003209	0.021715

	dij	company	usd	euro	Nse
1	ABB	0.23844*	-0.05752	0.074417*	0.195118*
2	CUMMINSIND	0.000687	-0.00415	0.003147	0.012452
3	GLAXO	0.004035	-0.0145	-0.00547	0.030938
4	GUJAMBCEM	0.074879	- 0.07389*	-0.04044*	0.135917*
5	HINDLEVER	0.026396	-0.01447	0.021315	0.067942
6	IFLEX	0.048416	-0.0387	0.033014*	0.093122*
7	MARUTI	0.003705	-0.0012	0.007666	0.01763
8	MICO	0.026821	-0.02662	0.02286	0.080916*
9	SESAGOA	0.02082	-0.00909	0.020025	0.057014
10	SIMENS	3.29E-05	1.60E-05	-0.00038	-0.00063
11	STER	9.62E-07	9.56E-07	9.90E-07	9.97E-07

	bij	company	usd	yen	euro
1	ABB	0.577292*	0.818461*	0.8426*	0.740092*
2	CUMMINSIND	0.040707	0.238489	0.076668	0.274708
3	GLAXO	0.818417	0.947735	0.988038	0.867418
4	GUJAMBCEM	0.108242	0.052183	0.142087	-0.13354
5	HINDLEVER	0.108242	0.052183	0.142087	-0.13354
6	IFLEX	0.88457*	0.767625*	0.469984	0.552846*
7	MARUTI	0.979649*	0.891619*	0.785178*	0.950329*
8	MICO	0.431965*	0.355669	0.43579	0.856592*
9	SESAGOA	0.772781*	0.910827*	0.837293*	0.760571*
10	SIMENS	-0.01786	0.085039	0.307426	0.772059*
11	STER	0.590568	0.730244	0.763964	0.705725

*indicates significance at 5% level

There exists asymmetric volatility spillover effect during the post-crisis period. HUL was significant, but had negative impact from USD where as GUJAMBCEM and IFLEX have positive impact from euro, while the same was negative for company ABB.

The values of b_{ij} (where i=j) coefficients were positive and significant at 5% level of significance for 5/11multinational companies, indicating the presence of GARCH effect. Own past volatility impact was highest for Maruti amongst the selected multinational companies. Moreover, the cross volatility impact emanating from two foreign exchange rates was positively significant at 5% level for 3/11 selected multinational companies while 6/11multinational companies had positive and significant impact from NSE NIFTY. The cross volatility impact emanating from foreign exchange rates and NSE NIFTY was more as compared to the own past volatility for most of the selected multinational companies. ARCH-LM test suggested no remaining ARCH effect in the residuals.

5. Discussions and Conclusion

The current study seeks to explore the asymmetric exchange rate exposure on MNC's stock return, if any and its varying nature, in the context of India around the financial crisis of 2008-2009. Such exploration might be significant to global fund managers, in their hedging decision, as well as to the policy makers. The studies related to the foreign exchange exposure at firm level, in the context of India, especially related to multinational companies, predominantly before and after the latest financial crisis of 2008-2009 have been restricted in quantity. Furthermore, the existing studies have hardly used the Multivariate GARCH model. The outcome of the present study reveals the significant impact of the recent financial crisis of 2008-2009 on the foreign exchange exposure at firm level under different selected multinational companies. It principally contributes to the literature in the sense that unlike the former studies it has considered the effect of current financial crisis on the association.

USD and Euro were most insignificant past innovation exposure coefficient during pre-crisis period while the same was little significant during the crisis period as compared to the post-crisis period. Past volatility impact arose from different currencies were always less than that arose from market. All four currencies had significant impact on the multinational companies during all sub periods. However, the impact was more in the crisis period. In this sector too, US dollar had the most significant exposure as compared to euro. During the crisis period, currency exposure arising out of past volatility was highest as compared to the other periods. Past volatility impact was always more from both market and currencies, as compared to past innovation impact upon companies.

Across time the MNCs were impacted more by past volatility of market than that of past news of market. Similar results are also attained in terms of currency exposure. However, US dollar was the predominant currency amongst all, which had higher exposure towards multinational companies across eleven different selected multinational companies. USD on an average had less impact on companies due to past innovation. Thus, while cross innovation impacts tend to disappear as the market enters into a new phase of recovery, news about past volatility or any type of announcement in foreign exchange market is less likely to affect the future volatility of the stock price of multinational companies. However, one should be cautious about the past volatility impact on present volatility arising out of foreign currencies upon selected multinational companies. This is particularly true for Indian market, as the study reveals, most of the multinational companies get impacted due to cross market volatility spillover. No asymmetric exposure was found during pre-crisis and crisis period but it was significant for few companies during the post-crisis period. The study reveals enough evidence about the volatility transmission mechanism from foreign exchange markets and also from stock market towards different multinational companies. The nature and extent of such spillover usually depends on the financial market. Thus, not only the hedger and speculators may find the results useful for decision making, but also the managers can use the findings before hedging the foreign currency risk, as pointed out by the study.

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