EXCHANGE RATE FLUCTUATIONS AND FIRM VALUE: IMPACT OF GLOBAL FINANCIAL CRISIS

Abstract

Purpose: This paper examines the presence of exchange rate exposure and its relationship with currency derivatives usage in the dynamic environment of the global financial crisis of 2008.

Design/Methodology/Approach: Using a sample of 624 Indian firms over the period of April 2001 to March 2016, this study investigates the linear and asymmetric exposure by dividing full sample period into different sub-periods around the crisis.

Findings: The evidence presented in the paper suggests that the firms are more exposed to the exchange rate changes since the onset of the financial crisis. However, there is a lack of evidence that the usage of currency derivatives is more effective in reducing exposure during the crisis/post-crisis period as opposed to the pre-crisis period.

Practical Implications: The findings are important to investors and managers for a better understanding of firm behaviours in relation to their risk management policies during the period of external shocks like crisis.

Originality/Value: There is a paucity of research to explore whether the effect of currency derivatives usage on exchange rate exposure varies during external shocks such as crisis periods. The paper provides novel evidence that the effectiveness of derivatives usage in alleviating exposure becomes less during the dynamic environment of crisis.

Key words: Exchange rate exposure, financial crisis, India, currency derivatives

Article Classification: Research Paper

1. INTRODUCTION

Financial theory suggests that the cash flows of the firm are sensitive to unanticipated changes in exchange rates (Hekman, 1983, 1985; Shapiro, 1975). The extent to which the value of the firm is affected by unexpected changes in exchange rates is known as exchange rate exposure of a firm (Adler & Dumas, 1984). The examination of exchange exposure is not only important for firms that involve in international transactions but also for domestic firms (Aggarwal & Harper, 2010). In spite of the extensive research, empirical findings are not able to detect the significant relationship between exchange rate changes and firm value. The weak empirical evidence on the relationship between exchange rates and the value of the firm gives rise to the 'exposure puzzle' (Bartram & Bodnar, 2007). One of the explanations of this 'puzzle' provided by empirical studies is the time varying property of exposure (Al-shboul & Anwar, 2014b, 2014c; Allayannis & Ihrig, 2001; Glaum, Brunner, & Himmel, 2000; Jorion, 1990; Koutmos & Knif, 2002; Williamson, 2001). The exchange rate exposure of firms may change over time due to changes in the level of exports, imports and firms' competitive situation. The changes in the foreign currency denominated assets, liabilities and hedging activities may also change the exposure of firms over time. Depending upon the firms' characteristics and the nature of their cash flows, firms may respond differently to the positive and negative changes in exchange rates which might result in the asymmetric exposure. In addition to the firm specific factors, exogenous factors such as exchange rate regime, policy switch and financial crisis may also have a significant impact on the level of exposure.

Firms might face different levels of exchange rate exposures in response to a financial crisis. Financial crisis brings excessive volatility in economic system and causes undue fluctuations in exchange rates. These unexpected changes in exchange rates could adversely affect the stock returns of firms if they have not properly hedged and secured their foreign currency cash flow

positions. Lack of appropriate use of hedging instruments takes firms' currency exposure to higher level during crisis period as compared to pre-crisis period. Post-crisis period mostly turns up by the introduction of some regulatory changes by central authorities to make system less vulnerable towards external shocks. Firms may become more proactive to use proper hedging instruments in the post-crisis period and might be able to bring down their level of exposure to currency fluctuations.

In the light of this, few studies have analysed the exchange rate exposure around various financial crises. While most of the studies find that financial crisis causes higher exchange rate exposure to firms, evidence in the post-crisis period is contrasting. On the one hand, Aquino (2005) and Verschoor & Muller (2007) report a significant increase in the number of firms having currency exposure in the post-crisis period due to inadequate hedging activities, few other studies reveal lower exposure (Al-shboul & Anwar, 2014a; Bacha, Mohamad, Raihan, & Mohd, 2013; Kiymaz, 2003; Mozumder, Vita, Kyaw, & Larkin, 2015; Ye, Hutson, & Muckley, 2014) on account of improved hedging policies. The understanding of how firms' stock returns respond to the exchange rate changes during crisis period is important for better management of risk hedging activities under unseen circumstances. Currency derivatives as a hedging device to manage currency risks is popularly used by the firms. Most of the existing literature has consensus that the usage of currency derivatives reduce exchange rate exposure (Allayannis & Ofek, 2001). However, in the unforeseen exchange rate shocks during crisis periods, one might expect that the impact of derivatives usage on exposure might vary over time. The effectiveness of derivatives usage in alleviating exposure might be less during the crisis periods due to unexpected changes in exchange rates. The impact of derivatives usage on exposure around financial crisis has not seen much attention in the literature. It is pertinent for firms to explore

whether the impact of derivatives usage on exposure varies during unexpected events like crisis for better formulation and management of hedging policies.

Accordingly, this paper investigates the level of linear and asymmetric exchange rate exposure at individual firm level in the environment of recent global financial crisis of 2008. In addition, this paper investigates whether the relationship between currency derivatives usage and exposure varies significantly over time around the period of crisis. This study examines these important research questions considering the case of 624 Indian firms during April 2001 to March 2016.

The global financial crisis of 2008 had the considerable effect on most of the developed and developing economies including India. India has strong trading relations with the United States and other developed countries. There was a significant decline in the volume of exports due to slump in the demand in the US and Europe which contributed towards the major trade deficit in India's balance of payment. Consequently, Indian rupee depreciated due to high domestic demand of foreign currency and large foreign currency outflows. Since the changes in the exchange rates affect the potential cash flows of the firms, Indian stock market too experienced a sharp fall in January 2008 in response to the global financial crisis.

There are several reasons why Indian firms would represent an interesting case study and a natural experiment of examining exchange rate exposure around the financial crisis of 2008. India has emerged as a second-largest economy amongst Asian developing countries after China in terms of GDP growth, international trade and foreign investment as per the report of World Economic Situation and Prospects, 2017. The volume of exports has witnessed strong growth in last few years in south Asia led by India and has already recovered to or beyond pre crisis peaks in contrast to the developed countries. The Indian rupee has depreciated for more than 45 percent in the last decade. Also, Indian companies faced huge losses during the crisis of 2008 due to

improper use of currency derivatives to hedge the currency exposure (Rajwade, 2010). In Spite of these facts which indicate that Indian firms are subject to face high exchange rate risk, no exclusive in-depth study has been conducted in India on this issue. Only a few studies have considered India as a part of their multi-country analysis of exchange rate exposure.

This study examines the presence and variation of linear as well as asymmetric exposure by segregating the full sample period into three sub-periods- pre crisis period, ongoing crisis period and post crisis period. Moreover, the paper investigates the effectiveness of currency derivatives usage in alleviating currency exposure during various sub-periods. Examination of these issues are likely to be of interest to investors and managers for a better understanding of firm behaviours in relation to their risk management policies during the period of any unexpected external shocks.

The findings of this study reveal the presence of significant exchange rate exposure in the full sample period of 2001-2016. There is a weak evidence of exposure in the pre-crisis period as opposed to the crisis and post-crisis periods. This suggests that the financial crisis of 2008 has strongly contributed to the overall strength of the exposure. The analysis suggests weaker evidence of the asymmetric exposure in the full sample period. Finally, the study finds that the currency derivatives usage is more effective in reducing exposure in the pre-crisis period as compared to the crisis and post-crisis periods. The study adds to the existing literature which mentions that the exposure can vary over the period of time and systematic factors like crisis may determine this variation. Additionally, the study has a unique contribution by providing evidence that the relationship between currency derivatives usage and exposure could vary over the period of time and the effectiveness of derivatives in reducing exposure might become lower during external shocks like crisis.

The remainder of this paper is organized as follows. The theoretical background and review of empirical evidence is presented in section 2, followed in section 3 by a description of the methodology used in this study for measuring exchange rate exposure. The empirical results and discussion are presented in section 4. The paper concludes in the Section 5.

2. THEORETICAL BACKGROUND AND EMPIRICAL EVIDENCE

Exchange rate exposure refers to the extent to which the value of the firm is affected by unexpected changes in exchange rates (Adler & Dumas, 1984). The exchange rate exposure is theoretically classified into three broad categories (Eun & Resnick, 2014). The first is *Transaction Exposure,* which is defined as the sensitivity of "realised" domestic currency values of the firm's contractual cash flows denominated in foreign currencies to unexpected exchange rates. The second is *Economic Exposure,* which is defined as the extent to which future cash flows are affected by unanticipated changes in exchange rates. The third is *Translation Exposure,* which refers to the potential that the firm's consolidated financial statements can be affected by changes in exchange rates. Theoretically all firms, domestic and international, are exposed to exchange rate risk. However, empirical evidence finds mixed results. While some studies report strong evidence of exposure (Bacha et al., 2013; Choi & Prasad, 1995; Kiymaz, 2003), a large number of studies reveal only small number of firms significantly affected by exchange rate changes (Chue & Cook, 2008; Jorion, 1990; Lin, 2011; Muller & Verschoor, 2007). One of the reasons of this inconclusiveness attributed by existing literature is the time varying property of exposure (Al-shboul & Anwar, 2014b, 2014c). Some studies report that exposure changes over time due to changes in the level of exports, imports and firms' competition situation (Glaum et al., 2000; Williamson, 2001). While other studies attribute this

nature of exposure to the effect of exogenous factors like exchange rate regime (Parsley & Popper, 2006), policy switch (Bacha et al., 2013) and financial crisis (Lin, 2011; Verschoor & Muller, 2007; Ye et al., 2014). The evidence of asymmetric exposure, i.e. the response of stock returns to positive and negative exchange rate changes differently, has also presented by few studies (Al-shboul & Anwar, 2014a; Koutmos & Martin, 2003, 2007; Muller & Verschoor, 2006).

Financial crisis is one of the major external factors that can affect the volatility of exchange rates and stock returns of firms. Several studies report that financial crisis has a significant impact on the level of exchange rate risk of a firm. These studies find that the firms face higher exposure during the period of crisis due to the episodic volatility of exchange rates. The studies also report firm's internal financial and hedging policies as a cause of higher exposure during crisis period. For example, Yip & Nguyen, (2012) report a significant increase in the level of exposure of Australian firms during the global financial crisis of 2008 but interestingly do not find any substantial increase in the proportion of firms that use hedging instruments. Lin (2011) investigates the exchange rate exposure of six emerging markets including India and reports that higher exposure during the crisis period of 2008 can be attributed to firm level factors like exports and foreign assets. Rossi (2011) also finds that firm's hedging and financial policies lead to higher exposure during crisis periods for Brazilian firms. Bacha et al. (2013) find that the Malaysian firms face higher exposure during Asian crisis period which reduced remarkably in the post crisis period. Lan, Chen, & Chuang (2015) find that the taiwanese firms faced higher exchange rate exposure during the financial crisis of 2008 as compared to Asian crisis and argue that a complete hedge strategy to reduce the risk for a single currency during the crisis is not appropriate as exposure may arise from either revenue side or cost side. Therefore, volatile

exchange rates during crisis period increase firms' exposure to exchange rate risk as firms are not well hedged in advance to tackle the unexpected situation.

The studies which analyse the exchange rate exposure around the financial crises, specifically in the post crisis period, provide contrasting results. Kiymaz (2003) finds exchange rate exposure of turkish firms for the period of 1991 to 1998 and argues that the exposure is lower in the post crisis period as firms begin giving more attention to their level of exposure. Al-shboul and Anwar (2014) also report lower exposure in the post crisis period (February 2009- November 2011) and attributed this to the introduction of some strict regulatory policies by Canada government after crisis. Ye et al. (2014) examine foreign exchange exposure of 20 emerging countries including India and find that firms face higher exposure during ongoing crisis period (January 2008-December 2008) as compared to the pre-crisis period. They argue that a reduction in exposure in the post crisis period might be a result of improved hedging activities conducted by firms after the crisis. Mozumder et al. (2015) determine exchange rate exposure of European firms around financial crisis of 2008 and report higher exposure during crisis period. They find that the exposure was lower in the pre-crisis and post crisis period which might indicate that during crisis firms were not able to hedge properly due to liquidity constraints. Few other studies present the opposite findings. For example, Aquino (2005) finds that the Philippine firms' stock returns were significantly affected by the exchange rate changes in the post Asian crisis period as investors start demanding extra return for firm's higher exchange rate risk. Verschoor & Muller (2007) also observed higher exposure for US multinationals in the post Asian crisis period and mention that firms did not increase their hedging activities after crisis. This indicates that firms face higher exposure in the post crisis period due to either higher cost of capital or inadequate

hedging activities. Firms that are able to incorporate improved and effective hedging activities may face lower exposure in the post crisis period.

Given the aforementioned mixed findings on exposure, this study re-examines the issue in order to explore how do firms react to exchange rate changes around the financial crisis and whether currency derivatives usage is more effective in reducing exposure of the firm around crisis period? In addition, the possibility of asymmetric exposure is also examined. This paper tries to extend the current literature by providing a comprehensive analysis of Indian case.

3. RESEARCH METHODOLOGY

3.1 Measuring Foreign Exchange Exposure

The exchange rate exposure of the firms for full sample period is estimated by the approach suggested by Jorion (1990) [i] as follows:

$$R_{it} = \beta_{0i} + \beta_{mi}.R_{mt} + \beta_{si}.R_{st} + \varepsilon_{it} \qquad (1)$$

where R_{it} is the monthly stock return of firm i in period t ; R_{mt} is the monthly return on the market portfolio in period t ; R_{st} is the monthly percentage change in the trade-weighted exchange rate index, measured as units of foreign currency per one Indian Rupee in period. The increase in the value of R_{st} indicates an appreciation of Indian Rupee against a basket of foreign currencies. The coefficients β_{mi} and β_{si} represent a measure of sensitivity of stock return of firm, i, to market risk and exchange risk; ε_{it} is the disturbance term. The value obtained for β_{si} for different firms can be interpreted as a level of exposure to exchange rates indicating the

extent to which the stock return responds to a 1% change in the exchange rate. In equation (1), β_{si} cannot be interpreted as 'total exposure' but rather the exposure of stock over and above that of the market portfolio i.e. residual exposure. In order to eliminate the effect of exchange rates from market portfolio, orthogonalization procedure was employed as suggested in the literature (Priestley & Ødegaard, 2007; Kiymaz, 2003). In this method, market portfolio returns are first regressed on the changes in the exchange rate and the residuals are captured. These residuals are that part of market portfolio returns which is not influenced by the exchange rate changes and thus, used in the equation (1) to estimate the exposure.

A positive coefficient means that firm's stock return increases when the Indian rupee is appreciated against the basket of other currencies. Equation (1) is estimated by ordinary least square (OLS) correcting for standard errors by Newey & West (1987) method[ii]. The robustness of the exposure coefficients is examined by using alternative exchange rate index and market portfolio index.

To examine the effect of financial crisis, the full sample period is divided into three sub-periods i.e. pre crisis period (April 2001- December 2007), ongoing crisis period (January 2008-March 2009) and post crisis period (April 2009-March 2016). The division of sub-periods is based on the time-varying performance of global and emerging markets (Ye et al., 2014) and is also supported by the structural break test of Bai and Perron (2003). The period-by-period exposure is determined by using interactive time dummies following prior studies (Parsley and Popper, 2006; Ye et al., 2014):

$$R_{it} = \beta_{0i} + \beta_{mi}.R_{mt} + \sum_{n=1}^{3}.\beta_{si,n}.D_{n,t}R_{st} + \nu_{it} \quad (2)$$

where $D_{n,t}$ is a time dummy variable: D1= 1, April 2001- December 2007; = 0, otherwise; D2 = 1, January 2008-March 2009; = 0, otherwise; D3= 1, April 2009-March 2016; =0, otherwise.

3.2 Asymmetric effect model

The following model has been used to find the asymmetric effects of exchange rate changes on the stock returns of the firms as suggested by Al-shboul & Anwar (2014b);

$$\varepsilon_{it} / \sigma_{\varepsilon it} = \beta_{0i} + \lambda_{1i} Z_{1t} + \lambda_{2i} Z_{1t} R_{st} + \lambda_{3i} Z_{2t} R_{st} + \mu_{it} \qquad (3)$$

Where the dependent variable is the estimated standardized residuals calculated from equation (1). Z_{1t} is a dummy variable which takes a value of unity if the exchange rate change, R_{st}, is negative; zero otherwise. Thus, λ_{2i} indicates how a negative change in the exchange rate i.e. depreciation of Indian rupee affects the dependent variable. Similarly, λ_{3i} indicates how a positive change in the exchange rate i.e. appreciation of Indian rupee affects the dependent variable as $Z_{2t} = 1 - Z_{1t}$.

3.3 Determinants of Exposure

The study uses cross-sectional regression model to examine the determinants of exposure during the crisis period. These characteristics include firm's net export sales scaled by total sales, size, currency derivatives usage and industry. Several studies have found a strong positive relation between firm's foreign exchange exposure and its foreign involvement (Choi & Prasad, 1995; Dominguez & Tesar, 2006; He & Ng, 1998; Jorion, 1990). The absolute value of net trade or net

exports (i.e. |exports-imports| scaled by total sales) is used to proxy for firm's involvement in international activities. The firms with higher value of |exports-imports| are more involved in international trade and thus are expected to have higher exchange rate exposure. To measure currency derivatives usage, a dummy variable is used that assigns a value of one if the firm uses foreign currency derivatives or zero otherwise. These data were hand-collected from the firms' annual reports. Previous studies have detected conventional negative relationship between currency derivative usage and foreign exchange exposure (Allayannis & Ofek, 2001).

Natural logarithm of firm's total assets is used for possible firm's size effects on exchange rate exposure. It is well established by literature that small firms tend to be more exposed to exchange rate risk than large firms (Bodnar & Wong, 2003; Chang, Hsin, & Shiah-Hou, 2013; Chow, Lee, & Solt, 1997; Dominguez & Tesar, 2006). Larger firms are more likely to hedge exchange exposure as a result of their economies of scale and therefore face lower exposure.

Several studies have found that industries are affected differentially by exchange rate movements. Industries differ in terms of pass through and markups (Allayannis & Ihrig, 2001; Bodnar, Dumas, & Marston, 2002), competitive structure (Marston, 2001) or industry concentration (Bartram & Karolyi, 2006) and hence may face different levels of exposure. The industry categories for this study follow the industrial categorization codes of (NIC) National Industrial Classification (see Table 4). Industry effect is controlled using dummies in all specifications of cross-sectional regressions.

Based on the previous literature, the following cross-sectional regression model is estimated. The standard errors are corrected for heteroskedasticity by the method suggested by White (1980).

$$|\beta_{si}| = \gamma + \gamma_1 |\text{Net\_EXP}|/\text{TS}_i + \gamma_2 SIZE_i + \gamma_3 CD_i + \sum_{k=1}^{18} \gamma_5^k INDDUM_i^k + \mu_i \qquad (4)$$

where $|\beta_{si}|$ is the absolute value of foreign exchange rate exposure coefficient of firm *i* estimated from equation (1). Following prior literature which argues that firm-level traits can assist only in explaining the magnitude rather than the direction of the exchange rate exposure (Aggarwal & Harper, 2010; Aysun & Guldi, 2011; Bartram, 2004; Choi & Prasad, 1995; Doukas, Hall, & Lang, 2001; Faff & Marshall, 2005), the absolute value of exposure coefficient is taken as a dependent variable. All independent variables are operationalized by taking the average of year-end figures for the sample period of 15 years, i.e. March 2002-March 2016. $|\text{Net\_EXP}|/\text{TS}_i$ denotes absolute value of net exports sales scaled by total sales for firm *i*, $SIZE_i$ is the logarithm of the firm's total assets, CD_i is the dummy variable having value 1 if the firm *i* uses currency derivatives for hedging purposes, zero otherwise, and $INDDUM_i^k$ are 18 industries dummies with Chemical, Plastic and Petroleum industry as the reference category for dummy variables. μ_i, the error terms, are assumed to be normally distributed.

3.4 Data and Sample

The sample of firms for the study is primarily sourced from Centre for monitoring the Indian economy (CMIE) Prowess database. Similar to previous studies, we exclude financial firms from sample firms because derivative usage for financial firms is often business related. The non-financial firms which are listed on Bombay Stock Exchange (BSE) are 4308. The non-financial listed firms that report international transactions (exports or imports) in each of the years of sample period are 1255, out of which 624 firms have no missing stock return data. Therefore, the final sample consists of 624 firms.

For estimating firms' exposure coefficients at first stage, monthly data was obtained. The market portfolio monthly returns are calculated from BSE Sensitive Index (Sensex) of 30 firms. The index value is available on the website of the Bombay stock exchange[iii]. 36 countries nominal effective exchange rate index (36 NEER; Base: 1985=100) published in Reserve Bank of India (RBI) monthly bulletin is used for the purpose of calculating monthly exchange rate changes[iv]. The monthly stock returns[v] of firms are obtained from CMIE prowess data base. In India, the 1997 Report of the Committee on Capital Account Convertibility under the Chairmanship of Mr. S S Tarapore provided the initial framework for the liberalisation of capital account transactions in India. The Committee recommended a phased implementation of capital account convertibility to be completed by the year 1999-2000. Considering the fact that capital flows have substantial influence on exchange rate, the time period of this study is April 2001 to March 2016.

4. EMPIRICAL RESULTS AND DISCUSSION

Table I reports the summary of the exposure estimates from regression equation (1). We can see that significant exposure to exchange rate risk is exhibited by approximately 77.7% (485/624) of the sample firms. The average value of exchange rate exposure coefficients is 1.645 indicating that a 1 percent appreciation of Indian rupee causes almost 1.64 percent gain in the firms' stock returns. These results are similar to those of previous studies on emerging markets which report more than half of their sample firms with significant exposure (Bacha et al., 2013; Kiymaz, 2003; Parsley & Popper, 2006; Tsai, Chiang, Tsai, & Liou, 2014; Ye et al., 2014). Table II shows that the exchange rate exposure coefficient estimates are robust to alternative measures of

exchange rate index (Real Effective Exchange Rate i.e. 36 REER) rate and market portfolio index (BSE S&P 500 index).

(Insert Table I about here)

(Insert Table II about here)

Table III presents a summary of the exchange rate exposure coefficients of the firms for different sub-periods. The prevalence and magnitude of exposure varies across sub-periods. A closer examination reveals that crisis was possibly the underlying reason for significant exposure for full sample period. Specifically, the average significant exposure is highest in the crisis period (2.911) which further reduced in the post crisis period (2.032). The average exposure is lowest in the pre-crisis period (1.260). The prevalence of exposure found to be slightly different. Only 18.7% firms are significantly exposed to the exchange rate risk during the pre-crisis period which increased significantly to 38.9% in the crisis period. This figure increased drastically in the post-crisis period to 72.91%.

(Insert Table III about here)

These results indicate that the financial crisis of 2008 caused higher exchange rate exposure for the firms as there was a substantial increase in the average magnitude of exposure. This evidence is consistent with the theoretical arguments and empirical studies (Bacha et al., 2013; Lin, 2011; Rossi, 2011; Yip & Nguyen, 2012) which suggests that higher exchange rate volatility during crisis period affect the stock returns of the firms. In the post crisis period, more firms are

significantly exposed to exchange rate risk but the average value of significant exposure coefficients is reduced. The reason may be that firms that faced higher exposure during crisis were able to reduce it by improved hedging activities. Also the high prevalence of exchange rate exposure may be the result of higher rate of return demanded by the investors of more firms to compensate the adverse impact of exchange rate changes. These findings are consistent with Ye et al. (2014) which find same results for 20 emerging markets including India.

The sign of the exposure coefficients are somewhat consistent in various sub-periods. The findings indicating that, on average, firms gain from the appreciation of domestic currency. This result is not surprising and consistent with the prior literature on emerging markets (Chue & Cook, 2008; Dominguez & Tesar, 2006; Muller & Verschoor, 2007; Tsai et al., 2014; Ye et al., 2014). These findings can be attributed to the reliance of Indian firms on imports for the production and exports to the other markets. Additionally, the heavy short-term capital inflow and outflow to India in recent years may be the other possible reason behind this phenomenon. Following the literature (Aggarwal & Harper, 2010; Aysun & Guldi, 2011; Bartram, 2004; Choi & Prasad, 1995; Doukas et al., 2001; Faff & Marshall, 2005), this study is not particularly concerned about the direction of exchange rate effects on equity returns but rather the extent of exposure in an absolute sense.

To provide further robustness, firms are grouped into their respective industries and industry-wise exposure coefficients are estimated. Table IV shows that in the full sample period, the evidence of significant exposure is strong and all the industries are significantly exposed to exchange rates which is consistent with the prior findings of firm level analysis. The pre-crisis period clearly reveals that very few industries are significantly exposed to exchange rates. The export-oriented Information Technology Industry has the highest exposure followed by the

Consumer Goods Industry. Crisis period exhibits strong evidence of exposure for most of the industries except a few, which is consistent with the expectations. In the post-crisis period, the average exposure coefficient of some industries has declined, while the exposure has increased for few industries. This might be the result of the effectiveness of the hedging policies implemented by some firms after the crisis.

(Insert Table IV about here)

Table V presents the results of the asymmetric effect model which shows whether positive or negative changes in the exchange rates have differential effect on the stock returns of the firms. It is evident that the presence of the asymmetric effect is weaker as compared to the linear effect. 99 (8%) firms are significantly affected by the positive changes in the exchange rates (appreciation of the Indian rupee) and most of these firms (71) gain from the appreciations. On the other hand, only 49 (16%) firms respond significantly to the negative changes in the exchange rate (depreciation of the Indian rupee) and on average, firms get adversely affected by the depreciation. One possible reason for this evidence of asymmetric exposure is that Indian firms might not have been hedging against both foreign currency receivables and payables. Suppose, if an exporter hedges only its receivables and not payables, then it might asymmetrically respond to the exchange rate changes. Therefore, asymmetric exposure may be the result of asymmetric hedging policies as documented also by Koutmos and Martin (2003).

(Insert Table V about here)

Table VI presents the factors that affect the exchange rate exposure of firms during various sub-periods. In the pre-crisis period, |Net_EXP|/TS is significantly positively related to exposure which is consistent with the expectation. Firms with larger size have lower exposure as they might be able to use more effective hedging instruments. The variable CD_i is significant in the pre-crisis period indicating that the firms were able to reduce their exposure by using currency derivatives. This finding might also explain the weak evidence of exposure in the pre-crisis period. The relative stability of the exchange rate and the effective use of currency derivatives kept exposure of the firms at a lower level.

However, the usage of currency derivatives seem to be less effective in reducing exposure of the firms during the crisis period. This is expected given the unforeseen volatility of exchange rates and the possibility of having large unhedged positions held by the firms. The stability of Indian rupee in the pre-crisis period might create a situation of moral hazard for the firms and thus, encourage firms to leave large unhedged positions. These unhedged positions might have led to a substantial loss for the firms during the crisis period and have overwhelmed the benefits derived from the hedged positions.

In the post-crisis period, the usage of currency derivatives does not help firms to reduce the exposure significantly. This explains the evidence of high prevalence of significant exposure of the firms during this period. This indicates that relying only on financial derivatives might not be an appropriate strategy to manage the exposure in the post-crisis period. Firms should devise a comprehensive hedging strategy including operational and financial hedges with some innovative instruments. It is advisable for firms to focus on operational hedges as well so that they can become less vulnerable to external shocks and can avoid the unexpected losses related to currency derivatives.

(Insert Table VI about here)

5. CONCLUSION

The relationship between changes in exchange rates and firm value has been well theorized and validated by a plethora of empirical studies. However, the evidence on the reaction of the firm value to the changes in exchange rate during external shocks like crisis is mixed. Also, there is a little research to explore whether the impact of derivatives usage on exposure varies during unexpected events like crisis and if firms respond differently to the positive/negative changes in the exchange rates. To address these issues and to provide further explanation to the exposure puzzle, this study considers the case of Indian firms. There are a few multi-county studies on this topic which include India but no study has examined a detailed comprehensive analysis of Indian firms exclusively. This study examines the exchange rate exposure of Indian firms and its relationship with currency derivatives usage during different sub-periods around the financial crisis of 2008. The study finds strong evidence of exchange rate exposure during the crisis and the post-crisis period as compared to the pre-crisis period. Also, the usage of currency derivatives is not found to be effective in reducing the exposure of the firms since the onset of crisis. These findings have important policy and managerial implications. The firms should be encouraged not to leave their exposure unhedged as these positions might lead to big losses in the period of external shocks. These losses can be avoided if firms hedge both revenue side and cost side cash flows. Firms should not rely completely on the currency derivatives to manage their exposure as derivatives are considered as double edged swords. Rather, firms should implement an integrated risk management system incorporating operating hedges and financial

hedges. Future research may explore the effect of operational hedges on exposure along with other determinants during the period of crisis.

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The author of this article has not made their research dataset openly available. Any enquiries regarding the dataset can be directed to the corresponding author.

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Notes

[i] The similar methodology has been adopted by numerous other studies (Choi & Prasad,1995; He & Ng, 1998; Dominguez & Tesar, 2006; Hutson & Stevenson, 2010; Ye et al., 2014)

[ii] The estimation through OLS and using adjusted robust errors is cited as a common practice in finance studies for time series models (Chow et al., 1997).

[iii] www.bseindia.com

[iv] Examining exposure to the trade weighted exchange rate index is a standard practice followed by literature (Jorion, 1991; Choi & Prasad, 1995; Bodnar & Gentry, 1993; Dominguez & Tesar, 2006)

[v] The stock returns of all firms, exchange rate changes and market portfolio returns are checked by Augmented Dickey Fuller (ADF) unit root test and found to be stationary

Tables

Table I
Summary of exchange rate exposure coefficients (Full Sample Period)

	(β_{si})
No. of firms with significant exposure	485
% of sample firms with significant exposure	77.72%
No. of firms with positive significant exposure (10% level)	485
No. of firms with negative significant exposure (10% level)	0
Average value of significant exposure coefficients	1.645
Average value of exposure coefficients of all firms	1.406
Minimum	-1.012
Maximum	4.323
Standard deviation	0.728

This table shows a summary of the estimated coefficients of Eq. (1): $R_{it} = \beta_{0i} + \beta_{mi}.R_{mt} + \beta_{si}.R_{st} + \varepsilon_{it}$. R_{it} is the monthly stock return of firm *i* in period *t* ; R_{mt} is the monthly return on the market Portfolio (BSE SENSEX) in period *t*; R_{st} is the monthly percentage change in the trade-weighted exchange rate index (36-NEER).

Table II
Robustness of exchange rate exposure coefficients (Full sample period)

	Exposure to REER (β_{si})	**Exposure to NEER with alternative market index (β_{si})**
No. of firms with significant exposure	478	483
% of firms with significant exposure	76.6%	77.4%
No. of Firms with positive significant Exposure (10% level)	478	483
No. of Firms with negative significant Exposure (10% level)	0	0
Average value of all exposure coefficients	1.399	1.406
Average value of significant exposure coefficients	1.619	1.649
Minimum	-1.014	-1.018
Maximum	4.121	4.323
Standard deviation.	0.729	0.719

This table provides robustness of the estimated coefficients of Eq. (1): $R_{it} = \beta_{0i} + \beta_{mi}.R_{mt} + \beta_{si}.R_{st} + \varepsilon_{it}$. Eq. (1) is re-estimated taking alternative market portfolio returns and exchange rate index. R_{it} is the monthly stock return of firm *i* in period *t* ; R_{mt} is the monthly return on the market Portfolio (BSE S&P 500 index) in period *t*; R_{st} is the monthly percentage change in the trade-weighted exchange rate index (36-REER).

Table III: Exchange rate exposure coefficients

	Sub-period Analysis		
	Pre crisis period (April 2001- December 2007) β_{s1}	**Crisis period (January 2008- March 2009)** β_{s2}	**Post crisis period (April 2009- March 2016)** β_{s3}
No. of firms with significant exposure	117	243	455
% of firms with significant exposure	18.7%	38.9%	72.91%
No. of Firms with positive significant Exposure (10% level)	99	240	455
No. of Firms with negative significant Exposure (10% level)	18	3	0
Average value of all exposure coefficients	0.427	1.709	1.657
Average value of significant exposure coefficients	1.260	2.911	2.032
Minimum	-5.460	-12.507	-1.351
Maximum	4.362	14.252	6.349
S.D.	0.621	0.653	0.641

This table shows a summary of the estimated coefficients of Eq. (2): $R_{it} = \beta_{0i} + \beta_{mi}.R_{mt} + \sum_{n=1}^{3}.\beta_{si,n}.D_{n,t}R_{st} + \nu_{it}$ R_{it} is the monthly stock return of firm i in period t ; R_{mt} is the monthly return on the market Portfolio (BSE SENSEX) in period t; R_{st} is the monthly percentage change in the trade-weighted exchange rate index (36-NEER). $D_{n,t}$ is a time dummy variable: D1= 1, April 2001- December 2007; = 0, otherwise; D2 = 1, January 2008-March 2009; = 0, otherwise; D3= 1, April 2009-March 2016; =0, otherwise.

Table IV : Industry-wise exchange rate exposure coefficients

Industry	Full Sample period	Pre-crisis period	During crisis period	Post-crisis period
Chemical, Plastic and Petroleum products	1.277***	0.345	1.880***	1.519***
Communication Services	2.266***	0.631	1.594**	3.137***
Construction and Real State	1.245***	0.165	1.661**	1.556***
Construction Materials	1.292***	0.335	1.677***	1.472***
Consumer Goods	1.842***	1.228***	1.528**	2.161***
Diversified	1.319***	0.035	1.625*	1.731***
Electricity	1.609***	0.402	1.567**	2.171***
Food and Agro based products	1.218***	0.184	1.803***	1.572***
Hotel and Tourism	0.981***	-0.003	0.739	1.331***
IT	1.777***	1.773***	1.502*	1.464***
Machinery	1.580***	0.594*	1.699***	1.828***
Metal and Metal products	1.514***	0.538	1.314**	1.727***
Mining	1.218***	0.200	0.387	1.462***
Miscellaneous Manufacturing	1.404***	0.163	2.461**	1.623***
Miscellaneous Services	1.731***	0.967**	2.457***	1.657***
Textiles	1.650***	0.906***	1.801*	1.690***
Transport Equipment	1.169***	-0.246	1.722**	1.594***
Transport Services	1.336***	0.307	1.663***	1.681***
Wholesale and Retail trading	1.460***	1.162**	0.927	1.360***

This table shows a summary of the estimated coefficients of Eq. (1): $R_{it} = \beta_{0i} + \beta_{mi}.R_{mt} + \beta_{si}.R_{st} + \varepsilon_{it}$. R_{it} is the average of the monthly stock returns of the firms belong to the industry *i* in period *t* ; R_{mt} is the monthly return on the market Portfolio (BSE SENSEX) in period *t*; R_{st} is the monthly percentage change in the trade-weighted exchange rate index (36-NEER). ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% level.

Table V: Asymmetric Exchange rate coefficients

	λ1i	λ2i	λ3i
No. of firms with significant exposure	35	49	99
% of sample firms with significant exposure	6%	8%	16%
No. of firms with positive significant exposure (10% level)	18	8	71
No. of firms with negative significant exposure (10% level)	17	41	28
Average value of significant exposure coefficients	-0.003	-1.657	0.8156
Minimum	-0.08	-4.3097	-2.845
Maximum	0.099	2.126	4.018
Standard deviation	0.06	1.64	1.705

This table shows a summary of the estimated coefficients of Eq. (3): $\varepsilon_{it}/\sigma_{\varepsilon it} = \beta_{0i} + \lambda_{1i}Z_{1t} + \lambda_{2i}Z_{1t}R_{st} + \lambda_{3i}Z_{2t}R_{st} + \mu_{it}$ R_{it} is the monthly stock return of firm *i* in period *t* ; Where the dependent variable is the estimated standardized residuals calculated from equation (1). Z_{1t} is a dummy variable which takes a value of unity if the exchange rate change, R_{st}, is negative; zero otherwise.

Table VI
Cross sectional analysis (Dependent variable: β_{si})

Variables	Pre-crisis period	During crisis period	Post-crisis period
Constant	2.567*** (8.08)	2.334*** (6.822)	1.321*** (6.053)
|Net exports| to Total Sales	0.652* (1.910)	0.112* (1.696)	0.102 (0.501)
Size	-0.154*** (-4.005)	-0.032* (1.523)	0.003 (1.217)
Hedge	-0.150* (-1.535)	-0.080 (-0.751)	-0.062 (-0.876)
Industry Dummies	YES	YES	YES
Adjusted R-Square	0.221	0.120	0.131
F-statistics	3.362***	2.315**	2.332***
No. of Observations	624	624	624

This table shows the cross-sectional regression analysis of Eq. (4): $|\beta_{si}| = \gamma + \gamma_1 |\text{Net\_EXP}|/\text{TS}_i + \gamma_2 SIZE_i + \gamma_3 HEDGE_i + \sum_{k=1}^{18} \gamma_5^k INDDUM_i^k + \mu_i$. $|\beta_{si}|$ is the absolute value of foreign exchange rate exposure coefficient of firm *i* estimated from equation (1). $|\text{Net\_EXP}|/\text{TS}_i$ denotes absolute value of net exports sales scaled by total sales for firm *i*, $SIZE_i$ is the logarithm of the firm's total assets, $HEDGE_i$ is the dummy variable having value 1 if the firm *i* uses currency derivatives for hedging purposes, zero otherwise, and $INDDUM_i^k$ are 18 industries dummies with Chemical, Plastic and Petroleum industry as the reference category for dummy variables. μ_i, the error terms. White (1980) heteroskedasticity-consistent standard errors are used. Numbers in the parentheses under the coefficients are the associated t-statistics. ***, **, and *, respectively, denote significance at the 1%, 5%, and 10% level.