Factors Determining the Exchange Rate Exposure of Firms: Evidence from India

Abstract

Exchange rate exposure is a strategic decision in finance and risk management at both the micro and macro level of business operations. Literature on the measurement, and management of this risk, has had no consensus on the factors affecting it as these factors seem to be dynamic. To consider a comprehensive study at the firm level, this article examines the exchange rate exposure of 271 constituent firms from the BSE S&P 500 index. The study period was from 2001 to 2020 divided into sub-periods around the financial crisis of 2008. The study uses two contemporary approaches (the capital market approach and the cash flow approach) and five relevant exchange rates (USD, EURO, GBP, JPY, and REER) to measure the foreign exchange. The sample firms were divided into 10 industrial sectors to identify the factors that led to exposure of firms to exchange rate volatility. We use multinomial logistic regression to regress the select factors with the measured value of exchange rate exposure. The findings of the article suggest that multinationalism, fixed asset utilization ratio, hedging activities, industrial sectors, size, and age of the firms are the significant determinants of such exposure. The results varied during the sub-periods and across industries.

Keywords

Determinants, exchange rate exposure, multinomial logistic regression

Introduction

Foreign exchange exposure (FXE) is the impact of a change in the exchange rate of a currency on any entity, like a firm, industry or country. The risks arising from volatility in exchange rates have been academically evaluated when Shulman, in 1970, questioned if the exchange rate risks were measurable (Shulman, 1970). Since then, there have been numerous theoretical and empirical studies on this topic. Previous studies have emphasized that FXE and its impact is dynamic in nature as it varies between entities, over time and in relation to varied currency on the same entity (Chen et al., 2016; Sikarwar, 2018). However, empirical evidence relating to the exposure, measurement and the relationships between exchange rate exposure and its determinants have been so incomplete and mixed that this phenomenon is considered a puzzle in academic literature.

Firms are exposed to exchange rate risk continuously; literature claims that there are three forms of such exposure; the transaction exposure, the translation exposure and the economic exposure (Hussain et al., 2020). While transaction exposure means the cash flow of the firm will be affected by exchange rate changes at an operational level, translation exposure is the possibility of misrepresenting the financial statements due to change in the exchange rates in the consolidated statements. Both these exposures are impossible to measure accurately and need to be hedged or adjusted while preparing the accounting records (Andrikopoulos et al., 2020). Perhaps it is the economic exposure which means the risk of losing the firm's value due to exchange rate volatility that needs to be measured and managed as it is not under the control of individual firms. Volatility in the exchange rate and its impact, specifically on firms, has been actively studied in the recent years. Yet, there is no consensus on the measurement, impact or the factors that determine such exposure.

The determinants of the FXE of firms are variables which impact the extent of exposure each firm faces to the changes in the exchange rates. In a globalized world, firms operate in multiple currencies, and most Indian firms operate in the four major currencies namely United States Dollars (USD), European Union (EURO), Great Britain Pounds (GBP), and the Japanese Yen (JPY). An aggregate rate of exchange that is actively monitored in the Indian financial market is the real effective exchange rate (REER; Lily et al., 2018), which shows the inflation adjusted rate of a basket of currencies against the Indian Rupee. Though individual firms rarely monitor this aggregate exchange rate, it is expected that fluctuation in this exchange rate that is used by central banks for policy decisions could impact on the firm's performance. This has been upheld by similar studies exploring the impact of exchange rate movements (Choi et al., 2019). It is thus imperative to consider each of these currency rates to examine the factors that possibly impact the firm's exposure to their movements.

This article classifies the sample firms into ten industrial sectors according to the Bombay Stock Exchange standard classification and studies to see if this could affect a firm's FXE and the approach in the study also measures exchange rate exposure of each sample firm using two approaches: the cash flow (CF) approach and the capital market (CM) approach. CM approach is calculated separately with four major exchange rates and one aggregate rate to capture any variances in the studied factors. Thus, FXE is measured six times, and the measured values are indicated as FXEcmUSD, FXEcmGBP, FXEcmEURO, FXEcmJPY, FXEcmREER and FXEcf.

The article examines various firm level variables to discern if any or all these factors lead to exchange rate exposure for firms and found that six factors did show significant possibility and they were Level of multinationalism, Industrial sector, Size, Age, the Fixed asset allocation rate and the hedging activities of the firm. The study period was from 2001 to 2020 sub divided around the global financial crisis of 2008 as: before crises (2001–2006), during crises (2007–2010), and after crises (2011–2020).

Literature Review

Defining FXE

Exchange rate exposure of firms refers to the impact of the changes in the exchange rate to the variables measuring firm performance. Earlier studies defined FXE as the sensitivity of firms' cash flows to the fluctuation in the exchange rates. Most studies agree that FXE is an important risk factor for firms around the globe. In defining such terms such as sensitivity, impact, and effect have been extensively used. Adler and Dumas (1984) defined FXE as the sensitivity of a firm's value to the exchange rate changes. To measure this sensitivity, they proposed to study the impact of unanticipated changes in exchange rates on stock prices. Madura (1989) defines FXE as the effect of an unexpected exchange rate change on the value of the firm. A semantic study by Jorion (1990) indicated that only a small sample of companies faced exchange rate exposure and proposed the augmented two-factor market model to estimate such risk at firm level. Bartov and Bodnar (1994) studied the US multinational firms and found no significant effect of FXE on firm value.

Since then, studies have reported significant FXE on both US and non-US based firms. For example, Choi and Prasad (1995) reported a significant exposure to the huge number of firms. The significant prevalence of long-term exposure of firms to exchange rate changes than short term exposure indicated difficulty in recognizing, modeling, and managing the longer-term effects of exchange rate risk (Martin & Mauer, 2003). Vita and Larkin empirically investigated the sensitivity of 100 Eurozone and non-Eurozone blue chip companies and correlated the exchange rate movement to their market values. This study also analyses the difference between financial and non-financial firms and found significantly positive exposures of European firms (Mozumder et al., 2015)

Recent studies have defined FXE as the effect of the exchange rate on the stock price and indicated that hedging instruments need to be implemented to protect companies from exchange rate exposure

(Šimáková & Rusková, 2019). There is a universal consensus that exchange rate fluctuations can affect a firm's value, however the extent of such an effect has been in question even in the most recent of studies (He et al., 2021). Despite consensus on the definition and significance of the exchange rate exposure, there have been varied findings on the measurement, variables affecting the exposure and the effect of this risk on firms, industries, and economies.

Measuring FXE

Researchers have not deviated much in terms of the approach to measure the exchange rate exposure of firms. Most studies regress individual firm returns with a variety of exogenous variables assumed to be impacted. And the coefficient is considered as the degree of exposure the firms have on the exchange rate fluctuation. According to Shulman (1970), the degree of risk is different from the amount of risk and the degree of risk is determined by political and economic factors while the amount of risk could be controlled by the firms. Also, he advised that real risk needs to be separated from perceived risk for a sound risk management decision. Since then, many approaches have been developed to measure the degree of risk and the amount of risk associated with the exchange rate exposure. After this, many studies indicated that exchange rate risk can be measured in a traditional way just like market risk Adler and Dumas (1984) by regressing the stock returns on the changes in exchange rates between the two currencies. Almost all later studies measured exchange rate exposure to firms following this approach. Some studies use a common trade-weighted index to represent the price of foreign currencies following the lead of Jorion (1990) and He and Ng (1998). A two-step regression was followed by first regressing the individual firm return against changes in different common foreign exchange and then the individual firm return is regressed against changes in two firm-specific foreign exchange rate indices (Fraser & Pantzalis, 2004). The study concluded that geographic network structure is associated with any exposure, is dependent upon the type of foreign exchange rate index used to capture exposure. In a recent study, firm level exchange rate exposure was estimated to be under constant linear model as the relationship between the simple return of a company versus the return of its index and currency. The regression was estimated to be using for four years weekly.

simple returns for each firm against respective indices (FTSE100, IBEX35, and DAX30 indexes) and currency, GBP/EURO (Andrikopoulos et al., 2020).

Though there have been many models and approaches suggested to measure the exact exposure of firms, the techniques suggested were either too complex or specific. Two popular approaches have emerged from the vast literature on the measure of FXE as follows.

Capital Market Approach

Adler and Dumas (1984) suggested that exposure to exchange risk can be quantified by the regression coefficient associated with stock returns regressed against exchange rate changes. This regression model was empirically examined by Jorion (1990, 1991), Bodnar and Gentry (1993), Bartov and Bodnar (1994), He and Ng (1998), and others. This approach is currently considered as the standard method for measuring FXE of entities such as firms, industries, and economies in many latest studies. This approach regresses the changes in the exchange rate with the stock price volatility assuming strong market efficiency that the firm values are integrated in the stock price.

$$R_{it} = \alpha + \beta_1 e_{it} + \beta_2 R_{mt} + v_{it}$$

In the model, R indicates the stock return of firm i from the indexed market at time t, R_{mt} is the return on the market at time t, the coefficients β_1 and β_2 are the measure of exchange rate exposure as regressed in the formula, and v_{it} is the error term.

In the capital market approach, the choice of the exchange rate used in the regression is usually based on the most active currency in a market or the currency with which the firms mostly trade internationally.

The Cash Flow Approach

The second most popular approach for measuring the FXE of firm, follows the logic that when exchange rate change takes place the cash flow as exchange fluctuations take place, the cash flows

$$\delta = h_1 - (h_1 - h_2)(1/r - 1)$$

Here δ refers to the elasticity or measure of exposure of the firm to the exchange rate. This can be positive or negative, indicating positive or negative exposure. H_1 is the foreign currency denominated revenue as a percentage of total revenue. H_2 is the foreign currency denominated cost as a percentage of total cost and is profits as a percentage of total revenue. This approach uses an uncomplicated model to measure a firm's FXE by considering the internal firm operation data. Though not very extensively used in literature, provides an effective tool to measure the FXE of firms even for unlisted firms whose market data is not readily available.

These two time-tested approaches to measuring exchange rate exposure are the CM approach and the CF approach that has been followed in this study. Though there are few modern techniques such as the quantile regression, moments and moving averages that have been used in the literature without much practical impact due to its complexity.

Significance of FXE

Mixed results have been the hall mark of empirical results in FXE measure and impact. Jorion (1990) showed insignificant sensitivity of exchange rate exposure on firm value of US firms established a viable regression approach to measuring such exposure to exchange rates. Choi and Prasad (1995) found a significant relationship between firm value and exchange rate changes and established a positive relationship between exchange rate exposure and foreign sales as a determinant of the same. He and Ng (1998) found some evidence that Japanese multinational companies were exposed to volatility in exchange rates. Hedging was considered a possible reason for the insignificant exposure of firms. Allayannis and Ofek (2001) claimed that firms which used currency hedges were less exposed than the ones that did not use such tactics. Many studies on the determinants of exchange rate exposure indicate variables such as demand elasticity, operating cost structures, firm level debt, market capitalization, ratio of foreign sales to total sales, firm size, and hedging have been evaluated as a determinant of FXE. In their paper (He et al., 2021) studied Chinese public firms from 2005 to 2018, found that smaller firms with high leverage and limited hedging were exposed to exchange rate fluctuations of both linear and non-linear nature.

Ye et al. (2014) addressed the FXE of emerging economies at firm and industry level. Parsley and Popper (2006) found significant impact of exchange rate pegs on the exposure of economies, firms, and industries. Bacha et al. (2013) studied the effect of financial crisis on FXE. Dewenter et al. (2005) and Haughton and Emma (2017) found significant impact of such occurrences on FXE and thereby firm performance. Classification of FXE on the industry specification was considered by Demirhan and Atış (2013), Parlapiano and Alexeev (2012), and Tang (2015) found ample proof that FXE varied among firms of different industry. In the recent years, efforts to relate FXE to the firm level distress Prasad et al. (2018) show significantly positive relationship between the two. Exposure in the agriculture industry has been studied with significant exposure and risk (Piccoli, 2020). Experts have contributed variously in developing measures and identifying factors and evaluating the impact of the exchange rate exposure from different angles.

There have been numerous theoretical and empirical research in the topic area, yet there has not been a comprehensive framework to understand the occurrence, preventive measures or remedy the effect of such exposures. This article follows a systematic framework to measure the firm level FXE and identify the determining factors that were used in the study. Accordingly the four dimensions were: (a) two approaches to measure the level of exposure on firms—the capital market approach and the cash flow approach; (b) five exchange rates in the context of the Indian Rupee (INR)—REER, USD, GBP, Euro, and JPY; (c) ten industrial sectors—basic materials, consumer durable goods and services (CDGS), diversified, energy and utilities, finance, fast-moving consumer goods (FMCG), healthcare, IT; and (d) a breakdown of the study period of 17 years into three sub periods—before, during and after the global financial crisis.

Dataset

The first step was to calculate the FXE measure of each individual firm under the capital market approach using the five exchange rates and the cash flow approach. These measures formed the dependent variable in the model to examine the determining factors. The variables tested for identifying the determinants of exchange rate exposure of firms were explored by considering variables in similar studies in the past like industrial sector to which the firms belong; size of the firms; multinationalism or the intensity of the firm's international business activity, the age of the firm, net working capital cycle, net fixed assets utilization ratio, and hedging activities of each sample firm.

Table 1 is the description of the data using mean and standard deviation. The number of data points is 5,420 which represents annual data of 20 years for each of 271 companies that formed the sample for this study. FXEcm refers to measure of FXE using CM approach, FXEcf is the measured value of FXE using Cash flow approach, USD, EURO, GBP, JPY and REER are the exchange rates. NWC is the net working capital ratio and FAU is the fixed asset utilization ratio of the sample firms individually.

Table 1. Descriptive Statistics of the Measurement of FXE for CM Approach.

CM Approach			CF Approach	
	Mean	Std. Dev	Mean	Std. Dev
FXEcmREER	1.06	0.81		
FXEcmUSD	1.06	0.75		
FXEcmGBP	0.87	0.83		
FXEcmJPY	0.83	0.80		
FXEcmEuro	0.88	0.74		
FXEcf			0.78	0.74
Ind sector	4.51	2.77	4.38	2.87
Multinationalism	3.82	0.81	3.18	1.21
Size	2.08	0.7	2.18	0.68
Hedge	0.75	0.43	0.41	0.49
Age	53	24.69	50.01	23.43
NWC Ratio	3.2	2.15	3.55	2.12

FAU Ratio	1.14	1.07	1.36	1.08

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews and SPSS.

Table 2. Exchange Rate Exposure of Firms Under Multiple Currencies and CF Approach. No

Exposure			Positive Exposure		Negative Exposure		
FXE Measure	# firms	%	# firms	%	# firms	%	Total Firms
FXEcm REER	83	30.63	87	32.10	101	37.27	**271**
FXEcm USD	75	27.68	109	40.22	87	32.10	**271**
FXEcm GBP	119	43.91	75	27.68	77	28.41	**271**
FXEcm Euro	115	42.44	87	32.10	69	25.46	**271**
FXEcm JPY	130	47.97	68	25.09	73	26.94	**271**
FXE Cf	118	43.54	71	26.20	82	30.26	**271**

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews and SPSS.

To meet the requirement of the model used in the study, which requires dependent variables to be nominal values, the measured value of FXE in various approaches and currencies were converted to nominal values coded as firms with no exposure, positive exposure and negative exposure. Table 2 summarizes the FXE measures using capital market approach for each of the five exchange rates and the cash flow approach as positive exposure, negative exposure and no exposure according to the tendencies of the measured exposure falling under different threshold in either direction; those values leaning toward zero were classified as no exposure.

Table 3 indicates the coding used in the model for every variable that was tested to identify the determinants. Values for each variable were nominalized from the classified values of the sample firms. Thus, the table indicates nine industries (energy and utilities were combined into one group), three sizes, five levels of multinationality and hedged or not hedged. These coded values were used as input for the multinomial regression equations.

Table 3. Coding of the Factor Variables at Nominal Levels for Further Analysis.

Variable	Codes	Values	# firms	%
Industrial sector	1	Basic Materials	51	18.80
	2	CDGS	57	21.00
	3	Diversified	10	3.70
	4	E&U	8	3.00
	5	Finance	36	13.30
	6	FMCG	24	8.90
	7	Healthcare	21	7.70
	8	Industrials	53	19.60
	9	IT	11	4.10
Size	1	Small	58	21.30
	2	Medium	135	49.80
	3	Large	78	29.00

Multinationality	1	PM	4	1.50
	2	HM	16	5.80
	3	MM	47	17.50
	4	LM	163	60.10
	5	PD	41	15.10
Hedge	0	Not hedged	67	24.60
	1	Hedged	204	75.40

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews and SPSS.

Note: PM, purely multinational; HM, highly multinational; MM, medium multinationality; LM, low multinational; PD, purely domestic

The Model

The multinomial logistic regression model is an extended model of the binomial logistic regression as it allows more than two nominal categorizations of the dependent variable. Many researchers (Santillán- Salgado et al., 2019; Sikarwar & Gupta, 2019) have successfully used dummy coding of independent variables in their use of the model. This model has been extensively used by risk analysts when they analyze the relationships between non-metric dependent variable and metric and non-metric categories of independent variables.

Y is the dependent variable which would be indicated in nominal values, measured values of the FXE is nominalized as positive exposure, negative exposure or no exposure. X_1, X_2, and so on are independent variables which are measured as continuous variables and nominal variables. In the current study the measures of multinationalism, hedge, industry, and age are nominal variables and net working capital ratio and the fixed asset turnover ratio, all independent variables are measured as binomial or multinomial variables. Then the two regression equations would be:

$$\ln\left(\frac{P_A}{P_C}\right) = \beta_{A0} + \beta_{A1}X_1 + \beta_{A2}X_2 \tag{1}$$

And

$$\ln\left(\frac{P_A}{P_C}\right) = \beta_{A0} + \beta_{A1}X_1 + \beta_{A2}X_2 \tag{2}$$

and so on.

Multinomial logical regression model requires the dependent variable/s to be measured at the nominal level. In this research, the measured values of exchange rate exposure were dependent variables. The measured values were used to categorize firms into three levels of exposure: no exposure, positive exposure, and negative exposure. The next assumption required one or more independent variables to be continuous, ordinal or nominal and be treated as continuous or categorical. In the present study the independent variables industrial sector (measured as categorical: 1 to 9) age (measured in years), hedging (yes/no: 0/1), multinationalism (measured in levels high medium low and none: 0–4), size (large, medium and small: 1–3), net working capital (measured as a ratio and the lognormal values used for analysis), fixed asset utilization (measured as times and the lognormal values used for analysis). Further assumption that the dependent variables should be mutually exclusive and exhaustive was addressed in the selection and measurement of the variables. The assumption of no multicollinearity was checked for both approaches using the test of multicollinearity (Tables 4 and 5).

Table 4. Test of Multicollinearity for CM.

	REER	USD	GBP	JPY	Euro	Sec.	MN	Size	Hedge	Age	NWC	NFAU
REER	1											
USD	0.1	1										
GBP	0	0.2	1									
JPY	0.1	0.2	0.4	1								
Euro	0.1	0.2	0.3	0.3	1							
Ind.	0	0	0	0	0	1						
MN	0	0	0	0	0	–0.1	1					
Size	0	0.1	0.1	0	0.1	0.1	–0.2	1				
Hedge	0	0.1	0.1	0	0.1	0.1	0.3	0.4	1			
Age	0	0	0	0	0	–0.1	0.2	–0.1	0	1		
NWC	0	0	0	0	0	–0.1	–0.2	0.2	–0.1	0	1	
FA U	0	–0.1	0	0	–0.1	0.1	–0.3	0.3	–0.2	0	0.1	1

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews and SPS.

Note: XREER, FXECM REER; XUSD, FXECM USD; XGBP, FXECM GBP; XEuro, FXECM Euro; XJPY, FXECM JPY; Ind Sector, Industrial Sector; MN, Multinationalism; NWC, networking capital ratio; NFAU, net fixed asset utilization ratio.

Table 5. Test of Multicollinearity for CF Approach.

	CF	Ind	MN	Size	Hedge	Age	NWC	FA U
CF	1							
Ind	0.1	1						
MN	–0.6	–0.2	1					
Size	0.1	0	0	1				
Hedge	–0.3	0	0.4	0.4	1			
Age	–0.1	–0.1	0.2	–0.1	0	1		
NWC	0	–0.1	0	0	0	0	1	
FA U	0	0.1	0	0.2	0	0.1	–0.1	1

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews and SPSS.

Note: Ind, industrial sector; MN, multinationality; NWC, networking capital ratio; NFAU, fixed asset utilization ratio.

Tables 4 and 5 describe the multicollinearity of the variables used in the model and as can be noted very low intercorrelation between all variables either in the CM approaches or the CF approach.

The next assumption requires a linear relationship between any continuous independent variables and the logit transformation of the dependent variable. This was ensured as the multinomial logistic regression was run in the selected software. And finally, the assumptions of no outliers, high leverage values or highly influential points have been addressed by considering the lognormal values of the raw measurements when the variables were found to be showing high volatility in values. For example, the measured values of the networking capital and the fixed assets utilization ratios were converted into lognormal values to address this concern.

Findings and Result

Under the CM approach, the exchange rates were studied separately and then the CF approach was considered using similar parameters. The industries were imbedded in the analysis as the industrial sector was one of the variables that were examined whether it could be a determinant. Finally, all the sub periods were considered for analysis.

Table 6 shows the model fitting information and the goodness of fit for the multinomial logistic regression for the full study period and each of the sub periods for each of the FXE measurement and approaches. A large Pearson Chi-square value means the possibility of poor fit of the model. It can be noted that most of the Pearson values are not significant in all periods at 5% except in case of the CF approach before crises and in all periods. This indicates that the model was a good fit for the full period of the study and all sub periods in almost all cases. The model fitting information also indicates whether the variables considered in the model are statistically significant in improving the model as compared to the intercept alone. In Table 6 the model is statistically significant at 5% for USD for all periods using Capital market approach. It is also significant for the JPY during the crisis and the EURO after the crisis identifies the independent variables that were statistically significant in the model. Multinationalism was found to be significant before and during the crisis under CM approach with REER; after crisis using the GBP and all the periods using the CF approach. Hedges were significant determinant of exchange rate exposure before the crisis using REER; in all periods using the USD, all periods and before the crisis using the GBP; all period and after the crisis using the Euro and in all sub-periods using the CF approach. The NWC ratio was significant with REER in all periods and after the crisis, and with GBP after the crisis. This was the only insignificant determinant under the CF approach. FAU ratio was a significant factor after the crisis using the REER; all periods and after the crisis using GBP, fully significant in all periods and all sub periods using the EURO; and after the crisis by using the JPY; under the CF approach, FAU ratio was significant in all periods, before the crisis and after the crisis. The industrial sector was a significant factor under the REER, GBP and the CF approach in all periods and sub periods; with USD and EURO it was significant in all periods, before and during the crisis and with JPY it was significant in all periods, before and during the crisis. Size was a significant determinant of FXE in all periods using REER and JPY; with USD, GBP, and EURO it was significant in all periods and before the crisis; and with the CF approach it was significant in all periods. Age was not significant in any period or sub periods using the REER, USD and EURO; it was significant before the crisis using the GBP, after the crisis under JPY and significant in all periods, before and after the crisis using the CF approach.

Further delving into the findings, the estimates impact each of these significant variables had on the exchange rate exposure of the firms are indicated on the parameter estimates Tables 9 and 10. The impact of each determinant on the exchange rate exposure is presented through the parameter estimates.

For the capital market approach, using REER as an exchange rate, hedging activity, fixed asset utilization ratio, industry (energy and utilities sector) and size (large and medium) recorded significant P values, which could affect the exchange rate exposures as much as the strength of their coefficients. It means these factors can be considered as the determinants of the FXE to REER. Similarly, networking capital, industry sector and size are the determinants of FXE of firms to USD and so on. Using the CF approach, all the variables except networking capital are the determinants of FXE of the sample firms.

Conclusion

A detailed study of the exchange rate exposure under the capital market approach across different currencies (REER, USD, GBP, Euro, and JPY) for the full period of the study (2001–2020) and subdivided periods (before, during, and after crisis) was undertaken. This approach looks at four important dimensions of the exchange rate exposure so the approach can be called the four-dimension framework (4D framework). Such comprehensive study on the measure and evaluation of exchange rate exposure at firm level has not been done in previous studies.

The findings of the study indicate that some of the selected variables have significant effect on the FXE values in all periods and sub periods. However, the USD and the JPY models do not provide a statistically significant good fit. So, it may not be possible to generalize that the chosen determinants could affect the exchange rate exposure of the firms.

The multinomial logistic regression model is formed based on the calculated values of exchange rate exposure using the cash flow approach was more versatile than the model builds based on the capital market approach with any currencies. This demonstrated the higher significance of more variables under the CF approach than CM approach. However, it must be remembered that a firm could have a different degree of exposure to different currencies, even if it does not have transactions in that specific currency. Besides the REER is an aggregated currency rate used by the reserve bank to monitor the economic indicators and the firms do not use this exchange rate as a bilateral exchange rate. REER was included as a measure in the model to provide a comprehensive evaluation of the firm's interaction with FXE.

The article recommends the managers of firms measure exchange rate risk comprehensively and identify the determinants of FXE. Firms can perceive and control this risk effectively by following the 4D framework suggested in the article. Such a systematic approach should help in efficient identification of the risk and ensure that transaction risk is hedged selectively, cash flows and earnings are strategically preserved, and firm performance can be monitored undeterred by the FXE. Development of FXE management strategies could be based on optimization models for currency-denominated cash flows and executed centrally by the firm's treasury for all FXE related hedging. A centralized oversight board can set controls to monitor the determining factors that impact a firm's exposure to exchange rate.

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Table 8. Likelihood Ratio Tests.

M	Var	All Period		Before Crisis		During Crisis		After Crisis	
		Chi-Sq	Sig.	Chi-Sq	Sig.	Chi-Sq	Sig.	Chi-Sq	Sig.
1	Multi-N	0.53	0.77	4.15	**0.02***	2.65	**0.03***	2.3	0.32
	Hedge	2.99	0.22	3.27	**0.02***	0.25	0.88	0.04	0.98
	NWC Ratio	7.69	**0.02***	0.69	0.71	0.42	0.81	7.5	**0.02***
	FAU	2.01	0.37	0.01	1	0.2	0.9	0.68	**0.01***
	Ind	29.63	**0.02***	21.31	**0.02***	22.41	**0.03***	23	**0.01***
	Size	17.08	**0.00***	1.7	0.79	1.75	0.78	2.12	0.71
	Age	163.86	0.53	176.68	0.27	171.62	**0.04***	173.28	**0.03***
2	Multi-N	0.58	0.75	1.54	0.04*	0.04	0.98	1.07	0.58
	Hedge	7.27	**0.03***	1.58	0.45	1.2	0.55	0.55	0.76
	NWC Ratio	1.62	0.45	1.33	0.51	0.18	0.92	7.31	0.03
	FAU	10.76	**0.01***	4.03	0.13	6.64	**0.04***	0.71	0.7
	Ind	37.62	**0.00***	30.25	**0.02***	34	**0.01***	20.75	0.19
	Size	38.17	**0.00***	8.09	**0.02***	6.64	0.16	2.86	0.58
	Age	189.56	0.1	177.71	0.25	182.88	0.18	192.76	0.08
3	Multi-N	1.31	0.52	1.45	0.48	0.84	0.66	3.41	**0.01***
	Hedge	3.14	**0.02***	1.61	**0.05***	0.72	0.7	0.22	0.9
	NWC Ratio	2.07	0.36	4.04	0.13	0.1	0.95	6.08	**0.05***
	FAU	2.53	**0.03***	0.06	0.97	3.6	0.17	2.64	**0.03***
	Ind	30.55	**0.02***	16.18	**0.04***	37.14	**0.00***	18.73	**0.02***
	Size	18.69	**0.00***	8.13	**0.02***	2.34	0.67	0.93	0.92
	Age	179.95	0.22	182.12	**0.02***	187.51	**0.01***	152.41	0.77
4	Multi-N	0.66	0.72	0.01	0.99	3.82	0.15	0.44	0.8
	Hedge	5.92	**0.05***	0.53	0.77	2.98	0.23	2.93	**0.02***
	NWC Ratio	2	0.37	0.83	0.66	0.46	0.8	3.63	0.16
	FAU	15.99	**0.00***	1.56	**0.05***	7.29	**0.03***	5.17	**0.05***
	Ind	35.94	**0.00***	31.71	**0.01***	16.34	0.43	17.61	0.35
	Size	55.32	**0.00***	10.38	**0.04***	1.21	0.88	2.91	0.57
	Age	170.79	0.38	202.18	**0.03***	156.84	0.68	205.25	**0.02***
5	Multi-N	0.15	0.93	1.44	0.49	0.08	0.96	0.14	0.93
	Hedge	1.63	0.44	2.16	0.34	0.26	0.88	0.08	0.96
	NWC Ratio	3.58	0.17	4.55	0.1	2.29	0.32	2.49	0.29
	FAU	2.74	0.25	0.93	0.63	1.35	0.51	8.28	**0.02***
	Ind	39.95	**0.00***	32.92	**0.01***	27.9	**0.03***	15.4	0.5
	Size	13.46	**0.01***	7.39	0.12	7.56	0.11	7.31	0.12
	Age	220.12	**0.00***	203.35	**0.03***	201.01	**0.03***	197.36	**0.05***
6	Multi-N	678.12	**0.00***	290.41	**0.00***	140.5	**0.00***	247.52	**0.00***
	Hedge	582.31	**0.00***	153.56	**0.00***	89.58	**0.00***	346.62	**0.00***
	NWC Ratio	1.93	0.38	0.61	0.74	2.18	0.34	0.93	0.63
	FAU	57.72	**0.00***	34.82	**0.00***	3.72	0.16	31.17	**0.00***
	Ind	339.12	**0.00***	166.46	**0.00***	103.85	**0.00***	149.19	**0.00***
	Size	240.88	**0.00***	130.26	**0.00***	53.8	**0.00***	72.08	**0.00***
	Age	876.18	**0.00***	444.17	**0.00***	341.51	0.5	628.27	**0.00***

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews.

Note: * indicates the p values are significant. Values in bold indicate significant P values and their corresponding R-square and parameter values

Table 7. The Strength of the Model.

Pseudo R-Square					Pseudo R-Square				
Measure	Period	Cox and Snell	Nagelkerke	Mcfadden	Measure	Period	Cox and Snell	Nagelkerke	Mcfadden
REER	AP	0.044	0.056	0.031	JPY	AP	0.056	0.065	0.28
	BC	0.1	0.113	0.049		BC	0.122	0.138	0.06
	DC	0.215	0.243	0.111		DC	0.26	0.299	0.147
	AC	0.1	0.223	0.048		AC	0.221	0.336	0.058
EURO	AP	0.058	0.067	0.01	GBP	AP	0.058	0.067	0.032
	BC	0.13	0.146	0.064		BC	0.116	0.131	0.056
	DC	0.21	0.239	0.112		DC	0.24	0.274	0.131
	AC	0.118	0.138	0.065		AC	0.091	0.104	0.046
USD	AP	0.057	0.117	0.062	CF Approach	AP	0.355	0.682	0.336
	BC	0.112	0.129	0.058		BC	0.585	0.665	0.416
	DC	0.241	0.272	0.127		DC	0.693	0.78.4	0.543
	AC	0.162	0.326	0.022		AC	0.385	0.689	0.442

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews.

Note: The four rows in each measure indicate the sub-periods of the study: All period, before the crisis, during the crisis and after the crisis respectively.

Table 9. Parameter Estimates.

M	P	Multi	Hedge	NWC	FAU	[Ind-1]	[Ind-2]	[Ind-3]	[Ind-4]	[Ind-5]	[Ind-6]	[Ind-7]	[Ind-8]	[Ind-9]	[Sz-1]	[Sz-2]	[Sz-3]	Age
1	AP	0.47	0.311	**0.007***	0.225	**0.006***	0.755	0.776	0.065	0.154	0.288	0.071	0.554	**0.026***	**0.006***	0.014	0.248	**0.038***
	BC	**0.046***	**0.019***	0.41	0.984	0.941	**0.041***	0.084	0.082	**0.033***	**0.031***	0.546	0.603	**0.005***	0.606	0.408	0.552	0.996
	DC	**0.016***	0.691	0.81	0.702	0.785	0.253	0.399	**0.019***	0.28	0.298	**0.026***	0.081	0.588	0.684	0.855	0.504	**0.028***
	AC	0.335	0.685	**0.018***	**0.046***	0.553	0.156	0.425	**0.011***	**0.014***	0.223	0.685	0.977	**0.013***	0.423	0.118	0.425	**0.045***
2	AP	0.152	0. 114	**0.015***	0.241	0.562	0.335	0.885	0.582	0.331	**0.002***	0.321	0.228	**0.032***	0.115	**0.012***	0.255	0.589
	BC	**0.046***	**0.019***	0.41	0.984	0.941	**0.041***	0.084	0.082	**0.033***	**0.031***	0.546	0.603	**0.005***	0.606	0.408	0.552	0.996
	DC	**0.016***	0.691	0.81	0.702	0.785	0.253	0.399	**0.019***	0.28	0.298	**0.026***	0.081	0.588	0.684	0.855	0.504	**0.028***
	AC	0.286	0.752	**0.032***	**0.014***	0.766	0.068	0.562	**0.005***	**0.042***	0.233	0.568	0.380	**0.033***	0.422	0.382	0.422	**0.008***
3	AP	0.115	**0.003***	**0.028***	0.258	0.445	0.358	0.466	0.225	0.103	**0.022***	**0.012***	0.766	**0.042***	**0.002***	**0.001***	**0.030***	0.152
	BC	0.284	**0.038***	**0.050***	0.815	0.21	0.568	0.794	0.83	0.996	0.893	0.581	**0.012***	0.84	**0.045***	0.394	0.297	**0.030***
	DC	0.508	0.414	0.841	0.717	0.679	0.954	0.803	0.583	0.95	**0.033***	**0.017***	0.577	**0.011***	**0.048***	0.922	0.47	0.999
	AC	**0.002***	0.521	**0.006***	**0.025***	**0.016***	0.152	0.225	**0.017***	**0.032***	0.111	**0.034***	**0.008***	0.158	0.562	0.338	0.562	0.332
4	AP	0.326	**0.022***	0.752	**0.012***	**0.036***	0.118	0.764	0.368	**0.035***	0.422	0.568	**0.002***	**0.032***	**0.000***	**0.001***	**0.000***	0.263
	BC	0.951	0.711	0.894	**0.025***	**0.010***	**0.015***	0.384	0.884	**0.012***	0.699	**0.049***	**0.013***	0.307	**0.020***	**0.040***	**0.018***	**0.022***
	DC	0.017	**0.009***	0.066	0.249	0.896	0.377	0.616	0.112	0.436	0.181	0.667	0.677	0.286	0.295	0.334	0.149	0.098
	AC	0.112	**0.003***	0.312	**0.011***	0.451	0.382	0.555	0.911	**0.002***	0.118	0.362	0.822	0.632	0.912	0.115	0.123	**0.011***
5	AP	0.749	0.152	0.324	0.454	**0.041***	0.225	**0.007***	0.658	0.524	0.148	0.665	**0.011***	**0.035***	**0.003***	**0.014***	**0.036***	**0.031***
	BC	0.343	0.222	0.439	0.707	**0.047***	**0.000***	**0.049***	0.741	0.899	0.174	0.758	**0.020***	0.194	0.529	0.799	0.331	**0.006***
	DC	0.864	0.616	0.115	0.333	**0.018***	0.282	**0.027***	0.282	0.878	0.772	0.772	0.598	**0.023***	0.129	0.054	0.559	**0.000***
	AC	0.922	0.869	0.185	**0.002***	0.068	0.558	0.364	**0.025***	0.338	0.521	**0.028***	0.668	0.213	0.119	0.325	0.106	**0.000***
6	AP	**0.002***	0.123	**0.025***	**0.041***	0.325	**0.005***	**0.012***	**0.016***	0.125	**0.005***	**0.011***	**0.002***	**0.000***	**0.020***	0.632	**0.036***	0.115
	BC	**0.002***	0.169	**0.041***	0.072	0.133	**0.029***	**0.009***	**0.030***	**0.022***	**0.003***	**0.019***	**0.000***	**0.000***	**0.000***	0.451	**0.040***	**0.006***
	DC	0.258	**0.023***	0.498	0.991	0.991	0.991	0.991	0.991	0.991	0.990	0.991	**0.004***	**0.000***	**0.001***	**0.029***	0.997	**0.000***
	AC	**0.005***	**0.012***	**0.021***	0.638	0.562	0.556	**0.025***	0.769	0.373	0.521	**0.000***	**0.005***	**0.002***	**0.004***	0.958	**0.035***	**0.011***

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews.

Note: * indicates the *p* values are significant. Values in bold indicate significant P values and their corresponding R-square and parameter values respectively

Table 10. Parameter Estimates (β Values).

		Multi	Hedge	NWC	FAU	[Ind-1]	[Ind-2]	[Ind-3]	[Ind-4]	[Ind-5]	[Ind-6]	[Ind-7]	[Ind-8]	[Ind-9]	[Sz-1]	[Sz-2]	[Sz-3]	Age
1	AP		0.23	0.06												0.29		–1.51
	BC	–0.21					*-*			*-*	*-*							
	DC	*-*							–2.25			–1.55						
	AC			0.10	*-*				*-*	*-*								2.86
2	AP		–0.29	*-*	0.12									0.69	0.57	*-*		2.83
	BC	*-*	*-*				*-*			*-*	*-*	1.19		*-*	0.834	0.40		–1.72
	DC	*-*					1.40		*-*		1.75	*-*			–0.99			*-*
	AC			–0.10	*-*				*-*	*-*				*-*				20.27
3	AP		*-*	*-*							0.60	*-*		*-*	0.58	0.33	*-*	0.46
	BC		*-*	*-*									*-*		*-*			–19.46
	DC										1.63	*-*		*-*	*-*			–21.04
	AC	*-*		–.09	*-*	0.96			1.61	0.95		1.12	*-*					19.25
4	AP		*-*		0.15					*-*			*-*	*-*	0.91	0.65	*-*	–2.23
	BC				*-*	*-*	–0.86			*-*		*-*	*-*		0.64	0.30	*-*	–20.11
	DC		*-*													–16.85		
	AC		*-*		*-*											–40.50		*-*
5	AP					*-*		*-*					*-*	*-*	0.43	0.26	*-*	–2.03
	BC					*-*	–0.90	*-*					*-*					37.72
	DC					*-*		*-*						*-*		–0.69		–21.28
	AC					1.095				1.083								–39.79
6	AP	1.52	2.03	*-*	0.16	1.52	*-*	1.52	2.25	2.46	*-*	2.00	2.09	*-*	2.99	1.45	*-*	21.17
	BC	1.54	1.63	*-*			*-*	2.54	*-*	2.40	2.27	2.78	2.20	*-*	4.89	1.58	*-*	3.44
	DC	2.05	1.91			32.19	32.06	32.97	30.59	29.23	30.17	26.56	32.48	*-*	3.64	1.38		4.330
	AC	1.65	–1.24	*-*	0.52	18.62	18.34	18.05	19.34		17.21	16.17	19.55	*-*	3.65	1.59	*-*	3.61

Source: Collected from CMIE, RBI, and BSE websites. Statistics generated on Eviews.

Note: ***-*** indicates significant p values but undefined coefficients/β values.

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