

Foreign Currency Exposure of Information Technology Firms in India

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Abstract: Exchange rates were deregulated in India in 1993, and were allowed to be determined by the market forces. Uncertainty about exchange rates causes foreign currency exposures having significant effects on the earnings of the firms. Eventually, stock prices of firms in the market respond to their respective foreign currency exposures.

This paper attempts to explore the determinants of foreign currency exposure of information technology firms in India. Information technology firms, in general, face a higher degree of foreign currency exposure as having relatively more share of overseas earnings in their total income. This study is based on monthly data of 56 information technology companies for the period spanning from financial year 2016-17 to financial year 2019-20. There are evidences showing the higher degree of foreign exchange exposure of firms in India. The Paper concludes that IT firms' foreign currency exposure is related inversely to the size of firm and positively to the price to book value ratio of firm. This aspect of foreign currency exposure needs further investigation and research. The findings of this paper have policy implications for the managers of the firms in India.

Keywords: Foreign exchange rate; CAPM, stock return; foreign exchange rate exposure

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I. Introduction

A foreign currency exposure is defined as a contracted, projected or contingent cash flow whose magnitude is not certain at present and depends on the value of the foreign exchange rates in future. Firms dealing in multiple currencies face foreign currency exposures on account of unexpected/ unanticipated changes in exchange rates. Information technology companies, in general, face a higher degree of foreign exchange exposure as having more share of overseas earnings in their total income. Foreign exchange exposure also varies from company to company, despite having similar composition of total revenue in respect of foreign earnings, depending on the firm specific factors.

He and Ng (1998) study indicates that 25% out of 171 Japanese multinationals have significant foreign currency exposure. Prasad and Prabha (2016) paper indicates that 21% of the Indian firms under study are significantly exposed to foreign exchange risk. Further, it is found that 57% of IT firms included in the sample have been significantly exposed to foreign exchange exposure. Tomanova (2014) paper shows that 34% of firms in Hungary are exposed to foreign exchange rate. Choi and Prasad (1995) find that 60% of the U.S. firms with significant foreign currency exposure gain from dollar depreciation. Bodnar and Gebhardt (1999) paper finds that 78% firms in Germany and 57% firms in the U.S. are likely to use currency derivatives.

Though the companies can mitigate foreign exchange exposures by using foreign exchange derivatives, it becomes quite interesting to investigate the determinants of foreign exchange exposure. The studies related to the determinants of foreign currency exposure conducted on firms operating in emerging markets are limited. This study explores the determinants of foreign currency exposure of information technology firms in the case of India. The terms foreign exchange rate exposure, foreign exchange exposure and foreign currency exposure have been used interchangeably in this Paper.

Objective of the Study

The basic objective of the study is to find the determinants of foreign currency exposure of information technology firms in India. To accomplish the objective, the study has:

1. To measure the foreign currency exposure of information technology firms in India.
2. To explore the determinants of foreign currency exposure of information technology firms in India.
3. To carry out a comparative study of magnitude of determinant variables of foreign exchange exposure in case of firms having significant exposure, and firms having insignificant exposure.

This study has been divided in six sections. Second section deals with the review of literature. Section three mentions sources of data used in the study. The research methodology employed to arrive at conclusion is also explained here. Section four contains results of the study and analysis carried out thereafter. Section five checks the robustness of the estimates indirectly by comparing the magnitude of determinants of foreign exchange exposure in significantly exposed firms with that in firms not significantly exposed. The conclusion of the study is given in section six.

II. Review of Literature

Larger volume of literature on the determinants of foreign currency exposure is related to developed countries. Fewer studies have been carried out in case of developing countries.

Prasad and Suprabha (2015) study carries out the comparison between two methods of measuring the foreign exchange exposure. They use a sample of 30 Indian firms. The study is conducted for a period starting April 2012 to March 2013 using the weekly stock returns of the firms. The results indicate that cash flow model is more intuitive, while exposures measured by using capital market model were counter intuitive. They suggested that cash flow model would be more useful to take strategic decisions to manage the foreign exchange exposure. However, they admit that in large part of studies in past capital market model has been used to measure the forex exposure of the firms. Prasad and Suprabha (2016) use to measure exchange rate exposure of Indian firms using capital market approach. The sample includes 76 non-financial firms. Daily data on concerned variables are taken for the period starting 1st April 2012 to 31st March 2013. The results indicate that 21% of the firms under study are significantly exposed to foreign exchange risk. Further, it is found that 57% of IT firms included in the sample have been significantly exposed to foreign exchange exposure.

Dhagat and Raju (2016) have tried to measure the determinants of foreign exchange exposure of 85 non-financial Indian firms by using panel data methodology for the period starting from 2001 to 2015. Firm specific variables viz. export earnings, import payments, net capital flows, size of the firm have been used to determine the foreign exchange exposure. The study finds that market capitalisation is relatively most significant determinant of foreign exchange exposure. Other determinants are net capital flows and trade.

He and Ng (1998) study investigates foreign exchange exposure of 171 Japanese multinationals for the period January 1979 to December 1993. The study uses hedging activity, size of firm, book to market value ratio, long term debt to market value as independent variables in the model. Results indicate that 25% of the firms have significant exposure to exchange rate. The foreign exchange exposure is determined by its export ratio and by variables that are proxies for its hedging needs. Foreign exchange exposure is found to increase with firm size.

Aggarwal and Harper (2010) paper has focused on 1265 domestic U.S. firms for the time period 1990-2003. Debt ratio, asset turnover, assets, sales, market value, market to book value have been used as independent variables. The study concludes that level of domestic firm exposure is related inversely to size, positively to R&D expenses and to a lesser extent positively to financial leverage and the market to book value ratio, negatively to asset turnover, asset tangibility, and industry concentration. Paper concludes that on average domestic firms' foreign exchange exposure is not significantly different from the exposure faced by multinational firms.

Chien-Hsiu Lin (2011) paper investigates the impact of foreign exchange rate fluctuations on stock returns in the Asian emerging markets. The results show that there existed extensive foreign exchange exposure in the Asian emerging markets from 1997 to 2011. Foreign exchange exposure intensified during 1997 Asian financial crisis and 2008 Global financial crisis period. Foreign exchange exposure has been attributed to firms with dollar assets.

Bhagawan and Lukose (2014) paper investigates exchange rate exposure of non-financial firms during 2006-11. Two factor model has been used. 11% of sample firms are significantly exposed to foreign exchange rate. A negative relationship between exchange rate exposure and use of foreign currency derivatives is indicated. Chue and Cook (2008) investigate exchange rate exposure of emerging market firms using an instrumental variable approach. Study finds negative and significant impact of various measures of debt on exchange rate exposure.

Allayannis and Ofek (2001) explore the use of foreign currency derivatives by S&P 500 non-financial firms in 1993. Results indicate that decision to use derivatives depends on exposure factors i.e., foreign sale and foreign trade, and on variables like size of firms and R&D expenditures. They also conclude that firms use currency derivatives for hedging, as their use, significantly reduces the exchange rate exposure that firms face.

Choi and Prasad (1995) use a model of firm valuation in order to test the exchange rate sensitivity of 409 U.S. multinationals for the period 1978 to 1989. It is found that 60% of the firms with significant forex exposure gain from dollar depreciation. Further, exchange risk sensitivity is found linked to firm specific operational variables like, foreign operating profit, sales and assets. Jorion (1990) paper examines the sensitivity of U.S. multinationals to foreign currency risk. The study focuses on exchange rate exposure determinants. It

finds that foreign exchange exposure is positively related to total foreign sales. Bodnar and Gebhardt (1999) paper finds that German firms are more likely to use currency derivatives (78% firms) as compared to the firms in U.S. (57%). Bodnar and Wong (2003) paper examines foreign exchange exposure of U.S. firms. A strong relationship between firm size and exposure of U.S. firms is established in the paper. Foreign cash flows are also have strong relationship with foreign exchange exposure. Positive relationship of foreign currency exposure with firm size and foreign cash flows is found.

Loderer and Pichler (2000) study examines the currency risk management practices of Swiss firms. Study finds that the firms do not quantify the currency exposures. Further, firms use the currency derivatives for hedging individual short term transactions and do not try to estimate aggregate exposures to transactions.

Tomanova (2014) paper investigates determinants of foreign exchange rate exposure of Hungarian firms for the period from 2000 to 2014. It shows that 34% of firms are exposed to foreign exchange rate. It is found that market capitalisation and foreign sales are important determinants of foreign exchange rate exposure.

Mahapatra and Rath (2017) compare the foreign exchange exposures of service sector firms and manufacturing firms in India. They find that service sector firms are more exposed to exchange rate fluctuations as compared to the manufacturing firms. Research, further, shows that important determinants are market to book value ratio and export, which are positively related with the exposure. On the other hand, size of firm is negatively related to the exposure. Sayed and Gayathri (2021) paper examines foreign currency exposure of 271 BSE S&P 500 firms for the period 2001-2020 in relation to U.S. dollar, Euro, Japanese Yen and real effective exchange rate. Paper finds that the significant determinants of foreign exchange exposure are fixed assets utilisation ratio, hedging activities, size and age of firms. Agnihotri and Arora (2021) study has considered daily stock returns of 260 firms for the period 2004 to 2019. Study shows that size of firms and quick ratio are inversely related to foreign exchange exposure. On the other hand, book to market value, asset turnover and foreign sales are positively related to the exposure.

He, Liu and Zhang (2021) investigate foreign exchange rate exposure of Chinese firms for the period 2005 to 2018. It is found that the exposure is positively and statistically significantly associated with growth opportunities of the firm. Negligible role is played by international operations of firms in explaining the exposure. Further, it is found that large firms are expected to have less exposure.

Griffin and Stulz (2001) conduct a study of cross country and industry analysis of the foreign currency exposure. The study says that weekly exchange rate shocks explain almost nothing of the relative performance of industries. While, using return measured over longer horizons, the importance of exchange rate shocks increases slightly. Further, it says that exchange rate shocks are more important for industries that produce goods for international trade, albeit economically small.

III. Data and Research methodology

Adler and Dumas (1984) defines the foreign currency exposure as coefficient of the exchange rate when returns on stocks of a firm are regressed on exchange rate of the currency.

Under capital market approach, simple two factor model is used to estimate the coefficient of exchange rate exposure sensitivity of a firm. This model can be described as given below:

$$gr_{it} = \beta_0 + \beta_1 ginrd_t + \beta_2 gnifty_t + u_t$$

Where, gr_{it} denotes return on stock of firm i at time t , $ginrd_t$ is % change in foreign exchange rate (Rupee in terms of U.S. Dollar) at time t , $gnifty_t$ is stock market return (NIFTY 500 index) at time t , and u_t is the error term. The β_1 denotes the foreign currency exposure of the firm and β_2 measures sensitivity of stock returns to capital market movements. In this model, a negative β_1 indicates negative exposure, in other words, the firm has exposure to the depreciation of foreign currency (U.S. Dollar).

The two factor model has been used in a variety of studies of foreign exchange exposure such as Bodnar & Gentry (1993), Bartov & Bodnar (1994) and Griffin & Stulz (2001) among others.

This study is based on monthly data spanning from financial year 2016-17 to financial year 2019-20. The total number of time series observations is 48 for each information technology (IT) company. This study includes 56 information technology companies: 10 NIFTY IT Index Constituent Firms, 43 S&P BSE IT Index Constituent Firms and 11 other IT firms which are not constituent of these two indices. There are 8 IT firms which are constituent of both NIFTY IT Index and S&P BSE IT Index. The appendix 1 lists the companies included in the study.

Exchange rate has been measured as units of Indian Rupee per U.S. Dollar. Data on exchange rate have been collected from the website of Reserve Bank of India. Data on return on stocks of companies and Nifty 500 have been collected from the website of National Stock Exchange of India.

After measurement of foreign exchange exposure β_1 for all the 56 information technology firms, a model to investigate the determinants of foreign exchange exposure is applied. In this way, the cross section sample size is 56 IT companies. The following model is used to identify the determinants of currency exposure of firms:

$$|\beta| = \alpha_0 + \alpha_1 LCAP + \alpha_2 PBVR + \alpha_3 NCLA + \alpha_4 FSTS + \alpha_5 CUDR + \alpha_6 STAR + \alpha_7 OPMR$$

where,

$|\beta|$: Foreign exchange exposure of the firm i ,

LCAP: Log of market capitalisation,

PBVR: Price to book value ratio

NCLA: Non-current liabilities to assets ratio

FSTS: Ratio of foreign sales to total sales

CUDR: Currency derivatives

STAR: Sales to total assets ratio

OPMR: operating profit margin ratio

The study period is 2016-17 to 2019-20 (four years). Average of annual values of above variables are used in the model, except currency derivatives. If a firm uses currency derivatives to manage foreign currency risk, value of 1 is assigned and value of 0 is assigned when firm does not use currency derivatives. Data on independent variables have been collected from the annual reports of the respective companies and website of Bombay Stock Exchange (BSE). The descriptive statistics of independent variables are given in appendix 2.

In literature, the parameters are usually suggested to identify the determinants of exchange rate exposure of firm are: size of the firm, growth opportunities, financial strength, exposure and strategies used to manage it, and operating strength.

Considering these parameters, different variables are identified to use them as determinants of the exchange rate exposure. The log value of total equity price (capitalisation) is employed as proxy for size of the firm. Price to book value ratio is used to represent growth opportunities. Total non-current liabilities to total assets ratio is used as proxy for financial strength. Foreign sales to total sales ratio is used to represent volume of exposure. Use of currency derivatives is employed as proxy to exposure management strategy by a firm. Sales to total assets ratio and operating profit margin are employed to represent operating strength of a firm. The rationale to include these variables in the model is given below:

i. Market capitalisation (LCAP)

Larger firms are more internationally oriented and are less likely to be affected by foreign exchange exposure. Large firms have greater ability to compete and are supposed to be more diversified either through product or client diversification. A negative relationship of firm size with the foreign exchange exposure is expected. Aggarwal and Harper (2010), Mahapatra and Rath (2017); and He, Liu and Zhang (2021) find negative relationship of firm's size on its foreign exchange exposure.

ii. Price to book value ratio (PBVR)

Price to book value ratio represents growth opportunities of a firm. Growth opportunities are associated with greater forex exposure. Price to book value ratio should exhibit a positive relationship with foreign exchange exposure. The positive relation between price to book value ratio and foreign exchange exposure has been endorsed by Aggarwal and Harper (2010), Mahapatra and Rath (2017), Agnihotri and Arora (2021), and He, Liu and Zhang (2021).

iii. Non-current liabilities to assets ratio (NCLA)

The ratio of non-current liabilities to assets represents financial risk of a firm. A positive relationship should be expected between foreign exchange exposure of a firm and its non-current liabilities to assets ratio.

iv. Ratio of foreign sales to total sales (FSTS)

Bodnar and Wong (2003) explore and confirm a positive relationship between ratio of foreign sales to total sales and forex exposure in case of U.S. firms. It is expected to have a positive relationship between ratio of foreign sales to total sales and foreign exchange exposure of a firm.

v. Currency derivatives (CUDR)

Foreign exchange exposure is expected to be negatively related to hedging activity of a firm. It literally means that the higher hedging activities of a firm lessen the amount of foreign exchange exposure involved. Allayannis and Ofek (2001) study confirms inverse relationship of hedging activity with the magnitude of forex exposure.

vi. Sales to total assets ratio (STAR)

A positive relationship of a firm's sales to total assets ratio (asset turnover) with its foreign exchange exposure is expected. Agnihotri and Arora (2021) confirm a positive relationship of asset turnover with foreign exchange exposure.

vii. Operating profit margin ratio (OPMR)

Firms with higher gross margin have more flexibility in setting the price of goods and services, and therefore it is expected that firms can absorb shocks more easily as compared to firms having low level of operating margin. A negative relationship is expected between operating margin ratio and foreign currency exposure of a firm. Aggarwal and Harper (2010) study included this variable in the model for determinants of foreign currency exposure.

To check the robustness of estimates delivered by the model, a comparative study of magnitude of determinant variables of foreign exchange exposure in case of firms having significant exposure and firms having insignificant exposure is carried out with help of the difference between means test. This test would help in establishing the robustness of estimates of parameters obtained after using the model to investigate the determinants of foreign currency exposure.

The t distribution of difference between means of two sample drawn from the population is:

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{S \cdot \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Where,

$$S = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}$$

\bar{X}_1 : Arithmetic mean of sample 1,

\bar{X}_2 : Arithmetic mean of sample 2,

n_1 : Number of observations in sample 1,

n_2 : Number of observations in sample 2,

S_1 : Standard deviation of sample 1,

S_2 : Standard deviation of sample 2.

If the difference between magnitudes of determinant variables in case of firms having significant foreign currency exposure and firms having insignificant foreign currency exposure is statistically significant, it will support the model's results relating to determinants of foreign currency exposure. **Error! Bookmark not defined.**

IV. Results and analysis

To check the stationary properties, we use Augmented Dickey Fuller (ADF) unit root test. Table 1 shows unit root test results for Rupee- Dollar exchange rate (%change), ginrd and % change in NIFTY 500 index, gnifty. It is evident that both the time series are stationary.

Table 1
Unit Root Test – ginrd and gnifty

	Variable	I(0)	Variable	I(0)
ginrd	-7.700***	gnifty	-6.9911***	

Note: 1. *** sign indicates t-values significant at 1% level of significance.

Table 2 shows unit root test results for stock return(% change in price) gr in case of each firm included in the sample.

Table 2
Unit Root Test – Firms' returns (gr)

Firm	I(0)	Firm	I(0)
Coforge Ltd	-8.841***	L&T Technology Services Ltd	-6.4334***
HCL Technologies Ltd	-6.1225***	Mastek Ltd	-7.5667***
Info Edge (India) Ltd.	-7.0268***	Majesco Ltd	-7.372***
Infosys Ltd	-6.9913***	Nelco Ltd	-8.3115***
Larsen & Toubro Infotech Ltd	-6.7971***	NIIT Ltd	-7.1036***
Mindtree Ltd	-6.3339***	Nucleus Software Exports Ltd	-7.7695***
Mphasis Ltd	-2.9349**	Oracle Financial Services Software Ltd	-7.8559***
Tata Consultancy Services Ltd	-8.8987***	Persistent Systems Ltd	-8.735***
Tech Mahindra Ltd	-6.8517***	Quick Heal Technologies Ltd	-6.2285***
Wipro Ltd	-8.5408***	Ramco Systems Ltd	-8.5277***
3i Infotech Limited	-7.5313***	Sasken Technologies Ltd	-8.2121***
63 Moons Technologies Ltd	-6.1589***	Sonata Software Ltd	-6.0212***

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Accelya Solutions India Ltd	-5.7172***	Tanla Platforms Ltd	-7.1114***
Aptech Ltd	-6.2861***	Tata Elxsi Ltd	-6.3748***
Axiscades Technologies Ltd	-8.143***	TVS Electronics Ltd	-6.329***
Birlasoft Ltd	-6.1535***	Zen Technologies Ltd	-6.285***
Brightcom Group Ltd	-6.721***	Zensar Technologies Ltd	-7.1031***
Cerebra Integrated Technologies Ltd	-3.1194**	R Systems International Ltd.	-5.873***
Cigniti Technologies Ltd	-6.0273***	Expleo Solutions Ltd.	-5.9106***
Cyient Ltd	-7.8261***	Saksoft Ltd	-8.8141***
D-Link India Ltd	-4.7287***	AGC Networks Ltd.	-7.2049***
Datamatics Global Services Ltd	-7.9665***	8K Miles Software Services Ltd.	-8.1274***
eClerx Services Ltd	-4.5918***	ScanpointGeomatics Ltd.	-8.166***
Firstsource Solutions Ltd	-6.2006***	Goldstone Technologies Ltd.	-6.5271***
HCL Infosystems Ltd	-7.6844***	Kellton Tech Solutions Ltd.	-7.8581***
Hind Rectifiers Ltd	-7.4855***	Mindteck (India) Ltd.	-8.7118***
Hinduja Global Solutions Ltd	-6.5832***	Subex Ltd.	-6.1122***
Intellect Design Arena Ltd.	-8.1311***	Take Solutions Ltd.	-8.2967***

Note: 1. *** sign indicates t-values significant at 1% level of significance.

The unit root test results as shown in Tables 1 and 2 confirm that all variables are stationary at level (I_0) of unit root at 1% level of significance. Thus, there is no issue of unit root or stationary. The time series of the variables are eligible for further use in estimations according to the model employed in this Paper.

The measurements of foreign exchange exposure β_1 obtained by employing capital market approach are given in Table 3. In total, 20 firms have been statistically significantly exposed to foreign exchange rate, while the exposure of 36 firms to exchange rate have been insignificant.

Table 3
Exchange Rate Exposure of IT Firms

Firm	β_0	$\beta_{2gnifty}$	β_{1ginrd}	r^2	F
Coforge Ltd.	0.6975	1.8536***	-3.3634***	0.34	11.4038***
HCL Technologies Ltd	0.2154	0.435**	-0.945**	0.12	2.9455*
Info Edge (India) Ltd.	1.6268	0.9514***	-1.2927*	0.15	4.0425**
Infosys Ltd	-1.0876	0.8426**	-0.3921	0.11	2.8892*
Larsen & Toubro Infotech Ltd	1.7959	0.7167**	-1.7866**	0.15	3.3833**
Mindtree Ltd	-0.2769	1.1065***	-1.8893***	0.14	3.6939**
Mphasis Ltd	0.3865	1.1711***	-1.1513*	0.28	8.9175***
Tata Consultancy Services Ltd	0.5056	0.805***	-1.0932*	0.18	4.7754***
Tech Mahindra Ltd	-0.0144	0.8625***	-1.7152***	0.17	4.7401***
Wipro Ltd	-0.187	0.2125	-0.7037	0.02	0.5192
3i Infotech Ltd	-1.1718	1.0899	1.608	0.11	2.7672*
63 Moons Technologies Ltd	-0.5978	1.8416**	-0.6043	0.14	3.7581**
Accelya Solutions India Ltd	0.0151	0.4926**	-0.2366	0.08	2.0517
Aptech Ltd	2.1121	1.5248**	1.204	0.17	4.6951*
Axiscades Technologies Ltd	-3.7524*	2.003***	2.551**	0.42	16.5125***
Birlasoft Ltd	-2.2545	1.4202***	-0.8544	0.17	4.7357***
Brightcom Group Ltd	-1.9133	9.335	-2.6341	0.03	0.6585
Cerebra Integrated Technologies Ltd	1.0181	1.2254	-0.3412	0.06	1.3127
Cigniti Technologies Ltd	-1.1873	0.9065*	-0.9385	0.07	1.7409
Cyient Ltd	-0.4412	0.4237	0.859	0.07	1.6282

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D-Link India Ltd	-1.3371	1.1732**	-0.4566	0.12	2.9543**
Datamatics Global Services Ltd	-1.335	2.6199***	-1.8651	0.35	12.136***
eClerx Services Ltd	-2.2927*	0.852**	-0.3918	0.13	3.4281**
Firstsource Solutions Ltd	-0.9919	1.3248***	-1.88**	0.21	5.8161***
HCL Infosystems Ltd	-4.7764***	1.4922***	-0.0814	0.21	5.7885***
Hind Rectifiers Ltd	0.8906	1.4902***	-1.7232*	0.22	6.1781***
Hinduja Global Solutions Ltd	-0.7039	1.5322***	-0.7893	0.29	9.1147***
Intellect Design Arena Ltd.	-2.7198	2.3113***	-1.9671*	0.32	10.7384***
L&T Technology Services Ltd	0.4263	1.2147***	-2.5711***	0.29	7.5084***
Majesco Ltd	-2.1195*	1.6739***	-0.4872	0.4	14.6976***
Mastek Ltd	1.168	1.7256***	0.5312	0.28	8.6354***
Nelco Ltd	0.0252	2.3031***	-3.4603***	0.29	9.1222***
NIIT Ltd	-0.8854	1.3841***	0.1848	41	15.8936***
Nucleus Software Exports Ltd	-0.6845	1.8591***	-2.7677**	17	4.7534***
Oracle Financial Services Software Ltd	-1.2225	0.7862***	-0.5843	0.2	5.7226***
Persistent Systems Ltd	-0.4593	1.0108***	-0.5042	0.18	4.9972***
Quick Heal Technologies Ltd	-1.7421	1.8233***	-0.7992	0.29	9.2406***
Ramco Systems Ltd	-3.8658**	1.6985***	-0.1235	0.29	9.1474***
Sasken Technologies Ltd	-0.5474	2.4445***	-1.3737	0.42	16.2138***
Sonata Software Ltd	0.8779	0.9122**	-0.101	0.13	3.252**
Tanla Platforms Ltd	0.5763	1.9074***	-1.098	0.15	3.9382**
Tata Elxsi Ltd	-1.7136	1.6733***	-0.8996	0.38	14.0515***
TVS Electronics Ltd	-1.2556	2.3192***	-3.149*	0.17	4.6037***
Zen Technologies Ltd	-2.4371	2.434***	-0.5692	0.28	8.8899***
Zensar Technologies Ltd	-1.5428	1.7509***	-3.0884***	0.36	12.4336***
R Systems International Ltd.	-0.3375	0.9756*	-0.1522	0.1	2.4389*
Expleo Solutions Ltd.	-3.2194**	0.924***	0.0586	0.17	4.5466**
Saksoft Ltd.	-1.202	1.6001***	-0.0612	0.19	5.1837***
AGC Networks Ltd.	0.0788	1.9873***	-1.9691	0.2	5.491***
8K Miles Software Services Ltd.	-3.5528	1.2755	8.3588***	0.28	8.7912***
ScanpointGeomatics Ltd.	-0.5066	1.1994*	-0.5101	0.09	2.1094
Goldstone Technologies Ltd.	0.8693	1.6506**	-3.2795*	0.1	2.4808*
Kellton Tech Solutions Ltd.	-4.5705*	1.7643**	-0.5668	0.13	3.4523**
Mindteck (India) Ltd.	-4.8705***	2.4779***	-0.9317	0.4	14.9236***
Subex Ltd.	-2.1559	1.3629***	-0.393	0.27	8.4107***
Take Solutions Ltd.	-2.4205	1.8984***	-3.5141***	0.3	9.6543***

Note: 1. * sign indicates significant at 10% level of significance.

2. ** sign indicates significant at 5% level of significance.

3. *** sign indicates significant at 1% level of significance.

Results based on the nature of foreign exchange exposure are summarised in Table 4. Out of 56 IT companies, 6 companies (11%) exhibit positive foreign exchange exposure, though statistically significant exposure only in case of 2 companies. On the other hand, 89% IT companies (50 in number) indicated negative foreign exchange exposure, which means that these firms have exposure to the depreciation of foreign currency (U.S. Dollar). Out of the 50 companies, 18 companies (32%) exhibit statistically significant negative foreign exchange exposure. In total, 20 IT companies(36%) displayed statistically significant foreign exchange exposure. These companies are Axiscades Technologies Ltd.,Coforge Ltd.,HCL Technologies Ltd.,Info Edge (India) Ltd.,Larsen & Toubro Infotech Ltd.,Mindtree Ltd.,Mphasis Ltd.,Tata Consultancy Services Ltd.,Tech

Mahindra Ltd., Firstsource Solutions Ltd., Hind Rectifiers Ltd., Intellect Design Arena Ltd., L&T Technology Services Ltd., Nelco Ltd., Nucleus Software Exports Ltd., TVS Electronics Ltd., Zensar Technologies Ltd., 8K Miles Software Services Ltd., Goldstone Technologies Ltd., and Take Solutions Ltd. Companies showing statistically significant foreign exchange exposure are predominantly Nifty IT Index and BSE S&P IT Index constituents.

Table 4
Exchange rate exposure of IT Firms

Firms	Positive Exposure			Negative exposure			Total
	Insignificant	Significant*	Total	Insignificant	Significant*	Total	
Nifty IT index constituents	0 (0%)	0 (0%)	0 (0%)	2 (20%)	8 (80%)	10 (100%)	10 (100%)
S&P-BSE IT Index constituents#	4 (11%)	1 (3%)	5 (14%)	22 (63%)	8 (23%)	30 (86%)	35 (100%)
Others	0 (0%)	1 (9%)	1 (9%)	8 (73%)	2 (18%)	10 (91%)	11 (100%)
Total	4 (7%)	2 (4%)	6 (11%)	32 (57%)	18 (32%)	50 (89%)	56 (100%)

Note: 1. * sign indicates significant at 10% level of significance.

2. # means S&P-BSE IT index constituents excluding firms already included in NIFTY IT Index

After measurement of foreign currency exposure β_1 for all the 56 firms, the model mentioned in research methodology section is applied to explore the determinants of foreign currency exposure of the firms. The results of parameter estimation of determinants of foreign exchange exposure β_1 , in case of all sample firms, are given Table 5.

Table 5
Determinants of Exchange Rate Exposure
(All IT Firms)

Variable	Coefficient	S.E.	t-Stat	p-Value
C	2.0736	2.5504	0.8131	0.420
CUDR	0.0403	0.4989	0.0808	0.936
FSTS	-0.0466	0.6011	-0.7761	0.938
LCAP	-0.1549	0.2736	-0.5664	0.574
NCLA	4.2378*	2.4376	1.7385	0.089
OPMR	-0.0096	0.0074	-1.2899	0.203
PBVR	0.2265***	0.0668	3.3878	0.001
STAR	0.586	0.1834	0.3164	0.53
R ²	0.30	D.W. Stat	2.4249	
F-Stat	2.9248***	A.I.C.	3.3988	

Note: 1. * sign indicates significant at 10% level of significance.

2. ** sign indicates significant at 5% level of significance.

3. *** sign indicates significant at 1% level of significance.

The firm size in this study is represented by log value of market capitalisation. The theory advocates a negative relationship of firm size with the foreign exchange exposure. The results of this study indicate that the firms having higher market capitalisation seem to have lower foreign exchange exposure. These results support studies conducted by Aggarwal and Harper (2010), Mahapatra and Rath (2017), Agnihotri and Arora (2021), and He, Liu and Zhang (2021).

The results of study show that firms having higher price to book value ratio seem to have higher foreign exchange exposure statistically significantly at 1% level of significance. Price to book value ratio represents growth opportunities of a firm and literature suggests a positive relationship between price book value ratio and foreign exchange exposure of a firm. Thus, the results support the theory and studies like, Aggarwal and Harper (2010), Mahapatra and Rath (2017), Agnihotri and Arora (2021), and He, Liu and Zhang (2021).

Higher level of non-current liabilities to total assets ratio represents financial risk and seems to enhance the foreign exchange exposure of firms. The results of this study show positive relationship between non-current liabilities to total assets ratio and foreign exchange exposure of a firm. Results are statistically significant at 10% level of significance.

Theoretically, higher foreign sale to total sale ratio of firms enhances their foreign exchange exposure. In case of all IT firms, there is no conclusive evidence that level of foreign sales to total sales increases the foreign exchange exposure of firms.

A negative relation of hedging activities with the exposure is predicted by theory, which means, more the firm hedges, lesser the foreign exchange exposure. There is no conclusive evidence that use of forex derivatives helps in mitigating the forex exposure of IT firms in India.

A positive relationship of a firm's sales to total assets (asset turnover) with its foreign exchange exposure is expected. The results of study exhibit that asset turnover is positively associated with foreign exchange exposure. The results are consistent with the results of Agnihotri and Arora (2021) study on foreign exchange exposure.

Literature on foreign exchange exposure suggestshigher level of operating profit margin ratio helps in lowering the foreign exchange exposure of firms. This study concludes that there is inverse relationship between operating profit and foreign currency exposure of a firm. Though, the results are not statistically significant. These results support the previous study conducted by Aggarwal and Harper (2010).

The results of parameter estimation of determinants of foreign exchange exposure β_1 , in case of firms having significant foreign exchange exposure, are given in Table 6.

Table 6
Determinants of Exchange Rate Exposure
(IT Firms with significant foreign currency exposure)

Variable	Coefficient	S.E.	t-Stat	p-Value
C	9.2133**	4.7923	1.9225	0.078
CUDR	-0.0521	1.2556	-0.0441	0.967
FSTS	1.8227	1.4090	1.2936	0.220
LCAP	-0.8477	0.5017	-1.6896	0.117
NCLA	3.4023	8.9133	0.3817	0.709
OPMR	-0.0238	0.0326	-0.7306	0.470
PBVR	0.2919***	0.0992	2.9405	0.012
STAR	0.0469	0.1707	0.2745	0.788
R ²	0.74	D.W. Stat	1.7333	
F-Stat	4.9605***	A.I.C.	3.1705	

- Note: 1. * sign indicates significant at 10% level of significance.
 2. ** sign indicates significant at 5% level of significance.
 3. *** sign indicates significant at 1% level of significance.

In case of firms having statistically significant foreign currency exposure, the study shows more strong results and all are in line with the theoretical expectations.

The results indicate a negative relationship between a firm's size and its foreign exchange exposure as exhibited in case of all IT firms. The results are consistent with Aggarwal and Harper (2010), Mahapatra and Rath (2017), Agnihotri and Arora (2021), and He, Liu and Zhang (2021) studies.

Results on price to book value ratio, like for all IT firms, show that price to book value ratio is negatively related to a firm's foreign exchange exposure. Results are statistically significant at 1% level of significance. The results support Aggarwal and Harper (2010), Mahapatra and Rath (2017), Agnihotri and Arora (2021), and He, Liu and Zhang (2021) studies.

The results of this study show positive relationship between non-current liabilities to total assets ratio and foreign exchange exposure of a firm. Though the results are not statistically significant, but are as per theoretical expectations as non-current liabilities to total assets ratio represents financial risk.

A positive relationship is indicated between foreign sales to total assets ratio and foreign exchange exposure of a firm. The results confirm the findings of Jorian (1990) and Bodnar and Wong (2003) studies.

A negative relation of hedging activities with the exposure is predicted by theory. The results of this study confirm the negative relationship, though results were not statistically significant. The results are in line with Bhagawan and Lukose (2014) and Allayannis and Ofek (2001) studies.

A positive relationship is indicated between sales to total assets ratio and foreign exchange exposure of a firm and it is in line with the results in case of all firms. The results support Agnihotri and Arora (2021) study. A negative relation of operating profit margin ratio with the foreign currency exposure is predicted by theory. The results also support this, albeit results are not statistically significant. Results are in line with the conclusion derived by Aggarwal and Harper (2010).

In case of IT firms having significant foreign exchange exposure, the study shows that all concerned variables have a relationship (positive or negative) with foreign currency exposure as per theoretical expectations. Table 6 shows that 74% of variation in foreign currency exposure is explained by determinant variables. Price to book value ratio and firm size are most important variables in determining the foreign currency exposure of IT firms.

V. Comparative study of magnitude of the determinants

The comparative study of magnitude of the determinant variables of foreign exchange exposure in case of firms having significant exposure and firms having insignificant exposure is summarised in Table 7.

Table 7
Determinants of Exchange Rate Exposure
Difference between means

Variable	CUDR	FSTS	LCAP	NCLA	OPMR	PBVR	STAR
$\bar{X}_1(20)$	0.85	0.6529	10.5285	0.0585	18.4929	4.5725	1.0739
$\bar{X}_2(36)$	0.6111	0.5267	10.0132	0.0591	20.45763	2.7994	0.7251
t-Stat	1.8487**	1.1503	2.0536**	-0.0031	-0.5749	2.3862**	1.2633

Note: 1. Critical values for t distribution for 54 degrees of freedom for one tailed test are 1.297, 1.674 and 2.397 at 10%, 5% and 1% level of significance respectively.

2. * *sign indicates significant at 5% level of significance.

3. Group X_1 comprises 20 IT firms having significant exposure to U.S. Dollar, while group X_2 comprises 36 IT firms having insignificant exposure to U.S. Dollar.

Table 7 noticeably shows that magnitude of three variables, namely- price to book value ratio, firm size and level of hedging activities is on average statistically significantly different in case of IT firms having significant forex exposure as compared to that in case of firms having insignificant forex exposure. These results are statistically significant at 5% level of significance. This confirms the robustness of the results relating to determinants of foreign currency exposure of IT firms in India as drawn in the study. Further, it also indicates that IT firms having significant foreign currency exposure use, in general, more foreign currency derivative strategies in comparison of firms having insignificant foreign currency exposure.

VI. Conclusion

Information technology companies, as in general expected, face a higher degree of foreign exchange exposure as having more share of overseas earnings in their total income. Foreign exchange exposure also varies from company to company, despite having similar composition of total revenue in respect of foreign earnings, and depends on the firm specific factors. This paper investigates into firm specific determinants of foreign exchange exposure. The main findings of the study are summarised below:

- i. 89% of IT firms included in the sample have displayed negative foreign currency exposure, while 11% firms displayed positive foreign currency exposure. In total, 36% of firms in the sample displayed statistically significant foreign currency exposure.
- ii. The firms having higher market capitalisation seem to have lower foreign currency exposure. It implies that firm size is inversely related to the foreign currency exposure in case of IT firms. The results are statistically significant.
- iii. The firms having higher price book value ratio seem to have higher foreign exchange exposure. Price to book value ratio represents growth opportunities of a firm and literature suggests a positive relationship between price book value and foreign exchange exposure of a firm. The results of this study are statistically significant.
- iv. Higher level of non-current liabilities to total assets ratio, which represents financial risk, seems to enhance the foreign currency exposure of IT firms.
- v. There is evidence that level of foreign sales to total sales ratio enhances foreign exchange exposure.
- vi. The use of foreign exchange rate derivatives lessens the foreign currency exposure of firms. There is evidence that use of foreign exchange derivatives helps in mitigating the foreign currency exposure in IT firms in India. Further, it is also indicated that IT firms having significant foreign currency exposure use, in general, more foreign currency derivatives in comparison of firms having insignificant foreign currency exposure.

vii. Sales to total assets ratio is positively related with foreign currency exposure of firms. Thus, higher sales to total assets ratio enhances the foreign currency exposure of firms.

viii. Higher level of operating profit margin ratio helps in lowering the foreign currency exposure of firms. The higher gross margin ratio helps in absorbing the shocks and adjusting the cost incurred suddenly.

It is evident from the study that the level of IT firms' foreign currency exposure is related inversely to the size of a firm, positively to the level of price to book value ratio, and to a lesser extent, positively to foreign sales to total sales ratio, sales to total assets ratio and non-current liabilities to total assets ratio, negatively to hedging activities and level of operating profit margin. This study has policy implications. Company managers should to re-think on this issue and the policy regarding the use of hedging contracts should perhaps be re-examined.

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Appendix 1

List of companies included in the study

S. No.	Firm	Trade
<i>NIFTY IT Index Constituent Firms</i>		
1	Coforge Ltd.*	IT consulting & Software
2	HCL Technologies Ltd.*	IT consulting & Software
3	Info Edge (India) Ltd.	Internet & Catalogue Retail
4	Infosys Ltd.*	IT consulting & Software
5	Larsen & Toubro Infotech Ltd.*	IT consulting & Software

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6	Mindtree Ltd*	IT consulting & Software
7	Mphasis Ltd.*	IT consulting & Software
8	Tata Consultancy Services Ltd.*	IT consulting & Software
9	Tech Mahindra Ltd.*	IT consulting & Software
10	Wipro Ltd	IT consulting & Software
<i>S&P BSE IT Index Constituent Firms</i>		
11	3i Infotech Limited	IT consulting & Software
12	63 Moons Technologies Ltd	IT consulting & Software
13	Accelya Solutions India Ltd	IT consulting & Software
14	Aptech Ltd	IT Training Services
15	Axiscades Technologies Ltd	BPO/KPO
16	Birlasoft Ltd	IT consulting & Software
17	Brightcom Group Ltd	IT Software products
18	Cerebra Integrated Technologies Ltd	Computer Hardware
19	Cigniti Technologies Ltd	IT consulting & Software
20	Cyient Ltd	IT consulting & Software
21	D-Link (India) Ltd	IT Networking Equipment
22	Datamatics Global Services Ltd	IT Software products
23	eClerx Services Ltd	BPO/KPO
24	Firstsource Solutions Ltd	BPO/KPO
25	HCL Infosystems Ltd	Computer Hardware
26	Hind Rectifiers Ltd	Electronic Components
27	Hinduja Global Solutions Ltd	BPO/KPO
28	Intellect Design Arena Ltd.	IT Software products
29	L&T Technology Services Ltd	Internet Software & Services
30	Majesco Ltd	IT consulting & Software
31	Mastek Ltd	IT Software products
32	Nelco Ltd	IT Networking Equipments
33	NIIT Ltd	IT Training Services
34	Nucleus Software Exports Ltd	IT Software products
35	Oracle Financial Services Software Ltd	IT consulting & Software
36	Persistent Systems Ltd	IT consulting & Software
37	Quick Heal Technologies Ltd	IT Software products
38	Ramco Systems Ltd	IT consulting & Software
39	Sasken Technologies Ltd	IT consulting & Software
40	Sonata Software Ltd	IT consulting & Software
41	Tanla Platforms Ltd	IT Software products
42	Tata Elxsi Ltd	IT Software products
43	TVS Electronics Ltd	Storage Media & Peripherals
44	Zen Technologies Ltd	Defence
45	Zensar Technologies Ltd	IT consulting & Software
<i>Other Firms</i>		
46	R Systems International Ltd.	IT consulting & Software
47	Expleo Solutions Ltd.	IT consulting & Software

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48	Saksoft Ltd	IT Software products
49	AGC Networks Ltd.	IT consulting & Software
50	8K Miles Software Services Ltd.	Internet Software & Services
51	ScanpointGeomatics Ltd.	Internet Software & Services
52	Goldstone Technologies Ltd.	IT consulting & Software
53	Kellton Tech Solutions Ltd.	IT Software products
54	Mindteck (India) Ltd.	IT Software products
55	Subex Ltd.	IT Software products
56	Take Solutions Ltd.	IT

Note: * Sign indicates that these firms' stocks are also constituents of S&P BSE IT Index.

Appendix 2
Descriptive Statistics

	NIFTY	INRD	CUDR	FSTS	LCAP	NCLA	OPMR	PBVR	STAR
Mean	8536	67.82	0.6964	0.5718	10.1972	0.0588	19.7559	3.4326	0.8497
Median	8956	67.75	1.0000	0.7257	9.9267	0.0351	20.4375	2.7874	0.6695
Min.	5830	63.68	0.0000	0.0000	8.3117	0.0014	-66.850	0.1181	0.0175
Max.	9992	73.99	1.0000	0.9788	12.7820	0.4521	145.55	13.6841	7.2687
S.D.	1125	2.64	0.4640	0.3864	0.9074	0.0793	24.7727	2.7722	0.9749
Obs.	48	48	56	56	56	56	56	56	56

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