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TOPIC
FINANCIAL AND CREDIT
RELATIONS

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VOLATILITY ANALYSIS OF CORRELATION BETWEEN FOREIGN CURRENCIES IN REFERENCE TO INDIAN RUPEE

Abstract

Introduction. Multinational firms have their revenue linked in number of currencies and their upside and downside movements can affect overall efficiency of firms.

Purpose of the research is to ascertain the correlation between exchange rate movements, to ascertain relative change in value of currency over period of time, to suggest measures to cope up volatility of exchange rate movements and for effective management of forex exchange market.

Methods. The analysis of each data set of exchange rate in detail to have insight of their mean, median, mode, skewness, kurtosis. An attempt has been made to drive out trend of movements and plot that in line diagram and correlation and other descriptive statistics have been calculated using SPSS software.

Results. The Pearson's correlation value is close to 1 in almost all cases, it indicates that there is a strong relationship between two variables. CAD with INR are positively skewed whereas USD, GBP, JPY are negatively skewed with INR. INR movements in CAD, JPY, USD and GBP have correlation indicating that all companies having transactions globally can predict that upward movement in one currency affects the movement of another currency.

Discussion. Based on above analysis, some suggestion have been drawn for improving functioning of forex exchange market in India.

Key words: volatility, analysis, correlation, foreign currencies, forex exchange market, mean, median, mode, skewness, kurtosis.

Introduction. Foreign exchange exposure is the risk linked with transactions of multinationals dealing in more than one currency due to unpredictable movement of currency in relation to home. It is risk due to uncertainty in direction of currency movements and these movements can prove financially detrimental for multinationals. Firms must assess and manage their foreign exchange exposures to be in win -win situation. The high volatility of exchange rates is a general accepted phenomenon and it has

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major impact on multinational's bottom line. Volatility in exchange rates has been quite large and it has affected sales as well as profit margins of multinationals in India. Even companies have witnessed their end due to these unfavorable exchange rate fluctuations. Movements in exchange rates prices are subject to volatility clustering i.e. having periods of calm where you found zero movement in terms of percentage movement and periods of high volatility which arises mainly due to reaction of events in environment nationally and internationally. Exchange rate movements play substantial role in risk measurement and their effective management which is outcome of exchange positions in foreign exchange. Hedging program aims at conversion of unpredictable risks into that zone where it is acceptable. The main challenge lies in identifying the risk that rests in acceptable zone for the risk manager and the type of hedging program the risk manager wishes to undertake.

Indian Forex market has witnessed sequential development during post reforms horizon right from pegged exchange rate mechanism to demand and supply driven market in 1993 and in 1994 to current account convertibility. Moving ahead of LERMS in 1993, free forces of market determined exchange rate. This led to increment in spot and forward market transactions and turnover of market grew up significantly from 16 billion US dollar in year 2005-2006 to around 55 billion US dollar in year 2014-2015.The depth of the foreign exchange market can also be gauged from the fact that the bid-offer spread in USD-INR pair is quite narrow now. [1]

RBI and GOI are continuously working to improve capital flows, Foreign institutional investors in corporate debt, expansion of risk management instruments and coming up of qualified foreign investors as unique group of investors and so on. Introduction of proper risk management mechanism is challenge and steps had been taken in that direction. CCI was set up in year 2003 which has proved to be landmark in mechanism of money as well as foreign exchange market in India. Commendable progress had been made in over the counter derivative products. Trade depository came into existence in 2012 to facilitate smooth functioning of forex market of India. Foreign exchange derivatives had also been fully operational between authorized dealers banks and their clients till now.

Review of literature. If we have close insight into literature, we can find handful of theoretical models focusing on determination of exchange rates and behavior shown. Fixed price assumption based models were available before 1990 where studies have been made by Marshall (1923), Lerner (1936), Nurkse (1944), Mundell (1961, 1962, 1963) and Fleming (1962). Demand and supply based model of exchange rate determination have been studied in depth by Frenkel(1976),Mussa (1976, 1979), Frenkel and Johnson (1978), Vitek (2005), Nwafor (2006), Molodtsova and Papell, (2007)

V. Kamesam, (2001)in his study quoted that knowing things about past makes it easier to predict future. Dornbusch (1976, 1980) gave rise to overshooting model which had been repeatedly tested by Alquist and Chinn (2008) and Zita and Gupta (2007).

Bekaert (1995) studied the effect of time variation on positions held in euro . He used vector auto regression to study the same. Vergni and Vulpiani (1999) witnessed during their research that there lies long term anomalies in forex exchange market.Batten (1999) studied various models of exchange rate valuation in depth and focused on need to incorporate risk coefficient for better and trust worthy results. Hodrick (1992, 1993) studied and concluded that auto regressive approach has more benefits than any other model. Further Johnson (2002) proposed model in order to find out correlation between trends and volatility. Zumbach (2002) used GARCH and FIGARCH models to examine trends and forecast errors.Solano (2004) focused on economic modeling of distribution of returns of exchange rate.

Background of study: Linking to theoretical perspective. Demand and supply are two market forces which determine the exchange rate in India. It is well accepted truth that exchange rate is determined by two blades of scissors under strict monitoring of RBI. So, we can study forex market as we study demand and supply and point where demand is equal to supply of forex the price is determined if all other things remain same.

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[1] I bid. https://www.rbi.org.in/scripts/bs_viewcontent.aspx?Id=2849)

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Equation 1 …. Total demand of forex(Dfx)= Total supply of forex(Sfx)

Dfx includes both interbank transactions and market transactions whereas Sfx includes interbank transactions, market transactions and supply of forex by RBI as intervention.

Equation 2…. Sfx= market supply (Mfx) + autonomous supply(Afx)

From 1 and 2

Dfx = Mfx+ Afx

Now this autonomous supply can either be negative or positive depending upon intervention by RBI.

So,

Equation 3… Dfx= Mfx $\pm$ Afx

RBI is net buyer in forex market when there is general scenario that foreign exchange rate is moving below the desired level. RBI also intervenes if there is excess supply in market and there is need to absorb that supply. Over here we have,

Dfx= Mfx-Afx   or we can say Mfx= Dfx+Afx

RBI becomes   net seller in foreign exchange market when there is general phenomenon that foreign exchange rate is moving above desired level. RBI intervenes to increase the supply. So, market supply will be less than market purchase by Afx

Dfx= Mfx + Afx or we can say that Mfx= Dfx- Afx

Keeping in view the theoretical derivation of exchange rates of rupee and other major currencies and role of RBI, There has been high volatility in forex market since last two decades which may be outcome of various global phenomenon and because of two market forces demand and supply (pic 1). Rupee has shown high volatility as compared to US dollar over period of two decades as shown in analysis by RBI. This forms base of research of this paper in which we try to find out correlation between movements in yen, dollar, pound in terms of Indian rupee.

Pic 1. Evidence of high volatility in exchange rate(US$/INR)
Source: Official website of RBI[2]

There exists high volatility in exchange rates and there is need to have insight of movements in exchange rates, an attempt is made to judge the correlation shown by different currencies in respect to indian rupee as in India forex rates are determined by open two market sources demand and supply and RBI plays important role of monitoring and intervention.

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[2] I bid. https://www.rbi.org.in/scripts/bs_viewcontent.aspx?Id=2849)

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Objectives of study:

- To ascertain the correlation between exchange rate movements
- To ascertain relative change in value of currency over period of time.
- To suggest measures to cope up volatility of exchange rate movements and for effective management of forex exchange market.

Research methodology. Volatility measures the deviation of present exchange rates in comparison to previous exchange rates. In this Paper we have measured volatility of rupee to USD, GBP, JPY and CAD since 1990 till 2015.

Skewness measures the symmetry the distribution is following. Perfectly symmetrical distribution have zero skewness. Positive skewness denote right side has more weightage than the left side whereas negative skewness denotes vice versa i.e. left side is more heavier. Kurtosis checks the shape of data so as to analyse that distribution resembles Gaussian distribution or not. In Gaussian distribution the kurtosis is zero whereas in flatter distribution, there is negative kurtosis and vice versa. Hence, we refer this as volatility of volatility.An attempt has been made to drive out trend of movements and plot that in line diagram and correlation and other descriptive statistics have been calculated using SPSS software.

Results. The data has been analysed for period of 25 years i.e. 1990 to 2015 (table 1). Data has been collected from www.x-rates.com, www.federalreserve.gov and yahoofinance.com. Data was analysed since 1990 to 2015 so as to know the relative change in value of currencies Proportionate change has been calculated using the formula

Change = (current years rate- previous years rate)/ previous years rate

Table 1

The data for analysis for period from1990 to 2015

YEAR	USD/INR	Proportionate change	GBP/INR	Proportionate change 2	CAD/INR	Proportionate change	JPY/INR	Proportionate change 3
1990	18.11		31.23687		14.99538		0.121298	
1991	22.71165	0.298386	39.9717	0.279632	19.8369	0.322868	0.169073	0.393865
1992	28.15582	0.239708	49.68905	0.243106	23.30104	0.174631	0.22231	0.314876
1993	31.29108	0.111354	46.98119	-0.0545	24.26063	0.041182	0.282837	0.272264
1994	31.39386	0.003285	48.09013	0.023604	22.98115	-0.05274	0.307693	0.087881
1995	32.41807	0.032625	51.15281	0.063686	23.63458	0.028433	0.346246	0.125297
1996	35.506	0.095253	55.42571	0.083532	26.03525	0.101575	0.326582	-0.056792
1997	36.36451	0.024179	59.56109	0.074611	26.25486	0.008435	0.30063	-0.079466
1998	41.35611	0.137266	68.54809	0.150887	27.87802	0.061823	0.317104	0.054798
1999	43.05267	0.041023	69.64358	0.015981	28.98327	0.039646	0.380039	0.198468
2000	44.93512	0.043724	67.99939	-0.02361	30.25132	0.043751	0.416886	0.096956
2001	47.15597	0.049423	67.91616	-0.00122	30.46815	0.007168	0.388551	-0.067968
2002	48.60898	0.030813	72.88484	0.073159	30.95158	0.015867	0.388141	-0.001055
2003	46.57064	-0.04193	76.18075	0.045221	33.3528	0.07758	0.402191	0.036198
2004	45.12676	-0.031	82.75716	0.086326	34.83518	0.044446	0.417557	0.038206
2005	43.92993	-0.02652	79.98543	-0.03349	36.27876	0.04144	0.399622	-0.042952
2006	45.24078	0.029839	83.41479	0.042875	39.90903	0.100066	0.388989	-0.026608
2007	41.48935	-0.08292	82.93584	-0.00574	38.57441	-0.03344	0.352574	-0.093615
2008	43.78233	0.055267	80.6188	-0.02794	41.12405	0.066097	0.425591	0.207097

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2009	48.3688	0.104756	75.6424	-0.06173	42.5107	0.033719	0.517119	0.215061
2010	45.65775	-0.05605	70.5686	-0.06708	44.30718	0.042259	0.520989	0.007484
2011	46.45992	0.017569	74.51852	0.055973	46.97385	0.060186	0.580074	0.113409
2012	53.42081	0.149826	84.66996	0.136227	53.50164	0.138966	0.669338	0.153884
2013	58.51233	0.09531	91.65329	0.082477	56.77306	0.061146	0.599778	-0.103924
2014	61.00759	0.042645	100.4891	0.096404	55.25379	-0.02676	0.577642	-0.036907
2015	62.89116	0.030874	96.07964	-0.04388	50.68307	-0.08272	0.521365	-0.097425

The change in value of currency since 1990 of all major currencies have witnessed almost same pattern throughout the period under study.

Testing correlation between pattern shown by various currencies in comparison to rupee shown on tables 2,3,4.

Table 2

Correlation between JPY / INR and GBP / INR

		Japanese Yen to Indian Rupee (JPY/INR)	British Pound to Indian rupee (GBP/INR)
JPY/INR	Pearson Correlation	1	.543**
	Sig. (2-tailed)		.004
	N	26	26
GBP/INR	Pearson Correlation	.543**	1
	Sig. (2-tailed)	.004	
	N	26	26

Value of correlation coefficient is 0.543 which depicts JPY/INR has positive linear correlation with GPB/INR. If we calculate coefficient of determination it comes to be 0.294849 which den otes that 29% of changes in british pound/ Indian rupee can be attributed to relationship between Japanese yen and british pound.

Table 3

Correlation between GBP/INR and CAD/INR

		British Pound/Indian Rupee (GBP/INR)	Canadian dollar/ Indian rupee (CAD/INR)
GPB/INR	Pearson Correlation	1	.894**
	Sig. (2-tailed)		.000
	N	26	26
CAD/INR	Pearson Correlation	.894**	1
	Sig. (2-tailed)	.000	
	N	26	26

Value of correlation coefficient is 0.894 which depicts GPB/INR has positive linear correlation with CAD/INR. If we calculate coefficient of determination it comes to be 0.799236 which den otes that 79% of changes in Canadian dollar/ Indian rupee can be attributed to relationship between Canadian dollar and british pound.

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Table 4

Calculation of correlation between USD/INR and CAD/INR

		USA dollar/Indian rupee (USD/INR)	Canadian dollar/Indian rupee (CAD/INR)
US dollar/Indian rupee	Pearson Correlation	1	.844**
	Sig. (2-tailed)		0
	N	26	26
Canadian dollar/Indian rupee	Pearson Correlation	.844**	1
	Sig. (2-tailed)	0	
	N	26	26

Value of correlation coefficient is 0.844 which depicts USD/INR has positive linear correlation with CAD/INR. If we calculate coefficient of determination it comes to be 0.712336 which denotes that 71% of changes in Canadian dollar/ Indian rupee can be attributed to relationship between Canadian dollar and US dollar.

As Pearson's correlation value is close to 1 in almost all cases , it indicates that there is a strong relationship between two variables. This means that changes in one variable are strongly correlated with changes in the second variable. Correlation and other descriptive statistics have been calculated using SPSS software (table 5).

Table 5

Descriptive statistics calculated using SPSS software

Parameters	CAD/INR	GBP/INR	USD/INR	JPY/INR
Mean	34.77	69.65	41.69	0.27
Standart error of mean	2.266	3.43	2.527	0.089
Median	32	72	44.5	0
Mode	23	83	45	0
Standart deviation	11.556	17.488	12.883	0.452
Variance	133.545	305.835	165.982	0.205
Skewness	0.434	-0.424	-1.227	1.105
Standart error of skewness	0.456	0.456	0.456	0.456
Kurtosis	-0.725	-0.364	3.387	-0.85
Standart error of kurtosis	0.887	0.887	0.887	0.887
Range	42	69	63	1
Minimum	15	31	0	0
Maximum	57	100	63	1
Sum	904	1811	1084	7

Canadian dollar and Indian rupee are positively skewed whereas USA Dollar, British Pound, Japanese Yen and are negatively skewed with Indian rupee.

Conclusions. Since there is great volatility in exchange rate movements, risk is associated with every upside and downside of exchange rate and there is need for incorporation of effective and sound hedging mechanism so as to cope up with this risk and safeguard multinationals and big business houses against forex risk .Rupee movements in Canadian dollar, Japanese yen, US dollar and British Pound have correlation indicating that all companies having transactions globally can predict that upward movement in one currency affects the movement of another currency.

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Based on above analysis, some suggestion have been drawn out so as to come out with some concrete parameters for improving functioning of forex exchange market in India.

1) More and more hedging instruments are required to cope up extreme volatility of Indian rupee against all major currencies of the world.

2) Steady liberalization of financial markets is need of the hour by fetching more attention on corporate and business houses who invest back in India.

3) Promotion of invoicing of trade in domestic currency will be extremely helpful and beneficial for all sectors of economy so as to cope up with extreme volatility.

4) There has been wide progress and enhancement of rupee market across globe especially in Dubai, Singapore, London and New York , so it is need of the hour to try and relocate offshore activities onshore. RBI has taken a number of steps in the recent past to liberalize currency futures market to obviate/reduce the need for the NDF market.3

5) There is need for effective coalition between OTC and exchange traded markets for currency futures

6) More Use of Options should be advocated and more focus should be on conducting seminars and workshops to teach and advocate the importance and practicability of risk management techniques.

7) Open ended foreign exchange positions are more prone to risk and there is need to develop strict monitoring mechanism by liberalizing open position limits of banks.

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