THE DETERMINANTS OF FOREIGN EXCHANGE RATE (FER) VOLATILITY IN THE INDIAN ECONOMY

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ABSTRACT

The purpose of this paper is to investigate whether some prominent factors in the Indian Economy have any impact on foreign exchange rate volatilities of Indian currency. This paper also identifies which foreign currency is most important exchange currency in the international exchange market, with respect to the Indian Rupee. The research paper makes an enquiry to find out, what is the causality between the Gross Domestic Product (GDP) growth rates, Index of Industrial Production (IIP)and the Wholesale Price Indexes (WPI) with the USD/INR exchange rates. The paper also tries to formulate the causality between the Stock Market in India (BSE 30 in our case) with the USD/INR exchange rate values.

After establishing and formulating the causality relation of USD/INR values with the above important parameters of the Indian Economy, namely, GDP growth rates, IIP values and the WPI values and with BSE 30 indexes, the paper proceeds to investigate as to what extent these above indexes determine the volatilities in the USD/INR rates. Finally, the research tries to find out the correlation between these determinants of USD/INR rates.

Keywords*: Indian economy, foreign exchange rate volatility, linear regression, granger causality, auto correlation function, GDP, IIP, WPI.*

Introduction:

The foreign exchange market is a form of global decentralized exchange where money in one currency can be exchanged for another. The price for which this exchange takes place is known as "Exchange Rate". As these exchange rates are affected by many national and international factors, therefore these exchange rate values are highly volatile in nature. In order to minimize the risks associated with these exchanges which are bound to take place in today's global competitive business environment, the knowledge of the determinants of foreign exchange volatilities is very important.

Understanding of, how the market shocks affect the exchange rate is very important for the government of any country to implement a credible monetary policy. The exchange rate also plays a crucial role in determining domestic inflation, the competitiveness and the overall economic health of a nation. Since the Breton Woods collapsed in 1971, the economies throughout the world including India switched from fixed exchange rate system to floating exchange rate system. This has resulted in larger volatility of exchange rates.

Today, the Indian economy is the third largest economy in the world in terms of Purchasing Power Parity (PPP). The economy is opening up to expand its horizon in the highly competitive global business environment. The industry accounts for 28% of the GDP and employ 14% of the total work force in India. The country is 12^{th} in the world in terms of nominal factory output. India is a premier IT service provider in the world. Tourism and hospitality in India is the largest service industry contributing up to 6.23% to the National GDP and providing 8.78 % of the total employment in India.

All these business sectors involve currency exchanges and the affinity to learn about the determinants of Indian foreign exchange rates volatility. It also necessitates the enquiry into how the prominent factors in the Indian economy like GDP growth rates, IIP values and WPI values affects the foreign exchange rate volatilities of its currency i.e., Indian Rupee

(INR).The need is to align the exchange rates with economic fundamentals so that the growth of the nation and its competitiveness are catalyzed and its people developed.

Literature Review:

According to the present literature, many factors determine the exchange rate volatilities of currencies across the globe. These factors involve both, factors local to the countries and also the factors which are global. Some of them are:-

- Levels of Output or Productivity in the country or countries, currencies of which are being exchanged.
- Inflation rates in those countries.
- Interest Rates.
- Money Supply and
- The openness of an economy.

The impact of these factors varies from country to country and is dependent on the economic condition of a particular country. Recently the result of Juthathip's research for developing Asia showed that exchange rates are determined by following five key variables, namely, productivity differentials (PROD), openness of the economy (OPEN), terms of trade (TOT), Net Foreign Assets (NFA) and Government Spending(GEXP).

So, according to the present literature, these determinants are said to impact a country's exchange rate volatilities:-

Money Supply Changes:

Dornbusch model (1976) explains that unanticipated monetary policy shocks results in large fluctuations in the exchange rates. These nominal shocks have a larger impact in the short run while its impact is negligible in the long run.

Interest Rate Differentials:

There exists a high correlation between interest rates, inflation and exchange rates. Interest rates are generally established by central bank of the country. Changes in interest rates influence the inflation rates, which in turn results in change in the exchange rates. More and more foreign capital will be attracted if the interest rates in a country are high and this will lead to appreciation in country's exchange rate. On the other hand lower the interest rates less will be the foreign capital inflows and low inflow of foreign capital leads to depreciation of currency.

Productivity Differentials:

According to Balassa-Samuelson doctrine (1964), rapid economic growth is accompanied by exchange rate appreciation because of differential productivity growth between tradable and non-tradable sector. The Balassa-Samuelson assumes that productivity increases more in tradable sectors than in non-tradable sectors. This would result in higher wages in the economy. As, the rise in wages in the non-traded sector is not matched by an equal rise in productivity improvement, it results in the elevation in prices of non-tradable goods. This leads to higher relative prices of non-tradable goods as compared to tradable goods and thus, leads to appreciation of the home currency exchange prices.

Trade Openness:

The existing literature suggests that more the openness of a country's trade policies less will be the Exchange Rate volatility for its currency.

Terms of Trade:

Terms of Trade is defined as the ratio of export prices to import prices in a country. The Literature suggests that increase in this ratio positively affects the price of the home currency.

Net Foreign Assets:

Capital inflows lead to increased demand for traded and non-traded goods. According to the existing literature an increase in the NFA will lead to increase in the exchange rates resulting from a rise in domestic demand for these goods.

Government Expenditure:

Exchange rates are affected by the changes in the government expenditure which are distributed among the tradable and non-tradable goods. It also depends on the Balassa-Samuelson hypothesis that exchange rate is fully determined by the supply side of the economy. Edward (1989) found that on increasing the public expenditure, exchange rates get appreciated to Stancik, (2007) many factors affect the According exchange rate volatilities, some of which are the openness of an economy, level of output, interest rates, exchange rate policy and independence of the country's central bank.

Orlowski's study, (2003) was to establish the impact of monetary policies on inflation & exchange rate risk premiums in the Hungary, Poland, and Czech Republic concludes that the governments of these countries succeeded in slowing inflation rather than exchange rate volatilities.

Kóbor and Székely (2004) study on volatility using a Markov regime-switching model allows them to identify periods of highly and lowly volatile exchange rates. Their result argues that volatility between these periods changes and is lower in lowly volatile periods. Bulí (2005) analyzes the relationship between exchange rate volatility and financial market liberalization. He concludes that liberalization significantly contributes to the stability of the exchange rate of a country. Kočenda and Valachy (2006) compare exchange rate volatility between fixed and floating regimes. Their findings confirm that volatility increases under a less tight, floating regime.

Granger (1987) is a means to measure volatility in time-series errors, it is a popular measure of exchange-rate volatility a measure of competitors' prices (rather than the GNP or WPI deflator) that is not correlated with volatility; proper specification that controls for auto-correlation; and applying the best proxy for exchange-rate risk.

Kurihara in 2006 argues that stock prices of other countries and GDP, may impact daily stock prices. He points out that the inquiry about dynamic relationship between exchange rate and stock prices is very important especially after the financial crisis in Asian Markets during 1997-1998. According to him, adoption of flexible exchange rate, international diversification, removal of capital flow barriers and cross market correlations has resulted in creating interdependence between the two. Thus, higher volatilities in exchange rates can be attributed to these changes.

Economic theories argue that changes in the exchange rates results in the changes in stock prices. However, there is no general agreement which underlies the above theoretical relationship and the empirical studies of the relationship and are still in conclusive (Joseph, 2002; Vygodina, 2006).

The traditional approach says that the movements in exchange rates lead to changes in stock prices while the other approach which is known as portfolio balance approach argues that exchange rates are determined by changes in the stock prices. Portfolio balance approach also states that stock prices are expected to have negative correlation with exchange rates.

Jorion (1990, 1991), Bodnar and Gentry (1993) and Bartov and Bodnar (1994) all failed to find any significant relation between simultaneous dollar movements and stock returns for US firms. Ma and Kao (1990) found that the appreciation in currency negatively affects the domestic stock prices for an export-dominant country and positively affects the domestic stock prices for an import-dominant country.

Pan (1999) used daily market data to study the causal relationship between stock prices and exchange rates in a set of Asia pacific economies and found that the exchange rates Granger cause stock prices with less significant causal relations from stock prices to exchange rate.

Granger (2000) studied the causal relationships between stock prices and exchange rates using data from the economies which were affected by the Asian financial crisis in 1997. The study showed that causality runs from exchange rates to stock prices in South Korea while in the Philippines market, the causality movement was in the opposite direction. Ibrahim (2000) conducted Granger causality tests between stock prices and exchange rates in Malaysia and found that there is no long-run relationship between exchange rates and stock prices. Yong and Isa (2000), Baharumshah (2002) and Hong (2002) studied the relationship between exchange rate and stock prices in Malaysia and concluded that stock market significantly affects exchange rates. Another study by Wu (2000) on Singapore argues that Singapore currency appreciation against the US dollar and Malaysian ringgit and depreciation against Japanese yen and Indonesian rupiah lead to a long-run increase in stock prices in most of the selected periods in the 1990s.

India's Exchange Rate Policy:

The exchange rate policy of India has witnessed a huge shift from a par value system to a basket-peg system over the period of time. With the opening up of Indian market in the 1990's, the Liberalized Exchange Rate Management System (LERMS) was set up. This dual exchange rate system was put in place to ensure the investor's confidence. In March 1993, LERMS was replaced by a unified exchange rate system. Since then, this market driven exchange rate system has ensured stability in the Indian economy. Any volatility has been dealt with market interventions in combination with monetary and administrative measures to ensure the financial stability. Today, several derivative instruments constitute the India's foreign exchange market. These derivative instruments have been introduced to act as risk management tools. They also come in handy, for ensuring product diversity.

Repo and reverse repo rates are used to control the liquidity impact of large capital inflows. Under the Open Market Operations (OMO), the RBI purchases extra cash in the economy and converts it to the government bonds. This checks the inflation in the economy and ensures stability in the economy. In April 2004; the Reserve Bank of India (RBI) introduced a new instrument of sterilization, the Market Stabilization Scheme (MSS). Since then the MSS has played a crucial role in medium term liquidity management and has helped India's cause to maintain a stable economic growth.

Estimation Techniques:

The sample study focuses on 20 years daily and yearly data sets spanning from 1992-2012.

Auto Correlation Function (ACF):

Autocorrelation is defined as the cross-correlation of a signal with itself. It determines the similarity between observations as a function of the time separation between them. ACF is a mathematical tool for finding repeating patterns. It is also used in signal processing and for analyzing series or functions of values, such as signals of time domain.

ACF between time s and t can be defined as,

$$R(s,t) = \frac{\mathrm{E}[(\mathrm{X_t} - \mu_\mathrm{t})(\mathrm{X_s} - \mu_\mathrm{s})]}{\sigma_\mathrm{t}\sigma_\mathrm{s}}$$

Equation 1 Autocorrelation

Where some repeatable process is X_t is the value produced by a given run of the process at time t.

Granger Causality Test:

The Granger causality test can be defined as the statistical hypothesis test for determining whether one time series is useful in forecasting another.

A time series *X* is said to Granger-cause *Y* if it can be shown, usually through a series of t-tests and F-tests on lagged values of *X*, that those *X* values provide statistically significant information about future values of *Y*. Let *y* and *x* be stationary time series. To test the null hypothesis that *x* does not Granger-cause *y*, one first finds the proper lagged values of *y* to include in a univariate auto regression of y

$$y(t) = a_0 + a_1\mathrm{y_{t-1}} + \mathrm{a_2y_{t-2}} + \cdots + \mathrm{a_m y_{t-m}} + \text{residual}$$

Equation 2 Granger Causality

Next, the auto regression is augmented by including lagged values of *x*:

$$y(t) = a_0 + a_1\mathrm{y_{t-1}} + \mathrm{a_2y_{t-2}} + \cdots + \mathrm{a_m y_{t-m}} + b_{pr_{t-p}} + \cdots + b_{qr_{t-p}}\text{residual}$$

Equation 3 Granger Causality

The null hypothesis that *x* does not Granger-cause *y* is accepted only if no lagged values of *x* are retained in the above regression.

Linear Regression:

Linear regression is an approach to modelling the relationship between a scalar dependent variable *y* and one or more explanatory variables denoted *X*. The case of one explanatory variable is called simple linear regression. More than one explanatory variable is known as multivariate linear regression. Coefficient of determination is used to find out the extent to which one variable determines the other and is represented by R^2.

Pearson's correlation Function:

Pearson's correlation coefficient between two variables is defined as the covariance of the two variables divided by the product of their standard deviations. The form of the definition involves a "product moment", that is, the mean of the product of the mean-adjusted random variables; hence the modifier *product-moment* in the name given to it.

The formula for the same is,

$$(\rho X, Y) \quad = \frac{COV(X,Y)}{\sigma_x\sigma_y} = \frac{E[(X-\mu x)(Y-\mu y)]}{\sigma_x\sigma_y}$$

Equation 4 Karl Pearson Regression

Research Methodology:

The research was segregated into two main parts:-

Indian currency is pegged against a basket of currencies in order to minimize risk. In the first part, the paper tries to find out which foreign currency is most important exchange currency with respect to Indian Rupee (INR) in the international market.

For this purpose, two most important international currencies with respect to INR were identified, from the basket of currencies against which INR is pegged. These two international currencies being the United States Dollar (USD) and the Great Britain Pound (GBP).

- ✓ USD is one of the world's dominant reserve currencies and is also very widely used international transactions.
- ✓ After the breakdown of Bretton Woods System in 1971, INR was linked exclusively to the GBP from 1971-1975, until the decision to peg INR to a basket of currency was implemented, in order to reduce risk associated with a single currency peg.
- ➢ On the 20 years daily data of USD/INR(fig1) and GBP/INR(fig2), we performed the Auto Correlation Function (ACF) to find out which one of the two is determining its future values or rates. This enables us to evaluate which of the two, USD/INR or GBP/INR, is being used more frequently in the international market, so that we can represent the Indian exchange rate in terms of single most important exchange rate for INR.

Fig1: Graph Plot on Normalised value of USD/INR

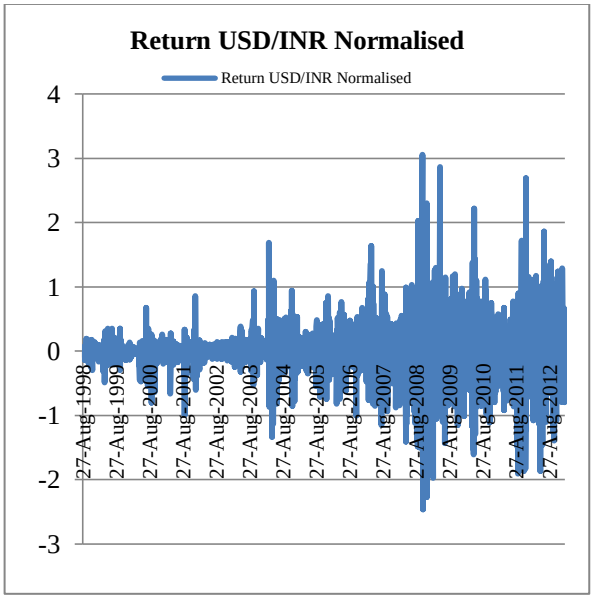
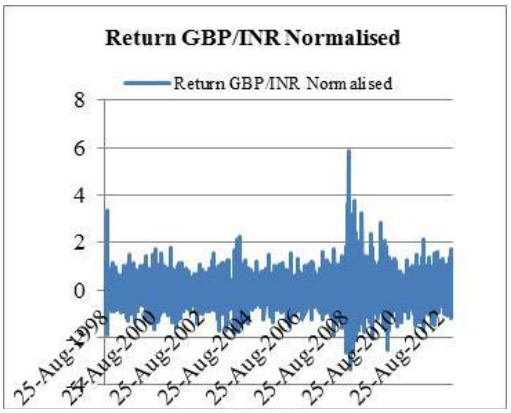


Fig2: Graph Plot on Normalised value of GBP/INR



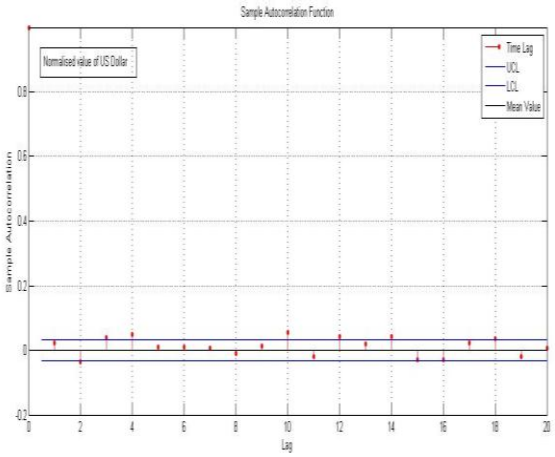


Fig 3: Autocorrelation Function Performed on Normalised value of USD/INR

The daily values of USD/INR were plotted on a time scale for the research purpose. The Auto Correlation Function (ACF) graph for USD/INR above shows that there are 4 time lags, represented in red, (as shown in fig3) at observation 4, 10, 12 and 14,which lie out of control limits. So this graph can be represented with the help of an equation 1.1..

$x_t = f(x_{t-4}) + f(x_{t-10}) + f(x_{t-12}) + f(x_{t-14})$

This leads us to interpret that the historical values of USD/INR rates will change or impact its future values in every 4 to 6 months.

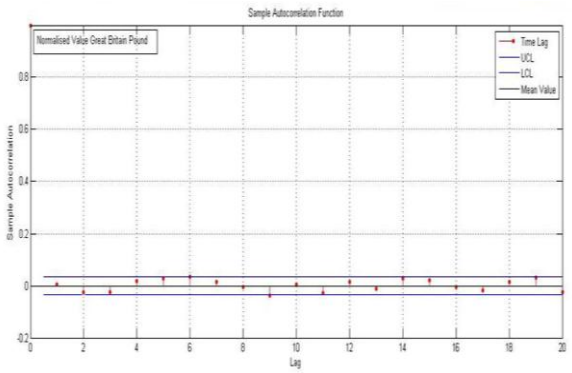


Fig 4: Autocorrelation Function Performed on Normalised value of GBP/INR

The daily values of GBP/INR were plotted on time scale. The Auto Correlation Function (ACF) graph for GBP/INR above shows that there are no time lags, represented in red, (as shown in fig4) at any observations which lie outside the control limits. This leads us to interpret that the historical values of GBP/INR rates will not change or impact its future values, frequently.

It can be concluded from the above ACF analysis that USD/INR exchanges are more frequent and thus more important than the GBP/INR exchanges. Therefore Indian exchange rate can be represented by USD/INR exchange values and this confines the focus of the research to make an enquiry into the *determinants of USD/INR volatilities in the Indian Economy.*

Granger Causality Test:

The Granger Causality Test was performed on the three most prominent factors of the Indian economy, namely GDP growth rates, IIP values and WPI values, each with respect to the USD/INR values. This is done in order to find out whether GDP growth rates, IIP and WPI have any role in determining the future values of USD/INR exchange rates. The granger causality of each of these factors with USD/INR helps us to formulate the causality relationship of each with the USD/INR exchange values. The paper also makes an enquiry into establishing the causality between the stock markets in India and the USD/INR rates. For this purpose, yearly data of BSE 30 indexes were collected and its causality was tested with respect to USD/INR by performing granger causality for the same.

Granger Causality between USD/INR and GDP growth rates:

The observations were considered at three different time lags to establish the causality between the GDP growth rates and USD/INR values.

The null hypothesis that neither GDP granger cause USD/INR nor USD/INR granger cause GDP for all three observations were assumed.

Following were the conclusions based on the observations**:**

Table 1.1: Granger Causality Test Preformed on GDP Growth Rates, USD/INR

Pairwise Granger Causality Tests			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
GDP does not Granger Cause USD	18	3.83614	0.049
USD does not Granger Cause GDP		0.59243	0.5672

At t=2

Null hypothesis that GDP does not granger cause USD/INR can be rejected. Null hypothesis that USD/INR does not granger cause GDP cannot be rejected.

At t=4

Table 1.2: Granger Causality Test Preformed on GDP Growth Rates, USD/INR

Pairwise Granger Causality Tests			
Lags: 4			
Null Hypothesis:	Obs	F-Statistic	Prob.
GDP does not Granger Cause USD	16	1.35645	0.3393
USD does not Granger Cause GDP		0.14209	0.9609

Null hypothesis that GDP does not granger cause USD/INR Table cannot be rejected. Null hypothesis that USD/INR does not granger cause GDP cannot be rejected.

Table 1.3: Granger Causality Test Preformed on GDP Growth Rates, USD/INR

Pairwise Granger Causality Tests			
Lags: 6			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
GDP does not Granger Cause USD	14	0.51011	0.789
USD does not Granger Cause GDP		0.2093	0.9285

At t=6

Both the null hypothesis cannot be rejected. At time lag 2, the GDP granger causes USD/INR, while for none of the time lags; USD/INR granger causes GDP. So it can be concluded that USD/INR= f (GDP) and GDP $\neq f$(USD/INR).

Granger Causality between USD/INR and IIP:

The observations were considered at three different time lags to establish the causality between the IIP and USD/INR values.

The null hypothesis that neither IIP granger cause USD/INR nor USD/INR granger cause IIP for all three observations were assumed.

At t=2

Table 1.4: Granger Causality Test Preformed on IIP, USD/INR

Pairwise Granger Causality Tests			
Lags: 2			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
USD does not Granger Cause IIP	18	0.89743	0.4314
IIP does not Granger Cause USD		0.1652	0.8495

Following were the conclusions based on the observations

Null hypothesis that USD/INR does not granger cause IIP cannot be rejected. Null hypothesis that IIP does not granger cause USD/INR cannot be rejected.

Table 1.5: Granger Causality Test Preformed on IIP, USD/INR

Pairwise Granger Causality Tests			
Lags: 4			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
USD does not Granger Cause IIP	16	0.48678	0.7462
IIP does not Granger Cause USD		1.52714	0.2928

At t=4

Null hypothesis that USD/INR does not granger cause IIP cannot be rejected

Null hypothesis that IIP does not granger cause USD/INR cannot be rejected.

Table 1.6: Granger Causality Test Preformed on IIP, USD/INR

Pairwise Granger Causality Tests			
Lags: 5			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
USD does not Granger Cause IIP	15	0.30412	0.8881
IIP does not Granger Cause USD		10.306	0.0211

At t=5

Null hypothesis that USD/INR does not granger cause IIP cannot be rejected. Null hypothesis that IIP does not granger cause USD/INR can be rejected. At time lag 5, the IIP granger causes USD/INR. While for none of the time lags, USD/INR granger causes IIP. So we can conclude that USD/INR= f (IIP) and IIP $\neq f$ (USD/INR).

Granger Causality between USD/INR and WPI:

The observations were considered at three different time lags to establish the causality between the WPI and USD/INR values.The null hypothesis that neither WPI granger cause USD/INR nor USD/INR granger cause WPI for all three observations.

Following were the conclusions based on the observations**:**

Table 1.7: Granger Causality Test Preformed on WPI, USD/INR

Pairwise Granger Causality Tests			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
WPI does not Granger Cause USD	18	1.61007	0.2373
USD does not Granger Cause WPI		0.68479	0.5215

At t=2

Null hypothesis that WPI does not granger cause USD/INR cannot be rejected. Null hypothesis that USD/INR does not granger cause WPI cannot be rejected.

Table 1.8: Granger Causality Test Preformed on WPI, USD/INR

Pairwise Granger Causality Tests			
Lags: 4			
Null Hypothesis:	Obs	F-Statistic	Prob.
WPI does not Granger Cause USD	16	1.72634	0.2478
USD does not Granger Cause WPI		0.58882	0.6817

At t=4

Null hypothesis that USD/INR does not granger cause WPI cannot be rejected. Null hypothesis that WPI does not granger cause USD/INR cannot be rejected.

Table 1.9: Granger Causality Test Preformed on WPI, USD/INR

Pairwise Granger Causality Tests			
Lags: 5			
Null Hypothesis:	Obs	F-Statistic	Prob.
WPI does not Granger Cause USD	15	12.661	0.0145
USD does not Granger Cause WPI		0.29352	0.8944

At t=5

Null hypothesis that USD/INR does not granger cause WPI cannot be rejected. Null hypothesis that WPI does not granger cause USD/INR can be rejected. At time lag 5, the WPI granger causes USD/INR. While for none of the time lags , USD/INR granger causes WPI. So we can conclude that USD/INR= f (WPI) and WPI $\neq f$(USD/INR).

Granger Causality between USD/INR and BSE 30 indexes:

The observations at three different time lags to establish the causality between the BSE 30 and USD/INR values.The null hypothesis that neither BSE 30 granger cause USD/INR nor USD/INR granger cause BSE 30 for all three observations.

Following were the conclusions based on the observations**:**

Table 1.10: Granger Causality Test Preformed on BSE-30, USD/INR

Pairwise Granger Causality Tests			
Lags: 1			
Null Hypothesis:	Obs	F-Statistic	Prob.
BSE30 does not Granger Cause USD	19	6.36351	0.0226
USD does not Granger Cause BSE_30		0.04452	0.8355

At t=1

Null hypothesis that BSE 30 values does not granger cause USD/INR can be rejected. Null hypothesis that USD/INR does not granger cause BSE 30 values, cannot be rejected.

Table 1.11: Granger Causality Test Preformed on BSE-30, USD/INR

Pairwise Granger Causality Tests			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
RetBSE 30 does not Granger Cause RetGDP	18	1.21882	0.3272
RetGDPdoes not Granger Cause RetBSE 30		0.25123	0.7815

At t=2

Null hypothesis that BSE 30values does not granger cause USD/INR cannot be rejected. Null hypothesis that USD/INR does not granger cause BSE 30 values cannot be rejected.

Table 1.12: Granger Causality Test Preformed on BSE-30, USD/INR

Pairwise Granger Causality Tests			
Lags: 4			
Null Hypothesis:	Obs	F-Statistic	Prob.
RetBSE 30 does not Granger Cause RetGDP	16	0.99139	0.4709
RetGDPdoes not Granger Cause RetBSE 30		0.80604	0.5586

At t=4

Null hypothesis that BSE 30 does not granger cause USD/INR cannot be rejected. Null hypothesis that USD/INR does not granger cause BSE 30 values, cannot be rejected.

At time lag 1, the BSE 30 values granger causes USD/INR.

While for none of the time lags, USD/INR granger causes BSE30 values. It can be concluded that USD/INR= f(BSE 30) and BSE 30 ≠ f(USD/INR).So above results can be formulated by the equation: ***USD/INR=f (GDP,IIP, WPI ,and BSE 30).***

Linear Regression:

Linear Regression was performed on the resulting equation of the granger causality test i.e.

USD/INR=f (GDP, IIP, WPI, and BSE 30), in order to find out that up to what extent the above four independent variables or factors, collectively determine the volatilities in the USD/INR rates.

Also, the linear regression of each independent variable of the above equation is separately performed with the USD/INR rates, in order to determine that up to what degree each of these variables, namely, GDP growth rates, IIP, WPI and BSE 30 affect the volatility in USD/INR exchange rates.

USD/INR=*f* (GDP, IIP, WPI, and BSE 30):

Table 1.13: Regression analysis of USD/INR=*f* (GDP, IIP, WPI, and BSE 30)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.627[a]	.393	.231	.004629421871101

R^2=0.393 signifies that GDP growth rates, IIP values, WPI values and BSE 30 indexes collectively determines the volatility in the USD/INR rates up to ***39.3%.*** The above table can be formulated into the following

Equation 5:-***USD/INR = .003 - .005(GDP) + .021(BSE_30) - .007(IIP) - .003(WPI)***

USD/INR = *f* (GDP):

Table 1.14: Regression analysis of USD/INR = *f* (GDP)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.068[a]	.005	-.051	.005412545705599

R^2= 0.005 signifies that GDP growth rates determine the volatility in the USD/INR rates up to ***0.05%.***

USD/INR = *f* (IIP):

Table 1.15: Regression analysis of USD/INR = *f*(IIP)

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.235[a]	.055	.003	.005273602520518

R^2= 0.055 signifies that IIP determine the volatility in the USD/INR rates up to ***5.5%.***

USD/INR = *f*(WPI):

Table 1.16: Regression analysis of USD/INR = *f*(WPI)

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.232[a]	.054	.001	.005276729327469

R^2= 0.054 signifies that WPI determine the volatility in the USD/INR rates up to ***5.4%.***

USD/INR = *f* (BSE 30):

Table 1.17: Regression analysis of USD/INR = *f*(BSE 30)

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.569[a]	.324	.286	.004461535250873

R^2 = 0.324 signifies that BSE 30 determine the volatility in the USD/INR rates up to ***32.4%.***

Karl Pearson Correlation:

After enquiring about which economic parameter determine the exchange rate (USD/INR) volatilities to what degree, and writing the USD/INR volatility as a function of GDP growth rates, IIP values, WPI values and BSE 30 indexes i.e. as,

USD/INR=f (GDP, IIP, WPI, and BSE 30)

The research was made to find out the correlation amongst the above independent factors or variables. This is done to rule out the problem of multi co-linearity from the above equation.

Karl Pearson Correlation Analysis:

Table 1.18: Karl Pearson Correlation analysis of USD/INR=*f* (GDP, IIP, WPI, and BSE 30)

	IIP	**WPI**	**GDP**	**BSE 30**
IIP	1	0.191	-.231	-.038
WPI	.191	1	-.162	-.119
GDP	-.231	-.162	1	.159
BSE 30	-.038	-.119	.159	1

The above table proves that there is no problem of multi-co linearity in the above equation, as the correlation between each of these factor variables is very low (< 0.5 or -0.5), which is well within the permissible limits ($-1<\rho<1$) for spearman correlation coefficient.

Conclusion:

There is no strong evidence that GBP/INR exchange rates are affected frequently by their historical values, hence the GBP can be considered less important exchange currency with respect to INR than the USD which is more frequently affected by their own historical values.

Therefore exchange rate of India can be represented by USD/INR exchange rates values.USD/INR volatilities can be represented by the equation.

Important parameters of the Indian Economy like GDP growth rates, IIP values, WPI values do make an impact on foreign exchange rate volatilities.

The stock market fluctuations in India also affect the foreign exchange rate volatilities in India, i.e. stock markets also determine foreign exchange values for Indian Rupee.

USD/INR=ƒ (GDP, IIP, WPI, and BSE 30), where GDP stands for GDP growth rate of India, IIP stands for Indexes of industrial Production, WPI stands for Wholesale Price Indexes in the country and BSE 30 represents the stock market of India.

GDP, IIP, WPI and BSE 30 collectively determine the variance in USD/INR rates up to about 39.3%. Amongst the above independent variables of the equation, BSE 30 is the most important factor in determining USD/INR volatilities and determines the volatility in the USD/INR values to up to 32.4%. BSE 30 is followed up by IIP values which determine the USD/INR volatilities up to 5.5%. While the WPI values determine 5.4% volatilities in the USD/INR rates, the GDP affects only 0.5% in the USD/INR rate changes.

The linear regression of the above equation can be formulated as,

USD/INR = .003 - .005(GDP) + .021(BSE_30) - .007(IIP) - .003(WPI)

The independent variables of the above equation, USD/INR=*ƒ* (GDP, IIP, WPI, BSE 30) have very low correlation between themselves. This rules out the possibility of multi co-linearity in the above equation.

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