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Role of Select Macro Economic Factors in Indian Foreign Exchange Rate with special reference to Dollar and Rupee: An Empirical Study

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Abstract

Foreign exchange reserve is an important phenomenon for global trade. The excess outflow of domestic currency due to any crisis leads to the devaluation of the domestic currency. It also forces central banks to deploy reserves to support their currencies. Foreign exchange is traded in financial markets and people with underlying interests like speculators, arbitrageurs & exporters.

This paper focuses on the study of the extent effect of macro-economic factors on the Indian foreign exchange rate, Indian rupee/USD by using a linear regression model (Excel) and a Random Forest model using (R).

Keywords: *Foreign Exchange, Vix, OPEC, Dow Jones, Nifty 50, Commodity, Balance of Payments*

1. INTRODUCTION

Exchange rate is a quantified amount of domestic currency against one unit of foreign currency. Determining the economic factors affecting Exchange rate and the extent of their impact is very necessary for formulation and modification of economic policies as countries cannot produce and consume everything on their own due to constraints of resources, high production cost, surplus, etc. So, trading across borders is essential.

The exporting country has to be compensated by the importing country in the form of currency of the exporting country which is the foreign currency for the importing country. Since one country cannot print the currency of another country, to compensate the other country for goods or services, one needs to have the currency of the country being compensated or USD which is the world's primary reserve currency.

The independent variables (Macro Factors) were selected as -

i) Crude Oil (*Proxy of the Balance of Payments):* More than one-third of the consumed energy is produced from crude oil. This is one of the most essential and dependable factors for energy production. Nations depend heavily on the import of crude oil for meeting their consumption from The Organization of Petroleum Exporting Countries (OPEC). So, Importing countries expend a large chunk of foreign currency for the payment against the crude oil imported.

ii) Gold Price *(Proxy of Commodity Market):* The commodity market comprises of -Agri-Product (Grains, Pulses, Edible Oils, etc.), Energy (Natural gas, Crude oil, etc.), Industrial non-ferrous metals (Aluminum, Steel, Copper), Precious metals (Silver, Gold commodity, etc.), Investment options, Upcoming market opportunity, Commodity based Mutual Funds and Exchange-traded Funds and Commodity stocks.

Other than gold traded as a commodity, gold, and currencies are interrelated in such a way that if there is an excess import of Gold in a country then it may lead to a trade deficit for the importing country and will lead to a fall in domestic currency valuation as there would be an excess supply of domestic currency in the forex market. Gold is also regarded as one of the stable commodities as its price volatility is much lesser than other commodities.

iii) Dow Jones *(Proxy of GDP Growth for Foreign):* As GDP raises so does the output of all goods and services in an economy leading to an increase in corporate earnings and making the stock market bullish. So for foreign currency, we have taken the 'Dow Jones Industrial Average which is the stock market index for 30 prominent companies on stock exchanges of the USA.'

iv) Nifty 50 *(Proxy of GDP Growth for Domestic):* Similarly for domestic we have Nifty 50, which is the weighted average of 50 listed prominent Indian companies on the National Stock Exchange in India.

v) CBOE VIX *(Implied Volatility - Foreign)*: Cboe Vix is real-time indexing derived from the SPX index option, used to project the next 30-day trend analysis.

vi) India VIX *(Implied Volatility - Domestic):* Similarly for the domestic market, we have used India Vix as it is based on NIFTY Index Option prices.

We are taking a proxy for some of the macroeconomic factors as we are conducting research on the daily exchange rate and macro factors like "balance of payments" and GDP are annual in nature.

2. LITERATURE REVIEW

According to *Roubini (2000)*, microeconomic variables affect economic factors. At the domestic level, it impacts on movement of Exchange rate. Variable like interest rate plays a major role in Exchange rate movement. Similarly, a small change in interest at the domestic level has a great impact on the market and vice versa. *Brahmasreneet al., (2014)* studied between "short-term and long-term connection of U.S. imported crude oil prices and exchange rates". It found that crude oil price determined by the Grange - caused from eight-month to the twelfth month. "The association between oil price, gold price, stock market, and exchange rate in India" was studied by *Jain (2016)*. The study says a drop in crude oil price influence negatively both the Indian Rupee exchange as well as the Sensex index. But for the gold price and Sensex, it has been found a fall in Sensex caused a gain in the gold price whereas a fall in the gold price causes a fall in Sensex. "The trend analysis data on the Chicago Board of Options Exchange Implied Volatility Index (CBOE VIX), National Stock Exchange Implied Volatility Index (India VIX), and Historical Volatility (HV) via DWT using Haarwavelets and applied RF and ARIMA for forecasting" said *Ghosh and Chaudhuri (2017)*.

3. OBJECTIVES OF THE STUDY

The present study is mainly based on secondary sources of information. It is being carried out in context with Exchange rate of the Indian Rupee to the USD.

The objectives of the study are as follows –

- To examine some selected macro-economic factors
- To identify factors that play a major role in determining the daily Indian exchange rate.

4. RESEARCH METHODOLOGY

- **Sources of Data**: The study will be based on the secondary data source. Daily data is collected from MetaStock for the period of

29-Aug-08 to 04-Mar-20. After that period, the effect of COVID-19 was very evident and there was a huge disruption.

- **Dependent Variable**: Indian rupee exchange price with respect to USD.
- **Independent Variables:** Crude Oil Price, Gold Price, Dow Jones Industrial Average, Nifty 50, CBOEVIX, India VIX.
- **Test:** Linear Regression Analysis using Excel**,** Random Forest Test using R.
- **Functional Form**: USD Exchange Return = $\alpha + \beta$ * Crude Oil price return + θ*Gold Price return+ δ* DJIA return+γ* Nifty 50 return+ λ* CBOE VIX+ ϕ*India VIX

5. DATA ANALYSIS AND PRESENTATION

INDIA VIX is the Volatility Index that measures the degree of fluctuations or unpredictability that active traders may face in the next 30 days in the NIFTY50 Index. In the year 1993 Chicago Board Options Exchange (CBOE) bring out the idea of VIX. The VIX is followed Black-Scholes Model for pricing options contracts. It's a five-key variable-based model to figure out the fair price of an options contract. It considered the price of the contract, Stock market price, expiry date, degree of risk-free, and instability. By the buy-sell prices of NIFTY options contracts the VIX comes down to the instability assumed by the traders.

In simple language, VIX is the level of fear or complacency it indicates. The higher volatility expectation is gauged through the higher value of INDIAVIX and vice versa. INDIAVIX has a high degree of negative correlation with Nifty. Thus, whenever INDIAVIX falls, NIFTY50 rises and vice versa.

Figure 1: Determination of Exchange Rate of a Dollar in terms of Rupees.

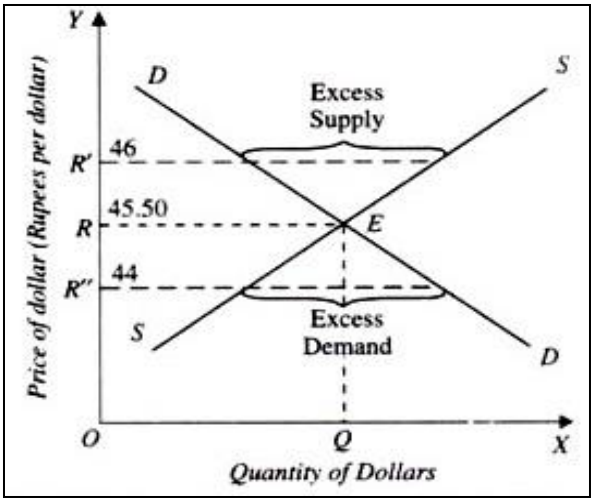
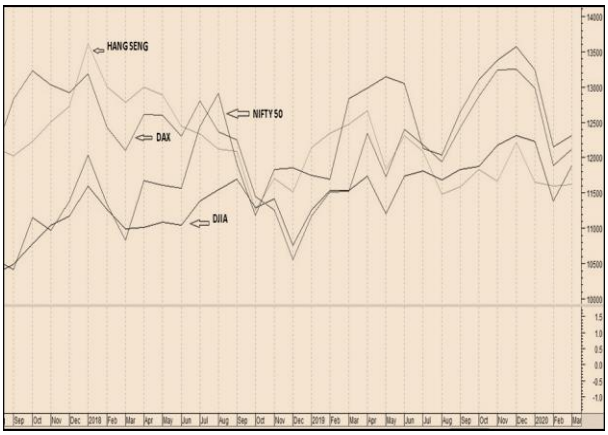


Figure 2: Graph for Movement of DJIA, NIFTY50, DAX, HANG SENG.



Source: *MetaStock*

Figure 2 depicts that the Nifty50 is the least stable when compared with DJIA, DAX, and

HANG SENG whereas DJIA is the most stable among them.

Figure 3: Graph for Movement of CBOE VIX and INDIA VIX.

Source: *MetaStock*

Figure 3 Shows that the fluctuation in INDIA VIX is more when compared with CBOE *VIX*.

Figure 4. India Foreign Exchange Reserves (1998-2020)

Source: *Reserve Bank of India*

Figure 4 portrait, on March 13, 2020 Foreign Exchange Reserves has come down to USD 481.89 billion which is a significant fall since the last 25 weeks. Just to keep up Exchange value of the Rupee in foreign exchange market central bank has to interfere in the favour of Rupee to control the situation. The study shows a significant fall of around $447.36 billion from Approximately $451.13 billion in foreign currency assets.

Figure 5. Changes In USD-INR Exchange Rate Data

Source: *MetaStock*

6. ANALYSIS AND FINDINGS

- **Regression**

Table 1. Regression Statistics

Regression Statistics	
Multiple R	0.497829676
R Square	0.247834386
Adjusted R Square	0.246146023
Standard Error	0.004344366
Observations	2680

In T**able 1**, the Adjusted *R Square value is 0.246* which explains the quantity of the adjustment in the dependent variable (Exchange Rate) that is predictable from the independent variables (Crude Oil Price, Gold Price, Dow Jones Industrial Average, Nifty50, CBOE *VIX*, India *VIX*). The Adjusted R Square may seem less significant and may only predict Exchange rate return with around *25% accuracy* level but this is only a matter of concern when you need to use the regression

equation to make accurate predictions. Here our main concern is to examine the variables affecting Exchange rate.

Table 2: Anova Table

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	0.016623	0.00277	146.7898	2.7236E-161
Residual	2673	0.050449	1.89E-05		
Total	2679	0.067072			

From **Table 2**, *Significance F is 2.7236E-161*which is much lower than 0.05 showing that the model as a whole is very significant and the independent variables have an impact on the dependent variable and can't be rejected.

Table 3: Regression Output Summary for Standard Error, Coefficients, t Stat and p-value

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.40116E-05	0.000207402	-0.115772824	0.907841285	-0.000430697	0.000382674	-0.000430697	0.000382674
CRUDE OIL	0.020331309	0.003923256	5.18225456	2.3557E-07	0.012638386	0.028024232	0.012638386	0.028024232
GOLD	0.029765774	0.008243013	3.611030641	0.000310593	0.013602446	0.045929101	0.013602446	0.045929101
DJIA	-0.02279367	0.00814748	-2.797634184	0.005184706	-0.038769672	-0.006817668	-0.038769672	-0.006817668
NIFTY50	-0.182253363	0.007059155	-25.81829633	2.027E-131	-0.196097321	-0.168413406	-0.196097321	-0.168413406
CBOE VIX	1.4414E-05	1.64177E-05	0.87795884	0.380044962	-1.77786E-05	4.66067E-05	-1.77786E-05	4.66067E-05
INDIA VIX	1.17411E-06	1.6421E-05	0.07150068	0.943004632	-3.1025E-05	3.33732E-05	-3.1025E-05	3.33732E-05

Table 3 analyzing the p-value, which tells the correlation between the dependent and independent variables, the most significant dependent variables are NIFTY50 and Crude Oil Price, followed by Gold Price, Dow Jones Industrial Average, CBOE VIX and INDIA VIX are the least significant.

So, we get the following relation-

USD Exchange rate return = -2.40116E-05 + 0.020331309*Crude Oil price return +0.029765774*Gold Price return+(-0.02279367)*DJIA return+ (-0.182255363)* Nifty 50 return+ 1.4414E-05* CBOE VIX+ 1.1741E-06*India VIX

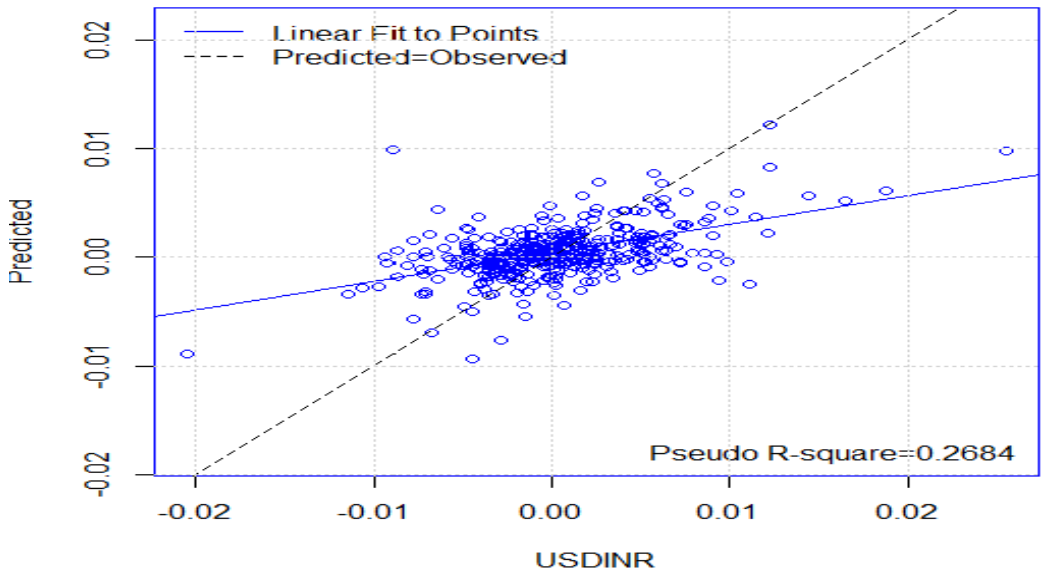
Figure 6: The Output of Random Forest Model Using R

```
Summary of the Random Forest Model
==================================

Number of observations used to build the model: 1875
Missing value imputation is active.

Call:
 randomForest(formula = USDINR ~ ., 
              data = crs$dataset[crs$train, c(crs$input, crs$target)], 
              ntree = 500, mtry = 3, importance = TRUE, replace = FALSE, na.action = randomForest::na.roughfix)

               Type of random forest: regression
                     Number of trees: 500
No. of variables tried at each split: 3

          Mean of squared residuals: 0.00002112053
                    % Var explained: 19.83

Variable Importance
===================

          %IncMSE IncNodePurity
NIFTY       67.03          0.01
CBOE.VIX    23.00          0.00
INDIA.VIX   18.23          0.00
DWJ         13.99          0.00
CRUDE.OIL    7.40          0.00
GOLD         6.68          0.00
```

In **Figure 6**, the mean squared residual is 0.00002 which means that the model is very effective and the random forest model suggests dependent data (Exchange Rate) can be explained by a dependent data set. Percentage variations can be explained only 19.83% of the time which is on the lower side, which means that the variations can be explained only almost 20% of the time.

The % Inc MSE shows that among independent variables Nifty50 has the most explainable power of Exchange Rate followed by CBOE VIX, India VIX, Dow Jones Industrial Average, Crude Oil Prices, and Gold Prices.

Figure 7: Graph for Predicted vs Observed Value of Exchange Rate Using 'R'



FINDINGS OF THE STUDY

i) The fluctuations in the USD Exchange are highly dependent on crude oil prices and NIFTY50 and considerably dependent on Gold Prices and Dow Jones Industrial Average.

ii) From the regression test, it has been observed that an increase in Gold price and Crude Oil prices will lead to an increase in Exchange rate whereas an increase in NIFTY50 and Dow Jones Industrial Average will decrease Exchange rate.

7. RECOMMENDATIONS AND CONCLUSION

- Regression and Deep Forest model were not able to predict Exchange rate and explain the variation efficiently, it could be because the macro-economic factors selected alone can't predict Exchange rate as we may need to add more independent factors and technical indicators to predict Exchange rate more effectively, also there is an intervention of government from time to time to make sure that the valuation of Rupee doesn't appreciate or depreciate much.
- The result also suggests that Foreign Institutional Investors in the share market are playing a major role in determining Exchange rate as the inflow of foreign exchange helps to lower exchange rate by appreciating the domestic currency& increase in NIFTY50 index.

The present study has been carried out with special reference to Rupee and Dollar. Future research may incorporate other countries as the individual country plays differently and figure out the new channel of influence that affect exchange rates.

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