INR to USD Currency Exchange Rate

What factors significantly affect the INR to USD currency exchange rate?

Financial Markets and Instruments
FIN 3560-01
Professor Michael A. Goldstein, PH.D.
4th December, 2013

Rishav Bansal | Manusha Chereddy| Kairavi Mehta| Hendry Susanto

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Executive Summary

This paper outlines the history of the Indian currency exchange market, the basics of the Indian currency markets, past trends, its evolution to present day and the most significant factors that affect the exchange rates of the Indian Rupee and the US Dollar. The general history provides a profound understanding as to how the Indian Rupee has affected the Indian economy. Accordingly, the purpose of this paper is to establish a regression model that can best predict the INR-USD exchange rate.

In order to conduct our analysis, with a general understanding of how foreign exchange rates are determined, we the factors found to be most affecting the volatility of these exchange rates. Regression analysis helped determine the most significant variables those theoretically affect foreign exchange rates. These variables put in a regression equation helped build a best-fit model in order to forecast the exchanges rates of INR. After reading similar papers and scholarly articles, eleven variables were chosen– Balance of Trade, Unemployment Rates, Stock Indices, M2 Money Supply, Interest Rates, Inflation rate, Budget Balance, Government Debt to GDP, Government Bond Yield, Current Account, GDP Growth and Gold Prices. Moreover, to improve the accuracy of the best-fit model, ratios were used as the currency exchange rate is in a ratio form as well (INR/USD). Further, the time frame used for each variable was monthly from 2000 to 2012. To obtain monthly data for many variables, the method of extrapolation was used. After running various regression models, it can be concluded that the most significant factors were unemployment rate ratio, inflation rate ratio, interest rate ratio, government debt/GDP ratio, budget balance ratio and government bond yield ratio. After finding the best fit model, lag approach was used to predict the future exchange rates using previous months' data for variables.

Moreover, the same variables from the best fit model were used to run regression models between Indian Rupee and British Pound Sterling and Indian Rupee and the Euro. This revealed that the same variables were not as significant in predicting exchange rates for Indian rupee and other currencies. Finally, this paper also compares the results of this paper to other similar research papers to point out the similarities and differences in the findings.

History of India's Exchange Rate System

The Indian foreign exchange market has gone through an evolution because of the changes in the exchange rate policies. It evolved from a par value system to a basket-peg in 1975 and further to a managed float exchange rate system in 1990.[1]

Early Stages: 1947-1977

During this period, the rupee followed the par value system of exchange and its value was fixed at 4.15 grains of fine gold. Since the US monetary authority kept the sterling-dollar exchange rate stable, the Reserve Bank of India (RBI) also maintained the par value of the rupee within a 1% band compared to the pound sterling[2]. India gained independence from Britain in 1947, but Britain being its former colony and biggest trading partner, it made sense for the rupee to be linked to the sterling and use it as an intervention currency. This meant that exchange rates of rupee in terms of gold as well as the dollar and other currencies were indirectly kept stable.[3] However, in September 1949 and June 1966, sliding gold prices caused a devaluation of the Indian rupee leading the RBI to reduce the par value of rupee in terms of gold to 2.88 and 1.83 grains of fine gold.[4] During this time frame, India had a strict protectionist regime and all forex activities were tightly controlled by the Reserve Bank in order to maintain the supply of the countries sparse foreign exchange reserves. This severely limited banks from trading currencies limiting the creation of a foreign exchange market.

In 1971, the breakdown of the Bretton Woods System and the floatation of major currencies opened floodgates of opportunity for the market to trade in a borderless currencies market.[5] This kind of openness in the market created more volatility and hence, in order to ensure that the rupee maintained its

[1] Pami Dua, Rajiv Ranjan, "Echange Rate Policy and Modelling in India", http://www.rbi.org.in/scripts/PublicationsView.aspx?id=12252#NS*
[2] RBI Publications, " Indian Foreign Exchange Market - A historical perspective", http://rbidocs.rbi.org.in/rdocs/PublicationReport/Pdfs/77577.pdf
[3] Ibid, 2
[4] Ibid, 2
[5] Ibid, 2

stability, it was linked with the pound sterling in December the same year. Furthermore, since according to the Smithsonian Agreement of 1971, the sterling was fixed to the US dollar, this also helped secure the rupees stability against the dollar.[6] Nevertheless, after 1972, there was a declining share of Britain in India's trade. Therefore, to reduce its dependence on one currency and maintain a more stable exchange rate, in September 1975 the rupee was delinked from the pound.[7] It was then pegged to a basket of currencies. The currencies and the weights assigned by the RBI were kept confidential so as to avoid any speculation in the market. This introduction by the RBI to match the rupee to a basket of currencies helped spark an interest in trading foreign exchange amongst the banking community in India.

Formative Period: 1978-1992

The real momentum for foreign exchange trading came into India in 1978 when the RBI allowed banks to undertake intra-day trading in foreign exchange. However, in order to regulate dealers against exposure, they restricted them to maintain square positions so that their positions were perfectly hedged at the close of business hours each day.[8] The exchange rate was determined by the RBI and was maintained within a 5% band with relation to basket of currencies and was quoted to authorized dealers (ADs) who used these rates for merchant transactions on a day to day basis which helped develop the markets.[9] The spread between buy and sell increased to 0.5%, encouraging the market to trade actively.[10] The only restriction that dealers had to comply with was that they were prohibited from taking a position that originated overseas when dealing with cross country positions on convertible foreign currency. Over time as similar transactions opportunities started to emerge, banks started profiting from foreign exchange trading. The foreign exchange market in India remained highly regulated till the 1990's with restrictions

[6] Ibid, 1
[7] Narendta Jadhav, "Exchange Rate Regime and Capital Flows: The Indian Experience" http://drnarendrajadhav.info/drnjadhav_web_files/Published%20papers/Exchange%20Rate%20Regime%20Capital%20Flow.pdf
[8] Ibid, 2
[9] Ibid, 7
[10] Ibid, 2

on external transactions, barriers to entry, low liquidity and high transaction costs.[11] These restrictions and severe constraints gave rise to a parallel market for foreign exchange called the hawala (unofficial) market which undermined the foreign exchange system. Towards the end of this era, the need for reform was realized when various factors led to difficulties in India's balance of payments. As a result of the Gulf crisis of 1990-1991, export revenues decreased, tourism reduced and oil prices increased.[12] All of this meant India had a balance of trade deficit of 3.2 % of GDP in the 1990's and it was during this period that India pushed for reforms to stabilize the situation.

Post-Reform Period: 1992 onwards

During this period, measures were taken to expand and develop the foreign exchange markets to help set a path to liberalize India's exchange control regimes and expand India's presence in the world market. The Reserve Bank realized that in order to have a stable and structured economy, it needed to have sound policies that reflected the fundamentals for trade, foreign investment, exchange rate policy, public financing. Moreover, it was important to create a favorable environment to help expand trade and investment.[13] Since the country was closed to the world for over four decades, there was still inefficiency in local markets which resulted in a massive drawdown in the foreign exchange reserves. To reduce the pressures of the trade deficit and to instill confidence amongst investors, the currency was depreciated by 20% in 1991.

These exchange rate adjustments were followed by the introduction of the Liberalized Exchange Rate Management System (LERMS) in 1992 which instituted the dual exchange rate.[14] The dual exchange rate ensured that of the total transaction, 60% of the conversion rates were quoted with respect

[11] Ibid, 2
[12] Ibid, 7
[13] Government of India "Overseas Investment Policy" http://business.gov.in/doing_business/overseas_invest_policy.php
[14] Ibid, 15

to market exchange rates while the other 40% were converted at RBI's official rates.[15] The LERM boosted the liberalization efforts, and was geared to encourage Indian investment overseas. This mechanism was important as the source of financing opened the door for Indian industries to access foreign markets, helping gain access to much needed technologies. According to the Government of India for the first time, "a route for cash remittances was allowed with restrictions on the total value"[16]. Further, LERM also helped to transition from the dual rate system to a market-determined or unified exchange rate regime on March 1, 1993.[17]

With the introduction of the unified exchange rate, the rupee is now a floating currency meaning that all foreign exchange transactions can finally take place at market determined rates. Banks no longer needed to transfer any portion of the foreign exchange they received from exporters and other measures to the Reserve Bank.[18] This bolstered the volumes for the day to day foreign exchange transactions. Although the Reserve Bank still monitors the exchange market to limit volatile fluctuations, this move towards a market determined rate gives a boost to the banking segment. In fact, it marked a shift in India's perception of the foreign markets, and was a huge step to initiate deregulation. This framework was proposed to reinforce and develop the foreign exchange market, as well as to help India improve its export competitiveness to meet world standards and maintain a stable and reliable currency.

Current Market Structure

Deregulation and liberalization of the market has helped India to grow in numerous ways. Over the years India's foreign exchange market has become more established, and accounts for larger trade volumes on a daily basis. According to the 2013 report of Triennial Central Bank Survey by the Bank for International Settlement, the total net basis daily average for foreign exchange instruments market was US$ 5,345 billion dollars. In comparison to other countries, India is ranked number 20 for it global

[15] Ibid, 2
[16] Ibid, 13
[17] Ibid, 2
[18] Ibid, 15

foreign exchange market turnover with a contribution share of 1% to the world total daily foreign exchange turnover.[19] Furthermore, according to Mr. Saumil Halani, Business Development Manager at FRR Forex, daily turnover volumes of INR/USD on Indian registered exchanges ranges between INR 16,000 crores to 19,500 crores which in US$ ranges from 256.4 billion to US$ 312.57 billion dollars (Exhibit 18). Much of the currency trading activity in India occurs between 9:00 to 9:35 am IST, and also between 4:30 to 5:00 pm IST (Exhibit 18). Furthermore, 9:00 to 9:35 am IST is the time when foreign exchange markets open in India and 4:30 to 5:00 pm IST marks the opening of the RBI fixing & European market (Exhibit 18). Additionally, according to the Gyan Jyoti Journal, Mumbai is the main foreign exchange center in India, and other centers are present in major cities like Kolkata, New Delhi, Chennai, Banglore and Cochin.[20] Moreover, according to Mr. Halani, apart from India, the USD/INR trading occurs mainly at "NDF (Non-Deliverable Forwards) Singapore market and on DGCX (Dubai Gold & Commodities Exchange) in Dubai" (Exhibit 18).

Reflecting on the Indian foreign exchange markets the year 2008 marked a significant advancement, with the RBI introducing the futures derivative segment into foreign exchange trading. In addition, later that year, the Securities and Exchange Board of India (SEBI) also permitted the trading in derivative contracts.[21] Indian foreign exchange market got another boost when the SEBI through the RBI permitted the trade of major currency pairs like INRGBP (Indian Rupee and Great Britain Pound), INREUR (Indian Rupee and Euro) and INRYEN (Indian Rupee and Japanese Yen).[22] These ongoing efforts by the Reserve Bank of India to advance the Indian foreign exchange markets shows India's commitment to being a global member of the world foreign exchange market. Globalization and ever growing exposure from other countries, especially the federal government's recent act of tapering quantitative easing, has resulted in constant monitoring of the foreign exchange markets by the RBI.

[19] Bank for International Settlement Report On: Foreign exchange turnover in April 2013. Pg 9-10 http://www.bis.org/publ/rpfx13fx.pdf
[20] Gyan Jyoti Journal Volume 1, Issue 3. http://www.gjimt.ac.in/wp-content/uploads/2012/12/pdf15.pdf
[21] Ibid, 22
[22] Ibid, 22

Regression Analysis

The aim of this analysis is to find the most effective regression model that can be used to predict the US dollars to Indian rupee exchange rate. The eleven variables were carefully chosen after going through scholarly articles, reading papers and intuition. Since the currency exchange rate INR/US$ is a ratio, the variables used were also converted to ratios for attaining the most appropriate regression model. For example, interest rate ratio is calculated by dividing India's interest rate by United States' interest rate. Next, the time frame used for each of the variables is monthly from 2000 to 2012. This gave us enough sample data points of 156 to find an accurate regression model. Following are the variables that were used in this paper:

Balance of Trade Ratio: The balance of trade is the difference between a country's imports and exports and is a large component of a country's balance of payments. Any changes in balance of trade can have an effect on the INR-USD exchange as currency exchange takes place due to trading between countries.[23]

Unemployment Rate Ratio: The unemployment rate measure the percent of people looking for jobs. Any changes in the unemployment rate will attract or prevent foreign investment. For example, as the unemployment rate decreases, the economy is deemed to be more stable and foreign investments in that country are likely to improve.

Stocks Index Ratios: Stock market can be used as a matrix to evaluate a country's economy. Hence, it can prove to be a determinant of the foreign exchanges rate. Thus, to evaluate the stock market in India, SENEX index was used, and for the US, DJIA was used. Similar to DJIA, SENSEX tracks the performance of thirty major companies on the Bombay Stock Exchange.[24]

M2 Ratio: M2 is a measure of the money supply, including M1 (cash and checking deposits) as well as short-term deposits such as money market funds. M2 is one of the key indicators of expectations of inflation rate and hence, can significantly affect currency exchange between INR-USD.

[23] "India Balance of Trade." TRADING ECONOMICS. 23 Nov. 2013 <http://www.tradingeconomics.com/india/balance-of-trade>.
[24] "Index Detail:BSE Sensex." BSE Sensex. 23 Nov. 2013 <http://in.reuters.com/finance/markets/index?symbol=.BSESN>.

Interest Rates Ratio: Interest rates can play a key role in determining the exchange rate between two countries. Thus, the benchmark repurchase rates reported by the Reserve Bank of India were compared to the widely used US Federal Fund rates reported by the US Federal Reserve.[25]

Inflation Rate Ratio: The rate of inflation is considered to be an important factor in determining the INR-USD exchange rate. Expectations of nominal inflations can significantly affect currency exchange rates.

Budget Balance Ratio: Budget balance is a matrix that reveals government's monetary policy. It is calculated by deducting government expenditure from government revenue. This variable was chosen based on personal inquisitiveness.

Government Debt/GDP Ratio: Government's debt as a percent of GDP is used to measure a country's ability to repay its debt which eventually has an effect on the country's borrowing and government yields. Due to this reason, it was included in the analysis.

Current Account Ratio: Current Account records a nation's exports and imports of goods and services and transfer payments. One of the major components of current account is foreign exchange because as the currency gets stronger, the imports are cheaper and exports are less competitive and vice versa.[26] Thus, current account was an important factor to use in our analysis.

GDP Growth Ratio: GDP growth informs one about the country's economic performance compared to the previous time period. This was chosen as a factor because an increase in GDP can result to increase in inflation and interest rates.

Gold Ratio: It is believed that gold is used as significant determinant in INR-USD currency exchange and gold is used as a medium of exchange in equivalence to currency value. Thus, it will be interesting to find evidence of gold prices affecting the exchange rates.

[25] "India Interest Rates." TRADING ECONOMICS. 23 Nov. 2013 <http://www.tradingeconomics.com/india/interest-rates>.
[26] "Current Account." Investopedia. 22 Nov. 2013 <http://www.investopedia.com/terms/c/currentaccount.asp>.

Process of finding the Best Regression Model

After selecting the different variables that are likely to have an impact on the INR-USD exchange rate, we ran individual regressions, a stepwise regression and a best subset model to pick the most significant factors that had an impact on the exchange rate.

Exhibits 2&3 reveal that Stepwise Regression and Best Subset Model both indicate that Government bond yield ratio, Government Debt to GDP ratio, Interest Rate ratio, Unemployment ratio and Inflation rate ratio and Budget Balance ratio are the most significant factors that influence INR-USD currency exchange rate.

Using these factors, we ran the regression model and the results can be seen in Exhibit 4. The regression Model 1 reveals that even though the R-square adjusted is very high, the standard error is low, and p-values are below 0.06, the VIF is very high for many of the factors (Exhibit 4). VIF is an index that measures to see if two or more predictor variables in a multiple regression model are highly correlated. Thus, a high VIF for the variables suggests that few variables are correlated. This reduces the predictive power or the reliability of the regression model as a whole. Thus, to obtain a more perfect regression model with lower VIF indexes, we eliminated the variables with high p-values until we got the Model 2 (Exhibit 5). Model 2 as shown in exhibit 5 indicates that interest rate ratio, inflation rate ratio, government Debt/GDP ratio and budget balance ratio are the most significant factors.

Nevertheless, solely based on p-values one cannot conclude Model 2 as the best yet. Although there is high correlation between variables of Model 1 compared to Model 2 as suggested by VIF, the Durbin Watson statistic for Model 1 is 0.599605 versus 0.462604 for Model 2 (Exhibits 4 &5). Durbin Watson statistic indicates whether there is correlation between variables overtime. For a sample of more than 100 data points and 6 variables it is appropriate to have Durbin Watson statistic of 1.44. Hence, as Model 1 has a higher Durbin Watson statistic it can be concluded that Model 1 is better than Model 2. This statistic is very low for both the models. This does raise a red flag as it violates one of the regression assumptions. For this paper it is unreasonable to go into depths of solving this problem, however, there is scope for further studies.

To further prove which model is more accurate, it is important to calculate which model is more precise in predicting the future. Hence, we used the Lag approach for both the models, and these results can be seen in exhibit 8. Exhibit 8 indicates that by using Model 1 (Lag 1), on average, one will be off by ±Rs.1.29 or ±2.86%, while using Model 2 (Lag 1), on average, one will be off by ±Rs.1.85 or ±4.01%. Therefore, based on the results, it can be concluded that Model 1 (Lag 1) is more accurate than Model 2 (Lag 1) in predicting the future exchange rate using past variables.

Therefore, after going through various steps it can be concluded that Model 1 (Lag 1) is a better model, and can be used by INR-USD currency exchange investors to predict the future and make trading/hedging decision accordingly. However, when investors are using this model to predict the future, it is important for them to understand that it is, on average that the actual currency will be off only by ±Rs.1.29 or ±2.86%. There can be instances when markets can behave in a highly unpredictable manner and in short term the actual currency exchange rate may differ from the predicted by more than ±2.86%. Nevertheless, in the long-term, the difference between actual and predicted INR-USD currency exchange rate will balance off to ±2.86%.

Uncovered Interest Parity & Purchasing Power Parity

To find other models that can also prove to be accurate to predict exchange rates, it is important to use uncovered interest rate parity. Uncovered Interest Parity shows how changes in interest rates can be used to speculate future exchange rates. Hence, we calculated the expected spot rates using the Lag approach. Using uncovered interest parity, we determined the expected spot exchange rates based on the INR-USD exchange rates and compared actual prices to the modeled expected spot prices. Through our analysis, we found that when using the uncovered interest approach, one will be off on average by only ±Rs.1.93 or ±4.10% when forecasting exchanges rates. Moreover, we also used the purchasing power parity model in the same way mentioned above. The only difference was this model used inflation rates instead of interest rates. Exhibit 17 reveals that using the purchasing power parity model on average one will be off by ±Rs.1.54 or ±3.31%. However, when this uncovered interest parity model and purchasing power parity model is compared to Model 1 (Lag 1), it can be concluded that Model 1(Lag 1) is a better

model (Exhibit 8 &17). Exhibit 8 shows that one will be off by on average by only Rs. ±1.29 or ±2.86% if Model 1 (Lag 1) is used to forecast exchange rates. Regardless, there will be instances when the markets can behave in a highly unpredictable manner.

Model Application to Other Major Currencies

To understand if the same economic factors could be used to predict the currency exchange rate between INR and other currencies, we used the factors from Model 1 (Lag 1) to predict the movements in the exchange between INR and other major currencies such as the Euro (EUR) and the British Pound Sterling (GBP). In doing so, we tested the results of each regression to determine whether the same exact variables used to predict the movements in INR-USD, could be used to accurately predict movements of INR with other currencies like the EUR and the GBP.

INR-EUR

The results in Exhibit 12, reveals that Model 1 (Lag 1) can only moderately predict the exchange rate movements between INR-EUR. Although the regression result seems to imply that the model has a better correlation between INR-EUR than INR-USD as the R^2 adj. value is 75.80%, our model seems to be less accurate in its predictions as the standard error value is 4.4252 versus INR-USD which is 1.7591. This anomaly can be explained by the fact that not all of the variables used in the INR-USD model are significant in its contribution to the INR-EUR regression. The p-values of variables such as Budget Balance and Government Debt/GDP fail to generate sufficient evidence of significant contribution to the model as their p-values are greater than 0.06 (Exhibit 9).

In addition, our model's inaccuracy in predicting INR-EUR is further emphasized as relatively the mean absolute deviation (MAD) and mean absolute percentage error (MAPE) is higher (Exhibit 12). As indicated by Exhibit 12, both the MAD and MAPE in the regression of INR-EUR is at least twice the amount found in the regression of INR-USD. This implies that the model's prediction of INR-EUR exchange will, on average, be off by ±Rs.3.52 or ±6.48%. Not only is our model relatively less accurate in predicting movements in INR-EUR, the effects of each variable are also significantly different. For

example, according to Exhibit 9 a unit increase or decrease in relative unemployment rates between India and the United States will change the exchange rate by approximately Rs.2.89, while a unit change in the same variable between India and the Euro Zone will either increase or decrease the INR-EUR exchange by almost Rs.63. Other variables that have significant difference in its contribution in both the INR-USD and INR-EUR model include the relative Government Debt/GDP ratio and the relative Interest Rate ratio between the two countries.

INR-GBP

In contrast to INR-USD and INR-EUR, we used Model 1 (Lag 1) in predicting INR-GBP and found it to be relatively uncorrelated. Exhibit 10 shows that, although there are only two variables interest rate and government debt to GDP are insignificant by a high p-value, the overall model can only explain 25.6% of the total movement in INR-GBP, as indicated by the R^2 adjusted value. With a p-value of 0.966, the regression result simply implies that the movement in relative interest rates has almost no effect in predicting movement of the INR-GBP exchange rates.

The inaccuracy of our model to predict the INR-GBP movement can be further examined through the MAD and MAPE values. Exhibit 12 shows that the exchange rate will be off by, on average, ±Rs.4.37 or ±5.72% when our model is used to predict the value of the INR-GBP exchange rates. The relatively low R^2 adj value of 25.6%, along with the high MAD value, indicates the Model 1 (Lag 1) has a very low level of accuracy when it comes to predicting values of INR with foreign currencies other than USD.

Similar to the situation in INR-EUR, the regression results in Exhibit 9 shows that the significance of each variable in determining the value of the exchange rate is also very different. For example, any unit change in relative government debt-to-GDP will result in ±Rs.17.4 change in the INR-USD exchange rate, but a unit change in the same variable will only result in a change of ±2.12 in the INR-GBP rate. Furthermore, as can be seen in Exhibit 10, the constant value in the regression equation of the INR-GBP model is very high at 51.5, while the constant of the INR-USD model is only 22.1. Such

high constant values might indicate that the current model holds insufficient significant variables to holistically explain the movement in INR-GBP, hence the inaccuracies of the model.

In order to create an accurate model to predict the movement of INR and other currencies like the EUR and GBP, the best subsets and stepwise regression has to be re-run in order to determine the unique, significant variables that can accurately explain the movement in exchange rates.

Comparing the Findings with Scholarly Articles

In the attempt to validate our findings, we compared our findings to two similar INR-USD exchange rates models found in the following scholarly articles:

- Analysis of Macroeconomic Determinants of Exchange Rate Volatility in India by Anita Mirchandani[27]
- Exchange Rate Dynamics in Indian Foreign Exchange Market: An Empirical Investigation on the Movement of USD/INR by Maram Srikanth and Braj Kishor[28]

Exhibit 13 shows that all three various models have an almost entirely different list of significant variables, which can mainly be caused by factors such as different time frames used in the research as well as different unit of measure for each variable. For example, Mirchandani uses only Indian interest rates while we used interest rate ratio between India and the US. From our research and analysis, there were common variables that were present in each model particularly interest and inflation rates, although they may not be significant contributors. Nonetheless, we believe that it is likely that both interest rates and inflation rates are substantially more significant factors in determining exchange rates between currencies. Moreover, from our analysis we can conclude that the difference in the results can be due to the different time frames used by different authors (Exhibit 13).

[27] Mirchandani, Anita. "Analysis of Macroeconomic Determinants of Exchange Rate Volatility in India." International Journal of Economics and Financial Issues 3 (2013): 172-79. EBSCOhost. 3 Nov. 2013.
[28] Srikanth, Maram, and Braj Kishor. "Exchange Rate Dynamics in Indian Foreign Exchange Market: An Empirical Investigation on the Movement of USD/INR." IUP Journal of Applied Finance 18 (2012): 46-61. EBSCOhost. 3 Nov. 2013.

Additionally, after looking at Mr. Srikanth's and Mr. Kishor's research papers, we realized that using the lag approach on the currency exchange rate might result various findings.[29] Thus, we used the lag approach for the currency exchange data and ran the regression model. Using this regression model, we calculated the predicted currency exchange rate after plugging previous month's exchange rate and then measured the forecasting accuracy. Exhibit 11 reveals results that if the lagged currency exchange rate model is used, on average one would only be off by ± Rs.0.68. The result from using this lagged currency exchange rate model is better than using the Model 1 (Lag 1) (Exhibit 8& 11). The lagged currency exchange rate model is better because it puts more weight on the more recent exchange rate compared to Model 1 (Lag 1) that gives equal weight to all the exchange rates.

Conclusion

This paper proves that unemployment rate ratio, interest rate ratio, inflation rate ratio, budget balance ratio, government debt /GDP ratio and government bond yield ratio are the most significant variables in determining the INR-USD exchanges. Moreover, one can use the Model 1 (Lag 1) regression model to forecast exchange rates and using it, on average, one will be off by ±Rs.1.29 or ±2.86%. However, through our analysis, we found that this model was inaccurate in predicting other currencies such as INR-EUR and INR-GBP exchange rates. Moreover, comparing our paper to other scholarly articles allowed us to generate with a more accurate model, lagged currency exchange rate model. Lagged currency exchange rate model was more accurate because, on average, one would only be off by ±Rs. 0.68 or ±1.45% when using that model. Therefore, investors who are involved in trading/hedging of INR-USD can use our findings to improve their prediction of the future. However, it is important that investors understand that this model is merely based on historic data, and future can highly vary from the past.

[29] Ibid, 28

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EXHIBIT 1: Simple Regressions

Regression Analysis: INR-USD versus BOT Ratio (India/US)

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The regression equation is
INR-USD = 46.1 - 0.00122 BOT Ratio (India/US)


Predictor                 Coef   SE Coef       T      P
Constant                46.0831    0.2613  176.39  0.000
BOT Ratio (India/US)  -0.001218  0.003734   -0.33  0.745


S = 3.25540   R-Sq = 0.1%   R-Sq(adj) = 0.0%
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Regression Analysis: INR-USD versus Unemployment Ratio

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The regression equation is
INR-USD = 55.2 - 6.04 Unemployment Ratio


Predictor             Coef  SE Coef      T      P
Constant            55.203    1.333  41.43  0.000
Unemployment Ratio  -6.0387   0.8689  -6.95  0.000


S = 2.84126   R-Sq = 23.9%   R-Sq(adj) = 23.4%
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Regression Analysis: INR-USD versus Stock Ratio

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The regression equation is
INR-USD = 46.1 - 0.00015 Stock Ratio


Predictor         Coef   SE Coef       T      P
Constant       46.0791    0.2625  175.57  0.000
Stock Ratio  -0.000153  0.002470   -0.06  0.951


S = 3.25648   R-Sq = 0.0%   R-Sq(adj) = 0.0%
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Regression Analysis: INR-USD versus M2 Ratio

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The regression equation is
INR-USD = 46.1 - 0.0014 M2 Ratio


Predictor      Coef  SE Coef       T      P
Constant    46.0792   0.2611  176.48  0.000
M2 Ratio   -0.00136  0.01017   -0.13  0.894


S = 3.25633   R-Sq = 0.0%   R-Sq(adj) = 0.0%
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Regression Analysis: INR-USD versus Interest Rate Ratio

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The regression equation is
INR-USD = 44.4 + 0.164 Interest Rate Ratio


Predictor              Coef  SE Coef       T      P
Constant            44.4057   0.2811  157.99  0.000
Interest Rate Ratio  0.16432  0.01825    9.00  0.000


S = 2.63584   R-Sq = 34.5%   R-Sq(adj) = 34.1%
```

Regression Analysis: INR-USD versus Inflation Ratio

```
The regression equation is
INR-USD = 45.8 + 0.0847 Inflation Ratio


Predictor           Coef  SE Coef       T      P
Constant         45.8424   0.2868  159.85  0.000
Inflation Ratio  0.08471  0.04530    1.87  0.063


S = 3.22017   R-Sq = 2.2%   R-Sq(adj) = 1.6%
```

Regression Analysis: INR-USD versus Budget Balance Ratio

```
The regression equation is
INR-USD = 46.1 - 0.0764 Budget Balance Ratio


Predictor                Coef  SE Coef       T      P
Constant               46.1207   0.2619  176.12  0.000
Budget Balance Ratio  -0.07640  0.06230   -1.23  0.222


S = 3.24074   R-Sq = 1.0%   R-Sq(adj) = 0.3%
```

Regression Analysis: INR-USD versus Government Debt/GDP Ratio

```
The regression equation is
INR-USD = 51.0 - 4.37 Government Debt/GDP Ratio


Predictor                    Coef  SE Coef      T      P
Constant                   50.984    1.106  46.09  0.000
Government Debt/GDP Ratio  -4.3738   0.9617  -4.55  0.000


S = 3.05765   R-Sq = 11.8%   R-Sq(adj) = 11.3%
```

Regression Analysis: INR-USD versus Government Bond Yield Ratio

```
The regression equation is
INR-USD = 41.7 + 2.01 Government Bond Yield Ratio


Predictor                      Coef  SE Coef      T      P
Constant                    41.7160   0.5099  81.82  0.000
Government Bond Yield Ratio  2.0143   0.2150   9.37  0.000


S = 2.59898   R-Sq = 36.3%   R-Sq(adj) = 35.9%
```

Regression Analysis: INR-USD versus Current Account Ratio

```
The regression equation is
INR-USD = 46.1 + 0.000044 Current Account Ratio


Predictor                  Coef    SE Coef       T      P
Constant                46.0763     0.2612  176.39  0.000
Current Account Ratio  0.0000438  0.0007182    0.06  0.951


S = 3.25648   R-Sq = 0.0%   R-Sq(adj) = 0.0%
```

Regression Analysis: INR-USD versus GDP Ratio

```
The regression equation is
INR-USD = 46.1 - 0.0041 GDP Ratio


Predictor      Coef  SE Coef       T      P
Constant    46.0994   0.2690  171.38  0.000
GDP Ratio  -0.00409  0.01231   -0.33  0.740


S = 3.25536   R-Sq = 0.1%   R-Sq(adj) = 0.0%
```

Regression Analysis: INR-USD versus Gold Growth Rate (%)

```
The regression equation is
INR-USD = 46.1 - 0.0227 Gold Growth Rate (%)


Predictor                 Coef  SE Coef       T      P
Constant               46.1057   0.2688  171.53  0.000
Gold Growth Rate (%)  -0.02271  0.05271   -0.43  0.667


S = 3.25456   R-Sq = 0.1%   R-Sq(adj) = 0.0%
```

EXHIBIT 2: Stepwise Regression Result

Stepwise Regression: Current Exchange versus BOT Ratio, Stock Ratio, M2 Ratio, Interest Rate Ratio, Inflation Ratio, Government Debt/ GDP Ratio, Unemployment Ratio, Government Bond Yield Ratio, Budget Balance Ratio, Current Account, GDP Ratio, Gold Growth

Alpha-to-Enter: 0.15 Alpha-to-Remove: 0.15

Response is Current Exchange on 12 predictors, with N = 156

Step	1	2	3	4	5	6
Constant	41.72	33.45	18.13	23.06	21.50	21.46
Government Bond Yield Ratio	2.01	3.12	2.44	2.78	2.67	2.62
T-Value	9.37	8.96	9.37	10.11	9.74	9.62
P-Value	0.000	0.000	0.000	0.000	0.000	0.000
Government Debt/GDP Ratio		5.2	17.1	18.0	18.4	18.2
T-Value		3.94	12.20	12.93	13.39	13.38
P-Value		0.000	0.000	0.000	0.000	0.000
Interest Rate Ratio			0.342	0.261	0.285	0.290
T-Value			11.69	6.79	7.34	7.52
P-Value			0.000	0.000	0.000	0.000
Unemployment Ratio				-3.8	-3.3	-3.1
T-Value				-3.16	-2.67	-2.52
P-Value				0.002	0.008	0.013
Inflation Ratio					0.066	0.067
T-Value					2.60	2.63
P-Value					0.010	0.009
Budget Balance Ratio						-0.063
T-Value						-1.91
P-Value						0.058
S	2.60	2.48	1.81	1.76	1.73	1.71
R-Sq	36.31	42.17	69.56	71.44	72.67	73.32
R-Sq(adj)	35.89	41.41	68.95	70.68	71.76	72.25
Mallows Cp	191.4	161.8	16.1	8.0	3.4	1.8

EXHIBIT 3: Best Subsets Regression Result

Best Subsets Regression: Current Exchange versus BOT Ratio, Stock Ratio, M2 Ratio, Interest Rate Ratio, Inflation Ratio, Government Debt/ GDP Ratio, Unemployment Ratio, Government Bond Yield Ratio, Budget Balance Ratio, Current Account, GDP Ratio, Gold Growth

Response is Current Exchange

Vars	R-Sq	R-Sq(adj)	Mallows Cp	S	BOT Ratio (Indian/US)	Unemployment Rate	Stock Rate	Interest Rate	M2 Rate	Inflation Rate	Government Debt/ GDP Rate	Budget Balance Rate	Current Account/ GDP Rate	Government Bond Yield Rate	Gold Growth Rate (%)
1	36.3	35.9	191.4	2.5990							X				
1	34.5	34.1	201.2	2.6358				X							
2	52.0	51.3	109.0	2.2642				X			X				
2	42.2	41.4	161.8	2.4845							X	X			
3	69.6	69.0	16.1	1.8086				X			X	X			
3	62.7	62.0	53.0	2.0016		X					X	X			
4	71.4	70.7	8.0	1.7575		X		X			X	X			
4	71.4	70.6	8.4	1.7598				X	X		X	X			
5	72.7	71.8	3.4	1.7251		X		X	X		X	X			
5	72.2	71.3	6.0	1.7404				X	X	X	X	X			
6	73.3	72.2	1.8	1.7101		X		X	X	X	X	X			
6	72.9	71.8	4.0	1.7227	X	X		X	X		X	X			
7	73.4	72.2	3.3	1.7124	X	X		X	X	X	X	X			
7	73.4	72.1	3.7	1.7147		X		X	X	X	X	X			X
8	73.5	72.0	5.1	1.7173	X	X		X	X	X	X	X			X
8	73.4	72.0	5.2	1.7180	X	X		X	X	X	X	X	X		
9	73.5	71.8	7.1	1.7228	X	X		X	X	X	X	X	X		X
9	73.5	71.8	7.1	1.7229	X	X		X	X	X	X	X		X	X
10	73.5	71.6	9.0	1.7284	X	X		X	X	X	X	X	X	X	X
10	73.5	71.6	9.1	1.7287	X	X	X	X	X	X	X	X	X		X
11	73.5	71.5	11.0	1.7344	X	X	X	X	X	X	X	X	X	X	X
11	73.5	71.4	11.0	1.7344	X	X		X	X	X	X	X	X	X	X
12	73.5	71.3	13.0	1.7404	X	X	X	X	X	X	X	X	X	X	X

EXHIBIT 4: Model 1 (Variables selected based on results from Exhibit 2 & 3)

Regression Analysis: Current Exchange versus Interest Ratio, Inflation Rate Ratio, Government Debt/ GDP Ratio, Unemployment Ratio, Government Bond Yield Ratio, Budget Balance Ratio

The regression equation is

Current Exchange = 21.5 + 0.290 Interest Rate Ratio + 0.0666 Inflation Ratio
+ 18.2 Government Debt/GDP Ratio - 3.06 Unemployment Ratio
+ 2.62 Government Bond Yield Ratio
- 0.0631 Budget Balance Ratio

Predictor	Coef	SE Coef	T	P	VIF
Constant	21.456	2.527	8.49	0.000	
Interest Rate Ratio	0.28998	0.03857	7.52	0.000	10.612
Inflation Ratio	0.06662	0.02529	2.63	0.009	1.105
Government Debt/GDP Ratio	18.247	1.363	13.38	0.000	6.426
Unemployment Ratio	-3.056	1.211	-2.52	0.013	5.361
Government Bond Yield Ratio	2.6202	0.2724	9.62	0.000	3.708
Budget Balance Ratio	-0.06312	0.03309	-1.91	0.058	1.013

S = 1.71008 R-Sq = 73.3% R-Sq(adj) = 72.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	6	1197.43	199.57	68.24	0.000
Residual Error	149	435.73	2.92		
Total	155	1633.16			

Source	DF	Seq SS
Interest Rate Ratio	1	563.22
Inflation Ratio	1	11.74
Government Debt/GDP Ratio	1	323.27
Unemployment Ratio	1	6.29
Government Bond Yield Ratio	1	282.26
Budget Balance Ratio	1	10.64

Unusual Observations

Obs	Interest Rate Ratio	Current Exchange	Fit	SE Fit	Residual	St Resid
27	3.7	48.695	48.984	1.150	-0.289	-0.23 X
28	3.7	48.860	45.758	0.752	3.102	2.02RX
95	1.3	39.220	43.228	0.261	-4.008	-2.37R
96	1.3	39.390	43.361	0.308	-3.971	-2.36R
97	1.4	39.210	43.349	0.302	-4.139	-2.46R
98	2.0	39.540	43.044	0.270	-3.504	-2.07R
106	3.0	47.560	41.519	0.377	6.041	3.62R
107	6.0	47.480	44.070	0.334	3.410	2.03R
108	6.0	49.560	49.044	1.564	0.516	0.74 X
145	24.0	52.760	49.343	0.466	3.417	2.08R
146	38.0	48.650	52.253	0.451	-3.603	-2.18R

Durbin-Watson statistic = 0.599605

EXHIBIT 5: Model 2

Regression Analysis: Current Exchange versus Interest Ratio, Inflation Ratio, Government Debt/ GDP Ratio, Budget Balance Ratio

The regression equation is
Current Exchange = 26.9 + 0.419 Interest Rate Ratio + 0.101 Inflation Ratio
- 0.0883 Budget Balance Ratio
+ 13.1 Government Debt/GDP Ratio

Predictor	Coef	SE Coef	T	P	VIF
Constant	26.904	2.135	12.60	0.000	
Interest Rate Ratio	0.41910	0.03462	12.11	0.000	5.289
Inflation Ratio	0.10082	0.03144	3.21	0.002	1.057
Budget Balance Ratio	-0.08831	0.04185	-2.11	0.036	1.002
Government Debt/GDP Ratio	13.087	1.592	8.22	0.000	5.419

S = 2.17431 R-Sq = 56.3% R-Sq(adj) = 55.1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	919.29	229.82	48.61	0.000
Residual Error	151	713.87	4.73		
Total	155	1633.16			

Source	DF	Seq SS
Interest Rate Ratio	1	563.22
Inflation Ratio	1	11.74
Budget Balance Ratio	1	24.84
Government Debt/GDP Ratio	1	319.48

Unusual Observations

Obs	Interest Rate Ratio	Current Exchange	Fit	SE Fit	Residual	St Resid
26	3.7	48.630	48.157	0.731	0.473	0.23 X
27	3.7	48.695	49.636	1.448	-0.941	-0.58 X
28	3.7	48.860	44.845	0.862	4.015	2.01RX
106	3.0	47.560	41.573	0.451	5.987	2.81R
107	6.0	47.480	43.154	0.387	4.326	2.02R
108	6.0	49.560	48.923	1.988	0.637	0.72 X
144	24.0	51.200	46.103	0.381	5.097	2.38R
145	24.0	52.760	46.076	0.384	6.684	3.12R
150	36.0	55.640	51.198	0.439	4.442	2.09R
152	36.0	55.750	51.147	0.437	4.603	2.16R
153	36.0	55.900	51.081	0.436	4.819	2.26R

Durbin-Watson statistic = 0.462604

EXHIBIT 6: Model 1(LAG 1)

Model 1 (LAG -1)
Regression Analysis: Current Exchange versus Unemployment Ratio, Interest Ratio, Government Debt/ GDP Ratio, Government Bond Yield Ratio, Budget Balance Ratio, Inflation Ratio

```
The regression equation is
Current Exchange = 22.1 - 2.89 Unemployment Ratio + 0.271 Interest Rate Ratio
                   + 0.0610 Inflation Ratio - 0.0788 Budget Balance Ratio
                   + 17.4 Government Debt/GDP Ratio
                   + 2.77 Government Bond Yeild Ratio
```

Predictor	Coef	SE Coef	T	P	VIF
Constant	22.135	2.637	8.39	0.000	
Unemployment Ratio	-2.886	1.257	-2.30	0.023	5.431
Interest Rate Ratio	0.27055	0.04014	6.74	0.000	10.512
Inflation Ratio	0.06099	0.02603	2.34	0.020	1.105
Budget Balance Ratio	-0.07880	0.03404	-2.32	0.022	1.013
Government Debt/GDP Ratio	17.373	1.405	12.36	0.000	6.317
Government Bond Yeild Ratio	2.7703	0.2809	9.86	0.000	3.565

S = 1.75908 R-Sq = 71.8% R-Sq(adj) = 70.7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	6	1168.46	194.74	62.93	0.000
Residual Error	148	457.97	3.09		
Total	154	1626.43			

Source	DF	Seq SS
Unemployment Ratio	1	379.31
Interest Rate Ratio	1	176.15
Inflation Ratio	1	14.60
Budget Balance Ratio	1	35.70
Government Debt/GDP Ratio	1	261.68
Government Bond Yeild Ratio	1	301.01

EXHIBIT 7: Model 2 (Lag 1)

Model 2 (Lag 1)
Regression Analysis: Current Exchange versus Interest Ratio, Inflation Ratio, Government Debt/ GDP Ratio, Budget Balance Ratio

```
The regression equation is
Current Exchange = 28.6 + 0.397 Interest Rate Ratio + 0.0959 Inflation Ratio
                   - 0.105 Budget Balance Ratio + 11.9 Government Debt/GDP Ratio


155 cases used, 1 cases contain missing values


Predictor                     Coef  SE Coef      T      P    VIF
Constant                    28.565    2.225  12.84  0.000
Interest Rate Ratio        0.39706  0.03630  10.94  0.000  5.187
Inflation Ratio            0.09586  0.03275   2.93  0.004  1.056
Budget Balance Ratio      -0.10487  0.04358  -2.41  0.017  1.002
Government Debt/GDP Ratio   11.871    1.659   7.15  0.000  5.315


S = 2.26436   R-Sq = 52.7%   R-Sq(adj) = 51.5%


Analysis of Variance

Source           DF       SS      MS      F      P
Regression        4   857.32  214.33  41.80  0.000
Residual Error  150   769.10    5.13
Total           154  1626.43


Source                    DF  Seq SS
Interest Rate Ratio        1  549.42
Inflation Ratio            1   11.78
Budget Balance Ratio       1   33.72
Government Debt/GDP Ratio  1  262.41
```

EXHIBIT 8: Model 1 (Lag 1) vs. Model 2 (Lag 1)

Model 1 (Lag 1)	**MAD**	**MAPE**
Average	±1.29	±2.86%
Standard Deviation	1.13	2.59

Model 2 (Lag 1)	**MAD**	**MAPE**
Average	±1.85	±4.01%
Standard Deviation	1.25	2.64

EXHIBIT 9: INR-EUR Regression Results Model 1 (Lag 1)

The regression equation is
Current Exchange = - 21.0 + 62.6 Unemployment Ratio + 1.63 Interest Rate Ratio
- 0.277 Inflation Ratio + 0.103 Budget Balance Ratio
+ 1.79 Government Debt/GDP Ratio
+ 3.35 Government Bond Yield Ratio

156 cases used, 1 cases contain missing values

Predictor	Coef	SE Coef	T	P	VIF
Constant	-20.993	7.849	-2.67	0.008	
Unemployment Ratio	62.553	4.117	15.19	0.000	1.230
Interest Rate Ratio	1.6339	0.2673	6.11	0.000	3.596
Inflation Ratio	-0.2770	0.1439	-1.93	0.056	1.117
Budget Balance Ratio	0.10337	0.05772	1.79	0.075	1.021
Government Debt/GDP Ratio	1.789	4.661	0.38	0.702	3.764
Government Bond Yield Ratio	3.3472	0.6841	4.89	0.000	4.795

S = 4.42518 R-Sq = 76.7% R-Sq(adj) = 75.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	6	9618.8	1603.1	81.87	0.000
Residual Error	149	2917.7	19.6		
Total	155	12536.6			

Source	DF	Seq SS
Unemployment Ratio	1	2195.5
Interest Rate Ratio	1	6720.0
Inflation Ratio	1	59.5
Budget Balance Ratio	1	54.9
Government Debt/GDP Ratio	1	120.1
Government Bond Yield Ratio	1	468.8

Unusual Observations

Obs	Unemployment Ratio	Current Exchange	Fit	SE Fit	Residual	St Resid
13	0.88	43.197	40.653	3.229	2.544	0.84 X
17	0.93	39.874	48.798	0.651	-8.923	-2.04R
18	0.94	39.906	49.474	0.706	-9.568	-2.19R
26	0.99	42.191	51.351	0.447	-9.160	-2.08R
114	1.11	67.225	61.741	1.858	5.484	1.37 X
119	1.07	69.843	69.672	3.209	0.171	0.06 X
143	0.96	69.570	60.332	1.159	9.238	2.16R
144	0.93	68.742	59.050	0.944	9.692	2.24R
150	0.87	70.092	73.126	1.989	-3.034	-0.77 X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

EXHIBIT 10: INR-GBP Regression Result using Model 1 (Lag 1)

Current Exchange = 51.5 + 11.6 Unemployment Ratio + 0.009 Interest Rate Ratio

- 1.24 Inflation Ratio + 0.0920 Budget Balance Ratio
+ 2.12 Government Debt/GDP Ratio
+ 3.82 Government Bond Yield Ratio

156 cases used, 1 cases contain missing values

Predictor	Coef	SE Coef	T	P	VIF
Constant	51.475	5.714	9.01	0.000	
Unemployment Ratio	11.568	3.435	3.37	0.001	3.298
Interest Rate Ratio	0.0091	0.2115	0.04	0.966	7.495
Inflation Ratio	-1.2362	0.3313	-3.73	0.000	1.231
Budget Balance Ratio	0.09196	0.04444	2.07	0.040	1.016
Government Debt/GDP Ratio	2.123	2.747	0.77	0.441	9.864
Government Bond Yield Ratio	3.8175	0.8469	4.51	0.000	3.120

S = 5.49197 R-Sq = 28.5% R-Sq(adj) = 25.6%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	6	1789.08	298.18	9.89	0.000
Residual Error	149	4494.09	30.16		
Total	155	6283.17			

Source	DF	Seq SS
Unemployment Ratio	1	260.66
Interest Rate Ratio	1	500.19
Inflation Ratio	1	280.96
Budget Balance Ratio	1	121.69
Government Debt/GDP Ratio	1	12.70
Government Bond Yield Ratio	1	612.87

Unusual Observations

Obs	Unemployment Ratio	Current Exchange	Fit	SE Fit	Residual	St Resid
4	1.24	67.745	65.374	2.098	2.372	0.47 X
5	1.26	66.925	65.663	2.069	1.261	0.25 X
6	1.28	67.642	63.753	2.612	3.890	0.81 X
17	1.51	67.563	78.540	0.911	-10.978	-2.03R
18	1.56	66.155	79.252	0.944	-13.098	-2.42R
27	1.60	69.465	65.649	5.056	3.815	1.78 X
79	1.52	86.960	76.033	0.643	10.927	2.00R
80	1.50	88.645	76.407	0.671	12.238	2.25R
83	1.45	87.956	75.212	0.745	12.743	2.34R
84	1.43	86.697	75.537	0.822	11.160	2.06R
85	1.42	86.788	75.005	0.893	11.783	2.17R
86	1.42	86.951	74.678	0.883	12.273	2.26R
153	1.25	85.627	85.556	2.028	0.071	0.01 X

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.

EXHIBIT 11: LAG Value of INR-USD

Lagged Value of INR/USD	MAD (Rupees)	MAPE (Rupees)
AVERAGE	±0.68	±1.45%
STDEV	0.81	1.66

EXHIBIT 12: Error Comparison Between Currency Exchanges

	Model 1			Model 1 (Lag)		
	INR/USD	INR/EUR	INR/GBP	INR/USD	INR/EUR	INR/GBP
R-Sq (Adj)	72.20%	75.10%	26.40%	70.70%	75.80%	25.60%
Std. Error	1.7101	4.4782	5.4602	1.7591	4.4252	5.4920
Average MAD	1.3106	3.5819	4.3200	1.2893	3.5166	4.3746
MAD Std. Deviation	1.0406	2.5316	3.1428	1.1326	2.5257	3.1205
Average MAPE	2.8909	6.6287	5.6549	2.8593	6.4839	5.7170
MAPE Std. Deviation	2.3757	5.2212	4.1634	2.5886	5.2229	4.1209

EXHIBIT 13: Comparison of Significant Variables in Different Models

	Anita Mirchandani	Maram Srikanth	Our Model
Time Frame	1991 - 2010	1999 - 2011	2000 - 2012
Time Period	Yearly	Quarterly	Monthly
Data Used for Variables	India Only	Mix (sometimes India only and sometimes relative to US)	All relative to US data
Variables Used	Inflation Rate	Inflation Rate	Inflation Rate
	Interest Rate	Interest Rate	Interest Rate
	External Debt	Current Account	Money Supply
	GDP	Capital Account	Balance of Trade
	Foreign Direct Investment	RBI's Net Intervention	Unemployment
		Foreign Reserves	Stock Index
		Money Supply	Government Debt/GDP
		3-Month Forward Premia	Budget Balance
		Index of Industrial Production	Government 10Y Bond Yield
		Forex Turnover	Current Account
			GDP
			Gold Prices
Significant Variables	INR Interest Rates	Lagged Value of USD/INR	Relative Interest Rates
	INR Inflation	INR Current Account	Relative Inflation Rates
	INR GDP Growth	Relative Money Supply	Relative Gov't Debt/GDP
		Relative Interest Rates	Relative Unemployment Rates
		Index Industrial Production	Relative Gov't Bond Yield
			Relative Budget Balance

EXHIBIT 14: Time Series of INR-USD Actual vs Predicted(Using Model 1 (Lag 1))

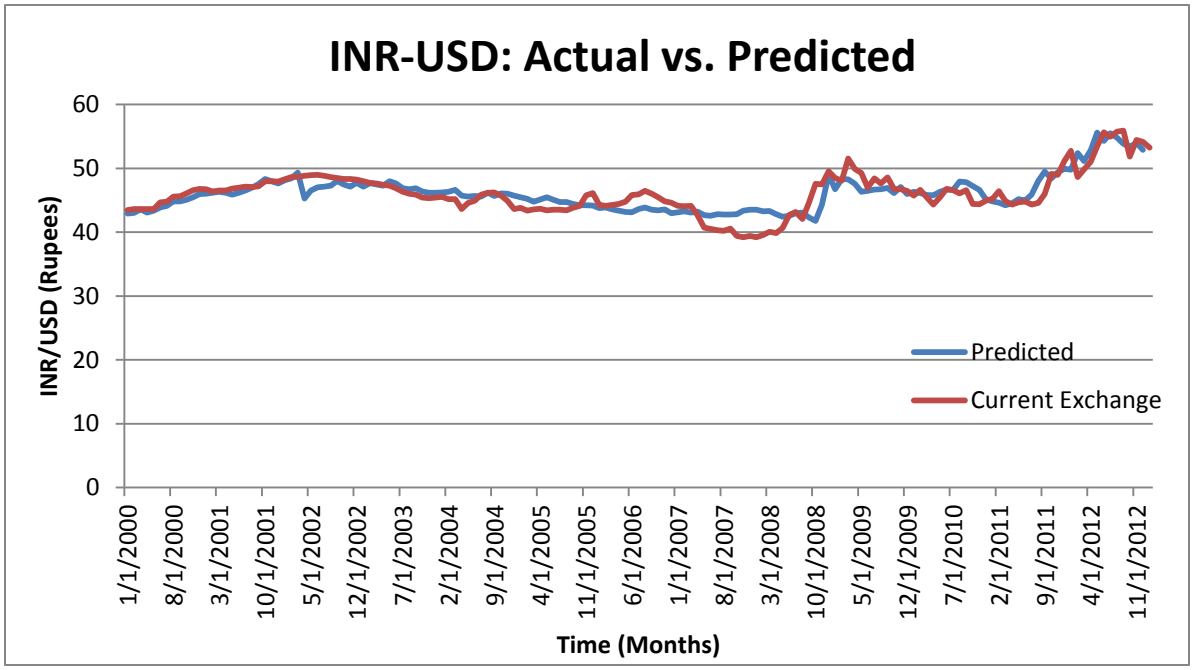

EXHIBIT 15: Time Series of INR-EUR Actual vs Predicted(Using Model 1 (Lag 1))

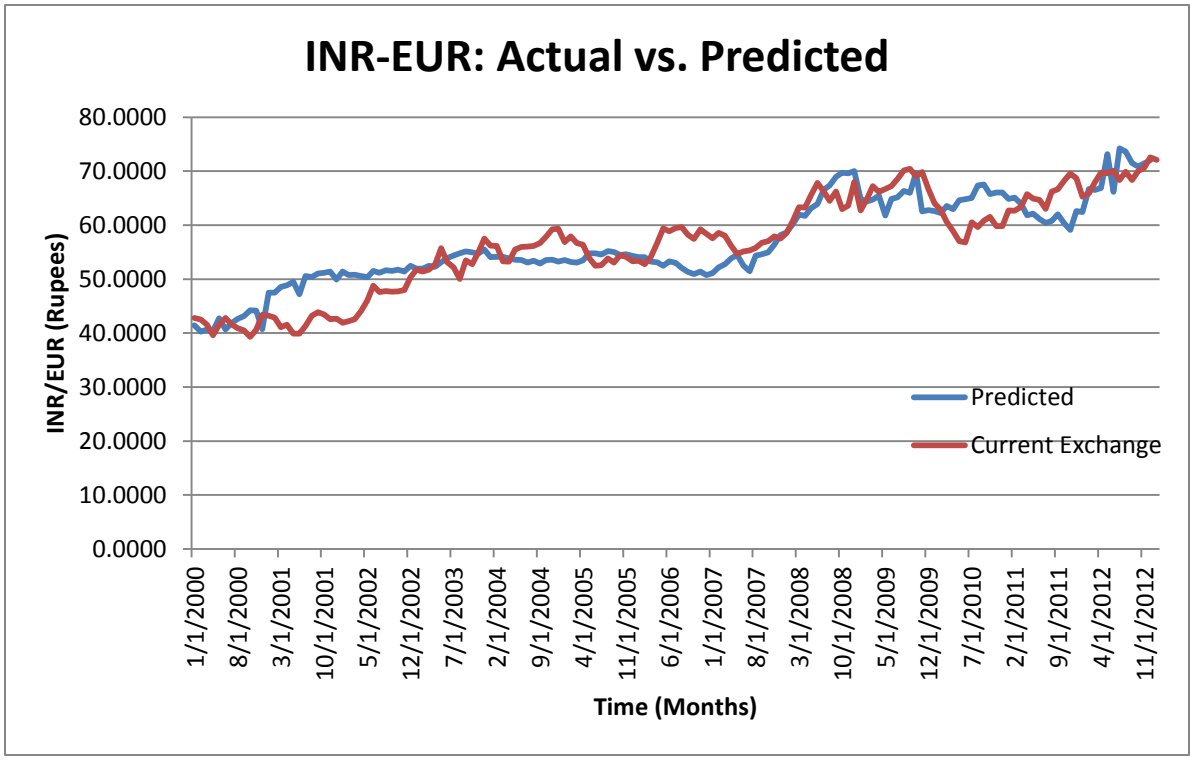

EXHIBIT 16: Time Series of INR-GBP Actual vs Predicted(Using Model 1 (Lag 1))

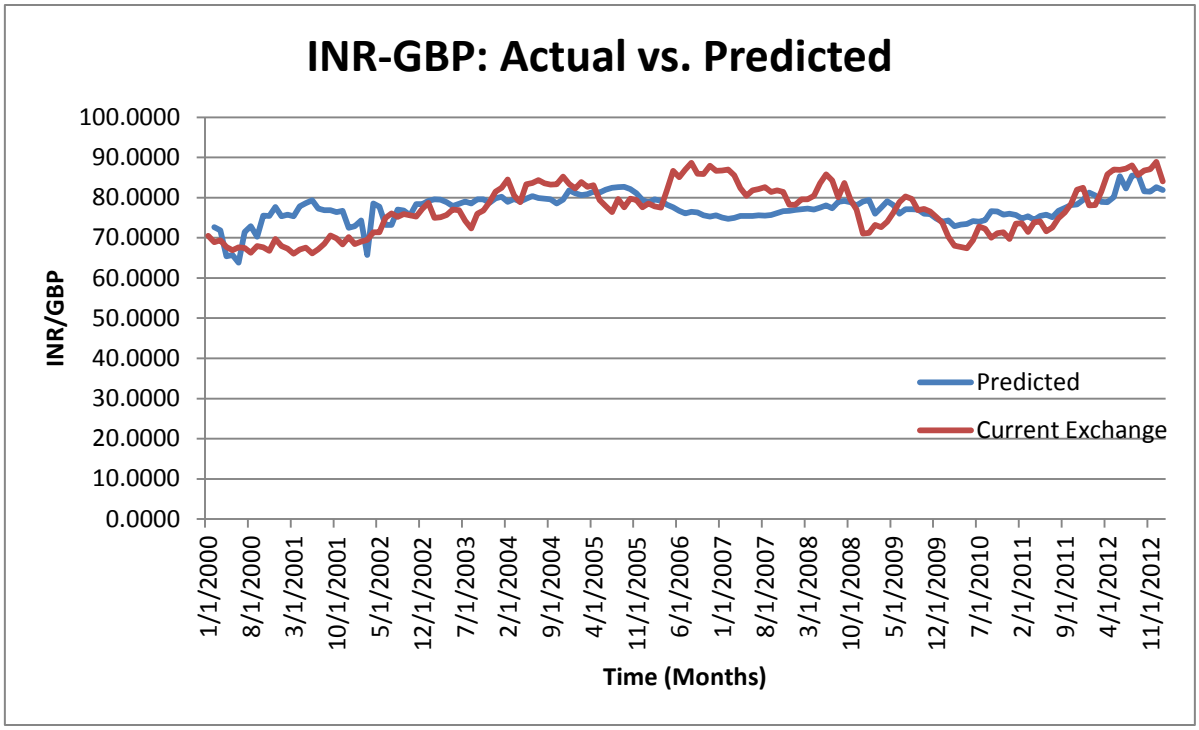

EXHIBIT 17: Uncovered Interest Parity & Purchasing Power Parity

Uncovered Interest Parity (Lag 1)	MAD (Rupees)	MAPE
Average	±1.93	±4.10%
Standard Deviation	1.43	2.87 %

Purchasing Power Parity (Lag 1)	MAD (Rupees)	MAPE
Average	±1.54	±3.31%
Standard Deviation	1.39	2.95 %

Exhibit 18: Email from a Professional who works in the Currency Derivative Segment in FRR Forex firm in India

1. What is INR USD trading volume on a daily basis? How big is the market?

Ans: Tentative volume is between 16000 Cr INR to 19500CR on Indian registered exchanges

2. When is the trading volume highest is it when UK market is open?

Ans: Generally between 9 to9.35 am IST and den between RBI fixing & European market opening and 4.30 to 5pm IST.

3. What are the centers where trading is primarily done? It said Mumbai Delhi and some other small states but is that true or is it UK, Singapore etc. In one of the articles it mentions that most of the trading is done onshore which means in India but is this correct?

Ans : Apart from India USDINR currently trades major at NDF Singapore market and on DGCX in Dubai.

4. After 1992/After liberalization took place what has been the change in the way the market rate is determined? Is it driven my market demand like companies needing exchange or is it banks speculating, trading just to hedge etc.

Ans: It is market driven

5. Current Scenario any particular incident which is important to note for the exchange rate market?

Ans: Fed starting tapering of Quantitative easing (Reducing current pace of stimulus in the economy) in coming quarters

Thanks and Regards,

Saumil Halani

Currency Derivative Segment

Business Development Manager

Head Office | 205, Embassy Centre | Nariman Point | Mumbai 400 021.

Phone: 022- 2283 2825 / 5122 | Cell: 9821515385

Email: saumilhalani@frrforex.in | Website: www.frrforex.in

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&

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Rishav Bansal

Kairavi Mehta

Manusha Chereddy

Hendry Susanto