Are Indian Forward Spot Markets Rational Forecasts of Future Spot Rates

Anjala Kalsie* and Anil Kumar Goyal**

ABSTRACT

The objective of the paper is to test the theory that forward spot markets are rational forecasts of future spot rates by studying data from Indian exchange markets over various forecast horizons ranging from one to twelve months. The time period is from August 2008 to 31 December 2013. The study found that there is high degree of correlation between the expected value of future spot rates calculated on the basis of Interest Rate Parity theory and the actual spot rate at the time of expiry of the derivative contract. The results of regression analysis shows that the actual spot rate at the time of expiry of the derivative contract is determined by the expected value of future spot rates, calculated on the basis of Interest Rate Parity theory. The empirical exercise also shows that the interest rate parity theorem helps in determining INR USD exchange rate (the future expected spot rate).

Keywords: Interest Rate Parity Theory, INR USD Exchange Rate, Forward Spot Markets, Future Spot Rates.

1.0 Introduction

Since 1991, the rigid, four-decade old, fixed exchange rate system replete with severe import and foreign exchange controls and a thriving black market has been replaced with a less regulated, “market driven” arrangement. While the rupee is still far from being “fully floating”, the nature of intervention and range of independence tolerated have both undergone significant changes. With abundance of foreign exchange reserves, imports are no longer viewed with fear and scepticism. The Reserve Bank of India and its allies now intervene occasionally in the foreign exchange market not always to support the rupee but often to avoid an appreciation in its value. Full convertibility of the rupee is clearly visible on the horizon. The effects of these developments are palpable in the explosive growth in the foreign exchange market in India.

*Assistant Professor, Faculty of Management Studies, University of Delhi, Delhi.
**Professor, Department of Management Studies, Rukmini Devi Institute of Advanced Studies, Delhi.
The rest of the paper is divided into following sections: Section 2 outlines the conceptual framework and section 3 reviews the existing literature. Section 4 discusses objectives and methodology, section 5 presents analysis and results and section 6 concludes.

2.0 Forward and Spot Markets

The forward exchange market is a market for contracts that ensure the future delivery of a foreign currency at a specified exchange rate. The price of a forward contract is known as the forward rate. For the policy makers, investors and portfolio managers the forward-spot relationship is of the great interest. If the government has no intervention on the value of a currency, the forward market will be governed by the private players or the supply and demand function of currency. In this case it is probable that the forward rate provides information on the future spot rate, but this is ultimately uncertain. What is certain is that the forward rates reflect the expectations forward market participants have on the changes of the spot rate during the specified interval. If the forward rate and the spot rate are the same, forward market participants do not expect much change in the price of a currency over the given period of time. Forward contracts can be used to hedge or cover exposure to foreign exchange risk. Broadly speaking there are two theories to determine the forward rate from the spot rate

2.1 Interest Rate Parity (IRP)

The difference between the forward exchange rate and the spot exchange rate is attributed to the interest rate differential between two countries as described by the theory of Interest rate parity (IRP). Interest rate parity plays an essential role in foreign exchange markets, connecting interest rates, spot exchange rates and foreign exchange rates. Interest rate parity is a no-arbitrage condition representing an equilibrium state under which investors will be indifferent to interest rates available on bank deposits in two countries.

\[
(1 + i_d) = \frac{E + (S_{t+k})}{S_t} (1 + i_f)
\]

\------------------(1)

where
E (S_{t+k}) = Expected spot exchange rate at time t+k
S_t = Spot exchange rate at time t
I_d = Interest rate in domestic currency
I_f = Interest rate in foreign currency
2.2 Purchasing Power Parity (PPP)

It is instructive to consider the Rupee-Dollar exchange rate in the light of the purchasing power parity (PPP) holding that the exchange rate between two currencies should equal the ratio of price levels in two countries. In its dynamic form PPP holds that the rate of depreciation of a currency should equal the excess of its inflation rate to that in the other country. In mathematical terms PPP theory is expressed as follows:

\[ \frac{e_t}{e_0} = \frac{(1 + i_h)t}{(1 + i_f)t} \]

where
- \( e_t \) = future spot rate
- \( e_0 \) = spot rate
- \( i_h \) = home inflation
- \( i_f \) = foreign inflation
- \( t \) = the time period

The relative form of PPP theory is an alternative version which postulates that the change in the exchange rate over a period of time should be proportional to the relative change in the price levels in the two nations over the same time period. This form of PPP theory accounts for market imperfections such as transportation costs, tariffs and quotas. Relative PPP theory accepts that because of market imperfections prices of similar products in different countries will not necessarily be the same when measured in a common currency.

3.0 Literature Review

A number of researchers have investigated the properties of forward exchange rates as predictors of future spot rates (Hansen & Hodrick, 1980; Bilson, 1981; Meese & Rogoff, 1983; Fama, 1984 ;Wolff, 1987b). The general consensus is that forward rates are not very good predictors of future spot rates. Both (Meese & Rogoff, 1983 & Fama, 1984) demonstrated that the current spot rate is a somewhat better predictor of the future spot rate than current forward rate.

Forward discount bias is a phenomenon that has been studied extensively in the literature. In addition to forward exchange unbiasedness being rejected, it is generally found that the change in the future exchange rate is negatively related to the forward discount. A prominent explanation for the rejection of forward rate unbiasedness is the existence of a time-varying risk premium. Other explanations involve peso problems,
irrationality of expectations, learning behavior and market inefficiency. Useful surveys of the empirical findings in this area are provided by (Hodrick, 1987; Lewis, 1995 & Engel, 1996).

The empirical literature of tests on the validity of the market efficiency may be classified into two groups. One group consists of the tests on the UH and the other is constituted by the tests on the MEH. Well-known examples in the first group include the joint tests conducted by (Geweke & Feige, 1979) which have provided some indications of why foreign exchange markets are not efficient (due to market participants’ risk averse behavior and the existence of transaction costs), while (Hansen & Hodrick, 1980) have rejected the MEH from the 1970s and the 1920s; the semi-strong-form tests undertaken by (Longworth, 1981) have rejected the joint null hypothesis of an efficient exchange market and no risk premium for the period ending in October 1976.

The studies of (Fama, 1984; Boothe and Longworth, 1986; Hodrick & Srivastava, 1986; Hakkio & Rush, 1989; Sephton & Larsen, 1991; Liu & Maddala, 1992a, 1992b) have also failed to support market efficiency hypothesis. Prior studies attributed the failure of market efficiency to several factors such as presence of risk premiums contained in forward rates, the correlation that is negative between expected future spot rates and the forward risk premia, are proven by empirical irregularities in regression tests.

A great number of studies have also been devoted to testing the Unbiasedness hypothesis (Lin & Chen, 1998; Lin, 1999; Lin & Lin, 2000 & Lin et al., 2002) provide thorough reviews of this empirical literature. Many of the studies in this area have considered only one sample period, one time horizon (mostly one month), and one or more currencies, so that the rejection or acceptance of the Unbiasedness hypothesis may well depend on the sample periods, currencies, and time horizons under study (Lin, 1999).

Nevertheless, in spite of a large body of literature, the empirical tests on the Unbiasedness hypothesis are inconclusive and conflicting. The Unbiasedness hypothesis is supported by a few early studies (Cornell, 1977 & Kohlhagen, 1979) but most of the more recent studies (Levich, 1979; Bilson, 1981; Gregory & McCurdy, 1984; Hsieh, 1984; Bakshi & Naka, 1997; Lin, 1999; Lin et al, 2002 & Chernenko et al, 2004) among others, have rejected the Unbiasedness hypothesis. Similarly, other studies (Edwards, 1982; Domowitz & Hakkio, 1985; Barnhardt & Szakmary, 1991; and Lin & Chen, 1998) have also provided mixed results for the Unbiasedness hypothesis.

The efficient markets hypothesis (EMH) has played an important role in understanding asset markets especially in the past few decades. It states that if economic agents are risk neutral; all available information is used rationally; the market is
competitive; and there are no taxes, transaction costs, or other frictions; then the foreign exchange market will be efficient in the sense that the expected rate of return to speculation in the forward exchange market will be zero (Gweke & Feige, 1979; Hansen & Hodrick, 1980).

The EMH implies that as forward exchange rates fully reflect available information about investors’ expectations of future spot rates, forward rates should be unbiased forecasts of future spot rates (Levich, 1979; Lin, 1999; & Lin et al., 2002). (Kletzer & Kholi, 2000) have undertaken monetary model of studying the exchange rate behavior in India by experimenting with the different variables of money stock and variants of relative prices, given the deviations from integration of financial markets and domestic trading market in comparison to the rest of the world for India. (Sanchez-Fung, 2003) studied the relationship between exchange rate and macroeconomic variables and found that exchange rate is more responsive in case of currency depreciation. (Xiaopu, 2002; MacDonald & Ricci, 2003) studied the long term macroeconomic determinants of real effective exchange rate are volatile capital flows, Openness of an economy and terms of trade. (Candelon et al., 2007) estimate bilateral equilibrium real exchange rates for European states using panel co-integration techniques. They reveal significant link of productivity levels, openness, inflation and real exchange rate. (Carrera & Restout, 2008) take Latin American nations for the time period from 1970 to 2006 and investigated the behaviour of real exchange rates by using non stationary panel econometrics analysis. The various factors responsible for exchange rate in the long run are explored as terms of trade, government spending, the financial openness and different nature of foreign capital flows.

Dua & Ranjan (2010) used VAR and BVAR for forecasting the performance of monetary model and analyse that whether it can beat Random Walk theory or not. (Shylajan et al., 2011) examined the relevance of Flexible-Price Monetary Model (FPMM) in the determination of Indian Rupee-US Dollar for the period 1996 to 2010 using monthly data on exchange rate, money supply, Index of Industrial production (IIP) and interest rate. The cointegration results indicate that the exchange rate is related with the macroeconomic fundamentals in the long run, while the VECM results could not find out any short run casual relationship between the variables despite the significant error correction term. (Dua & Ranjan, 2010) developed a model using variables from monetary and micro structure models also other macro economic variables with a focus of studying the relationship between rupee dollar exchange rate movements in India. The exchange rate policy is channelled by reduction in the excess volatility, maintaining adequate level of reserves, prevent the emergence growing exchange rate speculative markets and the development of orderly maintained foreign exchange rate market.
The Purchasing Power Parity holds good in long run but the monetary model does not explain the percent change in the prices associated with the percent change in the value of the currency i.e. appreciation and depreciation (Kletzer & Kholi, 2000). Also (Parveen et al., 2012) examine the major factors which contribute to exchange rate variability by using the data from Economic survey of Pakistan and IFS from 1975 to 2010. They employ ordinary least square method for analysis of results and conclude that inflation, economic growth, exports and imports bring variation in exchange rate of Pakistan. (Gan et al., 2013) used vectors of the variables to develop measures of the direction and extent of misalignment based on a reduced-form of real effective exchange rate (REER) model using unit root tests and cointegration. The various variables that had a long run relationship with the exchange rate are openness, money supply, productivity and government spending.

4.0 Objectives and Methodology

The objective of the paper is to test the theory that forward spot markets are rational forecasts of future spot rates by studying data from Indian exchange markets over various forecast horizons ranging from one to twelve months. The time period is from August 2008 to 31 December 2013. The time period is specifically chosen because currency derivatives were introduced in India with the launch of Currency Futures in USD INR by NSE in August 2008 only. The Null hypothesis is

Null Hypothesis: $E[S_{t+1}] = F_t$

The expected value of future spot rates calculated on the basis of Interest Rate Parity theory, equals the actual spot rate at the time of expiry of the derivative contract.

Alternate hypothesis: $E[S_{t+1}] \neq F_t$

The expected value of future spot rates calculated on the basis of Interest Rate Parity theory does not equal the actual spot rate at the time of expiry of the derivative contract.

4.1 Data collection

- Daily trade data for currency derivatives, mainly the futures contracts, with forward rate time horizons ranging from 1 month to 12 months was used and collected from the website of the National Stock Exchange Limited. On NSE, the price of a future contract is in terms of INR per unit of the foreign currency (USD in this case). The data is from August 2008 till December 2013.
- Daily spot rate data (USD/INR) was downloaded from the website: www.investing.com
Are Indian Forward Spot Markets Rational Forecasts of Future Spot Rates

- Data for actual future spot rates, for all the days when the contracts ended, was taken from the National Stock Exchange of India.
- Interest rates of India were taken from the website of the Reserve Bank of India. One-year Government Securities were taken as a reference.
- Interest Rates for the US required for calculating expected forward rates is taken from Treasury department of USA. 364-day T-bill yields were taken for the reference.

4.2 Methodology

For every derivative contract the expected future spot rate was calculated using the Interest Rate Parity theory (Equ. 1 reproduced under):

\[
(1 + i_d) = \frac{E_t + (S_{t+k})}{S_t} (1 + i_f)
\]

where
- \( E_t(S_{t+k}) \) = Expected spot exchange rate at time \( t+k \)
- \( S_t \) = Spot exchange rate at time \( t \)
- \( i_d \) = Interest rate in domestic currency
- \( i_f \) = Interest rate in foreign currency

If the forward rates are rational forecasts of future spot rates, then \( \alpha = 0 \) and \( \beta = 1 \). The same will be statistically analysed by using Correlation and Regression. The data was segregated month-wise, i.e. contracts ending in \( m=0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, \text{ and } 12 \) months. There are total 12380 data points which are divided into 12 sets based upon their contract period. On the aggregate as well as the month-wise segregated data, correlation tests were performed in order to check for the correlation between the expected future sport rates and the actual future spot rates.

After that regression analysis was run on the aggregate comprehensive data to determine the values for \( \alpha \) and \( \beta \), as well to find out the \( p \)-value on the basis which the null hypothesis shall be rejected/accepted.

\[
Y = \alpha + \beta X_t + \varepsilon_i \quad \text{(3)}
\]

The independent variable used in both the analysis was \( E_t \{S_{m,i}\} \), the expected future spot and the dependent variable was \( F_t \), the actual future spot rate.

5.0 Data Analysis and Interpretation

5.1 Results of correlation analysis

Month-wise segregation of data allowed the analysis of close to 1000 data sets for the future contracts maturing within 1-12 months on a monthly basis (Table 1).
Table 1: Data points spanning over the duration Jan 2009-Dec 2013

<table>
<thead>
<tr>
<th></th>
<th>1-month</th>
<th>2-month</th>
<th>3-month</th>
<th>4-month</th>
<th>5-month</th>
<th>6-month</th>
<th>7-month</th>
<th>8-month</th>
<th>9-month</th>
<th>10-month</th>
<th>11-month</th>
<th>12-month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data points</td>
<td>1091</td>
<td>1017</td>
<td>1044</td>
<td>1062</td>
<td>1018</td>
<td>1027</td>
<td>1053</td>
<td>1019</td>
<td>972</td>
<td>976</td>
<td>974</td>
<td>1127</td>
</tr>
</tbody>
</table>

The correlation coefficient for the whole data by keeping E [St+1] as the input and Ft as the output comes out to be 0.818571145. The details of correlation coefficient is shown in Table 2.

Table 2: Correlation coefficients for month=0,1,2,3,4,5,6,7,8,9,10,11,12

<table>
<thead>
<tr>
<th></th>
<th>1-month</th>
<th>2-month</th>
<th>3-month</th>
<th>4-month</th>
<th>5-month</th>
<th>6-month</th>
<th>7-month</th>
<th>8-month</th>
<th>9-month</th>
<th>10-month</th>
<th>11-month</th>
<th>12-month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation coefficient</td>
<td>0.97 46</td>
<td>0.93 62</td>
<td>0.90 01</td>
<td>0.85 87</td>
<td>0.83 37</td>
<td>0.83 13</td>
<td>0.81 26</td>
<td>0.78 29</td>
<td>0.75 3</td>
<td>0.72 65</td>
<td>0.69 71</td>
<td>0.68 79</td>
</tr>
</tbody>
</table>

The correlation between E [S_{t+1}] and F_{t} reduces as the contract duration increases from 1-month to 12-month period. The aggregate correlation coefficient lies approximately midway between the extreme values. This is understandable as the expected future spot rates only takes in to account the carrying cost to eliminate arbitration.

The factors such as demand and supply, seasonal factors, external factors such as US Fed tapering or the European crisis, etc. are not taken into account. That is why, the expected future spot rate is always higher than the current spot rate which may not always be the case. This is due to the interest rate differential between India and US. Since, the interest rates of India are higher than that of USA, the expected future spot rate is always higher than the current spot rate.

5.2 Results of Regression Analysis
As shown in Table 3, the regression analysis is significant since the p values for both intercept and E [S_{t+1}] is less than 5% level of significance.
Table 3: Key Regression Statistics

| Multiple R | 0.81857 |
| R Square   | 0.67005 |
| Adjusted R Square | 0.67003 |

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>t Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-1.67614532</td>
<td>-5.00796</td>
</tr>
<tr>
<td>$E [S_{t+1}]$</td>
<td>1.027560089</td>
<td>158.5425</td>
</tr>
</tbody>
</table>

P < α, intercept and predictor value is significant

1. $F_t = -1.676 + 1.0275E [S_{t+1}]$

i.e., $\alpha \neq 0$ and $\beta \neq 1$

The individual regression analysis is done for the different duration future contracts. The results of the same are reported in Table 4.

Table 4: Intercept and coefficient of regression analysis for future contracts with different durations

<table>
<thead>
<tr>
<th>Future contracts</th>
<th>A</th>
<th>B</th>
<th>$\alpha$</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-month</td>
<td>0.448</td>
<td>0.994</td>
<td>-6.628</td>
<td>1.125</td>
</tr>
<tr>
<td>2-month</td>
<td>0.759</td>
<td>0.987</td>
<td>-6.983</td>
<td>1.130</td>
</tr>
<tr>
<td>3-month</td>
<td>0.775</td>
<td>0.984</td>
<td>-4.942</td>
<td>1.087</td>
</tr>
<tr>
<td>4-month</td>
<td>0.971</td>
<td>0.979</td>
<td>-4.024</td>
<td>1.067</td>
</tr>
<tr>
<td>5-month</td>
<td>-1.084</td>
<td>1.018</td>
<td>-2.229</td>
<td>1.031</td>
</tr>
<tr>
<td>6-month</td>
<td>-4.883</td>
<td>1.092</td>
<td>-2.008</td>
<td>1.026</td>
</tr>
</tbody>
</table>

The result is same for the individual data sets also. Here all the null hypothesis is rejected at 5% level of significance.

$\alpha \neq 0$ and $\beta \neq 1$

6.0 Conclusion

There is high degree of correlation between the expected value of future spot rates calculated on the basis of Interest Rate Parity theory and the actual spot rate at the time of expiry of the derivative contract. It is true for overall data and month-wise data as well. Large positive correlations of the difference between the forward rate and the
current spot rate indicate variation through time in either the premium component of $F_t$ and spot rates or in the assessment of the expected change in the spot rate. Any forward rate can be interpreted as the sum of a premium and an expected future spot rate.

The results of regression analysis shows that the actual spot rate at the time of expiry of the derivative contract is determined by the expected value of future spot rates, calculated on the basis of Interest Rate Parity theory. The empirical exercise also shows that the interest rate parity theorem helps in determining INR USD exchange rate (the future expected spot rate).

References


**Websites**

www.nseindia.com