The Spot Forward Exchange Rate Relation in Indian Foreign Exchange Market - An Analysis

Nath, Golaka

CCIL

9 October 2013

THE SPOT-FORWARD EXCHANGE RATE RELATION IN INDIAN FOREIGN EXCHANGE MARKET – AN ANALYSIS

Golaka C Nath[1]

Abstract

Forward exchange rate bias explanation generally falls into two categories – assumption of rational expectation resulting in a risk premium and expectation errors which is systematic. The paper tests the bias in the Indian forward exchange markets using one-month and three month forward contracts. The study finds that the three month contracts have larger prediction errors than the one-month contracts. The paper also finds that the prediction errors have information content which leads to assume the presence of risk premium. The study also finds that risk one-month contracts have lesser variability vis-à-vis the three month contracts.

Keywords: forward exchange rate, India, CCIL, bias, puzzle, exchange rate premium, exchange rate

JEL Classification: F31

[1] gcnath@hotmail.com

THE SPOT-FORWARD EXCHANGE RATE RELATION IN INDIAN FOREIGN EXCHANGE MARKET – AN ANALYSIS

Introduction

A forward premium (discount) signifies that a foreign currency can be acquired forward by paying an appropriate price for a future settlement. When traders expect that the future spot price of a foreign currency is likely to be above the current spot price, they may buy it forward by paying the required premium till the traders realize that expected gain is no longer possible out of their action. In a reverse situation, the current forward price of the foreign currency is likely to be bid down till the traders realize that expected gain is no longer possible by this strategy. The forward exchange rate is used by the market to hedge uncovered position to get protection from future spot exchange rate fluctuations. The forward discount on a currency is the expected level of depreciation over the life of the forward contract plus a risk premium (to cover cost of inventory included) for holding it forward. Any new information that makes traders to feel that currency is likely to depreciate during the proposed contract period will result in a forward discount as the forward rate gets bid with expected future spot rate. Market uses all information about future path of the exchange rate movement to quote the premium or discount. Rational expectation drives the forward rate premium or discount. Any trader may gain from market speculation whenever the expected spot rate differs from the current forward rate. As the market has enough number of risk-neutral traders, forward rate is likely to be bid into equality with expected future spot rate. The forward exchange rate in all likelihood would equal the market's estimate of the future spot rate at the end of the contract period. The seller of the forward contract (willing to supply a foreign currency) is likely to acquire and hold either inventory of foreign currency (by incurring cost of borrowing) or borrow the currency (using a swap and incur cost for the same). The forward rate would take into account these costs and the trader will be viable when she earns at least the break-even cost of giving the future quote. A forward rate can be interpreted as the sum of a premium and expected future spot rate (Fama (1984)).

Researchers have found that the forward exchange rate is a biased predictor of the future expected spot exchange rate. Explanations have been given for the said bias and these

explanations can be broadly divided into two categories – assumption of rational expectations (forecast error as a risk premium) and expectation errors by the traders.

As the forward rate is used as a hedging tool by traders, the hedge effectiveness, no doubt, would depend on the relationship between spot and forward exchange rates. If both the rates have a good and statistically significant historical relationship, the forecasting becomes easier. However, the instability in their relationship may result in higher forecasting errors reducing the hedging benefit to traders (Tong (1996) and Briys and Solnick (1992)). Fama (1984) has shown that in the absence of material news, forecast errors result in higher risk premium. Wolff (1987) and Nijman, Palm and Wloff (1993) reported that approximately half of the forecast error is due to variation in the risk premium.

The unbiased forward rate hypothesis (UFH) theoretically argues that a forward exchange rate fully incorporates all available information about the exchange rate expectation of traders in the market (Chang (1988)). The purpose of this paper to understand the application of UFH in Indian foreign exchange market.

Indian Foreign Exchange Market

Indian foreign exchange market has come a long way in efficiently determining the exchange rate. The current market structure involves an Over the Counter (OTC) market in which banks trade among themselves, banks buying and selling foreign exchange to their constituents using various contracts, at times Reserve Bank of India (RBI) buying and selling currency to manage foreign exchange reserves[2], existence of Non-Deliverable Forward (NDF) market on Indian Rupee in places like Singapore and Dubai, a well-developed Currency Futures market, etc. India follows a full Current Account convertibility for the currency allows foreign investors to invest in Indian economy using Foreign Direct Investment (FDI) and Foreign Institutional Investors (FII) route. The

[2] Current foreign exchange reserves with RBI stand at about USD277billion (little over 6 months import equivalent).

currency settlement for institutional market happens through a Central Clearing House[3] for inter-bank OTC trades. The inter-bank deals settled through CCP are divided into 4 categories in terms of their settlement structure – CASH (T+0), TOM (T+1), SPOT (T+2) and FORWARDS (month(s) as per requirement). Unlike most of the markets, Indian market deals in Forwards which have standard settlement day[4] (typically last Mumbai Business Day of the Month). Concentration of inter-bank trading is in SPOT window with more than 85% in terms of deals and about 50% in terms of Value. Forwards account for little less 10% in terms of deals and more than 20% in terms of value (Table – 1).

Table -1: Distribution of Trading Activity

Period	Deals				Deal Value			
Financial Year	**CASH**	**TOM**	**SPOT**	**FORWARD**	**CASH**	**TOM**	**SPOT**	**FORWARD**
2002-03	0%	0%	74%	26%	0%	0%	71%	29%
2003-04	0%	0%	76%	23%	1%	2%	71%	26%
2004-05	2%	3%	76%	18%	8%	13%	59%	20%
2005-06	3%	4%	76%	17%	13%	17%	50%	20%
2006-07	2%	4%	79%	14%	13%	18%	50%	19%
2007-08	2%	3%	81%	14%	10%	13%	51%	26%
2008-09	2%	3%	81%	14%	10%	13%	48%	29%
2009-10	2%	3%	86%	9%	12%	16%	49%	23%
2010-11	2%	3%	88%	8%	12%	16%	51%	22%
2011-12	2%	3%	87%	9%	12%	15%	50%	23%
2012-13	2%	3%	87%	8%	13%	17%	47%	23%
2013-14 (Sep'13)	2%	2%	89%	7%	13%	17%	48%	21%

Source: CCIL

Deal size varies from less than USD1 million (about 20% in terms of deals but about 2% in terms of value) to more than USD20 million (about 3% in terms of deals but about 38% in terms of value). About 65% of deals take place for value between USD1 and USD5 million. Forwards upto 12 month are generally liquid and major concentration (more than 45% in terms of value and deals) is observed in 6months forwards.

Given the current market structure, Indian inter-bank foreign exchange market has witnessed dramatic growth during last one decade or so. The initiation of centralized

[3] Clearing Corporation of India Ltd. (CCIL) acts as the central clearing house providing Central Counter Party (CCP) services to the inter-bank market.

[4] A 1-month Forward contract purchased on 15th of a Calendar month implies buying a Forward for about 15days in effect.

clearing and settlement facility with CCP services[5], entry of FIIs into Indian market, allowing Currency Derivatives[6] trading in Stock exchanges, etc. resulted in higher trading activities in Indian foreign exchange market.

Table – 2: Foreign Exchange Settlement Values (Value in USD Billion)

	Spot		Forward		Total Deals[7]		Daily Average Deals	
Financial Year	**Trades**	**Value**	**Trades**	**Value**	**Trades**	**Value**	**Trades**	**Value**
2002-03	74,423	96	25,809	40	100,232	136	1,101	1
2003-04	251,258	355	76,668	132	330,517	501	1,425	2
2004-05	356,382	533	85,020	184	466,327	900	1,976	4
2005-06	371,059	585	84,337	240	489,649	1,180	2,084	5
2006-07	481,702	885	85,106	343	606,808	1,777	2,550	7
2007-08	609,676	1,595	106,683	811	757,074	3,134	3,181	13
2008-09	675,439	1,815	119,912	1,087	837,520	3,759	3,657	16
2009-10	759,149	1,468	81,424	673	883,949	2,989	3,843	13
2010-11	1,007,258	2,119	90,883	913	1,150,037	4,191	4,792	17
2011-12	1,115,364	2,326	110,585	1,077	1,283,178	4,643	5,579	20
2012-13	1,216,860	2,276	118,554	1,120	1,396,138	4,831	6,018	21
2013-14 (Sep'13)	711,465	1,190	55,229	525	798,516	2,456	6,710	21
Source: CCIL								

RBI has been publishing daily reference spot rates (at mid-day) for major currencies using a robust polling mechanism with inclusion of random mechanism in selecting banks to be polled and time (within a pre-specified time band) at which poll will take place. These reference rates are used as benchmarks for traders dealing in currencies. Thomson Reuters polls dealers for obtaining Forward Rates for various currencies and for various maturities. These rates are available as benchmarks for traders to deal in the market. All foreign exchange deals in the inter-bank OTC market are reported to CCIL for settlement. At times, CCIL may reject some deals of participants if they do not have requisite margin or the deals are above the approved exposure limit sanctioned by CCIL to the particular entity or the counter-party. As CCIL provides CCP services for Forward deals, many banks have availed the said services from CCIL and report the deals to CCIL soon after closing the forward deals. Since some of the banks have not joined the CCIL Forward Settlement services, many deals may not be reported to CCIL on the day of the deals and will be

[5] India is the first country in the World to provide CCP services in OTC Inter-bank Foreign Exchange market.
[6] Derivative Contracts settles (on expiry day) at RBI reference Foreign Currency Rate.
[7] Total Deals include CASH and TOM deals.

coming under CCIL settlement window when they enter the SPOT leg (typically Settlement -2 days or commonly known as S-2 days).

CCIL also publishes daily settlement statistics as well as a reference rate based on actual trading executed in the market. The said reference rate is calculated using all reported SPOT deals of USD1 million and above. CCIL also follows an exclusion criteria using +/- 3 standard deviation from the Weighted Mean Rate. The CCIL reference rate are published at the end of the day (at about 6PM) and uses all SPOT deals reported by that time. The RBI reference rate published at mid-day and CCIL reference rate published at the close of the day have very high correlation (99.99%). The variation in those reference rates observed ranges between 0.0557 and -0.0581[8].

Theoretical Framework

The forward exchange rate, f_t, observed at time *t* for an exchange rate at *t+1* is the market determined certainty equivalent of the future spot exchange rate s_{t+1}. The forward premium is generally quoted by dealers in percentage terms (annualized) can be used to calculate the forward rate using the simple equation below.

$$F_t = S_0 * e^{rt} \quad (1)^9$$

where S_0 is the spot exchange rate at time 0 and F_t is the forward exchange rate at time 't' while '*r*' is the appropriate forward premium charged for the contract period by the market maker / dealer. Fama (1984) split the certainty equivalent into an expected future spot rate and a premium using the following:

$$F_t = E(S_{t+1}) + P_t \quad (2)^{10}$$

[8] Calculated on average monthly rates.

[9] F_t and S_0 are in their logarithms. Log values are used (a) to make the analysis independent of whether exchange rates are expressed as units of currency i per unit of j or units of j per unit of i and (b) some models for premium can be stated in logs (Fama (1984)).

[10] The equation can be reframed as $F_t = E(S_{t+1}) + P_t + e_{t+1}$ to include the an exceptational error term

here $E(S_{t+1})$, expected future spot rate, is the rational or efficient forecast, conditional on all information available at 't'. We can reframe the equation to study effectiveness of forward exchange rate in determining the spot exchange rate by using the equation

$$S_t = \alpha_0 + \beta_0 * F_{t-1} + e_t \qquad (2A)$$

where S_t is the current spot exchange rate and F_{t-1} is the on-period lagged forward rate.

In order to give economic content to the above equation, Fama (1984) used a model that describes the determination of P_t,. It is evident from the equation (2) that, when we include an error term in the equation, even if the traders show rational behavior while trading in the sense that the error term (forecast error - e_{t+1}) is orthogonal to the information set available at time 't', risk aversion on part of market participants may lead to systematic departure of S_{t+1} from F_t[11].

From equation (2), the difference between the forward and current spot rate is given by

$$F_t - S_t = P_t + E(S_{t+1} - S_t) \qquad (3)$$

Fama (1984) considered regressions of $F_t - S_{t+1}$ and $S_{t+1} - S_t$ (both observed at *t+1*) on $F_t - S_t$ (observed at t.

$$F_t - S_{t+1} = \alpha_1 + \beta_1(F_t - S_t) + e_{1,t+1} \qquad (4)$$

$$S_{t+1} - S_t = \alpha_2 + \beta_2(F_t - S_t) + e_{2,t+1} \qquad (5)$$

According to Fama (1984), estimates of (5) tell us whether the current forward-spot differential, $F_t - S_t$ has power to predict the future change in the spot rate, $S_{t+1} - S_t$. Evidence that β_2 is reliably non-zero means that the forward rate observed at time 't' has information about the spot rate to be observed at 't+1'. Likewise, since $F_t - S_{t+1}$ is the premium P_t, plus $E(S_{t+1} - S_t)$, the random error of the rational forecast $E(S_{t+1})$, evidence that β_1 in (4) is reliably non-zero means that the premium component of $F_t - S_t$ has variation that shows up reliably in $F_t - S_{t+1}$. The equation (5) suggests that the restriction implied by the absence of arbitrage is $\alpha_2 = 0$, and β_2=1, and lack of autocorrelation in $e_{1,t+1}$ in case of non-overlapping forward contracts. Empirical evidence

[11] Dibooglu (1998)

suggests is significantly non-zero, rather less than 0[12]. The question arises how to treat the bias – a time varying risk premium or a systematic expectational error. Most research point out that β_2 a biased is a time-varying risk premium. Fama (1984) used equation (4) to recover information regarding risk premium. Equation (4) and (5) are complimentary: α_2= -α_1 and $\beta_1 + \beta_2$= 1.

Foreign Exchange Market Data

Traders in Indian foreign exchange market trade in spot and forwards (currency futures are traded in exchange) in OTC market with a well-defined structured settlement mechanism. Recently the exchange rate hit all-time high of 68.80 against USD but recovered substantially later.

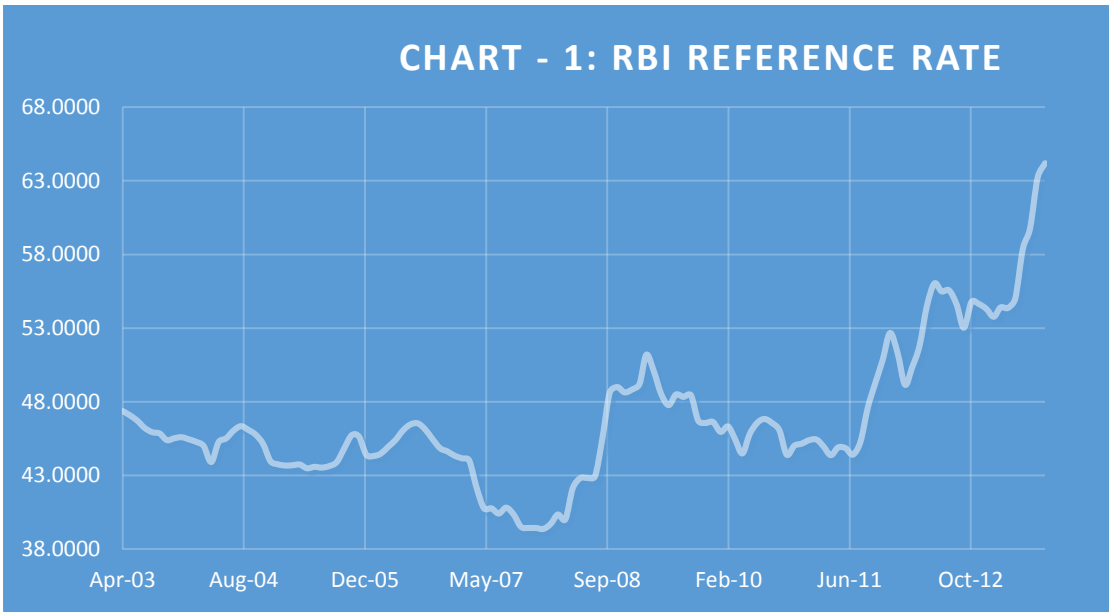
Table – 3: Descriptive Statistics of Indian Rupee-USD Exchange Rate (Apr'03 – Sep'13)[13]

Parameters	Monthly Average	Monthly Returns
Mean	46.82	0.24%
Standard Error	0.42	0.19%
Median	45.62	-0.02%
Mode	39.44	-
Standard Deviation	4.68	2.07%
Kurtosis	2.04	115.08%
Skewness	1.25	71.51%
Minimum	39.37	-4.35%
Maximum	64.19	6.54%
Count (Months)	126	125

The performance of Indian Rupee was in sync with most of the emerging market currencies like Indonesia and Brazil which lost ground against USD due to the news of possible Quantitative Easing by Federal Reserve of US.

[12] Frankel and Poonawala (2010)

[13] Data is monthly average RBI reference rate indicating an annualized Standard Deviation of about 16.22p in terms of value and 7.17% in terms of returns.



The forward market behavior in Indian Rupee-USD market very closely mimics the spot market in terms of performance. We have used average 1-month and 3-month forward premium charged by the market to estimate the Forward Exchange rate.

Table – 4: Descriptive Statistics of Forward INR-USD Exchange Rate (Level and return)

Variable	Forward-1M	Forward-3M	Return - M1	Return - M3
Mean	46.97	47.25	0.2%	0.3%
Standard Deviation	4.78	4.95	2.1%	2.0%
Median	45.70	45.93	0.0%	0.0%
Kurtosis	2.06	2.10	108.1%	100.2%
Skewness	1.27	1.30	69.9%	70.2%
Minimum	39.44	39.58	-4.3%	-4.3%
Maximum	64.74	65.72	6.4%	6.1%
N	126	126	125	125

Results

Table 5 shows the OLS regression result of the equation (2A) in which we can interpret the same as constant term is statistically zero as the same is not significant at 5% level for 1-month forward exchange rate but for the 3-month forward exchange rate, the same is non-zero indicating presence of a premium, or other factors, which may affect the spot exchange rate. While the lagged forward exchange rate is not significantly different from 1. This is

one of the most important criteria for the UFH to hold. The data contained serial autocorrelation which was corrected using standard procedure.

Table – 5: Relationship between Spot and Forwards Exchange Rate								
		Estimate	SE	t-Stat	Pr>|t|	DW	Obs	1st Order Auto Correlation
Intercept	1	0.2411	1.2690	0.19	0.8497	1.89	125	0.329
1-Month	1	1.0163*	0.0199	50.89	<.0001			
Intercept	1	13.9326*	3.8497	3.62	0.0004	0.9706	123	0.748
3-Month	1	0.7054*	0.0811	8.70	<.0001			
*significant at 1%								

In order to understand the prediction errors for both 1-month and 3-month forward exchange rates (in predicting future spot rates), we estimated the difference between the realized spot rates and predicted spot rate (forward rate quoted for the appropriate spot month). We observed that the average prediction errors are much higher in case of 3-months forward contracts vis-à-vis the 1-month forward contract.

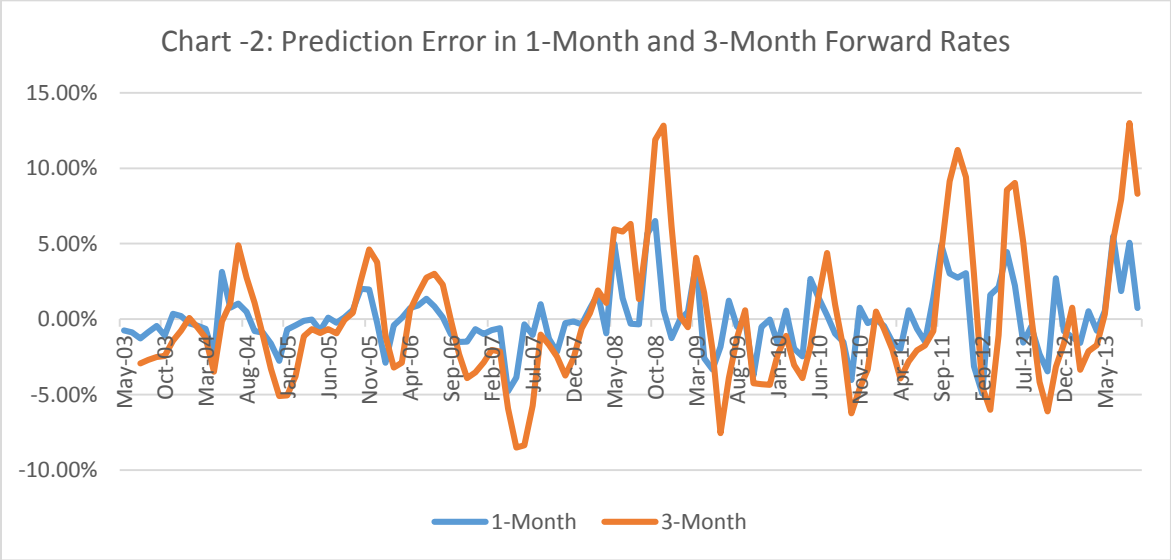


Table 6 gives the descriptive statistics of prediction error.[14] The average error for the entire period is negative for both 1-month and 3-months forward contracts – the realized spot rates were higher than the traded forwards for the relevant month. The prediction volatility

[14] Ratio (%) is calculated as (Difference between the realized spot and forward rate of the month)/Forward Rate for the month.

(monthly standard deviation) is higher for 3-month contracts vis-à-vis the 1-month contracts.

Table -6: Descriptive Statistics of Prediction Errors		
	1-Month Forwards	3-Month Forwards
Mean Prediction Error	-0.04%	-0.08%
STDEV	2.06%	4.35%
Maximum Prediction Error	6.51%	13.00%
Minimum Prediction Error	-4.92%	-8.51%
Positive Change	1.83%	4.17%
STDEV	1.67%	1.17%
Observations	50	48
Negative Change	-1.29%	-2.80%
STDEV	3.63%	1.91%
Observations	76	75

The study also finds that the prediction errors are large when the volatility is high. To test this phenomena, we calculated the correlation coefficients of monthly volatility (measured by monthly standard deviations) and absolute prediction errors.

Table – 7: Correlation between Prediction Error and Volatility			
	STDEV	1-Month	3-Month
STDEV	1		
1-Month	0.560485	1	
3-Month	0.545359	0.521258	1

Table -8 shows means, standard deviation and autocorrelations of $S_{t+1} - S_t$, $F_t - S_{t+1}$, and $F_t - S_t$. Unlike Fama (1984), as standard deviations of $S_{t+1} - S_t$ are more or less equal to the standard deviation of $F_t - S_{t+1}$, it cannot be said for certainty that the current spot rate is a better predictor of future spot rate than the current forward rate and vice-versa. However, for the 3-month forward rate, standard deviations of $S_{t+1} - S_t$ are larger than the standard deviations of $F_t - S_{t+1}$ and thus in terms of standard deviation of forecast erors, current forward rate is a better predictor of the future spot rate than the current spot rate. Barring the first lag, autocorrelations of changes in spot rate $S_{t+1} - S_t$ is close to zero for 1-month forward exchange rate. However, for 3-month forward exchange rate, barring

upto two lags, autocorrelation of changes in spot rate is close to zero. The autocorrelations of $F_t - S_t$ tell us a different story. The first order autocorrelations are 0.88 for 1-month and 0.91 for 3-month forward exchange rate and the decay of autocorrelations at successive lags suggests a first order autoregressive process. Since $F_t - S_t$ is the premium plus the expected change in the spot rate, the autocorrelations of $F_t - S_t$ indicate that premium and / or E $(S_{t+1} - S_t)$ vary in an auto-correlated way. The standard deviations of $F_t - S_t$ are relatively smaller at 0.23% and 0.63% per month for 1-month and 3-month exchange rate, whereas the same for other two series are much higher at above 2% and 4% for 1-month and 3-month exchange rates respectively. The result is similar to Fama (1984).

Table - 8: Autocorrelations, Means and Standard Deviation of Variables

Contract	Variable	ρ1	ρ2	ρ3	ρ4	ρ5	ρ6	ρ7	ρ8	ρ9	ρ10	ρ11	ρ12	Mean	STDEV
1-Month	$S_{t+1} - S_t$	0.36	0.05	-0.02	-0.03	0.11	0.18	0.03	0.01	0.02	-0.06	-0.14	-0.15	0.0024	0.0206
3-Month	$S_{t+1} - S_t$	0.76	0.36	0.07	0.05	0.14	0.18	0.14	0.06	-0.04	-0.13	-0.22	-0.24	0.0069	0.0438
1-Month	$F_t - S_{t+1}$	0.34	0.02	-0.06	-0.06	0.08	0.16	0.00	-0.01	0.00	-0.10	-0.18	-0.18	0.0006	0.0205
3-Month	$F_t - S_{t+1}$	0.76	0.35	0.04	0.01	0.10	0.14	0.09	0.01	-0.10	-0.20	-0.30	-0.32	0.0017	0.0428
1-Month	$F_t - S_t$	0.88	0.75	0.69	0.66	0.61	0.57	0.54	0.51	0.45	0.43	0.44	0.47	0.0031	0.0023
3-Month	$F_t - S_t$	0.91	0.80	0.75	0.71	0.67	0.63	0.60	0.57	0.53	0.51	0.52	0.52	0.0089	0.0063

We have used both 1-month and 3-month forward rates to test the theoretical framework for Indian market (equation 4 and 5). The result for equation (5) shows that the estimated $\beta_2$for one-month forward exchange rate is less than 1 at 0.8112 while the intercept $\alpha_2 = -0.0001$[15] . The result is in line with the results for developed markets. However, for 3-month forward exchange rate, estimated β_2 is more than 1 at 1.7172 with α_2 =-0.0078. The result from equation (4) shows complementarity of these two equation. The β_1 is 0.1888 while α_1 =0.0001 for (equation (4)) 1-mont forwards and β_1 is -0.7172 while α_1 =0.0078 for 3-month contracts.

[15] Both are not statistically significant

Table – 9: OLS Regression Estimates and Residual Autocorrelations of 1-month and 3-month contracts (N=125, First line pertains to 1-month forward and the second line pertains to 3-month forward)								
$\widehat{\alpha_1}$	$\widehat{\beta_1}$	$\widehat{\alpha_2}$	$\widehat{\beta_2}$	s($\widehat{\alpha}$)	s($\hat{\beta}$)	R_1^2	R_2^2	SS[16]
0.0001	0.1888	-0.0001	0.8112	0.0031	0.8242	0.0004	0.0078	0.0527
0.0078	-0.7172	-0.0078	1.7172	0.0067	0.6444	0.0101	0.0554	0.2227
Residual Autocorrelations								
			ρ1	ρ2	ρ3	ρ4	ρ5	ρ6
1-Month Forward			0.3430	0.0230	-0.0560	-0.0590	0.0870	0.1650
3-Month Forward			0.7560	0.3470	0.0320	-0.0030	0.0780	0.1240

For understanding the true predictive power of the forwards, we will use the equation (5) as in Frankel and Poonawala (2010). The null hypothesis of unbiasedness is the estimated β=1. The null would imply that there is no systematic time-varying component to the prediction error. The data is bucketed into two equal parts (April'03 to Jun'08 and Jul'08 to Sep'13) to understand if the results are stable over time. The results are produced below:

Table – 10: OLS Regression with data bucketing				
Observations	α	β	α	β
125	-0.0001	0.8112	-0.00784	1.7172
SE	0.0031	0.8242	0.00674	0.6444
t-Stat	-0.0200	0.9850	-1.16	2.66*[17]
Durbin-Watson	1.311		0.459	
62	0.00469	-4.303	0.01023	-3.8733
SE	0.0025	1.25	0.00558	1.0406
t-Stat	1.88	-3.44*[18]	1.83	-3.72*[19]
Durbin-Watson	1.487		0.582	
63	0.00188	0.979	-0.0095	2.2592
SE	0.00874	1.756	0.0175	1.2828
t-Stat	0.22	0.56	-0.54	1.76[20]
Durbin-Watson	1.339		0.497	

The coefficients for 1-month and 3-month forward exchange rate was found to be positive but only significant for 3-month forwards for the full sample but when we divided the data into two buckets, we found that for the first part (Apr'03 to Jun'08), the coefficients are negative and significant for both types of forwards. While testing the coefficients'

[16] SS (sum of squared errors).
[17] Significant at 1%
[18] Significant at 1%
[19] Significant at 1%
[20] Significant at 10%

significance (testing if α =0 and β=1), we found that for the entire data period, the p-values for α and β were 0.9850 and 0.8192 for 1-month forwards respectively and the same were 0.2469 and 0.2679 for 3-month forwards respectively. Hence, we fail to reject the H0: α =0 and β=1. However, for the first data bucket (April'03 to Jun'08) we found that the P-values are significant and hence the H0: α =0 and β=1 is rejected but for the second data period (Jul'08 to Sep'13), the H0 is not rejected.

Table – 11: Testing of Hypothesis					
	Test	Obs	Pr > F	F_Value	t-Stat
Intercept	0	125	0.9850	0	0.0000
1_month	1	125	0.8192	0.05	0.2236
Intercept	0	61	0.0649	3.54	1.8815
1_month	1	61	<.0001	17.98	4.2403*
Intercept	0	62	0.8302	0.05	0.2236
1_month	1	62	0.9905	0	0.0000
Intercept	0	125	0.2469	1.35	1.1619
3_month	1	125	0.2679	1.24	1.1136
Intercept	0	61	0.0717	3.37	1.8358
3_month	1	61	<.0001	21.93	4.6829*
Intercept	0	62	0.5905	0.29	0.5385
3_month	1	62	0.3302	0.96	0.9798

The prediction errors for both contracts were tasted for normality assuming that these are random and expectational errors. It was found that based on a Shapiro-Wilk statistic W=0.0955 and 0.935 with a p-values of 0.0004 and 0.0001 for 1-month and 3-month forwards respectively, we reject the null hypothesis and conclude that the prediction errors are not normally distributed. The Kolmogorov-Smirnov, Anderson-Darling, and Cramer-von Mises statistics also result in p-values less than 0.01, which confirm the conclusion that the prediction errors are not normally distributed.

T-12 : Tests for Normality of Prediction Errors								
	FORWARD1M				FORWARD3M			
Test	**Statistic**		**p Value**		**Statistic**		**p Value**	
Shapiro-Wilk	**W**	0.95496	**Pr < W**	0.0004	**W**	**0.93538**	**Pr < W**	**<0.0001**
Kolmogorov-Smirnov	**D**	0.10999	**Pr > D**	<0.0100	**D**	**0.12637**	**Pr > D**	**<0.0100**

Cramer-von Mises	**W-Sq**	0.35641	**Pr > W-Sq**	<0.0050	**W-Sq**	**0.47826**	**Pr > W-Sq**	**<0.0050**
Anderson-Darling	**A-Sq**	1.99739	**Pr > A-Sq**	<0.0050	**A-Sq**	**2.67367**	**Pr > A-Sq**	**<0.0050**

Conclusion

The forward-bias puzzle is based on two assumptions: (1) forward exchange rates equal expected future spot rates; and (2) expectations are rational. Relying on rational expectations, the assumption that forward rates equal expected future spot rates have been tested using actual future spot rates as proxies for expected future spot rates. Regressing actual future spot rates against current forward rates usually produced regression coefficients that were close to one. However, the recognition of the possible effects of unit roots made researchers to modify the equation as in equation (5). To achieve stationarity, current spot rates were subtracted from both sides of the original test equation. A large literature shows that estimates of β are usually closer to zero than to one and are often negative. This paper also finds that for a particular period, the β said was negative. Negative estimates of β seem to imply an informational inefficiency. Exchange rates fall when the forward premium seems to predict that they will rise. That apparent predictive error is the forward-bias puzzle. We found that the prediction errors are not normally distributed indicating information content of the same which need to be explored to explain the puzzle in Indian foreign exchange market.

The results from the paper show that for the entire period, we cannot reject the hypothesis that the β coefficient is 1 (and α coefficient is 0) for both 1-month and 3-month forward contracts indicating that forward market is still a biased predictor of the future spot exchange rate. However, the said relation was out of sync during the first period (April'03 to Jun'08) which may be due to inclusion of financial crisis period in the data set. The recent data (Jul'08 to Sep'09) shows that forward rates are still a biased predictor of future spot exchange rate for Indian foreign exchange market for both 1-month and 3-month contracts.

References:

Akram, Q., Rime, D., Sarno, L., 2008. Arbitrage in the Foreign Exchange Market: Turning on the Microscope. Journal of International Economics 76, 237-253.

Aslan, Ő., Korap, H., 2010. Does the uncovered interest parity hold in short horizons?. Applied Economic Letters 17, 361-365.

Bacchetta, P., van Wincoop, E., 2010. Infrequent Portfolio Decisions: A Solution to the Forward Discount Puzzle. American Economic Review 100, 870-904.

Baillie, R., Kiliç, R., 2006. Do asymmetric and nonlinear adjustments explain the forward premium anomaly?. Journal of International Money and Finance 25, 22-47.

Balke, N., and Mark E. Wohar, M., 1998. Nonlinear Dynamics and Covered Interest Rate Parity. Empirical Economics 23, 535-559.

Briys, E., Solnick, B., 1992. Optimal currency hedge ratios and interest rate risk. Journal of International Money and Finance 11, 431-445.

Chaboud, A., Wright, J., 2005. Uncovered interest parity: it works, but not for long. Journal of International Economics 66, 439-362.

Chakraborty, A., Evans, G., 2008. Can Perpetual Learning Explain the Forward-Premium Puzzle?. Journal of Monetary Economics 55, 477-490.

Chakraborty, A., Haynes S., 2008. Econometrics of the Forward Premium Puzzle. Economics Bulletin 6, 1-17.

Chinn, M., 2006. The (partial) rehabilitation of interest rate parity in the floating era: Longer Horizons, alternative expectations, and emerging markets. Journal of International Money and Finance 25, 7-21.

Chinn, M., Meredith, M., 2004. Monetary Policy and Long-Horizon Uncovered Interest Parity. IMF Staff Papers 51, 409-430.

Dibooglu, S., 1998. Forward Speculation, Excess Returns, and Exchange Rate Volatility: The Role of Risk Premiums, Review of International Economics, 6(3), 427-440.

Fama, E., 1984. Forward and Spot Exchange Rates. Journal of Monetary Economics 14 319-338.

Faust, J., Rogers, J., H., 2003. Monetary Policy's role in exchange rate behavior. Journal of Monetary Economics 50, 1403-1424.

Frankel, J., Poonawala, J., 2010. The forward market in emerging currencies: Less biased than in major currencies. Journal of International Money and Finance 29, 585-598.

Han, B., 2004. Is the forward premium puzzle universal?. Applied Economic Letters 11, 131-134.

Hochradl, M., Wagner, C., 2010. Trading the forward bias: Are there limits to speculation?. Journal of International Money and Finance 29, 423-441.

Kearns, J., 2007. Commodity Currencies: Why Are Exchange Rate Futures Biased if Commodity Futures Are Not?. The Economic Record 83, 60-73.

Levich, R., M., 1979. On the Efficiency of Markets for Foreign Exchange. In: R. Dornbusch, R., Frenkel, J. A. (Eds.), International Economic Policy: Theory and Evidence. Johns Hopkins: Baltimore, MD.

Mehl, A., Cappiello, L., 2009. Uncovered Interest Parity at Long Horizons: Evidence from Emerging Economies. Review of International Economics 17, 1019-1037.

Nickolaou, K., Sarno, L., 2006. New Evidence on the Forward Unbiasedness Hypothesis in the Foreign Exchange Market. The Journal of Futures Markets 26, 627-656.

Nijman, T.E., Palm, F.C., & Wolff, C.C.P. (1993). Premia in forward foreign exchange as unobserved components. Journal of Business and Economic Statistics, 11(3), 361-365.

Obstfeld, M., Rogoff, K., 2000. The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?. NBER Macroeconomics Annual 15, 339-390.

Sarantis, N., 2006. Testing uncovered interest parity using traded volatility, a time-varying risk premium and heterogeneous expectations. Journal of International Money and Finance 25, 1168-1186.

Sarno, L., 2005. Viewpoint: Towards a Solution to the Puzzles in Exchange Rate Economics: Where Do We Stand?. Canadian Journal of Economics 38, 673-708.

Sarno, L., Valente, G., Leon, H., 2006. Nonlinearity in Deviations from Uncovered Interest Parity: An Explanation of the Forward Bias Puzzle. Review of Finance, 10, 443-482.

Sercu, P., Vinaimont, T., 2006. The Forward Bias in the ECU: Peso Risks vs. Fads and Fashions. Journal of Banking and Finance 30, 2409-2432.

Sercu, P., Vandebroek, M., Wu, X., 2008, Is the forward bias economically Small? Evidence from European Rates. Journal of International Money and Finance 27, 1284-1302.

Tong, W.H.S., 1996. An examination of dynamic hedging. Journal of International Money and Finance, 15, 19-35.

Wang, P., Wang, P., 2009. Does a “Correct” Parameter Estimate Tell a Better Story about Foreign Exchange Market Efficiency?. Journal of International Money and Finance 28, 183-197.

Wolf, C., 1987. Forward Foreign Exchange Rates, Expected Short Rates, and Premia: A Signal Extraction Approach. Journal of Finance. 42, 395-406.