CHAPTER 2

UNBIASEDNESS AND RISK PREMIUMS IN THE INDIAN CURRENCY FUTURES MARKET

The relationship between the currency forward rate and realized spot rates has been one of the central issues in the literature of international financial markets. As pointed out by Pippenger (2011), it is one of the most important puzzles in the area of international finance. It seems reasonable to assume that high-interest rate currencies should depreciate so that the larger returns for currencies having high interest rate are offset by the equivalent loss associated with the currency depreciation. This hypothesis is known as uncovered interest rate parity (UIP). The UIP and the Forward Rate Unbiasedness Hypothesis (FRUH) are the most commonly used theories to establish the relationship between current forward rates and future spot rates. The UIP hypothesis states that expected return on a currency should equal the interest rate differential or forward premium (by virtue of covered interest rate parity\(^1\)) between two currencies (Bai and Mollick, 2010) or to be more precise, high yield currencies are expected to depreciate (Bekaert et al. 2007). In other words, the ex-post exchange rate change should equal the interest rate differential between two countries.

The UIP hypothesis under the assumption of no-arbitrage leads to the FRUH. The FRUH states that current forward rate should be an unbiased predictor of the future spot rate conditional on all information sets (Tai, 2003, Nikolaou and Sarno, 2005). In other words, if the market for

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\(^1\) The covered interest rate parity is the process of borrowing in one currency and simultaneously investing in another with the exchange rate risk hedged in the forward market, or, forward premium is equivalent to the interest rate differential between two countries’ currencies.
currency futures is efficient\(^2\), then current futures rate would be an unbiased estimate of the future spot rate. As a result, forward premium is expected to be an unbiased predictor of the future change in spot rate. Hereby, unbiasedness means that the currency futures price should not be significantly different from the corresponding future spot prices (Kohlhagen, 1979). However, if this is not the case, arbitrage opportunities will arise which will eventually make them equal. In other words, if we regress the spot rate at maturity on the current futures rate, the results should provide a unity slope coefficient, under the assumption of efficient markets. Alternatively, a slope coefficient of one should also be obtained in the regression of future change in spot rates on the current futures premium. For an extensive review of the empirical literature on foreign exchange rate expectations, refer to Engel (1996), Sarno (2005) and Jongen et al. (2008).

Empirical research, on the contrary, reveals that high interest-rate currencies have a tendency to appreciate. The unbiasedness of the forward rate has been overwhelmingly rejected many studies (Kodres, 1993; Cavaglia, Verschoor and Wolff, 1994; Baillie and Kilic, 2006; Nikolaou and Sarno, 2006) and the slope coefficient has been found to be significantly different from one, often even negative in most of the studies. The puzzle of the biasedness of the forward rate has been coined as the *forward premium anomaly* by Fama (1984). The forward premium anomaly is a condition when the forward rate is not an unbiased forecast of the spot rate in the future. Alternatively, expected excess returns on currencies, often referred to as risk premiums, and are possibly not zero (Tai, 2003). This situation arises when risk averse investors present in the market demand a risk premium causing the futures rate to deviate from the future spot rate.

\(^2\) In an efficient market, risk neutral and rational agents use all the information in forming expectations about the futures and spot price.
Fama (1984) also states that the reason for the failure of UIP is a time-varying risk premium. Baillie and Bollerslev (2000) suggest the forward premium anomaly as a widespread empirical result in the literature and find that returns on most of the nominal exchange spot rates are negatively correlated to the forward premium. This finding implies that the forward rate is not an unbiased predictor of future spot rates. The presence of a time-varying risk premium in currency futures markets is also confirmed by other studies, e.g. Wolff (1987), Theobald (1991), Panigirtzoglou (2004), Chiang and Yang (2007), Kiani (2009), just to mention a few.

Ehsani and Shahrokhi (2003) have tried to explain this puzzling relationship and put forward that the main reason for a negative relationship between the future currency spot rate and the forward rate can be attributed to surrogate variables used in place of expectations conditional on all the available information. Roon, Nijman and Veld (1998) found that the difference in the expected one period returns on futures contracts with different maturities could be attributed to the risk premiums present in the futures and spot prices spreads. Frankel and Poonawla (2010) study a sample of 14 emerging market currencies and state that the forward rate bias for emerging countries is lower than that of advanced countries. The forward premium anomaly remains a paradox in international financial markets (Baillie (2011)) which is important and worthwhile to be better understood. Chang (2011) have tried to solve the forward premium puzzle using covered interest parity, but failed. Due to the complex nature of the forward premium puzzle, Müller (2011) states that we should stop trying to work out this anomaly and should start looking for fundamentally better models for the determination of exchange rates.

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3 A variable that can be easily measured and used in place of one that cannot be measured or is difficult to measure.
In this study we provide a pioneer analysis of the relationship between currency spot and futures contracts traded at NSE which introduced rupee/dollar futures trading in India in August 2008. In our analysis we focus on the relationship between futures rates and realized spot rates for the Indian rupee US dollar exchange rate using futures contracts with maturities of one, two and three months. Our results suggest that futures rate is not an unbiased predictor of the future spot rate for longer maturity contracts and the observed risk premiums in the market become more significant with increasing maturity of the currency futures contracts. In other words, the expectations hypothesis should hold for the shorter maturity contracts but it is unlikely to hold true for contracts with longer maturities.

Our results are in line with Inci and Lu (2007) who investigate the significance of UIP and state that the currency risk premium may be a significant part of the basis for the contracts of longer-term while this may hold for contracts with shorter maturities. Their findings also suggest that the basis of the contracts of longer-maturity cannot predict the spot rate changes leading to rejection of UIP. On the other hand, the basis for short-maturity contracts is a useful indicator to predict the changes in the spot exchange rate between now and maturity.

We also examine the observed risk premiums and conduct tests in order to investigate whether the risk premiums are significant for the all maturities. We find that realized risk premiums for the one month futures contracts are not significant, while risk premiums for the two month and three month contracts are significantly different from zero and negative. The risk premium starts playing an increasingly important role for the longer maturity currency futures contracts (Inci
and Lu, 2007). As we go further in the future, the uncertainty increases which in turn increases the associated risk premium. This can be explained using two arguments.

The first explanation is based on the relationship between hedging and speculation activities. The hedging activities become more prevalent on contracts with longer maturities as the uncertainty in the exchange rate increases with time. Therefore, the pricing of longer maturity contracts will be more affected by risk premiums. Hedgers in currency markets typically are exposed in the spot market and use futures contracts to hedge against adverse long-term exchange rate movements in the cash market. On the other hand, speculators do not usually hold positions in the cash market but only operate in the futures market. As a consequence, if hedging activities are more than the speculating activities, we expect to observe more significant risk premiums in currency futures markets.

A second explanation, provided by Inci and Lu (2007), can be related to covered interest parity (CIP) that states that the futures-spot basis is equivalent to the interest rate differential between two countries’ currencies. Generally, the interest rates in short-term are set by central banks and are not affected by market risk premiums. However, as the maturity increases, the risk premium starts playing a more important role in the determination of interest rates, as these rates are set by market forces. Hence, it becomes important to study the behaviour of time-varying risk premium for different maturity contracts. Breuer (2000) states that forward contracts with longer maturities carry a great risk of valuation changes; hence they might have slope coefficients that are biased downwards and significantly smaller than one.
Unlike for stock markets, the inter-temporal risk-return relationship in foreign exchange markets is still very much unexplored. Hence, in this study, we also investigate the relationship between observed ex-post risk premiums and explanatory variables including the currency returns, the basis, as well as measures such as realized volatility, skewness and kurtosis of the currency returns. For stock markets, Pindyck (1984) and French et al. (1987) suggest that US stock market returns vary positively with the expected volatility of market returns. They have estimated the monthly variance (volatility) as the sum of the daily squared returns plus twice the sum of the products of adjacent returns. Jiang and Chiang (2000) state that volatility of currencies or equity markets might possibly explain excess returns in these markets since investors are rewarded for risk that can be measured by volatility. Hence, one could expect that risk premiums in the Indian rupee US dollar currency futures market are also positively related to volatility. The higher the volatility in the market, the higher might be the compensation investors will demand in the form of an additional risk premium. Such an argument is based on risk-averse investors and excess returns being closely tied to expected risk premiums which in turn are believed to be correlated to market volatility.

We also include higher moments of changes in the currency returns such as skewness and kurtosis. Some studies in the literature suggest that the mean-variance analysis is not sufficient to explain the risk-return relationship in emerging markets. Bekaert et al. (1998) state that the application of standard mean-variance analysis is problematic for emerging market economies, since, typically in these markets, returns exhibit significant skewness and excess kurtosis. Moreover, Harvey and Siddique (2000) put forward that assets that decrease the skewness are less desirable and should command higher expected risk premiums and vice-versa. Therefore, we
also examine whether the currency futures risk premium in the Indian market can be better explained by the inclusion of higher moments of the return distribution. Another reason for the inclusion of such measures stems from the recent literature on carry trades. For example, Brunnermeier et al. (2009) states that carry trades are prone to crash risk, that is, movements in the exchange rate between currencies of high and low interest rate are negatively skewed. Hence, these findings also motivate us to use the realized skewness and kurtosis of the currency returns as explanatory variables for the risk premium. Further, Christiansen (2011) investigates the intertemporal risk-return trade-off of foreign exchange rates using measures such as realized volatility, realized skewness and the value-at-risk. Investigating monthly excess returns and monthly foreign exchange risk measures calculated from daily observations, the author reports a strong contemporaneous risk-return relationship for ten currencies against the US dollar. Based on the above justification, we also expect to find a relationship between observed risk premiums in the forward market and realized measures of the currency returns.

The remainder of the chapter is organized as follows. Section 2.1 provides a brief review of the literature on the unbiasedness of forward rates and forward premiums as well as on risk premiums in currency forward and futures markets. Section 2.2 describes the methodology used in our analysis, while Section 2.3 provides the data and results of our empirical analysis.

2.1. LITERATURE REVIEW

As mentioned above, the unbiasedness of currency forward rates and the relationship between currency forward rates and realized spot rates has been one of the central issues in the literature of international finance. One of the most influential studies is Fama (1984), which point the
forward premium anomaly to a time-varying risk premium. He shows that there is a negative correlation between the implied risk premium and expected rate of depreciation and that the premium must have greater variance. Hodrick and Srivastava (1984) examine the risk premium in foreign exchange markets using a statistical model based on theoretical models of asset pricing. They find evidence of heteroskedasticity in the premium and suggest that the conditional expectation of the risk premium is a non-linear function of the forward premium. Kaminsky and Peruga (1990) investigate the presence of time-varying risk premiums in currency futures markets using the inter-temporal asset pricing model. They state that the risk premia arises due to the consumption risk. Modelling the conditional covariance using Engle’s ARCH model, they conclude that although the time-varying risk premium is an important determinant of the expected returns, still more flexible specifications are required for the model.

The currency risk premium has been validated in many other studies, including Hodrick and Srivastava (1987) and Bessembinder and Chan (1992). Hodrick and Srivastava (1987) reject the unbiasedness of daily futures prices as predictors of the next day’s futures price and report positive serial correlation in daily risk premiums. Bessembinder and Chan (1992) state that non-random price movements in the equilibrium theories of security pricing may be an evidence of either time-varying risk premia or market inefficiency. Their results support the presence of time-varying risk premia. Baillie and Bollerslev (1990) state that lagged changes in the forward rate appear to be significant in explaining the risk premium.

Yoo and Maddala (1991) conduct large sample tests for commodity and currency futures market to show that a representative large hedger, on average, consistently loses money in the futures
market which implies that they pay some risk-premium. On the contrary, they suggest that a representative large speculator consistently makes profit. They demonstrate that these large speculators are rewarded for the risk that they accept and also for the superior information that they possess and that this reward makes them stay in the futures market. They also find that if futures rates are more volatile, hedgers will be paying higher risk premium.

McCurdy and Morgan (1992) analyze weekly data for currency futures prices to investigate the nature of risk premiums. They measure the covariance risk and state that no significant risk premium is found when the parameters of the prices of the covariance risk are kept constant. However, they observed considerable premiums when the prices were allowed to vary along with the variances and conditional expected returns of the benchmark portfolio. Bessembinder (1993) tests the presence of risk premiums in a cross section of 22 markets, including financial, currency, metals and agricultural futures contracts. The author rejects the hypothesis of mean returns being equal to zero in only three out of a total 22 markets.

Liu and Maddala (1992) test the market efficiency hypothesis (MEH) in foreign exchange markets. They study four exchange rates, the British pound, the Deutsche mark, the Swiss franc and the Japanese yen against the US dollar. Using survey data on expectations for one-week and one-month ahead exchange rates, they investigate whether the violation of MEH is due to risk premia or expectational errors. They conclude that for the weekly data it is the risk premia and for the monthly data, it is both risk premia and expectational errors that lead to the violation of the MEH. Also, the tests of volatility of the currency futures market state that for the one month horizon, the forecasts fail the tests of rationality while for a short-term horizon like one week; the
forecasts do not fail such tests. Cavaglia, et al. (1994) demonstrated that the bias in the forward
discount could be attributed to the presence of large and time-varying risk premium.

Baum and Barkoulas (1996) have also confirmed the presence of significant risk premiums in the
currency future basis which in turn may be explained by variables stemming from stock and
bond markets. The suggested stock market variable is the dividend yield, while bond market
variables are the default spread and term spread. The default spread is measured by net returns
from investing in long-term corporate bonds in comparison to government bonds, while the term
spread is the premium demanded by investors for holding long term government bonds rather
than short-term US treasury bills. The authors find that the futures basis varies positively with
the riskiness in the stock market (dividend yield) and negatively with the riskiness in the bond
market (default and term spread). Peresetsky and de Roon (1997) have used the current spot
price, the current forward rate and the basis as determinants explaining the risk premium. They
confirm the presence of time varying risk premiums which are both statistically and
economically significantly different from zero.

Similarly, Roon et al. (1998) find that the difference in expected one period returns on futures
contracts with different maturities could be attributed to the risk premiums present in the spread
between futures and spot rates. Lauterbach and Smoller (1996) conducted tests for the presence
of risk premium in the Eurodollar futures and also examined the effects of the factors that could
affect the risk premium. Presence of positive premium on an average has been confirmed during
their sample period. Also, in contrast to other previous studies, they found that the premium was
independent of many factors like interest rate volatility, hedging imbalances and time to maturity
Further, Wolff (2000) studies the nature of the risk premium for fifteen currencies relative to the US dollar. For almost all currencies, the presence of a time-varying risk premium is confirmed in the analysis.

Jiang and Chiang (2000) also confirmed the presence of risk premium in foreign exchange market by using GARCH models. They establish that the volatility from the currency futures market affect the currency risk premium. They were able to characterise the conditional mean and volatility of currency risk premium using a variation of the conventional GARCH (1, 1) – M models. Also, Staikouras (2004) provides the evidence of time-varying risk premium in the interest rate future and state that both the premium and expected spot changes volatility are significant statistically with the latter being slightly higher than the former. Landon and Smith (2003) also study the hypothesis of the unbiasedness of forward exchange rate for yen-dollar exchange rates and find that the biasedness in the forward rate is induced by the time-varying risk premium and the absence of rational expectations. Panigirtzoglou (2004) estimated the exchange rate risk premium and the market prices of risk using the information in the foreign exchange implied volatilities from option prices. He states that the risk premium disappears when the market prices of the risk vectors are perfectly aligned or investors are risk neutral.

Lustig and Verdelhan (2007) study currencies of countries where interest rates are either higher or lower than in the US market. They explain that low interest rate currencies do not appreciate as much, while high interest rate currencies do not depreciate as much as suggested by UIP and observed interest rate differentials. Thus, domestic investors would earn negative returns on currency portfolios with low interest rates and positive excess returns on currency portfolios.
which have high interest rates. Phengpis and Nguyen (2009) study the risk premium in the British pound, the Danish krone, the Swedish krona and the euro foreign exchange market. Their results indicate that only the krone and the pound have a cointegrated relationship with the euro. They further state that cointegration of spot exchange rates can be considered as one of the factors representing time-varying risk premiums, since in order to maintain the relationship between currencies over the long-run, deviations would require dynamic adjustments of the concerned currencies.

Poghosyan et al. (2008) model the foreign exchange risk premium in Armenia using stochastic discount factor methodology. Using the weekly data on foreign and domestic deposits, they confirm the systematic presence of time-varying risk premium which increases with maturity. Jongen et al. (2008) attempt to determine the relative importance of presence of irrational expectations and the time-varying risk premium both, to explain the forward bias puzzle in the exchange rate markets. Using survey based measures of expectations; they state that the decomposition of the forward premium can be attributed in part to irrationality in the market participants and in part to the presence of time-varying risk premiums. Hence, they conclude that the forward premium unbiasedness hypothesis is rejected both due to the irrational expectations and the time-varying risk premium. Also they confirm that the time-varying risk premium increases for the contracts having more than one month maturity.

Kiani (2009) investigates the presence of time-varying risk premium in the monthly Singapore forward exchange rates for a period of November, 1983 to June, 2004. Using univariate signal plus noise model, he provides the evidence of statistically significant time-varying risk premium
in the Singapore forward exchange rates against the US dollar. Rezessy (2010) examined the
currency risk premium for Czech Republic, Hungary, Poland and Slovakia by applying Kalman
Filter. The co-movement of the premium series obtained with Kalman Filter and the survey data
for the forint (the Hungarian currency) and conclude both risk-premium-extended UIP and the
rational expectations hypothesis plays an important role in the currency market.

2.2. METHODOLOGY AND APPLIED MODELS

2.2.1. The Unbiasedness of the Futures Rate and the Futures Premium

According to the unbiasedness hypothesis, the futures rate should be an unbiased predictor of the
future spot rate conditional on all the information set \( I_t \) available at time \( t \). Thus, if the market
for rupee/dollar exchange rate is efficient, that is, risk neutral and rational agents use all available
information in forming expectations about currency spot and futures prices, then the current
futures rate, \( f_t^i \), for delivery at period \( i \), would be an unbiased predictor of the future spot rate,
\( s_{t+i} \), \( i \) periods from now, that is,

\[
E(s_{t+i} | I_t) = f_t^i \tag{1}
\]

In the above equation, let \( s_{t+i} \) denote the natural logarithm of the spot rate at time \( t \) for a contract
with maturity \( i \) (\( i = 1, 2 \) and 3 months), while \( f_t^i \) denotes the natural logarithm of the current
futures rate, for maturity in time \( i \) and \( E \) is the expectations operator. For testing the unbiasedness
hypothesis in the currency futures market, the ability of the futures rate to forecast the future spot
rate was initially tested in its level form by Cornell (1977), Frankel (1983) and Longworth
(1981). In such an analysis, the log of the spot rate at \( t+i \) is regressed upon the log of the futures
rate \( f_t^i \):
If the unbiasedness hypothesis holds, the coefficient $\beta_i$ should not be significantly different from one. Hence, generally the null hypothesis $\beta_i = 1$ is tested, in order to examine whether the futures rate can be considered to be an unbiased predictor of future spot rates. Note that initial tests of forward-rate unbiasedness using equation (2) were soon abandoned following a study by Meese and Singleton (1982) who provided evidence for non-stationary of both the spot rate $s_{t+i}$ and forward rate $f_t^i$. Under these circumstances estimating (2) would lead to a spurious regression and any inference drawn about the unbiasedness of the futures rate would be invalid, see for example, Zhu (2002) and Chakraborty and Haynes (2008). Therefore, instead of using the level regression equation, researchers soon turned their attention to regression models, where the logarithm of the current spot rate is subtracted from both sides of the original equation (2). Such an approach then leads us to testing the typical Fama (1984) UIP equation as:

$$s_{t+i} - s_t = \Delta s_{t+i} = \alpha'_i + \beta'_i(f_t^i - s_t) + \epsilon'_{t+i}. \quad (3)$$

The term on the left side in (3) is the future change in the log of the spot exchange rate and $(f_t^i - s_t)$ is the futures premium or so-called basis. We refer to equation (3) as the Futures Premium Regression Equation that has been examined in various studies testing the unbiasedness of currency forward rates. Prominent studies reporting similar regressions include Froot and Frankel (1989), Jongen et al. (2008), Wang and Wang (2009) and Bai and Mollick (2010). Again, in (3), if the futures premium is an unbiased predictor of changes in the spot rate from $t$ up to $t+i$, the coefficient $\beta'_i$ should not be significantly different from one under the assumptions of risk neutrality and rational expectations.
2.2.2. The Futures Bias, Risk Premiums and Rational Expectations

The unbiasedness of the futures rate or the futures premium is not required to hold when risk-averse investors are present in the market. In that case, the futures rate will differ from the expected spot rate by a risk premium and the rejection of the null hypothesis \( (\beta_i = 1) \) can be attributed to the presence of a time varying risk premium. The risk premium \( (\pi_t) \) is then the difference between the future spot rate at maturity and the currency futures rate today \( (E(s_{t+i}) - f_t^i) \). This definition of risk premium has been used in a number of studies like Hodrick and Srivastava (1984), Baillie and Bollerslev (1990), Kaminsky and Peruga (1990), Canova and Ito (1991), Peresetsky and de Roon (1997), Breuer (2000), Jiang and Chiang (2000), Chiang and Yang (2007), Chakraborty and Haynes (2008), Frankel and Poonawala (2010). Hence, assuming the existence of a risk premium in the currency futures market, equation (1) can be modified to

\[
E(s_{t+i}|I_t) = f_t^i + \pi_t
\]

or, alternatively,

\[
E(s_{t+i}|I_t) - f_t^i = (E(s_{t+i}|I_t) - s_t) - (f_t^i - s_t) = \pi_t
\]

where \( \pi_t \) denotes the risk premium on the futures contract that separates the expected change in the spot rate from the futures premium, as indicated by equation (5).

Now, consider the difference between the expected and realized spot rate at \( t+i \). Based on the rational expectations hypothesis, there should be no systematic pattern in the forecast error \( e_{t+i} \)

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Note that there are also several studies defining the risk premium as the forward rate minus the expected spot rate \( f_t^i - E(s_{t+i}) \), e.g. Fama (1984), Cavaglia et al. (1994), Backus et al. (1995), Baum and Barkoulas (1996), Engel (1996), Wolff (2000), Landon and Smith (2003), Kiani (2009), Rezessy (2010), among others.
which is the difference between the spot rate at maturity $s_{t+i}$ and the expected spot rate forecast $E(s_{t+i}|I_t)$ based upon the given information set $I_t$, as,

$$s_{t+i} = E(s_{t+i}|I_t) + e_{t+i}$$

(6)

However, assuming the existence of a time-varying risk premium, combining equation (4) and (6) we get

$$s_{t+i} = f_t^i + \pi_t + e_{t+i}.$$  \hspace{1cm} (7)

Then subtracting $s_t$ from both sides of equation (7), yields

$$\Delta s_{t+i} = (f_t^i - s_t) + \pi_t + e_{t+i}.$$  \hspace{1cm} (8)

From equation (2), the OLS estimator for $\beta_i$ is:

$$\hat{\beta}_i = \frac{Cov(s_{t+i}, f_t^i)}{\text{Var}(f_t^i)},$$

(9)

while the OLS estimator for $\beta'_i$ in equation (3) is

$$\hat{\beta}'_i = \frac{Cov(\Delta s_{t+i}, f_t^i - s_t)}{\text{Var}(f_t^i - s_t)}.$$  \hspace{1cm} (10)

Based on equation (7), the estimator for $\beta_i$ in (9) can also be rewritten as

$$\hat{\beta}_i = 1 + \frac{Cov(f_t^i, \pi_t)}{\text{Var}(f_t^i)} + \frac{Cov(f_t^i, e_{t+i})}{\text{Var}(f_t^i)}.$$  \hspace{1cm} (11)
In a similar manner, using equation (8) we can also rewrite the estimator for $\hat{\beta}'_i$ in equation (10) as

$$\hat{\beta}'_i = 1 + \frac{\text{Cov}(f^i_t - s_t, \pi_t)}{\text{Var}(f^i_t - s_t)} + \frac{\text{Cov}(f^i_t - s_t, e_{t+i})}{\text{Var}(f^i_t - s_t)} . \quad (12)$$

Equation (11) and (12) provide statistical evidence that the risk premium and non-rationality play an important and significant role in moving the coefficients $\hat{\beta}_i$ and $\hat{\beta}'_i$ away from unity. If we assume that there is no risk premium, that is, the participants are risk neutral, then the second term on the right side of Equation (11) and (12) becomes equal to zero. Further, if the rational expectations hypothesis holds, the third term also becomes zero and the coefficients $\hat{\beta}_i$ and $\hat{\beta}'_i$ would be expected to be not significantly different from one. Overall, as pointed out by Cavaglia et al. (1994), Landon and Smith (2003) and Jongen et al. (2008), both time-varying risk premiums and irrational expectations could be the reasons for observing the forward bias anomaly in many currency futures markets.

### 2.2.3. Determinants of the Risk Premium

In our empirical analysis we will also focus on the existence and explanation of a time varying risk-premium in the Indian rupee US dollar currency futures market. We will do this by examining the so-called ex post or realized risk premium in the Indian market. Under these circumstances, where instead of considering the expected spot exchange rate $E(s_{t+i})$ at time $t+i$, the actual realized spot rate $s_{t+i}$ will be used and the difference between the realized spot rate and the futures rate, $s_{t+i} - f^i_t$, can be tested in a regression analysis:

$$s_{t+i} - f^i_t = \gamma_0 + \gamma_1 x_t + \eta_{t+i} \quad (13)$$
where $x_t$ is a vector of explanatory variables given the information set $I_t$ and the term $\eta_{t+i}$ denotes the $i$th period prediction error. Here $s_{t+i}$ acts as proxy for the expected future spot exchange rate based on the information set available at time $t$, that is, $E(s_{t+i}|I_t)$ (Pippenger, 2011). In our empirical analysis we will try to examine the realized risk premium, using a number of explanatory variables. In particular, we will investigate the impact of the currency returns $(s_t - s_{t-1})$, denoted by $r_t$, the basis or futures premium $(f^i_t - s_t)$, and the realized variance, skewness and kurtosis of the currency returns on the ex-post risk premium in the Indian rupee US dollar futures market. Therefore, the multiple regression model in our empirical analysis takes the form:

$$s_{t+i} - f^i_t = \gamma_0 + \gamma_1 r_t + \gamma_2 (f^i_t - s_t) + \gamma_3 Var_t + \gamma_4 Skew_t + \gamma_5 Kurt_t + \eta_{t+i}$$ (14)

In equation (14), we explore whether the variables used have joint explanatory power for the risk premium in the currency futures market. In line with Christiansen (2011), we also explore whether the relationship between the risk premium and $x_t$ is non-contemporaneous. We perform this test by including the first lag of the explanatory variables in place of contemporaneous variables in equation (14). If the coefficients for the lagged variables turn out to be significant, we conclude that there is a delayed relationship between the risk premium and the explanatory variables.

The explanatory variables realized variance, skewness and kurtosis of the currency returns series are calculated using daily observations of the spot exchange rate and calculating the returns similar to Christiansen (2011). Thus, at a monthly frequency, we calculate the required measures based on calculated historical daily observations of the currency returns during the last $k=1, 2, 3$
months. Then we match the time horizon that is used to calculate the realized measures with the maturity of the futures contract. Thus, when analyzing realized risk premiums for one-month futures contracts, we calculate the variance, skewness and kurtosis at time \( t \) based on the previous months’ realizations of the currency returns. In the same manner, when examining the ex-post risk premiums of futures contracts with maturity of two (three) months, we calculate these measures based on daily calculated observations of the currency returns of the previous two (three) months.

For the realized variance, we consider the last \( n \) (with \( n = \) number of trading days during the last \( k = 1, 2, 3 \) months) daily observations of the spot exchange rate returns to calculate the realized variance during that period:

\[
Var_t = \frac{1}{n-1} \sum_{j=1}^{n} (r_j - \bar{r})^2
\]  

(15)

Here \( r_j \) is the return on currency on day \( j \) and \( \bar{r} \) is the average currency return during the last \( n \) trading days. The idea of realized FX volatility has been introduced by Anderson et al. (2001) who calculate the daily realized volatility this way based on high frequency intraday data. Wang and Yang (2009) have also calculated the daily realized variance using the same measure, while Christiansen (2011) calculates a realized volatility measure very similar to ours based on daily observations of the exchange rate during a given month. Using the same reasoning, we calculate the realized skewness \( Skew_t \) based on:

\[
Skew_t = \frac{1}{n-1} \sum_{j=1}^{n} \left( \frac{r_j - \bar{r}}{\sigma_t} \right)^3
\]  

(16)
In the equation above, $\sigma_t$ denotes the standard deviation of the currency returns during the last $n$ trading days. The realized (excess) kurtosis $\text{Kurt}_t$ is calculated using the following formula:

$$\text{Kurt}_t = \frac{1}{n - 1} \sum_{j=1}^{n} \left( \frac{r_j - \bar{r}}{\sigma_t} \right)^4 - 3$$

(17)

Note that the above equation actually specifies the excess kurtosis, by subtracting 3 (the kurtosis of the normal distribution) from the formula for the kurtosis. Thus, the variable can be interpreted as measuring the deviation of the kurtosis from that of a normal distribution.

2.3. EMPIRICAL ESTIMATION AND RESULTS

2.3.1. Data Description

We examine Indian rupee US dollar spot and futures contracts for the time period September 2008 to January 2013. The data\(^5\) for currency futures prices were downloaded from NSE website\(^6\). Data on spot exchange rates are taken from the RBI website. The RBI is the central governing body for all banks in India. All exchange rates for spot and futures contracts are denoted as Indian rupees per US dollar. The currency derivative segment of NSE is called NEAT-CDS trading system which provides a fully automated screen based trading nationwide. The NEAT-CDS is an order driven market where the orders are matched automatically on price–time priority basis. The first trade in the currency futures market in India started on August 29, 2008 when the NSE introduced the rupee/dollar trading. The contracts traded on NSE have a 12-month expiry cycle. All contracts expire two days before the last two working days of every

\(^5\) http://www.nseindia.com/marketinfo/fxTracker/fxTracker.jsp

\(^6\) The data has been taken from NSE for the reason that NSE has the maximum market share in the currency futures trading. For example, as on October 15, 2013, the market share of NSE in term of number of contracts traded was 59.85%, with MCX-SX and USE having a market share of 38.88% and 1.27% respectively.
expiry month (subject to holidays) when the contract ceases to trade at 12.00 PM. Simultaneously a new contract would appear with an expiry of 12 months ensuring the availability of 12 monthly contracts for trading at all points in time. The ultimate settlement day is the last working day (except Saturdays) of the expiry month.

Contracts for the rupee/dollar are specified in terms of lots (one lot equals USD 1000). Contracts are settled on a cash basis in terms of Indian Rupees and marked to market on a daily basis. The daily settlement price of the futures contract is its daily closing price which is calculated as the weighted average price last half-an-hour of the contract in CDS. If trading does not happen in a contract on a particular day, then the RBI reference rate on the last trading day of the futures contract is used\(^7\). Note, however, that since the advent of trading, the market for currency futures has been highly liquid. This is reflected in the fact that on the very first day of trading, a total of 65798 contracts valued at Rs. 2.91 billion were traded. From that time onwards, the trading in this segment of the market has been reporting a fast growth. Overwhelmed with the success of the rupee/dollar futures trade, NSE introduced the contracts for other currencies (rupee/pound, rupee/euro and rupee/yen) also in March 2010.

### 2.3.2. Tests for Unbiasedness

In the first step, we look at the relationship between spot and futures contracts with different maturities. Table 1 provides descriptive statistics for Indian rupee US dollar spot and futures contracts from September 2008 to January 2013 for 1-month contract; up to December 2012 for 2-month contract and up to November 2012 for 3-month contact. During the time period under

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\(^7\) Fact Book 2010, National Stock Exchange of India Limited
study, for all maturities, the mean of the quoted futures rates is higher than the mean of the current spot rate. Further, we generally find an upward sloping term structure with maturity such that the mean is increasing with maturity of the contracts. Based on Interest Rate Parity (IRP) considerations, this is in line with observed higher interest rates in the Indian market in comparison to the US market. For all maturities, the standard deviation of futures rates is higher than the spot rate, with the standard deviation of the 3-month futures contracts being the highest. However, we find that skewness and kurtosis are the highest for the spot rate, while they seem to decrease with maturity. As indicated by Table 1, the Jarque-Bera (JB) statistic suggests that for none of the series’ normality is rejected at the 5% significance level, however, it can be rejected at 10% level of significance.

Table 1 also shows results for Augmented Dicky Fuller (ADF) tests for the spot and futures rate. The null hypothesis under ADF test is that a series contains a unit root that is, the series is non-stationary. As we have not been able to reject the null hypothesis for spot and futures rates in their level as well as for the log of these rates even at the 10% level of significance, we conclude that the spot and futures rates are non-stationary. Figure 1 depicts the time-series of the spot exchange rate and futures rates for maturities of one, two and three months. We find that the Indian rupee was initially depreciating against the US dollar from September 2008 to April 2009. Since then the rupee started to appreciate against the US dollar with an exchange rate of 44.14 rupees/US dollar on July 28, 2011. However, the depreciation phase began again August, 2011 onwards. The figure also shows that for all maturities, at any point in time, futures quotes are higher than the spot rate which is caused by the higher interest rates for the Indian rupee in
comparison to the US dollar. Clearly the difference between the spot and futures prices becomes larger with increasing maturity of the futures contract.

**Table 1: Summary Statistics for Spot and Futures Quotes**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Max</th>
<th>Min</th>
<th>SD</th>
<th>Skew</th>
<th>Kurt</th>
<th>JB</th>
<th>ADF (Level)</th>
<th>ADF (Log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot</td>
<td>48.51</td>
<td>56.92</td>
<td>43.79</td>
<td>3.54</td>
<td>0.78</td>
<td>2.65</td>
<td>5.59*</td>
<td>-1.22</td>
<td>-1.29</td>
</tr>
<tr>
<td>1-M</td>
<td>48.73</td>
<td>57.11</td>
<td>44.03</td>
<td>3.59</td>
<td>0.78</td>
<td>2.56</td>
<td>5.65*</td>
<td>-1.22</td>
<td>-1.29</td>
</tr>
<tr>
<td>2-M</td>
<td>49.13</td>
<td>57.40</td>
<td>44.09</td>
<td>3.63</td>
<td>0.73</td>
<td>2.43</td>
<td>5.28*</td>
<td>-1.25</td>
<td>-1.33</td>
</tr>
<tr>
<td>3-M</td>
<td>49.39</td>
<td>57.60</td>
<td>44.22</td>
<td>3.64</td>
<td>0.69</td>
<td>2.37</td>
<td>4.97*</td>
<td>-1.35</td>
<td>-1.42</td>
</tr>
</tbody>
</table>

*Note:* SD denotes the Standard Deviation, Skew the Skewness and Kurt the Kurtosis. JB is the Jarque-Bera test statistics for normality that is approximately chi-squared distributed with two degrees of freedom (critical value at the 5% level $\chi^2_{0.95,2}=5.99$ and at 10% level, $\chi^2_{0.90,2}=4.61$). 1-M, 2-M, and 3-M denote the futures rate for contracts with maturities of one, two and three months. ADF reports the test statistic of the Augmented Dickey-Fuller test for stationarity of the spot and futures rates and the log of these rates.

**Figure 1: Plot of Spot and 1-M, 2-M and 3-M Futures Rate**
The figure shows the movement of Spot and Futures Prices for Indian rupee versus US dollar for futures contracts from September 2008 to January 2013 for 1-month contracts, to December, 2012 for 2-month contracts and November, 2012 for 3-month contracts.

We now investigate the unbiasedness of futures quotes for realized spot rates during the studied time period based on the suggested Futures Premium Regression Equation (3). Table 2 below shows results for the estimated regression models in order to examine whether the futures premium can be considered as an unbiased predictor of future changes in the spot rate. Our

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8We also examined the results for the Level Regression Equation (2). It yielded results that suggested the rejection of the unbiasedness of the forward rate at the 5% level for maturities of two and three months, and at the 10% level for one-month contracts. However, due to the non-stationarity of the spot and futures rate during the considered time period these results may be spurious and are not reported in detail here.
results indicate that while the estimated $\beta'$'s clearly deviate from one, their level of deviation increases with the maturity of the contract due to decreasing standard errors for the estimated coefficients. Note that for all the contracts, $\beta'$ is estimated to be positive. Also the explanatory power of the model is very low with value of $R^2$ being only 0.107 for the 1-month contract which increases as the maturity of the contract increases (0.607 for the 3-month contract). Thus, the futures premium explains the longer maturity contracts more than the shorter maturity contracts. Therefore, while we find that the coefficients deviate significantly from one; our results suggest that the unbiasedness hypothesis cannot be rejected for the 1-month contracts, however, for the longer maturity contracts; the unbiasedness hypothesis is significantly rejected.

Table 2: Results for the Futures Premium Regression Equation

<table>
<thead>
<tr>
<th></th>
<th>$\alpha'$</th>
<th>$\beta'$</th>
<th>$R^2$</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-M</td>
<td>-0.0052</td>
<td>1.8758</td>
<td>0.103</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>(-1.0094)</td>
<td>(1.127)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-M</td>
<td>-0.020***</td>
<td>1.86***</td>
<td>0.425</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>(-3.20)</td>
<td>(2.803)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-M</td>
<td>-0.027***</td>
<td>1.84***</td>
<td>0.607</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>(-4.69)</td>
<td>(3.96)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Figures in parenthesis represent the $t$-statistics; $s_{t+i}$ indicates the natural logarithm of the realized spot rate at $t+i$; $f_t^i$ indicates the natural logarithm of the futures rate; 1-M, 2-M, and 3-M respectively represent the future spot rate for contracts with one, two and three months maturity. $N$ is the number of observations. * indicates that the coefficient is significantly different from one at the 10% level, ** at the 5% level and *** at the 1% level.

Similar results with respect to the forward premium as a predictor of changes in the spot rate and the sign of estimated coefficients are reported in a number of studies, see e.g. Fama (1984), Froot and Frankel (1989), Kaminsky and Peruga (1990), Cavaglia et al. (1994), Backus et al. (1995), Inci and Lu (2007), Chakraborty and Haynes (2008), Wang and Wang (2009), Bai and Mollick (2010), Baillie (2011) and Pippenger (2011). Inci and Lu (2007) suggest that the basis can be
considered as a good predictor for changes in the spot rate for contracts with short maturity, while for contracts with longer maturity the unbiasedness condition is rejected. Kaminsky and Peruga (1990) and Backus et al. (1995) suggest that the forward premium on average wrongly predicts the direction of exchange rate movements in subsequent periods.

Pippenger (2011) states that a negative $\beta'$ implies an informational inefficiency that is, exchange rates fall when the forward premium suggests that they will rise. Baillie (2011), studying the UIP relationship of eight major currencies with the US dollar from 1988 to 2010 also report several periods where $\beta'$ is found to be significantly negative. Due to the strong results for the futures premium as a predictor of future changes in the spot rate, in the next section we investigate the realized or ex-post risk premiums in the relatively new Indian rupee US dollar market. We also aim to explain the dynamics of the risk premium and its relationship to measures such as the currency returns, the basis as well as realized volatility, skewness and kurtosis of the currency returns.

2.3.3. Examining the Risk Premium

The biasedness of the forward premium as a predictor for future exchange rate movements due the existence of a risk premium has been pointed out by a number of authors, see e.g. Fama (1984), Hodrick and Srivastava (1986), Wolff (1987), Kaminsky and Peruga (1990), Liu and Maddala (1992), Jabbour (1994), Baillie and Kilic (2006), Nikolaou and Sarno (2006), Chakraborty and Haynes (2008), Pippenger (2011), to mention a few. As mentioned above, theoretically, the basis can be considered as the sum of the expected change in the spot rate and a currency risk premium. Therefore, in the literature the failure of the unbiasedness of the futures
rate has often been attributed to the existence of a time-varying risk premium. In the following we will empirically examine the significance and nature of the risk premium in the Indian rupee US dollar futures market. Since, the ex-ante risk premium is generally unobservable; we consider the realized or ex-post risk premium \((s_{t+i} - f_t^i)\) in our empirical investigation. Thus, we examine the difference between the quote for the one month, two months and three months futures contract on a particular day and the realized spot rate at maturity of the futures contract, that is, one month, two months and three months later. Figure 2 exhibits the time series of the ex-post risk premium for the Indian rupee US dollar futures contracts. From a first glance we find that the risk premiums for the three different maturities exhibit a similar behaviour over the time period studied. For most of the months we observe negative risk premiums, that is, the realized spot exchange rate at maturity is below the futures quote one, two or three months earlier.

Ex-post risk premium for Indian rupee US dollar futures contracts for the period from September 2008 to January 2013 for 1-month contracts, to December, 2012 for 2-month contracts and November, 2012 for 3-month contracts.
Table 3 provides the summary statistics for the observed ex-post risk premiums for all maturities while Figure 3 provides a plot of the distribution of the risk premium using an Epanechnikov kernel estimator\(^9\). In Table 3 we also report the results of conducted Augmented Dickey-Fuller (ADF) tests for the realized risk premiums.

Table 3: Summary Statistics for Realized Risk Premiums for Different Maturities

<table>
<thead>
<tr>
<th></th>
<th>1-M Premium</th>
<th>2-M Premium</th>
<th>3-M Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-0.0014</td>
<td>-0.0082*</td>
<td>-0.012**</td>
</tr>
<tr>
<td></td>
<td>(-0.3524)</td>
<td>(-1.7053)</td>
<td>(-2.4164)</td>
</tr>
<tr>
<td>Max</td>
<td>0.0733</td>
<td>0.0562</td>
<td>0.0508</td>
</tr>
<tr>
<td>Min.</td>
<td>-0.0781</td>
<td>-0.0954</td>
<td>-0.0723</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.0284</td>
<td>0.0349</td>
<td>0.0350</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.2324</td>
<td>0.1406</td>
<td>0.1261</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>3.7235</td>
<td>2.4286</td>
<td>1.8811</td>
</tr>
<tr>
<td>JB</td>
<td>1.6332</td>
<td>0.8788</td>
<td>2.7953</td>
</tr>
<tr>
<td>ADF Test</td>
<td>-6.82***</td>
<td>-6.86***</td>
<td>-6.05***</td>
</tr>
</tbody>
</table>

Note: Figures in parenthesis represent the t-statistic for the estimated mean parameter of the realized risk premium \((s_{t+1} - f_t^1)\) for different maturities. ADF provides results on the Augmented Dickey-Fuller test for stationarity of the risk premium. JB is the Jarque-Bera test statistic that is, approximately \(\chi^2\)-distributed with two degrees of freedom. * indicates significance at the 10% level, ** at the 5% level and *** at the 1% level.

The results confirm that the observed risk premiums are stationary and reject the null hypothesis of a unit root for all maturities even at the 1% significance level. The mean of the risk premium is negative for all maturities and is also increasing in absolute terms with maturity of the futures contract. These results are in line with other studies, e.g. Canova and Ito (1991), Jiang and Chiang (2000) or Tai (2003). Canova and Ito (1991) report a negative average risk premium in the last sub sample of their study period for the JPY-USD exchange rate, which is – 8.74% per annum. Jiang and Chiang (2000) also find negative risk premiums for the Canadian dollar, Japanese yen and Deutschmark against the US dollar and suggest that risk premiums are a

\(^9\)The Epanechnikov kernel estimator estimates the probability density function of a random variable and is optimum in minimum variance sense.
reward for taking short positions in the futures market. Tai (2003) also finds negative monthly forward exchange risk premiums for several currencies, e.g. a monthly premium of -0.224% for the Japanese yen. On the other hand the author also reports positive risk premiums for several other currency markets including the Hong Kong dollar and Singapore dollar.

Figure 3: Epanechnikov Kernel Density Plot for Risk Premiums

Kernel Density Plot for realized risk premiums of Indian rupee US dollar futures contracts with maturities of k=1, 2, 3 months.

The increase in the magnitude of the risk premium with maturity suggests that returns from futures contracts are decreasing for longer maturity contracts. Further, the hypothesis that the mean of the risk premium is zero, can be rejected for the 2- and 3-month futures contracts at the
10% and 5% significance level respectively, while for 1-month contracts the mean of the risk premium is not significantly different from zero. These results are also coherent with the literature on risk premiums in currency markets suggesting that the premium becomes more significant for contracts with longer maturities, see e.g. Peresetsky and de Roon (1997) and Inci and Lu (2007).

Inci and Lu (2007) argue that for longer maturities risk premiums in the futures market start to play a more important role and lead to a rejection of the unbiasedness hypothesis. Since the economic rationale for the existence of futures markets is the possibility to transfer the exchange rate risk from risk-averse investors to those most willing or able to take it, see e.g. Bessembinder (1993), the risk premium could be interpreted as a compensation for taking on these risks. Another reason for this maturity effect in the risk premium, as suggested by Peresetsky and de Roon (1997), may be that for shorter maturity contracts bank loans are easily available that is not the case for longer maturities. Therefore, interest rate risk becomes more important for futures contracts with longer maturities and might lead to lower returns for such contracts.

Table 3 and Figure 3 also provide the standard deviation, skewness and kurtosis of the realized risk premiums. We find that for all the futures contracts, the distribution of the risk premium is clearly skewed to the right. Our results for conducted JB tests suggest that the normality for the distribution of the risk premium cannot be rejected for all the maturity contracts. In the next step we investigate whether the dynamics of the risk premium can be explained by explanatory variables including the currency returns, the futures premium and measures such as realized volatility, skewness and kurtosis of the currency returns.
2.3.4. Empirical Relationship between Risk Premium and Explanatory Variables

In this section, we investigate whether the ex-post risk premium in the Indian rupee US dollar futures market can be explained by exogenous variables related to the currency returns and futures premium. The literature suggests a number of variables that play a role in the determination of the risk premium. For example, Peresetsky and de Roon (1997) investigate the impact of the spot rate, futures rate and basis on the risk premium while Jiang and Chiang (2000) examine the influence of currency and stock market volatility on the premium. Christiansen (2011) suggests realized variance and realized skewness of the spot rate in combination with a tail-based measure such as value-at-risk as possible determinants of the risk premium. However, as evident in Table 1, the spot rate is a non-stationary variable and therefore, we cannot use spot rate directly as one of the determinants of the risk premium. We take the first difference of the log of spot rates and find currency returns which are found to be stationary.

We examine a model, following equation (14), with the currency returns, the basis as well as realized variance, skewness and kurtosis of the currency returns as possible determinants of the risk premium. In particular we are interested in the sign and magnitude of the coefficients $\gamma_i$ ($i=1, 2, 3, 4, 5$) and whether the variables are significant in explaining the risk premium. Table 4 reports the results of the estimated regression model for realized risk premiums and futures contracts with 1-, 2- and 3-month maturity in the contemporaneous form.10

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10 Note that similar to the study of Christiansen (2011), we also performed the tests for a non-contemporaneous relationship between the risk premium and the explanatory variables. However, none of the lagged variables was found to be significant in explaining the risk premiums. Hence, we decided not to report these results here. They are, however, available upon request from the authors.
Table 4: Regression Estimates for the Test of Significance of Risk Premium

\[ s_{t+i} - f_t^i = \gamma_0 + \gamma_1 r_t + \gamma_2 (f_t^i - s_t) + \gamma_3 \text{Var}_t + \gamma_4 \text{Skew}_t + \gamma_5 \text{Kurt}_t + \eta_{t+i} \]

<table>
<thead>
<tr>
<th></th>
<th>1-Month</th>
<th>2-Month</th>
<th>3-Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.0011</td>
<td>-0.025**</td>
<td>-0.038***</td>
</tr>
<tr>
<td></td>
<td>(-0.156)</td>
<td>(-2.561)</td>
<td>(3.617)</td>
</tr>
<tr>
<td>Currency Returns</td>
<td>0.1981</td>
<td>-0.240**</td>
<td>-0.257***</td>
</tr>
<tr>
<td></td>
<td>(1.419)</td>
<td>(-2.311)</td>
<td>(-3.155)</td>
</tr>
<tr>
<td>Basis</td>
<td>0.6855</td>
<td>1.031***</td>
<td>0.975***</td>
</tr>
<tr>
<td></td>
<td>(0.8510)</td>
<td>(3.289)</td>
<td>(4.386)</td>
</tr>
<tr>
<td>Variance</td>
<td>-116.78</td>
<td>189.96</td>
<td>343.83</td>
</tr>
<tr>
<td></td>
<td>(-0.815)</td>
<td>(0.928)</td>
<td>(1.470)</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.0077</td>
<td>-0.0025</td>
<td>-0.0015</td>
</tr>
<tr>
<td></td>
<td>(-0.968)</td>
<td>(-0.203)</td>
<td>(-0.109)</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.0010</td>
<td>-0.0024</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(-0.264)</td>
<td>(-0.443)</td>
<td>(-0.481)</td>
</tr>
<tr>
<td>R²</td>
<td>0.0779</td>
<td>0.2302</td>
<td>0.3869</td>
</tr>
<tr>
<td>F</td>
<td>0.7946</td>
<td>2.750**</td>
<td>5.68***</td>
</tr>
<tr>
<td>N</td>
<td>53</td>
<td>52</td>
<td>51</td>
</tr>
</tbody>
</table>

Note: \(s_{t+i}\) indicates the natural logarithm of the future spot rate; \(s_t\) is the natural logarithm of current spot rate; \(f_t^i\) indicates the natural logarithm of current futures rate; \(f_t^i - s_t\) is the basis; Figures in the parenthesis indicate the t-statistic. * indicates the coefficient is significant at the 10% level, ** at the 5% level and *** at the 1% level.

We find that for the 1-month contract, none of the explanatory variables is found to be significant. However, for contracts with 2-month and 3-month maturity, the currency returns are significant in explaining the risk premium at the 5% and 1% level of significance respectively. Also note that the magnitude of the coefficient \(\gamma_1\) increases with maturity, from -0.240 for 2-month contracts to -0.257 for contracts with a maturity of three months. The sign of the coefficients suggests that the higher the levels of the currency returns, the more negative will generally be the realized risk premium \((s_{t+i} - f_t^i)\), that is, the more the Indian rupee US dollar futures rate \(f_t^i\) will overestimate the realized spot rate \(s_{t+i}\). In other words, since interest rates during the considered time period are higher in India than in the US, the Indian rupee depreciates less against the US dollar than suggested by the futures rate due to a negative risk premium in the
market. Our results are consistent with those of e.g. Peresetsky and de Roon (1997) who investigate the risk premium in the ruble/dollar futures market and state that the current spot rate appears to have some predictive power for the risk premium. They also report the maturity effect of the spot rate as an explanatory variable, while we find that for longer maturities the magnitude of the coefficient for the currency returns increases.

The next important variable explaining the risk premium is the basis or futures premium. For futures contracts with maturity of 2-month and 3-month, the basis has a significant impact on the risk premium at 1% level. Note, however, that for all models the sign of the coefficient is positive, suggesting a tendency that the higher the basis at time $t$, the more will the futures rate $f_t^i$ underestimate the realized spot rate $s_{t+i}$.

We also find that the volatility of the spot rate, measured by the realized variance of daily spot exchange rates during the previous $k=1, 2$ and 3 months does not seem to play a role in the determination of the ex-post risk premium. The coefficient for the realized variance turns out to be insignificant in the equation for all the maturity futures contracts. Further, the magnitude of the coefficient for the realized variance is higher for contracts with longer maturity, although the explanatory power is slightly increasing with maturity. Note that the sign of the coefficient $\gamma_3$ is positive in all models (except for 1-month contracts), suggesting that the risk premium increases as the volatility of the spot exchange rate increases. Jiang and Chiang (2000) also report a positive relationship between the risk premium and the variance of the spot exchange rates. For equity markets, Chen, Guo and Zhang (2006) and Guo and Whitelaw (2006) also report a positive relationship between the risk premium and volatility.
Neither realized skewness nor realized kurtosis is found to be significant for any of the maturities studied. However, the negative coefficient for skewness in all equations may suggest that the more skewed (to the right) daily observations of the currency returns have been before time \( t \), the more will the futures rate \( f_t^i \) overestimate the realized spot rate \( s_{t+i} \). Similar results are obtained for the realized kurtosis suggesting a negative relationship between the kurtosis and the realized risk premium. Similar results for equity markets have been obtained by Hwang and Satchell (1999) who find that there is no significant relationship between the risk premium, skewness and kurtosis in equity markets of 17 emerging economies. However, they suggest that despite the insignificant estimates of the coefficients, models including higher moments maybe be preferable over simple mean-variance models.

With respect to the significance and explanatory power of the models we find that \( R^2 \) is clearly higher for the models examining realized risk premiums for futures contracts with a maturity of two and three months. Also, for these contracts, the F-test indicates that the overall model is significant at the 5% and 1% level and helpful in predicting realized values of the risk premium. Peresetsky and de Roon (1997) also report an impact on the maturity horizon on \( R^2 \) in their analysis: the coefficient of determination increases significantly from 0.01 for one-month contracts to 0.51 for four-month contracts.

Our finding that the risk premium is less significant for contract with shorter maturity can probably be explained by two reasons: the first explanation is based on the notion that the relationship between hedging and speculation activities plays a more important role in longer maturity contracts. Ederington and Lee (2002) state that hedging activities become more
prevalent on contracts with longer maturity and decline for shorter maturity contracts. Therefore, the pricing of longer maturity contracts will be more affected by risk premiums. Hedgers in currency markets typically hold positions in the cash market and use futures contracts to hedge against undesirable long-term exchange rate movements in the cash market. On the other hand, speculators do not usually hold positions in the cash market and only operate in the forward market. As a consequence, in case there are a lot of hedging activities relative to speculating activities, we expect to observe more significant risk premiums in currency futures markets such that the risk premium will be an important determinant of the futures rate. The risk premium can be expected to be more pronounced as the maturity of the contract gets longer.

A second explanation can be related to CIP that states that the futures-spot basis is equivalent to the interest rate differential between two countries’ currencies. Generally, the interest rates in the short-term are set by central banks and are, therefore, not affected by market risk premiums. However, as the maturity increases, the risk premium starts to play a more important role in the determination of interest rates, as these rates are arrived in the market through demand and supply forces. This means that the risk premium is not a vital part of the future-spot basis for short maturity contracts where UIP and the unbiasedness of the futures rate are likely to hold. However, for the same reason, UIP may not hold for contracts of longer-term maturity such that we can expect to find significant risk premiums in currency forward markets with longer maturities. These results are also supported by Inci and Lu (2007) who state that the risk premium may be an significant factor affecting basis long-term futures contracts while the same reasoning may not be true for short maturity contracts. As Equation (14) explains, the currency futures basis is informative about the realized risk premium, that is, deviations of the realized
spot exchange rate from the futures rate. Based on the same explanation, Inci and Lu (2007) suggest that the basis of contracts of longer-maturity cannot predict the spot rate changes between now and maturity, while it might be more helpful to predict currency futures returns, which are determined solely by the risk premium.

Moreover, we find that the risk premium is negatively related to the realized skewness of the spot exchange rate. However, while for all models the estimated coefficient for skewness is negative, none of these coefficients is significant. Harvey and Siddique (2000) suggested using the conditional or ex ante skewness to explain the variation in the currency risk premium. However, estimates of the ex ante skewness are generally more difficult to derive. Hence, we decided to use realized skewness based on historical exchange rate returns instead. The estimated relationship between the risk premium and the kurtosis in the rupee/dollar exchange rate is positive. However, also the coefficients for the kurtosis are not significant for any of the estimated models.

Given the short period of available data on Indian rupee US dollar currency futures it might also be worthwhile to further investigate the impact of these risk-based measures on the risk premium in future work. Also the results by Christiansen (2011) who finds that for several currency markets both realized skewness and Value-at-Risk have a significant impact on the excess return of these currencies over what is suggested by interest rate differentials, point towards this direction. Overall, we find evidence for significant realized risk premiums in the Indian rupee / US dollar futures market for contracts with maturities of two and three months. We also find a significant relationship between observed premiums and the currency returns and the basis.