# Indian Money Market:
# Market Structure, Covered Parity and Term Structure

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Abstract

In the context of the relatively recent deregulation of interest rates in India, this paper analyses the structure and inter-relationships of money market interest rates and studies the extent to which covered interest parity holds in India. The paper shows that there was a major structural break in September 1995 when in the wake of turmoil in the foreign exchange markets, covered interest arbitrage came into play in a big way for the first time. Even after September 1995, the forward premia continue to violate covered parity in systematic ways. These violations are shown to be related partly to the distortions in the foreign exchange market as measured by the premium in the unofficial foreign exchange market. Partly, however, covered parity violations also reflect distortions in the money market rates and in the formation of expectations. Though the money market is free from interest rate ceilings, structural barriers and institutional factors continue to create distortions in the market. Apart from the overnight inter-bank (call market) rate, the other interest rates in the money market are sticky and appear to be set in customer markets rather than auction markets. A well defined yield curve does not therefore exist in the Indian money market

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It is only in the early nineties that interest rates were progressively deregulated in India, and there have therefore been few studies about the behaviour of interest rates in the country. Even today, the secondary market for long term debt is highly illiquid and underdeveloped. This makes it difficult to carry out an empirical study about long term interest rates. By comparison, the money market is relatively more liquid making it a better candidate for empirical research (for example, Varma, 1996, 1997). This paper seeks to study the structure and inter-relationships of money market interest rates in India.

The money market encompasses a wide range of instruments with maturities ranging from one day to a year, issued by the government and by banks and corporates of varying credit rating, and traded in markets of varying liquidity. The money market is also intimately linked with the foreign exchange market through the process of covered interest arbitrage in which the forward premium acts as a bridge between domestic and foreign interest rates. Thus an analysis of money market interest rates covers four elements:

1. The *term structure* of interest rates (the segment of the yield curve up to a maturity of one year).

2. The *credit spread* between instruments of similar maturity but differing credit risk.

3. The *covered interest differential* between international interest rates adjusted for the forward premium and domestic interest rates of comparable maturity and default risk.

4. *Market structure differences* between continuously clearing auction markets and sticky price customer markets.

## Data

The money market instruments covered in this study include the call market, Treasury Bills (T-Bills), Certificates of Deposits (CD), Commercial Paper (CP), and Inter Corporate Deposits (ICD). On the foreign exchange side, the paper focuses on interest differentials based on dollar LIBOR and the forward premium of the dollar at three month and six month maturities. Since the foreign exchange market in India is not entirely free, it is also useful to look at the unofficial (black market or havala) exchange rate of the rupee and the premium of the havala rate over the official rate.

Official publications of the Reserve Bank of India (RBI) provide data on the call market and on primary market auctions of T-Bills. The US Federal Reserve Board publishes data on the dollar LIBOR rates of interest. Data on most of the others are not available in official publications, but are often published in the business press on the basis of quotations provided by market participants (brokers or dealers). In order to have a consistent source of data on these variables, this study relies on the data published every quarter in the *Economic and Political Weekly*. This includes weekly data on all the interest rates, forward premia and havala exchange rate (as quoted in Dubai) required for this study. Data for most of the variables were available from July 1994 onwards, but some key interest rates were available only from October 1994. Most of the study however uses data only from September 1995 because of a significant structural break that was detected during the course of the study as explained later in this paper. The study includes data up to the end of 1996.

As pointed out earlier, the forward premium acts as a bridge between domestic and foreign interest rates through the process of covered interest arbitrage. A bank operating in India which has access to borrowing abroad in dollars can convert this dollar borrowing into rupee borrowing by taking a forward cover in the foreign exchange markets. Its total borrowing cost measured in rupees has two components - the dollar interest rate which it pays and the forward premium that it pays for covering the exchange risk. If this total cost (the covered interest rate) is less than the domestic rate at which the bank can borrow, it would prefer to borrow abroad than in India. If enough banks make this shift, their action would push up the forward premia (as they all seek forward cover) and would also bring down the domestic interest rate by reducing the borrowing pressure in the domestic market. The reverse shift would take place if the covered interest rate were higher than the domestic rate. The principle of covered interest parity says that the covered interest rate equals the domestic interest rate for comparable maturity and default risk.

Covered interest parity holds very well when there are no restrictions on capital movements; for example, forward premiums are virtually identical to interest differentials in the Euro-currency markets which are completely free. Traders are known to quote forward premia by looking at interest differentials (Deardorff, 1979). For this reason, this paper refers to the covered dollar LIBOR as the implicit Euro-rupee rates; it is the rate that would prevail in the Euro-rupee market if such a market existed. For example, the (implicit) three month Euro-rupee rate is defined to be the three month dollar LIBOR *plus* the three month forward premium (annualized) of the dollar against the rupee. In the absence of a readily available overnight rate in the Euro dollar markets, the implicit overnight Euro rupee rate is defined to be the US federal funds rate *plus* the cash/spot forward premium (annualized) of the dollar against the rupee.

It is worth pointing out that since the LIBOR and federal funds rates have been quite stable during this period, while forward premia have been highly volatile, the Euro rupee rates behave very much like the forward premia with a constant added. This means that, except for the intercept terms, regression results using the implicit Euro rates are very similar to the results using the forward premia themselves. However, in an analysis of covered parities, the intercept term (or the mean of the interest differential) is quite important. Using the implicit Euro rates is therefore preferable to working with the raw forward premia.

The interest rates used in the study are the following:

| | |
|---|---|
| CALL | The weekly average (trade weighted) call market rate published by the RBI |
| TBPRIM | The implicit cut-off yield in the weekly auctions of 91 day T-Bills |
| TBSEC | The yield quoted by the Discount and Finance House of India (DFHI) for secondary market transactions in T-Bills |
| CDPRIM | The mid rate of yields on CDs in the primary market. CDs range in maturity up to one year, but a significant number are for three and six month maturities. |
| CDSEC | The yield quoted by the Discount and Finance House of India (DFHI) for secondary market transactions in CDs. |
| CPPRIM | The mid rate of yields on CPs in the primary market. CPs are typically for a maturity of six months |
| CPSEC | The yield quoted by the Discount and Finance House of India (DFHI) for secondary market transactions in CPs. |
| ICDPRIM | The mid rate of yields on ICDs in the primary market. ICDs are typically for a maturity of three months |
| ER3MO | The implicit Euro rupee rate for maturity of three months |
| ER6MO | The implicit Euro rupee rate for maturity of six months |
| ERFUNDS | The implicit Euro rupee rate for overnight maturity |
| HAVALAPR | The percentage premium of the havala exchange rate over the RBI reference rate |

## Market Structure

To gain an understanding of the overall structure of the money market, a factor analysis was carried out of the various interest rates. It is well established in international markets that factor analysis of interest rates on government securities typically yields two major factors (representing the term structure of interest rates) which explain almost all the variation in yields (Litterman & Scheinkman, 1991; Nelson & Schaefer, 1983). Since the interest rates used in this study included a wide range of risk classes, it was expected that factor analysis may partition the rates on the risk dimension in addition to the time dimension. It was therefore quite surprising to find that the two factors thrown up by the factor analysis (Table 1) had nothing to do with either maturity or risk. The first factor included the T-Bills, CD, CP and ICD rates while the second factor included the call rate and the (implicit) Euro rupee rates. The first factor spans the entire spectrum of the risk dimension from sovereign to corporate. The second factor spans the time dimension ranging from

**Table 1: Rotated Factor Loadings from Principal Component Analysis**

| Variables | Factor Loadings | |
|---|---|---|
| | **First Factor** | **Second Factor** |
| CALL | 0.294 | **0.836** |
| TBPRIM | **0.879** | 0.318 |
| TBSEC | **0.856** | 0.331 |
| CDPRIM | **0.766** | 0.529 |
| CDSEC | **0.959** | 0.185 |
| CPPRIM | **0.766** | 0.458 |
| CPSEC | **0.957** | 0.186 |
| ICDAVG | **0.810** | 0.369 |
| ER3MO | 0.418 | **0.868** |
| ER6MO | 0.426 | **0.804** |
| ERFUNDS | 0.118 | **0.913** |

overnight to six months.

But these two seemingly inexplicable factors have a very simple and intuitive interpretation in terms of market structure. The second factor includes rates drawn from the call market and the foreign exchange markets which are readily classified as auction markets. The interest rates in this factor are therefore continuously market clearing rates. On the other hand, as argued below, the first factor contains sticky interest rates characteristic of customer markets.

The CD and CP markets show clear traits of customer markets. Banks often subscribe to the CP of a large and valued customer in order to maintain the relationship. The same is true when a large customer wishes to place a CD with the bank. The secondary rates quoted by the DFHI are changed slowly and infrequently. The volume of trading done at these rates is often negligible indicating that they are quite far from being market clearing rates. The primary T-Bills rate is set by auction and would at first sight appear to be a market clearing rate. However, the RBI has often let large amounts devolve upon it to prevent a rise in the cut-off yield. Moreover, during periods of tight money, a significant portion of the T-Bills are sold through non competitive bids. These characteristics make the T-Bills rate as sticky as it would be if it were set in a customer market. In fact, the description of the primary T-Bill market as a customer market is not totally inappropriate if we regard the Government as a favoured customer of the RBI. Thus all the rates included in the first factor are set in customer markets and show evidence of stickiness.

Another piece of evidence in this direction is provided by the standard deviations of the different rates (Table 2). All the rates in the second factor (auction markets) show much higher variability than the rates in the first factor (customer markets). This is direct evidence on the stickiness of the latter. It is also possible that some of the auction market interest rates display the excess volatility that has been detected in other financial markets in India and elsewhere (Barua and Varma, 1994, Shiller, 1990). This is a topic for future research.

**Table 2: Volatility of Interest Rates in Customer Markets and Auction Markets**

| ***First Factor (Customer Markets)*** | | | ***Second Factor(Auction Markets)*** | | |
|---|---|---|---|---|---|
| Variable | Standard Deviation | Coefficient of Variation | Variable | Standard Deviation | Coefficient of Variation |
| CDPRIM | 2.74 | 0.19 | CALL | 9.23 | 0.68 |
| CDSEC | 1.35 | 0.09 | ER3MO | 6.45 | 0.36 |
| CPPRIM | 1.83 | 0.12 | ER6MO | 4.89 | 0.27 |
| CPSEC | 1.22 | 0.08 | ERFUNDS | 17.40 | 0.88 |
| ICDPRIM | 3.11 | 0.15 | | | |
| TBPRIM | 1.93 | 0.17 | | | |
| TBSEC | 2.27 | 0.21 | | | |

## Covered Interest Arbitrage: The Structural Break in September 1995

As indicated at the outset, there was a major structural break in the money market in September 1995 and, therefore, this paper uses data only from this point onward. The crux of this structural break was in the inter-relationship between the money market and the foreign exchange market, thought there were some shifts in the relationships between the domestic interest rate themselves.

This section studies the change that took place in September 1995 in the process of covered interest arbitrage.

The Indian foreign exchange and money markets went through a period of turmoil in the last quarter of 1995. After holding steady for nearly three years, the rupee started depreciating rapidly against the dollar. Simultaneously, the forward premia shot up to unprecedented levels. These developments had a immediate impact on the money markets too and the call market interest rate too rose sharply. The well known theoretical linkage between the money market and the foreign exchange markets was witnessed in practice for the first time. The interesting fact was that even after calm was restored in the markets, the new-found linkage persisted. This was thus a classic case of hysterisis in financial markets: markets and arbitrage mechanisms come into being in response to abnormally high profit opportunities; but once they have come into existence, they do not disappear when the profit opportunity returns to normal levels. The learning process that markets and market participants have gone through leaves a permanent impact.

Fig 1: Covered Interest Parity before & after September 1995

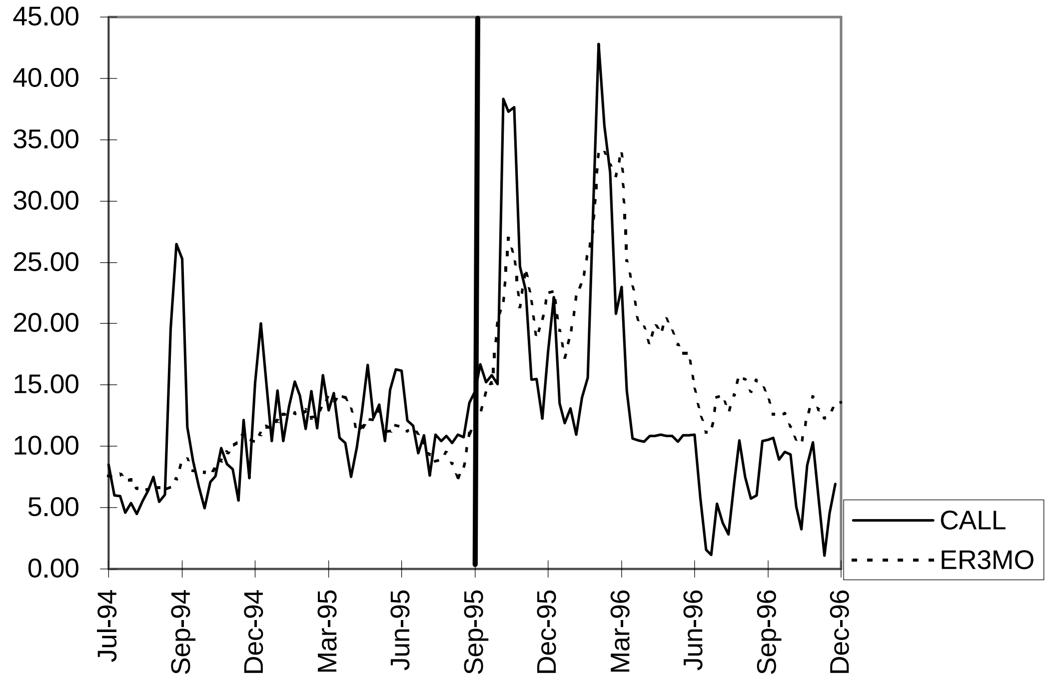


Fig 1 shows the call market interest rate and the three month implicit Euro-rupee rates plotted on the same graph. It may be seen that before September 1995, the two interest rates go their respective ways with little relationship to each other. After September 1995 however, the two rates track each other fairly well going through the same peaks and troughs. A structural break is visually evident from the graph. Statistical tests confirm the break. A regression of the Euro rupee on the call market had an R-Square of 0.58 after the break as against only 0.10 pre-break. The regression coefficient is significant at the 0.1% level post-break, but insignificant at even the 5% level pre-break.

The use of the call market rate in the above analysis is not quite appropriate. Strictly speaking, covered parity holds between instruments of similar maturity, risk and liquidity characteristics. Since LIBOR is an inter-bank market, the comparison should ideally be with a three month or six month inter-bank market in India. Unfortunately, an inter bank term lending market did not exist in India during the period of the study due to excessive reserve requirements on term borrowing. One possible comparison is with the call market which is an inter-bank market, but only for short term funds (overnight to a fortnight). Anecdotal evidence suggests however that in deciding whether to carry out the arbitrage, banks try to forecast the likely average of the call rate over the next three/six months and compare that forecasted average with the implicit Euro rupee rate. A strong case can be made for testing covered parity using a longer maturity rate like the CD rate (CDPRIM) at which banks borrow from large non-bank lenders.

The structural break was therefore tested using CDPRIM as well as other rates like TBPRIM and CPPRIM. as independent variables instead of CALL. These tests also confirmed the structural break. The regression coefficients were significant at the 0.1% post-break, but not pre-break. Covered parity was also examined using the six month rate (ER6MO) instead of the three month rate (ER3MO) as the dependent variable. The results were similar.

## Covered Arbitrage After September 1995

The above discussion indicates that covered interest arbitrage was practically non existent before September 1995, but has become a significant factor since then. It is however necessary to examine how effective this arbitrage has been even in this period in bringing the markets closer to covered interest parity.

One of the difficulties in studying covered interest parity in India is in identifying a domestic instruments of similar maturity, risk and liquidity characteristics as LIBOR. As stated earlier, there is no simple solution to this because of the absence of an inter-bank term market in India. On intuitive grounds, a strong case can be made for using the CD rate (CDPRIM) at which banks borrow from large non-bank lenders. This comparison showed a large and highly volatile differential between the implicit Euro rupee rate and the CD rate. The differential (ER3MO-CDPRIM) had a mean = 3.25% and a standard deviation of 4.57%; the mean is significantly different from zero ($t = 5.96$, $P < 0.001$). Similarly, (ER6MO-CDPRIM) had a mean of 3.15% and a standard deviation of 3.35%; the mean is again significantly different from zero ($t = 7.86$, $P < 0.001$). To put these magnitudes in proper perspective, it is worth noting that the mean absolute deviations from covered interest parity of quarterly average domestic money market (three month) interest rates in Canada, Germany, Japan, United Kingdom and the United States were 0.89% during 1974-79, 0.60% during 1980-82 and 0.26% during 1983-88 (Abaruchis, 1993).

The differential in India is therefore several times what prevailed in the developed economies even in the early days of floating exchange rates. In trying to understand this phenomenon, one can identify several possible determinants of this differential:

- *The slope of the term structure:* It is possible that while forecasting the future average call rate, banks may place too much reliance on the current call rate. This would be inappropriate because it would ignore the high degree of mean reversion of the call rate (see Varma 1997). Mean reversion implies that when the call rate is very high, it is likely to come down and vice versa. In both cases, the call rate would revert to the mean or “normal” rate. As shown in Varma (1997), the “normal” rate to which the call rate mean reverts is itself changing over time. Assuming that the term rate is a proxy for the normal rate, the slope of the term structure is a measure of the likely mean reversion in the call rate. A similar interpretation would follow from the expectations hypothesis about interest rates also. The slope of the term structure was defined as the difference between the T-Bills rate and the call rate (TBPRIM-CALL).

This independent variable has an alternative interpretation in terms of the difference between sticky price customer markets and continuously clearing auction markets. As shown earlier in this paper, the Euro rates and the call rate are market clearing rates, while the T-Bills and the CD rate are sticky. Since the dependent variable includes a component representing the spread between the two kinds of markets, we must have an independent variable which contains a similar component.

- *The credit spread*: If the risks involved in the Euro rupee borrowing are different from that of the CD borrowing, then the interest differential would reflect a risk premium. If this risk premium were time varying, it is likely to be correlated with other credit spreads. Two measures of the credit spread were tried: the difference between CDPRIM and TBPRIM (the credit spread between the government and the banks), and the difference between ICDPRIM and CDPRIM (the credit spread between banks and corporates).

- *The Havala Premium:* If the interest differential is driven by the restrictions on capital flows, it would be strongly correlated with the havala premium (HAVALAPR) which is driven by the same factors.

Regression analysis indicated that the credit spread was not a significant explanatory variable in explaining the interest differential (ER3MO-CDPRIM). The regression equation was therefore estimated using only the term structure slope and the havala premium as explanatory varaibles. The result  was as follows

```
ER3MO-CDPRIM = -2.018   -0.389(TBPRIM-CALL) +0.516 HAVALAPR
              (-1.506) (-8.707)             (3.374)
R-Square = 0.569, F(2,64) = 42.164 (P < 0.001)
```

It may be seen that the R-square is quite high (0.57) and both the term structure slope and the havala premium are highly significant factors determining the covered interest differential. The intercept term (representing that part of the mean interest differential which is not accounted for by the independent variables) is not statistically significant at even the 5% level. These results indicate that the covered interest differential is strongly influenced by the term structure slope and the havala premium, and that after these have been accounted for, the residual mean covered interest differential is not significant. Of the two explanatory variables, the first captures the distortions in the process of expectations formation and/ or the stickiness of prices in customer markets, while the second represents the distortions in the foreign exchange market due to exchange controls. These factors are therefore seen to be the principal impediments to the process of covered interest arbitrage in India.

The results for the six month differential were similar though the fit is not as good:

```
ER6MO-CDPRIM = -2.170   -0.193(TBPRIM-CALL) +0.574 HAVALAPR
              (-1.836) (-4.882)             (4.261)
R-Square = 0.384, F(2,64) = 19.953 (P < 0.001)
```

## Term Structure: Expectations Hypothesis

The results earlier in this paper on stickiness of many of the interest rates raises the perturbing possibility that much of what appears to be a term structure in interest rates only reflects the fact that the sticky three/six month rates are adjusting slowly to changed market conditions while the market clearing call rate has adjusted instantly. The expectations hypothesis of the term structure provides the possibility of resolving this question. Under the expectations hypothesis, the three month rate represents the market expectation of the average short term rate over the next three months. In each week we can therefore compute the actual realized average of the call rate over the three months; this is a thirteen week forward moving average (CALL13FA). Similarly, we can compute the six month (26 week) forward moving average (CALL26FA). We then regress these realized averages on a three/six month rate. If the three/six month rate is excessively sticky then

1. This regression would have little explanatory power
2. The realized average would be more volatile than the three/six month rate
3. The regression coefficient would be well in excess of unity

The empirical results are mixed. In the case of CALL13FA, the best predictor turned out to be TBPRIM with an R-square of about 0.34 which is not too low. But CALL13FA is much more volatile than TBPRIM; the regression coefficient is close to 3, and the hypothesis that the coefficient is unity is strongly rejected ($t = 3.53$, $P < 0.001$)

```
CALL13FA = -20.512  +2.849 TBPRIM
           (-3.215) (5.434)
R-Square = 0.349, F(1,55) = 29.524 (P < 0.001)
```

When CALL26FA was regressed against TBPRIM, the fit was poorer and the hypothesis that the slope is equal to unity is somewhat weakly rejected (t = 2.32, P = 0.025):

```
CALL26FA = -93.669 + 8.427 TBPRIM
           (-2.295) (2.637)
R-Square = 0.142, F(1,44) = 6.952 (P = 0.012)
```

Since the domestic interest rates other than the call rate are sticky, it was decided to investigate whether the Euro rates (which are set in auction markets) are a better predictor of the realized average call rate than the domestic rates. The results showed that the Euro rates have negligible explanatory power though their standard deviations are comparable to those of the realized averages. This reflects the fact (discussed earlier) that the Euro rates also reflect pressures in the foreign exchange market unrelated to interest rates.

The results provide statistical evidence of the often lamented absence of a well defined yield curve in the Indian money market despite a plethora of interest rates of different maturity, risk and liquidity characteristics.

## Conclusion

This paper has presented evidence on some major distortions in the Indian money markets and foreign exchange markets. The money market is free from interest rate ceilings, but the evidence shows that interest rate deregulation by itself has not been sufficient to produce well functioning markets. Structural barriers and institutional factors continue to create distortions in the market:

1. Apart from the call rate and the forward premia, the other interest rates in the money market are sticky and appear to be set in customer markets rather than auction markets.

2. Even after September 1995, the forward premia continue to violate covered parity in systematic ways. These violations have been shown to be related partly to the distortions in the foreign exchange market as measured by the havala premium. Partly, however, covered parity violations also reflect distortions in the money market rates and in the formation of expectations.

3. A well defined yield curve does not exist in the Indian money market because domestic interest rates other than the call rate are sticky. Systematic violations of covered parity prevent an implicit yield curve from being constructed through that rate.

It is evident therefore that while interest rate deregulation is useful, it is equally important to carry forward the process of structural deregulation in the money market.

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