Modeling Interest Rate Cycles in India

By

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Abstract

The present study tries to examine the behaviour of various Indian interest rates such as call money rate, and yields on secondary market securities with maturity periods of 15 to 91 days, 1-year, 5-years and 10-years. In the first stage, the study investigates the determinants of interest rates and finds that although the interest rates depend on some domestic marcoeconomic variables such as yield spread and expected exchange rate, they are mainly affected by the movements of international interest rates, although with some lags. The policy variables such as Bank Rate and Federal Funds Rate did not show any significant impact on any of the interest rates. Further, our results show that peaks in each interest rate are reached at different time points. Yield on 15 to 91 days t-bills is expected to peak sometime in the middle of 2006; one year yield is expected to peak in third quarter of 2006; yields on long term securities such as 5-year and 10-year bonds are expected to peak in fourth quarter of 2006. In sum, the study finds that there is a presence of cycles in the domestic interest rates in India, following international rates, and we have to learn to live with it. This trend may be same in most of the emerging market economies in Asia.

Introduction

In the era of globalization and stabilization, one of the macroeconomic variables that has come into greater focus is the interest rate. This is consequent upon a strengthened integration of the domestic financial sector with the external sector. As there is a slackening of restrictions in the cross movement of capital across

the countries, this has affected the behavior of domestic variables, particularly the interest rates. This has led to the emergence of a new interest rate channel through which the policy shocks can be transmitted to attain the growth objective. The channel has become more significant and stronger in most of the emerging economies in recent years, depending on the degree of openness of their capital account. Further, this has weakened/replaced the traditional terms of trade shocks that used to be prominent in a closed economy scenario and has also made the domestic financial markets vulnerable to the international shocks/cycles. Hence, any changes in the interest rate/monetary policy in the World (or largest) economy would affect the domestic financial market with a significant lag.

In India, the financial sector has undergone many changes since the stabilization program initiated in the early 1990s. With financial liberalization in the economy, flexibility has been imparted to the movement of interest rates. This is supposed to be a good sign for the economy as it is expected to enhance the efficiency in the financial system and thereby leading to the achievement of a higher growth rate. This policy stance is mostly backed up by the position of the monetarist and the financial liberalization school as opposed to the Keynesian school. According to the Monetarists, 'a flexible interest rate policy responds to the changes in the market conditions (demand and supply of credit), thereby enabling the economy to withstand and control the macroeconomic instabilities as an inflexible interest rate policy is prone to macroeconomic fluctuations' (King and Lin, 2005).

Currently, the domestic interest rates have been liberalized to a large extent and, hence, are presently market determined. Inflow of foreign capital in terms of both portfolio (FII) and long-term investments (FDI) has increased, with foreign exchange reserves bulging to almost US $ 140 billion. All these scenarios have made the domestic interest rates (particularly the short-term secondary market yields) more volatile and sensitive to short-term shocks that are generated through capital movements and to both domestic and international news. But the current study tries to investigate whether there are any interest rate cycles observable in India? Are the international interest rate cycles transmitted to the domestic money/financial markets? In other words, whether the movements in

the domestic interest rates are sensitive to the international interest rate cycles? If sensitive, then what is the time lag length? As the Indian economy is neither a fully opened nor a fully closed economy but it has a mix of both the characteristics, hence, it is quite possible that the international interest rate cycles might be transmitted with a long lag, although this may not be sharp. The previous trough in the international interest rate cycle that occurred in the year 2002 has resulted in a downward movement in the Indian interest rate structure. But that downward movement is not as sharp as was witnessed in the World Economy. Jha (2002) explains that in India, interest rates are highly rigid due to the high public debt, high non-performing assets (which were underestimated) and Reserve Bank of India's (RBI) policy of continuous accumulation of foreign exchange reserves. Currently, the international interest rate cycle is moving upwards as the US has already increased their interest rates around 8-10 times with this being followed by a similar increase the United Kingdom and Australia. This upward movement has already put pressure on the domestic interest rates and led to the hike in the short-term interest rates (reverse repo rate) by the RBI in its recent monetary and credit policy. But the concept of interest rate cycle is still new to the Indian financial sector and it will take time for it to adjust and live with the international interest cycles (Tarapore, 2004). Given this situation, the present study tries to identify the determinants of the interest rates and also tries to explore if there is any cyclical movement in the domestic interest rates in India.

Before undertaking a forecasting exercise, it is necessary to identify the model that explains the dependent variable in question. Theoretically, in a closed economy context, the domestic interest rates would be determined by the domestic factors. In a situation with full convertibility in the capital account, domestic interest rates are determined mainly by the foreign interest rates and the expected changes in the exchange rate. Given that the Indian economy would not fall into either of these two extremes, the domestic interest rates might depend on both the domestic as well as international factors. Although Edwards and Khan (1985) have developed an interest rate model for the emerging developing economies, it may not be possible to apply the same as there are many other additional factors (for example forward premium, country risk premium, etc.) that need to be considered in the present situation. But the

possible factors that affect the domestic interest rates can be drawn from their model. These are: foreign interest rates, domestic inflation expectations, exchange rate expectations, money supply, income, forward premium, risk, yield spread, credit disbursement, foreign institutional investments and policy shocks.

In the Indian context, there are a few studies that have attempted to examine the determinants of interest rates. Dua and Pandit (2002) have found that the foreign interest rates play a major role in determining the interest rates in India. Bhanumurthy and Agarwal (2003) showed that the Fisher relation is still valid in the Indian context and interest rates adjust to the expected retail market prices rather than to the wholesale market price. These two contrasting results show that in India, the interest rates depend on both domestic and foreign factors. Dua et al. (2003) in their subsequent study tried to forecast the behaviour of different short-term interest rates through the use of various time series models viz BVAR, ARIMA and ARCH/GARCH. From the empirical evidence, they observed that multivariate models do forecast well for long-run horizons while univariate models do forecast well for short-run horizons. But one lacuna of this study is that it does not examine the possible cyclical behaviour in the interest rate at least in the recent periods where the rates are deregulated to a greater extent. In this study, we examine the possible cyclical movements in various secondary market yields. If a cyclic behaviour is found, then the series is decomposed into trend and cyclical components and modeled separately. The interest rates considered for modeling and the related independent variables are discussed in the next section.

Following the literature, we have specified a general interest rate model presented below.

R = f (ERF/FPRM, GWPIF, R*, FII, SPY, GIIP, GBC/GM3/RESGM3)

　　　　　(-/+)　　　(+)　　(+)　(-)　(+)　(-)　　(-)

Where,

R - Domestic Interest Rate,

ERF – Expected Exchange Rate,

GWPIF - Expected Inflation Rate

FPRM - Forward Premium,

R* - Foreign Interest Rate,

FII - Foreign Institutional Investment,

SPY -Yield Spread,

GIIP - Growth Rate of Output,

GBC - Growth Rate of Gross Bank Credit,

GM3 - Growth Rate of Broad Money Supply,

RESGM3 - Growth Rate of Surprise Broad Money Supply.

The signs in parentheses show the expected signs of the variables. If depreciation in the exchange rate is expected in the future, it is likely to exert a negative impact on the domestic interest rate. Given the fact that there is a depreciation of the domestic rupee against the US dollar, there will be more demand for the dollar. The greater demand for the dollar resulting in inflow of foreign currencies will lead to expansion of the money supply and a consequent fall in the domestic interest rates in the economy. It is also generally argued that when there will be a fall in the value of the domestic currency, there will be less demand for domestic bonds, leading to a fall in the price of bonds and a consequent rise in the interest rates. In the same way, forward premium (FPRM) is also likely to exert a negative impact. The expected inflation rate (GWPIF) is likely to have a positive impact on the nominal interest rates. Otherwise, any rise in the expected inflation rate would bring down the real interest rates and consequently that would distort savings and investment in the economy. The foreign interest rate (R*) would have a positive impact. Unless domestic interest rates move up with the international interest rates, there would be an outflow of capital from the domestic country, and result in the advent of a crisis in the external sector of the economy. Domestic yield spread (SPY) would be positively related to the domestic interest rates, because the short rates follow up the movements in long rates. Otherwise, it would distort the financial market. The growth rate of the economy would have a negative impact because an increase in income has implications for the expansion of money supply, adversely affecting the interest rates. The growth of broad money supply (GM3), gross bank credit (GBC) and money surprise (RESGM3) lead to reduction in the interest rates which is based upon the Keynesian and the Neo-classical arguments.

Database

The interest rates considered for the study are Call Money Rate, 15-91 days Treasury Bill rate, and yields on 1, 5 and 10 year Government of India Securities. Regarding independent variables, the inflation rate is calculated from the Wholesale Price Index (WPI). Foreign interest rate is proxied by the LIBOR rate, Federal short-term Treasury bill rates of 3-month and 6-month maturity while for the policy shocks, we consider the RBI's Bank Rate and the US Federal Funds Rate. For yield spread, we consider the difference between domestic long-term yield and short-term yields. Foreign institutional investments are considered to capture the short-term shocks to liquidity in the money market and, hence, on the yields. Finally, both inflationary and exchange rate expectations are estimated by using the univariate models.

The analysis is based on monthly data covering the period from 1996:04 to 2005:03. The data on domestic interest rates and all the related domestic financial variables are collected from the 'Handbook of Statistics on the Indian Economy (RBI, 2005)' and various issues of Monthly Bulletin of the Reserve Bank of India. The only real variable, output, as measured by the index of industrial production (IIP) is collected from the Central Statistical Organization (CSO). We have considered IIP as a proxy for the overall output in the economy as the data on GDP is not available at a monthly frequency. The data on the foreign interest rates are collected from the Federal Reserve Bank of US's site. As mentioned above, the expected exchange rate (US dollar in terms of Indian rupees) and inflation rate do play roles in the determination of the domestic interest rates. The expected rates are calculated from the estimation of their respective univariate autoregressive process. It is perceived that besides the money supply, it is the money surprise or unanticipated money supply that can influence the interest rates in the economy. The money surprise is derived from the residuals of univariate autoregressive distributive process of broad money supply (M3). The study uses two alternative interest rate spreads; one, is computed by subtracting the yield on 15 to 91 days treasury bills from the 10-year yield on Government of India's securities and the second is by subtracting call money rate from the same (10-year yield on Government of India securities).

To capture the impact of the forward market rate and gross bank credit, the data on both are directly taken from the monthly bulletin of the Reserve Bank of India.

Before empirically examining the determinants of interest rates, the current section analyses the behaviour of domestic interest rate movements in the economy.[1] The short-term interest rates plotted in Figure 1 show that there is a downward trend of both call money rate and the 15 to 91 days Treasury bill rate. It may be noted that in the initial years although there were some deviations between the two rates, in the latter period both are moving closely. The medium term and long-term rates on Government of India securities as shown in Figure 2 also show a declining trend. It may be noted that in the more recent period, all the interest rates have started to show an upward trend. What then are the factors that are leading to current rise in the yields. Is it due to domestic factors or a response to the changes in the global financial market? This issue is empirically explored while examining the determinants of interest rates in India. In the subsequent section, we discuss the methodology for the analysis and forecasting.

Methodology

For investigating the determinants of interest rates in India, this study follows the cointegration approach. This is for the reason that the empirical research on macroeconomic relationships, particularly when dealing with relatively higher frequency data, would generally face the problem of non-stationarity. This constrains the researchers in using traditional econometric tools like the OLS, 2SLS, etc. To solve the problem of non-stationarity, as a strategy the cointegration approach has been developed (Engle and Granger 1987; Johansen 1988). The cointegration methods have been extensively used in the literature over the last two decades in testing the long-run relationships. But these methods suffer from some drawbacks. The basic condition for cointegration analysis is that the variables in the system should be non-stationary at levels and stationary of the same order. (The unit root tests that exist in the literature would be used to determine the order of integration of the variables.) But quite often

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[1] For details regarding the policy changes with respect to interest rates in India, see Appendix-2

researchers face the problem that the results derived from the existing unit root tests would differ depending on the power of the test. As a consequence, some test statistics might be falling in the region of acceptance/rejection border. Given this problem, in employing the cointegration technique, there exists scope for bias in choosing the unit root tests that give the same order of stationarity for all of the variables in the system. Further researchers also face the problem of variables with a different order of integration. Therefore, it limits the use of commonly used (traditional) cointegration analysis.

To overcome such a problem, Pesaran, Shin and Smith (2001) devised a bounds testing autoregressive distributed lag (ARDL) approach to cointegration that ignores the order of integration of variables. This ARDL-bounds testing method can be applied for testing any long-run relationships irrespective of the variables whether they are stationary at the same or different order. The technical details regarding the ARDL model and its bounds test method are presented in Appendix-1.

In the next stage, we discuss a framework for forecasting the interest rate cycle. Most of the studies on interest rate forecasting either followed a macro-econometric model or the pure time series model, depending upon the frequency of the data. But as the short-term interest rates and their forecasting depend more on short-term macroeconomic variables, it is not possible to construct a macro-econometric (simultaneous equation) model. Further, as the variables exhibit some sort of cyclical behaviour, it is not appropriate to apply time series models without separating the cyclical and trend components from their observed series. Hence, in this study, we decompose the series into trend and cyclical components and then use appropriate forecasting techniques.

In any econometric exercise, first it is important to establish the time series properties of the data. For this purpose, with the help of ADF and PP tests, we examine whether the variables in question are stationary or non-stationary. In the next stage, depending on the time series property, we decompose the series into permanent (trend) and transitory (cyclical) components. If the series is stationary, we follow the Hodrik-Prescot filter (1997). But if the series is non-stationary, we

follow the procedure developed by Beveridge and Nelson (1981), which is discussed subsequently.

Beveridge-Nelson Procedure

Real macroeconomic time series variables are often decomposed into a deterministic secular trend, a cyclical, and an irregular component. The deviation around the trend forms a cyclical pattern and is ascribed as business cycle in the literature. A typical economic cycle has a phase of upturn leading to the peak, followed by a downturn ending up in a trough. To arrive at cycles, a real macroeconomic time series is detrended by subtracting the trend value from each actual observation and the irregular component in the detrended series is smoothened by a 3-year or 5-year moving average. Even though it is a popular method, it assumes that the variable is trend stationary. This is often not the case, as a macroeconomic time series is often stochastic (random walk with a drift). Further, incorporating a deterministic trend in a series with unit roots often results in a misspecification error and the coefficients are statistical artifacts in the presence of non-stationary error term (Enders 1995). Apart this, the forecast function of a trend stationary model does not depend on current or past events. Thus, when the trend part is stochastic (random walk with drift) then this procedure is not appropriate. There are alternative methods of decomposition when the series has a stochastic trend. One such method is the Beveridge and Nelson (1981) decomposition method.

Beveridge and Nelson (1981) have developed a procedure to decompose a series into permanent and transitory components. As the decomposition procedure is useful only when the series is non-stationary at levels and stationary at first differences, let y_t be a non-stationary series. In the first stage, we estimate the first differences of y_t by using the Box-Jenkins method. Then the appropriate ARMA model would be fitted and let that be a ARIMA(0,1,2). This can be expressed as below.

$$\Delta y_t = a_0 + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} \tag{1}$$

In the next stage, after estimating β, and a_0 we obtain the in-sample forecasts of each observation of y_t and also the forecast errors, ε_t. With the help of estimated parameters and the forecast errors, one can estimate the irregular component of the y_t series as

$$C = -(\beta_1 + \beta_2)\varepsilon_t - \beta_2\varepsilon_{t-1} = y_t - \mu \qquad\qquad (2)$$

where, μ is a stochastic trend component in y_t.

Hence, the non-stationary series y_t is decomposed into the stochastic trend (or permanent) component (μ) and the irregular (or transitory) component (C). Here the irregular component is a stationary series and the permanent component would be non-stationary series.

After decomposing, we try to generate the out-of-sample forecast for the y_t series. For this purpose, we consider the trend/permanent component and the irregular/transitory component separately. First, we examine the time series properties of both the series and fit a suitable univariate model for both the series separately for the best fit. In the next stage, we estimate the *t+1* value of μ and C. By adding these two values we get the necessary forecast value, i.e., $\hat{y}_{t+1}$.

In this study, we use this decomposition method to forecast the various secondary market interest rates in India. In the first stage, by using equations (1) and (2), all the interest rate series are decomposed into permanent and transitory components. After deriving the decomposed series, in the next stage, by looking at the autocorrelation functions (ACFs) and partial autocorrelation functions (PACFs), appropriate univariate models are used to forecast these series separately.

But one of the limitations of the forecasts based on this univariate-decomposed series could be that it does not take the exogenous variables into consideration while forecasting. As the behaviour of macroeconomic variables might depend on other variables in the system, the forecasts based on the univariate model

possibly might not be robust. Hence, to overcome this limitation, we forecast the transitory component with the help of some macro variables. For this purpose, we select the variables based on theory. We use the principle component analysis to generate factors that explain the maximum variance of all the possible variables. This also reduces the degrees of freedom problem in forecasting. With the help of these generated factors we forecast the transitory components with the help of the Vector Autoregression (VAR) model. The permanent component would be forecasted by using the appropriate univariate model. The lag length for the VAR model would be determined with the help of Schwartz Bayesian Criterion (SBC). However, for an appropriate forecast, we have allowed flexibility in using univariate and multivariate techniques. In the next section we discuss the results.

Result Discussion

The correlation matrix presented in Table 1 shows that all the domestic interest rates except the call money rate (which has a weak relationship), are significantly correlated with the foreign interest rates and the exchange rate. While foreign interest rate has a positive relationship, the exchange rate has a negative relationship. However, it is surprising to observe that the inflation rate is not correlated with any of the nominal yields. Besides inflation rate, the other financial and real variables also do not exhibit a significant association with the domestic interest rates. As the correlation coefficients do not capture the lead-lag and cause-effect relationships between the variables, one needs to carry out modelling exercise to examine the issues very clearly.

Table 1: Correlation Matrix of Domestic Interest Rates with Different Related Financial and Real Variables

	ER	FII	FTBR3	FTBR6	LIBR3	GBC	GIIP	GWP
LIBR3	-0.63	-0.36	1.00	1.00	1.00	0.03	-0.09	0.13
YIELD1	-0.63	-0.41	0.92	0.91	0.92	-0.07	-0.17	0.01
YIELD10	-0.72	-0.43	0.92	0.92	0.92	-0.17	-0.24	0.01
YIELD5	-0.77	-0.38	0.91	0.91	0.91	-0.16	-0.13	0.00

Y1591	-0.41	-0.37	0.78	0.77	0.77	0.10	-0.05	-0.01
CMR	-0.12	-0.28	0.49	0.48	0.48	0.11	0.02	-0.05

While modelling through the time series analysis, for an appropriate time series analysis, one requires to know the time series properties of all the variables under consideration. Application of Augmented Dickey-Fuller test, for which the results are presented in Table 2, shows that Y5, Y10, FII, GIIP and GWPI are stationary in levels. The variables such as Y1591, Y1, ER, FPRM, FTB3, FTB6, and LIBR3 although non-stationary in levels but are found to be stationary in their first differences. Subsequently, the application of Phillips-Perron test confirms the similar property of the variables. This shows that there is a presence of mixture of both I(1) and I(0) variables.

After confirming the presence of I(0) and I(1) variables, we have applied the ARDL approach to cointegration with different sets of variables along with the presence of domestic interest rates as the dependent variable. Below we present the results for the models, which have cointegration relationship. Table 3 presents the F-test for cointegration and the long run coefficients of the corresponding cointegrating models. The F-statistics presented below show that all the statistics cross the upper band of the critical values as tabulated by Pesaran et al. (1999), rejecting the null of no cointegration in all the models. This implies that there exists a long-run relationship among the variables in the respective models. After ensuring the presence of cointegration, we have estimated the long-run coefficients. The R-Bar square for the long-run estimates shows that all the models are best fitting the data. They explain around 70 to 98 percentage of variation in the dependent variable.

Table 2: Unit Root Tests

Variables	ADF test		Philips-Perron test	
	In Levels	In Difference	In Levels	In Difference
Y1591	$-3.09(2)^T$	$-8.42(2)^N$	$-4.38(2)^T$	$-14.86(2)^N$
Y1	$-2.77(1)^T$	$-9.97(1)^N$	$-3.08(1)^T$	$-11.83(1)^C$
Y5	$-2.02(1)^N$		$-2.11(1)^N$	
Y10	$-2.13(1)^N$		$-2.14(1)^N$	
ERF	$-1.99(1)^C$	$-4.55(3)^N$	$-2.51(1)^C$	$-7.56(3)^N$
CMR	$-5.09(1)^T$		$-5.09(1)^T$	

FPRM	-2.59(3)^{T}	-7.02(2)^{N}	-3.93(3)^{T}	-7.59(2)^{N}
FII	-3.36(4)^{I}		-6.51(4)^{I}	
GIIP	-3.80(1)^{T}		-4.50(1)^{T}	
GWPIF	-3.30(1)^{C}		-2.73(1)^{C}	
FTBR3	-1.05(3)^{N}	-2.91(3)^{C}	-1.10(3)^{N}	-6.50(3)^{N}
FTBR6	-1.40(3)^{N}	-2.97(3)^{C}	-1.07 (3)^{N}	-6.30(3)^{N}
LIBR3	-1.02(3)^{C}	-2.77(3)^{N}	-1.05(3)^{N}	-5.50(3)^{N}

Note: The critical values at 1%, 5% and 10% are -3.494, -2.889 and -2.581 for with intercept but no trend and -4.049, -3.453 and -3.152 for with trend but no intercept and -2.587, -1.943 and -1.617 for no trend and intercept, respectively. The lag lengths for the tests are selected according to the minimum of AIC statistics. The trend and constant terms appear, when they are significant.

Where, T- refers to with trend and intercept, C- refers to no trend but with intercept while N -refers to no trend and intercept.

GIIP - Growth Rate of Index of Industrial Production
FPRM - Forward Premium
ERF - Expected Exchange Rate
GWPIF - Expected Inflation Rate
CMR - Call Money Rate
GM3 - Growth Rate of Broad Money Supply
FII - Foreign Institutional Investment
FTBR3 - 3 monthly Federal Reserve Treasury Bill Rate
FTBR6 - 6 Monthly Federal Reserve Treasury Bill Rate
LIBR3 - 3 Monthly Libor Rate for US Currency
Y1 - Yield on 1-Year Government of India Securities
Y5 - Yield on 5-Year Government of India Securities
Y10 - Yield on 10-Year Government of India Securities
Y1591- Yield on 15 to 91 days Treasury Bill
SP1591 - Yield Spread

The long-run estimates of the ARDL model shows that while the expected exchange rate, expected inflation rate and foreign institutional investment exert a negative influence the 6-monthly Federal Treasury Bill rate and the Spread rate however, exert a positive influence on the call money rate. The real output, and the money surprises do not have any significant impact. It is also noticed that by replacing the money surprise with the growth of broad money supply and considering either the Bank Rate or the Federal Funds Rate as exogenous policy variable in the system, the estimation strategy does not improve on the estimates. But when the 3-monthly Federal Treasury Bill rate is alternatively replaced either with the 6-monthly Treasury Bill rate or 3-monthly LIBOR rate, the sign of the estimates remain unchanged. They continue to exercise a positive influence on the call money rate.

Considering the yields of 15 to 91 days Government of India's treasury bill as the dependent variable in the system, it is seen that the real output has emerged to have a negative influence along with the continuance of the negative influence of the expected exchange rate and foreign institutional investment and the positive influence of 3-monthly Libor rate and interest rate spread. Other variables, such as expected inflation rate and replacement of forward premium with the expected exchange rate variables do not produce any significant impact on the yields of 15-91 days Treasury bill. Similar to the above result, it is also seen that incorporations of either Bank rate or Federal Fund's rate, as an exogenous variable do not improve the significance of the estimates. The result remains invariant to the incorporation of alternative interest rate spread variables.

In contrast to the above results, which considered short-term interest rates; if one considers the medium term rates, it is seen that yield on 1-year Government Security is negatively influenced by the expected exchange rate, foreign institutional investment and positively influenced by the 3-monthly LIBOR rate and the interest rate spread. Other variables do not play any important role in determining the annual yields on the Government of India security. In the case of 5-yearly Government of India Security, it is the only expected exchange rate that has shown a significant and adverse impact on its yield (Y5).

Further, as regards the above results on short and medium term interest rates, when one considers yield on 10-yearly Government of India's Security as a dependent variable, it is found that while the expected exchange rate, and foreign institutional investment are consistent in exerting an adverse impact, the 3-monthly LIBOR rate is consistent in exerting a positive impact. The inclusion of other variables except the alternative replacement of foreign interest rates does not improve the results. All the foreign rates whether it is the 3-monthly or 6 monthly Federal Treasury Bill rate or 3-monthly Libor rate, these continue to exert a positive impact on the domestic interest rates in India. This corroborates the findings of Dua and Pandit (2002). Looking at the error correction results, it shows that while short-term rates in the subsequent period adjust at a faster rate

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to any deviations from their equilibrium position in the previous period, the long rates adjust to the disequilibrium very slowly to return to their equilibrium position.

Table 3: Estimated Long-Run Coefficients Using ARDL Approach to Cointegration

	CMR	Y1591	Y1	Y5	Y10
GIIP	-1.48 [-1.27]	-.33 [-6.73]*			
ERF	-.371 [-4.20]*	-.29 [-5.87]*	-.24 [-2.42]*	-.43 [-2.45]*	-.34 [-2.05]**
GWPIF	-.323 [-2.81]*		-.098 [-.77]		
LIBR3		.91 [16.27]*	1.02 [7.50]*		.92 [5.11]*
FTBR6	1.14 [8.12]*			0.97 [12.48]*	
FII	-.006 [-1.68]***	-.0009 -[4.14]*	-0.008 [-1.85]**		-.001 [-1.69]***
RESGM3	-.18 [-.97]	-0.019 [-.23]			
GM3				-.12 [-.26]	.22 [1.48]
SP1591	1.76 [8.76]*	1.29 [10.69]*	.52 [3.02]*		.64 [1.46]
INPT	25.88 [5.42]*	21.34 [8.06]*	16.44 [3.34]*	28.26 [2.35]*	
ECM$_{-1}$	-.76 [-6.23]*	-.72 [-13.19]*	-.34 [-5.23]*	-0.54 [-2.14]*	-.14 [-2.90]*
R-Bar Square	.70	.92	.95	.98	.98
Cointegration F- Statistic	4.23(2)	3.36(1)	3.59(1)	4.83(2)	3.65(2)

Note: *denotes significance at 1% level; ** denotes significant at 5% level, and *** denotes significant at 10% level. The parentheses relating to the F-statistics of cointegration test indicate the lag lengths considered in the above models.*

From the above, the general conclusion that can be derived is that the expected exchange rate and foreign interest rates do play a significant role in the determination of interest rates in India. The magnitude of the foreign interest rate is higher than the expected exchange rate. While the expected exchange rate exercise an adverse impact, the foreign interest rates have a positive impact on the domestic rates. The negative impact of the expected exchange rate on domestic interest rates could be explained in that when we expect a depreciation of the domestic currency, this leads to a greater demand for foreign currencies. As a result, it gives rise to more inflows of foreign currency and a consequent expansion of money supply in the domestic money market. This exerts a downward pressure on the domestic rates of interest.

The above is also the reason why there is a negative impact of money surprises on interest rates. But surprisingly, the growth rate of bank credit and broad money supply do not play any role in influencing the interest rates in India. The positive influence of the foreign interest rate on domestic interest rate may be due to the competitive character of the financial environment and the central bank's policy decision. It is also seen that while foreign institutional investment has a negative impact on domestic interest rate; interest rate spreads have positive impact on the domestic interest rates. Foreign institutional investment's negative influence on the domestic interest rate has the same reasoning as in the case of the impact of depreciation of domestic currency on the domestic interest rates. The more is the foreign institutional investment; the more is the expansion in the level of money supply putting a downward pressure on the interest rate in the economy. The interest rate spread has a direct relationship for the reason that when interest rate on long-term maturity goes up, the short-term yields follow. The output variable has an adverse impact only on the yields of 15 to 91 day treasury bills while the expected inflation rate has an adverse impact only on the call money rate. Overall, it is found that the magnitude of impact of the interest rate spread is higher than that of any other variable (surprisingly, except the expected inflation rate in one case) irrespective of other domestic or foreign variables. And among the foreign variables, it is the foreign interest rate, which has a greater impact in terms of its magnitude.

Forecasting of Indian Interest Rate Cycle

As specified in the methodology section, this study tries to forecast the various interest rates in a different way compared to Dua et al. (2003). In the first stage, the actual observed series is decomposed into permanent and transitory components by using B-N procedure or through the H-P filter, depending upon the nature (stationary or non-stationary) of the series. As we found that Y1591 and Y1 are non-stationary and others are stationary variables (see Table 2), therefore, Y1591 and Y1 are decomposed through the B-N procedure. The permanent and transitory components are shown in Figure 3 and Figure 4. The other variables are decomposed through the H-P filter and are presented in Figure 5, Figure 6 and Figure 7. It may be visualized from the graphs that there is

no clear cyclical behaviour in the transitory components. The volatility has declined since the beginning of 1999. In Figure 8 transitory components of both Indian and foreign interest rates show that after 1999 the movements of these interest rates are moving closer, if not at the same level. This supports our earlier results that off late domestic interest rates are responding more to the movements in foreign interest rates.

The permanent and transitory components are forecasted separately. The forecasting models are presented in Tables 4 and 5. It may be noted that both transitory and permanent components of the non-stationary series (Y1591 and Y1) are predicted by using VAR models as the VAR model is found to give a better fit. For the stationary series such as Y10 and Y5, VAR models are used to predict the transitory components while univariate models are used to predict the permanent components. This is because the transitory components showed high volatility, which cannot be predicted using univariate models. In the case of CMR, although both VAR and univariate models are not robust, the univariate models are found to perform better as compared to the VAR models. Hence, both transitory and permanent components of CMR are predicted using univariate models. Here, for VAR models we are only presenting F-statistics, adj-R^2 and RMSE as the coefficients of individual variables are not important. Rather, a collective significance (from F-statistic) of all the variables present in the model is very important.

Table 4: Univariate Models Used for Interest Rate Forecasting

Dependent → Independent ↓	CMRP	CMRT	Y10P	Y5P
INPT	7.64 (13.93)*		3.79 (2.92)*	-0.06 (-2.83)*
AR(1)	1.96 (163.43)*	0.64 (16.32)*	0.65 (4.78)*	1.91 (52.61)*
AR(2)	-0.97	-0.90	0.33	-0.95

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	(-81.38)*	(-29.98)*	(2.46)*	(-25.73)*
MA(1)	1.66	-0.62	1.67	1.17
	(30.62)*	(-30.16)*	(28.05)*	(13.44)*
MA(2)	0.84	0.98	1.09	0.53
	(15.49)*	(1850.65)*	(24.54)*	(6.00)*
R-Bar Square	.99	0.12	0.99	0.99

Note: The suffix P and T in each variable denotes permanent and transitory components. '*' Indicates significant at 1 % level.

Table 5: Multivariate (VAR) Models Used for Interest Rate Forecasting

Model (lag length)	F-statistics	Adj R^2	RMSE
Y1T, FD1, FD2, FD3, FF1 (2)	3.6756*	0.27	0.19
Y1P, FD1, FD2, FD3, FF1 (2)	72.4855*	0.87	0.82
Y1591T, FFD1, FFD2, FFD3, FFD4 (2)	2.1473**	0.14	0.47
Y1591P, FD1, FD2, FD3, FF1 (2)	15.5075*	0.60	1.32
Y10T, FD1, FD2, FD3, FF1 (2)	10.6971*	0.47	0.29
Y5T, FD1, FD2, FD3, FF1 (2)	10.402*	0.46	0.32

Note: The suffix P and T in each variable denotes permanent and transitory components. '*' and '**' represents significant at 1 % and 5 % level respectively.

As explained in the earlier section, there are a number of possible factors that explain the domestic interest rates. For any modeling purpose, it is not possible to include all the variables at a time, although all are important. Hence, to overcome such problem, the study reduces all the possible domestic variables into three factors (FD1, FD2, FD3), which explains a 71.6 percent variation, by using the principle component approach. In the case of three foreign variables, we derived one factor (FF1) that explains 99.3 percent of variation in all the three variables. We have derived the factors separately for the domestic and foreign variables basically to examine the effects separately. Further, by mixing both domestic and foreign variables, we derived four factors (FFD1, FFD2, FFD3, FFD4) that explain a 76 percent variation. With the help of these factors and by using the Vector autoregression model, we predicted the interest rates. The order and structure of VAR models are chosen based on the predictive power in terms of low root mean square error (RMSE). For all the yields, the model consisted both domestic and foreign factors. In the case of CMR only, the model with

domestic factors showed low RMSE. The actuals and forecasts are provided in Figures 9 to Figure 13.

It may be noted from Figure 9 to Figure 13 that the fitted models accurately predict the in-sample behaviour (including the turning points) of all interest rates, except in the case of CMR. The long cycles that we found in the yields are also captured reasonably well. Given this performance of the models, it may be said that the out-of-sample forecasts can be robust. From the out-of- sample forecasts, it appears that the movement of interest rates would be upward from now onwards. This is in consonance with our view that the domestic yield rates respond majorily to the foreign rates, although with a significant lag. (From our VAR results it was found that it takes 5 to 6 months for the domestic interest rates to fully respond to movements in the foreign interest rates). Currently, as the foreign interest rates are already moving up, our prediction of a rise in domestic interest rates is highly feasible and also robust. Regarding the question of the time and peaks in the level of future interest rate cycles, our results predict that there will be peaks in each of the interest rates at different points of time. Yield on the 15 to 91 day t-bills is expected to peak sometime in the first quarter of 2006; one year yield is expected to peak in the second quarter of 2006; yields on long term securities such as 5-year bond and 10-year bonds are expected to peak in the fourth quarter of 2006. For the call money rate, as in the case of in-sample, the out-of-sample forecasts are also very volatile. Also, as there is no clear-cut cycle in the series, it is quite difficult to find out at what level it is going to peak. Further, as the call money rate depends on various factors other than the macroeconomic fundamentals, it may be difficult to predict its future behaviour, particularly with a high frequency data.

Conclusion

The present study tries to examine the behaviour of various Indian interest rates such as call money rate, and yields on secondary market securities with maturity periods of 15 to 91 days, 1-year, 5-years and 10-years. In the first stage, the study investigates the determinants of interest rates and finds that although the

interest rates depend on some domestic macroeconomic variables such as yield spread and expected exchange rate, they are primarily affected by the movement of international interest rates, although with a significant lag. The policy variables such as Bank Rate and Federal Funds Rate did not show any significant impact on any of the interest rates. The forecasts show that, except the call money rate, all yields are expected to move upwards following the upward movement of the international interest rate. Further, our results show peaks in each of the interest rates at different time points. The yield on 15 to 91 day t-bills is expected to peak sometime in the middle of 2006; the one year yield is expected to peak in the third quarter of 2006; yields on long-term securities such as 5-year and 10-year bonds are expected to peak in the fourth quarter of 2006.

The interest rate downturn, as witnessed since the year 2000, seems to have ended in the middle of 2004. The upturn in the interest rates on Government Securities started in the recent period is now likely to continue for at least about two years. However, as reflected from its observed movement, it may taper off at a peak much lower than the recorded during the high interest rate regime in mid-1990s'. This may be because the government is adhering to its fiscal discipline norms as set out in its Fiscal Responsibility and Budget Management Act (2003-04) for achieving its targets in 2008-09. But three reasons can be cited which might have contributed to the upward movement of domestic interest rates in the recent years. First, the real interest rate seems to have reached the floor during the industrial slow down of the early 21st century. There was only one possible way to move from there on. Secondly, the industrial recovery from about 2003 onwards together with the rising international oil prices generated a rising inflationary expectation which has also contributed to this upturn in the interest rates. Finally, the persistence of a high fiscal deficit and the limit to the RBI sterilization policy option has led to an increase in supply of government securities corresponding to the demand. To some extent, the upturn is restrained by easy liquidity created by the influx of foreign capital, especially in the form of portfolio investments in government securities. The cyclical movement in the interest rate during the market regime is not unexpected. It is also to be noted that the floor of the interest rate in a developing country like India is expected to be higher than that in rich countries with a surplus capital.

One obvious policy implication of this is that the soft interest rate regime witnessed during the late 1990s and the early 21st century is now over. The government would have to, therefore, borrow at a comparatively higher cost, which means the government (both centre and state level) would have higher interest costs on fiscal deficit. Second, the PLR on bank credit to the private sector is now unlikely to go down because of the hardening of the interest rates of Government Securities. The banks may have to, therefore, improve the operational efficiency to restrict the rise in PLR. Finally, the integration of interest rates in India, especially the yields on both short and lon-term Government Securities, with the global interest rates imply that the Indian financial system will now have a cyclical movement along with the global cycles. Hence, the Indian financial markets cannot remain immune to global financial system. The policy makers, therefore, have to take note of this in their monetary and fiscal policy operations.

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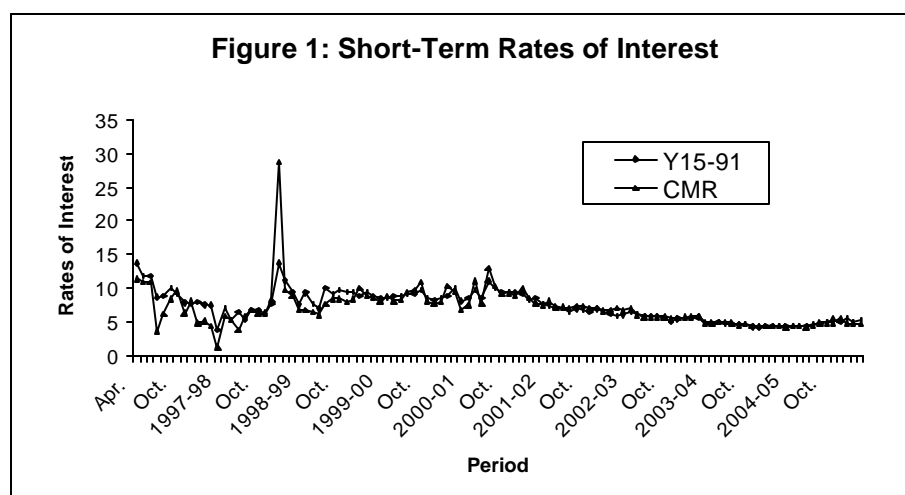
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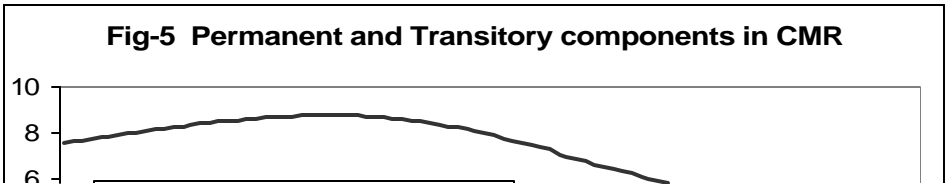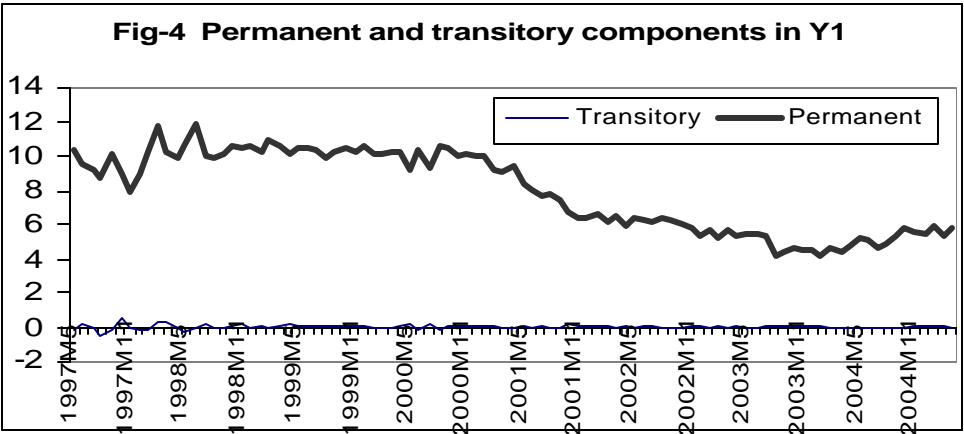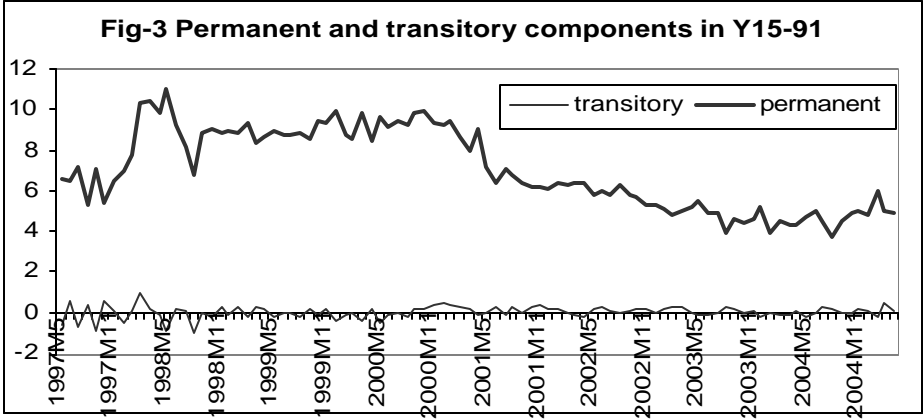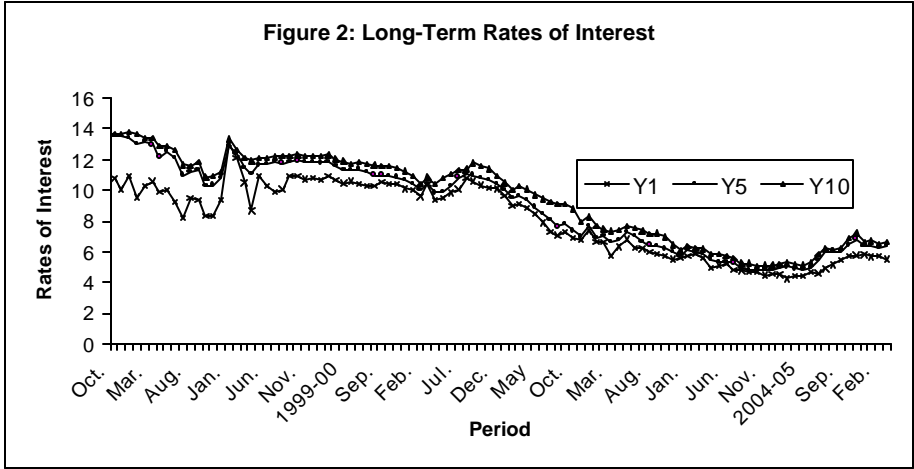
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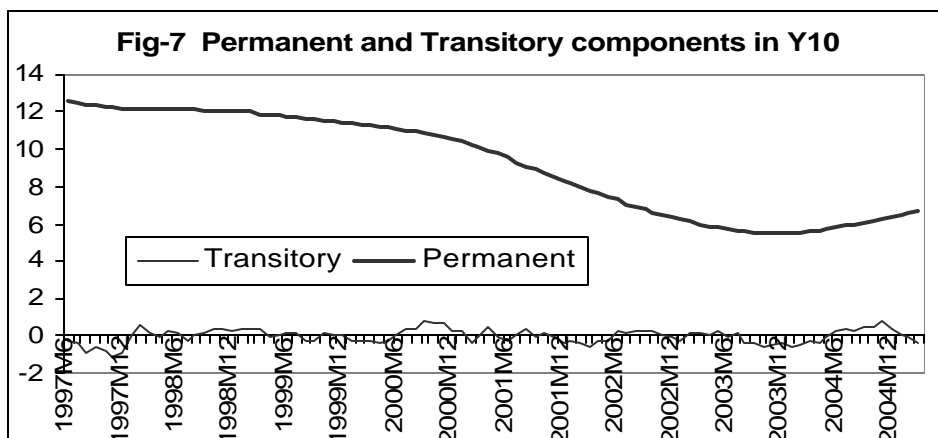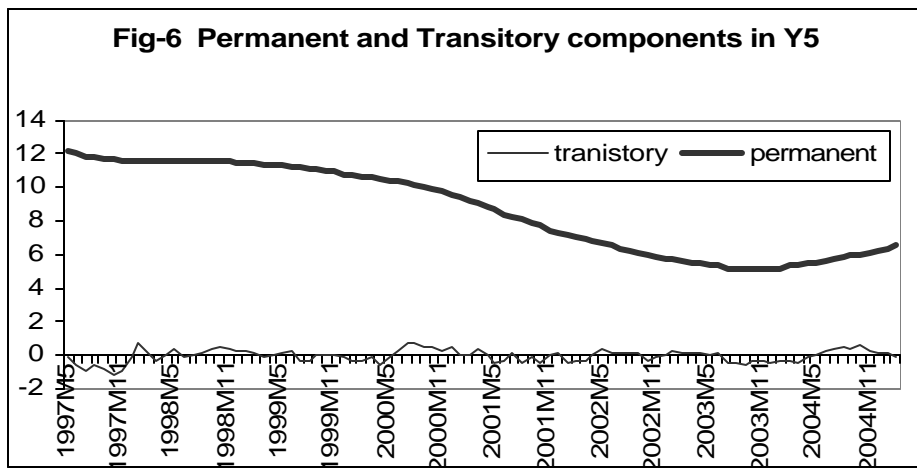
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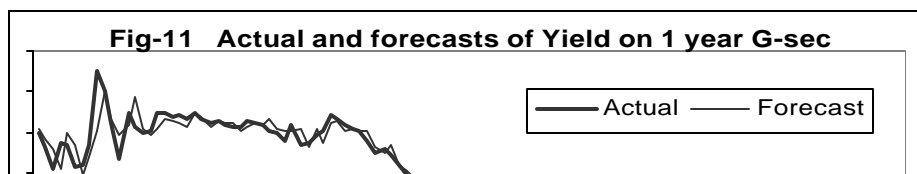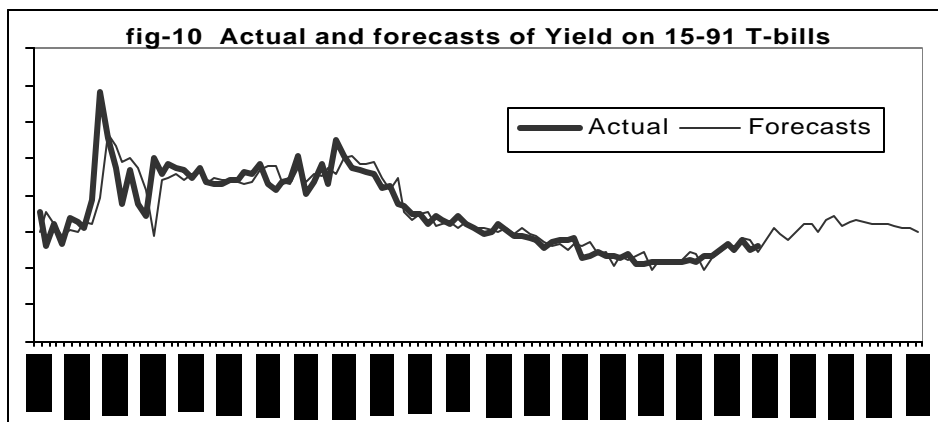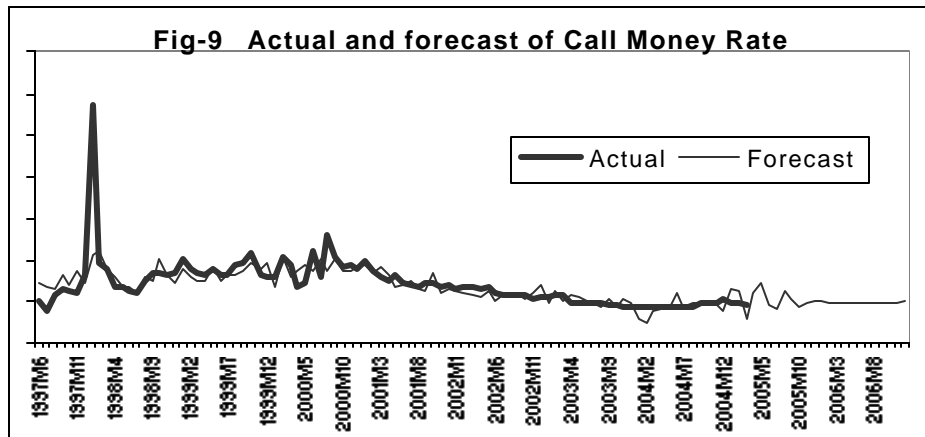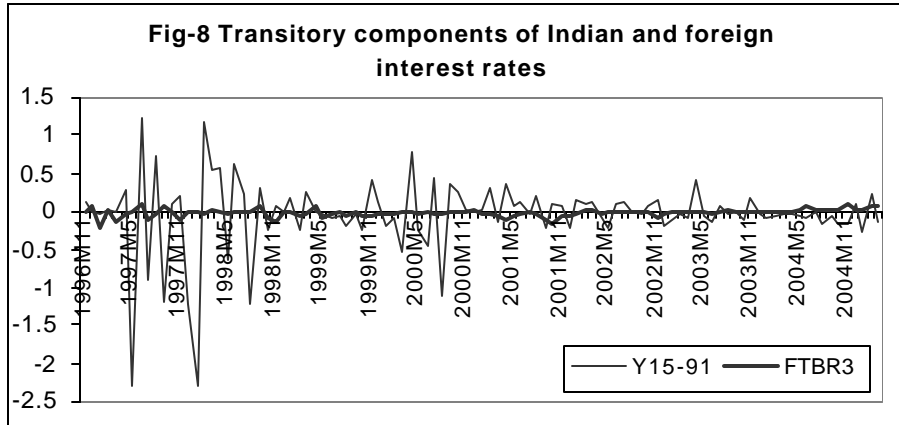
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Figure 1: Short-Term Rates of Interest

Figure 2: Long-Term Rates of Interest

Fig-3 Permanent and transitory components in Y15-91

Fig-4 Permanent and transitory components in Y1

Fig-5 Permanent and Transitory components in CMR

Fig-6 Permanent and Transitory components in Y5

14
12
10
8
6
4
2
0
-2

tranistory   permanent

1997M5
1997M11
1998M5
1998M11
1999M5
1999M11
2000M5
2000M11
2001M5
2001M11
2002M5
2002M11
2003M5
2003M11
2004M5
2004M11

Fig-7 Permanent and Transitory components in Y10

14
12
10
8
6
4
2
0
-2

Transitory   Permanent

1997M6
1997M12
1998M6
1998M12
1999M6
1999M12
2000M6
2000M12
2001M6
2001M12
2002M6
2002M12
2003M6
2003M12
2004M6
2004M12

Fig-8 Transitory components of Indian and foreign interest rates

Fig-9   Actual and forecast of Call Money Rate

fig-10 Actual and forecasts of Yield on 15-91 T-bills

Fig-11   Actual and forecasts of Yield on 1 year G-sec

Fig-12 Actual and forecast of Yield on 5 year G-sec

Fig-13 Actual and forecast of Yield on 10 year G-sec

Appendix -1

ARDL Approach to Cointegration:

Let the unrestricted two variable VAR model in levels be;

$$x_t = m + \sum_{j=1}^{p} \Phi_j x_{t-j} + e_t \tag{1}$$

where x_t is a (x_{1t}, x_{2t}), ì is vector of intercept and Ö is a matrix of unknown coefficients. And $e_t \sim IN(0, Ù)$ where 'Ù' is a positive definite matrix.

This procedure also assumes that both the series be purely I(1), or purely I(0) or cointegrated but excludes the possibility of seasonality roots and explosive roots.

Equation (1) can be expressed in the vector equilibrium correction model form in terms of long-run multiplier matrix and the short-run response matrix as below.

$$\Delta x_t = A + I x_{t-1} + \sum_{j=1}^{p-1} g_j \Delta x_{t-j} + e_t \tag{2}$$

where Ä=1-L is the difference operator, and the short-run coefficient matrix is :

$$g_j = \begin{bmatrix} g_{11} g_{12} \\ g_{21} g_{22} \end{bmatrix} \dots \tag{3}$$

The long-run coefficient matrix would be $I = \begin{bmatrix} I_{11} I_{12} \\ I_{21} I_{22} \end{bmatrix} = -(I_k - \sum_{j=1}^{p} \Phi_j)$

$$\dots \dots \dots \dots \tag{4}$$

Since the procedure focuses on conditional modeling of the scalar variable, x_{1t}, we may express $å_{2t}$ conditional in terms of $å_{1t}$ as;

$$å_{2t} = w_{12} \Omega_{22}^{-1} e_{2t} + u_t, \tag{5}$$

where $u_t \sim IN(0, w_{uu})$, $w_{uu} \equiv w_{11} - w_{12}\Omega_{22}^{-1}w_{21}$, and u_t is independent of $å_{2t}$

Substituting equation (5) in (2), we get a conditional model for Δx_{1t} as,

$$\Delta x_{1t} = A_1 + I_{12} x_{t-1} + \sum_{j=1}^{p-1} j'_j \Delta x_{t-1} + w' \Delta x_{2t} + u_t \tag{6}$$

To test for the presence of utmost one long-run relationship irrespective of the level of integration of x_2, it is necessary to introduce a zero restriction on one of the off diagonals of the ë matrix. The procedure assumes that the k-vector ë$_{21}$=0, which means that x_1 has no long-run impact on x_2. Under this restriction

$$\Delta x_{2t} = A_2 + I_{22} x_{2,t-1} + \sum_{j=1}^{p-1} g_{2j} \Delta x_{t-j} + e_{2t} \tag{7}$$

In the same way, equation (6) would become

$$\Delta x_{1t} = A_1 + \mathbf{1}_{11}x_{1,t-1} + \mathbf{1}_{12,2}x_{2,y-1} + \sum_{j=1}^{p-1} \mathbf{j}'_j \Delta x_{t-j} + \mathbf{w}'\Delta x_{2t} + u_t \tag{8}$$

where $\mathbf{1}_{12,2} \equiv \mathbf{1}_{12} - \mathbf{w}'\mathbf{1}_{22}$

It may be noted from equation (7)-(8) that this restriction would not preclude the short-run causation between x_1 and x_2.

To test for the absence of the level relationship in the system, the procedure excludes the lagged level variables. Hence the null hypotheses would be

H_0 : $\mathbf{1}_{11} = \mathbf{1}_{12,2} = 0$.

And the alternative hypotheses would be,

H_1 : $\mathbf{1}_{11} \neq \mathbf{1}_{12,2} \neq 0$.

To test the hypothesis, we estimate equation (8) and calculate Wald or F-statistic. The asymptotic critical value bounds when the variables are I(0) and I(1) have been provided by Pesaran, Shin & Smith (2001). The decision rule for this procedure is if the estimated F-statistic falls below the lower critical value, we accept the null hypothesis that there is no long-run relationship. If the test statistic falls above the upper critical value, we reject the null hypothesis, i.e., there exists a long-run relationship between the variables. But if the test statistic falls within the critical value bounds, we cannot draw any conclusion at this juncture and we need further information about the order of integration of variables (Pesaran, Shin & Smith 2001). After ensuring that there is a presence of long-run relationship among the variables in the model, the second stage of the analysis is to estimate the coefficients of the long-run and short run relations and make inferences.

Appendix -2

Review of Policy changes in respect of Interest Rates in India:

There are a number of reform measures undertaken in respect of interest rates for imparting financial liberalization in the economy since the early 1990s. Along with a phased reduction of the Statutory Liquidity Ratio (SLR), the deposit rates have been simplified in 1991-92 by reducing the number of slabs. In 1994-95, the fixation of minimum lending rates by banks for loans over Rs 2 lakh was no longer resorted to and banks were allowed to fix their Prime Lending Rate (PLR) for advances over Rs 2 lakh. The cooperative banks' lending and deposit rates were freed. The incremental SLR was reduced to 25 percent along with reducing the base level SLR to 33.75 percent. The CRR was reduced from 15 percent to 14 percent in 1995-96. In 1996-97, banks were given the freedom to fix deposit rates for the term deposits above one year maturity. CRR was reduced from 14 percent to 10 percent. Effective from April 1997, the Bank Rate served as the signaling rate or reference rate linking it up with all other rates. Banks were also conferred with the freedom to determine interest rates on term deposits

of 30 days and above. The entire structure of lending rates was deregulated along with freedom given to the banks to offer fixed/floating PLR on loans of all maturities including small loans upto Rs 2 lakh. The SLR was brought down to 25 per cent effective October 25, 1997. Interest rates on foreign currency deposits were to be determined by banks subject to the ceiling rate prescribed by the RBI; these rates were subsequently linked to LIBOR. With the supplemental agreement reached between the government and the Reserve Bank of India (RBI), the issue of *ad hoc* Treasury bill was completely done away with from April 1, 1997.

In 1998-99, banks were given the freedom to offer a differential rate of interest based on size of deposits. Banks were advised to determine their own penal rates of interest on premature withdrawal of domestic term deposits and NRE deposits. Banks were allowed to charge an interest rate on loans against fixed deposits not exceeding its PLR. The interim Liquidity Adjustment Facility (ILAF) was introduced in April 1999. This provided a mechanism for liquidity management through a combination of repos, export credit refinance and collateralized lending facilities (CLF) supported by open market operations at set rates of interest. The savings deposit rates were reduced from 4.5 percent to 4.0 percent. The CRR was reduced from 10 percent to 9 percent. After the success of ILAF, a full-fledged LAF was initiated on June, 2000. Interest rate in respect of repos and reverse repos were decided through cut-off rates emerging from the auctions conducted by the RBI on a uniform price basis. Banks were allowed to lend at sub-PLR rates. The CRR was reduced to 8 per cent from 9 per cent along with a reduction of Bank rate from 8 percent to 7 percent.

In 2001, there was a further reduction of the CRR from 8 percent to 5.5 percent. The Bank Rate was reduced from 7 percent to 6.5 percent. The Repo rate was reduced from 7 percent to 6 percent. The PLR of five major commercial banks declined from 11-12 percent to 10.75 to 11.50 percent in 2002-03. With effect from March 2003, the interest rate on savings account offered by the banks was reduced to 3.5 percent per annum from 4 percent annum. The CRR was reduced from 5.5 percent to 4.75 percent and further to 4.50 percent in June 2003. The Bank rate was reduced from 6.5 percent to 6.25 percent. The Repo rate was reduced from 6 percent to 5 percent. The RBI had reduced the interest rates on savings account, the only domestic deposit rate, which continues to remain administered, reduced from 4.0 percent to 3.50 percent. In order to provide consistency in interest rates offered to non-resident Indians, interest rates on NRE deposits were linked to LIBOR/SWAP rates for US Dollar from July, 2003. Interest rates on these deposits were reduced from 250 basis points above LIBOR/SWAP rates

to 100 basis points above LIBOR/SWAP rates effective from September 2003 and further to 25 basis points above LIBOR/SWAP rates of corresponding maturity from October 2003. From April, the above rates were further moderated to the LIBOR/SWAP rate and it was stipulated that the interest rates on NRE savings deposits should not exceed the LIBOR/SWAP rates for six-month maturity on the US Dollar deposits

The RBI has been following a policy stance of imparting flexibility to the interest rate structure. Concerned over the downward rigidity of lending rates, even while deposit rates were coming down, the RBI advised banks to announce their benchmark prime lending rates (BPLRs) based on their actual cost of funds, operating expenses and a minimum margin cover regulatory requirement. The BPLRs of five major banks are lowered by 25 to 50 basis points in December 2004 compared to the rates prevailing during 2004. In 2005, there is a marginal firming up of deposit rates by 25 basis points. Call money rates firmed up from the 2nd half of the year, reflecting lower liquidity on account of a large increase in bank credit. The bank rate remained unchanged at 6 percent. The repo rate (reverse repo rate) since October 2004, under LAF was raised by 25 basis points to 4.75 percent. The spread between reverse repo and repo was narrowed by 25 basis points to 125 basis points. The CRR has moved from 4.50 percent in January 2004 to 5 percent in January 2005.