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The Interbank Money Market in India: Evidence on Volatility, Efficacy of Regulatory Initiatives and Implications for Interest Rate Targeting

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The working of the interbank money market (the call money market) and the conduct of monetary policy are inextricably linked in economies that depend predominantly on indirect instruments of monetary policy. The stability of the call money rate, namely, the rate at which short term funds are lent and borrowed is, therefore, of critical importance to central banks which view it as an operational target to signal the stance of monetary policy. Experience shows that regulatory initiatives taken to improve the efficiency of market functioning also help in fostering market stability. In the Indian case, for example, it may not be inappropriate to postulate that permitting a wider section of market constituents to operate in the repos market (*viz.*, outside the central bank) since March 2003 led to a reduction in the volatility of the call money rate caused by improved matching of demand/supply between deficit/surplus segments. By the same token, therefore, there is a case for encouraging increased participation and, more importantly, expanding the range of eligible collateral for market repos to enhance the efficacy of short term interest rate targeting. The measures announced in the Annual Policy statement for 2005-06 and the suggestions made by the Technical Advisory Committee on Money Market to further expand the scope of activity in market repos are, therefore, highly significant in the present context.

JEL Classification : E52

Keywords : Call money market rate, Liquidity Adjustment Facility (LAF), Autoregressive Conditional Heteroscedasticity, Conditional Variance.

Introduction

The overnight call money or the inter-bank money market rate is presumably the most closely watched variable in day-to-day conduct of monetary operations and often serves as an operating target for policy purposes. The choice of operating tactics from

* The views expressed in the paper are solely those of the author and must not be ascribed to the institution to which he belongs.

quantity to rate based targeting, following the IS/LM based analysis of Poole (1970), has been largely accepted in favour of interest rate targeting, because of the diminished link between monetary aggregates and economic objectives of monetary policy as a result of the fast pace of financial innovations. Most central banks, therefore, presently use indirect instruments in an attempt to maintain the short term interest rate at a desirable level with the use of appropriate liquidity management practices. The most common of these instruments of liquidity management is the central banks' repo facility which enables modulation of the marginal liquidity on a day to day basis so as to ensure stable conditions in the money market and, particularly, to maintain the short term money market rate as close as possible to the official/policy rate. Changes in the short-term policy rate made by central banks provide signals to markets, and various segments of the financial system, therefore, respond by adjusting interest rates/returns depending on their sensitivity and the efficacy of the transmission mechanism. Economic implications for investment and spending decisions of producers and households follow as usual, thereby affecting the working of the real sector *viz.*, changing aggregate demand and supply, and eventually inflation and growth in the economy. It is, therefore, clear that the interest rate stance of a central bank and its implications for economic activity and inflation play an important role in the conduct of monetary policy.

The objective of the paper is, therefore, to assess the volatility pattern of the call money rate in India during the last three years and to estimate its sensitivity *vis-à-vis* the Reserve Bank of India's liquidity adjustment facility (LAF) auction decisions for the purpose of eliciting underlying market characteristics. Attempt is made to provide evidence, *albeit* indirectly, on how regulatory changes related to other instruments in the money market may have affected the functioning of the interbank call money market. Finally, some evidence is also offered on the link between money market volatility and interest sensitive financial markets, particularly the government securities market.

The remainder of the paper is structured as follows. Section I provides an overview of liquidity management in India while cross-

country experience is set out in Section II. Data used in the analysis are explained in Section III. Methodology used and the empirical analysis are presented in Section IV and concluding observations are given in Section V.

Section I

Liquidity Management in India

The liquidity management practice in India has undergone significant changes in the 1990s, from greater reliance on direct instruments to almost full dependence on indirect instruments over these years. The transition to this framework has been enabled because of far reaching changes in the framework of monetary policy enabled especially by the introduction of market based price discovery mechanism and reduction in the financing of government deficits by the Reserve Bank. As a consequence, it was possible to achieve a successful transition, since June 2000, to a full fledged liquidity adjustment facility (LAF) permitting eligible participants such as banks and primary dealers (PDs) to manage their day to day liquidity needs through recourse to the facility. The evolution in liquidity management practices over these years is a logical outcome of the economic reforms which led to the phasing out most of the standing facilities and reduced the emphasis on direct monetary policy instruments. The LAF allows the Reserve Bank to have a strong grip on system's liquidity, on a day to day basis, and consequently helps in achieving its goals of policy more successfully than was the case hitherto. In the recent times, as liquidity conditions have turned surplus because of capital flows, reverse repo auctions have been operated to sterilise excess liquidity to maintain stability in the money market rate around a desired level. Reverse repo operations are conducted on a daily overnight basis and, also for relatively longer period to enable absorption of excess liquidity depending on evolving conditions. Although the presence of excess liquidity naturally ordains that bids are fully accepted to gain the comfort of maintaining the market rate around the official rate, the decision on the acceptance of a given proportion of bids out of the total submitted is taken in keeping, *inter alia*, the daily

primary liquidity flow projections arising from various transactions of the Reserve Bank with the rest of the economic system. While a number of transactions capturing liquidity flows are pre-known to the Reserve Bank, quite a few like ways and means advances, changes in currency demand and cash balances of the government are not known *a priori* with certainty.

The inevitability of large open market operations under conditions of unabated capital flows is virtually preordained given the sensitivity of the inter-bank market to sudden changes in liquidity flows. However, the declining stock of Central Government securities with the Reserve Bank made it necessary to evolve alternative mechanisms to augment the inventory of repoable securities to ensure stability of the money market. Towards this end, the Reserve Bank in consultation with Government introduced the Market Stabilisation Scheme (MSS) in 2004 to absorb excessive/ enduring liquidity in the system. Yet given the unrelenting surge in foreign exchange inflows, the task of maintaining stability in the money market continues to remain a difficult task. In the current milieu, when the auction rate for LAF is generally kept fixed, the quantity is automatically determined, as all reverse repo bids are fully accepted. In this case, the market rate also quickly stabilizes around the reverse repo rate as the system's surplus liquidity is taken away at a given price. The comfort level achieved through daily liquidity management based on LAF however is occasionally disturbed when sudden liquidity shortages cause sharp fluctuations in the money market rate. Although, such spikes have often been short lived given the timely liquidity support offered by the Reserve Bank, yet there is a need to moderate these fluctuations in the larger interest of overall liquidity management.

On the other hand, for prudential reasons and as recommended by the Narsimham Committee in 1998, the Reserve Bank has transited to a system of pure interbank call/notice money market. Accordingly, the average lending by non banks in a reporting fortnight, based on their average daily lending in call /notice market during 2000-01, was progressively reduced from 85 percent (May 2001) to 75 percent (June 2003) to 60 percent (December 2003) to 45 percent (June 2004)

to 30 percent (January 08, 2005) to 10 percent (June 11, 2005) and completely phased out from the fortnight beginning August 06, 2005. Non bank participants except PDs are also not permitted to borrow from the call/notice market. As these limits on lending have been imposed, the parallel development of the repos market outside of the RBI managed by the Clearing Corporation of India Limited (CCIL) as a central counterparty has taken shape. Non banks are expected to take recourse to the collateralised repos outside the RBI for purposes of borrowing and lending of funds.

The CCIL meanwhile also introduced an innovative money market product called the Collateralised Borrowing and Lending Obligation (CBLO) in January 2003 which provided investors the benefit of guaranteed settlement and an exit option before maturity. As a result of the introduction of market repos and the CBLO and phased removal of non bank participation in the call money market, the trading volumes in these markets have increased substantially. Between 2003-04 and 2004-05, for example, the CBLO market grew by a phenomenal 1180 percent. The CBLO segment can be further encouraged by making it more attractive especially for urban cooperative banks to participate in the market by expanding the range of eligible repoable assets by making assets such as state development loans more acceptable through consolidation. Technical initiatives such as enabling repo transactions through secured and cost effective communications links could also be introduced to improve the reach amongst a multiplicity of small participants, thereby integrating dispersed pools of idle liquidity with the needs of solvent borrowers. In the past, significant regulatory reliefs such as that in March 2003 were offered when constituent subsidiary general ledger (CSGL) account holders were permitted to participate in the interbank repo market. More measures in this direction especially, permitting wider sections of the constituents of PDs to participate in the CBLO segment would in all likelihood help in further deepening of the money market. In regard to the range of eligible collateral assets, depending on the comfort level of the central counterparty, there is a need also to permit interbank repos in PSU bonds and private and corporate debt securities for market repos provided they are held in dematerialised form and transactions are done through recognised stock exchanges. This position has been indicated by the Reserve Bank

earlier. The same could, hence, also be considered in the case of CBLO market. The range of participants in the market has also been widened over time. In case of CBLO, for example, while banks, PDs and co-operative banks who are members of the Negotiated Dealing System (NDS) are permitted, non-NDS members like corporates, co-operative banks, NBFCs, Pension Funds and Trusts also became eligible as associate members of the CCIL's CBLO segment to borrow and lend in the CBLO market from January 2004. With the phasing out of the non-bank participation in the interbank call money market, once a greater range of market participants, especially deficit/surplus segments, is encouraged to participate together in a common but secured market for repos/CBLO and a wider array of repoable collateral is available, the efficiency of targeting of the inter-bank call money market would improve on account of better liquidity smoothing across market participants, especially during phases when liquidity shocks result in overshooting of the short term interest rate.

International evidence also underlines the fact that contrary to unsecured markets (especially, call money market), a collateralised repo market is able to achieve much better liquidity smoothing across solvent market participants despite the difficulties in the management of collateral risk (Freixas and Holthausen, 2001). In actual practice, the growth in the global market for repos with a widening pool of collateral has been driven by the improved confidence in the management/mitigation of risk and increased outsourcing of collateral risk management to central counterparties.

Section II
Some International Liquidity Management Practices

Different market based intervention techniques are employed by central banks to manage liquidity on a day-to-day basis. Central banks have been increasingly favouring market operations, especially buying and selling securities than standing facilities in conducting their monetary policies. While different practices and operational frameworks exist, the objective continues to be the same, namely, fostering stability of short-term interest rates around the operating target announced by central banks. The review of the liquidity

management practices presented here is based on several published sources or material otherwise available in the public domain.

The European Central Bank (ECB) intervenes in the money market through its most important policy instrument namely the Main Refinancing Operations (MRO) conducted through repos. The MROs provide the bulk of liquidity support and are implemented through weekly tenders for a maturity period of two weeks. The remaining liquidity needs are met by Long Term Refinancing Operations (LTRO) which are operated once a month and have a maturity of three months. Since June 2000, the MROs are conducted at variable rates. However, the ECB announces a minimum bid rate at which no bids are acceptable. Bids at the highest rate are accepted first and bids with successively lower rates are accepted in turn until the total liquidity to be injected is exhausted. The minimum bid rate indicates the stance of monetary policy. Besides the MRO the ECB also offers a marginal lending and standing deposit facility to counterparties. Since June 2000 the ECB has set its lending rate one percentage point above and its deposit rate one percentage point below the minimum bid rate announced for its MRO. The deposit facility is operated by the ECB in order to facilitate overnight deposits with the ECB. In principle, the deposit facility allows banks to reduce reserves when they have surplus reserves. The lending and deposit facilities of the ECB are made available half an hour after the closure of TARGET (**T**rans-European **A**utomated **R**eal-time **G**ross settlement **E**xpress **T**ransfer system) – a RTGS system used for settlement of central bank operations, large-value euro interbank transfers as well as other euro payments providing real-time processing and settlement in central bank money with immediate finality. The Eurosystem accepts a wide range of collateral assets from non financial institutions for its refinacing operations. Eligible collateral includes, apart from marketable debt instruments, non marketable debt instruments and even some equities. No difference is made between these assets in terms of quality as they fulfil minimum eligibility criteria specified by the Eurosystem. In retrospect, given this framework for liquidity management, it has been found that the overnight inter-bank rate EONIA (Euro Overnight Index Average) has generally remained within the corridor defined by lending and deposit rates, usually within one-half of a percentage point of the minimum bid rate. As a result, the marginal

standing facilities that define the corridor for policy rates have seldom been used by market participants in the Eurosystem.

The Bank of England (BoE) introduced fundamental changes in the operating procedures following the grant of operational independence in 1997 and the separation of Debt Management Office (DMO) in 2000. Accordingly, the BoE presently sets its own official rate of interest so as to meet the target rate of inflation set by the government. The daily operations of the BoE include an initial forecast of the liquidity need which is amended throughout the day. Market interventions are made at two regular times during the morning and noon. Additional facilities are offered late in the day above the official repo rate, which sets the ceiling for the overnight interest rate. Besides, the BoE also offers a standing deposit facility remunerated at rate lower than the official repo rate by one percentage point which, in effect, sets a floor to the overnight interest rate. In an assessment of the open market operations of the BoE, especially, in regard to the introduction of the special deposit facility, Allen (2002) suggests that its introduction since June 27, 2001 somewhat narrowed down the range of fluctuation of short rates around the official repo rate. The deposit facility, in fact, introduced as a "mopping" facility for surplus liquidity successfully limited the extent to which short dated rates could fall below the official rate, resulting in a proper control over the volatility of short rates.

The US Federal Reserve (USFR) intervenes through outright and temporary operations. Outright operations are conducted to offset long term imbalances in liquidity mismatches and conducted by way of treasury bill and coupons. Temporary operations are conducted through repos in treasury securities and are used to offset daily imbalances. The liquidity operations of the USFR are supported by discount window borrowings which serve as a marginal lending facility. The Federal Reserve System accepts a wide range of collateral such as mortgage based securities issued by federal agencies and government sponsored enterprises, apart from securities that are direct obligation of the US treasury or other securities that are fully guaranteed as to principal and interest by government agencies or government sponsored enterprises (Edwards, 1997).

Besides the central banks' own initiatives aimed at liquidity management, the repurchase transactions among domestic counterparties have increased phenomenally. The collateral acceptable for these transactions in the US includes, apart from treasuries, securities issued by Agencies (Fannie Mae, Ginnie Mae, *etc.*) and mortgage based securities guaranteed by Agencies. The Federal Reserve Banks also provide daylight overdraft facilities at a charge of 36 basis points to allow dealers to finance positions. Obviously, this is done to ensure that all genuine liquidity needs of the wider market are met and the settlement is completed without any problems. As at end December 2004 the outstanding volume of domestic market repos in the US was $ 5 trillion. In the case of Eurosystem also the growth in repo market has been encouraging although this segment is less integrated than the swap and unsecured segments, due to existing differences in practices, laws, regulations and fragmentation of market infrastructure. The ECB has been keenly interested in the activity in the repo market segment and has supported the integration of the euro market for short term securities. As at end December 2004, the Euromarket had about EURO 5 trillion outstanding as market repos. The enormous growth in the repos transactions has resulted from the perceived benefits of such transactions. Repo markets compete with banking system by providing a method of granting and receiving loans and generally tend to reduce interest rates for borrowers while increasing it for depositors. In addition, the market for repos based on bonds helps in improving the efficiency and liquidity of bond markets and minimise the probability of undue price fluctuations.

Besides the rapid growth of domestic repos markets, the international financial system has experienced increasing global integration and depth of the money markets in the recent years, helping to cover short term liquidity mismatches experienced by large banks/other financial institutions by means of repurchase transactions facilitated by the International Securities Market Association (ISMA). At present repurchase transactions are easily carried out across national borders besides those among domestic counterparties. According to the survey carried out by the ISMA in December 2003,

the total size of repo outstanding was estimated at EUR 3.77 billion. Survey results also suggested that whereas 39.3 per cent of reported outstanding repo contracts were with domestic counterparties, 52.1 per cent were cross-border including both euro and non-euro zone counterparties. The share of electronic trading of these transactions was also on the rise. The collateral analysis suggested that while fixed income securities issued by the sovereign governments in the EU were predominantly used as collaterals in repo transactions, the pool of collateral was widening with the increasing acceptance of non-government bonds (Pfandbrief and mortgage backed securities) and equity. It is widely believed that the growth of the collateralised repo market has served an important role, *viz.*, enhancing the overall stability of the financial system by removing counterparty risks by means of funded credit protection against risky transactions in unsecured wholesale financial markets.

An empirical analysis of the behaviour of volatility of short term money market rate conducted by Thompson (2003) for major developed countries shows that while volatilities have generally been reduced over time in the recent years, higher volatilities in countries such as the UK are ascribable to low reserve requirements. According to Thomson (also Kasman, 1992) low reserve requirements have tended to impede the flexibility of banks in managing their reserve positions leading to higher fluctuations in the overnight rate. However, most central banks in the developed world have taken initiatives to expand the scope of the market by enhancing the range of collateral acceptable for monetary operations and in some cases improving the participation rate itself.

Section III
Data : Sample and Definitions

As mentioned before, the empirical exercise is devoted to eliciting the volatility of the call money rate in the recent past including possible relationship with certain important regulatory initiatives taken by the Reserve Bank. The analysis is also devoted to assessing the sensitivity of interest rate targeting especially in

relation to the LAF auction decisions of the Reserve Bank on a day to day basis. Daily data on reverse repo auctions (submitted and accepted), weighted call money rate and the official repo rate are taken for the period from April 2002 to March 2005 which, by and large, has been a period characterised by surplus liquidity except for some sporadic periods of liquidity stress. The data employed is available in the public domain and is regularly disseminated through the official website of the Reserve Bank (www.rbi.org.in). Wherever required, data have been appropriately transformed for testing the hypothesis put forward in the paper.

Section IV
Methodology and Empirical Evidence

The econometric methods used in estimation are the Nelson Beveridge (NB) time series decomposition and an ARCH-M[1,1] (Autoregressive Conditional Heteroscedasticity in Mean) model estimation which is widely used for modelling volatility in financial markets. While the NB decomposition serves to differentiate between permanent and cyclical components in a time series, the ARCH model introduced by Engle (1982) imposes a systematic structure to the variance process making it amenable to interpretation and use in forecasting. These methods are briefly explained below in an understandable language, without using mathematical notations. References pertaining to the statistical methods are given at the end.

(i) Nelson Beveridge Decomposition

This decomposition method was proposed by Beveridge and Nelson (1981).The NB method is based on the presumption that stationary short term fluctuations tend to shift the long run path or the trend of the series in question. In the NB method, the contemporaneous innovation to the trend is perfectly negatively correlated with itself. For example, a positive shock to the call money rate because of consistent tightening of liquidity will be contemporaneously negatively correlated with the trend until shocks force the trend to adjust upwards over time. The NB method was applied to the weighted call money

rate with ARIMA(1,0,1) structure to obtain estimates of the cyclical (or temporary) component which are plotted in Chart 1 below.

Chart 1 clearly reveals a substantial containment of market volatility beginning March 2003 (observation number 600 onwards on the X-axis when the transient component looks considerably subdued) coinciding with the Reserve Bank's decision to permit CSGL account holders to participate in the market for interbank repos.

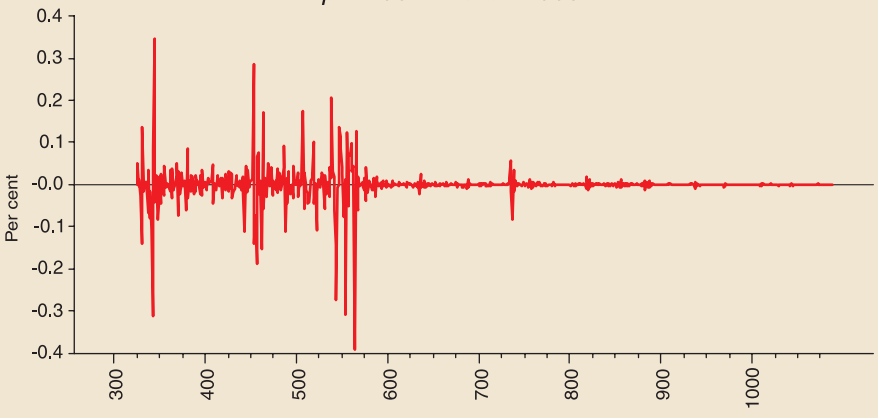
(ii) The ARCH-M Model

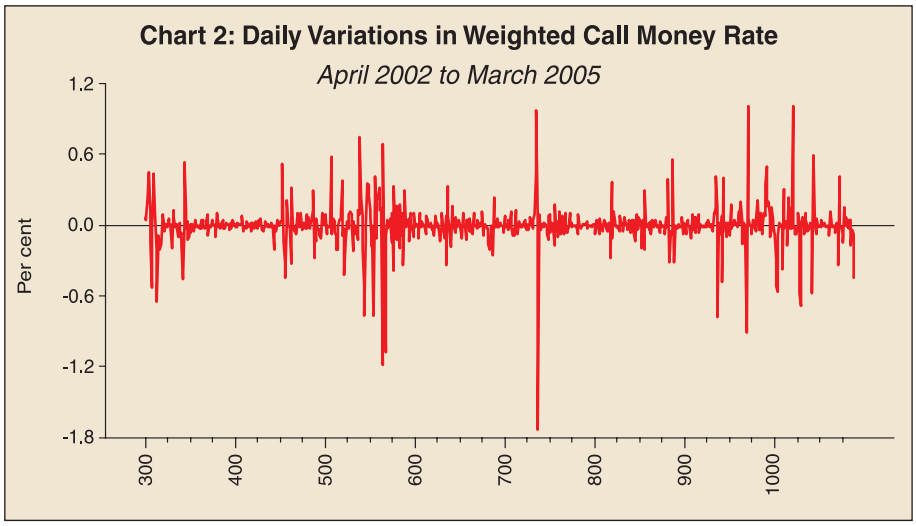
The standard ARCH effect in data implies 'volatility clusters' which can be captured to place appropriate structures to the volatility of the series, which may be otherwise highly unpredictable and difficult to interpret. The coefficients derived from estimated ARCH models are more efficient than those obtained from simple OLS method and offer a special ground for inference making. Chart 2 provides evidence on ARCH effects in call money rate suggesting episodic volatility including clusters of low amplitude variations followed by lower values and vice versa. It is, therefore, reasonable to specify the model for call money rate in terms of the mean and conditional variance equations in ARCH models.

As a variant to the general ARCH model described above, we employ here the ARCH-M model introduced by Engel *et.al* (1987)

Chart 1: Cyclical Component of Weighted Call Money Rate

April 2002 -March 2005





wherein each time the mean of the process is determined by additional information contained in standard deviation seen at the same time. The ARCH-M modelling is of special interest in studying financial time series as the conditional variance plays an important role in determining an explicit trade-off between expected returns and the variance or the covariance among returns. In the traditional capital asset pricing model (CAPM), for example, the expected excess return on the market portfolio is linear in its conditional variance, suggesting the usefulness of ARCH-M type models.

The algebraic structure of the ARCH-M model is presented below.

The Mean Equation

$$DIFRATE_t = f\{ TOTACCP_{t-i} \} + h_t + error_t$$

where $i = 0,\ldots,n$ *lags*

DIFRATE =the difference between weighted call money rate and the reverse repo rate (%).

TOTACCP =total amount of reverse repo bids accepted daily (Rs crore)

h = *model based conditional variance*

ERROR = error term

The mean equation explains the variations in the gap between call money rate and the policy rate (*viz.*, repo rate) by decision taken by the Reserve Bank in respect of the daily amounts of bids accepted from counterparties in reverse repo auctions and the recursive conditional variance itself. The model posited above does not use any lag(s) of the dependent variable in the equation. Taking lags of the dependent variable in the equation is often subject to criticism from practitioners, especially, the rationale of taking past information on the dependent variable into account. Critics often also question the validity of such empirical models arguing that since much of the explanation in the estimated equation is attributed to lagged dependent variables, they do not have much practical use. By dropping lagged endogenous variables therefore, we avoid this criticism, and the only term that is left unexplained is the error term, which may arise from factors such as less accurate projections of cash flows in the banking system arising from exogenous factors such as changing demand for currency by the public, government cash flows and flows on account of external capital/private remittances and even news and expectations *etc.* These mismatches in supply and demand of funds can be addressed by expanding the scope of the repo market especially when regulatory concerns require that the participation in the interbank call market should be limited to banks only. The error term is expected to be highly variable but can be suitably modelled by imposing systematic structure as proposed in the econometric literature so as to be useful in decision-making.

Conditional Variance

$h_t = f\{error^2_{(t-i)}\}$ + white noise

$i=1,\ldots..,n$

As the system is highly volatile and shows volatility clusters, the conditional variance of the process can be systematically captured using the square of previous error terms obtained from the mean equation. The estimation of conditional variance based on ARCH models has been customarily found quite successful in modelling financial markets with high frequency market operations and

volatility. They have also been used to forecast volatilities to address the needs of trading desks to help in evolving operating strategies.

As is evident from the recursive nature of the estimation, coefficients of the ARCH-M models are obtained from non linear numerical optimisation techniques applied to the joint estimation of the mean and variance equations. In this paper we employ the Berndt, Hall, Hall and Hausman (BHHH) procedure for maximising the log-likelihood function.

The estimated model specifies the daily difference between the weighted call rate and the official reverse repo rate as a function of the amount of the reverse repo bids accepted by the Reserve Bank daily and the conditional variance - assuming that conditional volatility itself plays an important role in explaining the gap between the two rates.

The coefficient estimates of the model suggest that variations in amounts accepted in reverse repo auctions have a statistically significant, though small, impact on the gap between the weighted call money rate and the reverse repo rate (aggregate coefficient estimate is invariant if even the first lag of the accepted amount is included in the estimation). For example, for the time sample under consideration, accepting additional Rs 10,000 crore on a current day would have reduced the said gap between the call money rate and the reverse repo rate, on an average, by barely two basis points. The

Empirical Estimate of the daily ARCH-M model
[April, 2002 to mid November, 2004]

(i) <u>The ARCH in Mean Equation</u> :

$$DIFRATE_t = \underset{(3.73)}{-0.044} - \underset{(-7.26)}{0.0000020}\ TOTACCP_t + \underset{(15.58)}{0.43}h_t$$

(ii) <u>ARCH-M Conditional Variance</u> :

$$h_t = \underset{(23.55)}{0.0088} + \underset{(9.46)}{1.15}\ error^2_{(t-i)}$$

Convergence : 132 iterations, Criterion 0.0000068<0.00001, Function Value :540.35
Figures in parenthesis are respective t-statistics for testing significance

implication of this finding is that even as the entire bid amount at reverse repo auction is accepted, and if the amounts accepted were to actually signify the total excess liquidity in the system, the model should be in a position to explain the gap almost fully. However, since the model, on an average, explains only 24 percent of the actual average gap of 25 basis points over the sample period, the usual law of equilibrium wherein if a rate is fixed, the amount is automatically determined and *vice versa* appears to be perceptibly violated. As it will be shown later, the average margin of error between the estimated gap and the actual gap reported above is attributable mainly to the phases when the money market suddenly became tight and the Reserve Bank had to offer accommodation through its repo window. On the other hand, the actual gap between the call rate and reverse repo rate during times of surplus liquidity especially, when the reverse repo window was open, is fairly well explained by the model with a minimal margin of error. It therefore, follows that any unexplained gap between the two rates could be ascribed to market segmentation (especially, the inability of the cash surplus and deficit segments to meet fully to clear the market) instead of auction decisions alone. It appears that the impedance in reaching an overall market wide equilibrium is because of frictions in the functioning of the money market which may need to be resolved to allow the market operate near its potential strength. This conclusion is corroborated by the fact that the coefficient of the ARCH-M effect in the mean equation is significantly much higher at 0.43 and hence, explains a large proportion of the average gap between the call and the reverse repo rate as compared to the reverse repo accepted variable. It is obvious that reduction of the gaps between the market rate and the policy rate could be achieved satisfactorily by containing the volatility of the money market, especially that occurring during instances of sudden liquidity stress, by widening the participation rate of economy wide deficit (demand)/surplus (supply) segments and expanding the range of repoable collateral in the repos market. It is noteworthy that recognising this aspect, the Reserve Bank in March 2003 permitted Constituent Subsidiary General Ledger (CGSL) account holders to participate in the repo market, thereby increasing the participation rate of constituents and substantially reducing the volatility in the market - a fact substantiated by empirical NB decomposition. Given

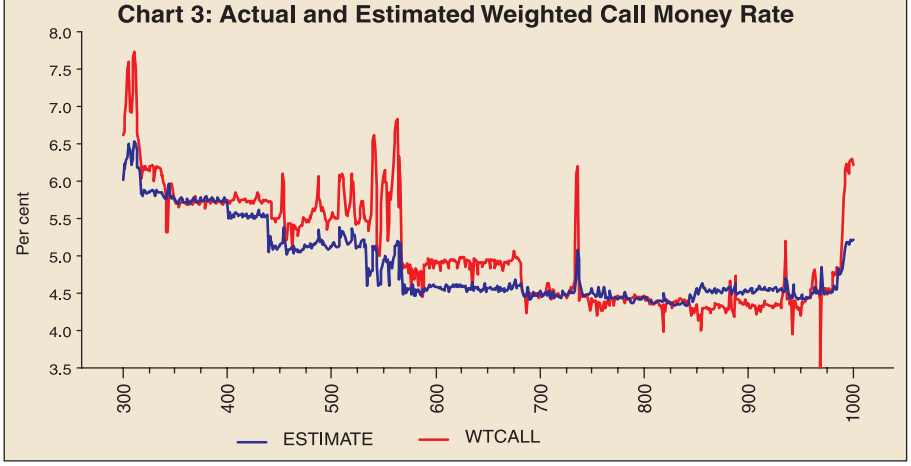
the integral link between the money and government securities market, increasing the range of repoable securities may also help in insulating the government securities market from exposures to market risks caused by random liquidity shocks.

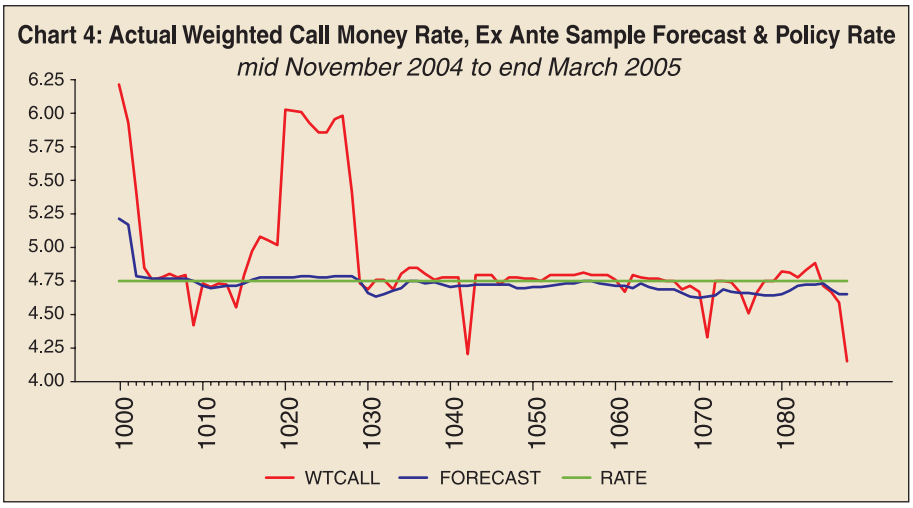
Chart 3 compares the actual call money rate with the estimated rate derived from the mean equation of the ARCH-M model estimated above. It is observed that though the estimated trajectory tracks the actual path of call money rate closely throughout the sample period, there are certain occasions when large spikes are observed which are not explained fully by the empirical model. These spikes caused by sudden mismatches in liquidity of the otherwise stable equilibrium require appropriate balancing through timely liquidity injection measures.

The daily *ex-ante* (out of sample) forecasts of call money rate for the period from mid November 2004 up to end March 2005 are plotted against the actual out turns in Chart 4.

Model estimates suggest that while the out of sample forecasts closely track the policy rate following the law of equilibrium mostly during periods of surplus liquidity with an average error of just three basis points, the call money rate shows the tendency to overshoot (average *ex-ante* tracking error of 17 basis points) during times of liquidity shortages which are seen as large spikes in the Chart 4, necessitating RBI to open its repo window. As depicted in Chart 5 the forecast performance is not significantly improved

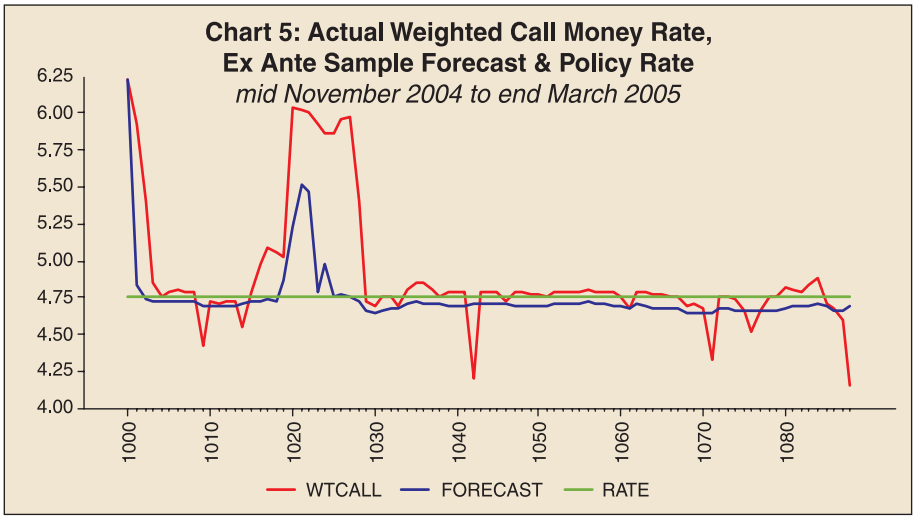
Chart 3: Actual and Estimated Weighted Call Money Rate





even if the model is augmented with the information on repo interventions (*viz.*, repo amounts accommodated by RBI during periods of liquidity shortages). Therefore, since the accommodation provided during shortages does not explain the variation in gaps substantially, it appears that much more explanation should be owed by other factors, namely the operational aspects in the market itself.

The inter-bank money market volatility may be transmitted to other financial markets causing financial entities to bear the costs of portfolio adjustments. One of these financial markets is the



government securities market which has a significant bearing on the balance sheets of banks and other financial institutions (especially, insurance companies and pension funds) given the large holdings of such securities in their portfolios. In order to test the impact of money market volatility on the volatility in the yields of government securities, a simple AR1 regression for the full sample is performed to compute the volatility in the yield of government securities (based on secondary market yield of the representative central government security with 10-year residual maturity). A regression is then performed with volatility of government securities as independent variable and the conditional volatility derived from the ARCH-M model as explanatory variable.

The empirical evidence suggests that the volatility in the government securities market is significantly influenced by the volatility (or liquidity shocks) in the money market, explaining about 22 per cent of the fluctuation in yield. It is therefore necessary that the volatility in the money market caused by liquidity shocks is moderated to the maximum extent possible so that securities yields are determined on the basis of fundamental economic factors such as inflationary expectations rather than day to day liquidity conditions.

$$\textbf{Volatility}_{\text{(10 year GSEC yield)}} = 0.0027 + 0.008\ \textbf{Condt. Variance}_{\text{(money market)}}$$

(2.80) (3.21*)

$$\bar{\mathbf{R}}^2 = 0.22 \text{ ; SEE} = 0.01 \text{ ; DW} = 2.10$$

'*' denotes that the coefficient is significant at 1%

Section V

Concluding Observations

The deviations of the call money rate from the policy rate particularly aggravated during periods of liquidity stress, notwithstanding complete accommodation offered to eligible

counterparties by the RBI suggests that encouraging greater participation and permitting a wider range of collateral in the repos market would help in improving the efficiency of interest rate targeting. The task of doing so though is admittedly difficult under the present circumstances given the perceived difficulties in collateral management such as pricing and risk mitigation for classes of collaterals other than sovereign securities.

It may, however, be mentioned that the willingness of central banks particularly those in developed economies to accept a wider array of commercial collaterals even for direct monetary operations is predicated upon the need to uphold the integrity of the policy rate and to minimise the cost of volatility in interest sensitive financial markets. It is in this context that the present structure of the money market needs to be viewed, given the implications for related financial markets. The evidence provided by the empirical model brings out that while the call money rate is tracked reasonably accurately during surplus liquidity conditions, the predictive power suffers a loss when liquidity shortages suddenly emerge. The fluctuations in the call money rate during these periods of shortage are observed to continue for a couple of days notwithstanding the fact that most often full accommodation is provided by the Reserve Bank. The average daily in-sample bias of 25 basis points in forecast seen during the sample period is attributable mainly to random liquidity shocks experienced by the market. This bias could be expected to increase whenever the market begins to return to the deficit mode. It, therefore, stands to reason that further integration of the money market by expanding participation in market repos and, perhaps more importantly, finding ways to introduce other classes of eligible collateral could help in the timely matching of the needs of the surplus and deficit sectors. Meanwhile, the feasibility of increasing the number of LAF operations alongside options to separate the timing of repo and reverse repo operations for market stabilisation could also be considered.

Given the increasing market orientation of the financial system and the significant interest sensitivity in the recent years, ensuring long term consistency between the policy rate and the targeted rate would serve to limit the volatility in different segments of interest sensitive financial activities.

The experience regarding the improvement in the stability of the money market rate since the expansion, in March 2003, of inter-bank repos market due to the participation of CSGL account holders, lends support to the idea that enhanced participation rate in the repos market would promote stability. The Annual Policy Statement of the Reserve Bank for the year 2005-06 has taken important initiatives to increase participation by permitting non-scheduled urban co-operative banks and listed companies having gilt accounts with scheduled commercial banks subject to eligibility criteria. The development of the market repos would also be benefited by the draft guidelines in respect of securitisation of standard assets leading to orderly growth of the market for asset backed papers, which may then have the likelihood of being accepted as eligible repoable collateral. The proposal for an electronic trading platform for market repos would also improve the price discovery process.

The introduction of other eligible collateral for repos/CBLO would reduce risk of unsecured lending in the call money market, and in others such as in the inter-corporate deposit market and hence serve to foster greater stability of the financial system. It is notable that the report of the Technical Advisory Committee on money market has also favoured the introduction of asset backed commercial papers. An expected externality from the expansion of eligible securities for market repos is the stimulus that would be imparted to the hitherto dormant markets for these financial products.

Finally, as a technical point of interest, since systematic or conditional element in volatility is a dominating feature of the market process, it is desirable that conditional volatility is estimated on an ongoing basis for forecasting the volatility of inter-bank money market rate for policy support.

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