Repo Market – A Tool to Manage Liquidity in Financial Institutions

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Abstract

Repo is used in India as an instrument for monetary policy by institutionalizing daily Liquidity Adjustment Facility (LAF) which allows banks and Primary Dealers to manage their liquidity needs. Liquidity stress in the market has an impact on the short term interest rate. Entities not having adequate securities balances borrow funds from inter-bank uncollateralized call market and the call rates are prone to liquidity shocks in the system. The spread between Call and Repo rates is likely to widen when there is liquidity stress in the market. The study tried to find the determinant of the spread. It found that LAF window activity as well as total money market activity has an impact on the spread. In order to understand if the spread behaves in a different manner when the system has excess liquidity vis-à-vis shortage of liquidity, a Regime Switching model using Goldfeld and Quandt's D-method for switching regression was used. The tests found that the monetary policy is stable in both the regimes and the effectiveness of monetary policy in both the regimes are not statistically different.

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Introduction

Repo is abbreviated form of "Repurchase Agreement" – a form of lending and borrowing mechanism used by Central Banks and Banking and near Banking Institutions all over the world to manage liquidity. Predominantly Repos are used by an institution for managing short-term liquidity fluctuations and not for funding general balance sheet. However, institutions may use the facility to fund leveraged position-taking in various securities. A survey by European Repo Council (ERC) of the International Capital Market Association (ICMA) in June'13 found that the total value of the repo contracts outstanding on the books of the 65 institutions was EUR 6.01 trillion, compared with the EUR 5.6 trillion in December 2012, (EUR 4.6 trillion in December 2008 and the pre-crisis peak of EUR 6.8 trillion in June 2007). The U.S. repo market shrunk to \$4.6 trillion in July'13[2], down 35 percent from a peak of \$7.02 trillion in the first quarter of 2008. Post Financial crisis, many regulations have been framed to make the banking business remain secure as the transmission from banking channel hurts the society most in the times of stress. Regulators feel that reforming the repo market is the top priority. They fear that repo market makes the banks vulnerable to sudden collapse should counterparties become nervous about doing business with them for some reason, as repeatedly happened around the time of the financial crisis. The repo market is believed to be a key channel through which the last Financial Crisis was transmitted. Repo being a collateralized transaction, repo lenders demanded higher collateral for a given level of cash lending during the crisis as asset prices declined. Investors holding leveraged portfolios of securities were required to post higher margins. The funding shortfall forced investors to selling assets which resulted in further decline in asset prices, creating a 'vicious cycle'. The problem was acute as a major part of the repo market used non-sovereign papers for the repo transaction. The financial market crisis witnessed the demand for quality collaterals as the value of the corporate papers started dipping. More recently, the regulatory focus on repo markets has intensified to ensure that the market remains stable at the time of stress. The Basel III Accord introduced quantitative liquidity requirements that stress-test large-bank funding practices and force firms to move from primarily overnight funding to longer-term financing arrangements.

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[2]Based on recent Federal Reserve data compiled from its 21 primary dealers.

Additionally, the global regulators are focusing on banks' reliance on short-term funding and on reform measures to more closely link capital and liquidity regulation. These efforts is likely to materially alter the way banks fund themselves and change the repo market for the better.

Unlike global repo market, Indian repo market predominantly uses sovereign securities though repo is allowed on corporate papers. The dominance of low-risk collateral means that it is much less likely to transmit shocks to other markets in case there is stress condition in the market. Repo market in India does not pose a systemic risk to the wider financial system.

The objective of the current study is to understand various dimension of the Indian repo market functioning and its important role as a tool to manage liquidity in the system. The rest of the paper is organized as follows: section 1 details current repo market microstructure, section 2 details the RBI repo system, section 3 details the market activity, section 4 details the types of collaterals used in the system, section 5 details the statistical analysis of the market and determinants of the spread and section 6 gives the concluding remarks.

Repo Market Microstructure

Repo is defined as an agreement in which one party sells securities or the other assets to a counterparty, and simultaneously commits to repurchase the same asset, at an agreed future date at a repurchase price. The said repurchase price would cover the original sell price plus a return on the use of the sale proceeds during the term of the repo. It is a financing arrangement used primarily in the government securities markets whereby a dealer or other holder of government securities sells the securities to a lender and agrees to repurchase them at an agreed future date at an agreed price which will provide the lender with an extremely low risk return. Such a transaction is called a repo when viewed from the perspective of the supplier of the securities (the party acquiring funds) and a reverse repo or matched sale-purchase agreement when described from the point of view of the supplier of funds**.** Repos are hybrid transactions that combine features of both secured loans and

outright purchase and sale transactions but do not fit cleanly into either classification. The use of margin or haircuts in valuing repo securities, the right of repo borrowers to substitute collateral in term agreements, and the use of mark-to-market provisions are examples of repo features that typically are characteristics of secured lending arrangements but are rarely found in outright purchase and sale transactions. The repo buyer's right to trade the securities during the term of the agreement, by contrast, represents a transfer of ownership that typically does not occur in collateralized lending arrangements. Repos are popular because they virtually eliminate credit problems. Traced back to the birth of Federal Reserve System and to the inception of the Bankers' Acceptances market at the close of World War I (in 1918). In 1923, the Fed began to use short term repos against Governments as a tool for altering bank reserves. Central Banks around the world use Repos to moderate Money Supply in the economy by way of providing liquidity at the time of stress and absorbing liquidity at the time of excesses.

Repo markets are generally separated into markets for "general" and "specific" collateral. In case of specific collateral, a piece of specific collateral is identified in the repo contract making it possible to obtain specified securities. Repos can be divided into four broad categories – (a) Classic Repo (US style); (b) Buy-Sell Back Repo (Indian market follows this type) and (c) Securities Lending for a fee and (d) Tri-party Repo. Classic repo involves an initial sale of securities with a simultaneous agreement to repurchase them at a later date with the start and end prices of the securities are the same and a separate payment of "interest" is made. Classic repo makes it explicit that the securities are only collateral for the loan and the coupon income will be accrued to the seller of the security. The principal difference between a repurchase agreement and a buy/sell back stem from the fact that repurchase agreements are always documented, while buy/sell backs are not required to be documented as there are implicitly two separate contracts. Most of the repo terms are taken from standard legal agreements – General Master Repo Agreement (GMRA). Buy/sell-back agreements and securities lending versus cash transactions have somewhat different legal and accounting treatments but these are equivalent economic function and also referred to as repo market transactions. Under a Tripartite repo, a common custodian /clearing agency arranges for custody as well as clearing and settlement of repos transactions. The system starts with

signing of agreements by all parties and the agreements include Global Master Repurchase and Tripartite Repo Service Agreements. This type of arrangement minimizes credit risk and can be utilized when dealing with clients with low credit rating.

The maturity of repo agreements typically fall into at least three descriptive categories: overnight, open and term. Overnight refers to repos with a single-day maturity (this should also typically covers repos conducted in Indian market on Fridays) and Indian market uses this form of the market quite efficiently. Term maturity refers to repos that have a fixed maturity longer than one day – recently Reserve Bank of India (RBI) introduced term repo for 7 and 14-days on reporting Fridays to mitigate the liquidity shortage in the system. Open maturity repos are those transactions where both parties have the option to terminate the repo each day. The open maturity structure permits entities in the repo transaction to continuously roll over overnight repos. In a securities lending transaction, two securities are swapped for a certain period of time. This typically happens when funds are perceived to have higher reinvestment risk which may result in bid-ask bounce for the repo seller of the securities.

Repo are used by traders to obtain cash or to obtain securities. Repo and reverse repo are two parts of the same transaction. A bank needing cash but having required securities can enter into a repo transaction with another institution by selling the securities under repo to acquire cash. In this case, the lender of the cash uses the securities as collateral. Repo transactions are typically used to fund "long" positions in securities - used to build up leveraged long positions in securities markets. A trader uses cash raised through an initial repo transaction to buy securities which, in turn, are repoed out to raise more cash to buy more securities and so on. With each transaction the leverage ratio is increased. The maximum extent of leverage that can be built up through this process is determined by the margin or "haircut". Haircut depends on the credit worthiness of the borrower of funds and the price volatility of the collateral. Haircuts for low-risk borrowers like banks using less-volatile collateral like sovereign bonds can be very low. Repo market is probably the lowest-cost source of leverage. In the reverse case, a bank might have short sold a particular security with a view on future price of the security and would like to borrow the same for delivery purpose. The short sale position results in cash inflows which can be used in the repo transaction to acquire securities for delivery purpose as no naked short sales are typically allowed in institutional markets. Or a bank in India can enter into a reverse repo transaction to borrow securities from another bank by lending cash but the purpose of the same is to maintain regulatory investment norms in Statutory Liquidity

Ratio (SLR). As Indian market follows a buy/sell back repo mechanism, it allows the borrower of the security to use the same for achieving SLR level specified by RBI. In markets where interest rate futures are liquid, securities are borrowed to manage delivery against the deliverable positions by the sellers in the futures market. Depending on their uses, either the securities or the cash serve as collateral for a particular transaction. In the case of specific collateral repos, the transaction enables participants to obtain particular securities issues.

Repo yield depends on whether the transaction involves general or specific collateral. In case of general repo, the yield is roughly comparable to other short-term money market interest rates. In case of special repo, the yield reflects the value of the collateral in the securities loan. In rare circumstances, participants sometimes transact at negative special repo rates[3]. Repo market facilitates arbitrage and speculative activity as it allows a trader to take leveraged positions by posting a small margin. Arbitrage, market-making and speculative activity are important facet of the repo market. The repo lender of the security has to maintain inventory of collaterals and has to price the same in such a manner to recover his holding cost – the security borrower should make money from short sale deals to make the same transaction viable. The speculator takes a view on interest rate and accordingly creates leveraged positions. Direct trading of the repo rate itself is commonly known as matched-book trading. It involves the borrowing of securities or cash through the repo markets with the intention of re-lending the cash or securities at more favorable rates in the same market. A Speculative trading activity involves taking a position on the basis of forecast of the direction of interest rates - speculating on the future direction of repo rates. If a trader expects rates to rise, one could borrow money for term and lend money overnight.

Figure: 1: Repurchase Agreement Structure

First Leg (Ready leg): Initial Transaction
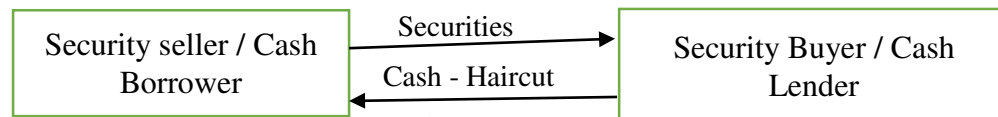
Second Leg (Forward Leg): Forward Contract
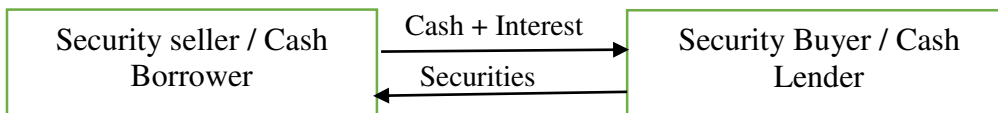
The above figure can be better explained using an example of Buy/Sell Back Repo. Bank A would like to do a repo to borrow funds from Bank B using a security (7.16% GOI 2023 issued on 20-

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[3] When the chance of penalties is high for failure to deliver the security.

May-2013) on Oct 21, 2013 for 21 days (repayment on Nov 11, 2013) for a Face Value of Rs.500million at 8.36%. The underlying bond is trading at 8.80% for settlement on Oct 21, 2013. The underlying security has a Clean Price of Rs.89.5197 (using 30/360E criteria) and has 151 days of accrued interest amounting to 3.0032 giving us a Dirty Price of Rs.92.5229. The consideration in the First Leg (Ready Leg) becomes Rs.462, 614,725. The repo interest will be charged on the above funds at 8.36% for 21 days. The same works out to Rs.2, 225,113 using Act/365 criteria. So the Borrower (Bank A) will pay to Bank B Rs.464, 839,838 on Nov 11, 2013 and take back the security. But in a Buy/sell back repo, the transaction is divided into two separate deals – in the second leg the repayment becomes the consideration and the Bank B must account the same in terms of a Clean Price and Accrued Interest. This is done to have proper accounting in the books as Clean Price is a part of the Balance sheet (Asset side when it enters the book) while accrued interest is absorbed in the Profit and Loss Account. The repayment amount in the second leg (forward leg) can be converted into a Dirty Price of Rs.92.9680 out of which 3.4010 is the accrued interest for 171 days[4] as on 11-Nov-2013. The implied Clean Price will be the difference between Dirty price and Accrued Interest. The same will reenter the Books of Bank A at Rs.89.5670 resulting in a small capital gain as it left the Book at Rs.89.5197. For Bank B, it can be a capital loss and can be leveraged for Tax purposes. By doing the repo deal at the agreed rates, the traders have also given their expectation about the future yield of the bond. The forward price of Rs.89.5670 implies a yield of 8.80% for the security on 11-Nov-2013. This implies that traders do not expect much change to the yield curve in next three weeks – expectation of a flat yield structure for next 3 weeks.

An important distinction between repo lending and a collateralized loan is that legal ownership of the security is transferred to the lender of funds which provides the repo lender with better control over the collateral in case the counterparty defaults. At times, repo transaction also provides for collateral substitution rights to the lender of security. Right of substitution may make the repo transaction restrictive as the borrower of the security has to maintain the collateral inventory or should be in apposition to borrow the same through another repo transaction if the lender of the security demands the same.

Indian repo market is predominantly an overnight repo market – dominated by banks and institutions. The market uses sovereign securities as collateral. The repo market in India was a pure

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[4] The repo interest is for 21 days while bond interest accrued is for 20 days – the one day shortfall is because of the different day count convention used for repo market (ACT/365) and bond market (30/360E).

OTC market where both lenders and borrowers to talk to each other to finalize a deal. The anonymous online repo dealing system introduced by Clearing Corporation of India Ltd. (CCIL)[5] helped the market to go for a radical change – moving from OTC market to an anonymous order driven market resulting in true price discovery of the repo yield. It provides for both General (Basket) and Special repo dealing. Large part of the repo market moved to this platform while very small part still remains outside this platform.

The trading activity in repo market indicates leverage positions taken by traders. A relatively higher volume in Special window would indicate traders are borrowing specific securities for their leveraged positions like delivery against short sale position or delivery against a forward contract like Interest Rate Futures. Buyers of the securities (having long positions with an interest rate view) in the outright market may also use the security in repo window to lend the same to other users. If the trading activity in the Basket window is higher, it would indicate traders are using the same more as a collateral to lend funds or some traders may be using the same for regulatory purpose like maintaining SLR.

In Indian market Repo market has three different segments – RBI Repo (daily LAF at a fixed rate), Market repo among banks and institutions at market determined rates and Collateralised Borrowing and lending Obligations (CBLO) – a repo variant with the combined structure of held-in-custody and tripartite repo in which the contract can be traded unlike other standard repo in which the security under repo can be traded but the contract cannot be unwound till the end of the contract. CBLO market has been the most liquidity form of the short term market with more than 60% of the short term market share. CBLO provides an anonymous order matching system for trading funds against the collaterals in the form of Government securities which are immobilized at the service provider.[6] CCIL allows entities to borrow from the market against Government securities after applying the applicable haircuts to manage risk. Both Market repo and CBLO trades are guaranteed by CCIL which plays the role of a CCP[7].

Central Bank Repo

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[5] CCIL introduced CROMS platform in Jan'09 for allowing institutions to deal in repo using both Basket and Special windows.

[6] CCIL offers CBLO trading platform for the market participants to trade. The system allows non-bank entities like Non-Banking Finance Companies, Large Corporates investing in Government securities, Large Oil Companies, etc. having stocks of Government bonds issues to support oil pool deficit.

[7] Central-Counter Party guarantees settlement of all trades in Market repo and CBLO.

Central Bank Repo is one of the oldest instruments of monetary policy. Federal Reserve started using a type of repo in 1920s while Bank of Canada used repos since 1953. Bank of England started using repos with government securities in 1997 but and Japan and Switzerland started using repos in 1997 and 1998, respectively. Canada, Italy and Sweden use the buy/sell-backs while Japan uses securities borrowing with cash collateral. The Netherlands uses a special loans system in which loans are collateralised via pledge on a pool of collateral (general). Most of the countries use the form of repo keeping in mind the legal and institutional framework that prevails in each country. The use of repos as a monetary policy instrument is more justified from the fact that repos are well suited to influence the interest rate level through two of the main channels used to implement monetary policy - for moderating or controlling liquidity in money markets and an effective mechanism for signaling to markets the desired level of interest rates. A central bank repo indicates the rate at which the Central Bank is willing to lend money against acceptable collaterals to Banks – to infuse liquidity to the system where there is shortage of funds. Most central banks follow an interest rate corridor to set a rate below the repo rate at which the Central Bank is willing to absorb excess liquidity in the Banking system if the need arises. So the repo and reverse repo rates indicate both support and resistance level for money market funds. The market logically has to operate within the interest rate corridor as a trader having excess cash would demand the minimum rate from a borrower of funds which she can get from the Central Bank by pledging excess cash with her. If a bank has faced shortage of liquidity, then it can approach the Central bank with acceptable collaterals to pledge and borrow funds at the repo rate. By changing repo rate, the central banks indicate the interest rate direction. A shift in monetary policy can be signaled by adjusting the interest rate corridor. Central Banks use repo to infuse liquidity to the system. During financial crisis, central banks around the world infused unprecedented level of liquidity to the financial system by lower the quality of acceptable collaterals thereby facilitating availability of credit to the economy from the banking system. McAndrews et al. (2008), Ashcraft et al. (2009), and Christensen et al. (2009) find that the liquidity measures adopted by the Federal Reserve were effective during the 2007-08 financial crisis. When liquidity dries up, central banks have two unique abilities: to provide liquidity in sufficient amounts in response to abnormal shocks (Bhattacharya and Gale, 1987; Acharya et al. 2008) and to diversify risk across many illiquid banks (Flannery, 1996; Rochet and Vives, 2004).

RBI uses a system called Liquidity Adjustment Facility (LAF) for moderating liquidity situation in the banking system. It has specific timing window (typically at the beginning of market hours) within which banks are required to access funds or park funds in which RBI is the counter-party.

The rates at which such transactions take place are fixed and are changed by RBI from time to time depending upon its monetary policy considerations. Currently, it uses repo rate for lending money to Banks and Primary Dealers against acceptable Government securities. However, it currently restricts the said borrowing with a cap of 0.5% of the Net Demand and Time Liabilities (NDTL) of a Bank. In case the Bank still requires more funds, it can access another window called Marginal Standing Facility (MSF) to borrow funds upto 1% of its NDTL. Recently RBI introduced a longer term repo under 7-day and 14-day on Reporting Fridays[8] windows with a market determined interest rate using auction mechanism. RBI also conducts LAF fixed rate repo auction second time in the afternoon on reporting Fridays to ensure that the liquidity is fully absorbed thought currently it opens a second LAF to allow banks to park surplus funds with RBI. The RBI has also made changes to the MSF window timing making it the last time slot (7PM – 7.30PM) in the banking channel for borrowing funds from RBI.

Repo is useful for monetary policy because they have a number of features: (a) it carry a low credit risk as they are collateralized; (b) they are relatively flexible and their features can be tailored by central bank according to liquidity conditions; (c) it does not affect securities prices or yield curve in general; and (d) Central banks can reach out to a broader range of institutions in case of need (viz. extending facility to select non-bank entities at the time financial crisis). Repo market also gives the credit spread to understand the stress in the market. The spread between clean Call rate and Market Repo Rate gives the perceived credit risk in the system. At the time of stress, the spread widens and at the time ample liquidity, the spread shrinks.

The securities used in the RBI daily LAF repo by a Bank (while borrowing money from RBI) can be considered under SLR requirement while the reverse repo deals entered with the RBI by a Bank does not provide SLR benefit as RBI does not use a pure Buy/Sell Back mechanism but credits the securities to a kind of pool account and not to the account of the individual Subsidiary General Ledger (SGL)[9] account of the Banks.

Market Activity

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[8] Alternate Fridays are reporting Fridays for Banks in which their NDTL is calculated for Regulatory maintenance of Cash Reserve Ratio and Statutory Liquidity Ratio.
[9] Banks have to maintain SGL account with RBI for keeping their Securities balances.

In Indian market, RBI support to the banking system through daily LAF has been a major liquidity management tool since its inception. However, the substantial liquidity injected[10] to the banking system in a very short span of time soon after the financial crisis resulted in interest rates moving to their lowest levels in short term money market and Treasury bills market. Since June'10, RBI has been continuously supporting the market with infusion of liquidity through daily LAF.

Table -1: RBI Injection of Liquidity to Banking System (Apr'07 to Nov'13)	
Parameters	Net RBI Support (₹. Crore)
Mean	7871
Standard Error	5890
Median	-1696
Standard Deviation	64252
Minimum	-130978
Maximum	146789
Months	119

Historically, the current stretch has been the longest period in which banks have been continuously borrowing funds from RBI (almost 42 months with a daily average borrowing of more than Rs.75000crores which is almost 1% of the current NDTL of the banking system). However, at times the liquidity support has been very high and touched about 2% of the NDTL of the banking system.

Chart - 1: RBI Policy Rate and Net Systemic Liquidity Support
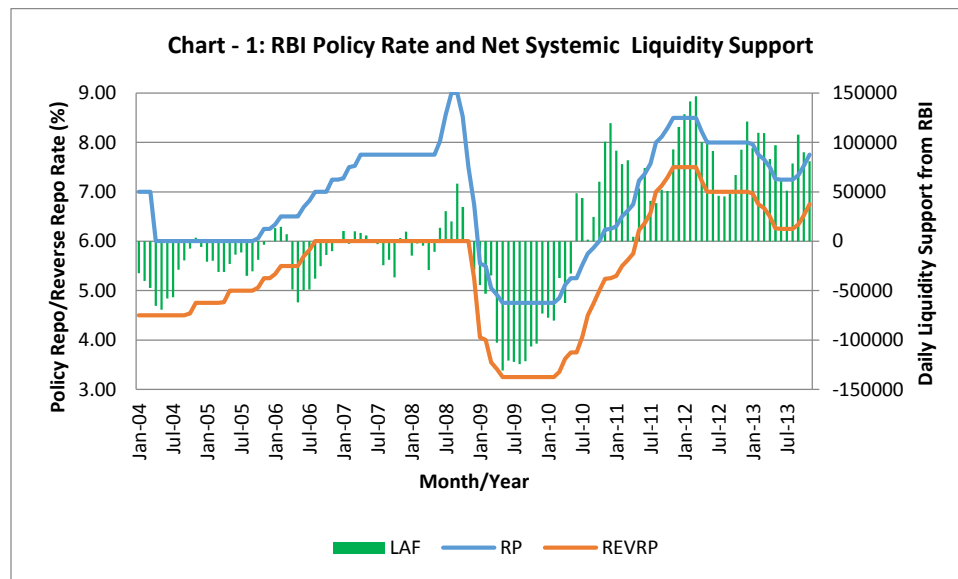
Net support to the banking system has a positive correlation with the policy rates – with Repo rate about 68% co-movement and with reverse repo about 78% co-movement. In recent times, Banks

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[10] RBI injected about Rs.500 ,000Crores (1Crore is 10million) in a short span of time to fend off the impact of financial crisis on Indian financial system.

have been continuously borrowing funds from the RBI. In 2009, the banks parked large sum of funds with the RBI in reverse repo window due to availability of excess liquidity in the system (as a fallout of financial crisis). Daily money market activity has not seen substantial variation during 2004-2013 and remained at about 1% of NDTL. Daily RBI LAF window witnessed wide variations in liquidity as Banks have to manage systemic liquidity with the help of this window.

| Table -2: Repo Rate, Spread, LAF Support and Market Activity (Daily Average)						
Year	Repo Rate	Rev. Repo Rate	Call Rate	Spread	Net LAF Support	Money Market activity[11]
2004	6.25	4.54	4.60	0.39	-35600	15195
2005	6.05	4.96	5.10	0.19	-19858	22969
2006	6.78	5.74	6.42	0.37	-21748	35794
2007	7.67	6.00	6.65	1.00	-6334	48917
2008	8.01	5.94	7.74	0.60	5146	56466
2009	4.92	3.42	3.47	0.60	-94805	81625
2010	5.47	4.15	4.90	0.59	9063	69913
2011	7.48	6.48	7.55	1.01	64524	67252
2012	8.14	7.14	8.30	1.29	94044	70678
2013	7.50	6.50	8.16	1.22	88788	97167

Market has been using RBI LAF system as a most important support system to ensure the proper liquidity management. However, fixed policy rate repos provide direction of the interest rate in the market. The market uses the said information to firm up other interest rates in the system like inter-bank call, market repo and CBLO rates. These three forms of short term market in India forms the backbone of the money market system and these rates typically hover around the policy rates – at the time of excess liquidity in the system, the rates are around the reverse repo rate while at the time of shortage, the same hovers around repo rate. The introduction of CBLO changed the structure of the Money market in India. Before 2004, the market heavily depended on uncollateralized overnight inter-bank call market for funding. RBI made some policy changes and restricted the exposure to uncollateralized market by putting exposure controls as high dependence on uncollateralized call market envisaged systemic risk to the entire system. In Jan'04, uncollateralized call market accounted for 62% of the market share while market repo accounted for 35% and CBLO accounted for less than 3% of the market share. Non-bank entities[12] (excluding Primary Dealers) were phased out from the uncollateralized call market and were advised to move

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[11] Total daily average trading activity in Call, Repo and CBLO markets.
[12] Non-bank entities like Mutual Funds, non-Banking Finance companies and Insurance Companies were typically lenders in the call market and were phased out from the call market in a calibrated manner.

to collateralized markets like Repo and CBLO. As of October'13, the CBLO accounted for about 59% of the market while market repo accounted for 28% market share and uncollateralized call market accounted for 14% of the market share.

RBI has been successful in moving larger volumes in the short term market to the collateralized segment from the clean call market. This has helped in removing systemic risk as well as created demand for securities as traders have to hold securities against which they can borrow funds from counter-parties.

Chart - 2: Market Share in Money Market
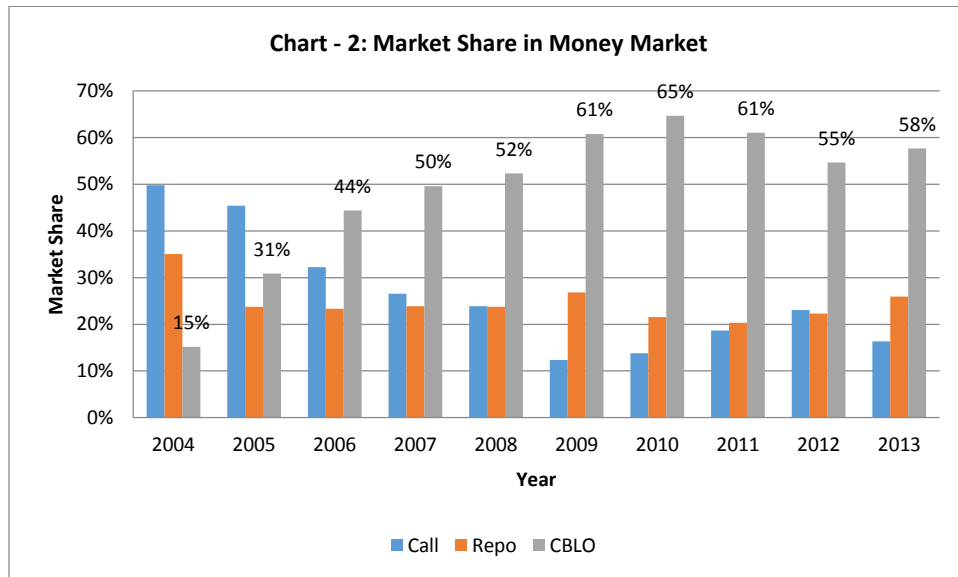
Money Market consolidated trading activity indicates the level of liquidity absorbed by the system. It has a very strong correlation with the systemic liquidity support from RBI. The correlation between absolute of net RBI LAF activity and consolidated money market volume has been found to be about 53% (monthly data from Jan04 to Nov'13) while the correlation between the spread between Call and market repo rates and consolidated money market volume is about 31% (monthly data Jan'04 to Nov'13) while with daily LAF, the correlation was 44%.

Chart - 3: Spread and Money Market Activity
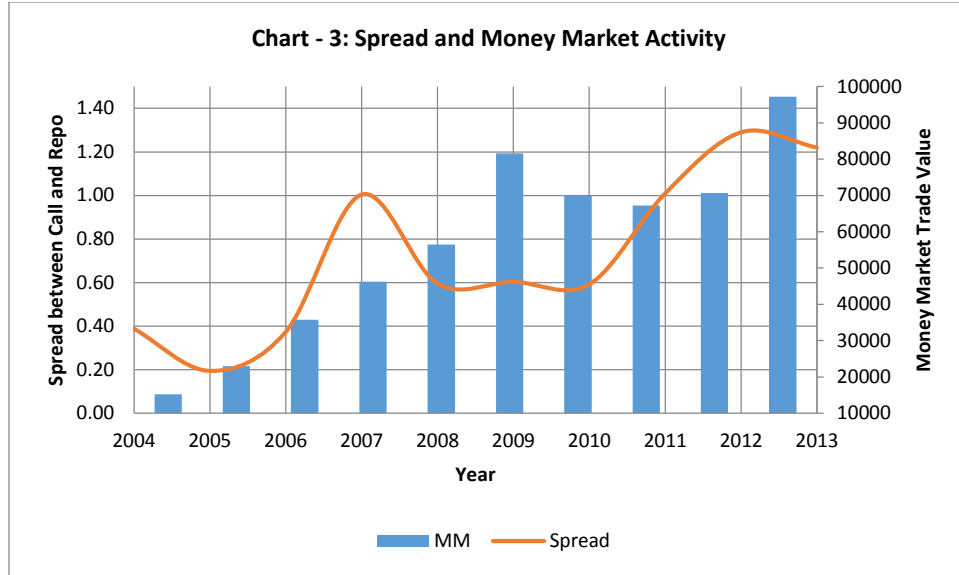
Interest Rate Corridor as measured by the difference between policy Repo and Reverse Repo rate had expectedly negative correlation with LAF (-35%) and Money market activity level (-22%). The short term market predominantly remains a pure overnight market and hence is exposed to high roll over risk. It will be interesting to see how far the recent introduction of term repo of 7 and 14-day on reporting Fridays is going to help in developing the term market in India.

	CV	RV	CBV	Spread	MM	LAF	Abs
Table – 3: Pearson Correlation Coefficients							
Prob > r under H0: Rho=0							
CV	1	0.85	0.79	0.68	-0.05	0.10	-0.20
		<.0001	<.0001	<.0001	0.604	0.33	0.041
RV	0.85	1	0.74	0.55	-0.06	-0.15	-0.24
	<.0001		<.0001	<.0001	0.564	0.125	0.014
CBV	0.787	0.743	1	0.50	0.22	-0.02	-0.07
	<.0001	<.0001		<.0001	0.022	0.878	0.503
Spread	0.68	0.55	0.50	1	0.31	0.44	0.36
	<.0001	<.0001	<.0001		0.001	<.0001	<.0001
MM	-0.05	-0.06	0.22	0.31	1	0.26	0.53
	0.60	0.56	0.02	0.001		0.004	<.0001
LAF	0.10	-0.15	-0.02	0.44	0.26	1	0.25
	0.33	0.13	0.88	<.0001	0.004		0.01
Abs (LAF)	-0.20	-0.24	-0.07	0.36	0.53	0.25	1
	0.04	0.01	0.50	<.0001	<.0001	0.01	

At the time of severe liquidity crunch, the rates move to unprecedented high levels. The volatility measured by the difference between daily high and low call rates and the spread between daily call and market repo rate have a correlation 0.68.

Table – 4: Descriptive Statistics of Volatility, Spread and market Activity						
Variable	N	Minimum	Maximum	Mean	Std Dev	Range
MM	119	10323	116450	55987	26097	106128
LAF	119	-130978	146789	7871	64252	277766
Abs	119	13	146789	51160	39387	146775
Spread	119	0.04	5.14	0.72	0.64	5.10
CV	106	0.76	13.92	2.10	1.48	13.16
RV	106	0.30	7.45	1.15	0.81	7.14
CBV	106	0.28	5.43	1.35	0.89	5.15
MM – Daily Money market activity; Abs – Daily average LAF support (absolute); CV, RV and CBV– Volatility in Call Repo and CBLO markets						

Securities Used in Repo Transactions

Repo transactions in Indian repo market use mostly Government securities though corporate bonds can be used for such transactions. Very few transactions take place using corporate bonds. Though market has a choice of using different permissible Government securities like Floating Rate Bonds, State Development Loans, Special securities like Oil Bonds issued by Government to fund oil pool deficits (subsidy payments), and Treasury Bills, traders have been using pure Government securities though in recent time, the Treasury Bills have been contributing to a sizeable share in total repo deals. This increase in market share for Treasury Bills is mainly due to high value of Treasury Bills issued since last three years[13].

Table – 5: Descriptive Statistics of Maturity of Securities used in Repo Deals				
MATURITY	Deals	Value	Share	Cumulative
< 1	4727	1190017	5.66%	5.66%
1	12103	3093265	14.72%	20.39%
2	13475	3071121	14.62%	35.00%
3	7213	1622740	7.72%	42.73%
4	8462	1970000	9.38%	52.10%
5	9192	1728779	8.23%	60.33%
6	6396	802253.8	3.82%	64.15%

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[13] Government has issued high value of short term Treasury Bills and Cash management Bills in the aftermath of Financial crisis. The notified amounts for Treasury Bills have increased substantially in recent times.

7	7915	1263331	6.01%	70.16%
8	6195	921031.5	4.38%	74.55%
9	9545	1062864	5.06%	79.60%
10	15383	1812031	8.62%	88.23%

Traders use the repo market in India more for liquidity management and less for managing portfolio of securities as can be seen from the portfolio of underlying securities used in the repo transactions. The market uses very short term securities and securities upto 2 years account for 35% of total repo deals in terms of value.

Table – 6: Descriptive Statistics of Securities used in Repo Transactions					
Year 2007					
Year	FRB	GS	SDL	SPL	TB
Securities	4	48	44	18	101
Value	1841	2234434	26481	253690	240102
Share	0.1%	81.1%	1.0%	9.2%	8.7%
Deals	55	13633	797	2945	2194
Year 2008					
Securities		50	50	25	106
Value		2863365	56792	635302	346845
Share	0	73.4%	1.5%	16.3%	8.9%
Deals		14336	1022	5710	2005
Year 2009					
Securities	1	58	75	22	120
Value	466	4936353	27613	327974	905559
Share	0.01%	79.6%	0.4%	5.3%	14.6%
Deals	9	21308	918	3331	5277
Year 2010					
Securities	1	61	62	15	133
Value	16728	3316671	16500	190150	847600
Share	0.38%	75.6%	0.4%	4.3%	19.3%
Deals	215	17931	703	2091	5864
Year 2011					
Securities	1	62	67	7	151
Value	55503	2202319	19475	206255	1468191
Share	1.40%	55.7%	0.5%	5.2%	37.2%
Deals	324	16383	571	1900	9619
Year 2012					

Securities	1	64	92	7	148
Value	103000	2256932	70177	78166	2101344
Share	2.2%	49.0%	1.5%	1.7%	45.6%
Deals	825	21145	1054	635	15087
Year 2013					
Securities	1	62	66	3	139
Value	1861	3200473	24508	1068	2831606
Share	0.0%	52.8%	0.4%	0.0%	46.7%
Deals	23	22618	543	22	16007

The most liquid securities in the underlying outright market are typically benchmark securities like 10-year and 5-years bonds. The markets share of these securities in repo deals is about 8% each vis-à-vis about 40% for 10-year bonds in outright underlying market. From the behavior of the repo market transactions, it can be implied that the market uses the repo deals to manage liquidity and not for leveraging securities portfolio holding. This may be due to the fact that the lending side of the market in repo is dominated by Insurance Companies and Mutual funds who typically do not have trading interest in securities and accept the securities as collaterals against funds lent. As the market does not witness significant short selling or as there is no Interest Rate Futures (IRF) market in India which requires borrowing of securities for delivery against obligations.

Determinants of Spread

Spread and volatility are important factors in understanding the stress in the market. The tight liquidity implies higher credit risk in the system and spread between collateralized and uncollateralized rates widens when the stress goes up in the market. However, empirically, volatility in Call market is relatively higher than the repo and CBLO markets. Call market is preferred by borrowers only when the avenues to access funds using collaterals are exhausted and can be said as a residual borrowing by Banks and Primary Dealers. Lenders would charge a premia when lending it in Call as they perceive the market as relatively riskier vis-à-vis other collateralized markets.

Chart 4: Spread and Volatility vis-a-vis Market Activity
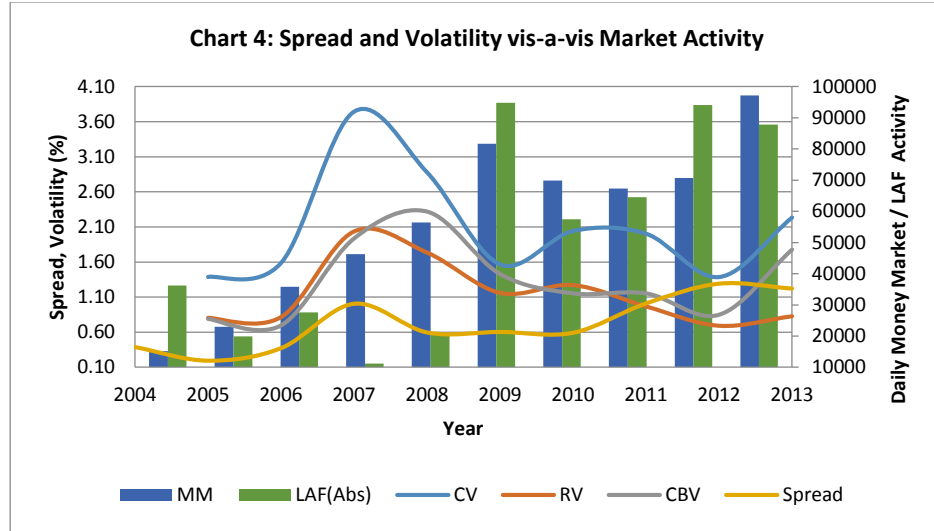
The daily LAF activity gives the systemic liquidity shortage or excess as Banks and Primary Dealers would use this window to manage their balance sheet. If LAF support is not sufficient due to quantitative limits or if the LAF policy rate is lower in other comparable markets like CBLO and market repo, then borrowers having securities would like to use these markets to borrow. Theoretically, the spread should be dependent on the amount of LAF support, money market activity, lagged spread (to find it there is any autoregressive structure) because past spreads indicate the continuity of stress condition. Further, the interest rate corridor has great significant to understand monetary policy stance of the central bank. In a channel system like LAF, RBI offers two standing facilities: a lending facility where it is ready to supply money overnight at a given lending rate against collateral and a deposit facility where banks can make overnight deposits to earn a deposit rate. The interest-rate corridor is chosen to keep the overnight interest rate in the money market close to the target rate. In a pure channel system, a change in policy is implemented by simply changing the corridor without any open market operations. Central banks typically react to changing economic conditions by increasing or decreasing their interest-rate corridor. The money market rates should be in the middle of the corridor. Widening of the corridor implies tighter monetary policy stance as borrowing from central bank is relatively costlier than placing money with the central bank. Hence, the interest rate corridor should also give some indication of the spread. The typical corridor used by RBI in normal circumstance has been 100bps. Hence, if the same goes beyond 100bps, we assume the tightening of the policy. We have used corridor as a dummy variable in the regression model. The linear regression model is likely to provide the determinants of the spread.

$$Spread_t = \alpha + \beta_1 * LAF + \beta_2 * MM + \beta_3 * Sp_{t-1} + \beta_4 * Sp_{t-2} + \beta_5 * Sp_{t-3} + \beta_6 * COR + \varepsilon \dots (1)$$

Table – 7: General Linear Model Results (Jan'04 – Nov'13 excluding Mar-Apr'07)				
Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.1213	0.0816	1.49	0.1401
LAF	1.91E-06	5.91E-07	3.23	0.0016
MM	3.71E-06	1.22E-06	3.04	0.0029
LS	0.5078	0.0939	5.41	<.0001
LS1	-0.0781	0.0659	-1.18	0.2388
LS2	0.0715	0.0515	1.39	0.1677
COR1	-0.0386	0.0688	-0.56	0.5756
R-Square		903	AIC	Durbin h[14]
0.6484		0.2894	48.2832	-0.4518(0.3257)
- * Indicates significant at 99%				

The estimated model indicates lag spread has no significant influence on the current spread. However, the spread is influenced by the LAF support and total money market activity and the relationships are positive. The original dataset contained two months of data which were found to be extreme outliers due to some extraordinary liquidity measures[15] introduced in March'07. The effect of the same continued till April'07[16] and the spread for March'07 was more than 5% while for April, the same was more than 2%. We publish the above results after dropping these two data outlier points. The Durbin-h stat clearly shows that h statistic is -0.4518 which is not statistically significant with a p-value of 0.3257, indicating no autocorrelation. Interest Rate corridor was not found to be statistically significant. Hence we dropped the same and the results did not change substantially (R-Sq changed from 0.6484 to 0.6474). The results show that LAF activity and consolidated money market activity along with one period lagged Spread has significant influence on the spread. The residual of the regression is normally distributed (Kolmogorov-Smirnov D stat of 0.079 (p value >0.08) indicating a better fit of the model.

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[14] Since lagged values are included in the equation, DW stat is not strictly valid. Durbin h is reported.
[15] Starting March 5, 2007, daily reverse repo absorptions was limited to a maximum of Rs.3,000crore each day comprising Rs.2,000crore in the First LAF and Rs.1,000crore in the Second LAF. This was announced at a time when Banks were parking about Rs.30000crores in RBI LAF window (on March 1, 2007).
[16] The restriction on reverse repo quantum was withdrawn in July'07.

Chart - 5: Distribution of Residual
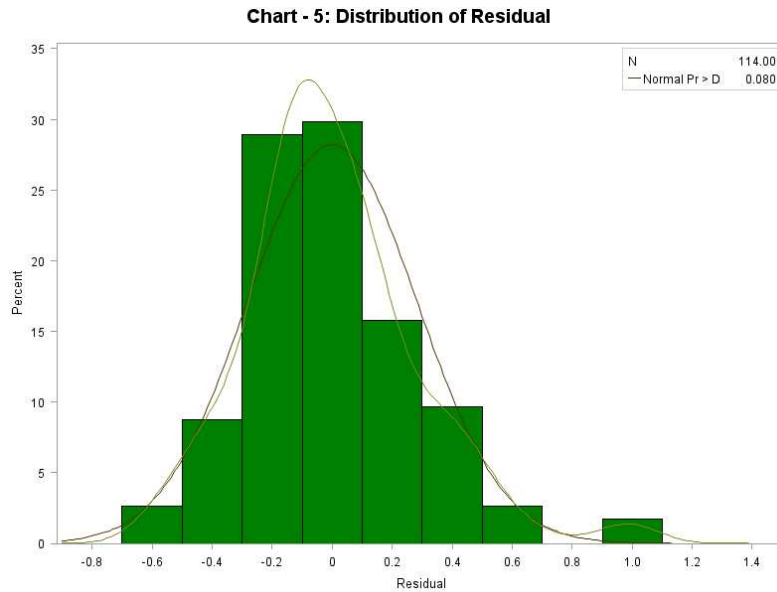
Chart-6: Kernel Density for Spread and Residual of Regression Model
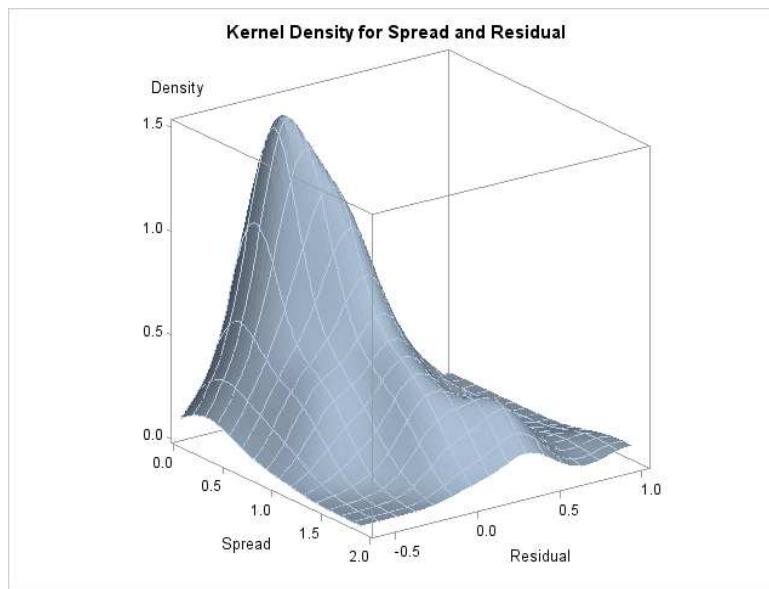
Determinants of Spread when Central Bank Absorbs Liquidity vs. Injecting Liquidity

Central bank liquidity support structure is the driver of systemic liquidity while the interbank market is the main market for trading in liquidity at appropriate cost. Central bank liquidity support (both infusion and injection) can be viewed as the market for primary liquidity whereas the interbank market can be considered as the secondary market for liquidity, where the liquidity obtained in the primary market is reallocated with

appropriate risk cover[17]. The study tried to understand if the spread behavior is different in different scenarios – excess secondary market liquidity in which the Central Bank absorbs liquidity and shortage of secondary market liquidity in which the Central Bank infuses liquidity to the system. We divided the dataset (Jan'04-Nov'13 excluding Mar-Apr'07 for specific reason already explained earlier in this paper) into two panels of datasets – Absorption and Injection.

Surplus liquidity may have no material influence on policy effectiveness, as has been the case in Hungary and South Africa (De Bondt (2002)). With surplus liquidity, monetary policy transmission mechanism can break down or become weakened. If the banks have surplus funds, the commercial bank will have discretion as to whether they lend their surplus to the central bank at the policy rate or create more credit by lowering credit standard if the policy rate is not attractive and the banks have the risk appetite. In case of surplus, the central bank's ability to transmit its preferred interest rate structure (yield curve direction) into the market gets weakened. The central bank being the monopoly supplier of funds in case of a shortage situation (banker of the last resort for commercial banking system), it works as a *price setter* - thereby indicating the marginal price of the banks' credit to commercial sector. If the shortage is a continuing feature of the market, the central bank becomes a net creditor of the banking system and the effectiveness of the monetary policy is likely to be stronger. However, the level of acceptable shortage for effectiveness of the monetary policy is a debate in itself.

In order to understand if the determinants of the spread are different in different market situation, we divided the data into two categories – absorption and injection of liquidity by RBI using the Linear Regression model in Eq 1. The result showed that in case of Injection of liquidity, lagged spread is significant along with LAF activity but in case of absorption, only LAF activity is significant. However, the results for INJECT shows AR structure.

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[17] A Bank may obtain Central Bank liquidity by using its excess holding of approved securities and use the same in the inter-bank Call market to lend at higher rate to a Bank which does not have required securities to obtain funding from Central Bank.

Table – 8: General Linear Model Results (Jan'04 – Nov'13 excluding Mar-Apr'07)								
Parameter Estimates - ABSORB					Parameter Estimates -INJECT			
Variable	Estimate	Standard Error	t Value	Approx Pr > |t|	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	0.0285	0.0515	0.55	0.583	0.3082	0.1462	2.11	0.0399
LAF	-2.90E-06	7.64E-07	-3.79	0.0004	3.92E-06	1.52E-06	2.58	0.0128
MM	1.66E-06	1.05E-06	1.58	0.1202	-1.61E-07	2.50E-06	-0.06	0.949
LS	0.1829	0.1116	1.64	0.1075	0.4394	0.1336	3.29	0.0018
LS1	0.1022	0.1088	0.94	0.3518	-0.0968	0.0818	-1.18	0.2425
LS2	0.0296	0.0488	0.61	0.5468	0.1294	0.1324	0.98	0.3331
R-Sq	RMSE	Durbin h			R-Sq	RMSE	Durbin h	
0.59	0.16983	0.56(0.29)			0.55	0.3316	-30.24(.01)	

Further, to understand if the spread behaves in a different manner when the system has excess liquidity vis-à-vis shortage of liquidity, we used a Regime Switching model using Goldfeld and Quandt's D-method for switching regression. Assuming that observations exist on some exogenous variables, z_{1i}, z_{2i}, .., z_{pi}, where z determines whether the ith observation is generated from one equation or the other. The equations are given as follows:

$$y_i = x_j' * \beta_1 + u_{1i} \quad if \sum_{j=1}^{p} \pi_j * z_{ji} \leq 0$$

$$y_i = x_j' * \beta_2 + u_{2i} \quad if \sum_{j=1}^{p} \pi_j * z_{ji} > 0$$

where π_j are unknown coefficients to be estimated. Define $d(z_i)$ as a continuous approximation to a step function. Replacing the unit step function with a continuous approximation by using the cumulative normal integral enables a more practical method that produces consistent estimates.

$$d(z_i) = \frac{1}{\sqrt{2\pi}\sigma} \int_{-\infty}^{\sum \pi_j * z_{ji}} \exp\left[-\frac{1}{2}\frac{\varepsilon^2}{\sigma^2}\right] d\varepsilon$$

D is the n dimensional diagonal matrix consisting of d(zi)

$$D = \begin{bmatrix} d(z_1) & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & d(z_n) \end{bmatrix}$$

The parameters to estimate are now the k β_1's, the k β_2's, σ_1^2, σ_2^2, p π's, and the σ introduced in the $d(z_i)$ equation. The σ can be considered as given *a priori*, or it can be estimated, in which case, the estimated magnitude provides an estimate of the success in discriminating

between the two regimes (Goldfeld and Quandt 1976). Given the preceding equations, the model can be written as:

$$Y = (1 - D) * X * \beta_1 + D * X * \beta_2 + W$$

Where W = $(1 - D) * U_1 + D*U_2$, and *W* is a vector of unobservable and heteroscedastic error terms. The covariance matrix of *W* is denoted by Ω, where $\Omega, = (1 - D)^2 * \sigma_1^2 + D^2 * \sigma_2^2$. The maximum likelihood parameter estimates maximize the following log-likelihood function.

$$\log L = -\frac{n}{2} log 2\pi - \frac{1}{2} log|\Omega| - \frac{1}{2} * [[Y - (1 - D) * X * \beta_1 - D * X * \beta_2]'^{\Omega^{-1}} * [Y - (1 - D) * X * \beta_1 - D * X * \beta_2]]$$

The parameter estimates and ANOVA table from this regression are shown below.

Table 9 : Nonlinear Likelihood Parameter Estimates for the Regime Switching Model				
Parameters for Two Regimes	**Estimate**	**Approx Std Err**	**t Value**	**Approx Pr > |t|**
sig1	0.299759	0.0294	10.2	<.0001
sig2	0.301833	0.0267	11.31	<.0001
intercept1	0.176698	0.216	0.82	0.4151
LS	0.636381	0.0997	6.38	<.0001
COR	-0.03858	0.1	-0.39	0.7004
MM	2.43E-06	1.88E-06	1.29	0.1994
intercept2	-0.06541	0.1596	-0.41	0.6828
LS	0.732519	0.1028	7.12	<.0001
COR	0.064435	0.1007	0.64	0.5239
MM	2.96E-06	1.75E-06	1.69	0.0943
p	445.2923	0	.	

Nonlinear Likelihood Summary of Residual Errors							
Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
spread	11	105	10.5031	0.1	0.3163	0.5905	0.5515

We have included five TEST statements to test the hypothesis that the parameters are the same in both regimes. The test results shown suggest that the variance Spreads, Sig1 and Sig2, are not significantly different in the two regimes. This clearly tells that the monetary policy is stable in both the regimes and the effectiveness of monetary policy in both the

regimes are not statistically different. The tests also show a significant difference in the AR term on the Spreads.

Table – 10: Test Results from Regime Switching Model (test of Coefficients)				
Test	**Type**	**Statistic**	**Pr > ChiSq**	**Label**
Test0	L.M.	0.8	0.3711	int1 = int2
Test1	L.M.	18372*	<.0001	b11 = b21[18]
Test2	L.M.	0.52	0.4702	b13 = b23
Test3	L.M.	3.14E+22*	<.0001	b14 = b24[19]
Test4	L.M.	0	0.9584	sig1 = sig2
* indicates significant at 1%				

Conclusion

Repo is used by market participants to obtain funds or to obtain securities depending on the need. This latter feature of the instrument is valuable to traders as it helps them to meet their contractual obligations, such as to make delivery for a short sale or against a futures contract. Repos are also used for leverage, to fund long positions in securities and to fund short positions for hedging interest rate risks. Repo markets have strong linkages with securities and derivatives markets. Repos are used by central banks both as a monetary policy instrument and as a source of information on market expectations. Repos carry a low credit risk as these are fully collateralized transactions and are used by central banks for liquidity management. Central banks also use Repo as an effective mechanism for signaling the stance of monetary policy.

In India, RBI has been using Repo as an instrument for monetary policy by institutionalizing daily Liquidity Adjustment Facility which allows banks and Primary Dealers to manage their liquidity needs. Market participants also trade in Repo using Government securities. The Repo market in India has been growing steadily and both Repo and CBLO account for a large part of the total short-term Money Market transactions.

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[18] Significant at 1% for Coefficient of Lag of Spread (AR term) in both regimes.
[19] Significant at 1% for Coefficients of Money Market Volume in both regimes

Liquidity stress in the market has an impact on the short term interest rate. The entities who do not maintain sufficient amount of Government securities in their portfolio may have to borrow funds in the inter-bank call market at higher interest rate. The spread between Call and Repo rate widens when there is liquidity stress in the market. The current study has explored the determinant of the spread. It found that LAF window activity as well as total money market activity has an impact on the Spread. In order to understand if the spread behaves in a different manner when the system has excess liquidity vis-à-vis shortage of liquidity, we used a Regime Switching model using Goldfeld and Quandt's D-method for switching regression. The tests found that the monetary policy is stable in both the regimes and the effectiveness of monetary policy in both the regimes are not statistically different.

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