Daily Reserves Maintenance Behaviour of Banks

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This article analyses the daily reserve maintenance behaviour of scheduled commercial banks (SCBs) in India across various cash reserve ratio (CRR) policy changes over the past decade. The analysis reveals that (i) the flexible inflation targeting (FIT) regime and introduction of automated sweep-in and sweep-out (ASISO) facility has been associated with a lower level of average daily excess reserves maintained by SCBs, freeing up incremental resources that may be used by banks for productive purposes; (ii) there has been reduction in volatility in daily reserves maintenance post ASISO, enabling banks to manage their daily reserves more effectively; and (iii) banks better manage their reserves when daily minimum maintenance requirements are at 90 per cent, with lower requirements leading to higher volatility.

Introduction

Reserve requirements, traditionally refer to the proportion of deposit liabilities with a bank that are usually impounded by central banks to increase public welfare by preventing banking panics and/or to execute changes in monetary policy. Changes in these requirements also alter the supply of credit. In a modern financial system, cash reserve ratio (CRR) requirements play multiple roles – (i) for prudential regulation by imposing liquidity buffers on financial institutions (microprudential), and thereby increasing system wide resilience against systemic shocks (macroprudential); (ii) for monetary policy implementation in different operational frameworks; and (iii) for liquidity management (Valle *et al.*, 2022; and Gray, 2011). Minimum reserve requirements can help in guiding and stabilising overnight rates. Reserve requirements when used as an additional instrument can improve policy outcomes substantially in an economy where financial frictions are present, and the central bank has a financial stability objective. Increase in reserve requirements reduces credit and output as banks pass the higher costs and restrict financing conditions; while on the other hand, it also reduces the incidence and severity of financial stress episodes. Immediate credit/output loss is compensated by reduced probability of financial stress; thus, the reserves requirements can be used to build financial sector resilience and reduce financial stress, the benefits being higher for emerging market economies than advanced economies (Glocker and Towbin, 2012 and Cantú *et al.*, 2024).

In India, all scheduled banks are required to maintain CRR as per Section 42(1) of the Reserve Bank of India (RBI) Act, 1934. Under the Act, banks are required to maintain a specified proportion of their net demand and time liabilities (NDTL) on an average basis over a reporting fortnight as CRR balances with the RBI. The averaging of reserves over a reporting fortnight is subject to maintenance of a minimum daily balance (stipulated as a proportion of actual regulatory requirements) during the fortnight. In a reserve averaging system, banks' demand for reserves are elastic on a daily basis, but interest inelastic on a longer-term basis due to the presence of standing facilities. Within the reporting fortnight, banks choose their daily maintenance levels based on a cost-benefit analysis of interest rate expectations *vis-à-vis* the rates on standing facilities. The CRR instrument underwent several changes during the refinement of monetary policy operations and the adoption of the flexible inflation targeting (FIT) framework by the RBI.

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To provide greater flexibility to banks in managing their day-end CRR balances, the RBI provided an optional automated sweep-in and sweep-out (ASISO) facility in August 2020 under which banks were able to pre-set a specific amount (or range) that they wished to maintain at the end of the day. Any shortfall or excess balances maintained by banks would automatically trigger marginal standing facility (MSF) or standing deposit facility (SDF) /reverse repo bids under the ASISO facility.

Considering the diverse behaviour of banks in maintaining cash reserves, the article has two broad objectives. Primarily, it analyses the reserve maintenance behaviour of banks under the pre-FIT and FIT regimes. Secondly, it looks into the introduction of ASISO and 24x7 payments system facilities and their impact on the volatility of reserve maintenance of the banks. Such measures are expected to lead to better liquidity planning and hence more efficient daily reserve maintenance by banks, with less volatility in the average daily maintenance. The analysis will help to better understand the efficacy of these measures introduced by the RBI.

With this backdrop, the article is structured into six sections. The next Section presents a brief history of regulatory requirements of CRR and its evolution over time. Section III depicts some of the stylised facts on the CRR maintained by SCBs. In Section IV, recent developments in CRR are discussed, while Section V gives an empirical analysis of the volatility of daily reserve maintenance of banks; Section VI concludes the article.

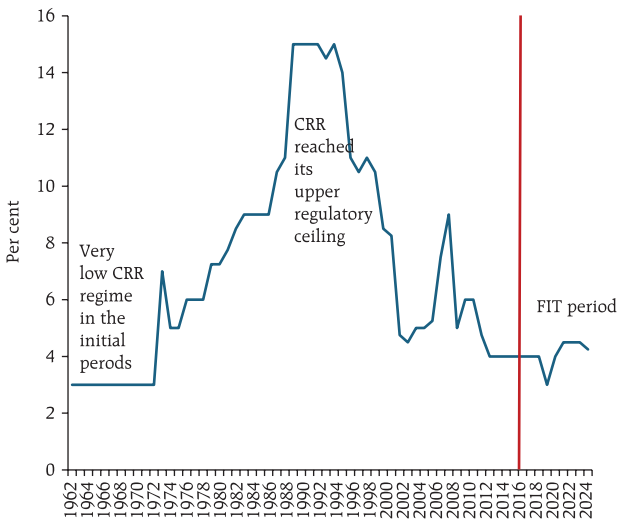
II. A Brief History of CRR in India

The reserve maintenance system in India has evolved over time. Initially, in terms of Section 42(1) of the RBI Act, the Reserve Bank could prescribe CRR for scheduled banks between 3 per cent and 20 per cent of total of their demand and time liabilities. With the amendment to the RBI Act in 2006, the RBI was provided greater flexibility in reserves management by removing the floor or ceiling on CRR prescriptions. In view of the amendment carried out in the RBI Act, (omitting sub-section (1B) of Section 42), RBI does not pay any interest on the CRR balances maintained by SCBs with effect from the fortnight beginning March 31, 2007.

Prior to September 1962, there were two separate reserve ratios for demand and time liabilities. The CRR to be maintained was 5 per cent and 2 per cent, respectively, for the demand and time liabilities. From September 16, 1962, uniform CRR prescription of 3 per cent was applied to both demand and time liabilities. Till 1980, regulatory CRR requirement level was below 6 per cent. During the 1980s, monetization of the fiscal deficit progressively became a dominant influence on the conduct of monetary policy, which had to contend with the secondary rounds of monetary expansion entailed by primary budget financing. Consequently, the CRR evolved as one of the principal instruments of monetary policy and the level of the CRR rose progressively to 15.0 per cent by 1992. At this high level, the CRR was viewed as a punitive tax on the banking system, adversely impacting their profitability. In the ensuing period, the CRR was gradually reduced to close to 10 per cent in 1998 and further to the range of 4 to 5 per cent during 2002-2006. The CRR was raised from 5.5 per cent to 9 per cent between January 2007 to August 2008 to tighten liquidity conditions prior to the unravelling of the global financial crisis (GFC) but was subsequently reduced sharply to 5.5 per cent in November 2008 and to 4.0 per cent by February 2013. Subsequently, from the time when the RBI adopted the FIT in 2016 till the COVID-19 pandemic in 2020, CRR remained unchanged at 4.0 per cent.

The reserve requirement was reduced to 3.0 per cent to supplement systemic liquidity when the pandemic struck in March 2020. CRR was normalised back in two phases to the pre-pandemic level of 4.0

Chart1: Historical Movements of Regulatory CRR in India



Source: DBIE, RBI.

per cent in May 2021. It was subsequently increased to 4.5 per cent in May 2022 as monetary policy stance shifted to withdrawal of accommodation. In December 2024, consistent with the neutral policy stance, CRR was proactively reduced by 50 basis points to 4.0 per cent of NDTL in two equal tranches of 25 bps each with effect from the fortnight beginning December 14, and 28, 2024 (Das, S., 2024) (Chart 1).

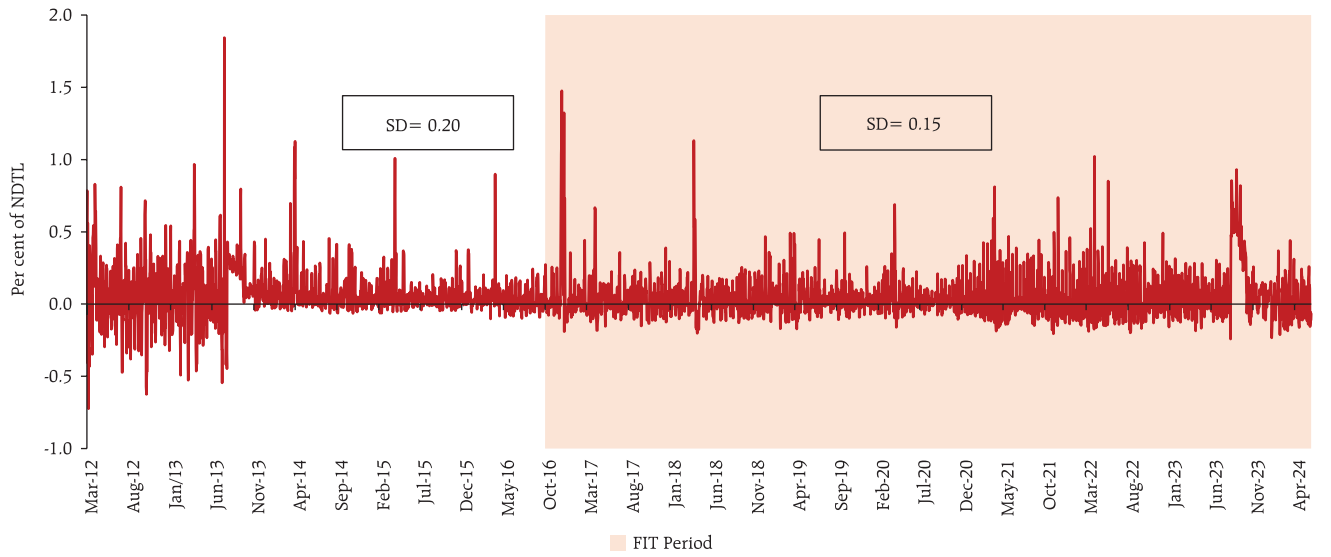
III. Stylised Facts on the CRR Maintained by SCBs

III.1 Pattern of CRR Maintained

Behaviourally, scheduled commercial banks (SCBs) maintain reserves over and above the daily requirements for several reasons. Such liquidity buffer helps them to manage unexpected cashflows, enabling better risk management and facilitate smooth payment and settlements aiding better operational efficiency. This would also enable them to adjust average maintenance during the fortnight as banks have to maintain 100 per cent of required reserves on an average. The cash reserves maintained by SCBs exhibit fluctuations in their daily maintenance. The volatility in daily excess reserves maintained by SCBs as a proportion of NDTL has fallen during the FIT period mainly attributed by the refinements in liquidity management and operating procedure of the monetary policy (Chart 2).

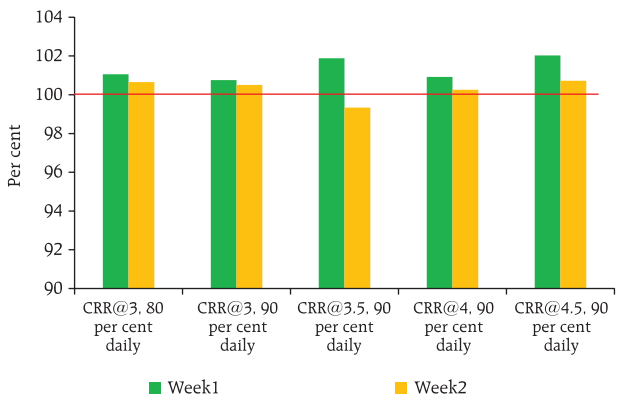
SCBs' daily cash reserve maintenance pattern reveals that there was a tendency of frontloading of reserves (more reserves maintained during the first week of the fortnight). The frontloading of cash reserves by SCBs was mainly to have greater

Chart 2: Maintenance of Excess CRR by SCBs



Source: DBIE, RBI.

Chart 3: Patterns of Average CRR Maintenance by SCBs as a Percentage of Requirement (Week-1 *vis-à-vis* Week-2) over Different Regimes



Notes: (i) Daily reserve maintenance by the SCBs (excluding small finance banks and payment banks) starting from 02 March 2019 to 30 April 2024.
(ii) Red line denotes 100 per cent daily maintenance during the fortnight.
Sources: DBIE, RBI; and Authors' calculations.

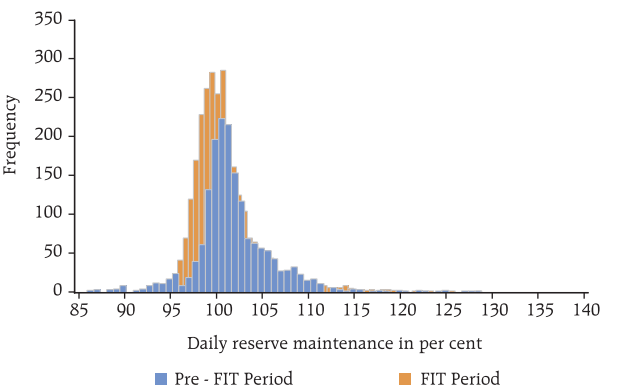
flexibility to meet the average maintenance requirement. Daily maintenance of CRR depends on business considerations of banks based on the evolving interest rate scenario. Moreover, at the systemic level, if the liquidity is in surplus during the first week of the reserve maintenance period, it could take care of the average requirement for the entire fortnight if the liquidity is deficit in the second week. Further, banks also maintain surplus reserves prior to holidays/weekends to take care of the unexpected cash outflows. Unanticipated cash outflows may drain out the reserves which may have an impact on daily minimum maintenance of required reserves. During holidays, when banks do not have many avenues for mobilising resources, excess reserves are maintained (Chart 3).

III.2 Distribution of Daily Maintenance of CRR as a Percentage of Requirement

The FIT regime adopted in September 2016 requires RBI to target the consumer price index (CPI) inflation at 4 per cent with the upper tolerance limit of 6 per cent and the lower tolerance limit of 2 per cent, while keeping in mind the objective of growth. The monetary policy committee (MPC) decides the policy repo rate to achieve the target. The operating framework of monetary policy aims at aligning the operating target, weighted average call rate (WACR), with the policy repo rate. Proactive liquidity management of the RBI facilitates the transmission from the policy repo rate to the entire financial system, which in turn, influences aggerate demand — the key determinant to balance inflation and growth.

In India, reserves need to be maintained on an average basis over a fortnight; however, a certain per cent of the CRR requirement needs to be maintained on any given day during the fortnight. This has helped banks in their day-to-day liquidity management to meet unforeseen flows while avoiding undue volatility in demand for funds. Banks' reserve maintenance is also in consonance with the changing liquidity conditions. The distribution of daily reserve balances by all SCBs as a percentage of requirement in the pre-FIT period and FIT period indicates a clear transition in the daily maintenance pattern mainly due to the evolving and refinement of liquidity management framework (Chart 4). In the pre-FIT

Chart 4: Distribution of Daily Reserve Maintenance as a Percentage of Requirement by SCBs (Pre - FIT *vis-à-vis* FIT)



Note: Daily reserve maintenance by the SCBs (excluding small finance banks and payment banks) starting January 2, 2012 to September 30, 2016 represents pre-FIT period and the FIT period covering the period from October 1, 2016 to April 30, 2024.
Sources: DBIE, RBI; and Authors' calculations.

period, SCBs were maintaining reserves in the range of 85 to 120 per cent of requirement along with a positive skew. During the FIT period, the range of daily reserve balances has reduced (in the range of 95 to 115 per cent) with some outliers.

The shift in distribution of daily reserve maintenance was reflected in the changes in skewness and kurtosis. In the FIT period, more banks were maintaining below 100 per cent on some days of the fortnight. With the improvement in the liquidity management framework during the FIT period, banks choose an optimum strategy of holding reserves based on their intraday cash flows and money market participation — enabling them to be more flexible in managing daily reserve requirements. A lower kurtosis value in the FIT period also substantiates the fact that most banks have maintained close to the average daily reserves as compared with the pre-FIT period. The volatility (measured in terms of standard deviation) of the daily reserve requirements of SCBs has reduced in the FIT period, indicating that the uncertainty on liquidity has reduced as compared with the pre-FIT period (Chart 4 and Table 1).

The average (mean) daily reserve maintenance as a percentage of requirement reduced during the FIT period as compared with the pre-FIT period. The volatility (as measured by standard deviation) has also decreased to 3.5 from 4.4 in the pre-FIT period. The statistical significance of differences in means and variances under the FIT period was tested against the pre-FIT period by formulating the following two hypotheses.

Table 1: Descriptive Statistics of Daily Maintenance of CRR as a Percentage of Requirement by SCBs

(in per cent)	Pre-FIT	FIT
Mean	101.9	100.9
Median	101.2	100.3
Maximum	146.1	128.3
Minimum	86.1	94.6
Std. Dev.	4.4	3.5
Skewness	1.6	2.1
Kurtosis	13.6	10.7

Note: Daily reserve maintenance by the SCBs (excluding small finance banks and payment banks) starting January 2, 2012 to September 30, 2016 represent pre-FIT period and the FIT period covering from October 1, 2016 to April 30, 2024.
Source: DBIE, RBI.

H01: There is no significant difference in the average daily reserve maintenance of SCBs between pre-FIT and FIT regimes.

H02: There is no significant difference in the variances (volatility) of daily reserve maintenance of SCBs between pre-FIT and FIT regimes.

The above hypotheses were tested through a couple of statistical tests. Both hypotheses were rejected at 1 per cent level of significance indicating that there is a significant difference in daily maintenance of CRR for pre-FIT and FIT regime (Table 2). Lower reserves maintenance post FIT would help in freeing up incremental resources of banks that may be deployed for productive purposes. The reduction in variance of the daily reserve maintenance by SCBs from the pre-FIT and the FIT period suggests, *inter alia*, lower uncertainty about liquidity availability, thus facilitating better reserves maintenance.

Table 2: Test Results for Equality of Mean and Variance

Mean Test			Variance Test		
Test Name	**Test statistic**	**p-value**	**Test Name**	**Test statistic**	**p-value**
t-test	7.92***	0.00	F-test	1.57***	0.00
Welch F-test	56.51***	0.00	Bartlett	111.24***	0.00

Note: All test statistics are in favour of rejecting the null hypothesis at one per cent level of significance, indicated by ***.
Sources: DBIE, RBI; and Authors' estimates.

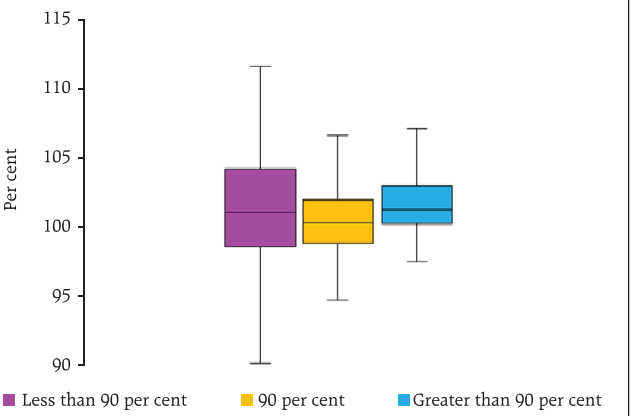
III.3 Distribution of Daily Maintenance of CRR as a Percentage of Requirement under Different Daily Minimum CRR Requirement Regimes

As discussed earlier, besides the prudential and monetary role, CRR is also used as a tool for liquidity management. CRR was used as an instrument of monetary policy and liquidity management in the pre-FIT regime, and it remains an important tool in the monetary policy toolkit even in the FIT regime. Apart from the absolute level of CRR, the norms on its daily minimum maintenance also play a crucial role in stabilising the overnight market rates. The daily minimum CRR requirement has varied between 70 per cent to 99 per cent on different occasions. In order to keep the system liquidity in surplus during the COVID-19 crisis, taking cognisance of hardships faced by banks in terms of social distancing of staff and consequent strains on reporting requirements, the daily minimum maintenance of the CRR was reduced to 80 per cent from the 90 per cent requirement (during the period from March 28, 2020 to September 25, 2020). On the contrary, daily minimum CRR balances requirement was raised to 99 per cent to tighten liquidity conditions during the 2013 taper tantrum from July 27, 2013 to September 30, 2013 as part of measures for monetary defence of the exchange rate (Kavediya and Pattanaik, 2016).

Banks' daily reserves maintenance behaviour under various prescriptions of daily minimum balances maintenance of CRR shows that there were changes in inter-fortnight variability across different regimes (Chart 5).

Volatility in the daily reserve requirements was notably high when the daily minimum prescription was low. Comparing the volatilities and average daily maintenances of CRR by SCBs under three different scenarios, *i.e.*, when the daily minimum prescriptions was less than 90 per cent, 90 per cent, and greater than 90 per cent, SCBs exhibited least volatility for the 90 per cent prescription while other two prescriptions (more than 90 per cent and less than 90 per cent) showed higher volatility in the reserve maintenance (Table 3).

Chart 5: Distributional Patten of Daily CRR Maintenance of SCBs under Different Daily Minimum CRR Stipulations



Note: Daily reserve maintenance by the SCBs (excluding small finance banks and payment banks) starting from the period January 2012 to April 2024. Outliers are excluded in the charts.
Source: DBIE, RBI; and Authors' calculation.

Thus, both extreme prescriptions – too much flexibility or too much stringency – were associated with increased volatility in daily reserves maintenance behaviour of banks. Extreme prescriptions have been made during challenging times and could have also resulted in more volatility in reserve maintenance by SCBs. The distributional pattern of the daily reserve requirements of SCBs under different minimum daily reserve requirement stipulations revealed that when the daily stipulations are relaxed towards the lower side, the variability of reserve maintenance seems to increase. Statistical tests for the three different scenarios confirm the significant difference in volatility of daily reserves maintenance of SCBs. The test statistics were significant at 1 per cent level

Table 3: Daily Reserve Maintenance as a Percentage of Requirement Statistics

Daily CRR requirements		Mean	Median	Std. Dev.
Scenario 1	Less than 90 percent	101.4	101.0	5.4
Scenario 2	90 percent	100.7	100.2	3.1
Scenario 3	Greater than 90 percent	102.3	101.2	3.6

Sources: DBIE, RBI; and Authors' estimates.

Table 4: Test for Equality of Variances

Test Method	Test Value
Bartlett	411.36***
Levene	117.45***
Brown-Forsythe	113.98***

Note: ***indicates significance at 1 per cent level.
Null hypothesis, Ho: There is no significant difference in the variances (volatility) of daily reserve maintenance under three scenarios given in Table-3.
Sources: DBIE, RBI; and Authors' estimates.

for three different test criteria rejecting the null hypothesis of having no differences in volatility (Table 4).

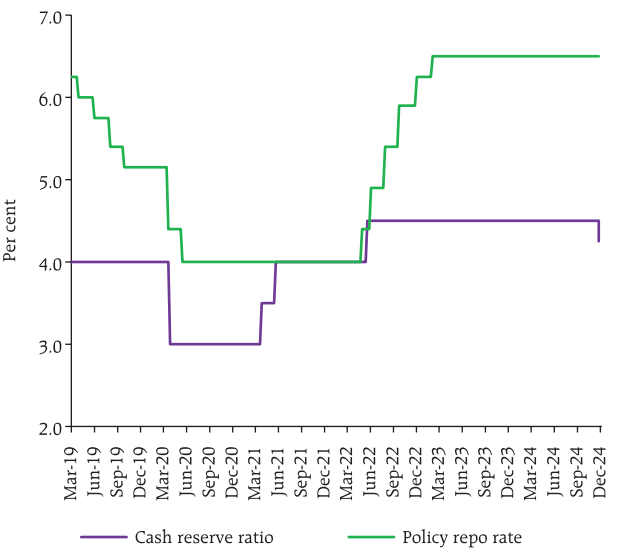
The above analysis suggests that 90 per cent daily minimum maintenance prescription for CRR is the optimal level for the SCBs. In the 90 per cent minimum daily maintenance scenario of FIT period, a significant improvement in liquidity planning and reserve maintenance by SCBs was seen (RBI, 2021).

IV. Recent Developments in CRR

During the recent years, various facets of the CRR instrument have been used in a nimble and prudent manner. To help the banks to tide over the COVID-19 related liquidity constraints, the level of CRR itself was reduced by 100 bps to 3.0 per cent of NDTL effective from March 28, 2020, for a period of one year to release primary liquidity of ₹1.37 lakh core (Das, S., 2020). Moreover, the requirement of minimum daily CRR balance maintenance was reduced from 90 per cent to 80 per cent of the prescribed CRR. Some exemptions were given to SCBs for maintenance of CRR to ensure adequate flow of credit to the productive sectors of the economy. Specifically, SCBs could deduct from their NDTL, the amount equivalent to the incremental credit disbursed by them to automobiles, residential housing, and loans to micro, small and medium enterprises (MSMEs), over and above the outstanding level of credit to these segments as at the end of the fortnight ended January 31, 2020, for maintenance of the CRR. Besides, new MSME borrowers were exempted from CRR maintenance for exposures up to ₹25 lakhs per borrower for credit extended up to October 1, 2021, an instance where CRR was used to promote sectoral flow of credit. The reduction of CRR to 3.0 per cent was gradually restored in two phases to 4.0 per cent by May 2021. In April 2022, the RBI hiked CRR by 50 bps to 4.5 per cent of NDTL, in keeping with the MPC's stance of withdrawal of accommodation, and CRR was recently reduced by 50 basis points to 4.0 per cent of NDTL in December 2024 (Chart 6).

In the early 1990s, incremental cash reserve ratio (ICRR) was introduced by the RBI, as part of aggregate demand management, particularly during the crisis period. In addition to the balances prescribed under Section 42(1) of the RBI Act, an additional average daily balance, calculated with reference to the excess of the total of demand and time liabilities (DTL) of the bank, termed as ICRR has been occasionally used by the RBI to manage excess liquidity in the system. The ICRR as a tool was deployed by the RBI in November 2016 (between September 16 and November 11, 2016) during demonetisation *i.e.*, withdrawal of legal tender status of ₹500 and ₹1000 denominations of banknotes, to absorb the excess

Chart 6: Movement of Repo Rate and CRR



Source: DBIE, RBI.

liquidity in the system as bank deposits swelled due to return of these banknotes. Recently, ICRR was used in July 2022 countercyclically – whereas all Foreign Currency Non-Resident (Bank) [FCNR (B)] and Non-Resident (External) Rupee (NRE) deposit liabilities are included for computation of NDTL, incremental FCNR(B) and NRE deposits raised during July 30 and November 4, 2022, were exempt from inclusion in NDTL for CRR maintenance. The ICRR was also used temporarily during August-October 2023 to absorb excess liquidity from the system caused by the return of ₹2000 banknotes, RBI's surplus transfer to the government, along with pick up in government spending and capital inflows.

IV.1 Automated Sweep-In and Sweep-Out (ASISO) Facility for end of the day LAF Operations

An important development, particularly in the context of disruptions caused by the COVID-19 pandemic, was the introduction of an automatic bidding facility, in addition to the existing manual bidding, for banks to manage their end of the day CRR balances through an optional automated sweep-in and sweep-out (ASISO) facility. This facility enabled banks to set a pre-assigned amount or a range of amount that they wished to keep as balances in their current accounts with the RBI at the end of the day, through e-Kuber[1] system. Depending upon the pre-set amount, marginal standing facility (MSF) and reverse repo bids were generated automatically without any manual intervention at the end of the day[2].

Although this facility was introduced to optimise the human resource deployment in the context of COVID-19 pandemic, banks have continued to use ASISO facility in managing their daily cash balances to minimise liquidity uncertainty to a certain extent. After the introduction of ASISO since August 06, 2020, the daily average level of cash reserves maintained by banks has reduced (Table 5).

The average (mean) daily reserve maintenance reduced during the ASISO period as compared with the pre-ASISO period (Table 5). The volatility (as measured by standard deviation) has decreased to 2.6 from 3.6 in the pre-ASISO period along with lower skewness and kurtosis. To test the statistical significance of the impact of ASISO on daily reserves balances by the SCBs, pre-ASISO period *vis-à-vis* ASISO period was tested through a couple of statistical tests for the following two hypotheses.

Table 5: Descriptive Statistics of the Daily Reserve Maintenance as a Percentage of Requirement by SCBs

Sample Period	Mean	Median	Max.	Min.	Standard Deviation	Skewness	Kurtosis
Pre-ASISO (01 March 2020 to 31 July 2020)	101.2	100.5	122.9	94.6	3.6	2.8	15.6
ASISO period (01 August 2020[3] to 10 December 2020)	100.7	100.2	108.9	96.5	2.6	1.1	4.1

Note: Daily reserve maintenance by the SCBs (excluding small finance banks and payment banks) starting from 01 March 2020 to 10 December 2020. For a better comparison equal number of days have been considered for pre-ASISO and post-ASISO period.
Sources: DBIE, RBI; and Authors' estimates.

[1] e-Kuber is the Core Banking Solution (CBS) platform of RBI wherein all members (Commercial banks, scheduled UCBs, Primary Dealers, insurance companies and provident funds, who maintain current account and securities accounts with RBI) can place their bids in the auction through this electronic platform.

[2] If a bank's current account balance is less than the set minimum balance, the system would auto-trigger an MSF bid for the difference between the current account balance and the set minimum balance limit. In case of any shortfall of securities in a bank's Repo constituent account, the auto-triggered MSF bid will be for a reduced amount, depending on the balance of securities available in the bank's Repo constituent account. If a participant's current account balance is greater than the set maximum balance, the system would auto-trigger a Reverse Repo bid for the difference between the set maximum balance limit and the current account balance.

[3] Though ASISO was introduced from 06 August 2020, data from 01 August 2020 was considered for comparison so as to cover full fortnight.

Table 6: Test Results for Equality of Mean and Variance

Mean Test			Variance Test		
Test Name	**Test statistic**	**p-value**	**Test Name**	**Test statistic**	**p-value**
t-test	1.040	0.292	F-test	1.952***	0.00
Welch F-test	1.116	0.290	Bartlett	10.195**	0.00

Note: ** and *** indicates significance at 5 per cent and 1 per cent levels respectively.
Sources: DBIE, RBI; and Authors' estimates.

H01: There is no significant difference in the average daily reserve maintenance of SCBs between the pre-ASISO and post-ASISO period.

H02: There is no significant difference in the variances (volatility) of daily reserve maintenance of SCBs between pre-ASISO and post-ASISO implementation.

The first hypothesis does not ascertain a statistically significant difference in daily maintenance of CRR between pre-ASISO and post-ASISO period. The second hypothesis (*H02*) on differences in variances of the daily maintenance pattern of SCBs is statistically significant indicating that the volatility in reserves maintenance has come down in the ASISO period (Table 6).

IV.II. Payment and Settlement Systems and Reserves Maintenance

The daily reserve maintenance statistics of SCBs indicated that the average daily CRR maintenance of SCBs came down marginally when the RBI introduced 24x7 services of both NEFT and RTGS — it declined to 100.7 per cent from around 101.0 per cent (Table 7).

The kernel density plot of the daily maintenance of CRR by the SCBs indicated that there is a change in the behavioural pattern of banks after the introduction of 24x7 payment and settlement systems — with both kurtosis and skewness declining (Chart 7).

V. Volatility in Daily Maintenance of CRR – Empirical Analysis

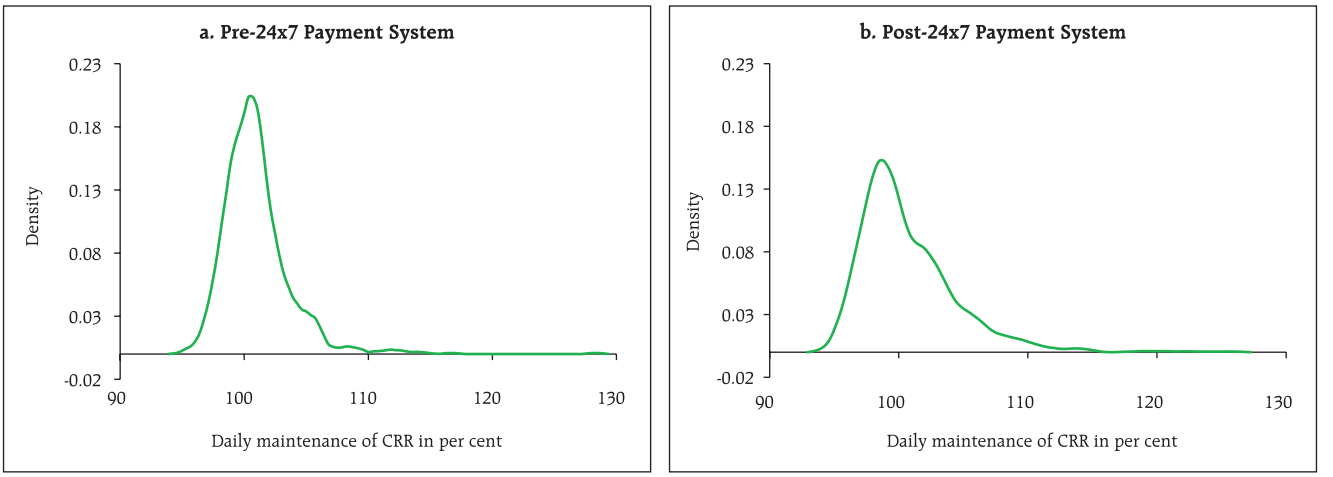
As mentioned earlier, the average excess maintenance and the volatility in daily maintenance of reserves by SCBs has declined particularly during the FIT period and subsequently, with the introduction of the ASISO facility. An empirical exercise employing generalised autoregressive conditionally heteroscedastic (GARCH) model was undertaken to formally examine the same. Variations in liquidity positions or liquidity shocks have an impact on the daily reserve maintenance by SCBs. For instance, negative liquidity shocks would put pressure on reserve maintenance level of SCBs — they will

Table 7: Descriptive Statistics of the Daily Reserve Maintenance as a Percentage of Requirement by SCBs

Sample Period	Mean	Median	Max.	Min.	Standard Deviation	Skewness	Kurtosis
Pre-24x7 Payment Systems (01 March 2020 to 31 July 2020)	101.0	100.7	128.3	95.0	2.8	2.4	16.8
Post-24x7 Payment Systems (11 December 2020 to 30 April 2024)	100.7	99.7	125.5	94.7	3.8	1.8	8.8

Note: Daily reserve maintenance by SCBs (excluding small finance banks and payment banks) starting from 02 January 2017 to 10 December 2020 considered for pre-24x7 systems period and from 11 December 2020 to 06 October 2023 for post 24x7 payment system period. Reserve maintenance with 90 percent daily requirement period considered for the comparison.
Sources: DBIE, RBI; and Authors' calculation.

Chart 7: Kernel Density Estimates: Daily Reserve Maintenance as a Percentage of Requirement by SCBs



Note: Daily reserve maintenance by the SCBs (excluding small finance banks and payment banks) starting from 02 January 2017 to 10 December 2020 considered for pre-24x7 systems period and from 11 December 2020 to 30 April 2024 for post 24x7 payment system period. Reserve maintenance under same (90 percent) daily requirement period considered.
Sources: DBIE, RBI; and Authors' calculation.

draw down on excess CRR for meeting the liquidity shortfalls. Further, the daily stipulated minimum maintenance norms for reserve requirements also affect the CRR maintained by SCBs. On the other hand, volatility of reserve maintenance is expected to be impacted by introduction of ASISO and the 24x7 payment and settlement facilities.

The analysis uses the daily data on CRR maintained by the SCBs during the period October 2016 to April 2024. Weekends are excluded as data for all variables were not available. The heteroscedastic effects on daily maintenance were tested statistically using the autoregressive conditionally heteroscedasticity (ARCH) test, which confirmed the presence of volatility clustering. Hence, a GARCH model was employed for the analysis. For robustness check, GARCH model parameters were estimated with various orders of ARCH and GARCH terms [GARCH (1,1), GARCH (1,2), GARCH (2,1) and GARCH (2,2)][4].

The dependent variable used in the model is the daily CRR maintained by SCBs as proportion of their NDTL. The explanatory variables are liquidity conditions proxied by the difference between overnight money market rates and policy repo rate. Since banks borrow funds mainly in the collateralised segment, the weighted average money market rate can be used to capture borrowing in both collateralised and uncollateralised segments. Accordingly, money market rate (MMR) spread (combined weighted averages market rates minus repo rate) has been used. The daily CRR requirements (CRR norms[5]) is also used as an explanatory variable in the mean equation.

In the variance equation, separate dummy variables for the introduction of NEFT (24x7), ASISO, RTGS (24x7) and COVID pandemic were included to capture those impacts along with ARCH and GARCH effects. The GARCH model specification is given in equations (1) and (2). The mean and variance equations of the selected GARCH (1,2) model is given as:

[4] Specification of GARCH model is chosen based on the information criteria.

[5] Though CRR is to be maintained at a prescribed per cent of NDTL on an average basis for the fortnight, the mandatory daily requirement is 90 per cent at present (varied between 70-80-90-95-99 in the past).

$$CRR\_Daily_t = \omega + \alpha_0 CRR\_Daily_{t-1} + \beta_0 Daily\_CRR\_Norms_t + \Phi MMR\_Spread_t + \varepsilon_t \quad (1)$$

and

$$\sigma_t^2 = \omega_1 + \alpha_1 \varepsilon_{t-1}^2 + + \beta_1 \sigma_{t-1}^2 + \beta_2 \sigma_{t-2}^2 + \vartheta\_NEFT(24X7) + \mu\_ASISO + \pi\_RTGS(24X7) + \lambda\_COVID \quad (2)$$

where CRR_Daily is the daily reserve maintenance by SCBs as a per cent of their NDTL, Daily_CRR_Norm is the daily stipulated minimum requirements of CRR in per cent, MMR_Spread (is the combined weighted average money rates - repo rate) is the proxy of the liquidity conditions and ε_t is the residual error term. In the conditional variance equation (2), α_1 denotes the coefficient of the ARCH term and β_1 and β_2 represent the coefficient of GARCH terms. ϑ, μ, π and λ capture the dummy variable effects on the volatility. The estimated parameters of the GARCH (1,2) models are presented in Table 8.

Table 8: Estimated Parameters of GARCH (1,2) Model

Mean Equation	
Variables	**Parameters**
Constant	85.178*** (3.387)
CRR_ Daily (-1)	0.128*** (0.025)
MMR_Spread	-0.415*** (0.090)
Daily CRR_Norms	0.031 (0.022)
Variance Equation	
Constant	1.557*** (0.164)
ARCH (1)	0.309*** (0.018)
GARCH (1)	0.051 (0.041)
GARCH (2)	0.488*** (0.038)
Dummy NEFT (24x7)	-0.323 (0.447)
Dummy ASISO	-0.569* (0.373)
Dummy RTGS (24x7)	1.444*** (0.400)
Dummy COVID	0.320 (0.500)
DW-statistics	1.817
LM test (F-statistics)	0.039

Notes: (i) Dependent variable is the daily CRR maintenance.
(ii) *, ** and *** indicates significance at 10 per cent, 5 per cent and 1 per cent levels respectively.
(iii) Standard errors in given in parenthesis.
Sources: DBIE, RBI; and Authors' estimates.

In the same modelling framework, individual money market rates viz, weighted average call money rates, weighted average tri-party rate, and the market repo rates were used in alternative model specifications to study the individual rate impact on the volatility of reserve maintenance. The results are given in the annex.

The coefficients of the spread between money market rates and repo rate have statistically significant negative impact on volatility of CRR maintenance. This indicates that when liquidity conditions become tighter, banks tend to reduce / draw down their excess CRR maintained with the RBI. However, the regulatory daily CRR norms/requirement do not have any impact on the reserve maintenance in the post FIT period. This could be due to banks keeping excess reserves over and above the RBI prescribed norms, *inter alia*, due to 24X7 RTGS and NEFT which could have increased the precautionary demand for reserves by SCBs.

The NEFT dummy is found to be insignificant in the conditional variance model indicating that introduction of NEFT 24x7 did not alter the volatility of the reserve maintenance. This could be because the NEFT transactions are mainly retail transactions, which are smaller in size, and they might not affect the overall liquidity available with the banks.

The variance equation of the model confirmed the significance of ASISO facility implemented for SCBs. The ASISO variable coefficient is negative and significant, indicating that ASISO facility has significantly reduced the volatility in the reserve maintenance of banks and enabled them to effectively manage their daily reserves.

The introduction of 24x7 RTGS has been associated with an increase in the volatility in CRR

maintenance as reflected in the positive coefficient for RTGS in the variance equation. RTGS functions on a round-the-clock basis, which can lead to fund withdrawal at any time, causing higher uncertainty and hence higher volatility in reserve maintenance when large interbank transfers take place. Banks generally maintain higher reserves prior to holidays or weekends to take care of uncertain cash flows.

Effective from December 30, 2023, the reversal of liquidity facilities under both the SDF and the MSF were allowed during weekends and holidays. This would facilitate liquidity management of banks by reducing their liquidity uncertainty and, hence, volatility in reserve maintenance, going forward.

VI. Conclusion

Reserves requirements and its various attributes (the CRR level, the daily minimum maintenance, incremental reserves requirements and exemptions on reservable liabilities) are effective liquidity management tools. The level of CRR *per se* is modulated to adjust the overall liquidity conditions with the banking system in accordance with the stance of monetary policy. The present study focusses on the policy implication of the changes in other facets of reserves requirement – the daily reserves maintenance of banks after the transition to the FIT regime and after the introduction of the ASISO facility and the daily minimum reserves maintenance requirement. The analysis reveals that (i) after the adoption of FIT by the RBI and with the introduction of ASISO facility, the average daily reserves maintained by the SCBs have been lower, thus freeing up incremental resources of banks that may be deployed for productive purposes; (ii) the volatility in daily reserves maintenance as percentage of requirement is significantly lower under the post ASISO regime, enabling banks to effectively manage their daily reserves; and (iii) the present 90 per cent of the daily minimum reserves maintenance requirement is appropriate – minimum daily maintenance requirement of less than 90 per cent leads to higher variability in reserves maintenance. The findings of the study, the first such known work on the subject, therefore, provide lessons for the future use of various facets of reserve requirements as a policy tool.

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Annex

Adopting the same notations used in the model1 & 2 stated in the article, three separate models considering three different market rates are given below:

Model1- Mean equation

$$CRR\_Daily_t = \omega + \alpha_0 CRR\_Daily_{t-1} + \beta_0 Daily\_CRR\_Norms_t + \Phi_1 call\ rate\_Spread_t + \varepsilon_t$$

Model 2- mean equation

$$CRR\_Daily_t = \omega + \alpha_0 CRR\_Daily_{t-1} + \beta_0 Daily\_CRR\_Norms_t + \Phi_2 Triparty\ \ rate\_Spread_t + \varepsilon_t$$

Model3- mean equation

$$CRR\_Daily_t = \omega + \alpha_0 CRR\_Daily_{t-1} + \beta_0 Daily\_CRR\_Norms_t + \ \Phi_3 Market\ repo\ rate\_Spread_t + \varepsilon_t$$

Variance equation

$$\sigma_t^2 = \omega_1 + \alpha_1 \varepsilon_{t-1}^2 + + \beta_1 \sigma_{t-1}^2 + \beta_2 \sigma_{t-2}^2 + \vartheta\_NEFT(24X7) + \mu\_ASISO + \pi\_RTGS(24X7) + \lambda\_COVID$$

The estimated parameters of the above three models are given in table -1.

Table 1: Estimated Parameters of GARCH (1,2) Model

Mean Equation			
Variables	**Model 1**	**Model 2**	**Model 3**
Constant	84.800*** (3.067)	82.067*** (3.092)	84.548*** (3.456)
CRR_ Daily (-1)	0.131*** (0.024)	0.124*** (0.024)	0.128*** (0.025)
Call rate Spread	-0.977*** (0.154)		
Triparty rate Spread		-0.810*** (0.079)	
Market repo rate Spread			-0.482*** (0.104)
Daily CRR_Norms	0.030 (0.019)	0.069*** (0.019)	0.023* 1.677)
Variance Equation			
Constant	1.488*** (0.160)	1.706*** (0.170)	1.568*** (0.165)
ARCH (1)	0.319*** (0.019)	0.341*** (0.020)	0.310*** (0.018)
GARCH (1)	0.037 (0.035)	0.035 (0.040)	0.056 (0.042)
GARCH (2)	0.507*** (0.034)	0.462*** (0.038)	0.481*** (0.039)
Dummy NEFT (24x7)	-0.540 (0.369)	-0.280 (0.509)	-0.354 (0.446)
Dummy ASISO	-0.737** (0.408)	-0.581* (0.405)	-0.616* (0.382)
Dummy RTGS (24x7)	1.157*** (0.398)	1.499*** (0.421)	1.420*** (0.400)
Dummy COVID	0.719* (0.434)	0.135 (0.550)	0.375 (0.504)
DW-statistics	1.792	1.789	1.815
LM test (F-statistics)	0.109	0.075	0.046

Notes: (i) Dependent variable is the daily CRR maintenance.
(ii) *, ** and *** indicates significance at 10 per cent, 5 per cent and 1 per cent levels respectively.
(iii) Standard errors in given in parenthesis.
(iv) Call rate spread = Call rate minus repo rate, Triparty rate spread = Triparty rate minus repo rate and Market repo rate spread = Market repo rate minus repo rate

Sources: DBIE, RBI; and Authors' estimates.