WORKING PAPER

Serial No. WP/001

Mumbai Inter-Bank Outright Rate (MIBOR): Benchmark Calculation and Methodology

February 2018

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Mumbai Inter-Bank Outright Rate (MIBOR) Benchmark Calculation and Methodology

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ABSTRACT

MIBOR is one of the most widely used benchmark rates in India. Up to July 2015, the National Stock Exchange (NSE) released the overnight MIBOR/MIBID rates using the polled quotes from a select panel. Post July 2015, the MIBOR has been released by the Benchmark Administrator, Financial Benchmarks India Limited (FBIL). The overnight MIBOR is computed using the volume weighted average of the overnight trades executed on the NDS-CALL platform between 9.00 am and 10.00 am. The computation methodology takes into consideration a minimum trade and volume criteria, fallback mechanism in case of inadequate trades/volumes and a suitable outlier identification mechanism to ensure that extreme rates are eliminated. During the first two months of 2017, the calculation of this benchmark was impacted due to inadequate trading, with the previous days' rate being repeated in one instance. Further after October 2016, there has been a decrease in the share of trades dealt on the NDS-CALL platform which has impacted the MIBOR computation during this period.

The NDS-CALL dealt and reported rates in the first hour (HI) of trading show a very high correlation and including H1 Reported deals with 1SD, 2SD and 3Sd criteria shows that such deals could be available for computation in case of insufficiency of Dealt trades. Statistical tests also show no qualitative difference between the data structure of H1 Reported and Dealt trades for data from January 2015 to February 2017. The H2 means for both these segments show significant variation, while the H1 and H2 rates of dealt transactions show convergence in both their means and variances. The analysis concludes by suggesting a new fallback mechanism using Reported trades upto 11.00 am for the computation of Overnight MIBOR rates in case computation is not possible up to 11.00 am. It is proposed to adopt the above method only when the mean and variance of the dealt and reported trades are convergent.

JEL Classification: E5, G17, G150, G170, C63

Keywords: Central Bank, Simulation, Reference Rate, Efficiency

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1. MIBOR - A SHORT HISTORY

Financial benchmarks refer to prices, estimates, rates, indices or values that are used by the market participants for pricing, settlement, and valuation of financial contracts. These are also known as "Reference Rates" as financial contracts are referenced to or valued through the financial benchmarks. The reference rate is a representative rate for the market on a particular day or at a particular time. These rates have become critical as a result of the proliferation of derivatives that are based on them as also due to the move towards automated trading. These rates have to be accurate, consistent and free of conflicts of interests and integrity issues that can create incentives for manipulation. Any loss of confidence in these rates may lead to widespread market disruptions. Hence, benchmark rates should ideally be computed by an unbiased source, be representative of the market, transparent, reliable and continuously available. These rates evolve with the markets as they have to be dynamic to capture the changing financing scenarios and patterns.

The MIBOR has been the most widely used benchmark rate in India. Over the years it has undergone several transitions in terms of the methodology, the underlying rates, the calculating agency and the regulator. It has moved away from being a polled rate determined by a select group of the market to a universal market-based rate. The following have been the major transitions in the evolution of the MIBOR.

2. FIMMDA-NSE MIBID-MIBOR

Based on the recommendations of the Committee for the Development of the Debt Market, the NSE developed and launched the NSE Mumbai Interbank Bid Rate (MIBID) and NSE Mumbai Interbank Offer Rate (MIBOR) as a benchmark for the overnight money market on June 15, 1998. Thereafter, NSE introduced the 14-day MIBIDMIBOR on November 10, 1998 and the 1-month and 3-month MIBID-MIBOR subsequently on December 1, 1998. It also introduced a 3-day MIBID-MIBOR on all Fridays with effect from June 6, 2008 in addition to the existing overnight MIBID-MIBOR. FIMMDA became a partner to NSE in co-branding the dissemination of MIBIDMIBOR for overnight and term tenors on March 4, 2002 and the product thereafter was rechristened as FIMMDA-NSEMIBID/MIBOR.

On each working day, the NSE polled quotes from a select panel of 30 banks/primary dealers during 9:40 AM - 9:45 AM for the overnight MIBIDMIBOR (3 days on Fridays) and during 11:30 AM 11:40 AM for the term MIBID-MIBOR (14-day, 1month and 3-month) on all the working days. The data so collected was subjected to bootstrapping, a non-parametric technique which involves trimming of the outliers, followed by generation of multiple data sets with a dynamically determined number of iterations and computation of mean and standard deviation for each of the multiple data sets. The number of iterations

could be determined dynamically and the bootstrapping ensured that the data sets were drawn at random, obviating the possibility of cartelization and of extreme observations excessively influencing the mean. The mean corresponding to the lowest standard deviation was taken as the fixing rate for the day, subject to availability of at least 14 quotes after trimming (not applied for the tenors where polled rates are less than 14). The trimming was carried out at four levels, viz. 2, 4, 6 and 8 quotes were removed with half from the top and half from the bottom in terms of levels. The overnight NSE MIBID-MIBOR was discontinued with effect from July 22, 2015.

3. FBIL OVERNIGHT MIBOR

Against the backdrop of several discoveries globally of market manipulation in LIBOR, Reserve Bank of India constituted a committee chaired by Shri P. Vijaya Bhaskar, Executive Director to review the process of computation and dissemination of major financial benchmarks in India, the governance mechanisms in the institutions involved in computing the benchmarks and other related issues. The Committee received inputs and views from the market, Clearing Corporation of India (CCIL) and academia, apart from RBI staff. RBI released the Draft Report of the Committee on Financial Benchmarks on its website on January 3, 2014 for public comments. The final report was published on February 7, 2014 and the recommendations made therein were accepted by RBI on April1,2014.

As per the report, FIMMDA and FEDAI were identified on April 15, 2014 as Benchmark Administrators for Indian Rupee interest rates and Forex benchmarks respectively. The Report recommended a change in the methodology for the computation of overnight MIBID-MIBOR from the existing poll-based method to volume-weighted average of trades executed between 9:00 AM and 10:00 AM each working day on the NDS-CALL[2] platform operated by CCIL. NDS-CALL platform is not an anonymous order matching system but an electronic chat-enabled dealing system which facilitates members to negotiate deals with counterparties.

Financial Benchmarks India (Pvt.) Limited (FBIL) promoted by FIMMDA, FEDAI and IBA was formed in as a private limited company on 9-Dec2014 with an appropriate governance structure for taking over the administration of benchmarks in a p h a s e d manner from t h e m a r k e t associations/body. FBIL took over the administration of the benchmark for the overnight inter-bank rate and announced the introduction of a new “FBIL - Overnight MIBOR” benchmark based on actual traded rates with effect from July 22,2015, replacing

[2] NDS-CALL platform refers to Negotiated Dealing System - Call Platform currently owned by RBI and developed and administered by CCIL enabling Inter-Bank members to execute their Call, Notice and Term Borrowing and Lending in an electronic platform.

the "FIMMDA-NSE Overnight MIBID/MIBOR". The dissemination of the new benchmark commenced on July 22, 2015, with the rates being released simultaneously on the websites of FIMMDA and CCIL.

4. MIBOR COMPUTATION METHODOLOGY

1. All trades executed on NDS-Call system excluding reciprocal and reported deals within the first hour of trading (currently from 9.00 A.M. to 10.00 A.M.) are used for computation of the new benchmark - FBIL-Overnight MIBOR (FBIL Overnight Mumbai Inter-Bank Outright Rate). The trades are pulled out from the NDS-CALL system immediately after the cut-off time.

2. Only T+0 settlement deals are picked.

3. For any working day, the maturity of the deals picked for computation of FBIL Overnight MIBOR is the next Mumbai Business Day, excluding Saturdays. For example, if Friday is a holiday but the following Monday is a Mumbai Business working day, FBIL Overnight MIBOR calculation on the previous Thursday will pick trades with a maturity of 4 days. Only trades for 5 crore and above are retained for further calculation.

4. A minimum of 10 trades with an aggregate traded value of 500 crore and more in the NDS-Call segment are taken as the threshold criteria for estimation of the volume-weighted average rate.

5. In case either of the criteria mentioned above is not met, the timeframe for computation of ratesisextendedby30minutesfirstandifboth the threshold criteria are still not met, then by another 30 minutes. If both the threshold criteria are still not met after the two extensions, no rate computation will be initiated. The previous working day's values will be used for dissemination. This fallback procedure can continue for a maximum of two consecutive working days after which if the threshold criteria are still not met, FBIL will not disseminate any rate on such days and banks will be required to use their own fallback mechanism. A notification to this effect will be published on CCIL/FIMMDA websites.

6. The Weighted Average Rate and Standard Deviation (STDEV) will be calculated for the retained trades that satisfy both the threshold criteria. These numbers will be rounded off to two decimal places.

7. A rate range will be computed - Maximum will be Weighted Average Rate + 3* Standard Deviation and Minimum will be Weighted AverageRate-3*Standard Deviation.

8. Any trades at rates outside the abovementioned Maximum and Minimum range will be considered as outliers and dropped from the data (i.e. Higher than Maximum and Lower than Minimum).

9. The final volume-weighted average rate and standard deviation will then be computed using the remaining trades. The said numbers would be rounded off to two decimal places at each stage.

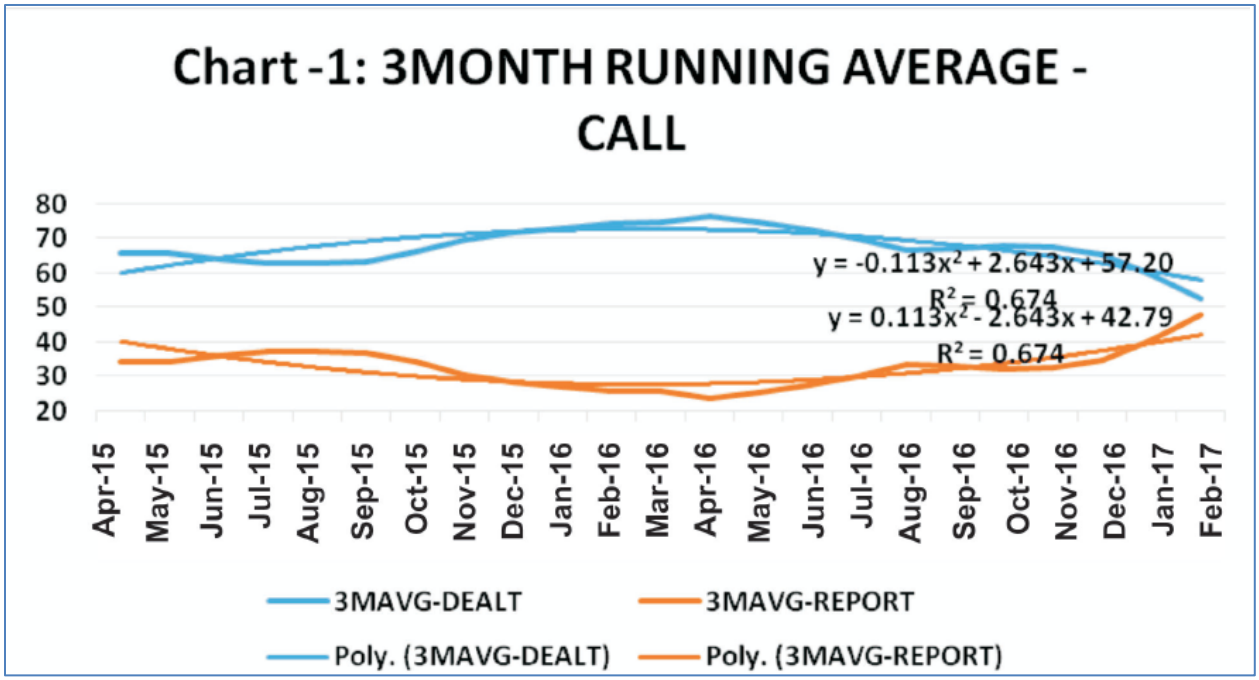
10. The rates so calculated as per the above methodology will be sent to the Benchmark Administrator, for vetting and will be published on receiving approval.

11. On receiving approval, the rate with standard deviation will be released as FBIL-Overnight MIBOR for the day by 10.45 A.M on the websites of FIMMDA and CCIL or such websites as may be notified. If the time is extended due to non-fulfilment of any of the threshold criteria, the dissemination time will be suitably extended.

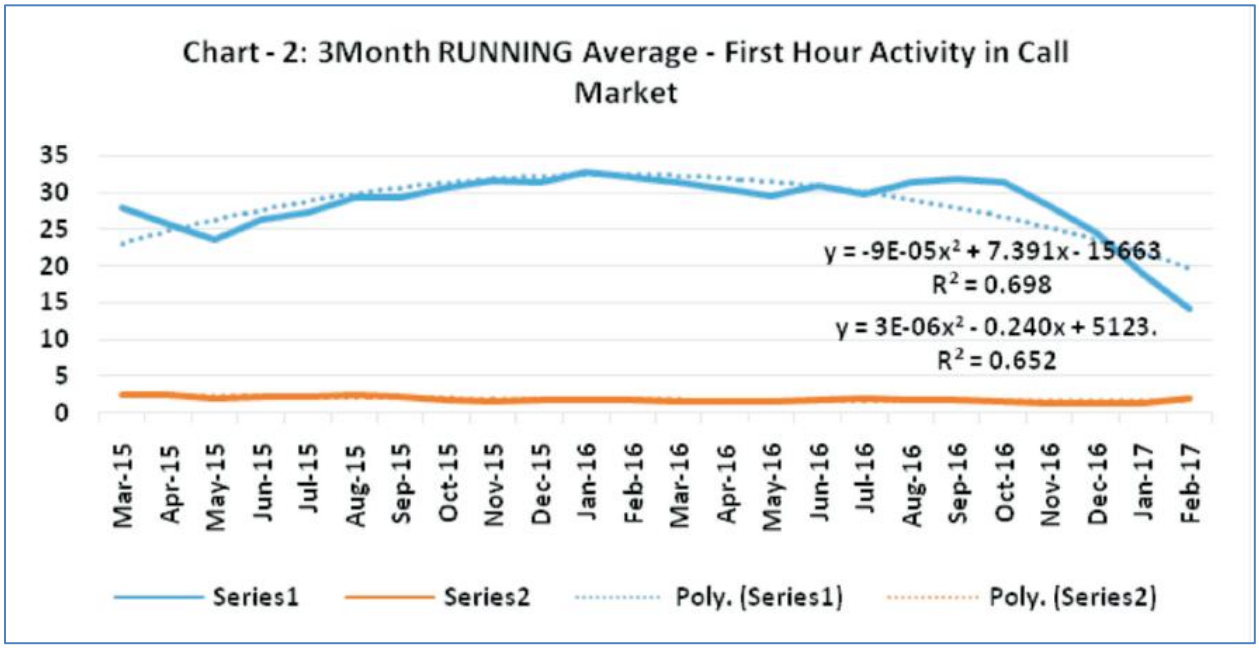
5. CHALLENGES IN COMPUTATION OF DAILY MIBOR

MIBOR is computed using the dealt transactions among Banks and Primary Dealers in the Inter-Bank Call market using the NDS-Call platform. Call market volume has been dropping in recent times. The first two months of 2017 witnessed significant drop in NDS-call dealt trades. The MIBOR computation was frequently affected in February 2017 due to non-fulfilment of the two threshold criteria in the first hour of trading and the computation was required to be done by extending the time, as provided in the methodology document. On one occasion, the overnight MIBOR could not be computed and the previous day's overnight MIBOR was adopted for the day, as provided in the methodology document. Recent months have seen an increase in the market share of reported deals. Market participants expressed their unease over any repetition of the previous day's rate. Chart - 1 shows the declining trend of NDS-Call Dealt volumes by using a 3-month running average trend-line. Gross volumes in the reported segment is continuously on the rise while the volume of dealt trades in NDS-call is slowly dropping. Till October, 2016, the volume of dealttradesusedtobemorethan70%of that of the total trades, but the same fell to less than 50% in January-February,2017.

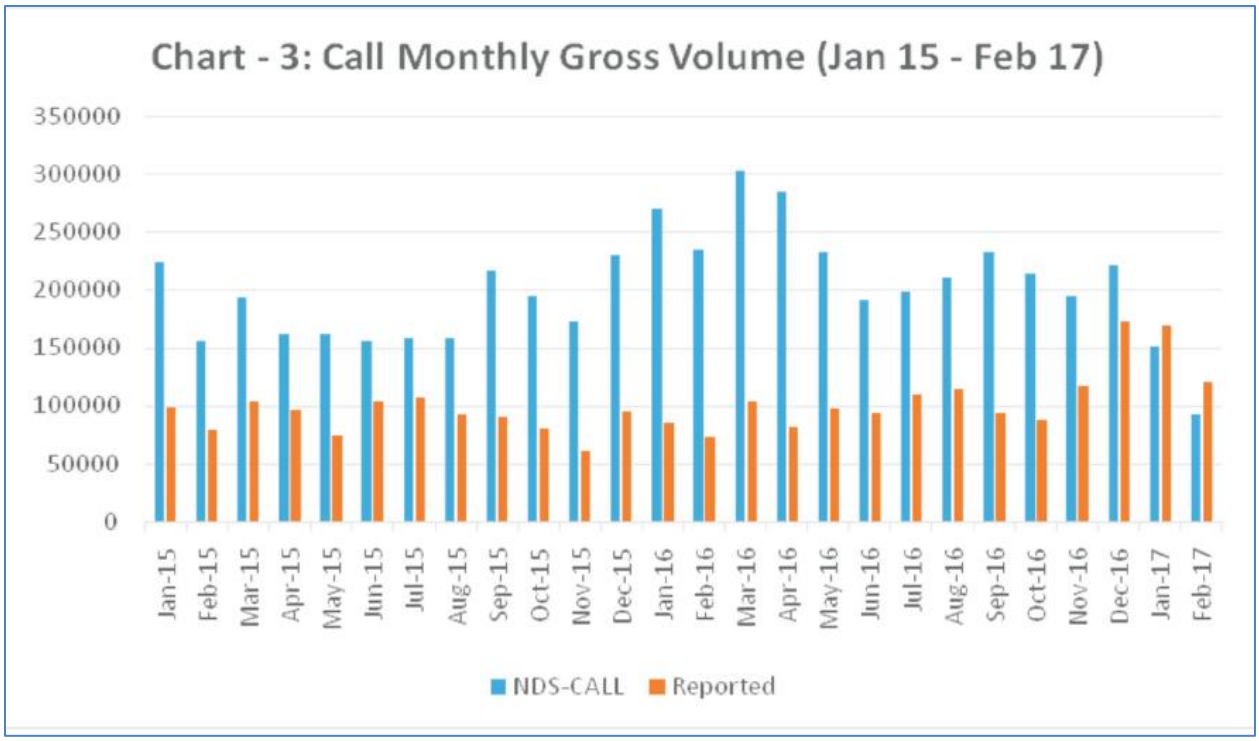
Table -1 gives the trend of the market in terms of gross market volume of Dealt and Reported segments, market share, and daily average. Daily average Dealt volume has dropped from 17736 crores in April, 2016 to 5803 crores in February 2017.



Reported average trade volumes increased from 3643 crores in February 2016 to 7543 crores in February, 2017.' Data analysis of the First Hour (Chart-2) trading activity which is used to compute the MIBOR shows that there has been considerable decrease in dealt trades and this has resulted in deferment of MIBOR computation.



Gross call market volume too has been falling in recent months due to improvements in liquidity conditions in the market. The Reported segment, however, has shown considerable increase in its volume. Co-operative banks have been very active as lender in the Reported segment. Co-operative Banks account for 99% of the trades in Reported segment as lenders (data from January, 2015 to February, 2017). Most of the Reported trades happen after 2.00 PM. **It may be mentioned that most of the co-operative banks use the reporting mechanism because they do not have access to NDS-Call Dealing platform.** If RBI allows them access to the NDS-Call Dealing platform, the Dealt segment is likely to see substantial volume growth.



Dealt trades have dropped from 78% of the market in April, 2016 to 43% in February, 2017 while the Reporting volume was on the rise during this period (Chart-4).

Analysis of Hourly Dealt activity shows depletion in activity level (Chart-5). The hourly activity in Reported trades is shown in Chart – 6.

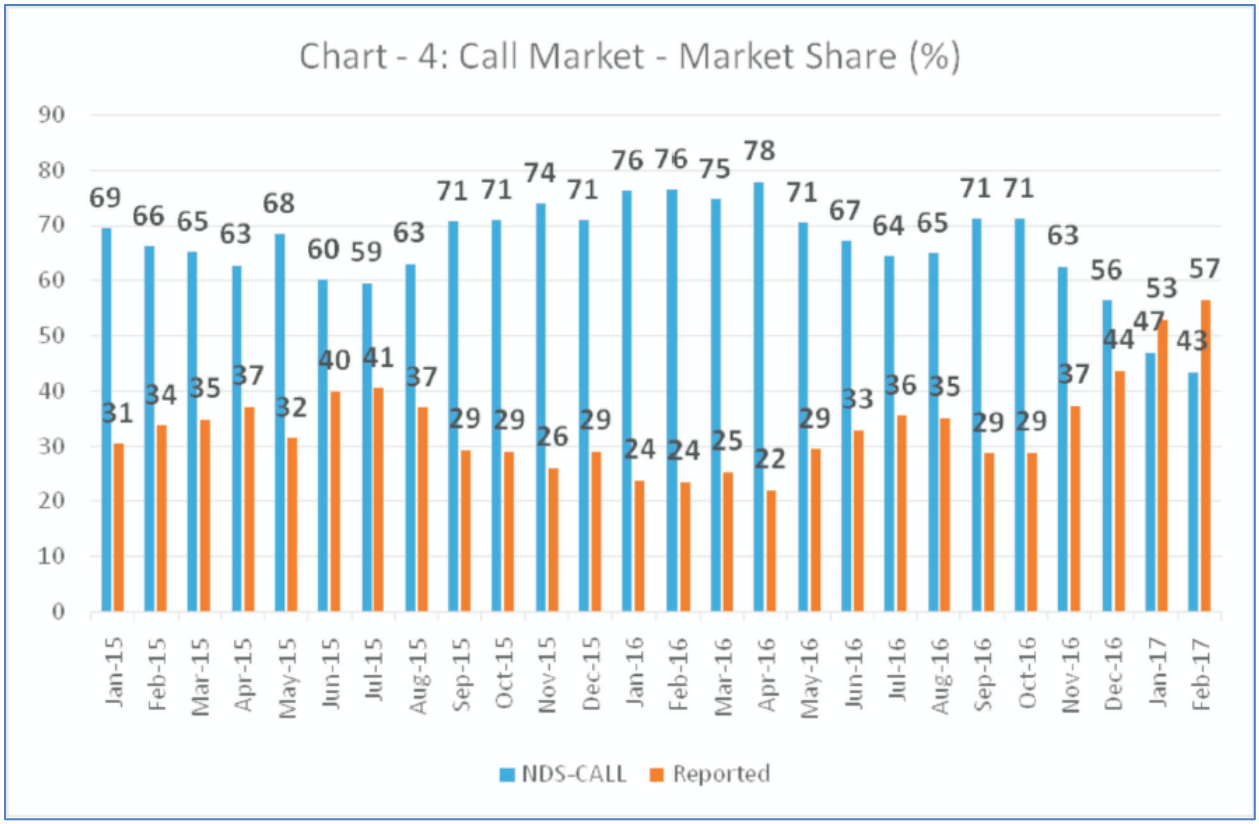


Chart - 4: Call Market - Market Share (%)
NDS-CALL
Reported

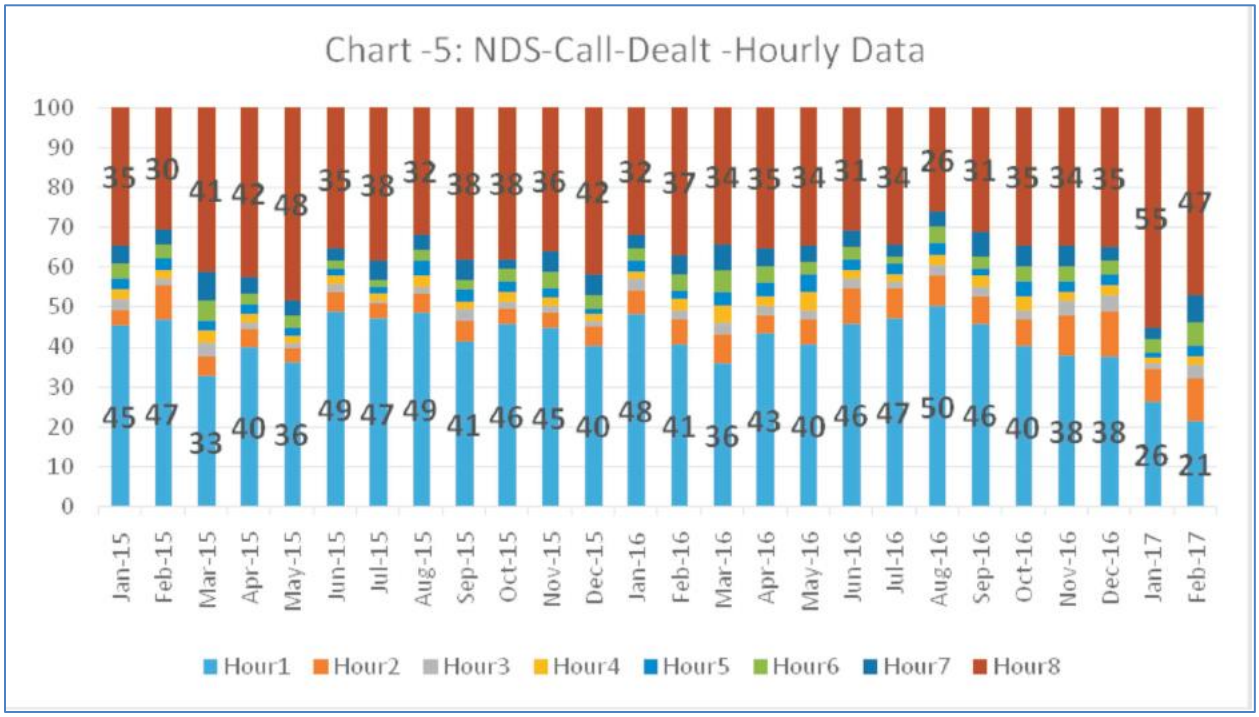
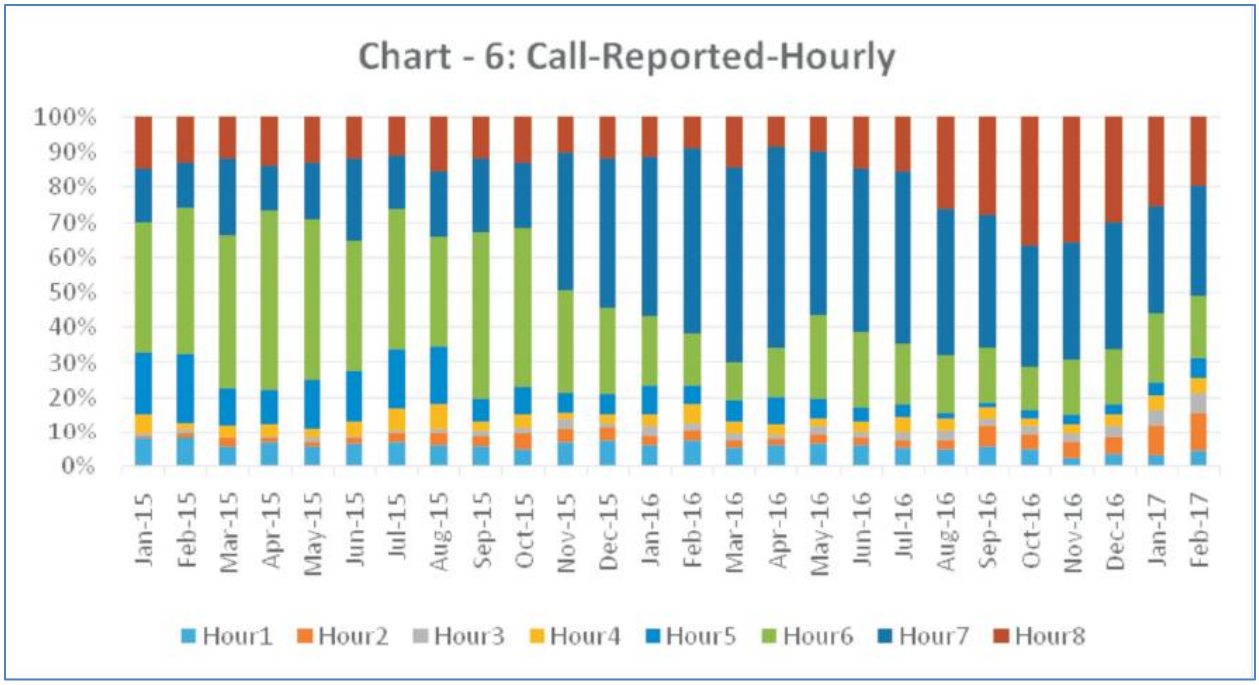
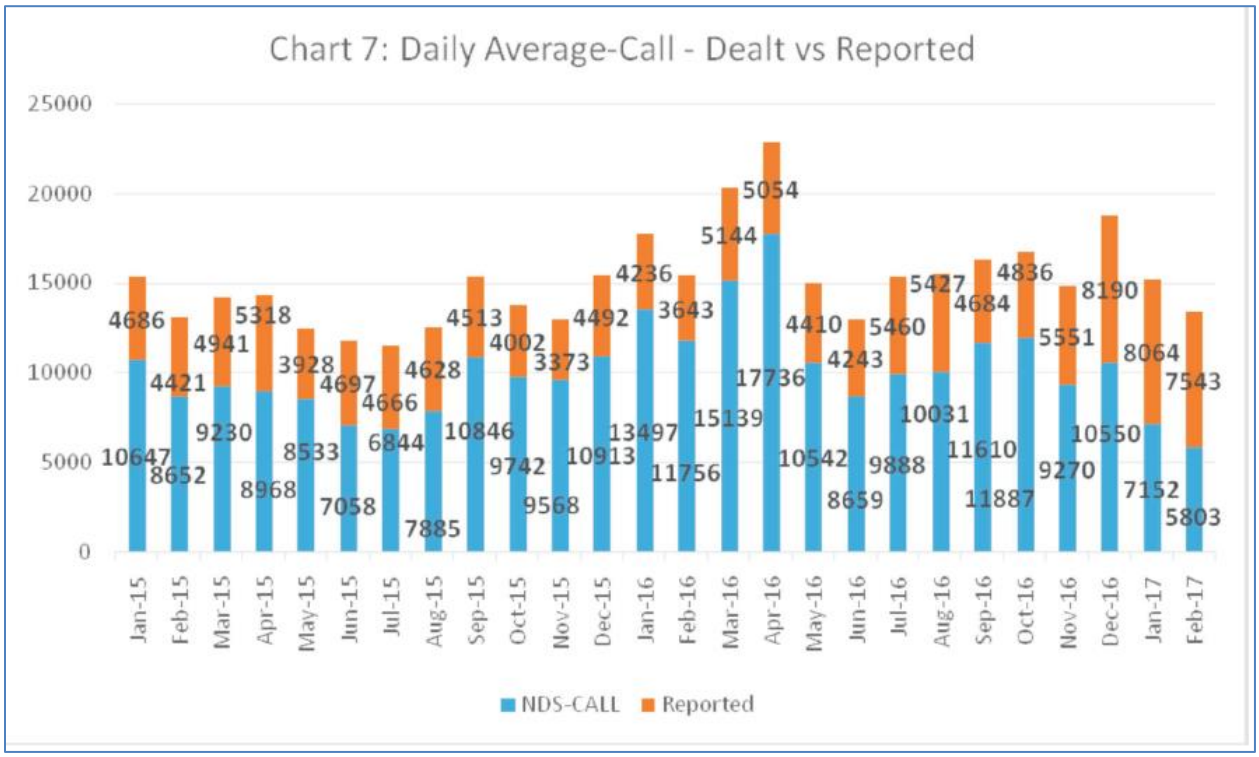
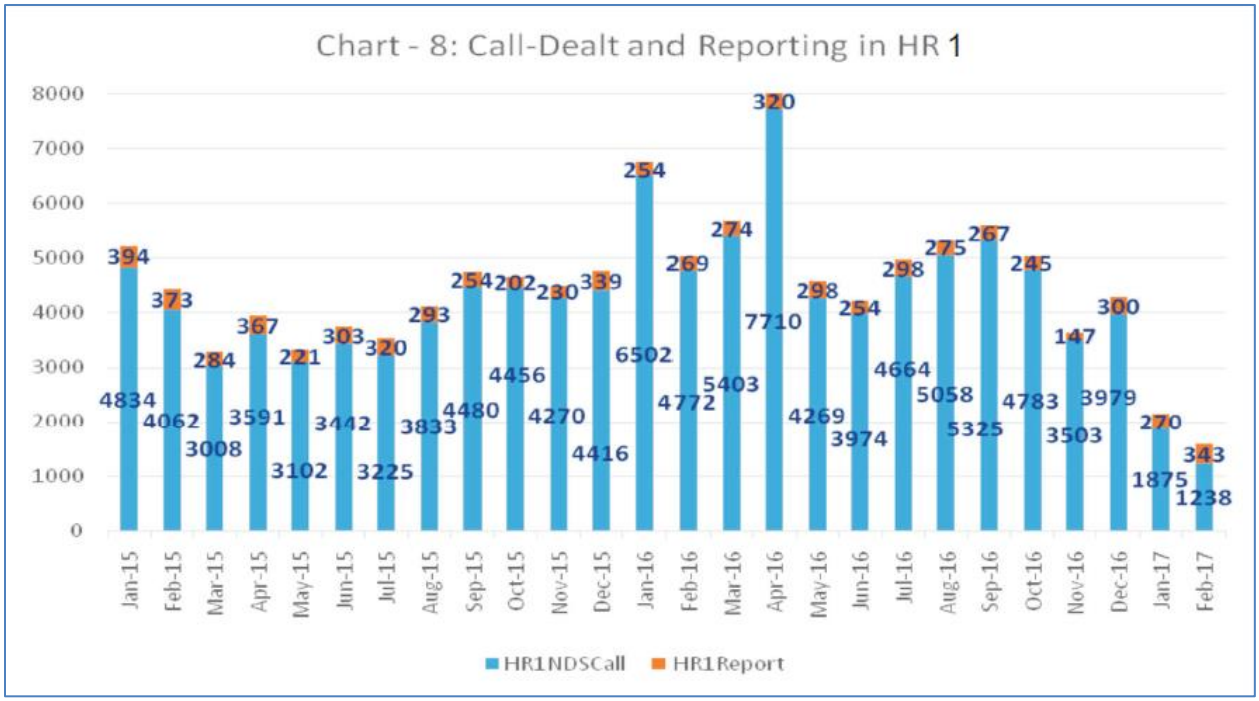


Chart -5: NDS-Call-Dealt -Hourly Data
Hour1
Hour2
Hour3
Hour4
Hour5
Hour6
Hour7
Hour8

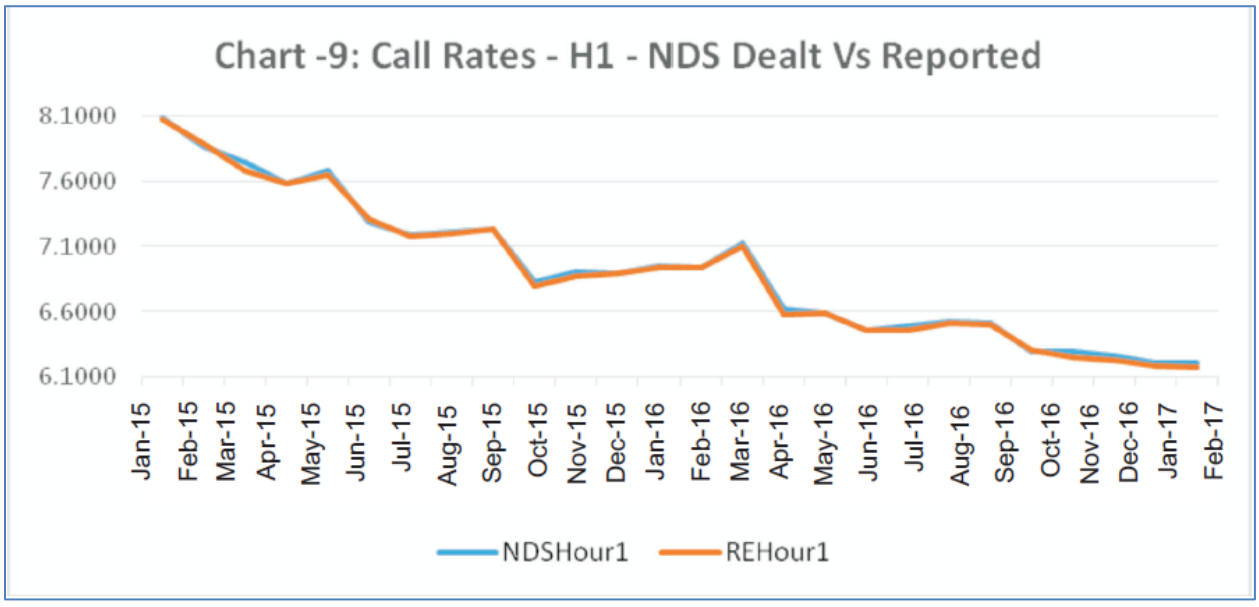


Daily average Call Market Volume is slowing down in recent months (Chart-7). Dealt deals have been on a declining trend in January-February, 2017 which resulted in a deferment of MIBOR computation on few days.



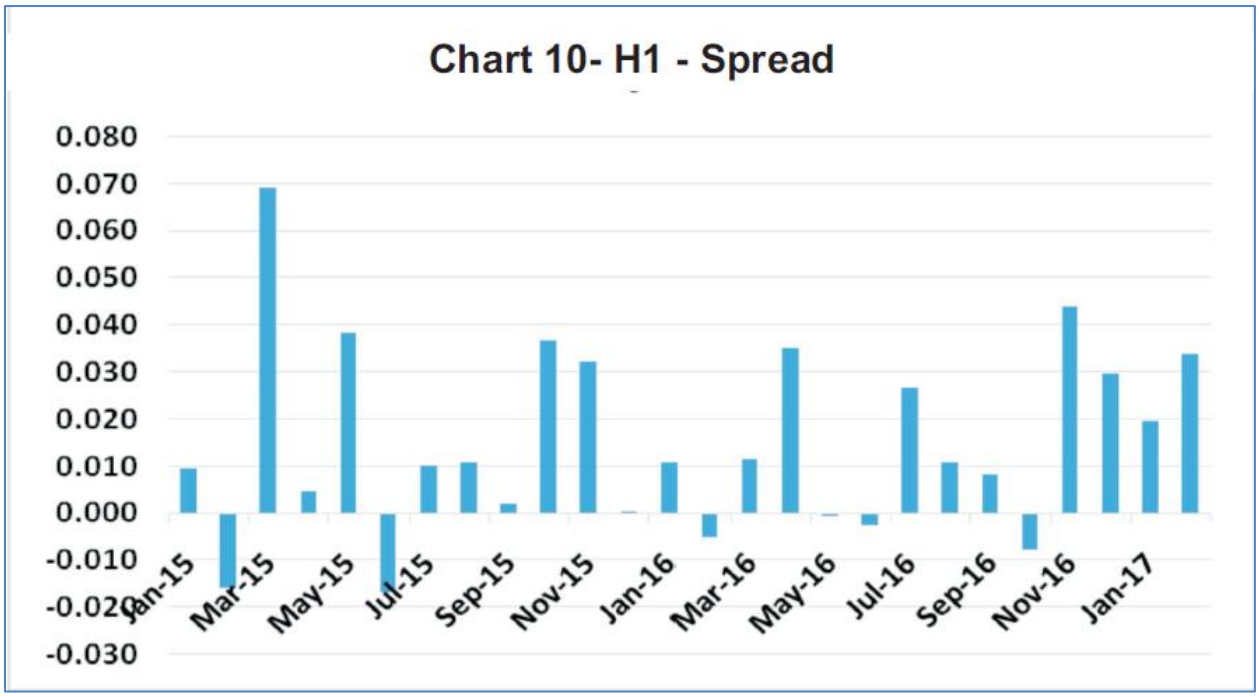


An analysis of the rates in both NDS-Call Dealt and Reported segments in First Hour (H1) of trading (9AM to 10AM) shows that they exhibit very high correlation, as given in Chart-9.



Typically, the lending side of the market in the Reported segment is dominated by Co-operative banks. Table 2 and 3 gives the lending and borrowing profiles of the Reported segment of the market. Primary Dealers dominate the borrowing side of the market in H1.

H1 spread (Dealt versus Reported) is negligible and is about 0.015 percentage points over 26 months (January, 2015 to February, 2017). If we include the Reported deals for H1 and 1SD, 2SD and 3SD criteria for inclusion, then we find that Reported deals will be available for computation in days when there is insufficiency of Dealt trades.



Some statistical tests for inclusion of Reported deals of only H1 as the last back up measure for estimation of MIBOR is presented below. The analysis clearly shows that there is no qualitative difference between the data structure of Reported and Dealt trades in the H1 in respect of the data from January, 2015 to February, 2017. However, the H2 Reported data shows statistically significant difference in the structure vis-à-vis H1 and, hence, should not be considered. There is a need to continuously monitor the data and when and if the data structure exhibit any significant change, Reported deals for Hour 1 should not be considered for inclusion in the overnight MIBOR computation.

Table-4 shows the result of a Paired T-Test for the H1rates of Dealt and Reported transactions. The F-Test result shows that there is no statistically significant difference in the variances of the rates in both markets. The t-stat and p-values of the Pooled T-test result show that the means of both the rates are not statistically different significantly.

Table -5 shows the result of a Paired T-Test for the Hour 2 rates of Dealt and Reported transactions. The F-Test result shows that there is no statistically significant difference in the variances of the rates in both markets. The t-stat and p-values of the Polled T-test result

show that the means of both the rates are statically different significantly. Hence, H2 rates of Reported deals should not be used as data points for calculation of overnight MIBOR.

Table - 6 shows the result of a Paired T-Test for the Hour 1 and 2 rates of Dealt transactions. The F-Test result shows that there is no statistically significant difference in the variances of the rates in the two time periods. The t-stat and p-values of the Pooled T-test result show that the means of both the rates are not statistically different significantly. Hence, the MIBOR calculation methodology using rates in Hour 2 of the Dealt transactions is logical and it should continue.

Table - 7 shows the result of a Paired T-Test for the H1 and H 2 rates of Reported transactions. The F-Test result shows that there is no statistically significant difference in the variances of the rates in the two time periods. The t-stat and p-values of the Pooled T-test results how that the means of both the rates are statically different significantly. Hence, the MIBOR calculation of using rates in H2 of the Reported deals should not be considered as it will destabilize and skew the overnight MIBOR.

6. SUGGESTIONS / CONCLUSIONS

1. Overnight MIBOR should be calculated using the current methodology which has been adopted by FBIL and communicated to the market.

2. Data can be augmented with reported deals of only Hour 1 to satisfy both the threshold criteria on days when they are not met even after extension of time.

3. In order to include reported deals, the following stringent outlier criteria is required to be followed:

a. Mean and Standard Deviation are to be computed using only NDS-Call Dealt trades (if there are at least 3 trades but less than 10 trades) as per the process explained in Bullet SerialNo.6inPage4above).

b. The Standard Deviation so calculated will be used for outlier criteria in respect of reported deals.

c. Any trade fulfilling the 2SD criteria can be included in the data for augmenting the data set for meeting the threshold criteria.

4. Monthly tests will be conducted to observe if the data in respect of reported deals are structurally diverging from that of the data in respect of dealt trades. If the mean and variance of the data in respect of reported deals are found to be statistically different, then the data will not be used for calculation of the Overnight MIBOR.

5. Reported deals will be only used when there are a minimum of 3 trades in the Dealt segment. If all such trades happen to be done at the same rate, the SD will be equal to zero. On such occasions, reported deals will be selected applying 2SD calculated on the basis of the previous day's Dealt segment. If SD is equal to zero for the Dealt segment of the previous day as well (till the closure of the prescribed time window for MIBOR computation on previous day), then the SD will calculated using an weighted-average scheme as given below:

a. Seven closest previous working days each with non-zero variance will be identified. The variance in respect of each day will be multiplied by the volume of dealt trade of that day (MIBOR window only) and a then a weighted average of variance will be calculated. The square root of the weighted average variance will be the SD to be used for selection of deals in the Reported segment using+/-2SD range criterion.

6. The Benchmark MIBOR will be computed only if the criteria of minimum 10 trades and aggregate volume of 500 crores value are met after including Reported deals of H1 in the dataset.

7. Further, if minimum of 3 dealt trades do not happen by 11.00AM in NDS-Call Dealt segment, the Reported deals will not be used for the day. On such occasions, Benchmark Market Repo Rate (MROR) of H1 (Basket Repo Rate of H1 after removing outliers, etc.) plus a spread (MIBOR Basket Repo of H1) of the previous working day will be used to give the MIBOR for the day. If previous working day's spread is not available, then the average of the last seven traded spreads (MIBOR - Basket Repo of H1) will be added to the Benchmark Market Repo Rate (MROR) of H1 for the day to arrive at MIBOR.

8. If all the fallback efforts for calculating MIBOR, as above, fail, then the previous working day's MIBOR will be published for the day.

Table 1: Call Market Structure (Amounts in rupees crore)								
Month	**Days**	**Dealt**	**Reported**	**NDS-CALL %**	**Reported %**	**Dealt daily**	**Reported daily**	**Call Market**
Jan-15	21	223591	98398	69	31	10647	4686	15333
Feb-15	18	155741	79577	66	34	8652	4421	13073
Mar-15	21	193821	103756	65	35	9230	4941	14170
Apr-15	18	161424	95732	63	37	8968	5318	14286
May-15	19	162120	74641	68	32	8533	3928	12461
Jun-15	22	155282	103331	60	40	7058	4697	11755
Jul-15	23	157420	107312	59	41	6844	4666	11510
Aug-15	20	157703	92564	63	37	7885	4628	12513
Sep-15	20	216914	90269	71	29	10846	4513	15359
Oct-15	20	194845	80035	71	29	9742	4002	13744
Nov-15	18	172226	60714	74	26	9568	3373	12941
Dec-15	21	229174	94328	71	29	10913	4492	15405
Jan-16	20	269949	84718	76	24	13497	4236	17733
Feb-16	20	235111	72861	76	24	11756	3643	15399
Mar-16	20	302785	102872	75	25	15139	5144	20283
Apr-16	16	283769	80868	78	22	17736	5054	22790
May-16	22	231921	97012	71	29	10542	4410	14952
Jun-16	22	190494	93350	67	33	8659	4243	12902
Jul-16	20	197758	109192	64	36	9888	5460	15348
Aug-16	21	210654	113962	65	35	10031	5427	15458
Sep-16	20	232197	93679	71	29	11610	4684	16294
Oct-16	18	213968	87052	71	29	11887	4836	16723
Nov-16	21	194671	116568	63	37	9270	5551	14821
Dec-16	21	221555	171982	56	44	10550	8190	18740
Jan-17	21	150197	169338	47	53	7152	8064	15216
Feb-17	16	92843	120691	43	57	5803	7543	13346

Table-2: Lending profile (%) in Hour 1 of the Reported segment		
Month	**Co-operative Banks**	**Others**
Jan-15	99.88	0.12
Feb-15	99.85	0.15
Mar-15	98.15	1.85
Apr-15	99.17	0.83
May-15	96.67	3.33
Jun-15	96.58	3.42
Jul-15	86.94	13.06
Aug-15	80.86	19.14
Sep-15	81.79	18.21
Oct-15	98.27	1.73
Nov-15	99.64	0.36
Dec-15	98.39	1.61
Jan-16	98.42	1.58
Feb-16	99.07	0.93
Mar-16	90.79	9.21
Apr-16	96.49	3.51
May-16	97.79	2.21
Jun-16	93.66	6.34
Jul-16	92.1	7.9
Aug-16	96.19	3.81
Sep-16	95.98	4.02
Oct-16	98.41	1.59
Nov-16	98.7	1.3
Dec-16	100	0
Jan-17	98.94	1.06
Feb-17	96.81	3.19

Table-3: Borrowing profile (%) in Hour 1 of the Reported segment		
Month	**Primary Dealers**	**Others**
Jan-15	98.19	1.81
Feb-15	99.7	0.3
Mar-15	99.5	0.5
Apr-15	100	0
May-15	99.41	0.59
Jun-15	97.11	2.89
Jul-15	89.86	10.14
Aug-15	86.07	13.93
Sep-15	89.76	10.24
Oct-15	100	0
Nov-15	100	0
Dec-15	100	0
Jan-16	100	0
Feb-16	100	0
Mar-16	100	0
Apr-16	100	0
May-16	100	0
Jun-16	100	0
Jul-16	100	0
Aug-16	100	0
Sep-16	100	0
Oct-16	100	0
Nov-16	100	0
Dec-16	73.71	26.29
Jan-17	84.15	15.85
Feb-17	81.75	18.25

Table 4: PAIRED T –TEST Result of Dealt and Reported Rate for Hour 1							
Group	**N**	**Mean**	**Std Dev**	**Std Err**	**Minimum**	**Maximum**	
DEALT H1	384	6.6801	0.3735	0.0191	6.0235	8.9941	
RPTED H1	367	6.6718	0.3717	0.0194	5.95	9.1563	
Diff (1-2)		0.00828	0.3726	0.0272			
Group	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
DEALT L H1		6.6801	6.6426	6.7176	0.3735	0.3488	0.402
RPTED H1		6.6718	6.6336	6.71	0.3717	0.3466	0.4007
Diff (1-2)	Pooled	0.00828	-0.0451	0.0617	0.3726	0.3547	0.3925
Diff (1-2)	Satterthwaite	0.00828	-0.0451	0.0617			
Method	Variances	DF	t Value	Pr > |t|			
Pooled	Equal	749	0.3	0.761			
Satterthwaite	Unequal	747.77	0.3	0.761			
Equality of Variances							
Method	Num DF	Den DF	F Value	Pr > F			
Folded F	383	366	1.01	0.927			

Table 5: PAIRED T-TEST Result of Dealt and Reported Rate for Hour 2							
Group	**N**	**Mean**	**Std Dev**	**Std Err**	**Minimum**	**Maximum**	
DEALT H2	381	6.6746	0.3822	0.0196	6.063	9.0909	
RPTED H2	374	6.5992	0.3513	0.0182	6.0188	7.4	
Diff (1-2)		0.0754	0.3672	0.0267			
Group	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
DEALT H2		6.6746	6.6361	6.7131	0.3822	0.3569	0.4115
RPTED H2		6.5992	6.5635	6.635	0.3513	0.3278	0.3784
Diff (1-2)	Pooled	0.0754	0.0229	0.1278	0.3672	0.3496	0.3868
Diff (1-2)	Satterthwaite	0.0754	0.0229	0.1278			
Method	Variances	DF	t Value	Pr > |t|			
Pooled	Equal	753	2.82	0.0049			
Satterthwaite	Unequal	749.77	2.82	0.0049			
Equality of Variances							
Method	Num DF	Den DF	F Value	Pr > F			
Folded F	380	373	1.18	0.1022			

Table-6: T-TEST Result of Dealt Rates in Hour 1 and Hour 2							
Group	**N**	**Mean**	**Std Dev**	**Std Err**	**Minimum**	**Maximum**	
DEALT H1	384	6.6801	0.3735	0.0191	6.0235	8.9941	
DEALT H2	381	6.6746	0.3822	0.0196	6.063	9.0909	
Diff (1-2)		0.00546	0.3779	0.0273			
Group	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
NDSCALL H1		6.6801	6.6426	6.7176	0.3735	0.3488	0.402
NDSCALL H2		6.6746	6.6361	6.7131	0.3822	0.3569	0.4115
Diff (1-2)	Pooled	0.00546	-0.0482	0.0591	0.3779	0.3598	0.3978
Diff (1-2)	Satterthwaite	0.00546	-0.0482	0.0591			
Method	Variances	DF	t Value	Pr > |t|			
Pooled	Equal	763	0.2	0.8417			
Satterthwaite	Unequal	762.27	0.2	0.8417			
Equality of Variances							
Method	Num DF	Den DF	F Value	Pr > F			
Folded F	380	383	1.05	0.6519			

Table 7: T- TEST Result of Reported Rates in H 1 and H 2							
Group	**N**	**Mean**	**Std Dev**	**Std Err**	**Minimum**	**Maximum**	
RPTED H1	367	6.6718	0.3717	0.0194	5.95	9.1563	
RPTED H2	374	6.5992	0.3513	0.0182	6.0188	7.4	
Diff (1-2)		0.0726	0.3615	0.0266			
Group	**Method**	**Mean**	**95% CL Mean**		**Std Dev**	**95% CL Std Dev**	
RPTED H1		6.6718	6.6336	6.71	0.3717	0.3466	0.4007
RPTED H2		6.5992	6.5635	6.635	0.3513	0.3278	0.3784
Diff (1-2)	Pooled	0.0726	0.0204	0.1247	0.3615	0.344	0.381
Diff (1-2)	Satterthwaite	0.0726	0.0204	0.1247			
Method	**Variances**	**DF**	**t Value**	**Pr > |t|**			
Pooled	Equal	739	2.73	0.0065			
Satterthwaite	Unequal	734.83	2.73	0.0065			
Equality of Variances							
Method	Num DF	Den DF	F Value	Pr > F			
Folded F	366	373	1.12	0.2777			

Table - 8: An example Volume Weighted Variance and Standard Deviation				
	SD	**Variance (SD^2)**	**Volume**	**Volume* Variance**
D1	0.25	0.0625	1500	93.75
D2	0.18	0.0324	850	27.54
D3	0.08	0.0064	754	4.83
D4	0.67	0.4489	689	309.29
D5	0.35	0.1225	1145	140.26
D6	0.48	0.2304	975	224.64
D7	1.02	1.0404	1540	1602.22
SUM		1.9435	7453	2402.53
AVG (Variance)				0.3224
Standard Deviation				0.5678