

Methodology of Calculation of the Benchmark

Treasury Bills Curve

20th June, 2018.

Version-2

FBIL started publication of FBIL Treasury Bills Curve (TBCURVE) for 7 tenors (14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months) with effect from 23rd August, 2018. Based on the interactions with the market participants and other stakeholders, FBIL has decided to publish the rates for 7 more tenors, viz. 7 days, 4 months, 5 months, 7 months, 8 months, 10 months and 11 months. Accordingly, the methodology document has been suitably updated. Publication of TBCURVE based on the revised methodology will commence on 30th July, 2018.

The FBIL T-Bills Curve will be computed on daily basis as per the following methodology:

TBCURVE Computation Methodology

1. For the purpose of computation of the Benchmark TB Rates, secondary market transactions of all Treasury Bills and Cash Management Bills dealt as well as reported on NDS-OM platform and settling on T+1 basis will be considered.
2. All trades and outstanding orders as and when relevant as per fallback mechanism described in Sr. No. 4 will be extracted after the close of Market Hours – typically after 5.00PM.
3. All deals having value of `5crores and above will be included in the dataset to compute the Benchmark TB Curve. No Constituent deals will be considered for computation of the rates. The trades would be classified based on their residual maturity from the settlement date. These trades will be put into various time buckets representing the benchmark tenors of 14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months. The trades in each of these buckets will serve as a medium for computation of a benchmark rate to represent a particular benchmark tenor. The following table will be used for bucketing the transactions.

Table- 1: Trades Captured in Tenor Buckets
Classification on the basis of Residual maturity

Bucket	Residual maturity (days)	Benchmark Tenor
1	1 to 16	14 Days
2	17 to 45	1 Month
3	46 to 71	2 Months
4	72 to 115	3 Months
5	116 to 200	6 Months
6	201 to 300	9 Months
7	>300	12 Months

4. Once the trades are put into their respective tenor buckets, the weighted average rate would be computed with the Standard Deviation of the Rates provided there are at least 3 trades in the tenor bucket. If there are less than 3 trades in a particular tenor, the weighted average rate and the Standard Deviation of the Rates would be computed after augmenting the tenor point data with the executable orders with a maximum Bid-Ask spread of 10 bps in NDS-OM system pertaining to that tenor bucket. The lower of the order values (of Buy and Sell orders) which satisfy the above criteria of 10bps spread will be included in volume to be used for computation of the benchmark TB Curve.
5. Outliers would be removed using +/-3SD criteria for each bucket. The Benchmark TBCURVE Rate for the tenors specified in Table 1 will be computed if there are minimum of 3 surviving data points. If the surviving data point is less than 3, the fall back mechanism will kick in.
6. For the purpose of computation of the Final Benchmark TB Curve Rate for the Tenors specified in Table 1, the methodology takes into consideration four parameters, namely, the *Distance, Volume, Amount and Rate*.
 - a. **Distance:** To calculate the *Distance* we follow steps i to v as under:
 - i. Calculate the difference between the residual tenors of a given trade with its respective benchmark tenor. For example, in case of trades with

a residual tenor of 15 days, this difference is computed as 15 minus 14 which equals -1.

- ii. Calculate the absolute value of this difference. Following our example, $|-1|$ is equal to 1.
- iii. Calculate the sum of these absolute differences, for all trades in the relevant maturity bucket. If we have trades with the differences of 12, 8, 6 and 1 day, then this is the sum of 12, 8, 6 and 1 which equals to 27.
- iv. Each tenor is then assigned a weight, based on its percentage share in the sum of these absolute differences in that relevant bucket. In our case, this is equal to 0.0370 i.e. 1 (calculated from Step ii) divided by 27 (calculated from Step iii).
- v. *Distance* is then calculated as the inverse of this percentage share. In our example, this equals to 27 i.e. 1 divided by 0.0370.

Thus, the parameter of *Distance* will vary depending upon the proximity of the residual tenor of a given trade to its benchmark tenor. Indeed, given the benchmark tenor of 14 Days, trades with a residual tenor of 15 days will have a greater weight (i.e. a weight of 27) vis-à-vis trades with a residual tenor of 2 days (i.e. a weight of 2.25), as it lies closer to our benchmark tenor.

- b. **Volume:** The volume is computed as the percentage share of the number of trades (frequency), for a given residual tenor, in the total number of all the trades within that respective maturity bucket. As an example, there has been only one trade with a residual maturity of 15 days, within the 14 Days maturity bucket which consists of a cumulative of 5 trades. Hence the weight assigned to this trade is 0.20 (i.e. 1 divided by 5). Thus, larger the number of trades at a given tenor, greater would be its influence on the benchmark rate.
- c. **Amount:** For a given maturity bucket, the third parameter used in computation is the *Amount* (value in `Crores²) of all the trades which have a residual maturity

² 1Crore is 10Million

that fall within that maturity bucket. The greater the value of the trades, the larger would be its weight in the computation process. For example, in case of the 1st maturity bucket, the trades with a residual maturity of 8 days and an amount of `70crores will play a larger role in influencing the 14-Days benchmark rate vis-à-vis trades with a residual maturity of 15 days and an amount of `5crores.

Having computed the parameters, Weighted Average Rate (WAR) (Annexure – 1) for each benchmark Tenor of the Curve:

$$WAR = WAR(\text{Amount}, \text{Distance}, \text{Volume}) = \frac{\sum(\text{Rate} \times \text{Amount} \times \text{Distance} \times \text{Volume})}{\sum(\text{Amount} \times \text{Distance} \times \text{Volume})} \quad (1)$$

7. Using the traded data with augmentation provision with outstanding orders wherever necessary, the Rates (yields) for each Tenor for the day will be computed.
8. If the Benchmark TBCURVE Rate for any tenor specified in Table 1 is not available for the day, the said Rate would be computed using the previous day's Benchmark TBCURVE Rate (traded, calculated or repeated as the case may be) for the relevant Tenor plus the average spread of two adjacent buckets for the day (Rate_t – Rate_{t-1}). When two adjacent spread points are not available, the computation will use the nearest available spread for the Tenor. This will result in having T-Bills Rates for almost all tenors on all days. The calculation process for these missing values is given below:

1	B	C	D	E	F	G
2	1M	2M	3M	6M	9M	12M
3	6.74	6.76	6.77	6.79	6.82	6.85
4	6.52	6.56		6.65	6.74	6.81
5		6.85	6.89			6.96
6	6.75	6.79	6.82	6.84	6.88	
7						
8	B	C	D	E	F	G
9	1M	2M	3M	6M	9M	12M
10	6.74	6.76	6.77	6.79	6.82	6.85
11	6.52	6.56	=D10+((C11-C10)+(E11-E10))/2	6.65	6.74	6.81
12	=B11+(C12-C11)	6.85	6.89	=E11+(D12-D11)	= F11+((G12-G11)+(E12-E11))/2	6.96
13	6.75	6.79	6.82	6.84	6.88	=G12+(F13-F12)

9. Following the computation of the Benchmark TBCURVE Rates for 14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months, the remaining intermediate tenors i.e. 7 days, 4 months³, 5 months, 7 months, 8 months, 10 months and 11 months will be calculated using interpolation/extrapolation.
10. The Benchmark TBCURVE Rates for the intermediate tenors will be computed from the Traded/Computed Benchmark TBCURVE rates, as explained in Annexure-2.
11. In case all attempts fail to estimate a Benchmark TBCURVE Rate for a particular Tenor on the Curve using the process explained in this document, previous day's Rate for the appropriate Tenor will be repeated.
12. If Benchmark TBCURVE Rates for all Tenors are not available for a day, the Benchmark TBCURVE of the previous day would be repeated (maximum upto 2 days).
13. The Rates would be published at about 5.30PM. If the market time is extended, the publication time will also suitably change.
14. A brief summary of revision is also available at Annexure 3.

Reference:

ESTIMATION OF A BENCHMARK TREASURY BILLS CURVE (Technical Document by Golaka C Nath, Member, FBIL OC and Manoel Pacheco, AM, CCIL)

³ 4M would be 120 days

ANNEXURE - 1

For the purpose of illustration we consider the transactions to be used for computation of the 14 Day benchmark Tenor. These transactions are categorized on the basis of their residual tenor and are aggregated to arrive at a cumulative Amount and Weighted Value (WV) for each residual maturity as indicated in 'Panel A of Table 2'. The number of trades, Amount and WV are then aggregated for those transactions with the same residual tenor as indicated in 'Table 1'.

Table 2: TB Transaction for computation of 14 Days Benchmark Rate								
Panel A				Panel B				
Residual Tenor	Amount (Rs. Cr.)	Yield	WV	Residual Tenor	Number of Trades	Amount (Rs. Cr.)	WV	Rate
	(a)	(b)	(a) x (b)			(a)	(b)	(c) = (b)/(a)
2	10.00	6.6089	66.089	2	2	20.00	132.18	6.6089
2	10.00	6.6089	66.089	6	1	50.00	330.08	6.6015
6	50.00	6.6015	330.08	8	1	70.00	458.64	6.5520
8	70.00	6.5520	458.64	15	1	5.00	32.50	6.4997
15	5.00	6.4997	32.50					

The outliers are removed using a 3SD criteria from the mean weighted average rate in each bucket. Only trades of 5 crores and above are used for computation.

For the purpose of computation of the benchmark rate, the methodology takes into consideration four parameters, namely, the *Distance*, *Volume*, *Amount* and *Rate*. The computation of these parameters is illustrated in 'Table 3' and is explained as follows:

Table 3: Computation of 14 Days WAR						
Variable	Notation	14 Day WAR				
Panel A: Tenor-Wise Information						
Residual Tenor ^{\$}	(a)	2	6	8	15	
Benchmark Tenor [@]	(b)	14				
Days	(c) = (a) - (b)	12	8	6	-1	
ABS(Days)	(d) = (c)	12	8	6	1	
Sum of ABS(Days)	(e) = Σ(d)	27				
Share in ABS(Days)	(f) = (d)/(e)	0.4444	0.2963	0.2222	0.0370	
Distance	(g) = 1/(f)	2.2500	3.3750	4.5000	27.0000	
No. of trades ^{\$}	(h)	2	1	1	1	
Sum of No. of Trades	(i) = Σ(h)	5				
Volume	(j) = (h)/(i)	0.4000	0.2000	0.2000	0.2000	
Amount (Rs. Cr.) ^{\$}	(k)	20.00	50.00	70.00	5.00	
Rate ^{\$}	(l)	6.6089	6.6015	6.5520	6.4997	
Panel B: Computed WAR						
WAR	$\frac{\sum(l) \cdot (k) \cdot (g) \cdot (j)}{\sum(k) \cdot (g) \cdot (j)}$	6.5610				
Rate to Closest Applicable Tenor ^{\$}		6.4997				

Notes: \$ Figures from Panel B of Table 2. @ Figures from Table 1.

ANNEXURE - 2

The computation of the tenors of 7 days, 4 months⁴, 5 months, 7 months, 8 months, 10 months and 11 months would be as follows:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Tenor	7	14	30	60	90	120	150	180	210	240	270	300	330	360
2	02-01-17	$C2 - (((D2 - C2) / (D1 - C1)) * (C1 - B1))$	6.1535	6.2509	6.1481	6.1017	$F2 + ((I2 - F2) / (I1 - F1)) * (G1 - F1)$	$F2 + ((I2 - F2) / (I1 - F1)) * (H1 - F1)$	6.1656	$I2 + (L2 - I2) / (L1 - I1) * (J1 - I1)$	$I2 + ((L2 - I2) / (L1 - I1)) * (K1 - I1)$	6.2021	$L2 + (O2 - L2) / (O1 - L1) * (M1 - L1)$	$L2 + ((O2 - L2) / (O1 - L1)) * (N1 - L1)$	6.2277
3	02-01-17	6.1109	6.1535	6.2509	6.1481	6.1017	6.1230	6.1443	6.1656	6.1778	6.1899	6.2021	6.2106	6.2192	6.2277

⁴ 4M would be 120 days

Brief Summary of revision of calculation of T-BILLS Rates

Sl. No	Extant Methodology	Revision made
1	Currently, the T-Bill rates are published for 7 tenors, viz. 14 days, 1 month, 2 months, 3 months, 6 months, 9 months and 12 months based on traded data. If the traded data is not available for a tenor, the rate for the tenor shall be determined as per the fall back mechanism.	Rates will also be calculated for additional 7 tenors, viz. 7 days, 4 months, 5 months, 7 months, 8 months, 10 months and 11 months using interpolation/extrapolation.