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Estimation Of A Benchmark Certificate of Deposit (CD) Curve

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ABSTRACT

Certificate of Deposits are issued by Banks for raising short term finance from the market and institutional investors like mutual fund houses and banks are the key investors. The trading is concentrated in first three months maturity tenors accounting for nearly 80% of the secondary market trading, with issuances in CDs maturing in 12 months or more. Due to the sparse trading in tenors beyond 3 months, the study suggests adding a spread to the T-Bills market rates for the days for tenors for which CDs are not traded. It also suggested considering a minimum of 3 trades for computation to improve data sufficiency. The design of the methodology for the computation of the CD curve takes into account four parameters: Distance, Volume, Amount and Rate. The final rate for each traded tenor is the weighted average taking into account the weight of all these 4 parameters. The regression and correlation results of the traded data for both CD and T-Bills indicate a strong relationship between the traded rates in these 2 markets. There is also a positive upward sloping spread (CDWAR – TBWAR) on the days when both these rates were traded.

The paper suggests the methodology for computation of the CD Curve. Initially the traded CD rates are calculated for each tenor having atleast 3 trades for all CD transactions of value Rs. 5 crore and above. The paper further elaborates on the fallback mechanism to calculate the rate in case of inadequate trades, using initially, the day's-Bill rate for that tenor, or the previous 7 days' traded spread, adding the CD spread of the adjacent tenors or as a last measure repeating the CD rate of the previous day. The results show that the actual traded rates are very close to the rates calculated using the T-Bills rates/ the average spread of 7 days lag. Analysis of the FBIL CD rates show that around 54% of the total trades lie within this rate indicating that the traded rates are on an average symmetrical around the benchmark rate.

JEL Classification: G1, G12, G0, E430,

Keywords: Certificate of Deposits, T-Bills, Spread, Tenors, Regression, Efficiency

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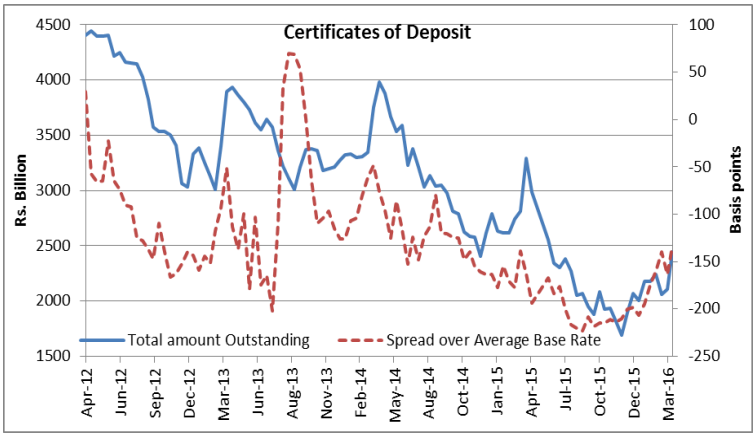
1. INTRODUCTION

Certificate of Deposits are issued by Banks for raising short term finance from the market. As the banks have generally higher ratings (specifically short term rating because of availability of liquidity from central bank), they could raise funds from the market at cheaper rates. CDs are an important source of raising funds for the banks themselves. These instruments are used by banks to meet their temporary asset-liability mismatches. CD rates are typically higher than yields on government securities as investors are required to deposit funds for a specified term exposing them to credit risks as against the risk-free sovereign securities. CD issuances also depend on liquidity. CD issuances fell amid easy liquidity as can be observed after demonetization. Institutional investors like mutual fund houses and banks are the key investors/buyers of these instruments.



CD issuances spike up during financial year ends as well as reissuances due to liquidity tightness. To address the spike in the CD rates at financial year-ends as banks rushed to meet targets, the Finance Ministry issued norms that required banks to reduce the proportion of bulk deposits and CDs to 15% of the total deposits by March 31, 2013. This led to a substantial decline in CD issuances with most public sector banks. Recognizing that bank investments in liquid schemes of mutual funds would, in turn, be invested in bank CDs, that could lead to systemic risks, RBI banned banks from holding more than 10% of their net worth in liquid schemes of mutual funds from January 2012. At the same time, SEBI's decision to reduce the threshold for mark-to-market requirement on debt and money market securities of mutual funds from 91 days to 60 days also contributed to reductions in CD holdings. While the market lost some appetite due to the several restrictions imposed on the participants by regulators, the slow credit off take has also been a contributor to the contraction of the CD market. Secondary market trading in CDs has been in a declining trend in line with the decline in issuances.

2. CD TRADING BEHAVIOR

The trading in CDs happen through OTC market and the same is reported to F-TRAC platform of CCIL. The trades are settled directly among participants using the clearing corporation of the Exchanges. Trading in CDs have been slowly falling as issuances have also gone down. The daily average trading has dropped to Rs. 4063 crores in 2016-17 vis-à-vis Rs.13283crores in 2012-13 (Table 1).

The trading is concentrated in first three months maturity tenors and account for a lion share of total trading activities. On an average nearly 80% of the total secondary market trading in CDs has been concentrated in CDs maturing within 3 months, although issuances are mainly concentrated in CDs maturing in 12 months or more. Mutual Funds, Public Sector Banks and Private Sector Banks are the most dominant participants in the secondary market. The spread over G-secs in the secondary market trading of CDs had been narrowing sharply till the last fiscal (Table 2). However, the spreads have started inching up again in recent months owing to rising liquidity tightness as well as increasing uncertainty in markets due to global developments along with competition from other money market instruments offering higher yields. CDs can get a boost from with the development of a benchmark Certificate of Deposit (CD) curve for inter-bank lending and borrowing based on dealt rates of various tenors of maturity up to a year. This measure will bring more transparency and lead to better pricing as CDs are currently priced through negotiations with the rates decided according to the demand, supply and the perceived credit risk of the issuer.

Till 2015, PSU banks used to dominate issuance of CDs with almost 80% of market share but the same dropped to 56% in 2016. Foreign banks hardly issue any CDs. Private Banks have started to issue CDs in good amount (Table 3).

3. DATA ANALYSIS OF CERTIFICATE OF DEPOSIT (CD) MARKET

To analyze the trading activity in the CD market, the trades were classified into buckets based on their residual maturity, as we had done in the computation of the Benchmark TBills Curve (Golaka C. Nath and Manoel Pacheco, 2018).

In all we derive 7 buckets as illustrated in *Table 4* to represent a benchmark tenor.

Trading Frequency: Table 5 represents the year wise trading frequency (number of days traded in a year) of CDs across all the tenor buckets. For example, in case of 2016, we found 227 trading days (out of a total of 241 trading days) on which, at least one CD having a residual maturity that falls in the 14-days benchmark tenor bucket, was traded.

Table- 4: Trades Captured in Tenor Buckets Classification on the basis of Residual maturity (April 2012 – Dec 2016)		
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

Amount and Number of Trades: Table 6 and Table 7 break down the amount (in Rs. Cr.) and number of trades of CD transactions across all tenors.

The results indicate active trading for tenors upto three months. Specifically, we find 70% of the trading activity (in terms of number and value) centered around tenors upto 3 months. Since the trading frequency beyond 3 months is not representative for computation of CD benchmark rate, we looked at other possible ways to build a robust and acceptable CD curve for tenors beyond 3 months. Dated Treasury Bills (DTB) upto 364 days are regularly issued by the Govt. and they are frequently traded in the secondary market. Hence, we considered T-Bills market rate plus a spread to estimate CD curve for the days when CDs are not traded for a particular Tenor. Table 8, presents the number of days the CD WAR can be computed under the same 3 and 5 minimum trade criteria.

From the data, we can see that considering minimum of 5 trades for computation of CD Rate may not be a good idea as the days of computation using the trade information drops significantly. Hence we decided to use the Minimum 3 trades criteria for computation of CD Rates.

The computation of Benchmark CD Rates are illustrated in Section 4.

4. METHODOLOGY FOR COMPUATION OF BENCHMARK RATES FOR CD CURVES

For the purpose of computation of the benchmark Rates, secondary market transactions of CD that are reported to the F-TRAC platform, have been considered. Transaction in the nature of inter scheme transfers are considered as **outliers** and have been excluded for the purpose of the computation. We classify the trades based on their residual maturity. These trades will represent 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.

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 9'. The number of trades, Amount and WV are then aggregated for those transactions with the same residual tenor as indicated in 'Panel B of Table 6'.

The outliers are removed using a +/-3 standard deviation criteria from the weighted average rate in each bucket. Only trades with a value of Rs.5 crores and above are used for computation.

For the purpose of computation of the CD benchmark rate, the methodology takes into consideration four parameters, namely, the *Distance*, *Volume, Amount and Rate,* as we have done for the TB Benchmark Rate. The computation of these parameters is illustrated in 'Table 10' and is explained as follows:

a. Distance: To calculate the *Distance* we follow steps i to v as under*:*

i. Calculate the difference between the residual tenor 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. 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 Rs. Crores) of all the trades which have a residual maturity 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 Rs. 70 crores 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 Rs. 5 crores.

Having computed the parameters, three alternative computation methodologies that has been considered to arrive at the weighted average rate (WAR) for each benchmark Tenor of the Curve:

$$\boldsymbol{WAR3} = \boldsymbol{WAR}(\boldsymbol{Amount}, \boldsymbol{Distance}, \boldsymbol{Volume}) = \frac{\sum(\boldsymbol{Rate} \times \boldsymbol{Amount} \times \boldsymbol{Distance} \times \boldsymbol{Volume})}{\sum(\boldsymbol{Amount} \times \boldsymbol{Distance} \times \boldsymbol{Volume})} \quad \textbf{(1)}$$

$$\boldsymbol{WAR2} = \boldsymbol{WAR}(\boldsymbol{Amount}, \boldsymbol{Distance}) = \frac{\sum(\boldsymbol{Rate} \times \boldsymbol{Amount} \times \boldsymbol{Distance})}{\sum(\boldsymbol{Amount} \times \boldsymbol{Distance})} \quad \textbf{(2)}$$

$$\boldsymbol{WAR1} = \boldsymbol{WAR}(\boldsymbol{Amount}) = \frac{\sum(\boldsymbol{Rate} \times \boldsymbol{Amount})}{\sum \boldsymbol{Amount}} \quad \textbf{(3)}$$

For all the tenor buckets, the WAR computed under the three methodologies appear to closely replicate the properties of the rate closest to the applicable tenor. Among the three methodologies, WAR3 was chosen, as it appears to be stable over time and accounts for characteristics of the amount, distance and volume of the CD transactions.

5. CD AND T-BILLS RELATIONSHIP FOR ESTIMATION OF SPREAD

We used the data for CDs and DTB market during the period of **October 2013 to December 2016** for building our curves for both CD and T-Bills. The methodology which was used to derive the CD Rates has been used to derive the DTB Rates and categorized into the tenors of 14 days to 12 Months. Table 11 gives the descriptive statistics of the traded rates for CDs and T-Bills. For robustness, we considered a subset of the total data period.

Using the historical data for the days in which both CDs and DTBs have been traded, the following regression equation is estimated to understand their relations in order to build a spread-based CD curve:

$$\boldsymbol{CD\ WAR_t = \alpha + \beta * DTB\ WAR_t + \epsilon_t} \qquad \textbf{(4)}$$

The regression results are indicated in Table 12:

The regression results give a very high R-square indicating strong relationship. The strong relationship is depicted in correlation coefficients between the traded CD Rates and the traded T-Bills Rates for all tenors as given in Table 13.

The traded Spread is then obtained as follows:

$$\boldsymbol{Traded\ Spread_t = Traded\ CD\ WAR_t - Traded\ DTB\ WAR_t} \qquad \textbf{(5)}$$

From the historical data (Oct'13 to Dec'16), we find a positive and upward sloping traded spread (for the days when both CD and T-Bills Rates in each tenor was available) as indicated in Table 14.

The major challenge is to find the appropriate rates for the days when both CDs and T-Bills are not traded in the market. In order to establish continuous T-Bills and CD curve we followed the methodology specified in Section 6.

6. PROCESS FOR COMPUATION OF BENCHMARK CD CURVE

The following steps are used to compute the CD Curve:

1. We use the computed CD Rates from trades wherever available subject to conditions mentioned like outliers using +/-3 standard deviation, minimum trade value of Rs.5crores and above, minimum 3 trades for each tenor etc.
2. For CD curve, first choice is to use the traded Rates where the trades satisfy the conditions discussed in this paper.
3. If traded rate is not available for a Day, compute the CD Rate by using the T-bills Rate calculated for the day and a traded spread of the previous day.

4. Traded spread is calculated as the difference between the TB rate and traded CD rate for the particular Tenor.
5. On second day (if the traded spread is not available) take the simple average of last "n" days of spread – currently "n" is set as 7 traded spreads irrespective of whenever such trades are available and add the same to the T-Bills Rate calculated for the day in order to arrive at the CD Rate.
6. If CD Rate is not available for the day (no CD minimum trades, no T-Bills minimum trades, compute the CD Rate by using the previous day's CD Rate (traded, computed with spread, Repeated) and the average spread of two adjacent rates or the nearby spread.
7. In case it is not possible to estimate the CD Rate for the second day, the CD Rate of the previous day is repeated.

Following the procedures discussed above, we could also compute the CD rates from 2012 to 2016. Table 15 provides a break-up of the number of days the CD WAR has been computed from trades, days when the CD rate has been implied from DTB rate and days when the previous days rate along with adjacent tenor spread is used.

The descriptive statistics of the CD Rates computed (Oct'13 to Dec'16) using the suggested methodology is given in Table 16. It can be seen that the results are very close to the actual rates computed on the days of trading of CDs given in Table 11. Table 17 gives the year-wise computation of actual CD rates and theoretical rates using past traded spread.

7. TESTING THE EFFICIENCY OF THE BENCHMARK CD CURVE

The distribution of rates in an ideal market should reflect the normal distribution i.e. the rates should be symmetric around the mean. To test the efficiency of the benchmark rate we conducted a distribution analysis for the 3 month benchmark tenor- the most liquid tenor on the curve. Trades with a residual maturity starting from 72 days and upto 115 days for the period of 23rd August 2017 to 30th April 2018 were analyzed. We calculated the daily rate at the 10th, 25th, 50th, 75th and 90th percentiles for all trades reported during the period and the cumulative value at each of these percentiles. In addition to this, the cumulative value of the trades' upto the computed FBIL Benchmark rate was also estimated. The summary statistics of the results for each month is shown in Table 18.

The results suggest that around 54% of the total trading value of trades lie within the FBIL CD Rate. This suggests that the traded rates are on an average symmetrical around the published benchmark rate.

8. CONCLUSION AND SUGGESTIONS

1. CD curve will be generated by computing the rates for 7 points/tenors of 14-day, 1, 2, 3, 6, 9 and 12 months. Trades reported to F-TRAC platform of CCIL will be captured grouped in the tenor buckets as explained in the methodology and technical document.

2. The computed CD rates from traded data will be used whenever available, subject to the conditions, namely, removal of outliers outside using +/- 3 standard deviation range, minimum trade size value of Rs.5crores and above and , minimum 3 trades for each tenor, etc.

3. If traded rate for a particular tenor, conforming to the criteria mentioned above, is not available on any working Day, the CD Rate for the tenor will be computed by taking the benchmark T-Bills Rate for the relevant tenor which has already been calculated for that day using both trades and order books data and the traded spread between traded CD rate and T-Bills rate of that tenor of the previous working day.
4. The traded spread is the difference between traded CD bucket and T. Bills rate for the particular tenor.
5. If the previous day's traded spread is not available, then average of last 7 available spreads **(Difference between traded CDCURVE Rate and TBCURVE Rate computed or calculated or interpolated with spreads)** would be taken and added to the TBCURVE Rate for the relevant tenor for the Day to give the CDCURVE rate for the Tenor.
6. If CDCURVE Rate for a Tenor is not available for the day (no CD minimum trades and no T-Bills minimum trades), the CDCURVE Rate would be computed by using the previous day's CD Rate (traded, computed with spread and repeated as the case may be) and the average spread of two adjacent CDCURVE Rates ($Rate_t$ - $Rate_{t-1}$) or the nearby spread as the case may be.
7. In case no CDCURVE Rate for a Tenor is possible to estimate for the second day, the CDCURVE Rate for the previous day would be repeated.

References

Golaka C. Nath and Manoel Pacheco. (2018, May). Estimation of A Benchmark Treasury Bills Curve. Rakshitra, pp. 7-20.

Table 1: Trading of Certificate of Deposits				
Period	**Trades**	**Value**	**Weighted Average Value**	**Weighted Average yield (%)**
2012-13	39624	1833097	13283	8.8774
2013-14	34228	1698860	7020	8.9368
2014-15	28958	1560787	6586	8.5662
2015-16	22454	1272810	5281	7.6574
2016-17	16018	979117	4063	6.6882

Table 2: Maturity wise Distribution of CD Trades*

Residual Maturity (Months)	2012-13			2013-14			2014-15			2015-16		
	Share (%)	WAY (%)	Spread over G-sec (bps)	Share (%)	WAY (%)	Spread over G-sec (bps)	Share (%)	WAY (%)	Spread over G-sec (bps)	Share (%)	WAY (%)	Spread over G-sec (bps)
1	22.16	8.49	40.17	20.23	8.75	19.69	26.50	8.37	6.46	28.24	7.61	37.67
2	18.12	8.68	56.55	25.08	8.99	44.04	27.15	8.56	18.01	22.90	7.62	30.66
3	25.87	9.03	87.89	22.18	8.87	53.42	24.64	8.63	25.04	28.76	7.75	41.88
4	6.45	9.05	92.82	3.09	9.00	71.83	4.15	8.70	27.51	2.10	7.69	35.55
5	3.04	8.88	75.30	2.02	8.86	57.19	2.11	8.75	24.89	1.46	7.66	30.11
6	3.97	8.93	83.59	2.93	9.05	56.04	2.24	8.75	25.13	2.99	7.78	47.12
7	2.42	9.10	95.33	1.54	9.73	73.54	1.10	8.75	27.01	1.60	7.79	32.36
8	1.94	9.17	104.51	2.28	9.06	69.07	1.05	8.89	28.67	1.64	7.84	31.04
9	2.16	9.20	108.76	2.82	8.50	74.65	1.17	8.82	30.10	1.54	7.95	37.84
10	2.18	9.46	128.52	2.26	8.59	79.57	1.50	8.92	31.59	1.96	8.09	41.58
11	2.01	9.45	129.00	2.96	8.71	77.20	1.72	8.94	39.50	1.89	8.18	46.30
12	9.67	9.20	118.19	12.60	9.41	72.55	6.67	8.75	46.93	4.92	8.04	69.33

*Excluding Inter Scheme Transfers. Source: CCIL

Table 3: Category-wise Distribution of CD Trades				
Year	**Public Sector Banks**	**Private Banks**	**Foreign Banks**	**Total**
Amount In Rs. Cr.				
2012	1047262	194945	664	1242871
2013	1271449	251988	1745	1525182
2014	1208422	227245	800	1436467
2015	787332	296444	1878	1085654
2016	566862	381349	1453	949664
Percentage Share of Total Traded Value (%)				
2012	84.26	15.69	0.05	100.00
2013	83.36	16.52	0.11	100.00
2014	84.12	15.82	0.06	100.00
2015	72.52	27.31	0.17	100.00
2016	59.69	40.16	0.15	100.00

Table 5: Tenor Wise Analysis of Trading Frequency in the CD Market*															
	No. of Days Traded in a Year								**As a Percentage of Total Trading Days**						
Year	**14D**	**1M**	**2M**	**3M**	**6M**	**9M**	**12M**	**Total Trading Days**	**14D**	**1M**	**2M**	**3M**	**6M**	**9M**	**CD 12M**
2012	174	180	177	182	182	176	172	182	96%	99%	97%	100%	100%	97%	95%
2013	230	241	227	228	232	212	241	244	94%	99%	93%	93%	95%	87%	99%
2014	235	235	235	224	211	196	211	236	100%	100%	100%	95%	89%	83%	89%
2015	240	239	240	206	194	184	166	241	100%	99%	100%	85%	80%	76%	69%
2016	227	232	230	218	196	185	196	241	94%	96%	95%	90%	81%	77%	81%
**Trades of Rs. 5 Cr. and above have been considered.*															

Table 6: Tenor Wise Analysis of Daily Average Value in CD Market*														
	Daily Average Value in Rs. Cr.							**Tenor Wise Percentage of Total Traded Value**						
Year	**14D**	**1M**	**2M**	**3M**	**6M**	**9M**	**12M**	**14D**	**1M**	**2M**	**3M**	**6M**	**9M**	**12M**
2012	948	1004	1438	1752	742	582	503	13%	15%	20%	26%	11%	8%	7%
2013	948	774	1711	1089	459	593	1043	14%	12%	25%	16%	7%	8%	16%
2014	1098	793	2044	982	362	286	755	18%	13%	33%	15%	5%	4%	11%
2015	896	599	1321	1024	303	327	485	20%	13%	29%	19%	5%	6%	7%
2016	799	591	906	936	368	292	472	19%	14%	22%	21%	8%	6%	10%
**Trades of Rs. 5 Cr. and above have been considered.*														

Table 7: Tenor Wise Analysis of Daily Average Trades in CD Market*														
	Daily Average Number of Trades							Tenor Wise Percentage of Total Trades						
Year	14D	1M	2M	3M	6M	9M	12M	14D	1M	2M	3M	6M	9M	12M
2012	18	22	27	32	18	15	14	12%	15%	18%	22%	13%	10%	9%
2013	18	17	29	17	11	14	23	14%	14%	22%	13%	8%	10%	19%
2014	19	16	31	15	8	7	17	17%	15%	28%	13%	6%	5%	14%
2015	15	14	21	13	7	8	10	19%	18%	26%	14%	7%	7%	8%
2016	11	11	14	11	6	5	9	18%	18%	22%	16%	8%	7%	12%
**Trades of Rs. 5 Cr. and above have been considered.*														

Table 8: No. of Days CDs have been Traded														
Minimum 3 Trades Criteria														
Period	14D		1M		2M		3M		6M		9M		12M		Total Trading Days
	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	
2012	162	89%	174	96%	165	91%	172	95%	179	98%	168	92%	152	84%	182
2013	227	93%	232	95%	226	93%	210	86%	209	86%	185	76%	229	94%	244
2014	231	98%	232	98%	233	99%	205	87%	177	75%	162	69%	182	77%	236
2015	236	98%	230	95%	233	97%	175	73%	152	63%	136	56%	114	47%	241
2016	211	88%	202	84%	195	81%	183	76%	149	62%	141	59%	142	59%	241
2012-2016	1067	93%	1070	94%	1052	92%	945	83%	866	76%	792	69%	819	72%	1144
Minimum 5 Trades Criteria														
Period	14D		1M		2M		3M		6M		9M		12M		Total Trading Days
	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	No. of Days	% Share	
2012	146	80%	158	87%	149	82%	160	88%	170	93%	140	77%	133	73%	182
2013	207	85%	214	88%	214	88%	186	76%	180	74%	156	64%	212	87%	244
2014	224	95%	215	91%	226	96%	184	78%	128	54%	102	43%	157	67%	236
2015	220	91%	208	86%	215	89%	145	60%	103	43%	85	35%	77	32%	241
2016	170	71%	159	66%	169	70%	134	56%	107	44%	90	37%	105	44%	241
2012-2016	967	85%	954	83%	973	85%	809	71%	688	60%	573	50%	684	60%	1144

Table 9: CD 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					

Table 10: 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) = ∑(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) = ∑(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					
WAR3	$\frac{\sum(l)\cdot(k)\cdot(g)\cdot(j)}{\sum(k)\cdot(g)\cdot(j)}$	6.5610			
WAR2	$\frac{\sum(l)\cdot(k)\cdot(g)}{\sum(k)\cdot(g)}$	6.5792			
WAR1	$\frac{\sum(l)\cdot(k)}{\sum(k)}$	6.5751			
Rate to Closest Applicable Tenor$		6.4997			
Notes: $Figures from Panel B of Table 2. @Figures from Table 1.					

Table 11: Descriptive Statistics of CD and DTB WAR

Variable	N	Mean	Std Dev	Minimum	Maximum
14D_CD	727	7.71	0.94	4.84	13.05
1M_CD	724	7.90	0.88	6.00	10.60
2M_CD	721	8.01	0.89	5.99	9.96
3M_CD	613	8.04	0.95	5.97	10.07
6M_CD	527	8.11	0.90	6.16	9.91
9M_CD	472	8.18	0.91	6.16	9.84
12M_CD	497	8.45	0.83	6.32	9.85
14D_DTB	505	7.52	0.87	3.72	9.59
1M__DTB	596	7.60	0.87	5.66	9.76
2M__DTB	547	7.68	0.85	5.70	9.74
3M__DTB	748	7.73	0.89	5.70	9.54
6M_DTB	559	7.77	0.88	5.75	9.27
9M__DTB	342	7.84	0.84	5.89	9.02
12M_DTB	386	7.89	0.84	5.80	9.06

Table 12: Regression Results for the Period of Oct'2013 to Dec'2016							R square
Dependent	**Independent**	***Coefficient***	***Estimate***	***Standard Error***	***T Stat***	***P-value***	
6M CD WAR	6M DTB WAR	α	0.43	0.07	5.85	<.0001	0.98
		β	0.98	0.01	105.30	<.0001	
9M CD WAR	9M DTB WAR	α	0.26	0.11	2.47	0.01	0.96
		β	1.01	0.01	76.09	<.0001	
12M CD WAR	12M DTB WAR	α	0.92	0.10	8.94	<.0001	0.95
		β	0.95	0.01	74.39	<.0001	

Table 13: Correlation of CD Rates v/s DTB Rates (Tenors Greater Than 3 Months)						
	CD_6M	**CD_9M**	**CD_12M**	**DTB_6M**	**DTB_9M**	**DTB_12M**
CD_6M	1	0.99 *<.0001*	0.99 *<.0001*	0.98 *<.0001*	0.97 *<.0001*	0.97 *<.0001*
CD_9M	0.99 *<.0001*	1	0.99 *<.0001*	0.99 *<.0001*	0.98 *<.0001*	0.98 *<.0001*
CD_12M	0.99 *<.0001*	0.99 *<.0001*	1	0.99 *<.0001*	0.98 *<.0001*	0.98 *<.0001*
DTB_6M	0.98 *<.0001*	0.99 *<.0001*	0.99 *<.0001*	1	0.998 *<.0001*	0.997 *<.0001*
DTB_9M	0.966 *<.0001*	0.981 *<.0001*	0.983 *<.0001*	0.998 *<.0001*	1	0.999 *<.0001*
DTB_12M	0.971 *<.0001*	0.98 *<.0001*	0.977 *<.0001*	0.997 *<.0001*	0.999 *<.0001*	1

Table 14: Spread analysis of CD WAR over DTB WAR					
Tenor	**CD Rate (%)**	**SD (%)**	**TB Rate (%)**	**SD (%)**	**Spread (%)**
14D	7.52	0.87	7.71	0.94	0.19
1M	7.60	0.87	7.90	0.88	0.30
2M	7.68	0.85	8.01	0.89	0.33
3M	7.73	0.89	8.04	0.95	0.31
6M	7.77	0.88	8.11	0.90	0.33
9M	7.84	0.84	8.18	0.91	0.34
12M	7.89	0.84	8.45	0.83	0.56

Table 15: CD Trading Analysis using Minimum 3 Trades Criteria							
Period	**14D**	**1M**	**2M**	**3M**	**6M**	**9M**	**12M**
Panel A: No. of Days CD WAR is computed from Trades							
2012	162	174	165	172	179	168	152
2013	227	232	226	210	209	185	229
2014	231	232	233	205	177	162	182
2015	236	230	233	175	152	136	114
2016	211	202	195	183	149	141	142
Panel B: No. of Days CD WAR is implied from DTB rates (DTB+Spread)							
2012	14	8	17	10	2	14	30
2013	17	12	18	34	35	59	15
2014	5	4	3	31	59	74	54
2015	5	11	8	66	89	105	127
2016	30	39	46	58	92	100	99
Panel D: No. of Days CD WAR is computed from Adjacent Tenor Spreads							
2012	6	0	0	0	0	0	0
2013	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0
Total	**1144**	**1144**	**1144**	**1144**	**1137**	**1144**	**1144**

Table 16: The descriptive statistics of the CD Rate							
	14D	***1M***	***2M***	***3M***	***6M***	***9M***	***12M***
Mean	7.72	7.84	7.93	8.01	8.10	8.18	8.26
Standard Error	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Median	7.79	8.04	8.15	8.24	8.21	8.24	8.24
Mode	-	-	-	-	8.88	9.20	9.25
Std Deviation	0.99	0.90	0.92	0.93	0.89	0.88	0.83
Sample Variance	0.98	0.81	0.85	0.87	0.80	0.77	0.69
Kurtosis	2.36	-0.56	-0.85	-0.86	-0.97	-1.00	-1.06
Skewness	0.77	0.04	-0.16	-0.22	-0.21	-0.12	-0.13
Range	8.21	4.60	3.97	4.09	3.81	3.80	3.53
Minimum	4.84	6.00	5.99	5.97	6.13	6.16	6.32
Maximum	13.05	10.60	9.96	10.07	9.94	9.97	9.85
Count	779	779	779	779	779	779	779

Table 17: Year-wise Comparison of Actual and Computed CD WAR					
Criteria/Year	**2012**	**2013**	**2014**	**2015**	**2016**
14 DAYS WAR					
CD WAR (From Traded Data)	8.37	8.6	8.5	7.59	6.77
CD WAR (with DTB + Spreads of 7 days Lag)	8.39	8.66	8.5	7.58	6.80
Deviation in Bps	2	6	0	-1	3
1 Month WAR					
CD WAR (From Traded Data)	8.59	8.81	8.63	7.74	6.95
CD WAR (with DTB + Spreads of 7 days Lag)	8.6	8.84	8.62	7.73	6.91
Deviation in Bps	1	3	-1	-1	-4
2 Months WAR					
CD WAR (From Traded Data)	8.76	8.88	8.75	7.83	7.03
CD WAR (with DTB + Spreads of 7 days Lag)	8.78	9.03	8.75	7.83	6.97
Deviation in Bps	2	15	0	0	-6
3 Months WAR					
CD WAR (From Traded Data)	8.91	8.99	8.87	7.89	7
CD WAR (with DTB + Spreads of 7 days Lag)	8.91	9.1	8.87	7.91	7.03
Deviation in Bps	0	11	0	2	3
6 Months WAR					
CD WAR (From Traded Data)	9.06	9.11	8.88	7.9	7.06
CD WAR (with DTB + Spreads of 7 days Lag)	9.06	9.15	8.93	7.96	7.15
Deviation in Bps	0	4	5	6	9
9 Months WAR					
CD WAR (From Traded Data)	9.21	9.08	9.04	8.02	7.08
CD WAR (with DTB + Spreads of 7 days Lag)	9.17	9.18	9.02	8.04	7.21
Deviation in Bps	-4	10	-2	2	13
12 Months WAR					
CD WAR (From Traded Data)	9.29	9.13	9.14	8.26	7.4
CD WAR (with DTB + Spreads of 7 days Lag)	9.24	9.13	9.1	8.08	7.37
Deviation in Bps	-5	0	-4	-18	-3

Table 18: Distribution Analysis of Rate in the 3-Month Tenor Bucket													
Month	10th Pctl.	25th Pctl.	50th Pctl.	75th Pctl.	90th Pctl.	FBIL CD Rate Pctl.	10th Pctl.	25th Pctl.	50th Pctl.	75th Pctl.	90th Pctl.	FBIL CD Rate Pctl.	Difference Between Median & FBIL CD Rate
Aug-17	27.14	41.72	76.67	96.67	100.00	50.00	6.1900	6.1920	6.2504	6.2554	6.2573	6.2174	0.0329
Sep-17	40.11	44.44	67.63	91.25	98.30	76.61	6.1280	6.1309	6.1458	6.1807	6.2101	5.8875	0.2583
Oct-17	64.42	68.08	84.47	95.99	99.80	35.84	6.1922	6.1960	6.2241	6.2407	6.2644	6.1352	0.0889
Nov-17	40.39	53.77	71.29	89.75	97.38	58.97	6.2228	6.2330	6.2574	6.3038	6.4069	6.2596	-0.0021
Dec-17	18.12	33.74	62.90	80.78	98.01	46.30	6.2523	6.2823	6.3252	6.3450	6.3962	6.2998	0.0254
Jan-18	39.09	53.86	71.10	90.44	99.01	43.60	6.6671	6.6773	6.7442	6.7718	6.8215	6.6629	0.0813
Feb-18	22.78	45.62	61.05	85.69	98.31	54.21	7.1856	7.2231	7.2477	7.2924	7.3500	7.2410	0.0067
Mar-18	10.70	23.98	51.44	79.55	92.07	62.39	6.9458	6.9899	7.0522	7.1765	7.2680	7.1170	-0.0647
Apr-18	35.90	50.03	65.45	88.60	96.01	59.43	6.5240	6.5736	6.6457	6.7481	6.8414	6.7263	-0.0806
Full Period	33.57	46.39	67.13	88.01	97.42	54.98	6.4963	6.5189	6.5613	6.6121	6.6737	6.5221	0.0391
Inter-Quartile Analysis								0.0226	0.0423	0.0509	0.0616		
									0.0650	0.0932	0.1125		
										0.1158	0.1548		
											0.1774		