FINANCIAL BENCHMARKS INDIA PVT. LTD.

FBIL G-Sec (Government of India Securities) Valuation Methodology

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FBIL G-Sec (Government of India Securities) Valuation Methodology

In pursuance of Reserve Bank of India's policy announcement in its Statement on Development and Regulatory Policies dated February 7, 2018, FBIL took over the responsibilities for administering the valuation of Government Securities (G-Secs) from FIMMDA with effect from March 31, 2018. However, the publication of valuation of G-Secs continued to be based on the methodology that was developed by FIMMDA in the past which has been placed on its website www.fimmda.org. FIMMDA was engaged as the Calculating Agent for valuation of G-Secs.

The extant valuation methodology is based on Cubic Spline model, using closing traded prices/ YTM of G- Secs as inputs. In 2010, FIMMDA examined the suitability of the available variants of Cubic Spline methodology like Waggoner, Anderson-Sleath and Pienaar-Choudhary. FIMMDA adopted the cubic spline methodology of Pienaar-Choudhary for G-Sec yield curve construction.

The Board of FBIL recently undertook an extensive review of the extant methodology for G-Sec valuation. Based on the conclusions of this review, the Board decided to retain the Cubic Spline model and its underlying principles for valuation of G-Sec, while agreeing to carry out certain improvements in the input selection framework and calibration of the model outputs to better reflect the underlying interest of the Indian sovereign yield curve.

It may be worth mentioning that the G-Sec market in India is not uniformly liquid across the curve and that a large number of G-Secs witness only sporadic trades or no trading activities at all.

This document presents the revised methodology for valuation of G-Secs and other related securities based on cubic spline model. The impact of the revised methodology for valuation of G-Sec has been examined extensively using market data for an extended period of time. The results in this regard are in the Annex.

It is to be noted that review of the calculation methodology of all the benchmarks published by FBIL is an ongoing process and the G-sec methodology will also be subject to regular review in future.

I. Coverage of Securities

The valuation methodology outlined hereunder will cover the following debt securities issued by the Government of India:

1. G-Secs
2. Floating Rate Bonds (FRB)
3. Inflation Index Bonds (IIB)
4. STRIPS
5. Special securities.

Additionally, FBIL will publish two yield curves based on Cubic Spline model as under:

a. Zero Coupon Yield Curve (ZCYC) for various maturities, and
b. Par Yield Curve (PYC) for various maturities.

II. Data and its Source

1. The calculation of prices/yield-to-maturity (YTM) of G-Secs for various maturities will be primarily based on the transaction-level data sourced from the NDS-OM Platform (both Regular/Odd lot and reported deals) of Reserve Bank of India which is operated by CCIL. Only trades that are settled on T+1 basis will be considered for this purpose.
2. The data for the purpose of computation will be normally the last one-hour data obtained from the NDS-OM (16.00 hours to 17.00 hours' window). If the threshold number of traded data is not met in this time-window, then trading data for the entire day will be taken into account. If on any business day, the trading session on the NDS-OM is **extended** for whatever reasons, all trades from 16.00 hours till the closure of the marketon that day will be considered for the calculation of Volume-Weighted Average Yield (VWAY) for all traded G-Secs (each identified by itsdistinctive ISIN) that meet the threshold criteria. Similarly, if the trading time for the market is **truncated** - under any circumstances on a particularday or for a longer period - the time-window of last one-hour for data collection will be adjusted accordingly.
3. Primary market (auction) results in respect of G-Secs and secondary market trades with face value of each traded ISIN **at ₹5 crores** and above will be considered for valuation purposes. Secondary Market purchase/sale conducted by RBI by way of Open Market Operations (OMOs) will also be included in the input data.
4. Keeping in view that all ISINs are not actively traded on all trading days, valuation process will be based on the hierarchy of inputs used for constructing the yield curve; the inputs will be categorized as Level 1, Level 2 and Level 3. The details in this regard are given below.
   a. Level 1 input will refer to three types of price/YTM data: (i) transaction-level secondary market data in respect of ISINs executed/reported on

the NDS- OM platform up to 5 PM (i.e. till closing time) on each business day, (ii) primary market data in respect of the auctioned ISINs on the day of auction, and (iii) data in respect of OMOs conducted by RBI.

b. Level 2 data refers to the secondary market observable/ tradable (MOT) price/YTM available on the NDS-OM Platform. The data will be collected on each business day at three different points of time, viz. 1 PM, 3 PM and 5 PM. The ISINs which satisfy all the following conditions will be eligible for Level 2 data:

- Face value not less than ₹10 crores
- Quotes representing bids and offers are available on all the three time points
- Volume-weighted average (VWA) spread between the bids and offers on each of the three time points does not exceed 10 basis points for ISINs with residual maturity of 5 years or less and 5 basis points for ISINs with residual maturity above 5 years.

The face value of the ISINs selected following this rule will be ₹10 crores. In other words, the number of Level 2 data input in respect of any eligible ISIN will be one. And the VWA YTM calculated on the basis of the bid and offer quotes outstanding at 5 PM will be taken as the YTM for that ISIN.

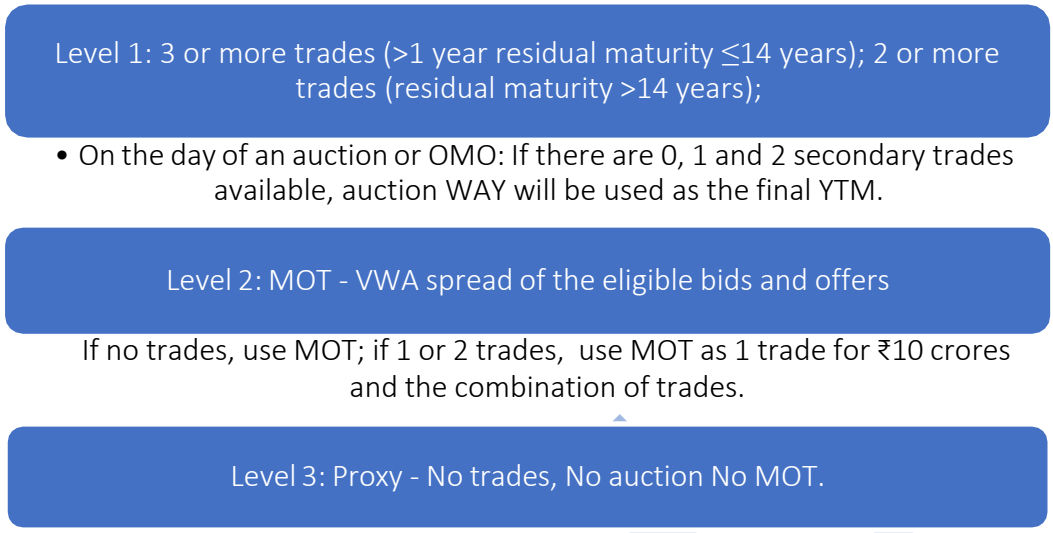
On the occasion of temporary market truncation - fall back will be applied, i.e. MOT will not be used due to non-availability of MOT at all three different points of time.

c. Level 3 data refers to proxy YTM which is calculated on the basis of the traded/ proxy YTM of the ISIN for the previous day as per the procedures detailed in this document.

5. The treatment of traded and non-traded ISINs will be as per their following categorization:

i. ISINs traded and used as input points in the model.
ii. ISINs traded but not used as input points in the model.
iii. Traded but do not cross the threshold of 3 trades and aggregate face value of ₹15 crores (for residual maturities between 1 and 14 years) or 2 trades and aggregate face value of ₹10 crores (for residual maturities exceeding 14 years).
iv. Not traded at all.

6. The process of the data collection is provided below:



III. Valuation of G-Secs - overarching principle:

All ISINs in respect of which Level 1 data, or in its absence, Level 2 data equal to or exceeding thresholds to be defined later in this document are available will be valued based on these data. In other words, although these ISINs, (which will, hereinafter, be referred to as 'Traded ISINs') will qualify to be included as model inputs, the model output prices will not be used for their valuation. They will be valued at their respective volume-weighted average yields (VWAY). The prices of traded ISINs will be derived from their VWAY.

ISINs other than Traded ISINs will be valued based on the ZCYC/PYC that will be constructed using the Cubic Spline (PC) model and an adjustment factor. An adjustment factor is required to account for the liquidity features of the maturity bucket to which the ISIN belongs and the ISIN's idiosyncratic characteristics. The procedure for estimation of adjustment factor together with the details of data inputs for this purpose are provided in the following sections.

IV. Security Selection for input in the Cubic Spline Model:

The current methodology of selection of inputs for the construction of the cubic spline model is based on two attributes of traded securities, namely, tenor and nodal point of a tenor. The maturity year of an ISIN is termed as its tenor. The nodal point of a tenor is that ISIN which was most liquid (in terms of traded volume) in the month previous to the date of calculation. The nodal point of a tenor usually remains unchanged during the month of calculation. For each tenor only a single nodal point is chosen for a month.

This has two consequences. Firstly, there is a loss of usable data as many well-traded ISINs on any given day get excluded from model estimation process. Secondly, the time gap between two closest nodal points cannot be controlled

leading to two consecutive nodal points being too close or too far apart – even more than a year. It is to be noted here that the intended output of the model is yield curve which is based on residual maturity and not tenor.

The revised methodology for input selection is thus driven by the following two main objectives:

- Maximum use of eligible traded securities as input to the model estimation process or, in other words, minimum loss of usable data
- Subject to the smoothness requirement of the yield curve estimated by the model, ensure reasonable number of input points in the various residual maturity buckets, as described below.

Since the distribution of traded securities are highly uneven across different segments of the maturity spectrum of the yield curve, selection criteria of traded securities as inputs to the model estimation process must reckon with this feature. Accordingly, the yield curve is divided into three segments based on each segment's special characteristics as well as on its level of liquidity as under.

1. **Residual Maturity ≤1 year:** Traded ISINs having less than or equal to 1-year residual maturity will not be used as model input for this segment. Instead, money market instruments representing overnight, 3 months, 6 months and 1-year residual maturities as explained at section V will be taken as model inputs. The rationale for this departure is the empirically observed fact that Level 1 and Level 2 data for ISINs with very short residual maturity can cause undue volatility in the short-end of ZCYC/PYC, when there are monetary policy-related events and/or large liquidity absorption/ expansion.
2. **1 year < Residual Maturity ≤ 14 years**: All ISINs with a residual maturity of more than 1 year and less than or equal to 14 years will fall under this segment. This is the most liquid segment of the Indian G-Sec market and enough Traded ISINs are available across the maturities spanning this segment.
3. **Residual Maturity > 14 years**: All ISINs with residual maturity above 14 years will be in this segment.

V. Inputs for the first segment (Residual Maturity ≤1 year):

The following 4 rates based on money market instruments will be used to construct inputs for 4 residual maturity points in this segment, namely overnight, 3 months, 6 months and 1year. Firstly, bond equivalent market YTMs will be worked out based on the market rates obtained through the process described below. These yields will be used to work out the prices of the 3 synthetic securities which would form inputs to the model.

1. **Overnight rate** – 7-day T-Bill (published by FBIL).

2. **3-month T-Bill rate** –FBIL T-Bill published rate for three months' tenor will be used. The maturity of 3 months will be assigned to this rate.
3. **6-month T-Bill rate** –FBIL T-Bill published rate for six months' tenor will be used. The maturity of 6 months will be assigned to this rate.
4. **12-month T-Bill rate** – FBIL T-Bill published rate for twelve months' tenor will be used. The maturity of 1 year will be assigned to this rate

VI. Inputs for the second segment (1 year < Residual Maturity ≤ 14 years):

All ISINs with residual maturity of more than 1 year and less than or equal to 14 years will come under this segment. ISINs for which a minimum of three (Level 1 + Level 2) data inputs (to be determined using the following steps) are available will be selected.

Level 1 data

1. All the ISINs with 3 or more trades during the last 60 minutes of the trading day will qualify as model inputs.
2. In respect of the remaining ISINs (i.e. with less than 3 trades during the last 60 minutes), those which are having 3 or more trades during the entire day will qualify as model inputs.
3. Identification and Removal of Outliers: The YTMs of all ISINs selected through the process described at (1) and (2) above, with a minimum of 5 trades, will be subjected to an outlier detection process. Outlier trades (Volume Weighted YTMs) will be identified and removed for further processing by using a Standard Deviation rule. The traded YTMs which are away by more than +/- 2 Standard Deviations from the mean will be identified and removed as outliers.
4. Weighted Average Price/YTM**:** After the removal of outliers, if any, the Volume Weighted Average Yield (VWAY) of all the remaining trades of each qualifying ISINs will be taken as potential Level 1 inputs.
5. On the days of auction**:**
    a. If an auctioned ISIN is traded on the day of its auction, but with no more than two trades, then the auction WAY published by RBI will be taken as Level 1 data.
    b. If a new ISIN is auctioned, it will be used as the input point and the other ISINs in the close proximity of this new ISIN (i.e. less than 0.25years of gap between two ISINs), will not be used as input points.

Level 2 data

6. If an ISIN has only two trades and a Level 2 data is available, then the latter data will be added to traded data to make that ISIN eligible as model

input. (this is applicable to a non-auction day or to the non-auctioned ISIN on an auction day)

A sub-set of all the eligible ISINs in this segment, selected as per the above rules will be used as actual input to the model. On the basis of extensive empirical analyses undertaken in this regard, it has been found that significant distortions in the yield curve can result if ISINs which are very close to one another in terms of their residual maturity are taken as model inputs. Also, if a large number of eligible ISINs are left out on this ground, loss of usable data will happen.

The following procedure has been found to provide an acceptable trade-off between these two competing considerations.

1. On the first business day of each week (usually Monday), all the eligible ISINs will be arranged in the ascending order of their residual maturities. The threshold criteria for the selection of ISINs to be used as input points is minimum of 15 trades and aggregate face value of ₹75 crores during the previous 5 business days under consideration. This selection is valid for the current week.
2. Two or more ISINs whose dates of redemption differ by 90 days or less will be grouped together. It has been observed that two close nodal points results in a locally jagged and uneven yield curve. This, in turn, distorts the estimated price/YTM of the non-input ISINs.
3. That ISIN of each group so formed, which has the highest product of number of trades and the corresponding volume during the last 5 business days will be chosen as the representative ISIN or input point of that group for the purpose of data input into the model for that week.
4. If for any of the following days of the week, the representative ISIN does not satisfy the threshold of minimum three data points including Level 1 as well as Level 2 data, Level 3 data (proxy YTM) for that ISIN will be input into the model.

   A proxy YTM is calculated using the sum of the previous day's YTM and the current day's market movement (Average of the difference between the current day's VWAY and the previous day's published YTM of the preceding and succeeding ISIN in terms of residual maturity. On If both the preceding and succeeding ISINs are not available, the market movement of the available one will be used, as illustrated below. In the case of ISINs at the either end of the maturity spectrum, viz. 2020 and 2060 currently, the market movement of the nearest available ISIN will be used.) For the first input ISIN, above 1-year maturity, FBIL 12-Month T-Bill rate will be considered as the preceding ISIN.

Illustration:

Proxy Calculation (Analysis done using actual traded data of June 30, 2020)

ISIN	Security Description	Maturity Date	No. of Trades	FV (₹ crores)	VWAY (%)	Previous Day's YTM (%)	Diff
IN0020060037	08.20 GOVT. STOCK 2022	15-Feb-2022			4.0589	4.0827	
IN0020160050	06.84 GOVT. STOCK 2022	19-Dec-2022	7	100	4.2095	4.2333	-0.02
IN0020180025	07.37 GOVT. STOCK 2023	16-Apr-2023	4	130	4.4002		
IN0020180488	07.32 GOVT. STOCK 2024	28-Jan-2024	28	360	4.7973	4.8136	-0.02
IN0020090034	07.35 GOVT. STOCK 2024	22-Jun-2024			4.9854	5.0082	-0.02
IN0020190396	06.18 GOVT. STOCK 2024	04-Nov-2024	43	435	4.9684	4.9978	-0.03

Note: The figures in red are ISINs with no traded data on June 30, 2020. So, a proxy YTM is calculated using the sum of Previous day's YTM and the current day's market movement (Diff between VWAY and Previous Day's YTM).

1. 8.20% GS 2022 was not traded on June 30, 2020. So it's YTM is calculated by adding the diff between the VWAY and Previous Day's YTM of 6.84% GS 2022 to the previous day's YTM of 8.20% GS 2022.
2. 7.35% GS 2024 is also not traded. Its YTM is calculated using the average of the diff of the preceding and succeeding ISINs (i.e. 7.32% GS 2024 and 6.18% GS 2024).

VII. Inputs for the second segment (Residual Maturity > 14 years):

This segment is characterized by thin trades. Selection of ISINs solely on the basis of traded data might result in only very few widely-spaced input points. This issue has been overcome by creating six maturity-buckets within this segment in such a way that at least one ISIN can be identified for each bucket as given below:

Bucket	Residual Maturity	Current Redemption Calendar Years	Minimum ISIN Requirement	Total ISINs in Bucket[1]
1	>14 to ≤18 years	2034-2037	1	5
2	>18 to ≤22 years	2038-2041	1	4
3	>22 to ≤26 years	2042-2045	1	5
4	>26 to ≤30 years	2046-2049	1	2

[1] As of June, 2020

5	>30 to ≤34 years	2050-2053	1	2
6	>34 years and above	2054-2060	1 #	3

The process of selection of ISINs from each of the six maturity-buckets for model input is described below.

1. For each bucket, at least one ISIN will be required for data input into the cubic spline model for ZCYC/PYC construction.
   # For the last bucket on the yield curve, one ISIN maturing in its terminal year (currently 2060) will be needed compulsorily in order to ensure smoothness of the ZCYC output of the Cubic Spline model.

Level 1 data

2. Select all ISINs with two or more trades during the last 60 minutes of the business day.
3. In respect of the remaining traded ISINs, select those ISINs with at least 2 aggregate trades in the entire day.
4. On an auction day, in respect of ISINs with 1 aggregate trade or no trade at all, use the WAY (weighted average yield) of auction published by RBI. Select those ISINs whose auctions were held.

Level 2 data

5. In respect of the rest of ISINs (with 0, 1 aggregate trades) add MOT [Marketable, Observable & Tradable], bids and offers on NDS-OM aggregating for a minimum face value of ₹10 crores with a spread not exceeding 5 basis points which are observed 1 PM, 3 PM and 5 PM each day – Level 2 data]. The Volume Weighted Average Yield of a particular security is calculated using the bids and offers outstanding at 5 PM, if there are qualifying bids and offers available at all three above mentioned time-periods. It will be used as the MOT input. Select those ISINs with at least 2 aggregate trades, including MOT.
6. In the case of ISINs with 5 or more aggregate trades, including MOT, outliers will be detected and removed using a mean +/- 2 SD rule.

Level 3 data

7. If in respect of any of the six maturity-buckets, there is no ISIN for which at least two trades are available [Level 1 plus Level 2 data], then a ISIN for that maturity bucket will be selected following the below-mentioned steps and a proxy YTM [Level 3 data] will be calculated thereof:
   a. ISIN in the bucket with the highest number trades (that were taken into consideration for its selection) multiplied by the respective volumes on the previous day.
   b. In the absence of a) above, the ISIN for which proxy YTM was used on the previous day will be considered.

8. After the selection of the ISIN, the proxy YTM will be calculated based on the following:

   a. When arranged in an ascending order of residual maturity, if the selected ISIN has a preceding as also a succeeding ISIN, then an average of the market movement of that day for the preceding and succeeding ISIN will be added to the previous day's YTM of that ISIN.

   b. If the ISIN has a preceding ISIN but no succeeding ISIN, then the market movement of the preceding ISIN will be added to the previous day's YTM of that ISIN.

   (Note: Market movement = Current Day's YTM – Previous Day's YTM of an ISIN).

   (Also, two or more ISINs whose dates of redemption differ by 90 days or less will be grouped together and the one with higher {Volume× No. of trades} product will be selected.)

Note: The below rule is applicable to all maturities.

On the day of the auction, when a new ISIN is auctioned and the same is used as the input point, then the proxy YTM for an ISIN preceding and succeeding this new ISIN, will be based on the previous day's ISIN, as explained in the illustration below:

Illustration: (The data used are hypothetical)

Security Description	Coupon	Maturity	29-Jul-20	30-Jul-20	Diff	Proxy YTM
06.45 GS 2029	6.45%	07-10-2029	5.9526%	5.9463%		
05.79 GS 2030	5.79%	11-05-2030	5.8344%	5.8262%	-0.01	
06.68 GS 2031	6.68%	17-09-2031	6.1033%		-0.01	6.0980%
07.95 GS 2032	7.95%	28-08-2032	6.2617%	6.2593%	-0.00	

Security Description	Coupon	Maturity	30-Jul-20	31-Jul-20	Diff	Proxy YTM
06.45 GS 2029	6.45%	07-10-2029	5.9463%	5.9593%		
05.79 GS 2030	5.79%	11-05-2030	5.8262%	5.8385%	0.01	
05.77 GS 2030	5.77%	03-08-2030		5.7717%		
06.68 GS 2031	6.68%	17-09-2031	6.0980%		0.01	6.1067%
07.95 GS 2032	7.95%	28-08-2032	6.2593%	6.2644%	0.01	

On July 30, 2020, the ISIN 6.68% GS 2031 was not traded, so a proxy YTM was calculated using the average market movement of the two ISINs in its proximity, i.e., 5.79% GS 2030 and 7.95% GS 2032.

On July 31, 2020, a new ISIN 5.77% GS 2030 was auctioned and, hence, it would replace the ISIN having maturity within 0.25 year of the maturity of the auctioned ISIN. Thus, the ISIN 5.79% GS 2030 gets replaced. Since 6.68% GS 2031 is not traded on July 31, we need to calculate the proxy YTM for this on this day also. Hence only for that day (it is July 31, 2020, in this illustration), the difference

between the current day's YTM and previous day's YTM is calculated using the ISINs which were used previous day for calculation of market movement.
The rationale behind the calculation of proxy YTM is to add the market movement of the day to the previous day's YTM. And this can be achieved only with an existing ISIN and not a newly-auctioned ISIN.

VIII. Adjustment factor

For the purpose of valuation of ISINs which do not qualify to be considered as input to the model i.e., those which are not "Traded ISIN" and the ISINs that are traded but the no. of trades does not pass the criteria, i.e., one or two trades in 1-year to 14-year maturity bucket or one trade in above 14-year maturity bucket, an adjustment factor (AF) will be added to their respective Model YTMs derived from ZCYC/PYC. This adjustment factor will be calculated and applied as described below:

1. AF of an ISIN (which is not a Traded ISIN) is the difference (both positive and negative) between its YTM on days when it traded (but did not qualify as a Traded ISIN i.e., it has only 1 or 2 trades and does not cross the filter of 2 trades and 3 trades in >14yrs maturity bucket and 1yr to 14yr maturity bucket respectively) and its model-generated YTM on those days.
2. Average of AF will be computed for each ISIN. This average will be calculated for the last two days when it was traded. The maximum look back period will be 20 trading days.
3. Negative spreads will be applied to individual ISINs and will not be considered for tenor-wise or bucket-wise spread computation.
4. Tenor Average Spread: If an ISIN did not trade on all the 20 trading days (the look back period), the average AF for all other ISINs maturing in the same calendar year will be its AF. This will be called Tenor-wise average spread.

Illustration: Adjustment Factor (in basis points) - Tenor-wise calculation as on June 30, 2020.

Coupon	Maturity	04-Jun-20	08-Jun-20	15-Jun-20	17-Jun-20	18-Jun-20	19-Jun-20	25-Jun-20	29-Jun-20	30-Jun-20	ISIN wise	Tenor wise	Final Spread Applied
8.12	10-Dec-20								10	14	12	12	12
11.60	27-Dec-20											12	12
7.00	21-Jan-21								7	15	11	9	11
7.80	11-Apr-21							7	6		6	9	6
7.94	24-May-21				7		9				8	9	8
10.25	30-May-21											9	9
6.17	15-Jul-21	0	10								5	9	5
8.79	08-Nov-21			14		16					15	9	15

In the above illustration, on June 30, 2020, the ISIN 11.60% GS 2020 had no trades in the last 20 trading days, so a tenor average is applied for this ISIN. Similarly, the ISIN 10.25% GS 2021 was also not traded in the last 20 trading days; in such case, the tenor-wise average spread is applied.

5. Bucket-wise Average Spread: If none of the ISINs maturing in a calendar year traded for all the 20 days, then the average AF in respect of the corresponding maturity bucket will be applied to all these ISINs.

Sr. No.	Residual Maturity	Bucket
1.	Upto 1 year	1st
2.	>1 year to ≤5 years	2nd
3.	>5 year to ≤8 years	3rd
4.	>8 year to ≤10 years	4th
5.	>10 year to ≤15 years	5th
6.	Above 15 years	6th

Illustration: Adjustment Factor (in basis points) - Bucket-wise spread calculation as on June 30, 2020.

Coupon	Maturity	ISIN wise	Tenor wise	Bucket wise	Final Spreads	Residual Maturity	Bucket Number
7.17	08-Jan-28		2		2	7.52	
6.01	25-Mar-28	-13	2		-13	7.74	3
8.6	02-Jun-28	2	2		2	7.92	
6.13	04-Jun-28	-17	2		-17	7.93	
7.26	14-Jan-29			33	33	8.54	
7.59	20-Mar-29	-2		33	-2	8.72	
6.45	07-Oct-29			33	33	9.27	4
6.79	26-Dec-29			33	33	9.49	
7.88	19-Mar-30	29	35	33	29	9.72	
7.61	09-May-30	36	35	33	36	9.86	

5.79	11-May-30		35	33	35	9.86	
9.2	30-Sep-30	43	35		43	10.25	5
8.97	05-Dec-30	33	35		33	10.43	

Note: Figures have been rounded off.

In tenor 2029, none of the ISINs have individual ISIN-wise spread, except 7.59% GS 2029. But the spread for 7.59% GS 2029 is negative, so it cannot be applied to any of the other ISINs. Hence, a bucket-wise spread is calculated and applied to the remaining ISINs of 2029 tenor. The bucket-wise average spread applicable to 2029 tenor is average of 0.29 and 0.36 equal to 0.33. This is the 4th Bucket, residual maturity >8 year to ≤10 years.

6. In case of non-availability of ISIN AF, Tenor AF or bucket AF on a valuation day, the bucket AF of the previous day is to be used.

IX. Inputs for the Model

The following details in respect of each identified ISIN will be used for the calculation of the model YTM/price:

1. Security description, for example, 7.17% GS 2028,
2. Date of maturity (DD/MM/YY),
3. Coupon,
4. Volume-weighted Average Price (Level 1, 2 or 3) of all the qualified ISINs, and
5. 7-day, 3-month, 6-month and 12-month T-Bills as described in the foregoing.

X. OUTPUTS

1. In respect of ISINs whose VWAY are used as inputs into the model, they will be valued at their model input VWAY.
2. In respect of ISINs that are not used as inputs into the model, but have VWAY that qualify the traded criteria, they will be valued at their traded output Prices/ YTM (VWAY).
3. In respect of ISINs that are not used as inputs into the model, they will be valued at their model output Prices/ YTM.
4. **YTM Change:**

   If the model YTM of a non-traded ISIN of a particular tenor, after adding the adjustment factor, shows an YTM which is lower than the YTM of a Traded ISIN of the same tenor and which is eligible as an input to the model, the model YTM of that ISIN will be increased to equal the YTM the Traded ISIN. Thus:

   YTM of a non-traded ISIN of a tenor will be ≥ the YTM of the Traded ISIN

with the lowest YTM of that tenor.

Yield change will not be applied to the ISINs with a negative Adjustment Factor.

5. **ZCYC and PAR Yield Curve**:

Based on the inputs as mentioned in paragraph V, VI and VII above, a zero-coupon (spot rate) curve is generated using the Cubic Spline output for maturities ranging from 0.25 years to 40 years (or equivalent to the highest issued G-Sec Bond). A Par Yield Curve is generated from the zero-coupon curve using standard formula.

Semiannual zero-coupon yield and semiannual Par Yield are converted into annualized yields and both semiannual and annualized yields are published.

XI. No changes are made in respect of the following:

1. Valuation of G-Sec in the 'When Issued' (WI) segment (Exception: In case there in no WI trade on a day, the previous day's rate will be repeated.)
2. Valuation of FRBs
3. Valuation of IIBs
4. Valuation of Special Securities like OIL Bonds
5. Valuation of STRIPS
6. Valuation of Other Approved Securities

XII. Others:

1. G-sec Valuation prices/yield will be published up to four decimal places.
2. G-Sec Valuation benchmark will be published by 7:00 p.m. on all Mumbai business days (except Saturday, Sunday and Mumbai holidays). The publication time may be suitably extended if the closing time of the NDS OM platform is extended for any reason.
3. In case, it is not possible to compute the G-sec valuation prices due to non-availability of adequate data following the aforesaid methodology, the valuation prices of the previous day will be repeated.
4. The methodology document will be reviewed annually or at earlier intervals if the need arises.

XIII. Data quality assurance and disclaimer:

While FBIL makes all reasonable efforts to ensure the accuracy of the benchmarks, it makes no warranty, representation or undertaking, expressed or implied by law or otherwise, in relation to the benchmarks, and expressly disclaim, to the fullest extent permitted by applicable law, all liability in any form whatsoever with respect to any errors or omissions, or losses caused by disruptions in the service or late publication of the Rates and other benchmarks or inaccuracy thereof or otherwise arising from the use of or reliance on the Rates and other benchmarks and contents in its website.

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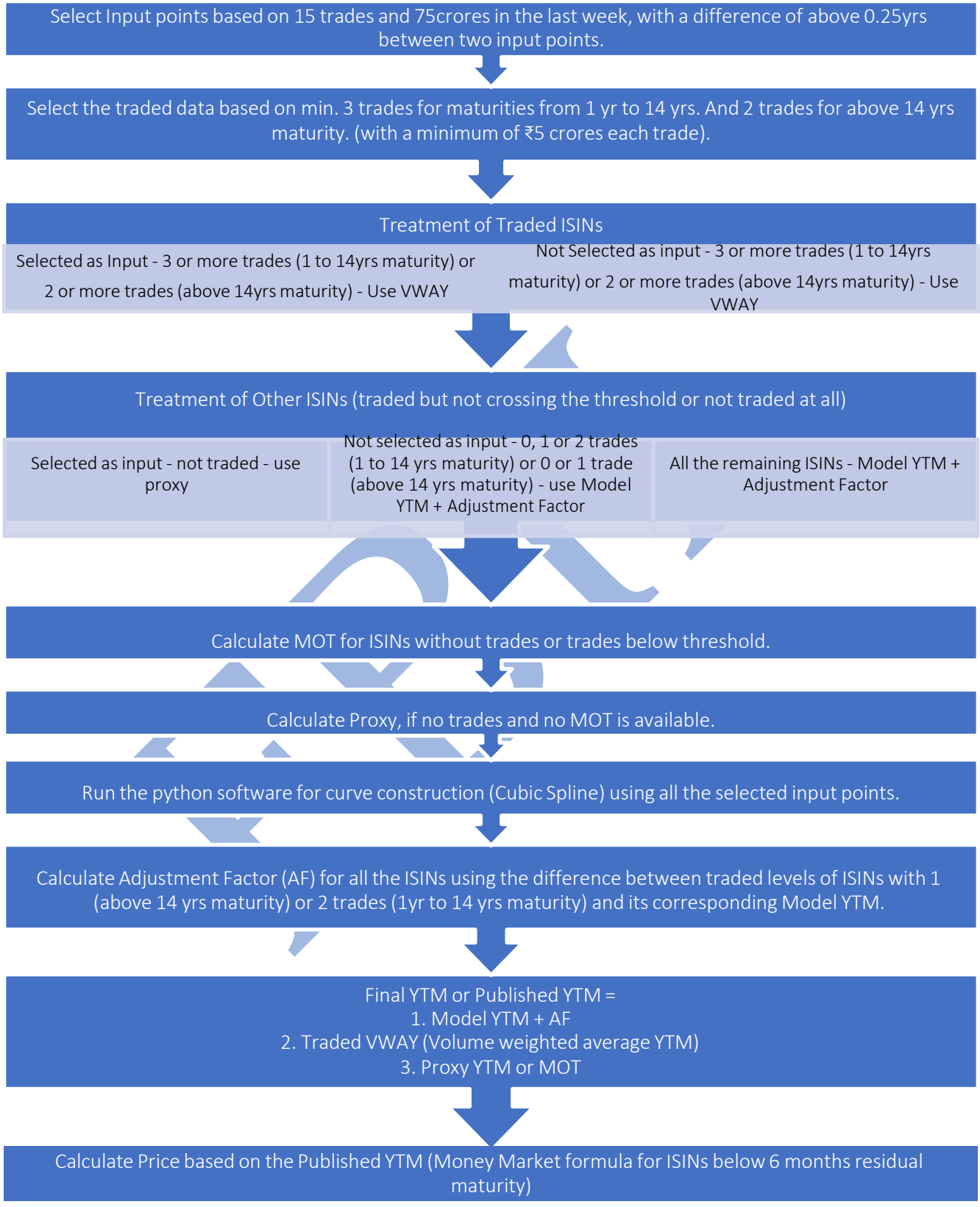
FLOW-CHART



Note: On the day of an auction, if the auctioned ISIN is not traded at all or the threshold criteria in respect of trades are then the auction WAY is used for valuation.

Annex-1

G-Sec Valuation publication format:

GSEC_Valuation.xlsx

GSEC_STRIPS_ZCYC.xlsx

Annex-2

	Existing Version -III	Revised Version-IV
1	Older illustration under point 5 (Section VIII) demonstrating calculation of bucket AF.	Updated illustration given for bucket AF under Section VIII, point 5 (page 14). ***NOTE: The Version III illustration and Version IV illustration have been shown below.**
2	No description of fallback process in case of unavailability of Adjustment Factor(AF) data under section VIII of the methodology.	Addition of a line [point 6, Section VIII] describing fallback process stating that if there is unavailability of ISIN AF, Tenor AF and Bucket AF for a particular security on a valuation date, the Bucket AF value of previous day will be used.

Bucket AF Illustration Version IIII

Coupon	Maturity	ISIN wise	Tenor wise	Bucket wise	Final Spreads
7.17	08-Jan-2028		2	10	2
6.01	25-Mar-2028	-13	2	10	-13
8.60	02-Jun-2028	2	2	19	2
6.13	04-Jun-2028	-17	2	19	-17
7.26	14-Jan-2029			19	19
7.59	20-Mar-2029	-2		19	-2
6.45	07-Oct-2029			19	19
6.79	26-Dec-2029			19	19
7.88	19-Mar-2030	29	35	19	29
7.61	09-May-2030	36	35	19	36
5.79	11-May-2030		35	19	35
9.20	30-Sep-2030	43	35		43
8.97	05-Dec-2030	33	35		33

Bucket AF illustration Version IV

Coupon	Maturity	ISIN wise	Tenor wise	Bucket wise	Final Spreads	Residual Maturity	Bucket Number
7.17	08-Jan-28		2		2	7.52	3
6.01	25-Mar-28	-13	2		-13	7.74	
8.6	02-Jun-28	2	2		2	7.92	
6.13	04-Jun-28	-17	2		-17	7.93	
7.26	14-Jan-29			33	33	8.54	4
7.59	20-Mar-29	-2		33	-2	8.72	
6.45	07-Oct-29			33	33	9.27	
6.79	26-Dec-29			33	33	9.49	
7.88	19-Mar-30	29	35	33	29	9.72	
7.61	09-May-30	36	35	33	36	9.86	
5.79	11-May-30		35	33	35	9.86	
9.2	30-Sep-30	43	35		43	10.25	5
8.97	05-Dec-30	33	35		33	10.43	

Annex - 3

Glossary of Terms:

- **OMO:** Open Market Operations are the market operations conducted by the Reserve Bank of India by way of sale/ purchase of G-Secs to/ from the market with an objective to adjust the rupee liquidity conditions in the market on a durable basis.
- **NDS-OM:** National Dealing System is an order driven electronic system, where the participants can trade anonymously by placing their orders on the system or accepting the orders already placed by other participants. NDS-OM is operated by the Clearing Corporation of India (CCIL).
- **PYC: Par Yield Curve** is a graphical representation of the **yields** of hypothetical Treasury securities with prices at **par**. On the **par yield curve**, the coupon **rate** will equal the **yield** to maturity (YTM) of the security.
- **ZCYC:** Zero Coupon Yield Curve (**ZCYC**) identifies the cost (return) of a cash flow of a particular tenor for a bond.
- **YTM:** Yield to Maturity (YTM) is the expected rate of return on a bond if it is held until its maturity. The price of a bond is simply the sum of the present values of all its remaining cash flows. Present value is calculated by discounting each cash flow at a rate; this rate is the YTM.
- **IIBs: Inflation Indexed Bonds (IIBs)** are bonds wherein both coupon flows and Principal amounts are protected against inflation. The inflation index used in IIBs may be Wholesale Price Index (WPI) or Consumer Price Index (CPI).
- **FRB: Floating Rate Bonds (FRB**) are securities which do not have a fixed coupon rate. Instead, it has a variable coupon rate which is re-set at pre-announced intervals (say, every six months or one year). FRBs were first issued in September 1995 in India.
- **ISIN:** International Securities Identification Number is a code that uniquely identifies a specific securities issue. The organization that allocates ISINs in any particular country is the country's respective National Numbering Agency (NNA).
- **VWAP:** Volume Weighted Average Price is the ratio of the value traded to total **volume** traded over a particular time horizon (usually one day).
- **STRIPS:** Separate Trading of Registered Interest and Principal Securities are the securities created by way of separating the cash flows associated with a regular G-Sec i.e. each semi-annual coupon payment and the final principal payment to be received from the issuer, into separate securities. They are essentially Zero-Coupon Bonds.
