Fixed Income Money Market and Derivatives Association of India (FIMMDA),
2nd Floor, UNITED INDIA BUILDING,
Next to RBI Amar Bldg Monetary Museum,
Sir P.M. Road, Fort, Mumbai 400 001.
Tel: 022- 2269 0321- 26
Fax: 2262 6454

CUBIC SPLINE METHODOLOGY FOR VAUATION OF G-SECS

THE CUBIC SPLINE METHODOLOGY

A model for yield curve takes traded yields for available tenors as input and generates the curve through interpolation and curve fitting, so as to minimize the error between traded and model prices. Cubic Spline methodology has been chosen by FIMMDA as it allows minimum error while giving a smooth, continuous curve, which is essential for correct pricing of debt securities. The technical details of the yield curve construction, optimization, smoothing is given in Annexure 1.

A. Methodology (UPDATED 1st March 2018)

The methodology for generation of the yield curve and the valuation for G-Secs are highlighted below: -

Curve generation is done on the basis of inputting yields/prices in Level 1(traded), Level 2(Market observable & tradable yields/prices) or Level 3(proxy)

> **Nodal points:**
> For generation of yield curve, the yields of traded securities are required to be entered as input. These are Nodal Points. Generally, the nodal points are selected across the yield curve based on the number of trades and volume in a month. A nodal point is a security that crossed the filter of 50 trades and Rs500 crores in the previous month on the NDS –OM and Reported segments taken together.

a) **Identification of Nodal Points:** On the first working day of every month, the FIMMDA Valuation Committee would identify "**Nodal Points**" (one bond per calendar year tenor -2018, 2019, etc..) from the outstanding stock of Government of India Securities on the basis of most traded securities recording highest No. of trades * Volume (NDS OM + Reported) in each tenor. The valuation committee will have powers to identify a security for a nodal point even if it fails the filter criteria if it feels that such continuation will aid/improve yield curve generation(Eg: long gap between two nodal points or steepness of the curve between two tenors.)

b) **Selection of Bonds for curve construction**: From the Universe of all outstanding bonds :

   i.   For each year only one bond would be taken for curve construction.

   ii. A Nodal Point selected for a tenor at the beginning of a month will not be changed during the course of the month.

   Level 1: Traded yields/Prices: The selection of traded yields/prices for different tenors is as under:

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iii. A traded nodal point bond should have traded a minimum number of trades and minimum volume of trades as decided by the "Daily Filter" set for the month by the Valuation Committee.

Daily Filter:

Identify the **Nodal Point** with largest number of Trades (T1) and Volumes (V1) and also the **Nodal Point** with Minimum Number of Trades (T2) and Volumes (V2) during a month.

The daily filter criterion is 3 month moving average of the ratio of: % of T2/T1 and % of V2/V1

iv. For the segments 15 years and beyond, the no. of trades and volume calculated as per the filter criteria or 2 trades and Rs.10 crores whichever is less will be the daily filter criteria for considering the securities traded yields to be input into the Matlab yield curve generation.

v. The model prices/yields will be replaced by LTP/LTY in case of all securities.

vi. Other criteria: The other criteria in selecting inputs for the curve construction are:
If a new bond has been issued during the month and the bond meets FIMMDA's criteria for being a **Nodal Point** Bond (but not designated as such) then the new bond would be taken into curve construction, if:

a) It passes the "Daily Filter Criteria".

b) If an existing paper qualifying for a **"Nodal Point"** is already trading, then the new paper will replace the existing nodal point if the yield of the new paper is lower than the existing paper.

c) If the yield of the new paper is higher than the existing paper, then the new paper will replace the old paper will replace the existing nodal point only if the no. of trades *volume is more than the existing paper.

In all other cases, the existing security will continue to be an input point.

- For the tenors less than1-year tenor, the traded yield of shortest tenor T-Bill would be used.
- Only G-Secs without features like floating coupon, embedded options etc. would be used as inputs for curve construction.

c) **Level 2 inputs**: With a view to adopt the FASB and IFRS Level 1, 2, and 3 criteria, the level 2 criteria of Fair Valuation is adopted. Thus, in case there are no trades in any **Nodal Point/ any other security** on a particular day, a "**Market Observable & Tradable**" (MOT) input for the Nodal Point would be used. The "Market Observable and Tradable" input is one in which the **Nodal Point/ any other security** has "bids" and "offers" aggregating a minimum of Rs. 10 crore each at 12 noon, 2pm and 4 pm with a maximum spread of 10 bps. The weighted average "mid-yield" of the particular security

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across the three time- frames would be the MOT input.

Filter Criteria for MOT:

1) For Nodal Point in all tenors and for all other bonds: The MOT should pass the traded data "Filter" criteria (total of bid and offer amount PLUS the traded amount to be equal or greater than the Filter amount, and total number of bids and offers PLUS the traded number of trades to be equal or higher than the Filter number of trades).

2) **For IIB** the minimum bid/offer can be Rs.5 crores each at only two times: 12 noon and 4 pm.
(And for FRB please refer to the document Valuation of FRBs under G Sec. Valuation tab on FIMMDA's website: www.fimmda.org)

It was decided that for FRB and IIB also the model price/yield be replaced with LTP/LTY even if there is 1 trade and Rs.5 Cr volume (w.e.f. 1st April, 2017).

i. The inputs for curve generation will be in the following order:
   a. If the **Nodal Point** has traded and passed the daily filter criteria, then the yield and price of that traded bond.
   b. In the absence of (a) MOT input for the Nodal Point.
   c. In the absence of (a), and (b), "**Proxy Yields**" would have to be used for the selected **Nodal Point** securities.

d) **Level 3: Proxy yield**

For any tenor if the **Nodal Point** does not trade on a particular day and there is no MOT then proxy yield for that tenor has to be generated. Proxy yield would be generated as follows:

For **Nodal Point** that did not get traded, the proxy yield would be calculated by adding a factor to that bond's traded/proxy yield of the previous day. The factor would be calculated as follows:

a. Difference in yield between today and yesterday is computed for the traded **Nodal Point** security of the tenor immediately preceding the tenor for which proxy yield is required. Similar difference in yield is computed for immediately succeeding tenor.

b. Average of the difference in yield of the two tenors (traded on both the days) is computed as the factor.

c. If no preceding Nodal Point is traded then the factor would be the difference in yield of the immediate succeeding traded **Nodal Point**; or

d. If no succeeding **Nodal Point** is traded, then the factor would be the difference in yield of the immediate preceding traded **Nodal Point**.

e. If both preceding and succeeding Nodal Points are not traded on that day as well as the previous day, then the difference between the preceding Nodal Point yields irrespective of traded/proxy on both days will be used as the factor.

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f. **Proxy calculation for 1st Year paper**: If 1st year paper is not traded nor has MOT, and the succeeding tenor nodal point is also not traded, the traded yield of the T Bill (money market yield) having maturity nearest to that of the 1st year Nodal Point security will be converted into G-sec yield and used as proxy yield for the 1st year Nodal Point.

Base liquid zero rate curve and par-yield curve generation: - Based on the above data, a base liquid zero rate curve based on Cubic Spline approach is generated. Further, a smoothing technique is applied to ensure that the forward rate curve is smooth. The par-yield curve is generated from the zero-rate curve.

B. **Computation of illiquidity:** - The illiquidity factor is calculated based on the yield differential between the yield of a traded bond and the model generated par yield for the same bond's residual tenor on that day. It would be generated daily. The process of calculating the illiquidity factor is elaborated in "Illiquidity Factor" below.

Illiquidity factor

The illiquidity factor would be calculated as below:

a) Illiquidity Factor (IF) is the difference (only positive; negative difference to be floored as zero) between the traded yield and model generated yield.
b) IF will be calculated for all the illiquid papers (Non-nodal point papers) whenever there is a trade in that paper.
c) 4-week (20 trading days) moving average will be calculated for each paper.
d) That will be the IF for that paper provided the paper was traded at least 5 days out of 20 trading days.
e) Otherwise, the tenor average IF will be used for that paper.
f) Tenor average IF is the average of IFs of all illiquid papers in a particular tenor.
g) When no trade takes place during last 20 trading days in any of the illiquid papers in a particular tenor, there can be no 4-week moving average IF.
h) In such a situation, the tenor average IF will be carried forward till any trade takes place in an illiquid paper.
i) When a new paper is issued in a tenor and that paper qualifies to be a Nodal Point or if there is a change in a nodal point in a tenor, the calculation of 4-week moving average IF for all the illiquid papers in that tenor will be restarted from that date.
j) On the day of issue of new paper or change in nodal point all the other papers in that tenor will not have 5 day moving average. Only tenor average will be available provided any one paper in that tenor is traded apart from Nodal point.
k) When an illiquid paper is traded on the day of issue of new paper or change in nodal point, the difference between the traded yield and model generated yield will be the IF.
l) Otherwise when no illiquid paper is traded, the difference between the illiquid papers traded yield on the immediately preceding day or second preceding day and the traded/MOT/proxy yield of the new/changed nodal point will be the IF for that paper.
m) When no trade takes place during last 2 trading days in any of the illiquid papers in a particular tenor, where a new/changed nodal point has been issued, the difference between the model generated yield for an illiquid paper on previous day of issue of new paper/ changed nodal point and its model generated yield on the day of issue of new paper will be taken as IF.

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C. Valuation & Substitution of Model Prices

The model generated yield + illiquidity factor will be substituted in case of the following bonds:

> Except Nodal Point all other securities: Actual traded/MOT yield if not available will replaced by the model generated yield + illiquidity factor

D. **Yield Change**:
a. If, after adding the "Illiquidity Factor", the non-traded bonds in a particular tenor show a yield which is <u>lower</u> than the yield of a traded bond whose volume and trades have passed the filter for recognition for valuation purposes, the model – determined yield (including the IF) would be increased to equal the yield of the traded bond. Thus:

> *Yield of a non-traded bond in a particular tenor would be = or > than the yield of the traded bond with the lowest yield in that tenor.*

b. If there are no trades in a particular tenor, the Model Yield plus the IF would give the final yield for valuation of bonds in that tenor.

E. **Valuation for securities in When Issued (WI) segment**: Presently, FIMMDA is not providing valuation for these securities. After discussion and the need of the market participants to value their portfolio, it has been decided that FIMMDA will provide valuation. As the announcement for auction of security is presently made in the beginning of the week and WI trading starts from Tuesday till Friday auction result, it has been decided to give valuation for WI security from Tuesday to Thursday based on the closing traded price/yield. On Friday, the closing price of WI security will be the same as the usual securities and so no separate price will be announced.

F. SDL Valuation:
FIMMDA publishes the prices/yields for all the State Govt securities calculated in accordance with "*para 3.6.2 of RBI Master Circular for banks dated 1ˢᵗ July, 2015*" or modified guidelines if any as per Benchmark Committee's recommendations in this regard.

Para 3.6.2 of RBI Master Circular for banks dated 1ˢᵗ July, 2015

State Government securities will be valued applying the Yield to Maturity (YTM) method by marking it up by 25 basis points above the yields of the Central Government Securities of equivalent maturity put out by PDAI/ FIMMDA periodically.

G. Other 'approved' Securities
Other approved securities will be valued applying the YTM method by marking it up by 25 basis points above the yields of the Central Government Securities of equivalent maturity put out by PDAI/ FIMMDA periodically.
For Valuation of Uday/Discom Bonds (Please refer Valuation of Investment Circular dated 31ˢᵗ March 2017 Page No. 9-10).

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