TECHNICAL RELEASE

Bond Pricing Agency Malaysia – Benchmarks

MYOR Index & MYOR Backward Term Rate Methodology

October 2022

enquiries@bpam.com.my

Bond Pricing Agency Malaysia Sdn. Bhd. [200401028895 (667403-U)]
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ABBREVIATION & DEFINITION

MYOR	Malaysia Overnight Rate
MYOR-i	Malaysia Islamic Overnight Rate
RFR	Risk free rate
BPAM	Bond Pricing Agency Malaysia
SONIA	Sterling Overnight Index Average
€STR	Euro Short Term Rate
TONA	Tokyo Overnight Average Rate
Lookback period	A look back is an agreed number of banking days prior to the date on which the rate of interest is to be determined
Observation Period	The period commencing the agreed look back prior to the start of the interest period and ending the agreed look back prior to the interest payment date at the end of the interest period

Introduction

1. RFR Indexes are designed to meet operational and economic requirements of certain lenders and borrowers by allowing for the calculation of compounded average rates over custom time periods.

2. BPAM MYOR Index measures the cumulative impact of compounding the MYOR on a unit of investment over time, with the initial value set to 100.00 on 4 Jan 2021, the first value date of the MYOR and computed up to *18 decimal places*. The index is compounded by the value of each MYOR thereafter. The change in the MYOR Index for any reference period can be used to calculate the compounded MYOR over the period.

3. For consistency, all RFR Indexes are published using a base value of 100 and with a precision of *8 decimal places*. This matches the approach taken for the official SONIA, €STR and TONA indexes.

4. In accordance with Malaysia money market convention, interest is calculated using the actual number of calendar days, but assuming a 365-day year.

5. The RFR Index methodology features:
    - Determining index values for business days;
    - Calculation with lookback with observation shift
    - Calculation with lookback without observation shift
    - Calculation with 18 decimal point, where displayed with 8 decimal point.
    - Using ACT365 day count basis.

6. First Day for each RFR Indexes is as follows

RFR	First Published Date
MYOR	04/01/2021, Monday
MYOR-i	16/02/2022, Wednesday

*Historical MYOR data is available from 01/01/2015 to 31/12/2020.

7. BPAM will publish daily:
    - Daily MYOR / MYOR-i rates
    - BPAM MYOR Index and BPAM MYOR-i Index
    - Compounded MYOR / MYOR-i (“Backward Term Rate”) of 1-week, 1-month, 2-month, 3-month, 6-month and 12-month

8. The compounded MYOR / MYOR-i (“Backward Term Rate”) and Index will be published on each day 10 minutes after the MYOR / MYOR-i are published on BNM website, at approximately 10:10 a.m. and 12:10 p.m. respectively.

9. The compounded MYOR / MYOR-i (“Backward Term Rate”) and Index will only be revised on a same-day basis (at approximately 2:10 p.m. and 4:10 p.m.) if the day’s MYOR / MYOR-i publication was revised or if an error was discovered in the calculation of the compounded MYOR / MYOR-i (“Backward Term Rate”) or Index.

10. Compounded MYOR / MYOR-i (“Backward Term Rate”) and Index are provided on an “as is” basis without any warranties of any kind, and BPAM shall not be liable for any damage or loss which may arise from reliance on the data obtained from BPAM.

Calculating MYOR Index

All RFR Indexes use the same underlying calculation methodology for determining index values for business days.

$$Compounded\ Index_i = Compounded\ Index_{i-1} \times (1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention})$$

Where:

i	=	The business day for which index is being calculated
i-n	=	The business day falling n business days before i (and, therefore, i-1 is the business day immediately preceding i)
N	=	The lookback day count, for indexes including a lookback.
$Compounded\ Index_i$	=	The index for business day i, calculated and published on day i. All published Index values are rounded to 8 decimal places. $Compounded\ Index_1 = 100$
$Compounded\ Index_{i-1}$	=	The index value calculated on business day i-1. While the published value of the index is always rounded to 8 decimal places, the underlying calculation uses the previous day's index value that has been rounded to 18 decimal places.
RFR_{i-N-1}	=	The RFR rate with an effective date of i-N-1, calculated and published by the relevant official body on business day i-N. For indexes without any lookback, N=0, so this will be equal to RFR_{i-1}, which is published on day i.
Weighting	=	The weighting to apply to the RFR rate for business day i-N-1. The Weighting will equal the number of calendar days from business day i-1 to business day i, i.e. the number of calendar days between the previous business day and the current business day.

Overview on Market Conventions - Lookback *with* or *without* Observation Shift

1. A "look-back" mechanism provides that the interest payable over an interest period is not determined by the RFR over the interest period but over an "observation period". This ensures the parties know the interest that will be payable at the end of that interest period a few days in advance of the payment date.

2. The observation period is determined in the same way, e.g., if there is a 5-business day look-back, the observation period begins five business days before the beginning of the relevant interest period and ends on (but excludes) the day five business days before the end of that interest period.

3. The interest rate for the interest period is determined by reference to the daily MYOR during the observation period.

4. The key difference between the two methods relates to the weighting of the daily MYOR in the compounding formula. Lookback *with* observation shift method shifts the weighting of the daily RFRs back to the days in the observation period, while Lookback *without* observation shift method it remains based on the days in the interest period.

5. BPAM calculated index using an N-day lookback can be calculated and published N days in advance. More specifically, BPAM provides MYOR Indexes calculated using both methods lookback with and without observational shift.

Calculating Compounded MYOR from BPAM MYOR Indexes

The compounded MYOR / MYOR-i ("Backward Term Rate") for a given publication date incorporate all the MYOR values starting 1-week, 1-, 2-, 3-, 6-and 12-months before the publication date where the complete data set will be published in BondStream 12.0.

The BPAM MYOR Indexes can be used to calculate the annualised interest rate and interest amounts due on MYOR based loans for any period as follows:

1. Select the appropriate index to calculate the annualised interest rate.

   Annualised interest rate on a loan is calculated using the following formula:

$$Annualised\ Interest\ Rate\ (\%) = \left(\frac{Index\ Value\ on\ End\ Date}{Index\ Value\ on\ Start\ Date} - 1\right) \times \frac{365}{Duration}$$

2. Round the calculated rate to the precision specified in the loan contract.

3. Add any specified spread.

4. Use the rounded interest rate and spread to calculate the interest amount.

$$Interest\ Amount\ = Notional\ \times\ (Rounded\ Annualised\ Interest\ Rate + Spread) \times \frac{Duration}{365}$$

Appendix 1: MYOR Index Working Example and Calculation Convention

The index value for each day is calculated using the (MYOR / MYOR-i) rate for the previous business day, which is published on the same day as the index calculation.

Example 1: Calculating MYOR Index Value on 18 Feb 2021 (weekday)

- BPAM MYOR Index value on the previous business day,
  Index Value (17 Feb 2021) = 100.210566776233421181 (18dp)

- MYOR Rate on 17 Feb 2021, published on 18 Feb 2021 around 10am.
  MYOR Rate (17 Feb 2021) = 1.75

- There is **1** calendar day between 17 Feb 2021 and 18 Feb 2021.
  By referring to the formula below:

$$Compounded\ Index_i = Compounded\ Index_{i-1} \times (1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention})$$

$$100.215371392448720044 = 100.210566776233421181 \times (1 + \frac{1.75 \times 1}{365})$$

Example 2: Calculating MYOR Index Value on 1 Mar 2021 (weekend)

- BPAM MYOR Index value on the previous business day,
  Index Value (26 Feb 2021) = 100.253815924713333989 (18dp)

- MYOR Rate on 26 Feb 2021, published on 1 Mar 2021 around 10am.
  MYOR Rate (26 Feb 2021) = 1.72

- There is **3** calendar day between 26 Feb 2021 and 1 Mar 2021.
  By referring to the formula below:

$$Compounded\ Index_i = Compounded\ Index_{i-1} \times (1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention})$$

$$100.267988792937211271 = 100.253815924713333989 \times (1 + \frac{1.72 \times 3}{365})$$

Example 3: Calculating MYOR-i Index Value on 18 Feb 2022 (Missing data)

- BPAM MYOR-i Index value on the previous business day.
  Index Value (17 Feb 2022) = 100.004684931506849315

- Assuming, MYOR-i Rate on 17 Feb 2022 is not published on 18 Feb 2022, considered as missing data and will take previous business day MYOR-i rate into calculation.
  MYOR Rate (16 Feb 2022) = 1.71

- There is **1** calendar day between 17 Feb 2022 and 18 Feb 2022.
  By referring to the formula below:

$$Compounded\ Index_i = Compounded\ Index_{i-1} \times (1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention})$$

$$100.009370082499530869 = 100.004684931506849315 \times (1 + \frac{1.71 \times 1}{365})$$

Example 4: Calculating MYOR Index Value on 31 Dec 2020 (Historical Data)

- BPAM MYOR Index value on the previous business day.
  Index Value (04 Jan 2021) = 100, first day of MYOR Rate.

- MYOR Rate on 31 Dec 2020, *MYOR Rate (31 Dec 2020) = 1.75*

- There is **4** calendar day between 31 Dec 2020 and 4 Jan 2020.
  By referring to the formula below:

$$Compounded\ Index_{i-1} = Compounded\ Index_i \div \left(1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention}\right)$$

$$99.980825595091352343 = 100 \div \left(1 + \frac{1.75 \times 4}{365}\right)$$

Appendix 2: Applying BPAM MYOR Indexes (Lookback without Observation Shift)

Illustration of 5-Days Lookback period on a MYOR referencing loan

Rate for	01-Mar Mon	02-Mar Tue	03-Mar Wed	04-Mar Thu	05-Mar Fri	06-Mar Sat	07-Mar Sun	08-Mar Mon	09-Mar Tue	10-Mar Wed
Published on	02-Mar Tue	03-Mar Wed	04-Mar Thu	05-Mar Fri	08-Mar Mon	-	-	09-Mar Tue	10-Mar Wed	11-Mar Thu
MYOR	1.75%	1.72%	1.75%	1.75%	1.75%	-	-	1.75%	1.75%	1.75%

Loan Start Date	Loan End Date	Observation Date	MYOR	Weighting (Days)	Remarks
09-Mar	10-Mar	02-Mar	1.72%	1 Day, 09-Mar to 10-Mar	Use Rate for 02-Mar, published on 03-Mar
10-Mar	11-Mar	03-Mar	1.75%	1 Day, 10-Mar to 11-Mar	Use Rate for 03-Mar, published on 04-Mar
11-Mar	12-Mar	04-Mar	1.75%	1 Day, 11-Mar to 12-Mar	Use Rate for 04-Mar, published on 05-Mar
12-Mar	15-Mar	05-Mar	1.75%	3 Days, 12-Mar to 15-Mar	Use Rate for 05-Mar, published on 08-Mar
15-Mar	16-Mar	08-Mar	1.75%	1 Day, 15-Mar to 16-Mar	Use Rate for 08-Mar, published on 09-Mar

Example for a loan based upon the BPAM MYOR index with a 5-day *lag*, which the values are published 5 business days in advance. Loan is for RM100m with a duration of 7 days, from 9 March 2021 to 16 March 2021. Assuming the spread of 1.5%.

1. Calculate the compounded MYOR / MYOR-i ("Backward Term Rate")

   i. $$Annualised\ Interest\ Rate\ (\%) = [\frac{Index\ Value\ (Lag\ 5) on\ 16\ Mar\ 2021}{Index\ Value\ (Lag\ 5)\ on\ 9\ Mar\ 2021} - 1] \times \frac{365}{Duration, 09-Mar\ to\ 16-Mar}$$

$$1.74592882\% = (\frac{100.306068849686832898}{100.272494042575480109} - 1) \times \frac{365}{7}$$

   ii. Alternative approach,

$$Annualised\ Interest\ Rate\ (\%) = \left[\prod_{d=1}^{Duration}\left(1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention}\right) - 1\right] \times \frac{365}{Duration}$$

$$1.74592882\% = \left[\left(1 + \frac{1.72\% \times 1}{365}\right)\left(1 + \frac{1.75\% \times 1}{365}\right)\left(1 + \frac{1.75\% \times 1}{365}\right)\left(1 + \frac{1.75\% \times 3}{365}\right)\left(1 + \frac{1.75\% \times 1}{365}\right) - 1\right] \times \frac{365}{7}$$

2. Calculate Interest Amount

$$Interest\ Amount\ = Notional\ \times\ (Rounded\ Annualised\ Interest\ Rate + Spread) \times \frac{Duration}{365}$$

$$RM62{,}250.69\ = RM100m\ \times\ (1.746\% + 1.5\%) \times \frac{7}{365}$$

Appendix 3: Applying BPAM MYOR Indexes (Lookback with Observation Shift)

Illustration of 5-Days Lookback period on a MYOR referencing loan

Rate for	01-Mar Mon	02-Mar Tue	03-Mar Wed	04-Mar Thu	05-Mar Fri	06-Mar Sat	07-Mar Sun	08-Mar Mon	09-Mar Tue	10-Mar Wed
Published on	02-Mar Tue	03-Mar Wed	04-Mar Thu	05-Mar Fri	08-Mar Mon	-	-	09-Mar Tue	10-Mar Wed	11-Mar Thu
MYOR	1.75%	1.72%	1.75%	1.75%	1.75%	-	-	1.75%	1.75%	1.75%

Loan Start Date	Loan End Date	Observation Date	MYOR	Weighting (Days)	Remarks
09-Mar	10-Mar	02-Mar	1.72%	1 Day, 02-Mar to 03-Mar	Use Rate for 02-Mar, published on 03-Mar
10-Mar	11-Mar	03-Mar	1.75%	1 Day, 03-Mar to 04-Mar	Use Rate for 03-Mar, published on 04-Mar
11-Mar	12-Mar	04-Mar	1.75%	1 Day, 04-Mar to 05-Mar	Use Rate for 04-Mar, published on 05-Mar
12-Mar	15-Mar	05-Mar	1.75%	3 Days, 05-Mar to 08-Mar	Use Rate for 05-Mar, published on 08-Mar
15-Mar	16-Mar	08-Mar	1.75%	1 Day, 08-Mar to 09-Mar	Use Rate for 08-Mar, published on 09-Mar

Example for a loan based upon the BPAM MYOR index with a 5-day Observation Shift, which the values are published 5 business days in advance. Loan is for RM100m with a duration of 7 days, from 9 March 2021 to 16 March 2021. Assuming the spread of 1.5%.

1. Calculate the compounded MYOR / MYOR-i ("Backward Term Rate")

iii. $$Annualised\ Interest\ Rate\ (\%) = [\frac{Index\ Value\ (Shift\ 5) on\ 16\ Mar\ 2021}{Index\ Value\ (Shift\ 5)\ on\ 9\ Mar\ 2021} - 1] \times \frac{365}{Duration, 02-Mar\ to\ 09-Mar}$$

$$1.74592882\% = (\frac{100.30637107053469894}{100.272796162262900041} - 1) \times \frac{365}{7}$$

iv. Alternative approach,

$$Annualised\ Interest\ Rate\ (\%) = \left[\prod_{d=1}^{Duration}\left(1 + \frac{RFR_{i-N-1} \times Weighting}{Day\ Count\ Convention}\right) - 1\right] \times \frac{365}{Duration}$$

$$1.74592882\% = \left[\left(1 + \frac{1.72\% \times 1}{365}\right)\left(1 + \frac{1.75\% \times 1}{365}\right)\left(1 + \frac{1.75\% \times 1}{365}\right)\left(1 + \frac{1.75\% \times 3}{365}\right)\left(1 + \frac{1.75\% \times 1}{365}\right) - 1\right] \times \frac{365}{7}$$

2. Calculate Interest Amount

$$Interest\ Amount\ = Notional\ \times\ (Rounded\ Annualised\ Interest\ Rate + Spread) \times \frac{Duration}{365}$$

$$RM62{,}250.69\ = RM100m\ \times\ (1.746\% + 1.5\%) \times \frac{7}{365}$$

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General Enquiries

enquiries@bpam.com.my

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