WORKING PAPER

Serial No. ER/011

Impact of LIBOR Transition on MIFOR Benchmark

September 2020

Golaka Nath
Manoel Pacheco

Economic Research Department

The Clearing Corporation of India Ltd.

Impact of LIBOR Transition on the MIFOR Benchmark

Golaka C. Nath [$] Manoel Pacheco[@]

Abstract

The FBIL Mumbai Interbank Forward Outright Rate (MIFOR) is an implied domestic interest rate based on the covered interest rate parity theory and is computed using the USD/INR Forward Premia Rates and the London Interbank Offered Rate (LIBOR). The Financial Conduct Authority (FCA) of UK has announced in 2017 to discontinue LIBOR by the end of 2021. There are other alternative Risk Free Rates (RFR) that have been proposed to be used as a replacement rate to LIBOR. This paper studies the possibilities of the MIFOR Curve computation in light of this LIBOR transition. The objective of this study is (a) To detail the changes to the MIFOR computation methodology post LIBOR cessation, (b) To compute the Adjusted MIFOR curve using a Fallback rate as a replacement rate to LIBOR and back test the computation under this revised framework (c) To explore alternative methods to compute the Fallback rate and analyze its impact on the MIFOR curve, and (d) To raise the issues of concern on the selection of an appropriate Fallback rate to compute the Modified MIFOR for the new contracts. The preliminary results suggests that the there is a noticeable difference between the MIFOR Curve computed using the LIBOR and the adjusted MIFOR computed using the Fallback Rate for tenors beyond 3 months. The analysis puts forth some questions in terms of the methodology and convention to be used when using the fallback rate were a consensus from the market would be required to finalize the design of proposed MIFOR Curve. Similar concerns are raised in the computation of the modified MIFOR curve to be used for new contracts.

JEL Classification: D47, E43, G21, G23, G01

Keywords: Covered Interest Rate Parity, Market Design, Interest rates, Banks, Non-Banks, LIBOR transition, Benchmark rate, MIFOR Curve

[$] Senior Vice President, Department of Economic Research & Surveillance, Membership & HRD, The Clearing Corporation of India Ltd., Mumbai, India. Email- gcnath@ccilindia.co.in / gcnath@yahoo.com

[@] Manager, Department of Economic Research & Surveillance, The Clearing Corporation of India Ltd., Mumbai, India. Email- mpacheco@ccilindia.co.in

The Authors are greatly indebted to Ms. Sahana Rajaram, Ms. Payal Ghose and Ms. Priyanka Shiraly for their valuable suggestions and feedback towards this paper. The views expressed in this paper are solely those of the Authors and do not represent that of the organization they are affiliated to. The authors retain sole responsibility for any errors or omissions in the paper. This paper is an updated version of the paper published on August 31, 2020. All details in the earlier version of this paper have been retained. The earlier version of this paper can be provided on request.

1. INTRODUCTION

The Mumbai Interbank Forward Outright Rate (MIFOR) is a benchmark interest rate published by the Benchmark Administrator Financial Benchmarks India Limited (FBIL) since April 2018. It is an implied domestic interest rate that is based on the FBIL Forward Premia Curve and the LIBOR Curve. The FBIL Forward Premia Curve is a transaction based benchmark that is computed from the Cash-Tom and Spot-Forward forex swap transactions which are reported to the Clearing Corporation of India (CCIL) for settlement. CCIL performs the role of the Calculation Agent for the FBIL Forward Premia Curve and the FBIL MIFOR Curve. Specifically, the MIFOR is calculated based on the Rolling forward premia rates and LIBOR. MIFOR is linked to the LIBOR published at 11.00 AM London time. It accounts for the interest rate differential between the U.S. and India for the settlement dates over various tenors from overnight, one month, two months, three months, six months and twelve months. The Indian entity pays LIBOR to borrow dollars in the interbank market and gets rupees in the currency swap. In addition to the use of LIBOR, MIFOR calculation accounts for premia attributable to the currency exchange rate risk and credit risks of the banks. The Indian banks use this benchmark for setting prices on forward-rate agreements and derivative such as swaps.

LIBOR is an Inter-Bank Offered Rate (IBOR) which has been in existence for over four decades and has traditionally been used as a benchmark interest rate for pricing products such as loans, floating rate notes and derivative contracts. The LIBOR represents the interest rate at which banks can borrow money on an unsecured basis in the wholesale market. It is polled for seven tenors (Overnight, 1 week, 1 month, 2 months, 3 months, 6 months and 12 months), based on the submissions from a panel of 20 banks. It is currently published for five currencies namely, USD, EURO, CHF, JPY and GBP.

Over the past few years, there have been concerns identified with respect to the relevance of IBORs. Firstly, being a panel based submission, such rates are susceptible to manipulation (as evidenced by the LIBOR rate rigging scandal). Secondly, the liquidity in the short term wholesale funding market for tenors other than overnight has remained shallow, raising concerns regarding the reliability of polled IBORs from the illiquid term segment of such markets. Thirdly, there has been a growing preference by banks towards less risky sources of wholesale funding, such as the use of the repo market, in efforts to reduce counterparty credit risk. The LIBOR, being an unsecured rate, reflects credit risk. These issues of concern with the setting of LIBOR have been well discussed on various forums. With the decision of Financial Conduct Authority to do away with the LIBOR by the end-of year 2021, multiple alternatives have been proposed globally to replace LIBOR.

To address these inherent weaknesses in IBORs and specifically transition away from LIBOR, Central banks and regulatory bodies across various countries around the globe, have been initiating reforms to move towards a more credible and reliable alternative

reference rate that is rooted in transaction-based data from liquid markets. Based on the jurisdiction and the associated currency, the following alternative reference rates (Table 1) have been chosen as replacement rates for LIBOR (ISDA, 2020) :

Table 1: Alternative Reference Rates for LIBOR

Currency	Alternative Reference Rates	Working Group	Administrator	Type of Rate
USD	Secured Overnight Financing Rate (SOFR)	Alternative Reference Rate Committee	Federal Reserve Bank of New York	Secured
GBP	Sterling Overnight Index Average (SONIA)	Working Group on Sterling Risk-Free Reference Rates	Bank of England	Unsecured
Euro	Euro Short-Term Rate (€STR)	Working Group on Risk-Free Rates	European Central Bank	Unsecured
CHF	Swiss Average Rate Overnight (SARON)	National Working Group on CHF Reference Rates	SIX Swiss Exchange	Secured
JPY	Tokyo Overnight Average Rate (TONAR)	Cross-Industry Committee on Japanese Yen Interest Rate Benchmarks	Bank of Japan	Unsecured

A comparison of the LIBOR rates with their currency equivalent alternative reference rates, suggest that there are certain adjustments that would need to be taken into account while using the alternative reference rate as a replacement to the LIBOR. In most jurisdictions that look to find an alternative to their dollar linked borrowings, SOFR is preferred as the fallback to LIBOR. Taking the example of USD LIBOR and its alternative SOFR, the following points can be noted: First, the LIBOR curve is a forward looking curve polled for the tenors upto 1 year, while the SOFR is an overnight rate. Hence a term structure adjustment would be required to align the two rates. In case of SOFR, the Compounding in Arrears methodology has been considered to account for this adjustment. Second, the LIBOR is an unsecured rate that reflects credit risk while the SOFR is a secured rate and is considered as a risk-free/near risk free rate. Accordingly, a spread adjustment to account for such risk should also be considered.

This paper establishes a framework for computation of the FBIL MIFOR curve in light of the LIBOR transition. The objective of this study is as follows:

(a) To detail the changes to the MIFOR computation methodology post LIBOR cessation.
(b) To compute the "Adjusted MIFOR" curve using a Fallback rate and spread, as a replacement rate to LIBOR and back test the computation under this revised framework. This all in fallback rate based Adjusted MIFOR has been proposed for legacy contracts.
(c) To explore alternative methods to compute the Fallback rate and analyze its impact on the "Adjusted MIFOR" curve.
(d) To raise the issues of concern on the selection of an appropriate Fallback rate, called "Modified MIFOR" applicable for new contracts.

The paper is organized in the following sections: *Section 2* provides the discussions and studies carried out globally around the impact of LIBOR transition. *Section 3* describes the data used in the study. *Section 4*, details a proposed methodology for computing the FBIL MIFOR curve using a Fallback Rate defined by ISDA/Bloomberg as a replacement rate to USD LIBOR. *Section 5*, provides alternative specifications considered for computing the MIFOR Curve post LIBOR cessation. *Section 6* highlights the empirical findings of the study. Finally, *Section 7* concludes with a list of questions and concerns that the market participants would need to take into account while finalizing the methodology to be adopted to compute both the Adjusted and Modified MIFOR.

2. LITERATURE REVIEW

The impact of LIBOR transition is felt globally and hence regulators from various jurisdictions have floated multiple suggestions on the alternative reference rates. IBOR rates in major markets like US, UK, Europe and Japan, propose alternate reference rates such as SOFR, SONIA, €STR and TONAR respectively.

Schrimpf and Sushko (2019) provide an overview of RFR benchmarks and compare the key characteristics of the benchmarks. They explore the possibility that a new normal could prevail allowing for multiple rates to coexist, fulfilling different purposes and market needs. They discuss about the backward and forward looking term rates and their issues. Forward looking term rates, are known at the beginning of the period to which they apply and are not based on mechanical compounding of O/N rates. Because forward looking rates are an outcome of a market-based price formation process, they embed market participants' expectations about future interest rates and market conditions. Further, the authors highlight that "term rates based on derivatives reflect the market-implied expected path of future O/N rates over the term of the contract, but do not embed premia for term funding risk."

Oliver Wynman (2020) presents the views of various market participants on the LIBOR transition issues, the ARRC considerations for fallback rate, the regulatory implications and impact on products.

ABS (2020) discusses the calculation methodology of proposed fallback rate SOR based on actual transactions in the USD/SGX FX SWAP market and the SOFR published by the Federal Reserve Bank of New York. "This would be the synthetic rate for deposits in Singapore Dollar (SGB) which represents the effective cost of borrowing the SGD synthetically by borrowing U.S. Dollar (USD) for the same maturity and swapping out the USD in return for the SGD. The 1-month, 3-month and 6-month Fallback rate (SOR) will be published with an approximately 1-month, 3-month or 6-month lag, respectively. This is because the Fallback Rate (SOFR) is published in-arrears and would only be available after the accrual period."

Bank of Thailand (BOT) had floated a consultation paper in May, 2020, on the impact of LIBOR transition on THBFIX, where the fallback rate was SOFR. The feedback received by BOT (July, 2020) puts forth the respondent financial institutions and corporates suggestions and concerns. The concerns were: 1) that a fixed spread may not fully reflect full economic cycle over the future period. For this THOR, a new THB interest rate benchmark is proposed as an alternative 2) that the availability of the fixation value at the end of the period which may not give sufficient time to prepare for payments given internal payment approval processes 3) that it would require changes in IT infrastructure to account for compounding in arrears 4) that it would require communication with the customers and the engagement with end-users 5) that a replacement of THBFIX with THOR be proposed. However the response by BOT was to the necessity to transition to Adjusted THBFIX for legacy derivatives contracts under ISDA agreement 6) Related to Accounting, Risk and Valuation of the contracts given that the rate would be available in arrears. In most cases, the response from BOT indicated that the market participants had to adjust their systems to support the international consensus.

Finally, the most important concern, which is of relevance to our paper, was on the applicability of Adjusted THBFIX to "A product for which a forward looking term rate is required e.g. trade finance". The response from BOT clearly states that "Adjusted THBFIX will not be able to serve contracts/ products which require a forward looking term rate. Market participants would switch to more suitable reference rates. In the future a forward looking term rate fixed from THOR overnight interest rate swap (OIS) could be considered as another option, depending on the success of its current development plan " (BOT, July 2020). BOT (August, 2020) provides the details on the computation methodology to be adopted for Fallback THBFIX, linking it to SOFR in arrears. It states that the latest available Fallback SOFR record date from Bloomberg's publication for each tenor (fallback SOFR is an all-in rate which includes fixed spread adjustment) would be used as substitute for USD Interest Rate.

In India, the benchmark FBIL-MIFOR would be impacted by the transition of LIBOR to a new IBOR. Nath *et. al.* (2018) is one of the first papers that traces the design and development of the MIFOR benchmark calculation and the validation of the rates that are derived from the forward premium and LIBOR rates. It discusses in detail the calculation methodology covering, the minimum selection criteria, outlier criteria, fallback system in the absence of traded rates etc. The month-end forward premia rates are computed from the respective spot-forward pairs. The rolling forward premia rate is traded/interpolated from the corresponding two month-end rates and the rupee forward premia from the relevant forward premia rate and the Spot rate for the day. The FBIL (2020) has highlighted the concerns that would be faced with the computation of MIFOR in the event of LIBOR transition.

In this study, we attempt to look at the details on how the LIBOR transition would impact the computation of MIFOR rates by providing an in-depth analysis of the computation methodology of the Fallback Rate, the various alternatives that can be used to compute corresponding MIFOR curve and the issues associated with the fall back mechanism especially when the benchmark has to combine a forward-looking underlying currency premia with a adjusted SOFR rate compounded in arrears.

3. DATA

The FBIL MIFOR curve is currently published for 6 tenors namely, overnight, 1 month, 2 month, 3 months, 6 months and 12 months and was launched in April 2018. Two datasets were created for the purpose of this study. The first database encompasses the inputs that are required to compute the MIFOR Curve from the period of April 2018 (benchmark launch date) to July 2020. These inputs include the FBIL Forward Premia curve which has been sourced from FBIL, the USD LIBOR rates which have been sourced from the Federal Reserve Economic Data (FRED) and the SOFR Rate has been obtained from Refinitiv (RIC-USDSOFR=).

The second dataset consists of a historical series of the inputs that are used for computing the Fallback Rate defined by the ISDA IBOR Fallback methodology for the legacy contracts and for new contracts. The all-in-Fallback Rate that compares directly with current LIBOR, is the sum of two components- the Adjusted SOFR, which is the SOFR compounding in arrears and the spread adjustment value which is computed as the median of a historical difference of the LIBOR for the applicable tenor over the Adjusted SOFR for the same tenor. The historical series of the Adjusted SOFR, the spread adjustment and the Fallback Rate were independently estimated from August 2009 to July 2020 by the authors and was compared with that available on the Bloomberg Terminal. For new contracts, most alternatives under consideration suggest the use of the Adjusted SOFR to accordingly compute Modified MIFOR.

4. ALTERNATE MODELS FOR MIFOR COMPUTATION POST LIBOR CESSATION

This section explores alternative ways of computing the adjusted and modified MIFOR curve by revisiting the selection of the Forward Premia rate that could be used in the computation given that the Fallback Rate would be compounded in arrears. The first method discussed here includes the use of the fallback rate as proposed by ISDA / Bloomberg. In addition, alternative methods to compute the Fallback Rate are also examined.

A Fallback rate is an adjusted version of the alternative reference rate that has been identified by the respective Working Group in each jurisdiction, as an alternative to the respective IBOR. In case of USD LIBOR, SOFR has been identified as the alternative reference rate. ISDA has appointed Bloomberg to calculate and distribute the Fallback Rates for IBORs such as LIBOR. In case of USD LIBOR, Bloomberg would be publishing the Adjusted Reference Rate, the Spread Adjustment and the All-in Fallback Rate:

(a) The Adjusted Reference Rate (ARR): The ARR represents the SOFR rate compounded in arrears for the applicable LIBOR tenor.

(b) The Spread Adjustment: The spread adjustment is the Median spread between the LIBOR and ARR for a 5 year history starting 1 day prior to cessation event.

(c) The All-in Fallback Rate is the sum of the ARR and the Spread Adjustment.

4.1. Method 1: Mapping the Rate Record Date to the Trade Date of the FBIL Forward Premia Rate using the Fallback Rate Proposed by ISDA/Bloomberg

To compute the MIFOR curve under Method 1, the Rate Record Date of the All-in Fallback Rate was mapped with the Trade date of the FBIL Forward Premia Rate. This is illustrated in Table (2) by way of a step-wise calculation for the 1-month FBIL MIFOR as on 27-01-2020:

Step 1: Identification of the Relevant Dates for the FBIL MIFOR Curve:

Table 2 highlights the applicable dates associated with the FBIL Forward Premia Curve and the LIBOR Fallback Rate to be used in the Adjusted FBIL MIFOR Curve computation.

Table 2: Applicable Dates for FBIL MIFOR Curve Computation

Table 2a: Relevant Dates for the 1-Month FBIL Forward Premia Rate*

Sr. No.	Description of Dates	Date	Day
1.	Trade Date for the 1-month FBIL Forward Premia Rate	27-01-2020	Monday
2.	Spot Value Date for the 1-Month FBIL Forward Premia Rate	29-01-2020	Wednesday
3.	Settlement Date for the 1-Month FBIL Forward Premia Rate	28-02-2020	Friday

Table 2b: Relevant Dates for the Fallback Rate

Sr. No.	Description of Dates	Date	Day
1.	LIBOR Rate Record Date	27-01-2020	Monday
2.	Accrual Spot Date	29-01-2020	Wednesday
3.	Offset Lag (viz. 2 business days prior to the Accrual Spot Date)	27-01-2020	Monday
4.	Accrual Start Date	27-01-2020	Monday
5.	Accrual End Date (viz. 1 Month after the Accrual Start Date) (26th Rate will be applicable till 27th)	27-02-2020	Thursday
6.	Fallback Observation Date	27-02-2020	Thursday
7.	Payment Date (viz. 2 business days after the Fallback Observation Date)	02-03-2020	Monday
8.	Median Period Start Date (viz. 5 years prior to the Median Period End Date)	24-12-2014	Wednesday
9.	Median Period End Date (viz. 1 Month plus 2 business days prior to the Rate Record Date)	24-12-2019	Tuesday

*Dates highlighted in Red are relevant dates used in computing the 1M FBIL MIFOR as per the extant methodology.

Step 2: Computation of the Adjusted SOFR:

The Adjusted SOFR would be computed by compounding the SOFR rates (Table 3) for a period starting from the Accrual Start Date of 27-01-2020 and ending at the Accrual End Date of 27-02-2020[1], as:

Table 3: Illustration of the SOFR Rates used in Adjusted SOFR Computation

Date	Day	O/N SOFR	Daily Un-annualized SOFR	Description
27-01-20	Monday	1.53000	1.000042500	LIBOR Rate Record Date/Accrual Start Date/Forward Premia Trade Date
28-01-20	Tuesday	1.53000	1.000042500	
29-01-20	Wednesday	1.53000	1.000042500	Accrual Spot Date/Spot Value Date
30-01-20	Thursday	1.58000	1.000043889	
31-01-20	Friday	1.60000	1.000133333	
03-02-20	Monday	1.59000	1.000044167	
04-02-20	Tuesday	1.60000	1.000044444	
05-02-20	Wednesday	1.59000	1.000044167	
06-02-20	Thursday	1.59000	1.000044167	
07-02-20	Friday	1.58000	1.000131667	
10-02-20	Monday	1.58000	1.000043889	
11-02-20	Tuesday	1.58000	1.000043889	
12-02-20	Wednesday	1.57000	1.000043611	
13-02-20	Thursday	1.57000	1.000043611	
14-02-20	Friday	1.58000	1.000175556	
17-02-20	Monday			SOFR Holiday
18-02-20	Tuesday	1.60000	1.000044444	
19-02-20	Wednesday	1.59000	1.000044167	
20-02-20	Thursday	1.60000	1.000044444	
21-02-20	Friday	1.58000	1.000131667	
24-02-20	Monday	1.58000	1.000043889	
25-02-20	Tuesday	1.59000	1.000044167	
26-02-20	Wednesday	1.58000	1.000043889	(26th Rate will be applicable till 27th)
27-02-20	Thursday			Accrual End Date/Fallback Observation Date
28-02-20	Friday			Forward Premia Settlement Date
02-03-20	Monday			Payment Date

$$ARR_{1,t} = \frac{360}{360} \times \frac{1}{(27/02/20 - 27/01/20)/360} \times \left[\left(1 + \frac{1}{360} \times 1.5300\%\right)\left(1 + \frac{1}{360} \times 1.5300\%\right) \ldots \left(1 + \frac{1}{360} \times 1.5800\%\right) - 1\right] = \mathbf{1.58101}\%$$

Step 3: Computation of the Spread Adjustment Value:

To compute the Spread Adjustment, the applicable tenor plus 2 business days is subtracted from the Rate Record Date. For the Rate Record Date of 27-01-2020, this date would be the

[1] The SOFR rate for 27-02-2020 will not be used for compounding in the ARR formula.

24-12-2019 (since 25-12-2019 is a holiday). A 5 year period is considered starting from 24-12-2014 to 24-12-2019. During this 5 year period, the median of the daily spread between the LIBOR and ARR is estimated. The Spread Adjustment for the Rate Record Date of 27-01-2020 was computed as **0.09868%** (Table 4)**.**

Table 4: Computation of Spread Adjustment

Date	Day	1M LIBOR	1M Adj. SOFR	Spread	Description
24-12-14	Wednesday	0.1688	0.0824	0.08632	Median Period Start Date
25-12-14	Thursday		0.0824		
26-12-14	Friday		0.0824		
29-12-14	Monday	0.1693	0.0807	0.08860	
30-12-14	Tuesday	0.1695	0.0797	0.08982	
			.		
			.		
			.		
19-12-19	Thursday	1.7851	1.5416	0.24351	
20-12-19	Friday	1.7799	1.5419	0.23796	
23-12-19	Monday	1.7920	1.5429	0.24911	
24-12-19	Tuesday	1.8048	1.5435	0.26121	Median Period End Date
25-12-19	Wednesday				SOFR Holiday
26-12-19	Thursday				
27-12-19	Friday				
Median				0.09868	

Step 4: Computation of the All-in Fallback Rate:

The All in Fallback Rate (Table 5) is the sum of the ARR and the Spread Adjustment, which is equal to **1.67969%** (1.5810+0.09868).

Table 5: Computation of All-in Fallback Rate

Rate Record Date	Fallback Observation Date	Adjusted SOFR	+ Spread Adjustment	= All in Fallback Rate
27-01-20	27-02-20	1.58101	0.09868	1.67969

Step 5: Computation of the Adjusted MIFOR Curve

The Adjusted MIFOR Curve can be computed using the Fallback Rate as:

$$Adjusted\ MIFOR_{27/01/20} = \left[\left(1 + All\ in\ Fallback\ Rate \times \frac{N}{36000}\right) \times \left(1 + Rolling\ Forward\ Premia\ Rate \times \frac{N}{36500}\right) - 1\right] \times \frac{365}{N}$$

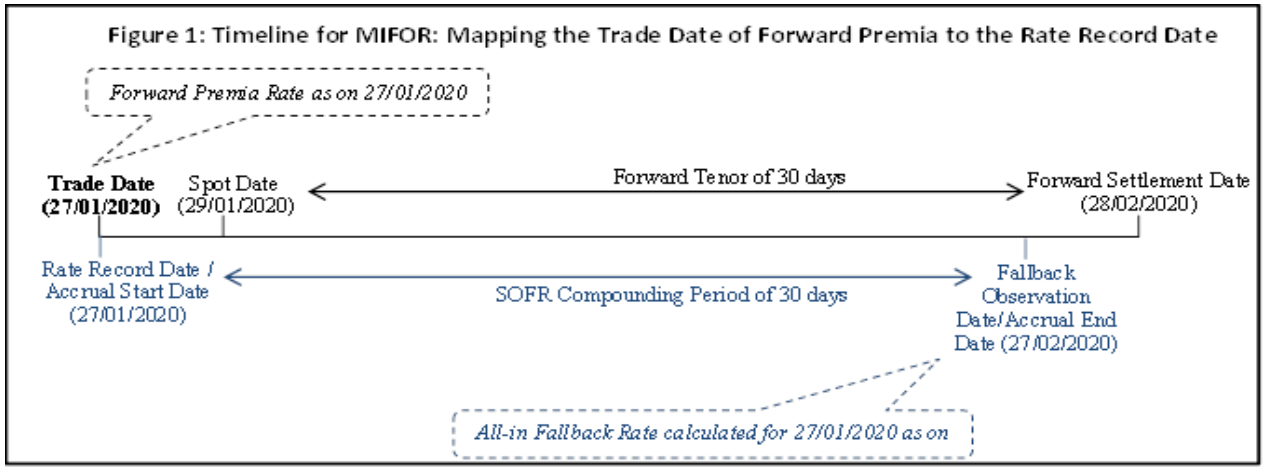
where

- *All in Fallback Rate* is for the Rate Record Date of 27/01/20 and Fallback Observation Date of 27/02/20
- *Rolling Forward Premia Rate* is for the Trade Date of 27/01/20 (Spot Value Date of 29/01/20) and Settlement Date of 28/02/20.
- N is the number of days from Forward Premia Settlement Date to Spot Value Date.

$$Adjusted\ MIFOR_{27/01/20}$$
$$= \left[\left(1 + 1.67969 \times \frac{28/02/20\ -\ 29/01/20}{36000}\right)\right.$$
$$\left. \times \left(1 + 3.5843 \times \frac{28/02/20\ -\ 29/01/20}{36500}\right) - 1\right]\ \times \frac{365}{28/02/20\ -\ 29/01/20}$$
$$= 5.2923\%$$

In case of the 1 month MIFOR for 27/01/2020, the Forward Premia Rate for the Trade date of 27/01/2020 has a spot settlement date of 29/01/2020 and a forward settlement date of 28/02/2020. The FBIL forward premia rate would be known as on 27/01/2020. The All-in Fallback Rate for the Rate Record Date of 27/01/2020 would be known on the Fallback Observation Date (FOD) which falls on the (or after) the Accrual End Date of 27/02/2020. Accordingly, the 1 month Adjusted FBIL MIFOR for the 27/01/2020 would be published on (or after) 27/02/2020. The Timeline for this example is illustrated in Figure 1.

Figure 1: Timeline for MIFOR: Mapping the Trade Date of Forward Premia to the Rate Record Date



Step 6: Computation of the Modified MIFOR Curve

The Modified MIFOR Curve can be computed using the Adjusted SOFR as:

$$Modified\ MIFOR_{27/01/20}$$
$$= \left[\left(1 + Adjusted\ SOFR \times \frac{N}{36000}\right) \times \left(1 + Rolling\ Forward\ Premia\ Rate\ \times \frac{N}{36500}\right)\right.$$
$$\left. - 1\right]\ \times \frac{365}{N}$$

where

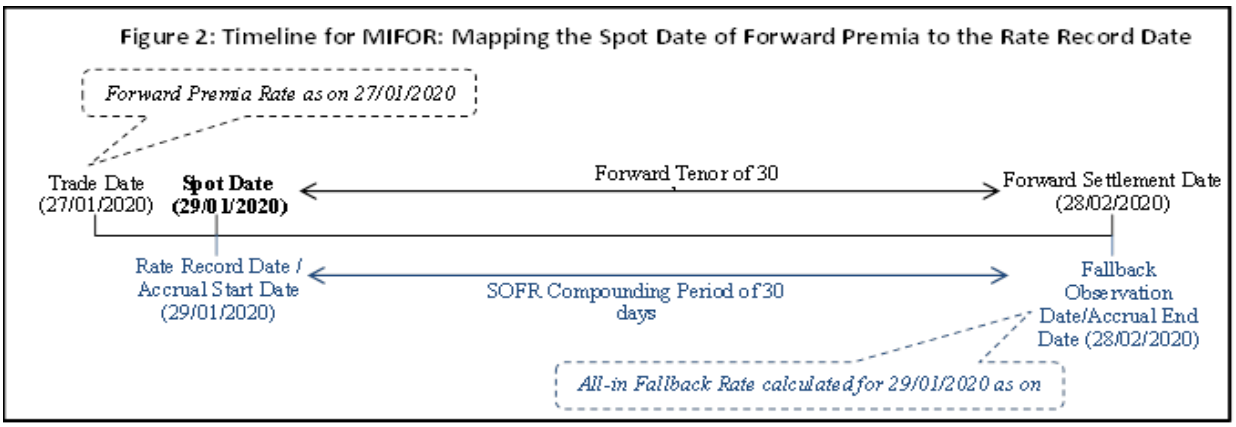
- $Adjusted\ SOFR$ is for the Rate Record Date of 27/01/20 and Fallback Observation Date of 27/02/20
- $Rolling\ Forward\ Premia\ Rate$ is for the Trade Date of 27/01/20 (Spot Value Date of 29/01/20) and Settlement Date of 28/02/20.
- N is the number of days from Forward Premia Settlement Date to Spot Value Date.

$$Modified\ MIFOR_{27/01/20}$$
$$= \left[\left(1 + 1.58101 \times \frac{28/02/20\ -\ 29/01/20}{36000}\right)\right.$$
$$\left. \times \left(1 + 3.5843 \times \frac{28/02/20\ -\ 29/01/20}{36500}\right) - 1\right]\ \times \frac{365}{28/02/20\ -\ 29/01/20}$$
$$= 5.9120\%$$

4.2. Method 2: MIFOR Computation by Mapping the Spot Value Date of the Forward Premia Rate To The Rate Record Date Associated With The Fallback Rate

In this method, the Rate Record Date of the All-in Fallback Rate was mapped with the spot value date of the FBIL Forward Premia Rate. The same is illustrated by considering the example of the 1 month MIFOR for 27/01/2020. The Forward Premia Rate for the Trade date of 27/01/2020 has a spot settlement date of 29/01/2020 and a forward settlement date of 28/02/2020. This forward premia rate is known as on 27/01/2020 itself. The All-in Fallback Rate for the Rate Record Date of 29/01/2020 would be known on the Fallback Observation date which falls on the (or after) the Accrual End Date of 28/02/2020. Accordingly, the 1 month MIFOR for the 27/01/2020 would be published on (or after) 28/02/2020. The Timeline for this example is illustrated in Figure 2[$].

[$] It is pertinent to note that the Forward Premia Settlement Date would be adjusted for USD and INR holidays while the Accrual End Date would be adjusted for USD holidays. Hence the Forward Premia Settlement Date may not always be the same as the Accrual End Date, as depicted in the illustration.

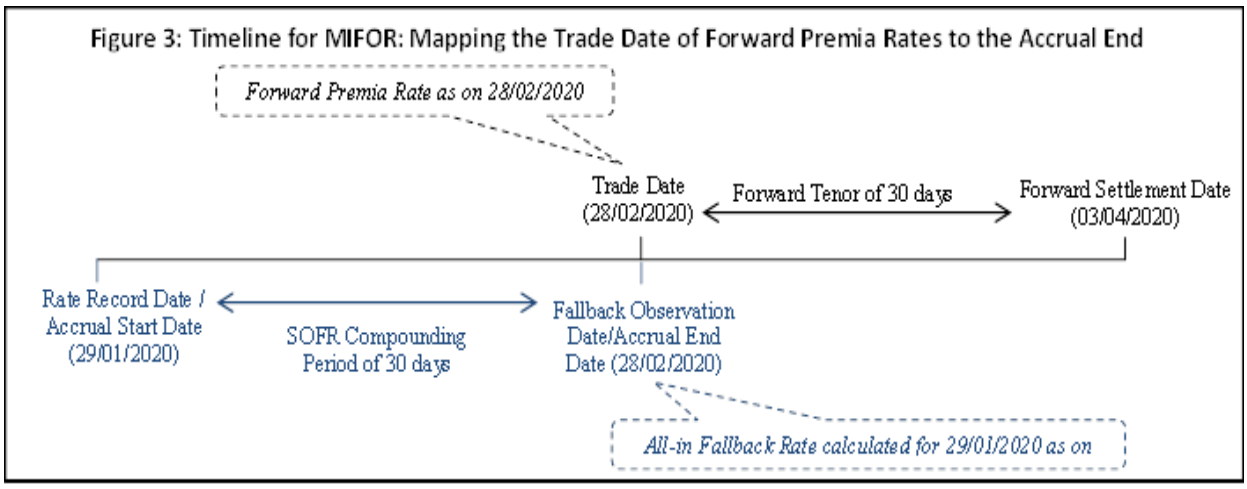


This method would help in better alignment of the Forward tenor to the SOFR compounding period. However, it would result in the dissemination of the 1 month MIFOR being extended by 1 to 2 additional business days.

4.3. Method 3: MIFOR Computation By Mapping The Trade Date Of The Forward Premia Rate To Accrual End Date Associated With The Fallback Rate

In this method, the Trade Date of the FBIL Forward Premia Rate was mapped to the Accrual End date of the All-in Fallback Rate. This method is built on the premise that floating rate linked instruments such as floating rate bond or loans have the floating-leg interest rate set and known at the beginning of the term of the contract or at each reset date. This rate decided on each reset date is applicable until the next reset date. The same is illustrated by considering the example of the 1 month MIFOR for 28/02/2020. The Forward Premia Rate for the Trade date of 28/02/2020 has a forward settlement date of 03/04/2020. This forward premia rate is known as on 28/02/2020 itself. The All-in Fallback Rate for the Rate Record Date of 29/01/2020 would be known on the Fallback Observation date which falls on the (or after) the Accrual End Date of 28/02/2020. Accordingly, the 1 month MIFOR for the 28/02/2020 would be published on (or after) 28/02/2020. The Timeline for this example is illustrated in Figure 3[$]:

[$] It is pertinent to note that the Forward Premia Settlement Date would be adjusted for USD and INR holidays while the Accrual End Date would be adjusted for USD holidays. Hence the Forward Premia Settlement Date may not always be the same as the Accrual End Date, as depicted in the illustration.



While computing the MIFOR rate using this method, instances were observed wherein the Accrual End Date was the same for two consecutive Rate Record Dates. Accordingly, the Forward Premia Rate associated with the Accrual End Date had to be repeated. The Fallback Rate for such instances would be unique, resulting in a unique MIFOR Rate. This is illustrated for the Rate Record Dates of 06-04-18 and 09-04-18 both of which have the same Accrual End Date of 09-10-18 (as 08-10-18 was a SOFR Holiday). Accordingly, the Forward Premia for the Trade Date of 09-10-18 would have to be repeated for these two days. For the purpose of this illustration, the MIFOR computed on the first date among these two dates was considered (Table 6). The dates of 07-04-18 and 08-04-18 were Saturday and Sunday.

Table 6: Computation of the MIFOR Curve by Mapping Forward Premia Date to the Accrual End Date

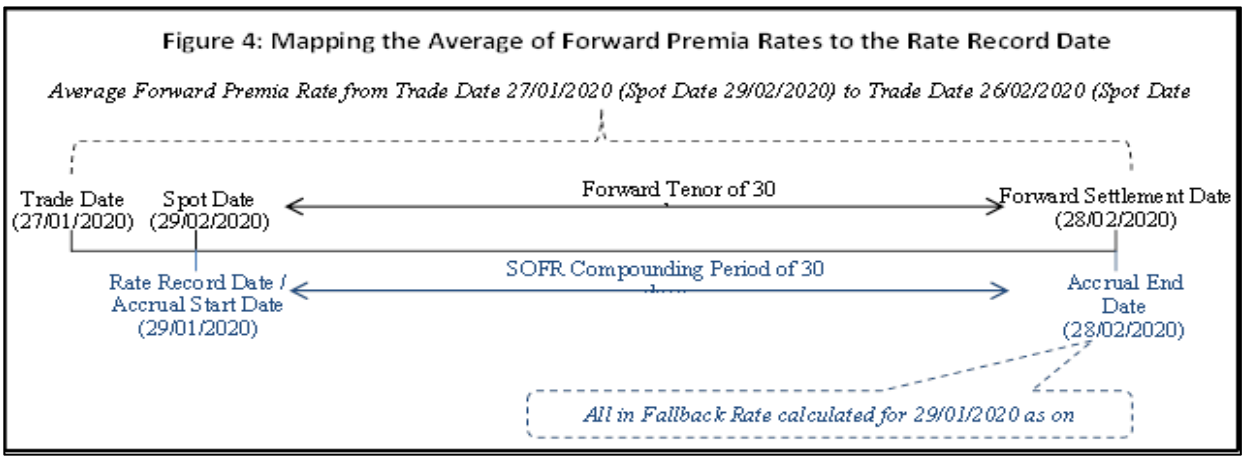
Forward Premia					Using All-in Fallback Rate			
Trade Date	Tenor	Spot Date	Settlement Date	USD/INR Premia	Rate Record Date	Accrual End Date	All-in Fallback Rate	FBIL MIFOR Using All-in Fallback Rate
03-10-18	6M	05-10-18	05-04-19	4.3588	03-04-18	03-10-18	2.21547	6.6539
04-10-18	6M	09-10-18	09-04-19	4.4021	04-04-18	04-10-18	2.21708	6.6993
05-10-18	6M	09-10-18	09-04-19	4.5328	05-04-18	05-10-18	2.21949	6.8340
08-10-18	6M	10-10-18	10-04-19	4.4665	05-04-18	05-10-18	2.21949	6.7669
09-10-18	6M	11-10-18	11-04-19	4.5519	06-04-18	09-10-18	2.22647	6.8605
09-10-18	6M	11-10-18	11-04-19	4.5519	09-04-18	09-10-18	2.22812	6.8622
10-10-18	6M	12-10-18	12-04-19	4.4786	10-04-18	10-10-18	2.23033	6.7904

A few instances were also observed when the Forward Premia for a given trade date could not be used in the computation. This is illustrated for the Trade Date of 08-10-18. For the Trade Date of 08-04-18, the Accrual End Date of 05-04-18 (which is the last available Fallback Rate) was repeated to compute the MIFOR as on 08-10-18.

4.4. METHOD 4: MIFOR Computation By Mapping The Average Forward Premia Rate To The Rate Record Date Associated With The Fallback Rate

In this method, the Rate Record Date of the All-in Fallback Rate was mapped with an average of FBIL Forward Premia Rates. The same is illustrated by considering the example of the 1 month MIFOR for 27/01/2020. An average of the Forward Premia Rates was computed for a period starting from the trade date of 27/01/2020 (and spot settlement date of 29/01/2020) to the trade date of 26/02/2020 (and the spot settlement date of 28/02/2020). The average forward premia rate would be known as on the date of 26/02/2020. The All-in Fallback Rate for the Rate Record Date of 29/01/2020 would be known on the Fallback Observation date which falls on the (or after) the accrual End Date of 28/02/2020. Accordingly, the 1 month MIFOR for the 27/01/2020 would be published on (or after) 28/02/2020. The Timeline for this example is illustrated in Figure 4[$]:

Figure 4: Mapping the Average of Forward Premia Rates to the Rate Record Date



Rather than using a single point estimate, this method would help in taking into account the Forward Premia Rates realised during the entire tenor period of 30 days.

5. Alternative Fallback Rate based on Alternate Spread Adjustment and SOFR Compounding methods

In this section, alternative methods were explored to compute the Fallback Rate to be used in the MIFOR Curve computation. Specifically, two issues were examined:

1. Examining alternative measures to compute the Spread Adjustment value
2. Exploring the impact of compounding the Overnight SOFR inclusive of the daily Spread Adjustment for the tenor of the MIFOR contract.

[$] It is pertinent to note that the Forward Premia Settlement Date would be adjusted for USD and INR holidays while the Accrual End Date would be adjusted for USD holidays. Hence the Forward Premia Settlement Date may not always be the same as the Accrual End Date, as depicted in the illustration.

On these lines, the following measures were considered:

5.1. Method a: Compounding the SOFR plus Spread Adjustment Value

In this method, the Fallback Rate is computed by compounding both the SOFR plus the Spread Adjustment value as:

$$Fallback\ Rate = \left[\left(1+\frac{t_1}{360}\times(SOFR_{t1}+Spread)\right)\left(1+\frac{t_2}{360}\times(SOFR_{t2}+Spread)\right)\ldots\left(1+\frac{t_n}{360}\times(SOFR_{tn}+Spread)\right)-1\right]\times\frac{360}{t_{n+1}-t_1}$$

where,

the Spread was defined as the 5 year median of the difference between the LIBOR and the Adjusted SOFR, computed as on the accrual start date.

5.2. Method b: Compounding the SOFR plus Average of Max and Min Spread

Computing the Fallback Rate based on compounding the SOFR plus the spread adjustment, wherein the Spread adjustment is defined as:

$$Spread\ Adjustment = \frac{Max\ Spread + Min\ Spread}{2}$$

where

- *Spread is the difference between the LIBOR and Adjusted SOFR during a 5 year look back period.*
- *Max Spread is the maximum Spread observed during a 5 year look back period*
- *Min Spread is the minimum Spread observed during a 5 year look back period*

5.3. Method c: Compounding the SOFR Plus Max and Min Spread Weighted by Count

In this method, the Fallback Rate is computed by compounding the SOFR plus the spread adjustment, wherein the spread adjustment is defined as:

$$Spread\ Adjustment\ = (Max\ Spread * weight1 + Min\ Spread * weight2)$$

where

- *Spread is the difference between the LIBOR and Adjusted SOFR during a 5 year lookback period.*
- *Max Spread is the maximum Spread observed during a 5 year look back period*
- *Min Spread is the minimum Spread observed during a 5 year look back period*
- *weight*1 *is defined as the count of the all the Spreads above the average spread observed during a 5 year look back period*
- *weight*2 *is defined as the count of the all the Spreads below the average spread observed during a 5 year look back period*

5.4. Method d: Compounding the SOFR Plus Max and Min Spread Weighted by Sum

In this method, the Fallback Rate is computed by compounding the SOFR plus the spread adjustment, wherein the spread adjustment is defined as:

$$Spread\ Adjustment\ = (Max\ Spread * weight1 + Min\ Spread * weight2)$$

where

- *Spread is the difference between the LIBOR and Adjusted SOFR during a 5 year lookback period.*
- *Max Spread is the maximum Spread observed during a 5 year look back period*
- *Min Spread is the minimum Spread observed during a 5 year look back period*
- *weight*1 *is defined as the sum of the all the Spreads above the Median spread observed during a 5 year look back period*
- *weight*2 *is defined as the sum of the all the Spreads below the Median spread observed during a 5 year look back period*

5.5. Method e: Compounding the SOFR plus Average of Year-Wise Median Spreads

In this method, the Fallback Rate is computed by compounding the SOFR plus the spread adjustment, wherein the spread adjustment is defined as:

$$Spread\ Adjustment\ = Average(S1,\ S2,\ S3,\ S4\ , S5)$$

where,

- $S1$ to $S5$ are the medians of the daily spreads computed during each of the 5 years in the lookback period.
- Daily Spread is the difference between the LIBOR rate and the Adjusted SOFR

6. EMPIRICAL ANALYSIS AND FINDING

This section provides detail on the Adjusted and Modified MIFOR results arrived at through various specifications and does a comparative analysis of the same.

6.1. Method 1: Mapping the Rate Record Date to the Trade Date of the FBIL Forward Premia Rate using the Fallback Rate Proposed by ISDA/Bloomberg

In this section, the MIFOR curve was back tested using, method 1, the proposed methodology as defined in Section 4, by computing the fallback rate as defined by the ISDA IBOR fallback methodology. MIFOR curve was computed by mapping the Trade Date of the Forward Premia Rate to the Rate Record Date associated with the Fallback rate. Since a compounding in arrears setting was adopted for computing the Fallback Rate, the MIFOR curve using this proposed framework would be published after the accrual period as on the Fallback Observation Date. A comparison of the Modified MIFOR Curve computed using the Adjusted Reference Rate (ARR) and Adjusted MIFOR computed using the All in Fallback Rate is provided in Table 7.

Table 8 presents the percentage share of the total number of days during which the absolute spread (in Bps) between the MIFOR Rate computed using LIBOR and the Adjusted MIFOR rate computed using the replacement rates falls within the specified threshold bucket. For example, in case of the O/N Rate, it is seen that for around 46% of the total

Table 7: Descriptive Statistics of MIFOR Under Method 1

	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR
		O/N			1M			2M	
Mean	5.8394	5.8819	5.9099	6.1198	5.9778	6.0804	6.2778	6.0092	6.1662
Median	5.9382	5.9831	6.0209	6.3145	6.1712	6.2783	6.4596	6.2425	6.3958
Stdev	2.0224	2.0357	2.0404	1.0866	1.1232	1.1222	0.8003	0.9321	0.9285
Kurtosis	123.1368	119.7591	118.7033	2.5475	1.2132	1.2016	0.8992	-0.1072	-0.1292
Skewness	8.5759	8.4105	8.3520	0.0565	-0.0970	-0.0894	-0.6579	-0.6551	-0.6454
Minimum	3.0338	3.0423	3.0545	3.4787	3.3790	3.4951	3.7746	3.5743	3.7513
Maximum	37.7080	37.7263	37.7587	11.3782	11.0045	11.1062	8.9245	8.8108	8.9641
CoV	34.6333	34.6101	34.5256	17.7560	18.7897	40.5458	12.7480	15.5120	15.0583
Count	529	529	529	540	540	540	518	518	518
		3M			6M			12M	
Mean	6.4695	6.0666	6.2956	6.7042	6.1969	6.5234	7.1014	6.3331	6.9302
Median	6.6053	6.3049	6.5292	6.8438	6.4590	6.7773	7.1442	6.3169	6.8930
Stdev	0.6259	0.8294	0.8211	0.3987	0.6402	0.6334	0.2541	0.3713	0.3983
Kurtosis	0.1364	-0.0128	-0.0217	-0.5768	0.1819	0.1922	-0.3549	-0.8073	-0.8717
Skewness	-0.7742	-0.8376	-0.8212	-0.6570	-1.1204	-1.1238	-0.5388	-0.1748	-0.1985
Minimum	4.4502	3.8897	4.1455	5.7061	4.5589	4.9029	6.4082	5.5427	6.0909
Maximum	8.2209	8.0562	8.2870	7.3869	7.0504	7.3665	7.6042	7.0348	7.6426
CoV	9.6748	13.6720	13.0432	5.9473	10.3303	9.7092	3.5786	5.8628	5.7478
Count	500	500	500	445	445	445	324	324	324

trading days considered in the sample, the absolute spread between the MIFOR computed using the All-in Fallback Rate and that computed using LIBOR was less than or equal to 5 basis points.

Table 8: Distribution of the Absolute Spread Between MIFOR Using LIBOR and MIFOR Using Method 1						
Threshold Bucket	O/N	1M	2M	3M	6M	12M
Panel A: Modified MIFOR Using the Adjusted SOFR						
0 to <=5 Bps	69.94%	19.63%	4.83%	1.60%	0.00%	0.00%
>5 to <=10 Bps	18.15%	29.26%	14.86%	1.20%	0.00%	0.00%
>10 to <=20 Bps	7.18%	38.52%	26.25%	28.40%	0.45%	0.00%
>20 to <=30 Bps	2.65%	4.63%	34.56%	11.00%	19.33%	0.00%
>30 to <=40 Bps	0.38%	0.56%	6.95%	24.80%	27.64%	0.00%
>40 to <=50 Bps	0.19%	1.11%	0.97%	11.00%	24.27%	3.09%
>50 to <=75 Bps	0.76%	2.96%	3.09%	8.80%	13.03%	40.12%
>75 to <=100 Bps	0.57%	3.33%	4.05%	4.80%	4.49%	42.28%
>100 to <=200 Bps	0.00%	0.00%	4.44%	8.40%	10.79%	14.51%
>200 to <=300 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>300 Bps	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%
Panel B: Adjusted MIFOR Using the All-in Fallback Rate						
0 to <=5 Bps	46.12%	38.70%	24.90%	14.20%	29.21%	7.72%
>5 to <=10 Bps	35.16%	37.41%	32.24%	25.80%	21.80%	12.04%
>10 to <=20 Bps	13.80%	15.19%	30.31%	30.20%	22.92%	24.38%
>20 to <=30 Bps	2.46%	1.48%	0.58%	8.00%	8.76%	18.52%
>30 to <=40 Bps	0.57%	0.93%	0.77%	6.20%	1.80%	20.68%
>40 to <=50 Bps	0.38%	1.30%	1.54%	2.20%	1.57%	5.56%
>50 to <=75 Bps	0.76%	3.15%	4.05%	4.80%	5.39%	11.11%
>75 to <=100 Bps	0.57%	1.85%	4.05%	6.00%	5.17%	0.00%
>100 to <=200 Bps	0.00%	0.00%	1.54%	2.60%	3.37%	0.00%
>200 to <=300 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>300 Bps	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%

The daily series for each of the rates in consideration is provided in Figure 5.1–5.6 in the Annexure. It is observed that a noticeable diversion exists between the FBIL MIFOR Curve computed using LIBOR and both the Adjusted and Modified MIFOR for tenors beyond 3 months.

6.2. Method 2: Mapping the Rate Record Date to the Spot Value Date of the FBIL Forward Premia Rate

Using method (2), the Rate Record date associated with the Fallback Rate was mapped to the Spot value date of the FBIL Forward Premia Rate. The descriptive statistics of the MIFOR Curve using LIBOR and Adjusted and Modified MIFOR is provided in *Table 9*. *Table 10* presents the percentage share of the total number of days during which the absolute spread (in Bps), between the MIFOR computed using LIBOR and the Modified and Adjusted MIFOR computed using the replacement rates (ARR and All-in Fallback Rates), falls within the specified threshold bucket.

Table 9: Descriptive Statistics of the MIFOR Curve									
	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR
		O/N			1M			2M	
Mean	5.8438	5.8829	5.9109	6.1290	5.9803	6.0828	6.2871	6.0113	6.1683
Median	5.9397	5.9733	6.0111	6.3191	6.1694	6.2719	6.4625	6.2408	6.3997
Stdev	2.0218	2.0407	2.0454	1.0780	1.1223	1.1213	0.7876	0.9317	0.9281
Kurtosis	123.4497	122.3009	121.2258	2.6399	1.1890	1.1780	0.8593	-0.1588	-0.1796
Skewness	8.5961	8.5210	8.4620	0.0780	-0.0831	-0.0756	-0.6172	-0.6446	-0.6352
Minimum	3.0338	3.0525	3.0642	3.4787	3.3824	3.4987	3.7746	3.5790	3.7565
Maximum	37.7080	37.9808	38.0129	11.3782	11.0007	11.1024	8.9245	8.8085	8.9617
CoV	34.5972	34.6890	34.6041	17.5884	18.7672	18.4335	12.5278	15.4999	15.0467
Count	528	528	528	538	538	538	516	516	516
		3M			6M			12M	
Mean	6.4774	6.0678	6.2969	6.7072	6.1968	6.5231	7.1040	6.3312	6.9278
Median	6.6067	6.2988	6.5287	6.8479	6.4580	6.7739	7.1466	6.3109	6.8893
Stdev	0.6145	0.8300	0.8217	0.3971	0.6424	0.6356	0.2527	0.3751	0.4019
Kurtosis	-0.0061	-0.0194	-0.0271	-0.5415	0.2194	0.2277	-0.3043	-0.8227	-0.8886
Skewness	-0.7264	-0.8363	-0.8202	-0.6696	-1.1316	-1.1340	-0.5531	-0.1735	-0.1983
Minimum	4.6127	3.8931	4.1489	5.7061	4.5426	4.8850	6.4082	5.5154	6.0682
Maximum	8.2209	8.0583	8.2893	7.3869	7.0450	7.3604	7.6042	7.0348	7.6420
CoV	9.4868	13.6780	13.0490	5.9211	10.3661	9.7438	3.5568	5.9238	5.8019
Count	498	498	498	443	443	443	322	322	322

Table 10: Distribution of the Absolute Difference Between MIFOR using LIBOR and using the Replacement Rates						
Threshold Bucket	O/N	1M	2M	3M	6M	12M
Panel A: Modified MIFOR Using the Adjusted SOFR						
0 to <=5 Bps	71.40%	20.82%	3.10%	0.60%	0.00%	0.00%
>5 to <=10 Bps	17.80%	29.93%	17.83%	2.41%	0.00%	0.00%
>10 to <=20 Bps	7.20%	35.87%	25.58%	28.31%	0.23%	0.00%
>20 to <=30 Bps	1.89%	4.83%	31.59%	11.85%	18.06%	0.00%
>30 to <=40 Bps	0.38%	0.74%	8.72%	23.49%	28.44%	0.00%
>40 to <=50 Bps	0.19%	0.74%	1.16%	11.24%	24.83%	4.66%
>50 to <=75 Bps	0.57%	3.16%	2.71%	8.03%	13.09%	38.51%
>75 to <=100 Bps	0.38%	3.53%	4.26%	4.82%	4.74%	42.24%
>100 to <=200 Bps	0.00%	0.37%	5.04%	9.24%	10.61%	14.60%
>200 to <=300 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>300 Bps	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%
Panel B: Adjusted MIFOR Using the All-in Fallback Rate						
0 to <=5 Bps	50.00%	39.03%	24.03%	14.46%	29.12%	6.52%
>5 to <=10 Bps	32.01%	35.13%	35.08%	26.31%	22.12%	12.42%
>10 to <=20 Bps	14.39%	17.29%	25.97%	29.52%	22.35%	25.47%
>20 to <=30 Bps	1.52%	1.12%	1.94%	7.83%	8.58%	14.91%
>30 to <=40 Bps	0.57%	0.37%	1.36%	5.62%	1.58%	22.05%
>40 to <=50 Bps	0.38%	0.74%	1.36%	2.01%	2.48%	6.83%
>50 to <=75 Bps	0.57%	3.72%	3.88%	5.02%	4.97%	11.80%
>75 to <=100 Bps	0.38%	2.60%	4.07%	5.82%	4.51%	0.00%
>100 to <=200 Bps	0.00%	0.00%	2.33%	3.41%	4.29%	0.00%
>200 to <=300 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>300 Bps	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%

A comparison of the daily rates in consideration is provided in *Figure 6.1-6.6 in the Annexure*.

6.3. Method 3: Mapping the Trade Date of the Forward Premia Rate to Accrual End Date associated with the Fallback Rate

In this method, the Trade Date of the FBIL Forward Premia Rate was mapped to the Accrual End date of the All-in Fallback Rate. This method was built on the premise that floating rate linked instruments such as floating rate bond or loans have the floating-leg interest rate set and known at the beginning of the term of the contract or at each reset date. This rate decided on each reset date is applicable until the next reset date. Accordingly, the Forward Premia Rate as on the Accrual End Date was used to compute the MIFOR Curve. The descriptive statistics of the MIFOR Curve using LIBOR, the Adjusted MIFOR and Modified MIFOR is provided in *Table 11.* Table 12 presents the percentage share of the total number of days during which the absolute spread (in Bps) between MIFOR computed using LIBOR and the method 3 falls within the specified threshold bucket.

Table 11: Descriptive Statistics of the MIFOR Curve

	O/N			1M			2M		
	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR
Mean	5.8394	5.8819	5.9099	6.0241	5.9382	6.0408	6.0800	5.9396	6.0968
Median	5.9382	5.9831	6.0209	6.2693	6.2463	6.3445	6.3902	6.2365	6.3951
Standard Deviation	2.0224	2.0357	2.0404	1.1613	1.2181	1.2172	1.0203	1.0698	1.0658
Kurtosis	123.1368	119.7591	118.7033	1.7160	1.5332	1.5265	0.2742	0.3029	0.2852
Skewness	8.5759	8.4105	8.3520	-0.0480	-0.0402	-0.0331	-0.8520	-0.8443	-0.8331
Minimum	3.0338	3.0423	3.0545	3.4787	3.3404	3.4500	3.6468	3.4155	3.5863
Maximum	37.7080	37.7263	37.7587	11.3782	11.4540	11.5569	8.9245	8.7849	8.9396
CoV	34.6333	34.6101	34.5256	19.2782	20.5137	20.1495	16.7810	18.0118	17.4808
Count	529	529	529	563	543	543	563	521	521
	3M			6M			12M		
	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Mod MIFOR	Adj MIFOR
Mean	6.1897	5.9899	6.2191	6.2963	6.1214	6.4477	6.4496	6.2979	6.8943
Median	6.5339	6.2443	6.4562	6.5811	6.3293	6.6538	6.7616	6.4716	7.0670
Standard Deviation	0.9863	0.9803	0.9700	0.9202	0.7624	0.7570	0.9298	0.5467	0.5785
Kurtosis	0.4062	0.6395	0.6485	0.4976	0.5039	0.4911	-0.2087	-0.3998	-0.4733
Skewness	-1.1512	-1.1568	-1.1526	-1.2622	-1.1641	-1.1588	-0.9934	-0.7141	-0.6714
Minimum	3.7414	3.5066	3.7594	4.0159	4.1643	4.5061	4.3165	5.0665	5.6122
Maximum	8.2209	8.0506	8.2682	7.3869	7.4447	7.7675	7.6042	7.3263	7.9815
CoV	15.9339	16.3660	15.5977	14.6146	12.4546	11.7404	14.4160	8.6802	8.3915
Count	563	500	500	563	440	440	563	320	320

Table 12: Distribution of the Absolute Spread Between MIFOR Using LIBOR and MIFOR Using Method 1						
Threshold Bucket	O/N	1M	2M	3M	6M	12M
Panel A: Modified MIFOR Using the Adjusted SOFR						
0 to <=5 Bps	69.94%	16.94%	6.72%	6.00%	2.73%	2.50%
>5 to <=10 Bps	18.15%	20.81%	7.87%	8.20%	8.18%	2.50%
>10 to <=20 Bps	7.18%	36.10%	35.89%	34.00%	13.18%	8.44%
>20 to <=30 Bps	2.65%	17.13%	21.88%	19.20%	18.86%	8.75%
>30 to <=40 Bps	0.38%	4.42%	22.46%	3.00%	22.27%	25.00%
>40 to <=50 Bps	0.19%	1.29%	3.26%	11.40%	10.23%	12.50%
>50 to <=75 Bps	0.76%	2.76%	1.34%	17.60%	7.95%	11.25%
>75 to <=100 Bps	0.57%	0.55%	0.58%	0.60%	16.59%	24.06%
>100 to <=200 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	5.00%
>200 to <=300 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>300 Bps	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%
Panel B: Adjusted MIFOR Using the All-in Fallback Rate						
0 to <=5 Bps	46.12%	33.52%	22.07%	16.60%	3.64%	2.81%
>5 to <=10 Bps	35.16%	22.65%	14.97%	10.60%	5.00%	2.81%
>10 to <=20 Bps	13.80%	25.97%	31.48%	13.20%	5.00%	2.19%
>20 to <=30 Bps	2.46%	10.68%	19.39%	19.00%	4.09%	3.44%
>30 to <=40 Bps	0.57%	3.68%	9.40%	21.40%	12.27%	0.94%
>40 to <=50 Bps	0.38%	0.37%	0.38%	16.80%	13.64%	0.63%
>50 to <=75 Bps	0.76%	1.84%	1.15%	0.80%	49.09%	5.63%
>75 to <=100 Bps	0.57%	1.29%	0.96%	1.00%	5.00%	37.81%
>100 to <=200 Bps	0.00%	0.00%	0.19%	0.60%	2.27%	43.75%
>200 to <=300 Bps	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
>300 Bps	0.19%	0.00%	0.00%	0.00%	0.00%	0.00%

A comparison of the daily rates in consideration is provided in *Figure 7.1-7.6 in the Annexure*.

6.4. Method 4: Mapping the Rate Record Date to the Average FBIL Forward Premia Rate

Rather than using a single point estimate, in this method an average of the Forward Premia rate, realised in the same period during which the SOFR was compounded in arrears, was considered in the FBIL MIFOR Curve computation. This method would help in taking into account the Forward Premia Rates realised during the entire tenor period of 30 days. The descriptive statistics of the MIFOR Curve using LIBOR and that derived from the ARR and the All-in Fallback Rate is provided in *Table 13.*

Table 14 presents the percentage share of the total number of days during which the absolute spread (in Bps) between the MIFOR computed using LIBOR and the MIFOR computed using the replacement rates (ARR and All-in Fallback Rates) falls within the specified threshold bucket.

A comparison of the daily rates in consideration is provided in *Figure 8.1-8.6 in the Annexure.* It was observed that using an average of the realised forward premia rates, resulted in over-smoothening of the MIFOR Curve.

Table 13: Descriptive Statistics									
	Current MIFOR	Mod MIFOR	Adj MIFOR	Current MIFOR	Using Adjusted SOFR	Using All-in Fallback	Current MIFOR	Using Adjusted SOFR	Using All-in Fallback
		O/N			1M			2M	
Mean	5.8438	5.8829	5.9109	6.1290	5.9724	6.0750	6.2871	5.9969	6.1538
Median	5.9397	5.9733	6.0111	6.3191	6.1896	6.2968	6.4625	6.2884	6.4421
Stdev	2.0218	2.0407	2.0454	1.0780	1.0511	1.0500	0.7876	0.9128	0.9088
Kurtosis	123.4497	122.3009	121.2258	2.6399	0.1837	0.1600	0.8593	0.4219	0.3906
Skewness	8.5961	8.5210	8.4620	0.0780	-0.7160	-0.7082	-0.6172	-0.9940	-0.9838
Minimum	3.0338	3.0525	3.0642	3.4787	3.5048	3.6193	3.7746	3.6333	3.8101
Maximum	37.7080	37.9808	38.0129	11.3782	7.9618	8.0633	8.9245	7.2798	7.4327
CoV	34.5972	34.6890	34.6041	17.5884	17.5984	17.2835	12.5278	15.2214	14.7678
Count	528	528	528	538	538	538	516	516	516
		3M			6M			12M	
Mean	6.4774	6.0522	6.2813	6.7072	6.1818	6.5080	7.1040	6.3230	6.9196
Median	6.6067	6.3556	6.5754	6.8479	6.4463	6.7734	7.1466	6.4711	7.0877
Stdev	0.6145	0.8242	0.8142	0.3971	0.6502	0.6440	0.2527	0.3852	0.4124
Kurtosis	-0.0061	0.7342	0.7400	-0.5415	0.6890	0.6868	-0.3043	0.6736	0.4677
Skewness	-0.7264	-1.1650	-1.1604	-0.6696	-1.3518	-1.3535	-0.5531	-1.3573	-1.2912
Minimum	4.6127	3.7291	3.9857	5.7061	4.3535	4.6979	6.4082	5.2463	5.7928
Maximum	8.2209	7.0156	7.2343	7.3869	6.7794	7.1011	7.6042	6.6762	7.2941
CoV	9.4868	13.6173	12.9622	5.9211	10.5182	9.8951	3.5568	6.0924	5.9599
Count	498	498	498	443	443	443	322	322	322

Table 14: Distribution of the Absolute Difference Between MIFOR using LIBOR and using the Replacement Rates						
Threshold Bucket	O/N	1M	2M	3M	6M	12M
Panel A: Using the Adjusted SOFR						
0 to <=5 Bps	71.40%	14.31%	12.98%	7.23%	1.35%	0.00%
>5 to <=10 Bps	17.80%	15.06%	15.31%	7.23%	1.58%	0.00%
>10 to <=20 Bps	7.20%	19.52%	22.09%	17.87%	8.35%	0.31%
>20 to <=30 Bps	1.89%	13.75%	12.60%	19.68%	14.22%	3.42%
>30 to <=40 Bps	0.38%	12.64%	7.56%	11.04%	17.61%	5.28%
>40 to <=50 Bps	0.19%	6.51%	7.56%	5.62%	18.74%	6.52%
>50 to <=75 Bps	0.57%	11.71%	11.43%	12.25%	20.99%	42.24%
>75 to <=100 Bps	0.38%	2.42%	3.88%	10.24%	7.90%	22.98%
>100 to <=200 Bps	0.00%	2.97%	5.04%	7.23%	9.26%	19.25%
>200 to <=300 Bps	0.00%	0.19%	0.78%	0.80%	0.00%	0.00%
>300 Bps	0.19%	0.93%	0.78%	0.80%	0.00%	0.00%
Panel B: Using the All-in Fallback Rate						
0 to <=5 Bps	50.00%	16.73%	14.92%	18.47%	16.25%	15.53%
>5 to <=10 Bps	32.01%	17.47%	12.79%	15.26%	19.86%	13.04%
>10 to <=20 Bps	14.39%	19.70%	21.12%	20.08%	23.02%	24.53%
>20 to <=30 Bps	1.52%	15.06%	17.25%	10.64%	12.19%	19.25%
>30 to <=40 Bps	0.57%	7.43%	14.15%	8.03%	9.03%	6.52%
>40 to <=50 Bps	0.38%	6.32%	7.75%	6.02%	6.32%	3.42%
>50 to <=75 Bps	0.57%	10.22%	4.46%	12.45%	5.42%	8.07%
>75 to <=100 Bps	0.38%	2.97%	3.10%	4.42%	0.68%	6.52%
>100 to <=200 Bps	0.00%	3.16%	3.10%	3.21%	7.22%	3.11%
>200 to <=300 Bps	0.00%	0.00%	0.58%	0.60%	0.00%	0.00%
>300 Bps	0.19%	0.93%	0.78%	0.80%	0.00%	0.00%

6.5. Comparison of the FBIL MIFOR with the Adjusted MIFOR and the Modified MIFOR for the 6-Month Tenor

A detailed analysis has been carried out by computing the Adjusted MIFOR and Modified MIFOR for the 6-month tenor during the period from April 2018 to July 2020. The Adjusted MIFOR, which is computed using the All-in Fallback Rate, is proposed for legacy contracts while the Modified MIFOR, which is computed using the Adjusted SOFR, is proposed for new contracts. The 6 month MIFOR tenor has been chosen for analysis as it is a tenor often referenced by market participants to hedge the semi-annual cash flows arising from cross currency swap transactions undertaken with their clients.

6.5.1. Computation of Adjusted MIFOR for Legacy Contracts by Mapping the Trade Date of Forward Premia (FP) to the Rate Record Date

Using this Method, the 6 month MIFOR was computed from April 2018 to January 2020, wherein daily SOFR from February 2020 to July 2020 were used in the MIFOR computed for the month of January 2020. Figure 9 (in the annexure) compares the 6-month MIFOR using LIBOR with the Adjusted MIFOR. The Adjusted MIFOR was computed by mapping the Trade Date of Forward Premia with the Rate Record Date.

The descriptive statistics for each of these series is provided in Table 15. A deviation was observed between the FBIL MIFOR computed using LIBOR and Adjusted MIFOR more prominently since October 2019. On an average, the FBIL MIFOR was found to be 6.70% while the Adjusted MIFOR which takes into account a historical spread adjustment was recorded at 6.52%.

Table 15: Descriptive Statistics of FBIL MIFOR and Adjusted MIFOR by Mapping Forward Premia Trade Date to Rate Record Date From Apr-2018 to Jan-2020

	FBIL MIFOR Using LIBOR	Adjusted MIFOR
Mean	6.7042	6.5234
Median	6.8438	6.7773
Standard Deviation	0.3987	0.6334
Kurtosis	-0.5768	0.1922
Skewness	-0.6570	-1.1238
Range	1.6808	2.4636
Minimum	5.7061	4.9029
Maximum	7.3869	7.3665
Count	445	445

A distribution analysis of the 6-month FBIL MIFOR with the Adjusted MIFOR is provided in Table 16.

Table 16: Percentile (Pcntl.) Distribution of MIFOR by Mapping Forward Premia Trade Date to Rate Record Date from Apr-2018 to Jan-2020		
	FBIL MIFOR Using LIBOR	Adjusted MIFOR
5th Pcntl.	5.95534	5.13682
10th Pcntl.	6.0885	5.35058
25th Pcntl.	6.4436	6.3047
50th Pcntl.	6.8438	6.7773
75th Pcntl.	7.0312	6.9732
100th Pcntl.	7.3869	7.3665

A correlation matrix of the FBIL MIFOR using LIBOR with Adjusted MIFOR (Table 17), suggests a significant correlation (above 0.90) between the two series in consideration.

Table 17: Correlation of Rates by Mapping Forward Premia Trade Date to Rate Record Date from Apr-2018 to Jan-2020		
	FBIL MIFOR Using LIBOR	Adjusted MIFOR
FBIL MIFOR Using LIBOR	1	
Adjusted MIFOR	0.9417	1

Table 18 provides the descriptive statistics of the spread of the FBIL MIFOR (using LIBOR) over the Adjusted MIFOR for the period in consideration. It was observed that Adjusted MIFOR was on an average approximately 18 bps lower than the FBIL MIFOR computed using LIBOR.

Table 18: Descriptive Statistics of Spread by Mapping Forward Premia Trade Date to Rate Record Date from Apr-2018 to Jan-2020	
	FBIL MIFOR - Adjusted MIFOR (Bps)
Mean	18.0815
Median	9.3800
Standard Deviation	29.0690
Kurtosis	2.2194
Skewness	1.7763
Range	118.6200
Minimum	-12.8800
Maximum	105.7400
Count	445

A two-sample T-Test was further conducted between the FBIL MIFOR and the Adjusted MIFOR (presented in Table 19).

Table 19: Two Sample T-Test Between FBIL MIFOR and Adjusted MIFOR From April 2018 to Jan 2020 Mapping Forward Premia Trade Date to Rate Record Date

Type	Method	N	Mean	Std Dev	Std Err	Minimum	Maximum
FBIL MIFOR Using LIBOR		445	6.7042	0.3987	0.0189	5.7061	7.3869
Adjusted MIFOR		445	6.5234	0.6334	0.03	4.9029	7.3665
Diff (1-2)	Pooled		0.1808	0.5292	0.0355		
Diff (1-2)	Satterthwaite		0.1808		0.0355		

Type	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
FBIL MIFOR Using LIBOR		6.7042	6.667	6.7413	0.3987	0.3741	0.4268
Adjusted MIFOR		6.5234	6.4644	6.5824	0.6334	0.5943	0.678
Diff (1-2)	Pooled	0.1808	0.1112	0.2504	0.5292	0.5057	0.555
Diff (1-2)	Satterthwaite	0.1808	0.1112	0.2505			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	888	5.1	<.0001
Satterthwaite	Unequal	748.15	5.1	<.0001

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	444	444	2.52	<.0001

It was observed that the test for equality of variances, as indicated by the Folded F stat, was rejected suggesting that the variance of the FBIL MIFOR was significantly different from the variance of the Adjusted MIFOR. It was further observed that the difference in the Means under the assumption of unequal variances was found to be statistically different from 0.

Given the noticeable difference, possible reasons for the divergence between the FBIL MIFOR using LIBOR and the Adjusted MIFOR were explored. The reasons for the divergence are highlighted as follows:

- Difference between the LIBOR and Adjusted SOFR: Figure 11 compares the monthly average rate of the LIBOR with that of the Adjusted SOFR. A significant divergence between the monthly average LIBOR and monthly average rate of the Adjusted SOFR was observed more prominently since October 2019.
- Difference between the Historical Spread Adjustment Value and the Realized Spread of LIBOR over Adjusted SOFR: Figure 12 highlights that, on a monthly average basis, the spread adjustment value (which is the 5-year historical median between the LIBOR and the Adjusted SOFR) has remained largely constant in the range of 0.31% to 0.34% throughout the period in consideration. The Realized spread, defined as the difference between LIBOR and Adjusted SOFR during the current months, however has widened more prominently since October 2019.

A comparison of the rates on a daily basis, concurs with the results from the month average basis, wherein that the historical 5 year spread is not always in sync with the realized

spread, specifically during times of a sharp rise or drop in the interest rates . Since October 2019, the spread between the LIBOR rates and the 6M Adjusted SOFR rate prominently widened but the Median Spread used for computing the Fallback rate and in turn the Adjusted MIFOR remained largely constant. Additionally, the Adjusted SOFR rates computed since late October 2019, being compounded in Arrears, reflected the drop in the O/N SOFR rate (in March 2020) but the LIBOR, did not capture the same until March 2020. Post LIBOR cessation, since the Spread Adjustment would remain as a constant figure, this could be a concern while using the fallback rate. A comparison of the USD LIBOR rate with the Fallback rate along with the sub-components computed using the ISDA methodology is provided in Figure 13.

6.5.2. Computation of Modified MIFOR for New Contracts by Mapping the Trade Date of Forward Premia (FP) to Accrual End Date

Using this Method, the rates were computed from October 2018 to July 2020, wherein the SOFR rates from April 2018 to September 2018 are used in the MIFOR computed for the month of October 2018. Figure 10 compares the Modified MIFOR, which are computed by mapping the Trade Date of Forward Premia with the Accrual End Date, with the 6-month FBIL MIFOR using LIBOR.

The descriptive statistics for each of these series is provided in Table 20. A deviation was also observed between the FBIL MIFOR computed using LIBOR and Modified MIFOR. On an average, the FBIL MIFOR was found to be 6.15% while the Modified MIFOR, which is computed from compounding the SOFR for the given tenor without any spread adjustment, was recorded at 6.12%.

Table 20: MIFOR Rates by Mapping Forward Premia Trade Date to Accrual End Date From Oct-2018 to Jul-2020

	FBIL MIFOR Using LIBOR	Modified MIFOR
Mean	6.1498	6.1214
Median	6.4142	6.3293
Standard Deviation	0.9864	0.7624
Kurtosis	-0.3387	0.5039
Skewness	-0.9249	-1.1641
Range	3.3710	3.2804
Minimum	4.0159	4.1643
Maximum	7.3869	7.4447
Count	440	440

A distribution analysis of the 6-month MIFOR in each case is provided in Table 21.

Table 21: Distribution of MIFOR Rate by Mapping Forward Premia Trade Date to Accrual End Date from Oct-2018 to July 2020		
	FBIL MIFOR Using LIBOR	Modified MIFOR
5th Pcntl.	4.1136	4.4198
10th Pcntl.	4.2566	4.6746
25th Pcntl.	5.7095	5.9532
50th Pcntl.	6.4142	6.3293
75th Pcntl.	6.9949	6.6122
100th Pcntl.	7.3869	7.4447

A correlation matrix of the FBIL MIFOR using LIBOR with the Modified MIFOR (Table 22), suggests a high correlation (above 0.88) between the two series in consideration.

Table 22: MIFOR Rates By Mapping Forward Premia Trade Date to Accrual End Date From Oct-2018 to Jul-2020		
	FBIL MIFOR Using LIBOR	Modified MIFOR
FBIL MIFOR Using LIBOR	1	
Modified MIFOR	0.8896	1

Table 23 provides the descriptive statistics of the spread of the FBIL MIFOR (using LIBOR) over the Modified MIFOR for the period in consideration. It was observed that the Modified MIFOR, which does not take into account a spread adjustment, was higher than the FBIL MIFOR by around 3 bps.

Table 23: Descriptive Statistics of Spread by Mapping Forward Premia Trade Date to Accrual End Date From Oct-2018 to Jul-2020	
	FBIL MIFOR- Modified MIFOR (Bps)
Mean	2.8380
Median	-13.8200
Standard Deviation	46.4969
Kurtosis	-0.7264
Skewness	0.6382
Range	191.4100
Minimum	-98.4800
Maximum	92.9300
Count	440

A two-sample T-Test conducted between the FBIL MIFOR and Modified MIFOR is presented in Table 24. While the difference in the variance of the FBIL MIFOR with that of the Modified MIFOR was observed, the difference between the Means of the two series was not found to be significantly different from 0.

Table 24: Two Sample T-Test of FBIL MIFOR Using LIBOR with Modified MIFOR For Oct-2018 to Jul-2020							
Mapping Forward Premia Trade Date to Accrual End Date							
Type	Method	N	Mean	Std Dev	Std Err	Minimum	Maximum
FBIL MIFOR Using LIBOR		440	6.1498	0.9864	0.047	4.0159	7.3869
Modified MIFOR		440	6.1214	0.7624	0.0363	4.1643	7.4447
Diff (1-2)	Pooled		0.0284	0.8816	0.0594		
Diff (1-2)	Satterthwaite		0.0284		0.0594		

Type	Method	Mean	95% CL Mean		Std Dev	95% CL Std Dev	
FBIL MIFOR Using LIBOR		6.1498	6.0574	6.2422	0.9864	0.9253	1.0563
Modified MIFOR		6.1214	6.05	6.1929	0.7624	0.7151	0.8164
Diff (1-2)	Pooled	0.0284	-0.0883	0.145	0.8816	0.8422	0.9248
Diff (1-2)	Satterthwaite	0.0284	-0.0883	0.145			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	878	0.48	0.6331
Satterthwaite	Unequal	825.55	0.48	0.6331

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	439	439	1.67	<.0001

6.6. Alternative Methods Considered for Computing the Fallback Rates post LIBOR cessation

In this section, alternative versions of the Fallback rate were explored to analyze the impact of the same on the MIFOR curve. Specifically, the following series were computed and compared:

a) Fallback Rate as defined by ISDA/Bloomberg IBOR methodology (defined as M1)
b) Fallback Rate based on compounding both the SOFR plus the Spread Adjustment (defined as M2)
c) Fallback Rate based on compounding the SOFR plus (Max Spread+Min Spread/2) where Max and Min spread is arrived at from the 5 year lookback period (defined as M3).
d) Fallback Rate by compounding the SOFR plus (Max*weigh1t+Min*weight2) where the weight1 and weight2 were defined as the Count of the spreads above the average spread and that below the average spread as a percentage of the total count (defined as M4).
e) Fallback Rate based on compounding the SOFR plus (Max*weigh1t+Min*weight2) where the weight1 and weight2 were defined as the Sum of the spreads above the median and that below the median as a percentage of the total sum (defined as M5).
f) Fallback Rate based on the compounding the SOFR plus the average of year-wise medians (defined as M6).

A comparison of the descriptive statistics for each of the series with the 6M LIBOR rate is provided in Table 25.

Table 25: Descriptive Statistics to the Alternative Methods to Compute the Fallback Rate

	M1-All in Fallback Rate (Bloomberg)	M2- Compounding (SOFR+Median Spread)	M3-Compounding SOFR+(Max+Min)/ 2	M4-Compounding SOFR+ (Max*weight + Min*weight) ~ weight is count	M5-Compounding SOFR+ (Max*weight + Min*weight) ~ weight is sum	M6-Compounding SOFR + Average of Year-Wise Median	6M LIBOR
Mean	1.40664	1.40871	1.56548	1.44984	1.65093	1.43996	1.48892
Median	1.27113	1.27295	1.43274	1.32490	1.52019	1.30626	1.42711
Standard Deviation	0.79581	0.79706	0.81559	0.79769	0.82729	0.81035	0.81624
Kurtosis	-1.35479	-1.35511	-1.35048	-1.35266	-1.34850	-1.35264	-1.25413
Skewness	0.38031	0.38005	0.38196	0.38360	0.36333	0.38264	0.12357
Range	2.29542	2.29894	2.40506	2.34981	2.45170	2.34721	2.58848
Minimum	0.46805	0.46858	0.54871	0.45828	0.60277	0.48926	0.31940
Maximum	2.76347	2.76752	2.95376	2.80808	3.05447	2.83647	2.90788
Count	1421	1421	1421	1421	1421	1421	1421

Figure 14 compares the alternative fallback rates computed from the Median based spread measures while Figure 15 depicts the Fallback rate computed from spreads estimated using a Maximum and Minimum weighted scheme. It was observed that the Fallback Rates computed using a Median Based spread measure were found to be more stable as compared to the Fallback Rates computed using the Maximum spread and Minimum spread based weighting scheme.

The 6-month MIFOR was computed by using each of the Fallback rates estimated above along with the Forward Premia rate wherein the Trade Date of forward premia mapped to the Rate Record Date (Method 1). The descriptive statistics of the 6-month MIFOR using LIBOR and the MIFOR computed using the alternative Fallback rates is provided in Table 26.

Table 26: Descriptive Statistics of the 6 month MIFOR Computed under Alternative Fallback Rates

	FBIL MIFOR Using LIBOR	MIFOR Using M1	MIFOR Using M2	MIFOR Using M3	MIFOR Using M4	MIFOR Using M5	MIFOR Using M6
		where M1 is All in Fallback Rate (Bloomberg)	*where M2 is Compounded (SOFR+Median Spread)*	*where M3 is Compounded SOFR+(Max+Min)/2*	*where M4 is Compounded SOFR+(Max*weight + Min*weight) ~ weight is count*	*where M5 is Compounded SOFR+ (Max*weight + Min*weight) ~ weight is sum*	*where M6 is Compounded SOFR +Average of Year-Wise Median*
Mean	6.7042	6.5234	6.5268	6.7147	6.5851	6.8181	6.5797
Median	6.8438	6.7773	6.7814	6.9772	6.8449	7.0823	6.8448
Stdev	0.3987	0.6334	0.6342	0.6418	0.6210	0.6407	0.6376
Kurtosis	-0.5768	0.1922	0.1933	0.2002	0.2461	0.1952	0.1809
Skewness	-0.6570	-1.1238	-1.1244	-1.1285	-1.1475	-1.1258	-1.1256
Range	1.6808	2.4636	2.4665	2.4979	2.4466	2.4985	2.4681
Minimum	5.7061	4.9029	4.9040	5.0721	4.9824	5.1776	4.9600
Maximum	7.3869	7.3665	7.3705	7.5700	7.4290	7.6761	7.4281
Count	445	445	445	445	445	445	445

A comparison of 6-month MIFOR under each of these methods along with the FBIL MIFOR (using LIBOR) is provided in Figure 16 and Figure 17 respectively.

7. CONCLUSION

LIBOR transition and its impact on the Indian markets benchmark rate FBIL-MIFOR was the central theme of this paper. It discussed the details from the perspective of calculation of the rate with the proposed fallback rate and the possible alternate methods to compute MIFOR curve. Back-testing the data with these alternate methods puts forth multiple questions (a) How do we address the difference between MIFOR Curve using LIBOR and that using the proposed Fallback rate, which increases with an increase in tenor especially beyond 3 months. (b) What would be the appropriate forward premia rate to be selected in computing the MIFOR curve using the fallback rate (c) What are the alternate specification for computing the Fallback rate by using the adjusted SOFR compounded in arrears and a fixed spread. In this paper, various alternate specifications are discussed that would possibly account for the increasing difference between existing and proposed MIFOR rates for the higher tenors. This could be due to the need to compound the daily risk component. The larger concern that the forward term rate quoted in Indian markets are at the beginning of the period and the proposed Fall back rate is in arrears still remains.

In this study, we observe a noticeable diversion between the FBIL MIFOR Curve computed using LIBOR and the MIFOR computed using the replacement rates of Adjusted SOFR as well as the Fallback Rate for tenors beyond 3 months. The analysis further revealed that using a forward rate as a single point estimate rather an average rate realised during the forward tenor period, would serve as a better option at the time of computing the FBIL MIFOR Curve using the Fallback rate.

An analysis was carried out for the 6 month MIFOR for a period from April 2018 to July 2020 by comparing the MIFOR computed using LIBOR, the MIFOR by mapping the forward premia trade date to fallback rate record date (backward-looking) and the MIFOR by mapping forward premia trade date to accrual end date (forward-looking). The MIFOR with a backward-looking Forward Premia Rate rather than a forward-looking Forward Premia rate appeared to provide for a better approximation of the existing MIFOR curve.

Alternative fallback rates were computed from the Median based spread adjustment measures as well as spreads adjustment measures estimated using a Maximum and Minimum weighted scheme. It was observed that the Fallback Rates computed using a Median Based spread measure were found to be more stable as compared to the Fallback Rates computed using the Maximum spread and Minimum spread based weighting scheme.

There are market suggestions to have an process for publishing a forward looking term SOFR rate by 2021 if there is sufficient liquidity in SOFR derivatives market (Wynman,2020). Other markets have also considered using a domestic interest rate as a replacement to the fallback rate in the long run. These issues remain a notable area for future research work.

References

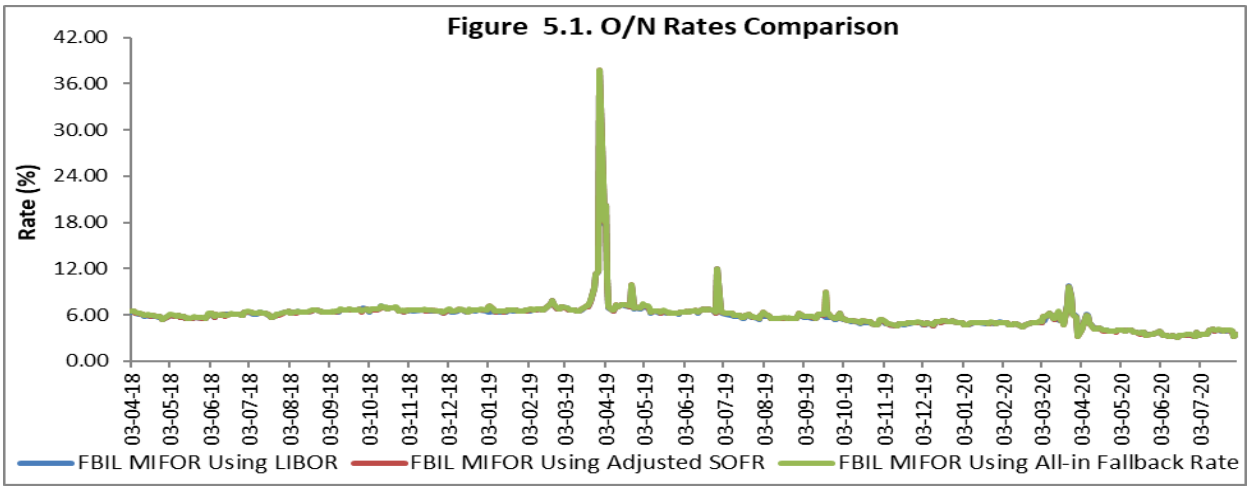
1. Methodology for Computation of Benchmark Forward Premia and MIFOR Curve April 2018, Golaka Nath, Sahana Rajaram, Manoel Pacheco
2. IBOR Transition Guide for Asia (July 2020). Source ISDA website. http://assets.isda.org/media/7b78f06e/202e9dcd-pdf/
3. BOT (July 2020), Responses to Market Participants Feedbacks on Adjusted THBFIX Consultation
4. ABS,(August, 2020) "Calculation methodology for fallback rate SOR"ABS Benchmarks Administration
5. FBIL (July 2020), "Note on LIBOR Transition – revision to the MIFOR methodology", internal note
6. FBIL(June 2020), "Update on LIBOR Transition – MIFOR Roadmap" , internal note
7. Schrimpf A., Sushko V., (2019), "Beyond LIBOR: a primer on the new reference rates", BIS Quarterly Review, March.
8. Oliver Wyman, (2020), "LIBOR transition: The State of Play"

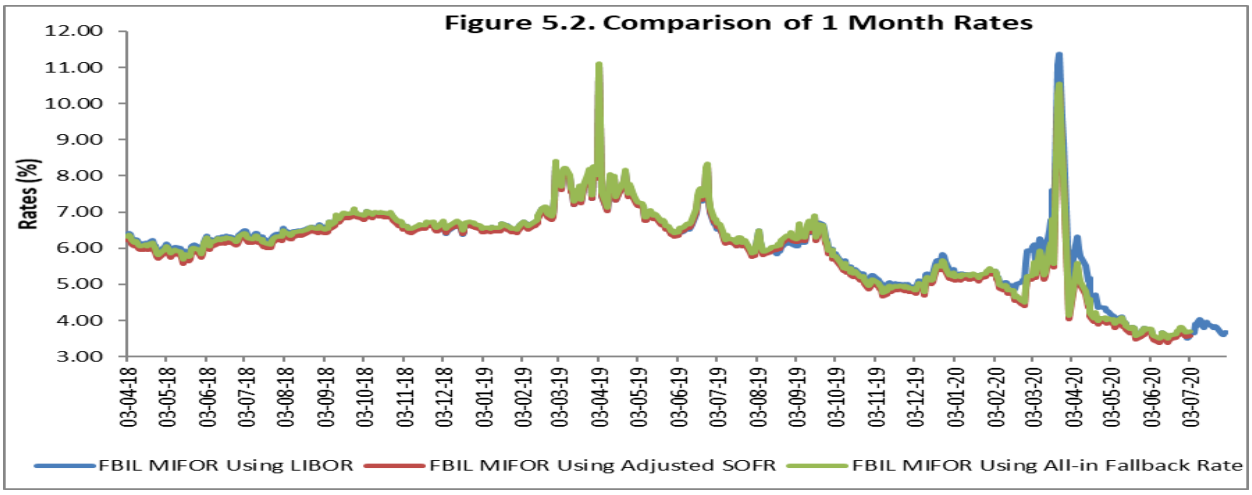
Additional Resources

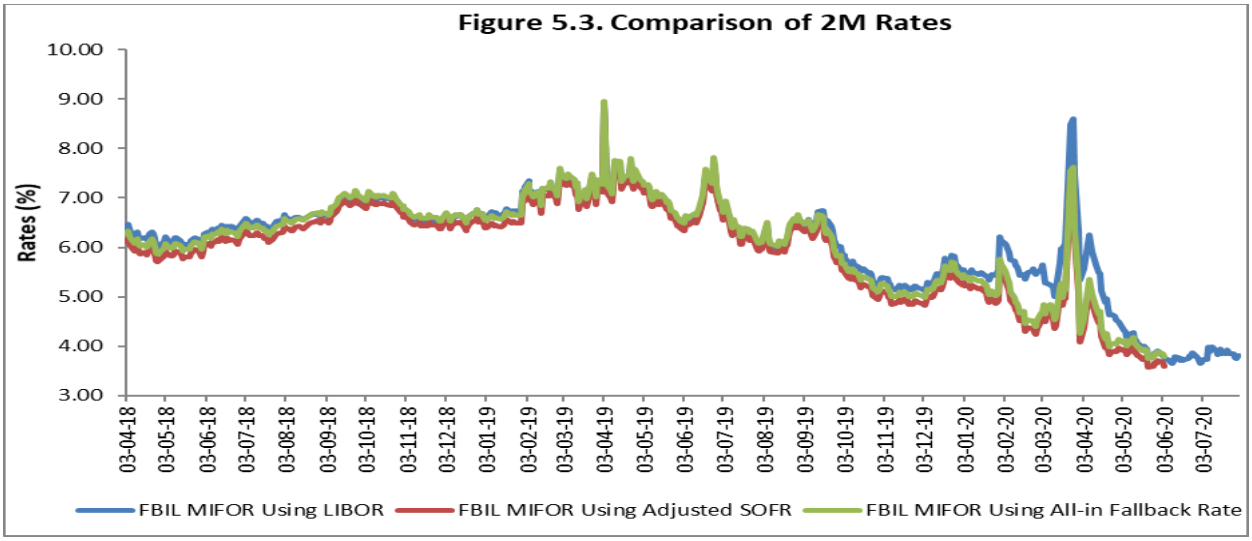
1. An excel worksheet illustrating the calculation of the Fallback rate and the Adjusted MIFOR is provided in the following link: https://www.ccilindia.com/Research/Lists/CCILKnowledgeCenter/Attachments/48/MIFOR%20Calculations_2018.xlsx

Annexure

Mapping the Rate Record Date to the Trade Date of the FBIL Forward Premia Rate using the Fallback Rate Proposed by ISDA/Bloomberg







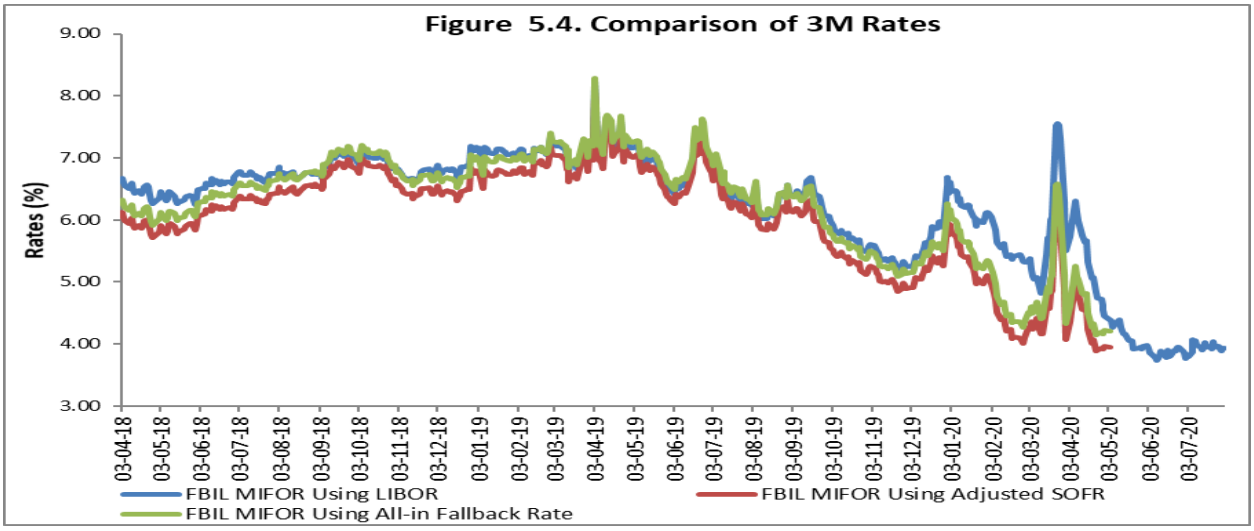


Figure 5.4. Comparison of 3M Rates
Rates (%)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

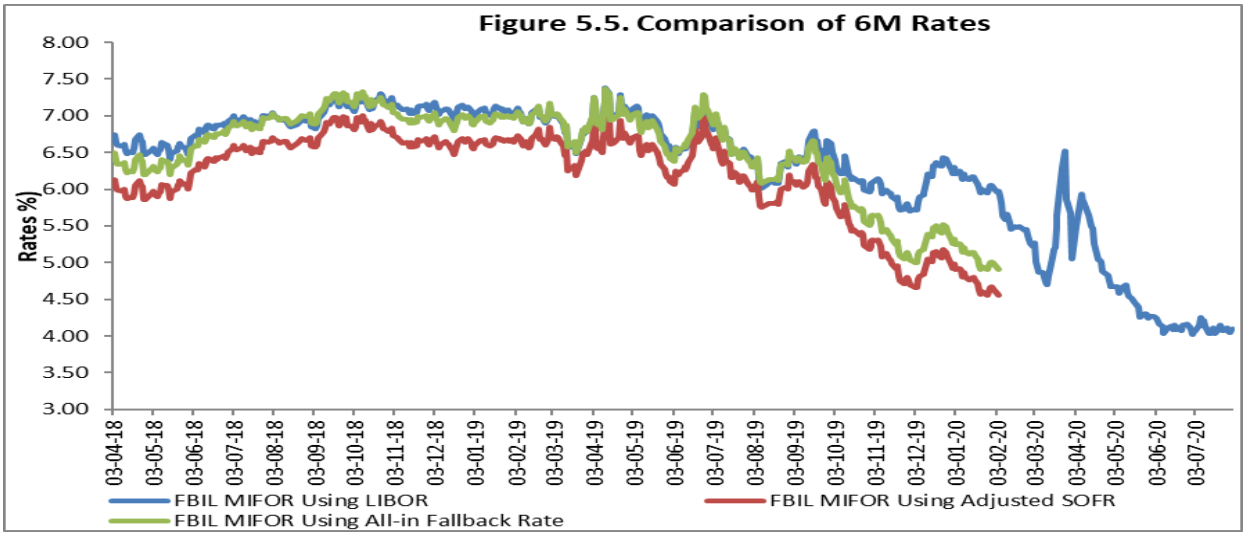


Figure 5.5. Comparison of 6M Rates
Rates %)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

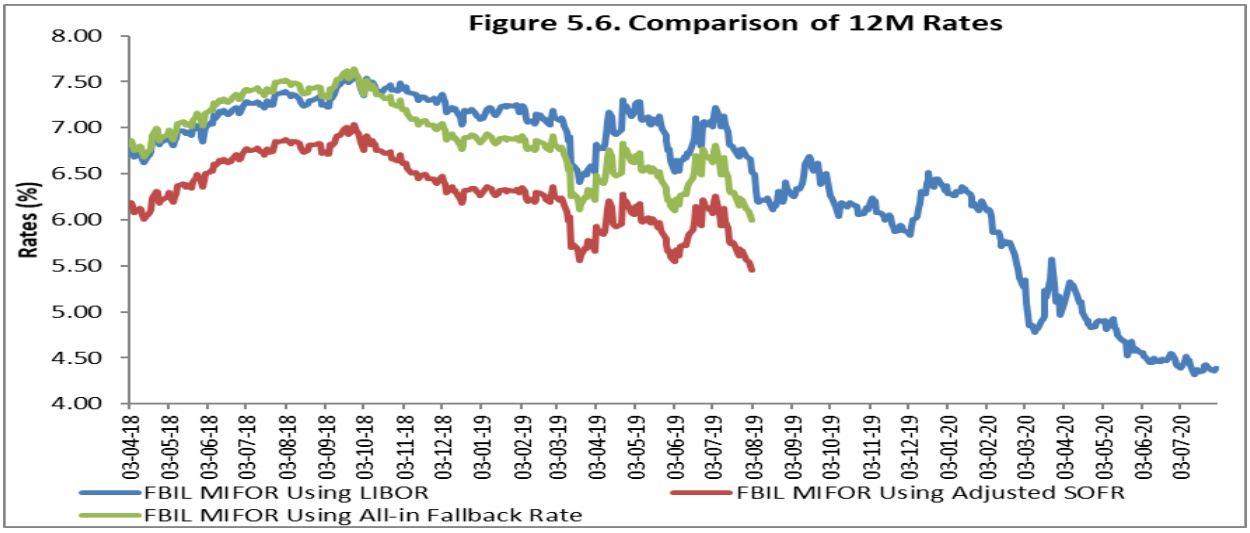
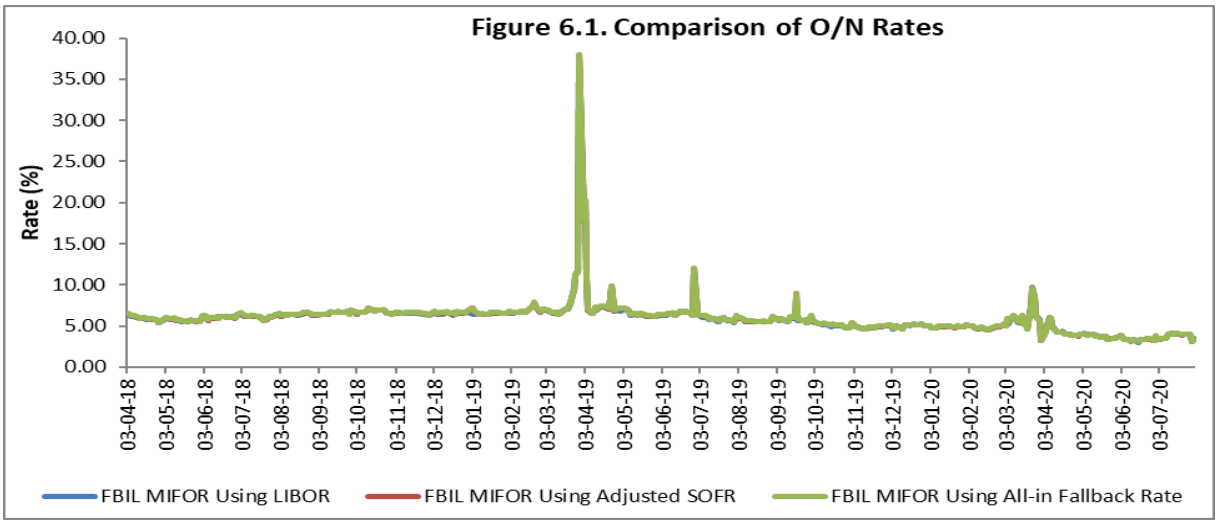
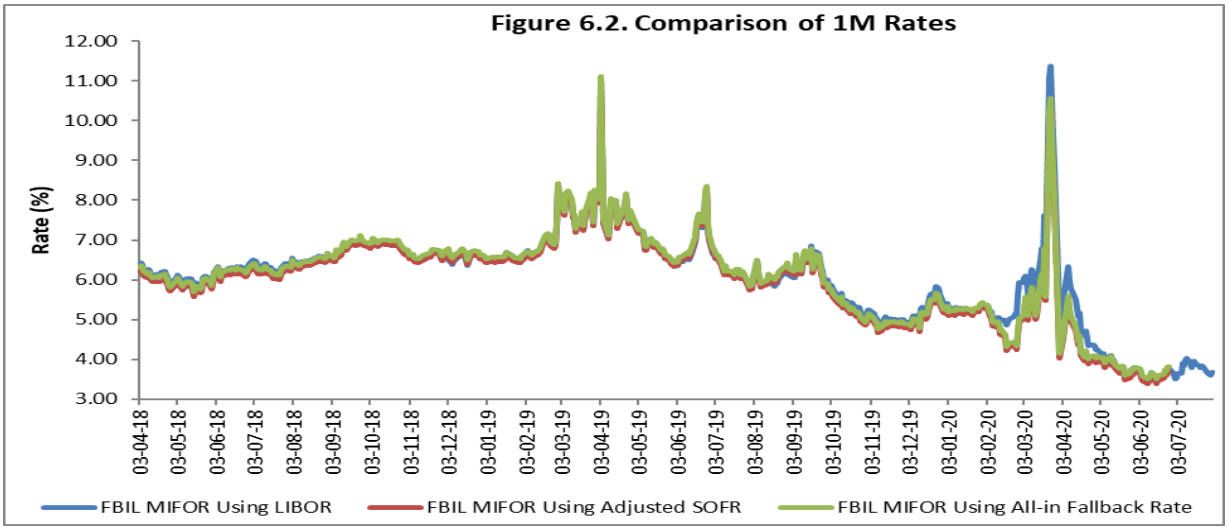
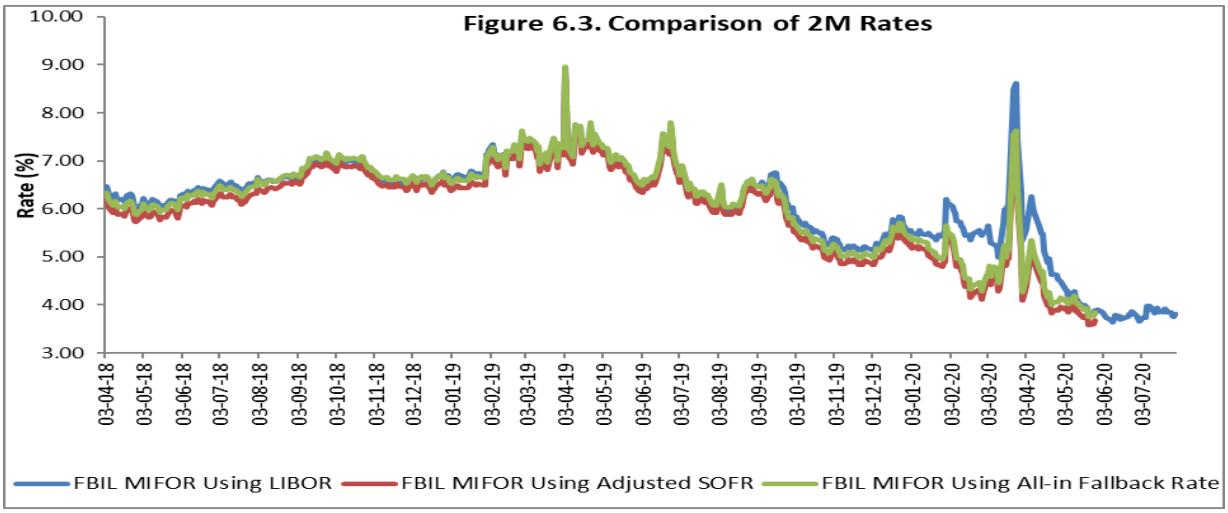


Figure 5.6. Comparison of 12M Rates
Rates (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

Mapping the Rate Record Date to the Value Date of the FBIL Forward Premia Rate







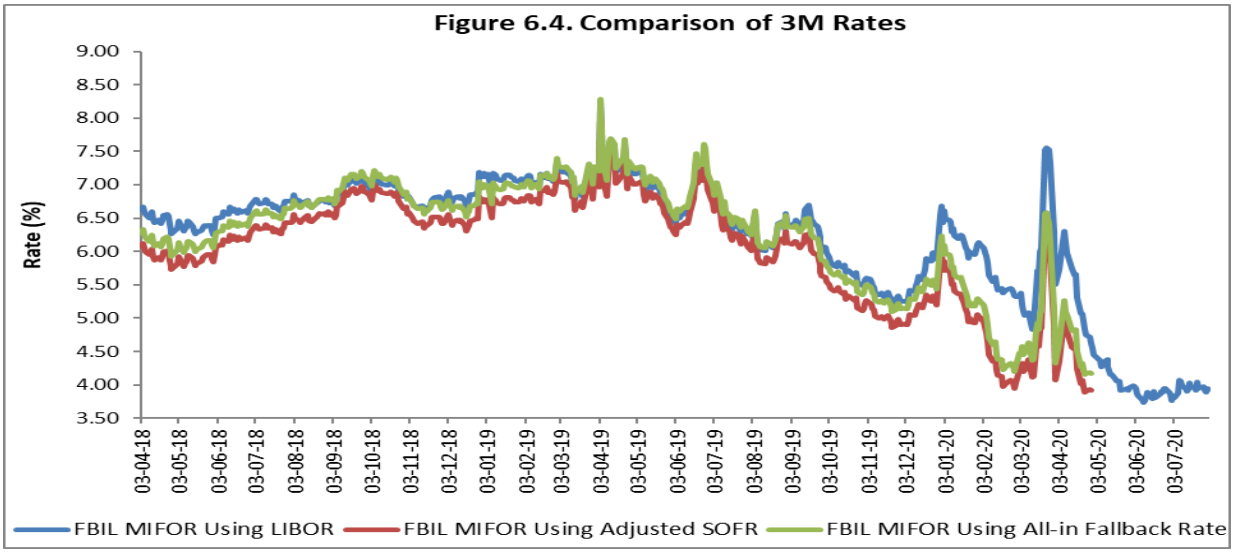


Figure 6.4. Comparison of 3M Rates
Rate (%)
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

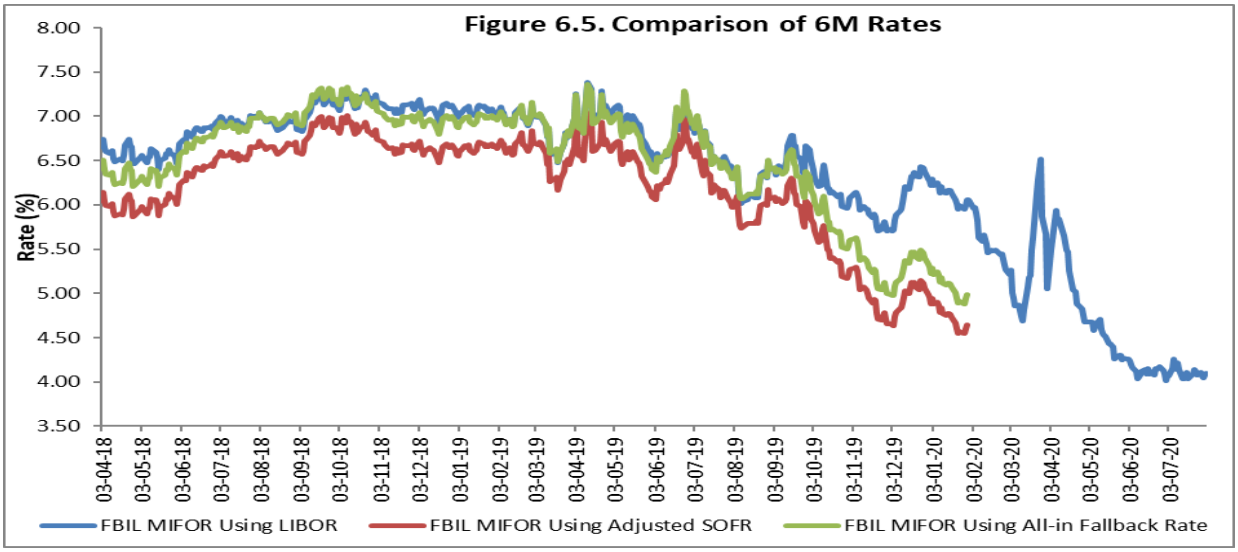


Figure 6.5. Comparison of 6M Rates
Rate (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

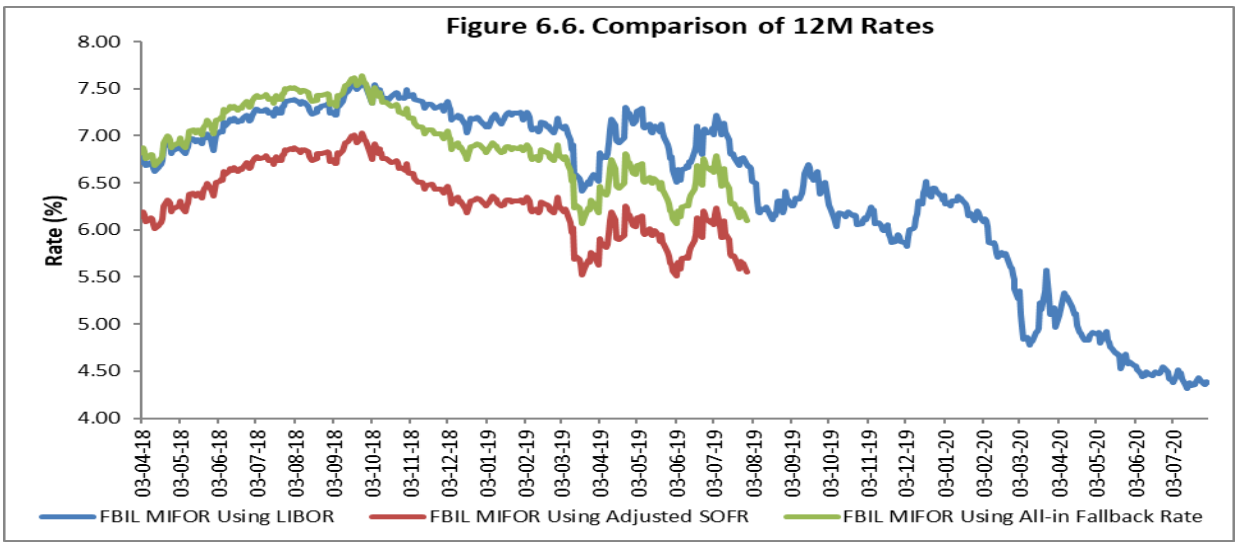
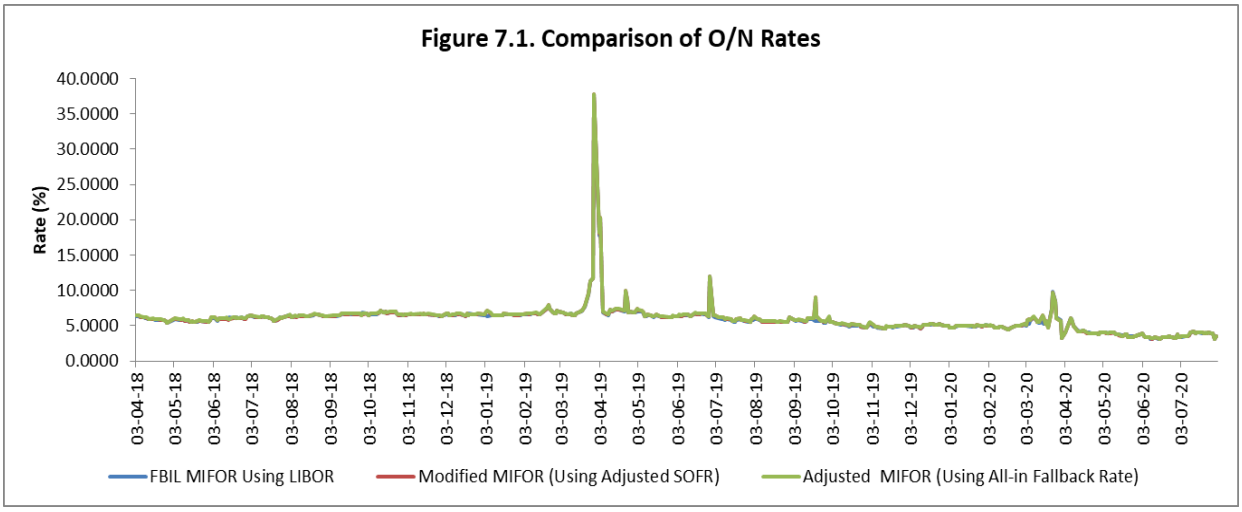
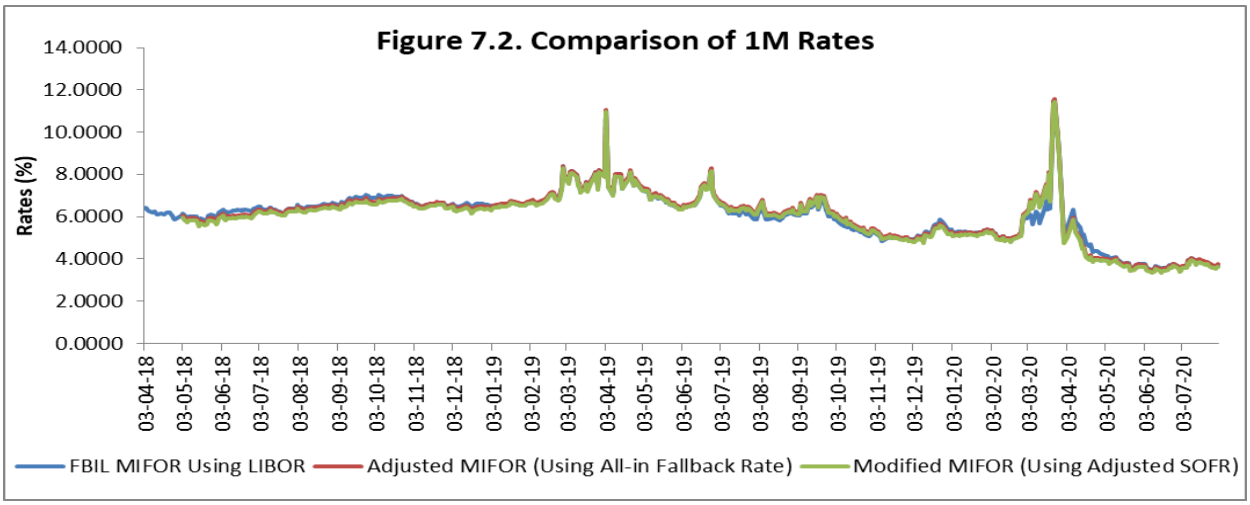
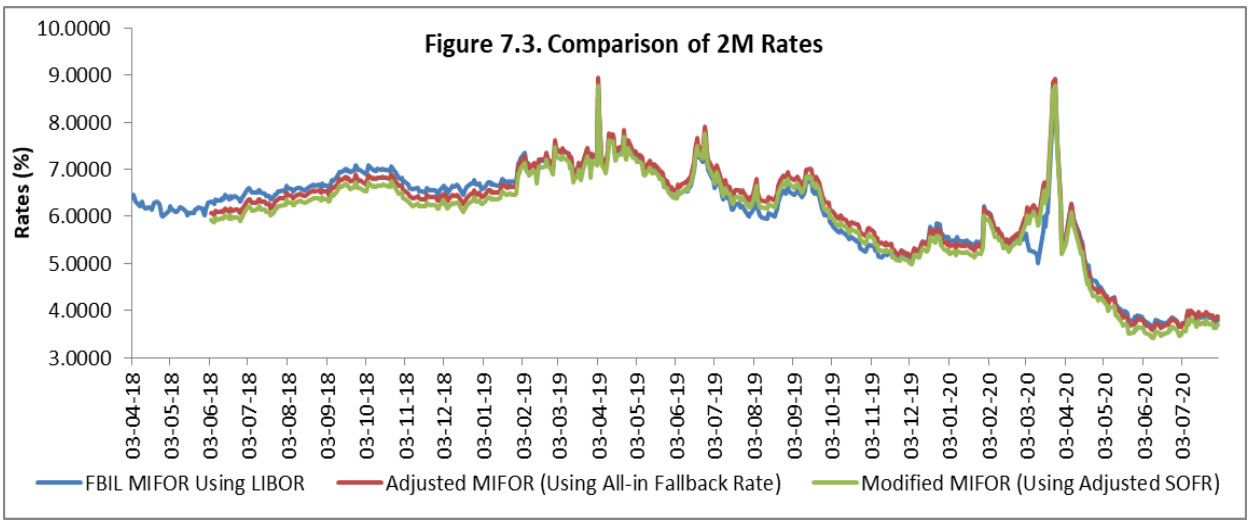


Figure 6.6. Comparison of 12M Rates
Rate (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

Mapping Accrual End Date of the Fallback Rate to the Trade Date of the FBIL Forward Premia Rate







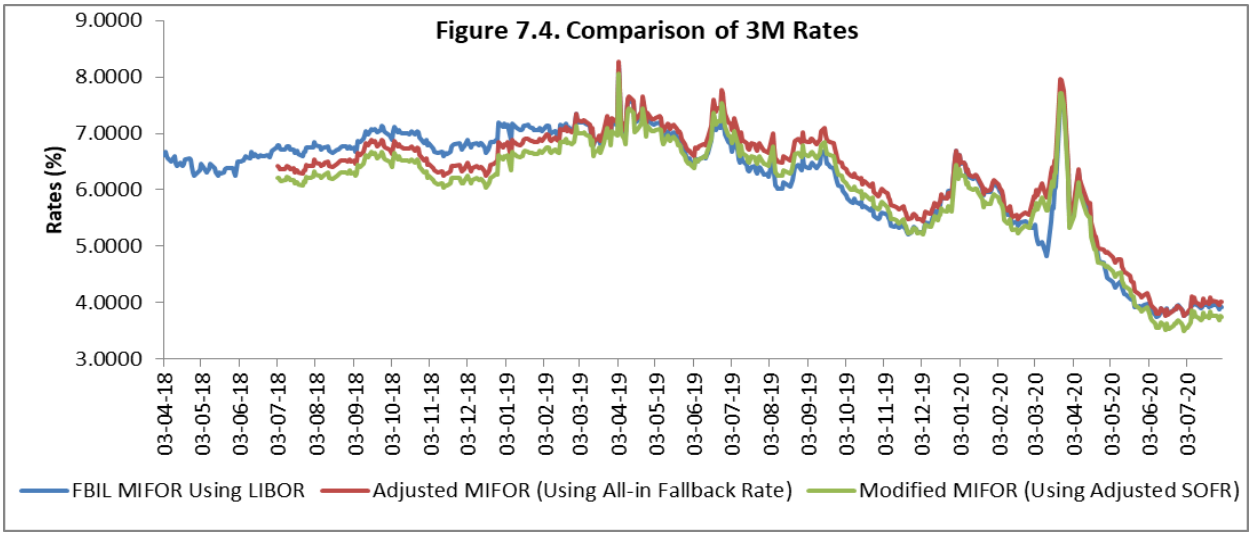


Figure 7.4. Comparison of 3M Rates
Rates (%)
9.0000
8.0000
7.0000
6.0000
5.0000
4.0000
3.0000
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
Adjusted MIFOR (Using All-in Fallback Rate)
Modified MIFOR (Using Adjusted SOFR)

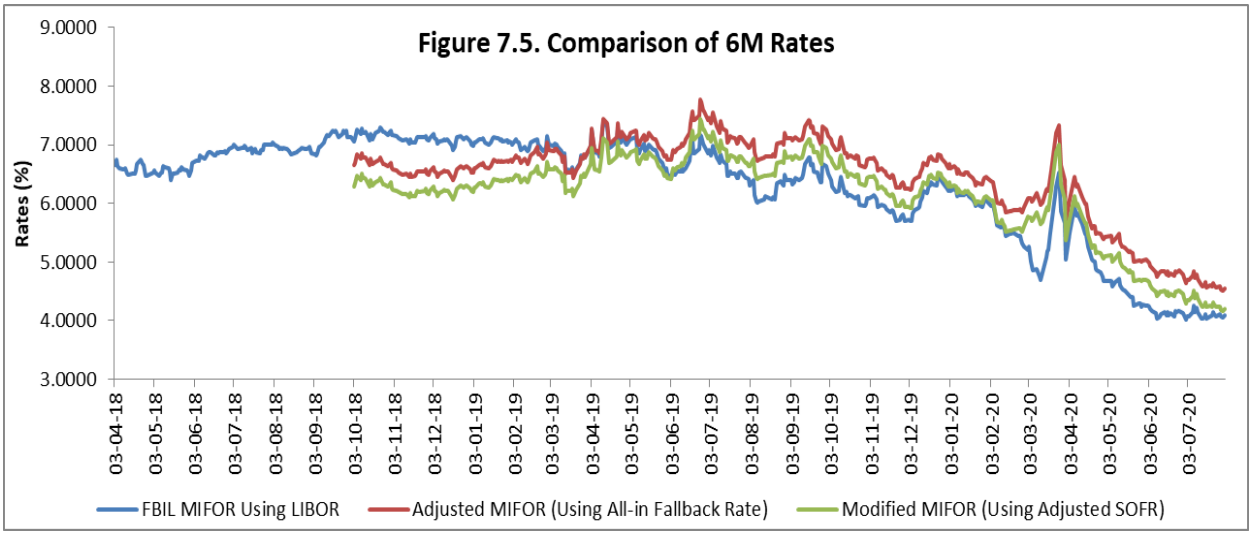


Figure 7.5. Comparison of 6M Rates
Rates (%)
9.0000
8.0000
7.0000
6.0000
5.0000
4.0000
3.0000
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
Adjusted MIFOR (Using All-in Fallback Rate)
Modified MIFOR (Using Adjusted SOFR)

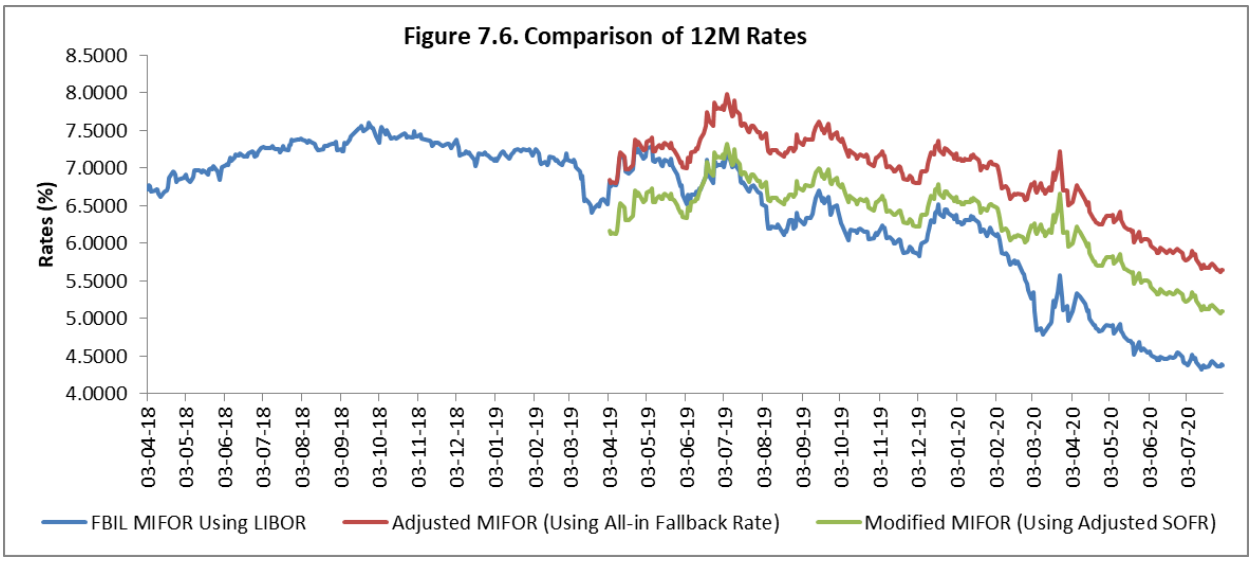
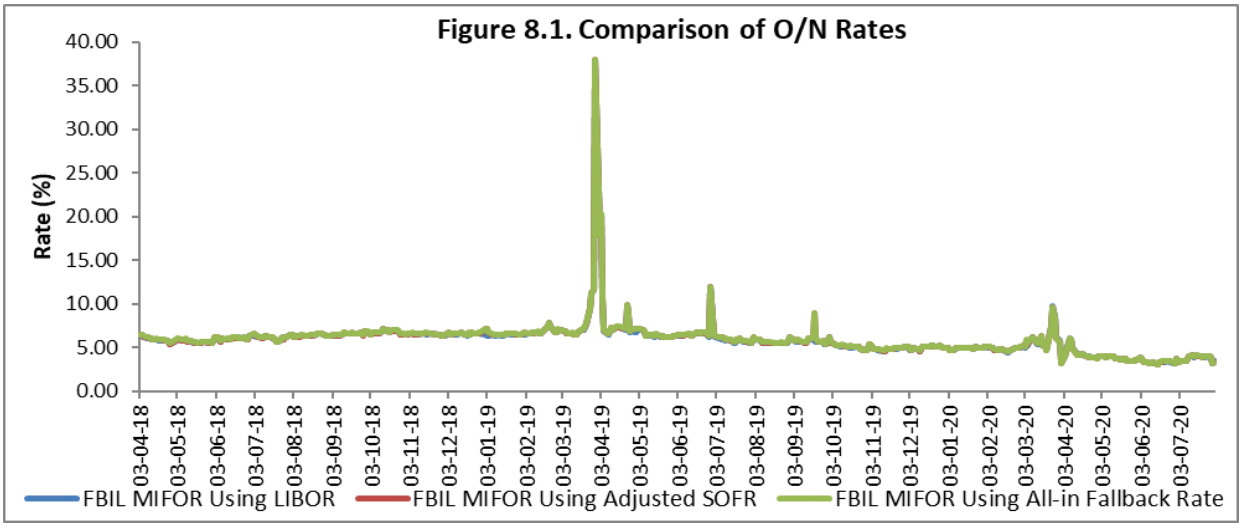
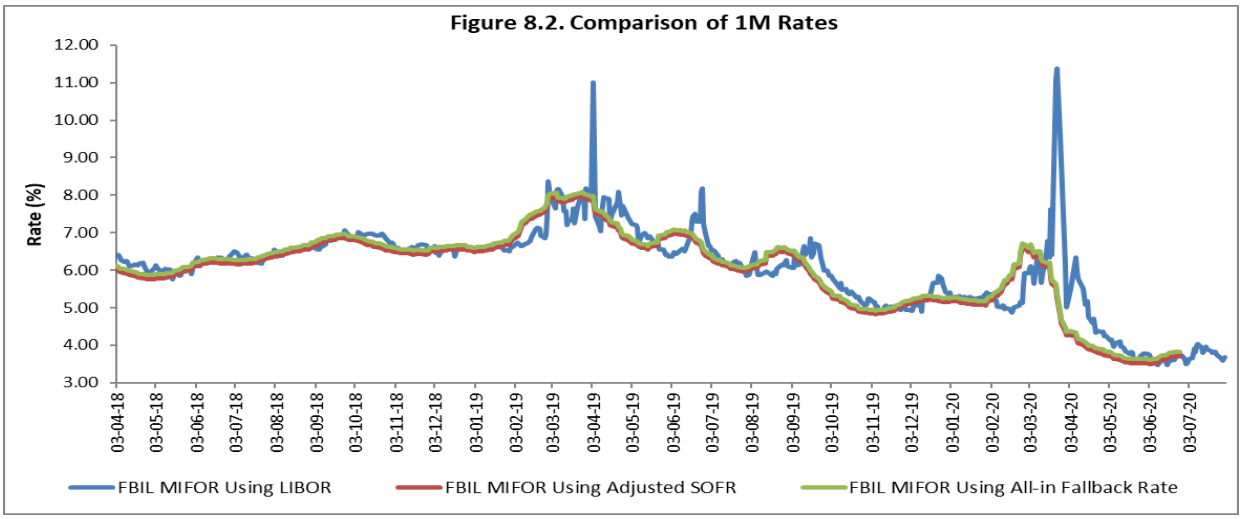
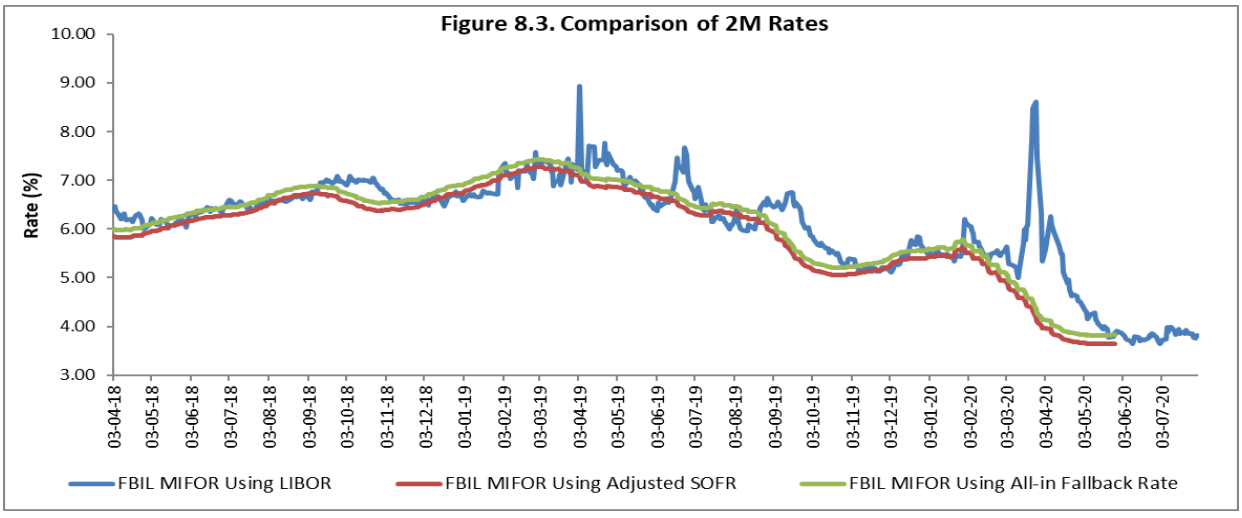


Figure 7.6. Comparison of 12M Rates
Rates (%)
8.5000
8.0000
7.5000
7.0000
6.5000
6.0000
5.5000
5.0000
4.5000
4.0000
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
Adjusted MIFOR (Using All-in Fallback Rate)
Modified MIFOR (Using Adjusted SOFR)

Mapping the Rate Record Date to the Average FBIL Forward Premia Rate







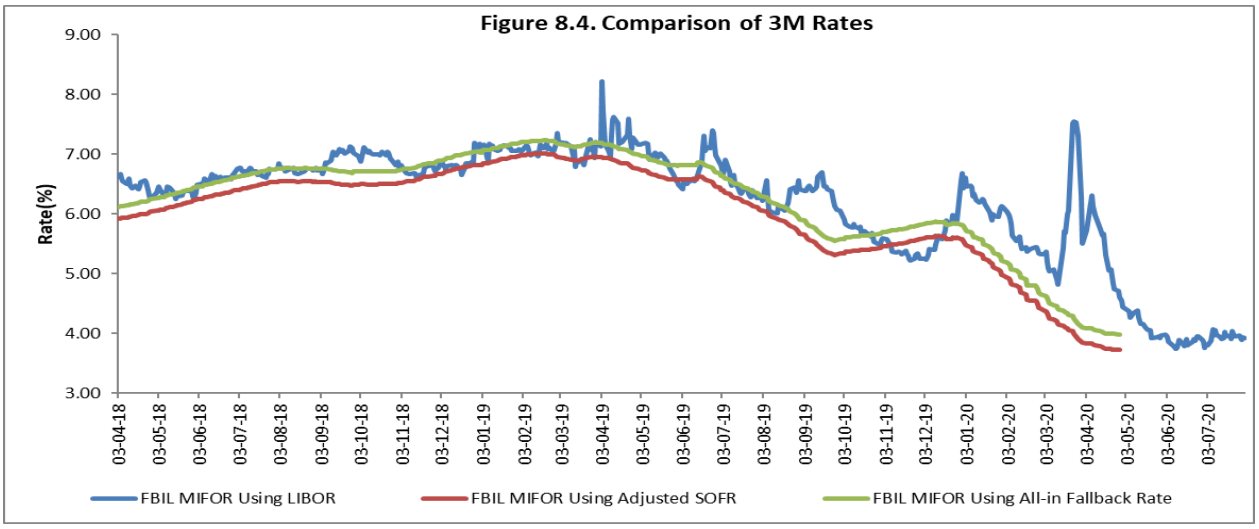


Figure 8.4. Comparison of 3M Rates
Rate(%)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

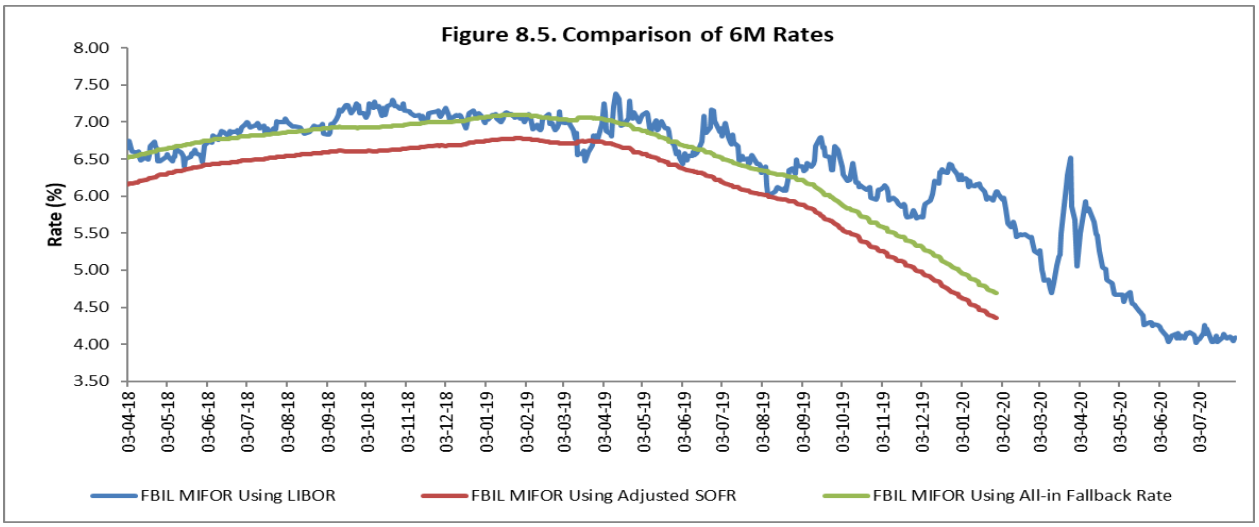


Figure 8.5. Comparison of 6M Rates
Rate (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

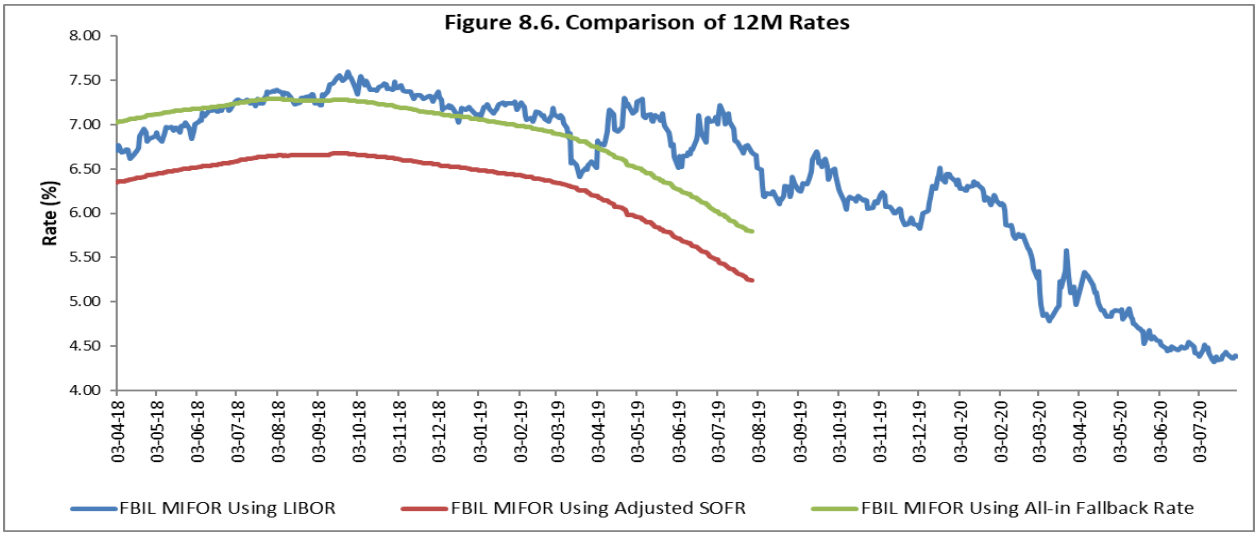


Figure 8.6. Comparison of 12M Rates
Rate (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
03-02-20
03-03-20
03-04-20
03-05-20
03-06-20
03-07-20
FBIL MIFOR Using LIBOR
FBIL MIFOR Using Adjusted SOFR
FBIL MIFOR Using All-in Fallback Rate

Figure 9: Comparison of 6-Month FBIL MIFOR Using LIBOR and the Adjusted MIFOR (Mapping the Forward Premia Trade Date to the Rate Record Date)

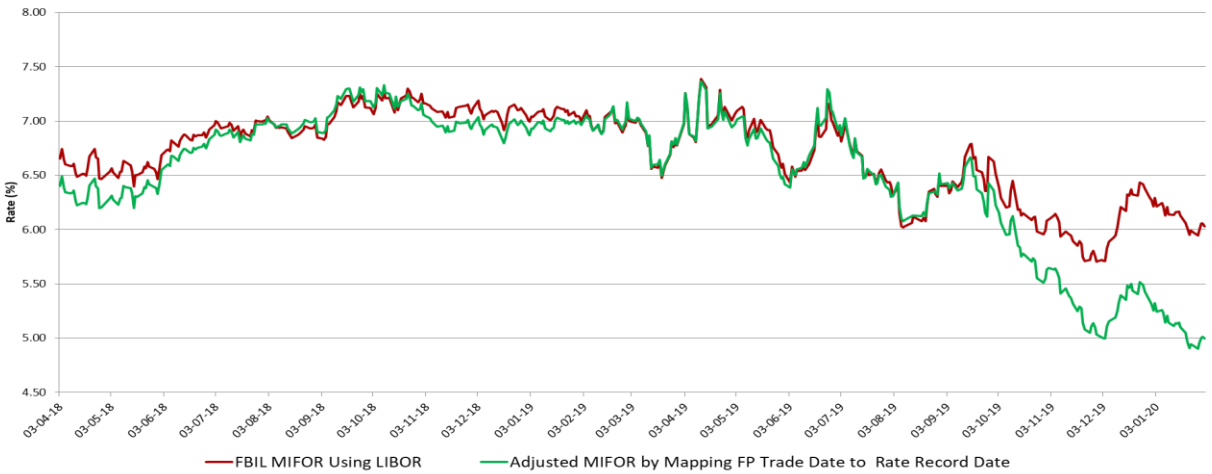


Figure 10: Comparison of FBIL MIFOR with Adjusted MIFOR and Modified MIFOR (Mapping Forward Premia Trade Date to Accrual End Date)

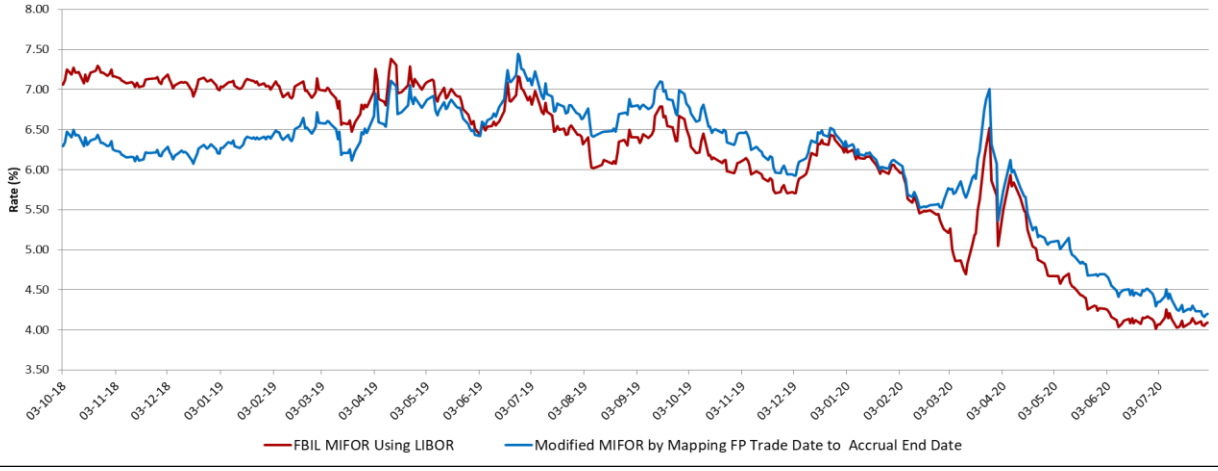


Figure 11: Comparison of Monthly Average Rate of LIBOR with Adjusted SOFR

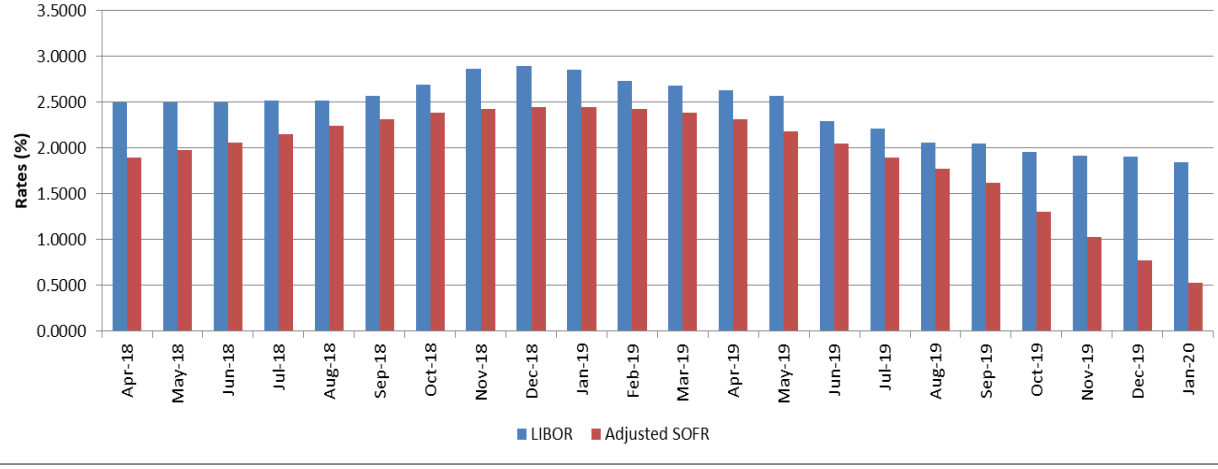


Figure 12: Comparison of the Spread Adjustment Value with the Spread of LIBOR over Adjusted SOFR

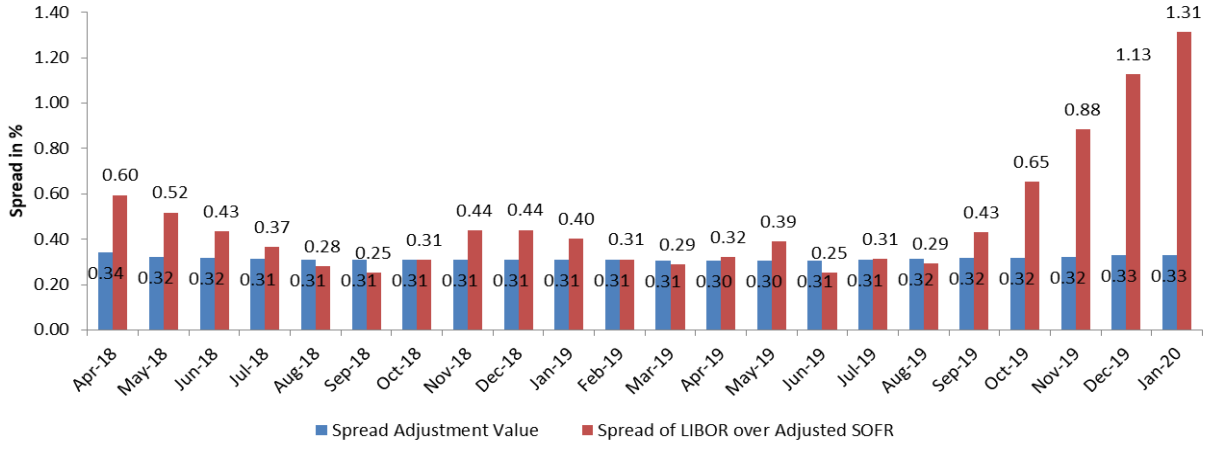


Figure 13: Comparison of LIBOR with the Fallback Rates (M1) with Sub-Components

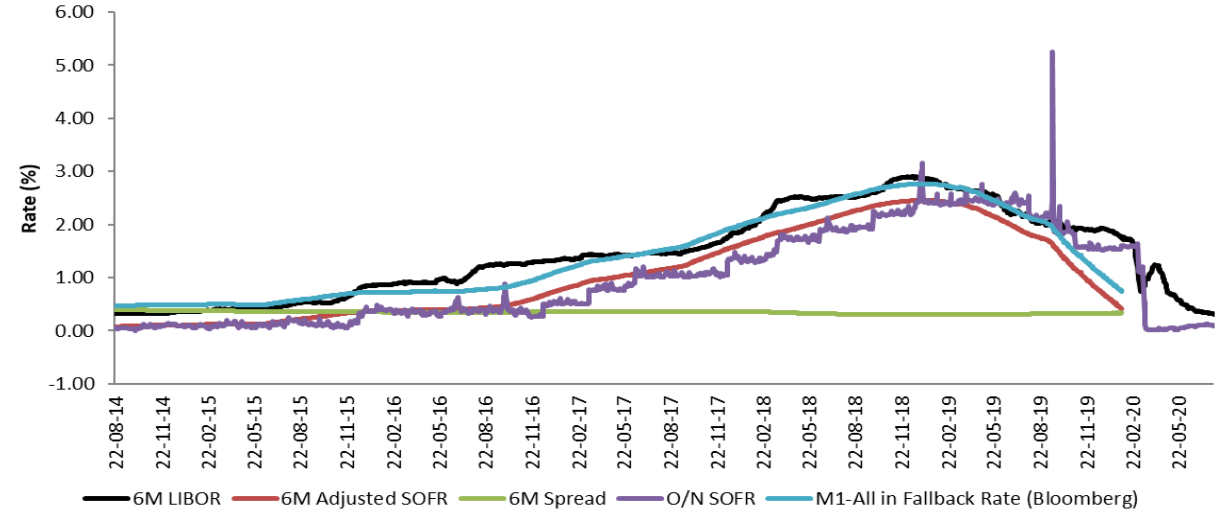
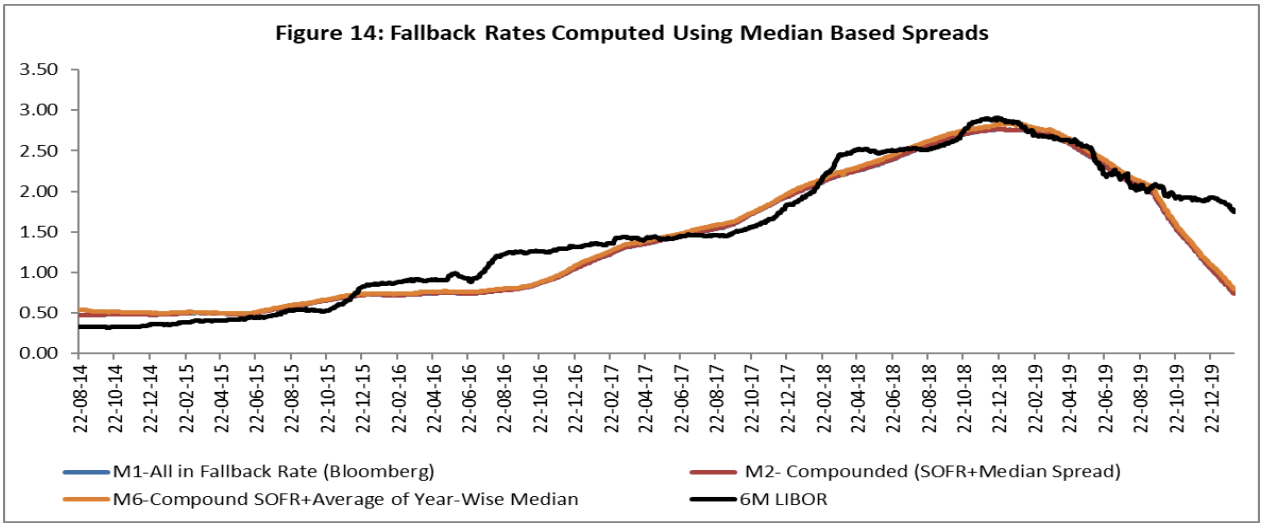


Figure 14: Fallback Rates Computed Using Median Based Spreads



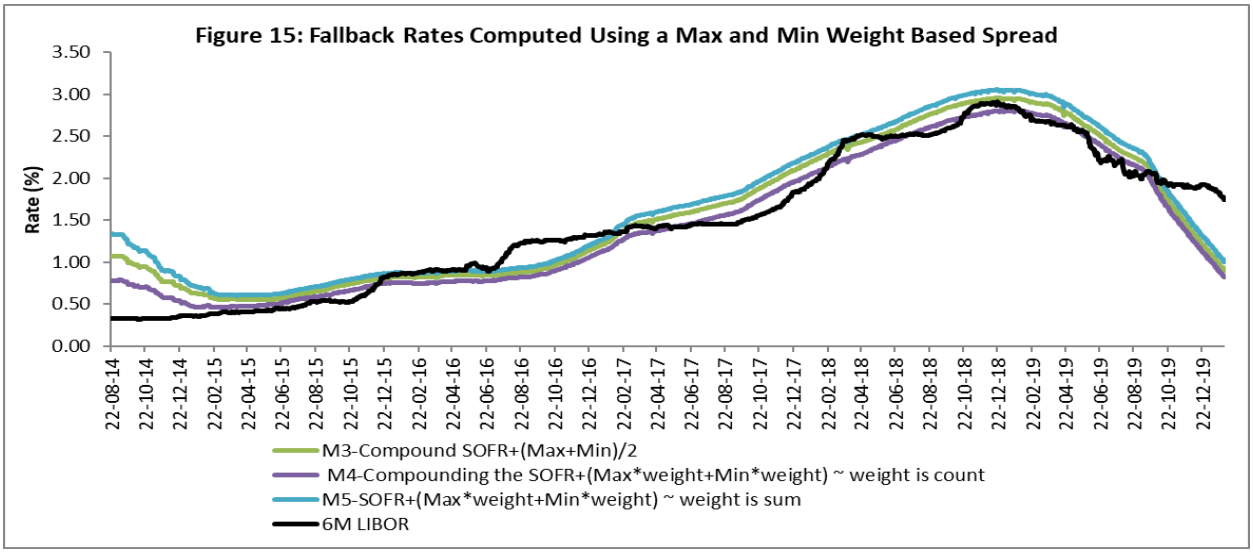


Figure 15: Fallback Rates Computed Using a Max and Min Weight Based Spread
Rate (%)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
22-08-14
22-10-14
22-12-14
22-02-15
22-04-15
22-06-15
22-08-15
22-10-15
22-12-15
22-02-16
22-04-16
22-06-16
22-08-16
22-10-16
22-12-16
22-02-17
22-04-17
22-06-17
22-08-17
22-10-17
22-12-17
22-02-18
22-04-18
22-06-18
22-08-18
22-10-18
22-12-18
22-02-19
22-04-19
22-06-19
22-08-19
22-10-19
22-12-19
M3-Compound SOFR+(Max+Min)/2
M4-Compounding the SOFR+(Max*weight+Min*weight) ~ weight is count
M5-SOFR+(Max*weight+Min*weight) ~ weight is sum
6M LIBOR

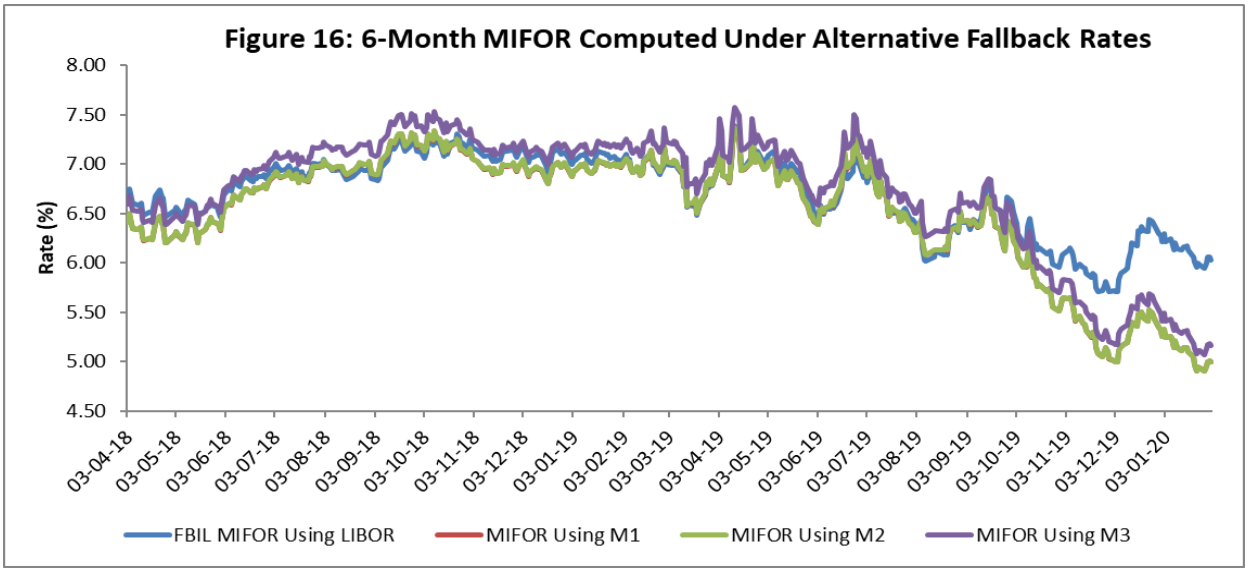


Figure 16: 6-Month MIFOR Computed Under Alternative Fallback Rates
Rate (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
FBIL MIFOR Using LIBOR
MIFOR Using M1
MIFOR Using M2
MIFOR Using M3

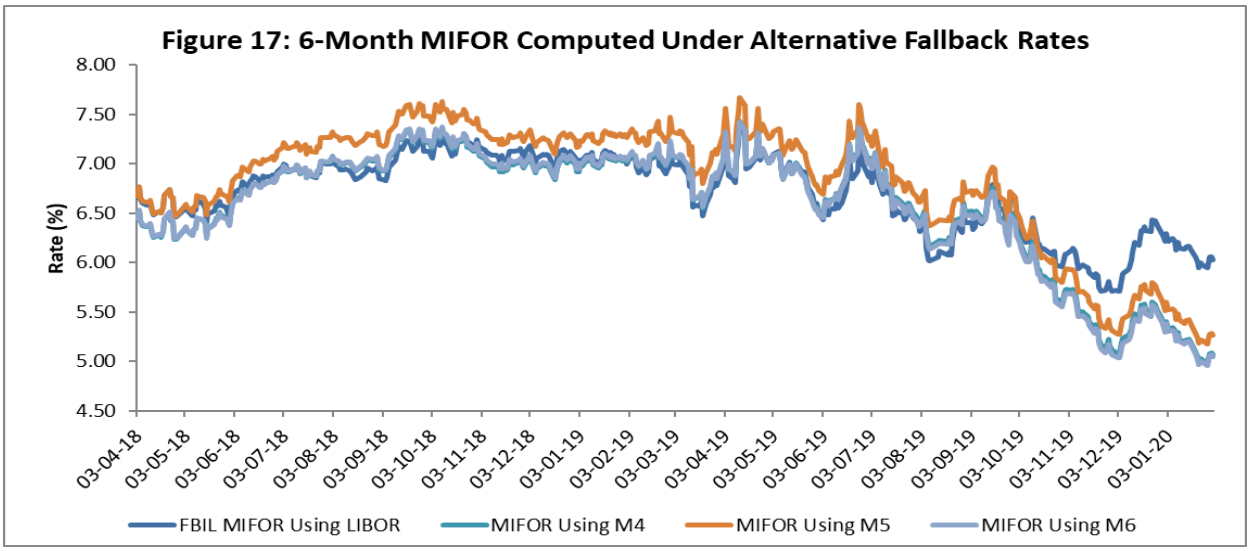


Figure 17: 6-Month MIFOR Computed Under Alternative Fallback Rates
Rate (%)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
03-04-18
03-05-18
03-06-18
03-07-18
03-08-18
03-09-18
03-10-18
03-11-18
03-12-18
03-01-19
03-02-19
03-03-19
03-04-19
03-05-19
03-06-19
03-07-19
03-08-19
03-09-19
03-10-19
03-11-19
03-12-19
03-01-20
FBIL MIFOR Using LIBOR
MIFOR Using M4
MIFOR Using M5
MIFOR Using M6