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Designing An Unbiased Reference Rate

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ABSTRACT

In India since 2015, the Financial Benchmarks India Limited (FBIL) has been the Benchmark Administrator for the benchmarks in the Money, G-Sec, Forex and Derivatives market. These benchmarks are largely based on traded data and in the absence of a deep market like in the case of the Tem Money and FX-Options benchmarks, they are polled from market participants. In the Forex market, the RBI has been disseminating the INR-USD reference rate using the spot trades executed on the Reuters and FX-CLEAR platforms in a random time sequence of 15 minutes between 11.30 am and 12.30 pm. The volume weighted average rate so calculated is used as the Reference Rate for valuation purposes. Though there are adequate number of trades in this time window (14% of total trading), there is a need to efficiently handle the challenges of randomization.

The proposed methodology for the Reference Rate calculation suggests the time interval for consideration should be 15 minutes anytime between 11.30 am and 12.15 pm. The time repetition should not be in any sequence. Using the FX-CLEAR trade data from 01/01/2013 to 08/01/2018 between 11.30 am -12.30 pm, random time slots of 15 minutes were created and multiple simulations were run daily to compute the volume weighted average rate. This methodology takes care of randomization challenges as there were negligible instances of repletion of a time-slot, considering the sample period of 1210 days. The final volume weighted average rate for the day was calculated using the rates executed during that time-slot, after removing the outliers. In addition to this, the weighted average rate after removal of two extreme trades and the Median rate were also calculated. The rates calculated using these methods for 4 simulations were found to be statistically similar to the RBI reference rate. However, the simple average of 4 simulated rates has the lowest RMSE (RBI Reference Rate as the model)

JEL Classification: **E5**, G17, G150, G170, C63

Keywords: Central Bank, Simulation, Reference Rate, Efficiency

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1. INTRODUCTION

Reference Rates are benchmarks for the market – be it an interest rate, exchange rate, commodity price, etc. The market uses the same for valuation of the holdings on its balance sheet to find out the true value of the book. Any incorrect reference rate used for valuation of assets or liabilities can have serious impact on the balance sheet of an entity. Further, a reference rate is a point of commonality as both sides of the market use the same rate for valuation. If the rate is accepted as a benchmark rate, the same has legal status in terms of settlement prices. For example, documents like ISDA use the mention of the benchmark rate to be used for settlement of trades, specifically in OTC markets.

Globally, computation of benchmark rates has gone through many stages. LIBOR, the global benchmark for lending and borrowing, positions valuation, derivatives pricing, etc. has gone through significant changes in recent times after it was established that entities manipulated the computation process to move the rate in their favour. Banks have paid significant amount of fines to regulators in various out-of-court settlements. There is a move to globally replace LIBOR with alternative rates like Repo Rate which can be used as benchmark rate. There is a move towards establishing benchmarks from traded information. By executing a trade, the user internalizes the rate in its books and hence such rate is more market driven that a rate established using polling. Companies like Thomson Reuters are globally discontinuing benchmark calculation and dissemination. In many jurisdictions, central banks and governments have established separate benchmark administrators to administer benchmarks. This aids in increasing the confidence of users in benchmarks. Benchmark administrators prefer to calculate the benchmarks using transparent and simple methodology from the trades executed in the market. Erstwhile Benchmark calculating and disseminating agencies have given cessation notice to the market indicating their intention of not publishing benchmarks as the responsibility on them is huge. However, market needs a smooth transition so that trades are not affected because of change in benchmark regimes.

2. BENCHMARK CALCULATION IN INDIA

In markets like India, most of the trades in financial markets happen through electronic means. Even OTC trades are pushed through electronic chat based systems so that proper audit trail is maintained. This makes benchmark calculation process simple, accurate and transparent. Benchmark administrators have appointed Benchmark Calculation Agent with execution of Service Level Agreements to calculate the benchmark rates on the basis of approved methodology. The methodology documents are debated and approved by the regulators before the benchmark is computed and disseminated. Financial Benchmarks India Ltd. (FBIL) has been created in India with participation of FIMMDA, FEDAI and IBA as the Benchmark Administrator. FBIL has slowly taken over calculation and dissemination of

some of the benchmarks and created few new benchmarks. In 2015, it started with the overnight MIBOR (Mumbai Interbank Overnight Rate) and currently it disseminates Term MIBOR, Option Volatility Matrix, TB and CD curves and Market Repo (MROR). It is also in the process of disseminating few more widely sued benchmarks like Forwards, OIS, MIFOR, etc. This dissemination has become imperative as Thomson Reuters has intimated cessation of the benchmarks it was publishing all these years.

3. BENCHMARKS AND BENCHMARK ADMINISTRATION PROCESS

Benchmark administration process is a very critical task. The oversight committee of the benchmark administrator typically debates and recommends methodologies to be used for establishing a benchmark. The market feedback is extremely important for any benchmark to be successful. Hence, a consultative process is initiated before finalizing the methodology. A benchmark can not only be used for valuation; it can be traded as a derivative product. Hence, the methodology must be backed by quality research using historical data. Finally, the methodology needs to be vetted by the regulator. Benchmark administrator must set up elaborate systems for computation validation and dissemination. Benchmark publication is a costly affair as it requires investment in software, hardware, network, etc. and the administrator must have a revenue model to remain relevant. Globally, administrators charge fees for use of the benchmarks. This income helps them to remain independent.

In India, FBIL has been working on many benchmarks on a continuous basis. Most of the benchmarks used in the market is calculated out of trades. Since trades are either executed in electronic platforms or executed over phone, administrator has decided to use primarily the electronic system based transactions. For example, MIBOR is computed using NDS-Call platform which facilitate execution of overnight borrowing and lending by Banks and primary dealers. Earlier, MIBOR used to be computed as an offer rate but today the same is computed as a mid-rate. Since MIBOR is used for trading swaps, the rate is published in the morning and hence benchmark is calculated using first hour of trading in the NDS-Call execution system. The Term MIBOR is a polled based system as the Term market in India is not developed. Hence, the benchmark administrator has identified participants who will provide quotes for various terms – 14D, 1M and 3M. Option Volatility Matrix is a poll based benchmark and has been widely used. Traders provide “At The Money” (ATM) volatility numbers along with Risk Reversal and Straddle of 25 Delta. This is polled at close of the market hours and used for valuation of the contracts. However, all FC-Rupee options contracts are reported to Trade Repository. Hence, implied volatilities may be computed from such reported trades to compare with the polled numbers. Treasury Bills curve is computed using all trades reported and executed in NDS-OM platform. Since Treasury Bills are traded through order books, the executable orders with a spread of 10bps is also

accepted as a fall back option in case enough trades are not available. Certificate of Deposits curve is calculated using trades reported to F-TRAC reporting platform. These curves are computed after market close. Market Repo Rate (MROR) is computed from the trades executed during first hour of trading in Repo dealing platform CROMS.

4. CHALLENGES IN BENCHMARK COMPUTATION

The major challenge in benchmark computation is participation in polling. Large banks and institutions have shown their reluctance to participate in polls as regulatory compliance is costly. Hence there is increasing dependence on traded data for benchmark computation. However, in many segments trades are drying up or are very few to compute the benchmark. If the liquidity dries up in a segment, the benchmark computed out of the said segment may be costly to trade. Waterfall mechanism is built into the system so that benchmarks can be calculated and disseminated on daily basis in time. If large number of trades happen in a segment, the methodology of computation can be more innovative. There has been debate (specifically in forex market) that trades of a small time zone should be taken for computation rather than taking all trades during the day.

RBI has been disseminating INR-USD reference rate which is widely used in the market for valuation purposes. RBI uses trades executed in the market in a window of 15 minutes during the time period between 11:30AM and 12:30PM. Currently, Forex market spot trades on INR-USD happen in Reuters and FX-CLEAR platforms. RBI collects the trades from these two systems and computes the Reference Rate using a random time sequence of continuous 15 minutes between 11:30AM and 12:30PM. This process works fine as we have large number of trades executed in INR-USD market between 11:30AM and 12:30PM. However, there are many challenges of randomization and this needs to be handled efficiently.

The use of one-hour time window accounts for about 14% of total trading (01/01/2013-08/01/2018) as in Table -1.

Year-wise analysis of data shows that the pattern of trading has remained more or less uniform across various time slots. Simple average and weighted average rates are very close to each other indicating more or less same standard market lot is used by traders. Volatility of Rates (Table – 2A and 2B) also remained more or less the same during a particular year irrespective of the time bucket. The year 2013 was highly volatile while 2016 was least volatile year.

5. METHODOLOGY OF REFERENCE RATE COMPUTATION

Currently Reference Rate released by RBI is computed using a random 15 minutes' widow within a pre-fixed umbrella window of 11:30AM – 12:30PM as the market is believed to be

most active during this part of the day. The base data used for computation of Reference Rate are the inter-bank USD-INR trades executed in the market through FX-CLEAR terminal of CCIL and Thomson – Reuters terminal. A volume weighted average rate is calculated for the 15 minutes' window that becomes the Reference Rate. The said Reference rate is used for valuation purposes. Currently no outlier criteria are used while computing the Reference Rate.

6. RANDOMIZATION OF TIME

An efficient computation process using randomization may follow the below mentioned path:

The difference between start time and end time should be 15 minutes and it may start anytime between 11:30:00AM and 12:15:00PM. Any start time after 12:15:00PM will not have required 15 minutes of data. The random process should be such that the time repetition should not be in any sequence. Multiple time slots of 15 minutes should be used for efficient rate computation. We used trades data from FX-CLEAR platform from 01/01/2013 to 08/01/2018 between 11:30:00AM and 12:30:00PM and created random time slots of 15 minutes each on daily basis. We ran multiple simulations on daily basis and computed the volume weighted average rate of the trades executed in FX-CLEAR system. Out of 1210 days of data, we found that 233 time slots have been repeated during the 5 years. There are only 4 instances in which the time slots were repeated within 9 days. Average time of repeat of a time slot is about 571 days. The time slot repeated 3 times only on a few occasion Table - 3.

Once the time slot is established, the computation system pulls out the inter-bank trades executed during that time zone slot and identifies the outlier, if any, using given outlier detection rules and computes the simple volume weighted average rate.

7. RATE EFFICIENCY

We ran many simulations to extract the rates for various 15-minutes time slots between 11:30AM and 12:30PM for the period from 01/01/2013 to 08/01/2018 to find out how these rates are compared to the daily weighted average rate of the market. The weighted average rate[3] is calculated by taking all reported deals till day end which goes for final settlement. The rates calculated out of simulation process (4 simulations given below, Table -4) were found to be statistically same when compared to RBI reference rate. We have calculated (1) weighted average rate taking all trades during the random time period, (2) weighted average rate after removing two extreme trades (in terms of price) from both sides and (3) the Median Rate.

[3] The calculation of WAR is elaborated in CCIL Daily Spot Rate Technical Document.

All methods produced more or less similar results (Table – 5A, 5B and 5C). Hence, trading system like FX-CLEAR provide important information on trade and rates may not vary from other trading systems as participants will always arbitrage between systems irrespective of liquidity. Relative lower liquidity in FX-CLEAR system has not affected rate efficiency.

However, we created another rate by taking simple average of 4 simulated rates and compared their RMSE (taking RBI Reference Rate as the model) to find out if this average rate is better than a single simulation. The results show that average rate has lowest RMSE (Table -6).

8. CONCLUSION

In Indian market, benchmark calculation is simplified because of existence of electronic platforms. For a market like Forex, reference rates may be calculated using the present randomization of time as the market trades in an almost uniform manner across the time slots during the day.

Table 1: Market Share of Trading		
Time Bucket	**Trade Quantity (USD)**	**Market Share**
09:00 - 09:30	96292500000	8%
09:30 - 10:00	81299500000	7%
10:00 - 10:30	75389500000	6%
10:30 - 11:00	79091500000	6%
11:00 - 11:30	84171000000	7%
11:30 - 12:00	87125000000	7%
12:00 - 12:30	86049000000	7%
12:30 - 13:00	77501000000	6%
13:00 - 13:30	67954000000	5%
13:30 - 14:00	70442500000	6%
14:00 - 14:30	69726000000	6%
14:30 - 15:00	74658000000	6%
15:00 - 15:30	76203000000	6%
15:30 - 16:00	76246000000	6%
16:00 - 16:30	73837500000	6%
16:30 - 17:00	63858500000	5%
Total	1240000000000	100%

Table 2A – Rate and Volatility Comparison across years									
	2013			2014			2015		
Time Bucket	WAR	SAR	STD	WAR	SAR	STD	WAR	SAR	STD
09:00 - 09:30	58.9122	58.9317	3.9627	61.1472	61.1399	1.1106	64.2297	64.2375	1.6080
09:30 - 10:00	58.8148	58.8330	3.9317	61.0787	61.0796	1.0880	64.2366	64.2549	1.6200
10:00 - 10:30	58.8165	58.8427	3.9704	61.1184	61.1262	1.1140	64.2012	64.2264	1.6274
10:30 - 11:00	58.8442	58.8677	3.9451	61.0990	61.1114	1.0998	64.2043	64.2281	1.6067
11:00 - 11:30	58.6595	58.6719	3.9589	61.1168	61.1264	1.1047	64.1377	64.1676	1.6015
11:30 - 12:00	58.7929	58.8045	3.9089	61.1011	61.1131	1.0951	64.1621	64.1978	1.6005
12:00 - 12:30	58.7638	58.7755	3.9502	61.0502	61.0467	1.0715	64.1723	64.1842	1.5877
12:30 - 13:00	58.7792	58.7983	3.9378	61.0870	61.0772	1.0784	64.2183	64.2372	1.5944
13:00 - 13:30	58.7582	58.7745	3.9580	61.0948	61.1168	1.1263	64.2136	64.2248	1.5745
13:30 - 14:00	58.5723	58.5821	3.9436	61.1046	61.0959	1.1299	64.2807	64.2755	1.5924
14:00 - 14:30	58.7608	58.7644	3.9019	61.0811	61.0963	1.0932	64.2499	64.2590	1.6120
14:30 - 15:00	58.7889	58.7925	3.9513	61.0593	61.0799	1.0924	64.1793	64.1934	1.6029
15:00 - 15:30	58.8591	58.8693	3.9424	61.0448	61.0556	1.0929	64.1861	64.1856	1.6009
15:30 - 16:00	59.1100	59.1108	3.9175	61.0822	61.0847	1.0803	64.2023	64.2035	1.5910
16:00 - 16:30	59.0595	59.0695	3.9231	61.0734	61.0829	1.1053	64.2126	64.2034	1.6106
16:30 - 17:00	59.3211	59.3157	3.9081	61.0537	61.0632	1.1278	64.1970	64.1970	1.6335

Table 2B – Rate and Volatility Comparison across years						
	2016			2017		
Time Bucket	WAR	SAR	STD	WAR	SAR	STD
09:00 - 09:30	67.2401	67.2388	0.6428	65.2606	65.2752	1.3318
09:30 - 10:00	67.2361	67.2356	0.6491	65.2516	65.2841	1.3234
10:00 - 10:30	67.2499	67.2494	0.6419	65.1673	65.2240	1.3204
10:30 - 11:00	67.2393	67.2425	0.6401	65.1663	65.2333	1.3153
11:00 - 11:30	67.2374	67.2448	0.6449	65.1356	65.1981	1.2819
11:30 - 12:00	67.2408	67.2423	0.6329	65.1157	65.1829	1.2762
12:00 - 12:30	67.2362	67.2358	0.6374	65.1237	65.1888	1.2852
12:30 - 13:00	67.2363	67.2323	0.6439	65.1486	65.2122	1.2965
13:00 - 13:30	67.2476	67.2474	0.6394	65.1830	65.2455	1.3185
13:30 - 14:00	67.2401	67.2381	0.6275	65.2236	65.2824	1.3446
14:00 - 14:30	67.2591	67.2596	0.6346	65.1997	65.2778	1.3316
14:30 - 15:00	67.2442	67.2473	0.6417	65.1633	65.2412	1.3400
15:00 - 15:30	67.2508	67.2503	0.6291	65.1969	65.2699	1.3320
15:30 - 16:00	67.2305	67.2328	0.6203	65.1488	65.2242	1.3122
16:00 - 16:30	67.2204	67.2227	0.6277	65.1452	65.2145	1.3134
16:30 - 17:00	67.2200	67.2227	0.6332	65.1742	65.2226	1.3100

Table 3: Randomization of Time					
Date	Start Time	End Time	Start Time	Logical Key[4]	Days
4/28/2017	11:30:00	11:45:00 AM	11:30:00 AM		
2/25/2013	11:30:03	11:45:03 AM	11:30:03 AM		
5/19/2017	11:30:04	11:45:04 AM	11:30:04 AM		
2/17/2016	11:30:07	11:45:07 AM	11:30:07 AM		
3/9/2015	11:30:14	11:45:14 AM	11:30:14 AM		
9/1/2015	11:30:14	11:45:14 AM	11:30:14 AM	1	176
6/17/2016	11:30:16	11:45:16 AM	11:30:16 AM		
12/11/2014	11:30:20	11:45:20 AM	11:30:20 AM		
8/12/2015	11:30:20	11:45:20 AM	11:30:20 AM	1	244
11/23/2016	11:30:20	11:45:20 AM	11:30:20 AM	1	469
4/12/2016	11:30:21	11:45:21 AM	11:30:21 AM		
12/9/2013	11:30:22	11:45:22 AM	11:30:22 AM		
2/3/2016	11:30:22	11:45:22 AM	11:30:22 AM	1	786

Table 4 : Simulated Rates												
	Simulation 1			Simulation 2			Simulation 3			Simulation 4		
Date	Trades	Value ($ Mn)	Spot Rate	Trades	Value ($ Mn)	Spot Rate	Trades	Value ($ Mn)	Spot Rate	Trades	Value ($ Mn)	Spot Rate
1/1/2013	23	12	54.8123	22	11.5	54.8310	18	9	54.8365	27	13.5	54.8022
1/2/2013	30	16	54.4112	47	24.5	54.3933	34	18	54.4032	35	18	54.3860
1/3/2013	36	18	54.4409	36	18	54.3987	31	15.5	54.4175	34	17	54.4167
1/4/2013	34	17	54.8520	35	17.5	54.8519	44	22	54.8423	39	19.5	54.8499
1/7/2013	42	21	54.9751	35	18	54.9806	38	19.5	55.0092	32	16	54.9735
1/8/2013	41	21.5	55.3460	36	19	55.3438	37	19	55.3418	33	16.5	55.2964
1/9/2013	37	18.5	54.9634	26	13	54.9346	25	12.5	54.9291	27	13.5	54.9394

[4] When the time slot gets a Repeat

Table 5A :Descriptive Statistics (Weighted Average Rate)						
	SIM1	**SIM2**	**SIM3**	**SIM4**	**RBI**	**WAR**
Mean	63.2260	63.2254	63.2261	63.2267	63.2269	63.2240
STDEV	3.6840	3.6852	3.6864	3.6869	3.6843	3.6841
Table 5B :Descriptive Statistics (Weighted Average Rate – Bootstrapping)						
	SIM1	**SIM2**	**SIM3**	**SIM4**	**RBI**	**WAR**
Mean	63.2429	63.2341	63.2270	63.2287	63.2269	63.2240
STDEV	3.6715	3.6785	3.6878	3.6897	3.6843	3.6841
Table 5C :Descriptive Statistics (Median)						
	SIM1	**SIM2**	**SIM3**	**SIM4**	**RBI**	**WAR**
Mean	63.2257	63.2251	63.2258	63.2264	63.2269	63.2240
STDEV	3.6840	3.6853	3.6866	3.6872	3.6843	3.6841

Table 6 : RMSE of Simulated Rates					
	SIM1	**SIM2**	**SIM3**	**SIM4**	**AVG**
RMSE	0.0230	0.0230	0.0223	0.0223	0.0182