

LIBOR fallback

A quantitative perspective

Singapore Management University – 8 April 2019

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LIBOR fallback

- 1 A brief introduction to LIBOR and benchmarks
- 2 New benchmarks
- 3 IBOR Fallback: consultation and expectations
- 4 Risk management
- 5 Conclusions

A Quant Perspective on IBOR Fallback Consultation Results –
version 2.1

<https://ssrn.com/abstract=3308766>

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What is LIBOR?

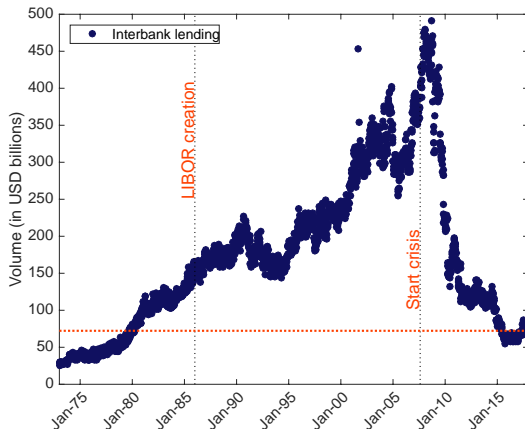
Originally developed by the British Banker Association (BBA) and officially launch in 1986. Administration of the benchmark transferred to ICE Benchmark Administration (IBA).

The methodology is based to a trim average of the answer by the panel banks to the question *“At what rate could you borrow funds, were you to do so by asking for and then accepting interbank offers in a reasonable market size just prior to 11 am?”*

The LIBOR benchmarks *is produced for five currencies (CHF, EUR, GBP, JPY and USD) and seven tenors based on submissions from a reference panel of between 11 and 16 banks for each currency.*

Other similar benchmarks are: EURIBOR (EUR), TIBOR (YEN), CIBOR (DKK), STIBOR (SEK), BBSW (AUD), CDOR (CAD), SOR (SGD)

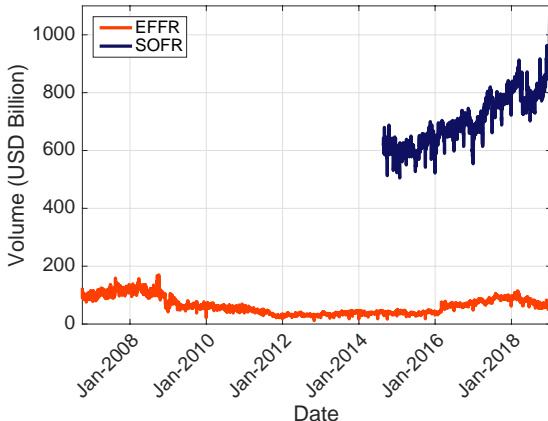
LIBOR – decrease of importance



Source: US Federal Reserve – All Commercial Banks in the United States – Interbank loans

LIBOR is essentially measuring the rate at which banks are **not** borrowing from each other.

Unsecured versus secured lending



Effective Federal Fund Rate (unsecured) and Secured Overnight Financing Rate. Data from the Federal Reserve Bank of New York.

Derivative markets size - CCPs

CCP outstanding amounts (April 2019):

- LCH – USD 353.3 trn – <https://www.lch.com/index.php/services/swapclear/volumes>
- CME – USD 16.5 trn – <https://www.cmegroup.com/education/cme-volume-oi-records.html>
- EUREX – EUR 13.0 trn – <http://www.eurexclearing.com/clearing-en/markets-services/eurex-otc-clear/interest-rate-swaps/clearing-volume>

BIS statistics: IR derivatives notional outstanding:

USD 415,000,000,000,000

ETD Interest rate trading (2018): 4.55 billion contracts.

Cleared at LCH SwapClear:

2018: USD 1,077,000,000,000,000

2019 (YTD 5 Apr): USD 344,743,270,468,688 (SGD 1,080 bn)

S&P 500 market: USD 23 trillions. / US debt: USD 21.5 trillions.

European Benchmark Regulation

Jul 2014: FSB's paper *Reforming Interest Rate Benchmarks*.

The EU Benchmarks Regulation ((EU) 2016/1011) entered into force on 1 January 2018. Of the most interest here: *Interest rate benchmark* (Article 18) and *Critical benchmark* (Article 20).

Article 29 (1) on the use of benchmarks in the union: “A supervised entity may use a benchmark [or a combination of benchmarks[...]]” For provider providing a benchmark on 30 June 2016, they have to apply before 1 January 2022 (Article 51).

Critical benchmarks are EURIBOR, EONIA, LIBOR, STIBOR. For critical benchmarks: regulators have power to compel administrator to publish the benchmark for up to 24 months (Article 21).

July 2017's speech by Andrew Bailey, the CEO of the FCA, on *The future of LIBOR: Panel bank support to sustain LIBOR until end-2021 will enable a transition that can be planned and executed smoothly*

OIS discounting

Since March 2017, mandatory Variation Margin in most jurisdictions (UMR).

Theorem (Collateral with cash price formula)

In presence of collateral with rate c in currency X for a quote in currency X , the quote in time t of an asset with price V_u^c in time u is

$$V_t^c = N_t^c \mathbb{E}^{\mathbb{X}} \left[(N_u^c)^{-1} V_u^c \mid \mathcal{F}_t \right]$$

for some measure \mathbb{X} (identical for all assets, but potentially currency dependent).

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New benchmarks

There is a push by regulators, e.g. FSB, to move away from IBOR and to RFR.

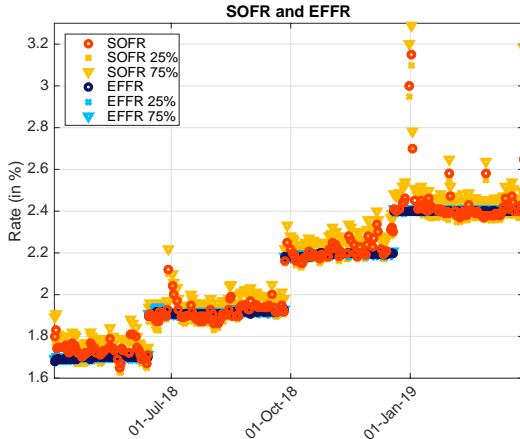
- GBP (SONIA): Published by Bank of England. Unsecured.
- CHF (SARON): Switch from TOIS to SARON end 2017. Secured.
- USD (SOFR): Published by the Fed since April 2018. Secured.
- EUR (ESTER): To be published by ECB from 2 October 2019. Unsecured.
- JPY (TONA)

Note: IBA (the administrator of LIBOR) is planning to launch a *USD Bank Yield Index*. Ameribor?

Ccy/ Current	Alter.	Type	Remarks
AUD / BBSW	RBA Cash	Unsec.	Multiple-rate approach adopted.
CAD / CDOR	Enhanced CORRA	Secured	Multiple-rate approach adopted. Term RFR developed in 2019. Enhanced CORRA in Q1.
JPY / LIBOR	TONA or TI- BOR	Unsec.	Transition is necessary. Term RFR discussed. Public consultation, deliverables by late 2019.
ZAR / JIBAR	Reformed Jibar ZARibor SASFR	Unsec. Unsec. Secured	Reformed Jibar for existing derivative contracts. Multiple-rate approach recommended Treasury bill curve and GC repo market potential for term RFRs. Recently formed MPG will map project plans once benchmark rates have been finalised in Q2 2019.

US – SOFR

The Secured Overnight Financing Rate (SOFR) is a broad measure of the cost of borrowing cash overnight collateralized by Treasury securities.



US – SOFR – clearing

The SOFR benchmark is published since April 2018.

Two CCPs have announced SOFR-based swap clearing.

Nevertheless, they use different collateral/PAI mechanism:

LCH PAI will be paid at EFRR, like for the other products.

CME PAI will be paid at SOFR, the same benchmark used for the floating leg (since Q3 2018).

LCH has cleared the first SOFR-linked swap (basis SOFR-1bp - EFRR) on 18 July 2018.

[https://www.lch.com/resources/news/
lch-clears-first-sofr-swaps](https://www.lch.com/resources/news/lch-clears-first-sofr-swaps)

Note: Simple OIS discounting does not apply to SOFR OIS at LCH.

US – SOFR – Market activity

SOFR-linked OTC derivatives

LCH First cleared swaps (July)

CME First cleared swaps (October)

New RFR futures have been launched recently:

- EFR 1-month: CME
- SOFR 1-month: CME, ICE
- SOFR 3-month: CME, ICE

21 Feb: contracts CME SOFR futures: USD 3.3 trillion notional = USD 51M in PV01

52 SOFR swaps traded in 2018 (USD 6.3 billion notional). More basis (vs EFR) than outright.

Around USD 80 bn SOFR-linked notes issued (72 notes) by March.

US – SOFR – Market activity

Date	Issuer	Notional (USD)	Tenor (Y)
26/07/18	Fannie Mae	6,000,000,000	1.5, 0.5, 1.0
14/08/18	World Bank	1,000,000,000	2.0
20/08/18	Credit Suisse AG/NY	100,000,000	0.5
22/08/18	Barclays	525,000,000	0.25
30/08/18	MetLife	1,000,000,000	2.0
18/09/18	Wells Fargo	1,000,000,000	1.5
20/09/18	Triborough Bridge & Tunnel	107,280,000	13.5
05/10/18	Credit Suisse	1,056,000,000	0.5, 1.0
19/10/18	JP Morgan	800,000,000	2.0
24/10/18	Toyota Motor Credit Corp.	500,000,000	0.25
31/10/18	Fannie Mae	5,000,000,000	0.5, 1.0, 1.5
02/11/18	Credit Suisse AG/NY	500,000,000	1.5
08/11/18	Freddie Mac	1,000,000,000	0.5
09/11/18	Bank of Montreal	600,000,000	0.5
15/11/18	Federal Home Loan Bank	4,000,000,000	0.5, 1.0
19/11/18	Bank of Nova Scotia	1,700,000,000	0.5
28/11/18	European Investment Bank	1,000,000,000	3.0
06/12/18	Federal Home Loan Bank	3,600,000,000	
19/12/18	Freddie Mac	2,000,000,000	
21/12/18	Federal Home Loan Bank	4,000,000,000	
09/01/19	Freddie Mac	552,000,000	
10/01/19	Freddie Mac	1,195,000,000	
11/01/19	Freddie Mac	340,000,000	
Total		37,772,280,000	

US – EFR to SFR transition

ARRC proposed a 6 steps process:

- 1 Infrastructure for futures and/or OIS trading in the new rate is put in place by ARRC members (2018)
- 2 Trading begins in futures and/or bilateral, uncleared, OIS that reference SFR. (CME SFR futures – May 2018)
- 3 Trading begins in cleared OIS that reference SFR in the EFR PAI/discounting (Planned Q1 2019; LCH – Jul 2018)
- 4 CCPs offer choice between EFR PAI/discounting or SFR. (Planned Q1 2020; CME - Oct 2018).
- 5 CCPs no longer accept new contracts for clearing with EFR PAI/discounting except for reducing outstanding risk. Existing contracts using EFR PAI/discounting continue to exist. (Planned Q2 2021 – LCH announced move to SFR PAI/discounting on new and legacy swaps Q2 2020)
- 6 Creation of a term reference rate based on SFR-derivatives; once liquidity has developed to produce a robust rate. (Planned end of 2021)

EUR – EONIA to ESTER transition

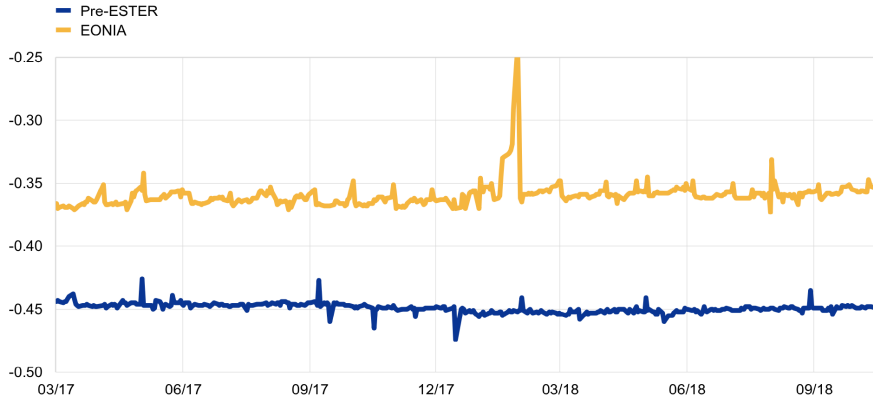


Figure from ECB documents.

EUR – EONIA to ESTER transition

The ESTER to be published by ECB as of 2 October 2019.

<https://www.ecb.europa.eu/press/pr/date/2019/html/ecb.pr190314~28790a71ef.en.html>

Preferred transition path: *time-limited recalibration approach with a spread and clean discounting*.

This is fundamentally different from the USD approach.

EONIA's current methodology will be developed to become a dependent on ESTER as of a recalibration date. EONIA and ESTER to be published beyond this date. $EONIA = ESTER + \text{spread}$ with a fixed and constant spread. Proposed by sub-working-group on EONIA-ESTER transition, approved by working-group on Euro RFR. Under discussion at EMMI (consultation).

Spread computed by ECB based on public data.

EUR – EONIA to ESTER transition

Clean discounting regime: single PAI is used with a given counterparty and at a given CCP (by opposition to dual PAI).

The report did not provide sufficient details on the mechanics of discounting for legacy EONIA transactions or whether the applicable rate would be ESTER or ESTER plus a spread, thus requiring more guidance on how discounting and collateral remuneration would be performed [...].

The approach requires alignment across CCPs, a compensation mechanism and standard documentation on legacy trades.

EUR – EONIA to ESTER transition

The description by the working group is lacking details (also indicated in the consultation answers). The ECB document creates a confusion between PAI and discounting!

Liquidity: EONIA and ESTER trades will be linked to the same rate from the recalibration date. Long dated EONIA trades are in effect long dated ESTER trade. The EONIA liquidity will automatically translate into ESTER liquidity on recalibration date. The spread and recalibration date are not fixed yet and today's liquidity cannot be used for risk management of ESTER.

ESTER is published T+1 while EONIA is published in T. This has system and payment (and potentially term sheet) impacts.

LCH SwapClear to propose ESTER clearing from October 2019. Framework internally validated, but not publicly announced yet.

UK – SONIA – Market activity

New RFR futures have been launched recently:

- SONIA 1-month: CurveGlobal, ICE
- SONIA 3-month: CurveGlobal, ICE, CME
- SONIA MPC dates: CME

Monthly average cleared: GBP 4.2 tn in 2018.

In 2019: IRS – 15% / OIS – 30% / FRA – 30%

Around GBP 15.6 SONIA FRN (8.7 bn in 2019)

Some pension fund have switch to SONIA swap for interest rate risk management.

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Fallback

Legal matters

Currently the IBOR fallback in ISDA definitions is not robust.

Implementation target for legal documentation: sometime in 2019

Amendment to ISDA definitions: apply to new trades.

Protocol for existing transactions.

What is fallback?

Replacement of a discontinued benchmark by a number related to a replacement benchmark, called *adjusted RFR* and an adjustment to, in some sense, make the new number equivalent to the discontinued one, called the *spread adjustment*.

Adjusted RFR computed on the IBOR fixing date. Spread adjustment computed on (or around) the announcement date.

Triggers

Fallback

Criteria

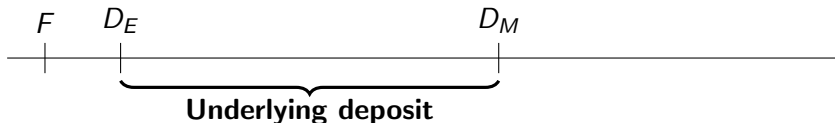
- Value transfer
- Manipulation (RFR and spread)
- Consistency
- Similarity with existing instruments
- Valuation simplicity
- Risk management

An ISDA consultation took place from 12 July to 23 October 2018 (GBP, CHF, JPY, AUD). The results of the consultation have been presented on **27 November 2018**. More consultations expected related USD and EUR. Document expected on the technical details and the legal wording.

LIBOR derivatives – dates

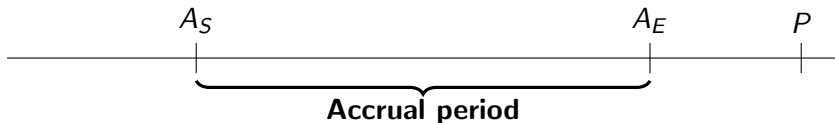
Benchmark dates

- Fixing date (F)
- Underlying deposit effective date (D_E) – T+2 for IBOR
- Underlying deposit maturity date (D_M)



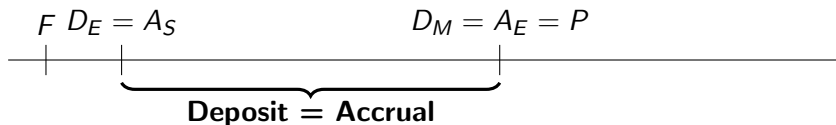
Derivative dates

- Start accrual date (A_S)
- End accrual date (A_E)
- Payment date (P)

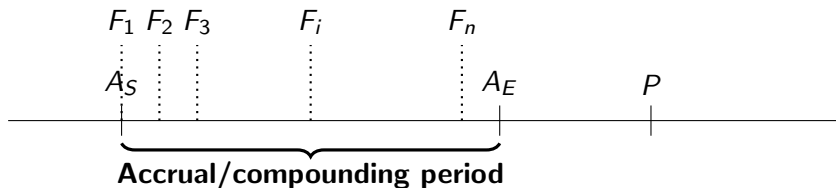


Vanilla IRS and OIS

LIBOR IRS



OIS



Typically: $P = \text{last fixing publication} + 2 \text{ business days}$

Fallback – Adjusted RFR options

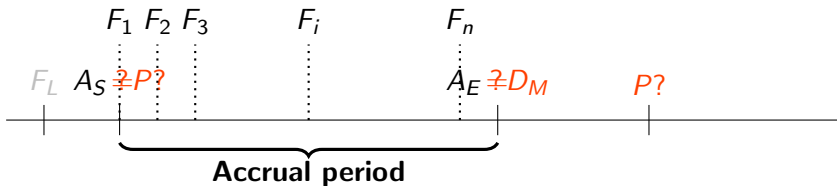
Option 3: Compounded Setting in Arrears Rate

For this option, the consultation text indicates “*The fallback could be to the relevant RFR observed over the relevant IBOR tenor and compounded daily during that period.*” This is translated in the consultation into the formula

$$FR^j(t_0) = \frac{1}{\delta^j(t_0)} \left(\prod_{i=1}^n \left(1 + \delta_i^O I^O(s_{i-1}) \right) - 1 \right).$$

Pro: Interest rate, same term, similar to OIS, available?

Con: Available late, achievable?, wrong period? FRA?



Fallback – Adjusted RFR options

Option X1: OIS Benchmark

This option is not proposed in the ISDA consultation.

In t_0 the rate of the OIS associated to the IBOR start and maturity deposit dates is measured to create an OIS benchmark.

Pro: Term interest rate, correct period, similar to OIS

Con: Not in ISDA consultation. Available? FSB OSSGs message.

Confusion between target market and fallback? *“The FSB recognises that in some cases there may be a role for term rates, including RFR-derived term rates.”*

ICE swap rate, ICE Term SONIA based on futures

Working group consultation on Term SONIA Reference Rate (TSRR). Working group on Euro risk-free rate. Also working groups for USD and JPY. It is surprising that ISDA, the public-private working groups and the CCPs are not fully aligned on this issue.

Term Reference Rate

Do we need term rate?

For new derivatives: OIS-like derivatives (compounded rates) work well for interbank.

For fallback: The term rate fallback problem is a *term rate problem*, not an overnight problem, even if the fallback is overnight based; a term rate is required for the solution.

For bonds and loans: ? Some overnight-linked bonds/certificates (EIB, World Bank, Fannie Mae, Credit Suisse)

ICE swap rate, ICE Term SONIA based on futures

Working group consultation on Term SONIA Reference Rate (TSRR). Working group on Euro risk-free rate. Working groups in USD and JPY.

Fallback – Forward-looking v backward-looking

OIS benchmark and *compounded in arrears* are the same before the fixing date in term of valuation and risk management.

The floating leg amount paid is the spot OIS rate as measured at the fixing date t_0 for the period $[u, v]$ and it is paid in v .

$$\begin{aligned}
 & E^{\mathbb{X}} \left[(N_v^c)^{-1} N \delta F^c(t_0; u, v) \right] \\
 &= N E^{\mathbb{X}} \left[(N_{t_0}^c)^{-1} \delta N_{t_0}^c E^{\mathbb{X}} \left[(N_v^c)^{-1} F^c(t_0; u, v) \mid \mathcal{F}_{t_0} \right] \right] \\
 &= N E^{\mathbb{X}} \left[(N_{t_0}^c)^{-1} \left(\frac{P^c(t_0, u)}{P^c(t_0, v)} - 1 \right) P^c(t_0, v) \right] \\
 &= N E^{\mathbb{X}} \left[(N_{t_0}^c)^{-1} (P^c(t_0, u) - P^c(t_0, v)) \right] \\
 &= N (P^c(0, u) - P^c(0, v))
 \end{aligned}$$

(1) tower property of conditional expectation. (2) $F^c(t_0; u, v)$ is \mathcal{F}_{t_0} -measurable, the formula of the forward and the definition of $P^c(t_0, v)$. (3) martingale property of $P^c(., x)$.

Fallback – Forward-looking v backward-looking

The cash flow in the backward-looking option is also paid in v but based on the composition of the daily rates r_i compounded over the period. This is similar to the floating payment of an OIS. The present value is given by

$$\begin{aligned} E^{\mathbb{X}} \left[(N_v^c)^{-1} N \left(\prod_{i=1}^n (1 + \delta_i r_i) - 1 \right) \right] &= NP^c(0, v) \left(\frac{P^c(0, u)}{P^c(0, v)} - 1 \right) \\ &= N(P^c(0, u) - P^c(0, v)) \end{aligned}$$

Fallback - spread options

When?

Values computed just before the discontinuation's announcement.

Option 1: Forward Approach

The spread adjustment [is] calculated based on observed market prices for the forward spread between the relevant IBOR and the adjusted RFR in the relevant tenor at the time the fallback is triggered.

Option 2: Historical Mean/Median Approach

The spread adjustment [is] based on the mean or median spot spread between the IBOR and the adjusted RFR calculated over a significant, static lookback period (e.g., 5 years, 10 years) prior to the relevant announcement or publication triggering the fallback provisions.

Pro: No manipulation, easy to compute and verify.

Con: Value transfer. Not related to current market situation.

Fallback in Singapore

Singapore's key benchmark for interest rate is SOR. The rate is computed from USD-LIBOR (and FX swaps). SOR will need to develop its own fallback mechanism. The SOR administrator is the Association of Banks in Singapore (ABS).

A revised Singapore SOR based on SOFR is being considered by a group led by the Singapore Foreign Exchange Market Committee (SFEMC). SOR Recalibration approach versus fallback.

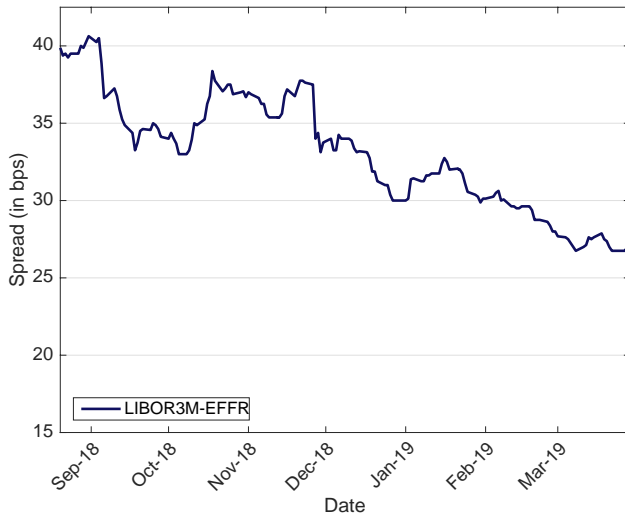
Planned ISDA consultation in 2019.

Waiting for USD term rate?

LIBOR fallback

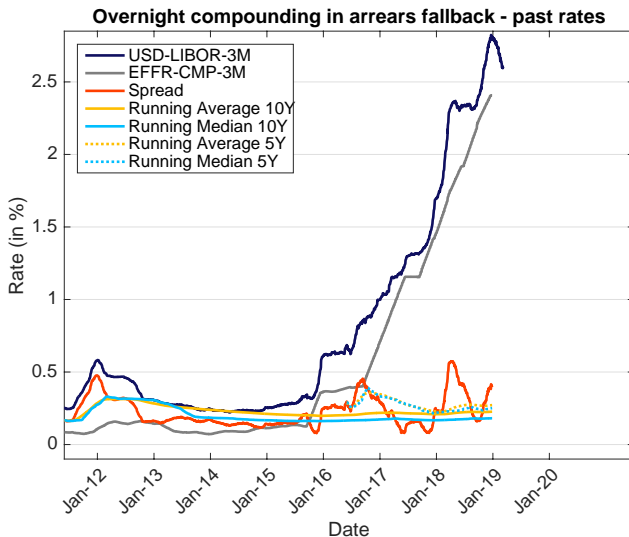
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Has the value transfer started?

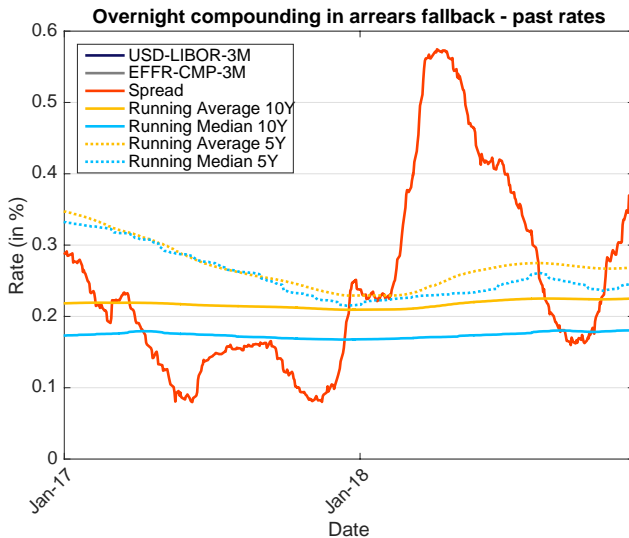


Basis spread in USD, tenor 30 years.

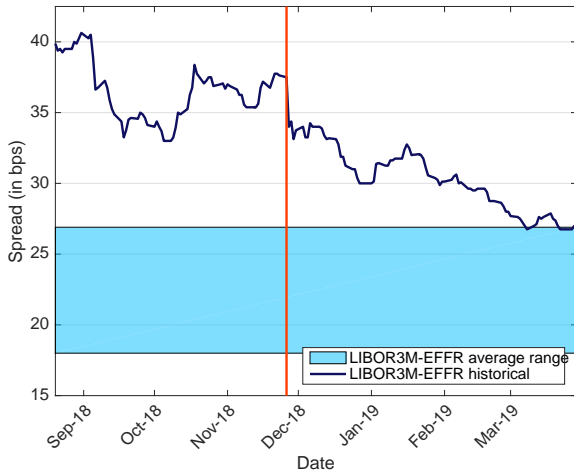
Has the value transfer started?



Has the value transfer started?

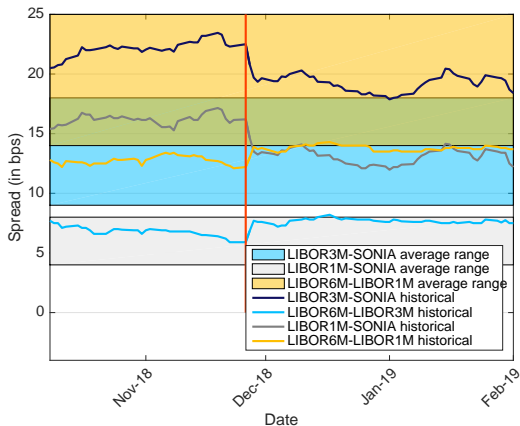


Has the value transfer started?



OIS is moving IRS!

Has the value transfer started?

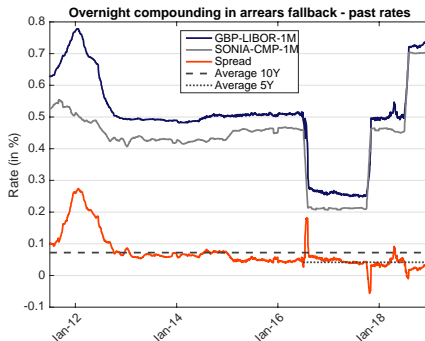


Basis spread in GBP, tenor 30 years. Jump on consultation results announcement date!

Has the value transfer started?

Example: LIBOR-1M/SONIA.

Hypothesis: LIBOR discontinued on 1-Jan-2022. Historical spread for LIBOR-1M v SONIA-compounded-in-arrears-over-1M (announcement on 1-Jul-2021 with 10Y look-back. The mean for that almost 8-year period is 7.2bps. Compare to the spread in long term basis swaps which was 16.2 bps for the 30Y tenor.



Impacts on banks: value transfer

Possible value transfer (arbitrage opportunities?)

- USD
 - LIBOR Fallback spread (if historical mean/median selected); already started
 - EFR-SOFR transition at LCH (discounting switch with CCP estimated compensation)
- EUR
 - EURIBOR Fallback spread (if fallback and historical mean/median selected)
 - EONIA-ESTER transition (discounting switch with ??? estimated compensation)
- GBP
 - LIBOR Fallback spread (if historical mean/median selected); already started
 - RPI: Potential change of methodology/fallback to CPI

Fallback – quantitative impacts - delta

The fallback procedures have potentially important impacts in term of value transfer, risk management and valuation complexity.

Delta profile: 6M x 5Y, USD LIBOR 3M, 100m

USD-DSCON-OIS		USD-LIBOR3M-IRS	
	USD		USD
USD-EFFR-1M	-9		
USD-EFFR-3M	17	USD-FRA3M-1Mx4M	-2,539
USD-EFFR-6M	-33	USD-FRA3M-3Mx6M	-2,441
USD-EFFR-9M	1	USD-FRA3M-6Mx9M	0
USD-EFFR-1Y	-126	USD-IRS3M-1Y	-4
USD-EFFR-2Y	-299	USD-IRS3M-2Y	-9
USD-EFFR-3Y	-456	USD-IRS3M-3Y	-15
USD-EFFR-4Y	-610	USD-IRS3M-4Y	-17
USD-EFFR-5Y	-888	USD-IRS3M-5Y	38,468
USD-EFFR-7Y	-97	USD-IRS3M-7Y	12,791
USD-EFFR-10Y	0	USD-IRS3M-10Y	0
USD-EFFR-15Y	0	USD-IRS3M-15Y	0
USD-EFFR-20Y	0	USD-IRS3M-20Y	0
USD-EFFR-30Y	0	USD-IRS3M-30Y	0
Total	-2,499	Total	46,234

Legacy

Fallback – quantitative impacts - delta

The fallback procedures have potentially important impacts in term of value transfer, risk management and valuation complexity.

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USD-EFFR-30Y	0	USD-IRS3M-30Y	0
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Legacy

USD-DSCON-OIS	
	USD
USD-OIS-1M	-6
USD-OIS-3M	0
USD-OIS-6M	-4,905
USD-OIS-9M	-4
USD-OIS-1Y	-153
USD-OIS-2Y	-298
USD-OIS-3Y	-345
USD-OIS-4Y	-685
USD-OIS-5Y	37,606
USD-OIS-7Y	12,789
USD-OIS-10Y	0
USD-OIS-15Y	0
USD-OIS-20Y	0
USD-OIS-30Y	0
Total	43,999

OIS Benchmark

Fallback – quantitative impacts - delta

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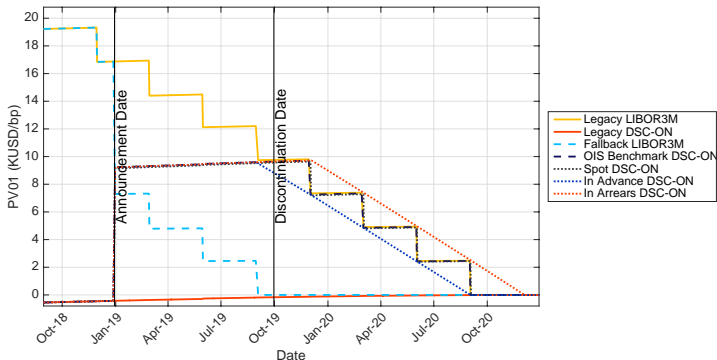
USD-DSCON-OIS		USD-LIBOR3M-IRS	
	USD		USD
USD-EFFR-1M	-9		
USD-EFFR-3M	17	USD-FRA3M-1Mx4M	-2,539
USD-EFFR-6M	-33	USD-FRA3M-3Mx6M	-2,441
USD-EFFR-9M	1	USD-FRA3M-6Mx9M	0
USD-EFFR-1Y	-126	USD-IRS3M-1Y	-4
USD-EFFR-2Y	-299	USD-IRS3M-2Y	-9
USD-EFFR-3Y	-456	USD-IRS3M-3Y	-15
USD-EFFR-4Y	-610	USD-IRS3M-4Y	-17
USD-EFFR-5Y	-888	USD-IRS3M-5Y	38,468
USD-EFFR-7Y	-97	USD-IRS3M-7Y	12,791
USD-EFFR-10Y	0	USD-IRS3M-10Y	0
USD-EFFR-15Y	0	USD-IRS3M-15Y	0
USD-EFFR-20Y	0	USD-IRS3M-20Y	0
USD-EFFR-30Y	0	USD-IRS3M-30Y	0
Total	-2,499	Total	46,234

Legacy

USD-DSCON-OIS		USD-SOFR-OIS	
	USD		USD
USD-EFFR-1M	-9	USD-SOFR-1M	2
USD-EFFR-3M	0	USD-SOFR-3M	0
USD-EFFR-6M	0	USD-SOFR-6M	-4,905
USD-EFFR-9M	-50	USD-SOFR-9M	46
USD-EFFR-1Y	-92	USD-SOFR-1Y	-62
USD-EFFR-2Y	-277	USD-SOFR-2Y	-23
USD-EFFR-3Y	-435	USD-SOFR-3Y	87
USD-EFFR-4Y	-595	USD-SOFR-4Y	-93
USD-EFFR-5Y	-722	USD-SOFR-5Y	38,321
USD-EFFR-7Y	-46	USD-SOFR-7Y	12,833
USD-EFFR-10Y	0	USD-SOFR-10Y	0
USD-EFFR-15Y	0	USD-SOFR-15Y	0
USD-EFFR-20Y	0	USD-SOFR-20Y	0
USD-EFFR-30Y	0	USD-SOFR-30Y	0
Total	-2,226	Total	46,207

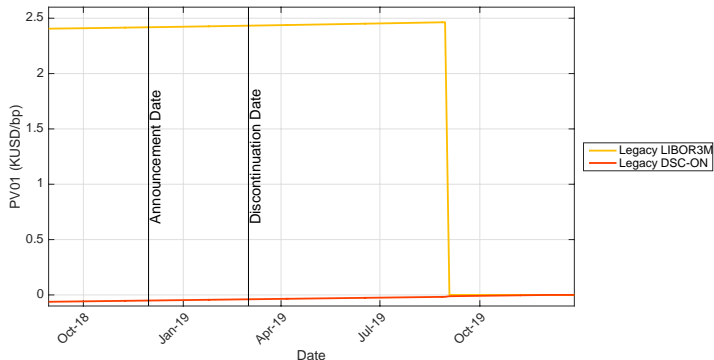
OIS Benchmark

Risk profile through time



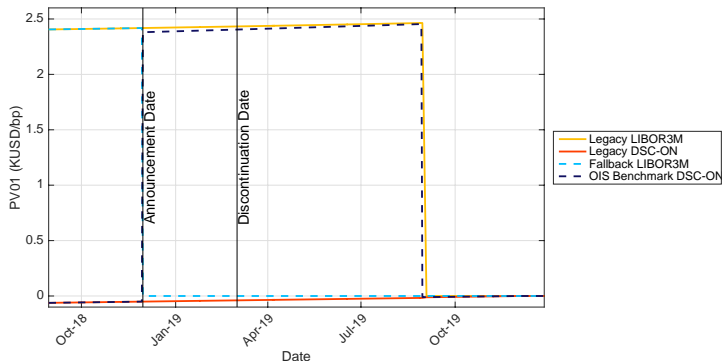
Transition from IBOR based market to ON based market through fallback.

Risk profile through time – No discontinuation



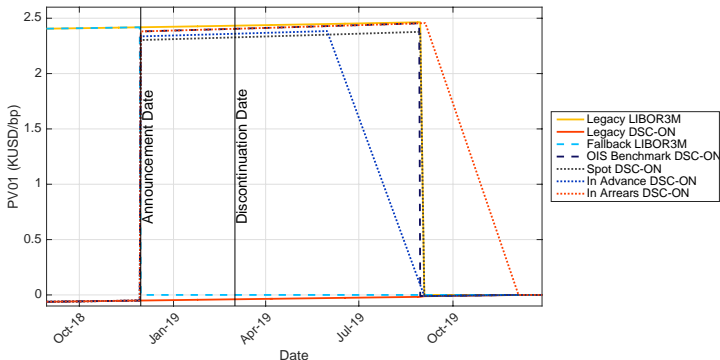
Legacy IBOR trade ignoring discontinuation. PV01 for each curve.

Risk profile through time – Discontinuation OIS Benchmark



Discontinuation with OIS benchmark fallback option. PV01 for each curve.

Risk profile through time – Discontinuation



Discontinuation with all fallback options. PV01 for each curve.

Risk profile – mixed delta

USD-DSCON-OIS		USD-LIBOR3M-IRS	
	USD		USD
USD-OIS-1M	-12	USD-FRA3M-1Mx4	-2,512
USD-OIS-3M	15	USD-FRA3M-3Mx6	-2,472
USD-OIS-6M	-41	USD-FRA3M-6Mx9	0
USD-OIS-9M	1	USD-IRS3M-1Y	-4
USD-OIS-1Y	-144	USD-IRS3M-2Y	-12
USD-OIS-2Y	-340	USD-IRS3M-3Y	16,881
USD-OIS-3Y	-17,412	USD-IRS3M-4Y	16,393
USD-OIS-4Y	-17,009	USD-IRS3M-5Y	0
USD-OIS-5Y	37,439	USD-IRS3M-7Y	0
USD-OIS-7Y	12,639	USD-IRS3M-10Y	0
USD-OIS-10Y	0	USD-IRS3M-15Y	0
USD-OIS-15Y	0	USD-IRS3M-20Y	0
USD-OIS-20Y	0	USD-IRS3M-30Y	0
USD-OIS-30Y	0		
Total	15,136	Total	28,274

Risk profile. Profile as of December 2018 under the hypothesis that discontinuation will take place on 1 Jan 2022.

Vanilla becoming exotics? Cap/floor

Vanilla IBOR caplet with strike \bar{K} , expiry t_0 and paid-off in v :

$$\delta^j(t_0)(l^j(t_0) - \bar{K})^+.$$

Amount in the case of *compounding setting in arrears*? Amount still paid in v and is given, for a spread S , by

$$\delta^j(t_0) \left(\frac{1}{\delta^j(t_0)} \left(\prod_{i=1}^n \left(1 + \delta_i^0 l^O(s_{i-1}) \right) - 1 \right) + S - \bar{K} \right)^+$$

The important difference is the the *expiry date*, which is now delayed to $s_{n-1} = v - 1d$. The pay-off can be written as

$$\max \left(\prod_{i=0}^{n-1} \left(1 + \delta_i F^O(s_i, s_i, s_{i+1}) \right), 1 + \delta K \right) - 1$$

The vanilla IBOR cap/floor are becoming Asian options using compounding as averaging method on rates.

Vanilla becoming exotics? Cap/floor

Theorem

Let $0 = s_{-1} \leq s_0 < s_1 < s_2 < \dots < s_n$. In the a HJM one-factor model, the price of an instrument paying in s_n the maximum of a fixed amount $1 + \delta K$ and $\prod_{i=0}^{n-1} 1 + \delta_i^0 I^O(s_{i-1})$ is given by

$$F_0 = P(0, s_0)N(\kappa + \sigma) + (1 + \delta K)P(0, s_n)N(-\kappa)$$

where

$$\sigma^2 = \sum_{i=0}^{n-1} \sum_{j=0}^{n-1} \int_0^{\min(s_i, s_j)} (\nu(\tau, s_{i+1}) - \nu(\tau, s_i))(\nu(\tau, s_{j+1}) - \nu(\tau, s_j)) d\tau.$$

and

$$\kappa = \frac{1}{\sigma} \left(\ln \left(\frac{P(0, t_1)}{(1 + \delta K)P(0, t_n)} \right) - \frac{1}{2} \sigma^2 \right).$$

Vanilla becoming exotics? Swaptions

The swaption issues are the same in the compounded in arrears and OIS benchmark cases.

The approach for a Black or SABR model is to focus on the annuity and swap rate

$$A_t = \sum_{i=1}^n \delta_i P^c(t, t_i).$$

and

$$S_t = \frac{\sum_{k=1}^{\tilde{n}} \tilde{\delta}_k P^D(t, \tilde{t}_k) F^j(t, s_k, e_k)}{A_t}.$$

and write the value of an option of strike K and expiry θ through a change of numeraire as

$$N_0 E^N [(N_\theta)^{-1} A_\theta (S_\theta - K)^+] = A_0 E^A [(S_\theta - K)^+].$$

It is enough to model the one-dimensional quantity S_t to obtain the price.

Vanilla becoming exotics? Swaptions

With the spread, the meaning of S_t changes as it needs to incorporate the spread and is not the same for each swaption.

$$S_t = \frac{\sum_{k=1}^{\tilde{n}} \tilde{\delta}_k P^c(t, \tilde{t}_k) (F^0(t, s_k, e_k) + S_k)}{\sum_{i=1}^n \delta_i P^c(t, t_i)}.$$

New swaptions: OIS based and no spread. Legacy IBOR trades that have fallback: overnight compounded plus non-zero spread. The spread is on the floating leg which often (at least in USD and EUR) does not have the same frequency and day-count as the fixed leg. The spread cannot be exactly incorporated into the fixed side.

Fallback and CCPs

CCPs related questions:

- What is the procedure at CCPs to change the IBOR fallback?
- Will CCPs impose a fallback changes to legacy cleared trades?
- Will the same fallback apply to cleared and uncleared trades?

LCH rule 1.8.12 states: *[...] provided that where the rate for a Reset Date (i) is unavailable (including where such rate ceases, or will cease, to be provided by its administrators), [...] the Clearing House will determine an alternative rate at its sole discretion.*

LCH (Circular No 3999)

if/when the CCPs adopt the new fallback provision, the rule will apply to all trades

CME Group email (21 December 2018)

We intend to align with ISDA to include revised fallback language [...] CME reserves the right to make necessary adjustments based on consultations with our clients.

LIBOR fallback

- 1 A brief introduction to LIBOR and benchmarks
- 2 New benchmarks
- 3 IBOR Fallback: consultation and expectations
- 4 Risk management
- 5 Conclusions**

Benchmarks – Timetable

- Jul 2014 FSB's paper *Reforming Interest Rate Benchmarks*
- Apr 2017 GBP preferred RFR: Reformed SONIA
- Jun 2017 USD preferred RFR: SOFR
- Jan 2018 The EU Benchmarks Regulation entered into force
- Apr 2018 First SOFR rate published
- Sep 2018 EUR preferred RFR: ESTER
- Oct 2018 ISDA consultation on fallback
- Nov 2018 Results ISDA consultation on fallback
- ??? 2019 Brexit?
- ??? 2019 New ISDA definitions including fallback provisions
- Oct 2019 First ESTER rate published
- End 2021 End LIBOR agreement FCA/LIBOR panel banks
- Dec 2021 End transition period for EU Benchmark Regulation

Conclusions

- Change of overnight benchmark (e.g. EFFR to SOFR or EONIA to ESTER) is a major undertaking.
- A clear fallback procedure is required. The ISDA consultation and its results have left many details open, including the achievability of the option selected. A substantial work is still required to obtain a non-ambiguous fallback procedure.
- Procedures selected responsible for value transfer. Some transfer may have taken place already and some may take place later.
- Changes from IBOR to overnight benchmarks as the main interest rate benchmarks require rethinking hedge their interest rate risk (derivatives and ALM).
- Potentially the new world will be more complex than the old if different solutions are selected in different currencies.
- The selected transition and fallback solutions require a substantial work from a quant finance and system perspective.

Contacts

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Quantitative finance
Derivatives market
Model validation
Market infrastructure