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Transition to New Benchmark – abandoning LIBOR

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Preamble – ever changing landscape

In 2007 we thought we new all about the fundamentals objects we were operating with:

- Clearly defined benchmarks (LIBOR, BBSW) and associated curves

- Reliable interbank credit, and hence

- Stable single currency basis

The quant community was tasked with pricing more and more complex structures within these firm boundaries.

The perfect storm of 2007-2008 changed all this

- Unreliable interbank credit, hence

- Volatile single currency basis

- Multiple curve pricing environment, as a consequence

Now the quant's job is more about pricing relatively simple products in a complex environment.

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and now that we were getting used to this

a new paradigm and a storm cometh.

Background

In the early 1980s, banks started looking for a standard benchmark to calculate the prices on an array of financial products
The most widely used benchmark—the London Interbank Offered Rate (LIBOR)—was first published in 1986,

Libor is defined as:
The rate at which an individual Contributor Panel bank __could__ borrow funds'
This definition is amplified as follows:

- The rate which each bank submits must be formed from that bank's perception of its cost of funds in the inter-bank market.
- Contributions must represent rates formed in London and not elsewhere.
- Contributions must be for the currency concerned, not the cost of producing one currency by borrowing in another currency and accessing the required currency via the foreign exchange markets.
- The definition of "funds" is: unsecured inter-bank cash or cash raised through primary issuance of inter-bank Certificates of Deposit

Libor was calculated by the Intercontinental Exchange (ICE)

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Background

In late September 2012, Barclays was fined £290m because of its attempts to manipulate the Libor,

On 28 September 2012, an independent review was published, recommending that an independent organisation with government and regulator representation, called the Tender Committee, manage the process of setting LIBOR under a new external oversight process for transparency and accountability.

Manipulation of benchmark rates for the financial benefit of individuals and institutions resulting in reduced use of the benchmark, have made their future use doubtful. Also, apparently the volume of LIBOR references transactions has substantially declined.

Various working groups have been established to coordinate international work to review and reform interest rate benchmarks – replacing the existing ones with risk-free, or nearly risk-free, rates (RFRs) .

In the markets which face the disappearance of IBORs, notably markets currently reliant on LIBOR, there needs to be a transition to new reference rates – a long and arduous process.

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Proposed Benchmark Rates

Four alternative benchmarks are considered for a rate between T and $T+f$ where $T = t + \text{lag}$ and f is the tenor of the rate

- Spot Overnight Rate $SOR_f(t) = RFR_t$

$$SCR_f(t) = \frac{1}{\delta_f}\left((1 + \delta_1 SOR_t)^{\delta_f/\delta_1} - 1\right),$$

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Proposed Benchmark Rates

- Compounding Setting in Arrears Rate

$$ARR_f(t) = \frac{1}{\delta_f}\left(\prod_{u=T}^{T+f-1\mathrm{bd}} (1 + \delta_u RFR_u) - 1\right),$$

δ_f is the cash day count fraction for the accrual period, and δ_u is the cash day count fraction for the overnight accrual period

- It reflects actual rate over the period
- Being an average rate it is less volatile

This rate has the disadvantage that is not available until the **end** of the accrual period. As a result the actual rate over the period may differ from the expectation at the beginning of the period.
This is not ideal for loans/deposits.

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Proposed Benchmark Rates

- Compounding Setting in Advance Rate

$$ADR_f(t) = RA_f(t)\big(1 + \delta_f RA_f(t)\big)$$

$$\text{where} \quad RA_f(t) := \frac{1}{\delta_A}\left(\prod_{u=t-f}^{t-1\text{bd}} (1 + \delta_u RFR_u) - 1\right)$$

- This rate is available on the IBOR fixing date t, that is at the beginning of the payment period
- Relects actual rate over comparable period
- Less volatile

but is backwards looking. Market conditions may have changed since the relevant historical period, which could lead to differences from the current market term structure and may affect hedging.
Introduces convexity as it is defined at t and paid at $T+f$

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Triggers and Fallbacks – the switchover process

The switchover will be triggered upon

- a public statement or publication of information by or on behalf of the administrator of [the relevant IBOR] announcing that it has ceased or will cease to provide [the relevant IBOR] permanently or indefinitely, provided that, at that time, there is no successor administrator that will continue to provide [the relevant IBOR]; or

- a public statement or publication of information by the regulatory supervisor for the administrator of [the relevant IBOR],….

If this happens IBORs will be replaced by fallback rates

IBOR	Fallback Rate
GBP LIBOR	SONIA
CHF LIBOR	SARON

As these rates are overnight rates they will need to be adjusted for a 'term'

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Spread Adjustment Methodology

The overnight RFRs are risk-free or nearly risk-free whereas the relevant IBORs incorporate a bank credit risk premium and a variety of other factors (*e.g.,* liquidity, fluctuations in supply and demand). While it would not be possible to replicate these factors upon a permanent discontinuation of the relevant IBOR, a spread adjustment could apply to the relevant adjusted RFR as a **rough proxy (??)**.

The spread adjustment will be calculated as of the business day before the fallback is triggered (*i.e.,* the business day before the public statement is made or the formal publication of information regarding permanent discontinuation) but will not apply until the fallback takes effect (*i.e.,* the first day that the relevant IBOR is not published following a permanent discontinuation.

The methodologies intend to: (1) eliminate or minimize value transfer at the time the fallback is applied; (2) eliminate or minimize any potential for manipulation; and (3) eliminate or mitigate against the impact of market disruption at the time the fallback is applied
DO NOT THINK THIS REALLY WORKS!

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Spread Adjustment Methodology – Forward Approach

The spread adjustment could be 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.

For each frequency f on the calibration date, t_0, for each t calculate spread

$$CS_f(t_0, t) = FL_f(t_0, t) - FR_f(t_0, t).$$

where FL_f is the t forward Libor rate, FR_f is the t forward RFR rate

A forward spread curve up for the adjusted RFR in each relevant tenor could be published on a daily basis up until the date the fallback is triggered.
Upon the permanent discontinuation of the relevant IBOR (at t_1), the fallback would consist of the adjusted RFR (as published each day going forward), plus a spread based on the relevant curve.

$$LF_f(t) = R_f(t) + CS_f(t_0, t) \quad \text{for } t \geq t_1$$

A variation would be to use the average of the spreads based on the curves for a period of days or months before the trigger date.

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Spread Adjustment Methodology – Forward Approach

The forward approach is not directly compatible with the spot overnight rate approach, because the spot overnight rate (payable) at the end of the tenor will have convexity, although the spread can implicitly include the convexity adjustment.

The forward approach prevents significant value transfers near the date the fallback is triggered because spread adjustments match the expected market pricing as of the day before the fallback is triggered.
What about the actual fallback day? Any other days?

Potential disadvantages of the forward approach:
- It requires functioning markets and extensive market data, which may not be readily available. Any market data considered must be accurate, verifiable and accessible to market participants. It should not be based on any proprietary data from individual dealers.
- Availability of the curves required to compute this approach would be dependent on a vendor continuing to calculate and publish the curves up until the fallbacks are triggered. There is no guarantee that a vendor would do so.
- It may be vulnerable to manipulations and distortions in the market.

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Spread Adjustment Methodology – Historical Mean/Median Approach

The spread adjustment could be 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. This spread adjustment could then be used from the end of a one-year transitional period after the fallback takes effect. Alternatively the spread could be linearly interpolated from the market spread at the trigger date to the fallback date.

Potential advantages of the historical mean/median approach:
- It reflects current market conditions at the time the fallback takes effect (?)
- It captures the tendency of interest rates to fluctuate around a long-term mean. (*so what?!*)
- It ultimately ameliorates the effect of market distortions and potential manipulation at the time of triggering It is based on readily available information.

Potential disadvantages of the historical mean/median approach:
- It is unlikely to be present-value neutral on the calibration date because spot rates are unlikely to be consistent with forward rates
- It requires long histories of IBOR fixings and adjusted RFR fixings.

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Spread Adjustment Methodology – Spot-Spread Approach

The spread adjustment could be based on the spot spread between the IBOR and the adjusted RFR on the day preceding the relevant announcement or publication triggering the fallback provisions (on the average over a preceding period of time.

$$CS_f(t_0) = L_f(t_0) - R_f(t_0).$$

The spot-spread approach is not compatible with the compounded setting in arrears rate.

Potential advantages of the spot-spread approach:
- It is simple to implement and understand.
- It requires only IBOR fixings and adjusted RFR fixings at the time of triggering.

Potential disadvantages of the spot-spread approach:
• It is unlikely to be present-value neutral on the calibration date because it only reflects spreads under market conditions at the time of calibration, which could differ from anticipated market conditions.

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Spread Adjustment Methodology – Summary

	Forward Approach	Historical Mean/Median Approach	Spot-Spread Approach
Spot Overnight Rate	Not compatible		
Compounded Overnight Rate	Not compatible		
Compounded Setting in Arrears Rate			Not compatible
Compounded Setting in Advance Rate			

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Indicative Ranking of Options

Potential preferences for the Adjusted RFRs are:

1. Compounded Setting in Arrears;
2. Compounded Setting in Advance;
3. Convexity-adjusted Overnight; and
4. Spot Overnight.

Potential preferences for Spread Adjustment Methodologies are:

1. Forward;
2. Historical Mean/Median; and
3. Spot-Spread

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Indicative Ranking of Options

- The preference for the Compounded Setting in Arrears is based on the similarity to the existing OIS market and the clear cross-hedging abilities that currently exist. We also note that a spot market for 3 month OIS, for example, could be accessed if a user wished to set the rate at the beginning of the period in a similar way to the current IBORs:

- Compounded Setting in Advance Rate does not reflect a forward-looking rate which differs from the current IBORs. This approach applies the actual rate (compounded) for the previous period to the current period thereby creating an offset back by one period. This is less preferred to the Compounded Setting in Arrears due to this inherent lag (offset). However, this method does allow for the rate to be input at the beginning of the current period .

- The Convexity-adjusted Overnight Rate does represent the actual returns better than the Spot Overnight Rate due to the compounding. However, we believe this is inferior to both the Compounded Setting in Arrears and Advance methods. These two methods calculate the term rate from actual RFRs published each day over the relevant period. The convexity Adjusted Overnight Rate is observed on a single day (then compounded) which may not be representative of the actual returns over that period.

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Indicative Ranking of Options

- The Forward Approach could preferred as it is a current representation of the prevailing market conditions and forward expectations.

- Using the Historical Mean/Median Approach spread is less preferred to the Forward Approach. The Mean/Median does not take account of the actual market expectations (as embedded in the Forward Approach) and relies on past averages irrespective of whether markets have fundamentally changed over the averaging period

- The Spot-Spread Approach is considered the least favourable of the spread adjustment methodologies. Despite the relative simplicity of this method, it is susceptible to point-in-time risks. If the market is at an extreme level when the spread is calculated (which is quite possible when a trigger event occurs) this unusual spread is 'locked in' for the remainder of the trade.

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Some of the Issues to be Considered

Benchmark rate term structures

As proposed benchmark replacements have all targeted short tenor overnight rates, how will new and legacy longer dated exposures be treated? How suitable will the new rates be?

The proposed overnight rates have the potential to create cash flow uncertainty e.g. with loans interest costs would be confirmed at the end of the interest period instead of the beginning, or tenor mismatch, or lag.

Global consistency

As reform efforts have proposed varying replacement benchmarks across the five LIBOR currencies, with an emphasis of reforming derivative products initially, how will market participants reconcile changes in benchmark rates across products and jurisdictions?

The potential currency-specific products and rates means transactions such as cross-currency hedging will need to adjust for the different basis in each currency. Businesses must determine how to best minimise basis risk within any given currency and develop approaches for managing cross currency basis risk for varying rates.

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Some of the Issues to be Considered

Liquidity of new and legacy products
How do the markets sustain sufficient liquidity in both existing LIBOR indexed products and new reference rate products during transition periods?
To enable the markets to operate effectively and efficiently, the creation of a basis market would aid in the closing of legacy contracts during the transition process.

Credit spread differential
LIBOR inherently includes inter-bank credit on unsecured borrowings. Some of the proposed benchmark rates are secured and exclude credit components. How does a shift to secured wholesale funding impact markets?
Where risk free rates are used as replacements to IBORs, there could be impacts on values if fall backs are triggered. This bank credit risk element needs to be reflected, in pricing new deals, credit spread premia may be considered between new and legacy transactions.

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Some of the Issues to be Considered

System infrastructure

How will new benchmark rates impact an institution's operational constructs?

The transition to a new rate could mean a number of strategic, business and technological changes to a number of stakeholders. Alternative reference rates could require costly changes in internal and third-party pricing, accounting, and risk management models and systems

Fall back provisions – Derivatives

How does uncertainty in LIBOR's future impact current swaps and agreements?

Amendments, including changes to ISDA masters and CSAs may need updating to reflect the permanent discontinuance of a benchmark. Fallback provisions may exist that allow the use of alternative rates, however the continued publication of LIBOR in spite of reduced liquidity may render a fallback rate as contractually prohibited. If amendments to derivatives result in recognition of a new contract, additional collateral may be required.

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Some of the Issues to be Considered

Fall back provisions – Corporate lending
How does uncertainty in LIBOR's future affect corporate lending and borrowing and hedging arrangements?
Parties to agreements may need to consider building in flexibility to amend interest rate determination provisions that may result from the discontinuation of LIBOR. They will need to consider whether any revised terms result in extinguishment (a new contract) or modification with consequent accounting implications.

Fall back provisions – Debt and floating rate securities
How does uncertainty in LIBOR's future impact debt securities?
Issuers/trustees should consider how a replacement rate could affect noteholder interests. Disclosures regarding uncertainty relating to future levels of benchmark rates, the possibility of rate discontinuance and/or replacement, and the potential impact on payments arising from discontinuance or replacement

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Some of the Issues to be Considered

Benchmark rate for hedging

How will derivative hedging be impacted by new reference rates?
It is unclear whether a mechanism to hedge existing LIBOR-linked loans and debt will exist after the transition period and there is the potential for basis risk between bilaterally-agreed loans and related derivatives. The introduction of new benchmarks could critically affect existing hedges. It is unclear whether additional guidance to assist transition and allow for continuation of existing hedge relationships will be provided. In the meantime, businesses should include reference to the potential replacement rate in their hedge documentation to avoid discontinuation of longer term hedges.

Legal issues

Contract rennegotiations.

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Fallback Calculation Period

IBOR for a deposit is defined by 3 dates:
- Rate set date t_0
- Effective date (deposit start date) t_s
- End date (also usually Payment date) t_e

These dates are set irrespective of the derivatives and follow currency specific conventions.
For example, t_s is usually 2 business days after t_0 (using modified following convention) and t_e is a number of months after t_s, using the same convention. So the rate is always set for the stipulated number of months or longer.

Dates for derivatives are set differently. For example, if we have a quarterly swap with the 15th of March roll, the 15th of Mar/Jun/Sep/Dec are set as period start/end and then moved to the next business day. We may end up with rolls by few days longer than 3 months and then the next rall will be shorter than 3 months

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Fallback Calculation Period

Derivative payments are defined by 4 dates:
- Rate set date t_0 - the same as for deposit
- Accrual start date A_s
- Accrual end date A_e
- Payment date t_p

The rate set date is what links IBOR to the derivative.
These two schedules are not necessarily consistent.

For the new benchmark it would be natural to use either the IBOR period $[t_s, t_e]$, or the derivative calculation period $[A_s, A_e]$ as the accrual period.

In the first case it may happen that $t_e > t_p$ and the payment is not known at t_p.

In the second case different instruments fixing on the same index on the same day may have different fixing value.

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Fallback Calculation Period – proposed solutions

Two modifications to the either of the calculation periods are proposed: Lockout or Backward shift.

Let us assume that we have a quarterly swap with the 20th as the roll date and the swap is not for GBP IBOR. So, two sets of holidays need to be considered – London and X.

Further, let us assume that on a particular roll the 20th is a non-holiday day in London, but 20th, 21st and 22nd are public holidays. The 20th on t+3 months is a Monday - good for both London and X.

OIS Payment is 2bd after the end of the period. Assume the same for the new benchmark.
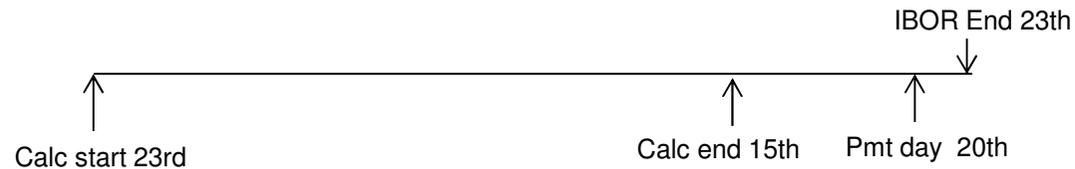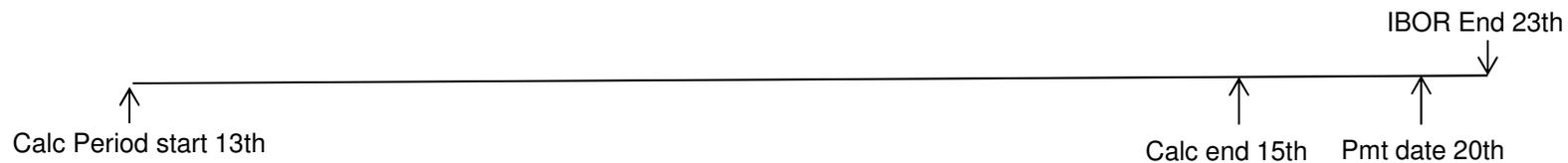
The swap roll:

Fixing day:20th   Calc Period start 23rd   Payment date 20th

IBOR Period:

Fixing day:20th   IBOR Period start 23rd   IBOR End 23th

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Fallback Calculation Period – proposed solutions

Using IBOR Period - Lockout:

IBOR End 23th

Calc start 23rd

Calc end 15th   Pmt day 20th

The rate on the 15th is 'locked' and used over 6 business days – to 23rd
Note: some daily resets will be never used.

Using IBOR Period – Backward (6bd) shift:
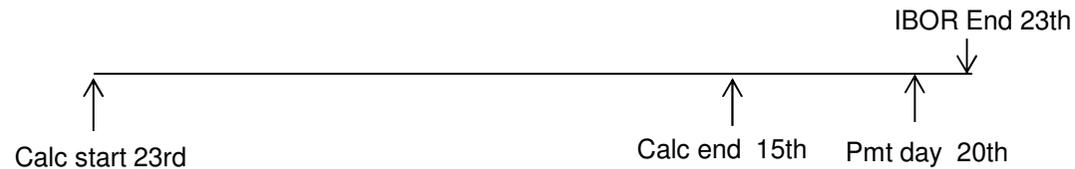
IBOR End 23th

Calc Period start 13th

Calc end 15th   Pmt date 20th

Note: some daily resets will be used twice.

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Fallback Calculation Period – proposed solutions

Using Swap Calculation Period - Lockout:

IBOR End 23th

Calc start 23rd   Calc end 15th   Pmt day 20th

The rate on the 15th is 'locked' and used over 2 business days – to 20th
Note: some daily resets will be never used.

Using Swap Calculation Period – Backward (2bd) shift:

IBOR End 23th

Calc Period start 17th   Calc end 15th   Pmt date 20th
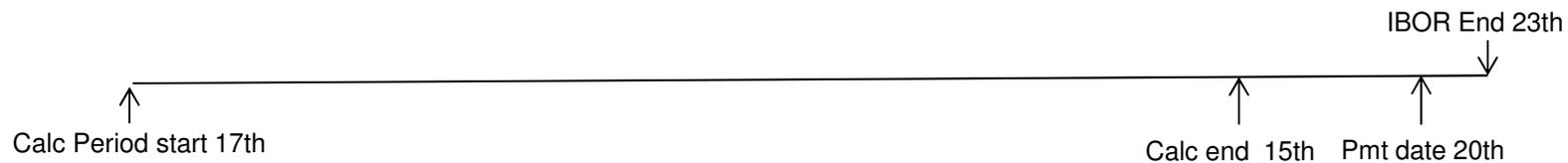
Note: some daily resets will be used twice.

Swap Calculation Approach is preferred.

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New Benchmark – valuation issues

Products similar to new RFR have already been traded in Brazil, see [2].
In [5] it is shown that before t_s forward-looking and backward looking
versions of the fallback valuations of the coupon are the same.

$P(0, t_s)$-$P(0, t_e)$

However vanillas become exotics

The payout of the caplet with a spread s is

$$\delta_f \left(\frac{1}{\delta_f} \left(\prod_{u=T}^{T+f-1\text{bd}} (1 + \delta_u RFR_u) - 1 \right) + S - K \right)^+$$

This is a Geometric Asian option

The valuation methods are further developed in [6], where extended T-forward measure is introduced for $t>T$.
This allows the same framework to price both forward- and backward-looking forwards.
This framework FMM (Forward Market Model) is extension of LMM.

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