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LIBOR Transition

Update on Replacement Indices

May 2021

The London Interbank Offered Rate (LIBOR) Transitioning Out

What is LIBOR?

- The London Interbank Offered Rate (LIBOR) is a benchmark interest rate where major global banks lend to one another in the international interbank market for unsecured short-term loans.
- LIBOR is administered by the Intercontinental Exchange (ICE) which polls banks to get rates that they would charge other banks for short-term loans in various tenors.
- The Financial Conduct Authority (FCA), responsible for regulating LIBOR in the UK, determined the market for unsecured bank to bank lending is no longer sufficiently active to represent the underlying market.

How is it Calculated?

- ICE polls a panel of global banks for each currency and tenor. For USD LIBOR, there are 16 major banks. A trimmed mean approach is used, removing the highest and lowest quartiles, to come to the level published daily.
- In April 2018, the methodology was revised to strengthen the LIBOR calculation by using a waterfall methodology.
  - Level 1 – transaction-based level which takes a volume weighted average of all eligible transactions
  - Level 2 – uses transaction-derived data from a panel bank if it does not have sufficient transactions
  - Level 3 – expert judgement is used

Issues with LIBOR

- The method by which it is calculated has allowed banks to collude by submitting artificially low rates.

Why does the FCA matter?

- The FCA has exhausted its efforts in making LIBOR a sustainable benchmark and consequently has since redirected its attention to executing a smooth transition to an alternative reference rate.
- The FCA continues to work closely with market participants, specifically with the Working Group on Sterling Risk-Free Reference Rates (RFR).
- The RFR recommends the Sterling Overnight Index Average (SONIA) based on overnight interest rates in the wholesale market.
- Other alternative reference rates include Euro Short Term Rate (ESTER), Swiss Average Rate Overnight (SARON) and Tokyo Overnight Average Rate (TONA), however this presentation is focused on the US jurisdiction.

Source: Bloomberg/Citi Research – Libor Transition Overview; Financial Conduct Authority

Benchmark Reform

The Issue: The Cessation of LIBOR

- In 2017, the UK Financial Conduct Authority (FCA) announced the termination of LIBOR and their expectations for the market to transition to a risk-free benchmark.
- On March 5th, 2021, the official sunset date was confirmed: USD LIBOR will be non-representative after June 2023; and all non-USD LIBOR will be discontinued end of 2021.

The Replacement: Secured Overnight Funding Rate (SOFR)

- SOFR, a risk-free index, is an over night rate calculated as a volume-weighted median of transaction level tri-party repo data collected from BNY Mellon, General Collateral Financing (GCF) repo transaction data, and data on bilateral Treasury repo cleared thru Fixed Income Clearing Corporation (FICC).
- Similar to the role the FCA plays in the UK financial markets, the Alternative Reference Rate Committee (ARRC), a group of private-market participants assembled by the Federal Reserve Board, and the NY Fed has been guiding the US market to transition to a LIBOR replacement. However, the goal of recommending a forward-looking term (a rate beyond one year) SOFR by 2021 remains unfulfilled.

Issues with SOFR as a LIBOR Replacement*

SOFR is currently a backward-looking average. But market participants (particularly lenders), are looking for an alternative that includes:

- A forward-looking component
- An unsecured credit-sensitive component that is positively correlated with changes in bank credit, as a SOFR benchmark will create matched funding distortions on a bank's balance sheet.
  - Why? Yields on assets tied to SOFR (like Treasury repo) will *decline* in periods of financial stress (flight to quality) just as bank funding costs *rise*. This gap could worsen the strain.

Alternatives to SOFR:

- American Interbank Offered Rate (AMERIBOR)
- Bloomberg Short-Term Bank Yield Index (BSBY)
- U.S. Dollar ICE Bank Yield Index (BYI)

Source: Barclays; New York Federal Reserve Bank

Summary: LIBOR Replacement Prospects

Reference Rate	What is it?	How is it calculated?	Pros and Cons	Scope of Use
Secured Overnight Funding Rate (SOFR)	Volume-weighted median secured funding rate similar to Fed Funds	Volume-weighted median of transaction level tri-party repo data collected from BNY Mellon General Collateral Financing (GCF) repo transaction data, and Bilateral Treasury repo cleared through Fixed Income Clearing Corporation's (FICC) Delivery vs. Payment repo service	**Pros**: Covers multiple repo market segments, allowing for future market evolution. Overnight, nearly risk-free reference rate that correlates closely with other money market rates; part of the ARRC's transition plan; issuance continues to grow especially in the home loan bank system **Cons:** Not forward looking or credit sensitive; doesn't reflect cost of funds for smaller banks that don't have access to repo markets	Large global banks
American Interbank Offered Rate (AMERIBOR)	Based on small loans or short-term funding between smaller banks; includes commercial paper (30 to 270 days)	Weighted average of executed unsecured borrowing transactions between small and mid-sized banks, broker-dealers and insurance companies on the American Financial Exchange (AFX) platform.	**Pros**: Overnight rate published daily along with 30- and 90-day averages; considers credit spread that SOFR is missing. **Cons**: Not as applicable to larger banks, low daily transaction data, only overnight	Small to mid-size banks
Bloomberg Short-Term Bank Yield Index (BSBY)	All-in yield with overnight, 1-month, 3-month, 6-month and 12-month tenors based off time series on bank spreads from deposits, commercial paper and certificate of deposit transactional data	Three day rolling period on bank spreads from deposits, commercial paper (CP) and certificate of deposit (CDs) transactional data from a dataset that goes back to 2016	**Pros:** Based on data going back to 2016 and International Organization of Securities Commissions (IOSCO) compliant; doesn't rely on subjective input; strongly correlated with LIBOR; utilizes a volume weighted average **Cons**: If either CD or CP volume trends lower requires robust check; not EU BMR compliant; lack of ARRC endorsement; limited history; lack of liquid derivatives market	Large global banks
U.S. Dollar ICE Bank Yield Index (BYI)	Forward-looking, credit-sensitive benchmark, based on actual transaction data for 1-month , 3-month and 6-month tenors	Rolling 5-day collection window, based on primary market bank funding transactions sourced from designated data provider banks and secondary market transactions (min lot size 5mm, min deal size 500mm). Min volume $15B (or 100 transactions) across all maturities	**Pros**: Tracks LIBOR well when normalized to exclude extremes **Cons**: Calculation not formalized; need longer data set to establish integrity	Large global banks

Source: Bloomberg/Citi Research – Libor Transition Overview; BofA Alternative Reference Rates; WSJ: LIBOR Replacement Competitor Gains Strength from New Offerings; TD Securities Virtual Roundtable: Are We Headed to a Multi-Rate Benchmark?

Secured Overnight Funding Rate (SOFR)

What is SOFR?

- SOFR is the official benchmark rate that was set to succeed LIBOR.

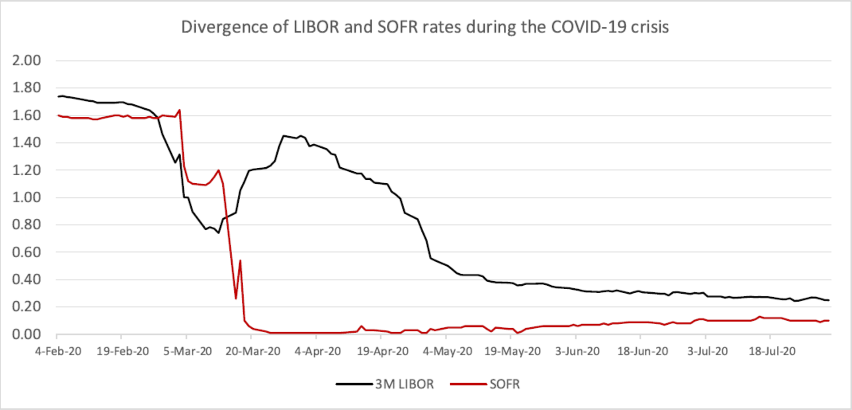
How is it Calculated?

- SOFR is derived from real repurchase agreement ("repo") transaction data from the Broad General Collateral Rate Repo (BGCR) plus data on transactions cleared through the Fixed Income Clearing Corporation's Delivery vs. Payment repo service. Repo is a way to borrow funds, typically on a short-term basis, collateralized in this case by Treasury securities.
- The repo market has three segments: tri-party (where a custodian holds the securities), bilateral (where two parties exchange cash and securities without a custodian) and general collateral (an intra-dealer market, settled through clearing banks).
- This rate is based on actual transaction data from overnight tri-party repo, general collateral financing, and cleared bilateral repo, with all Federal Reserve transactions excluded.

Issues with SOFR as a LIBOR Replacement

- SOFR currently lacks a forward-looking term rate and consideration of credit spread for bank loans.
- Unfortunately, it is unlikely that the Fed will be able to publish an official term repo rate given the lack of liquidity in SOFR futures. A forward-looking term rate would have to be derived from one-and three-month futures.
- Since SOFR comprises repo transactions, it lacks the credit spread bank loans require.
  - Banks' funding costs have risen in the current economic environment, which has required more hedging with LIBOR-linked floating loans. These hedges will not function if they are SOFR-linked due to lack of credit spread.

In March 2020, the Fed's liquidity operations put downward pressure on SOFR while apprehension around Banks' credit pushed LIBOR rates up, resulting in extreme divergence from the LIBOR benchmark.



Source: Bloomberg

Alternative Rate: American Interbank Offered Rate (AMERIBOR)

What is AMERIBOR?

- Ameribor is an overnight rate calculated by the American Financial Exchange (AFX). The AFX is a centralized, electronic, self-regulated, fully transparent platform launched in 2015. Daily postings include the overnight rate the 30-day and 90-day average.

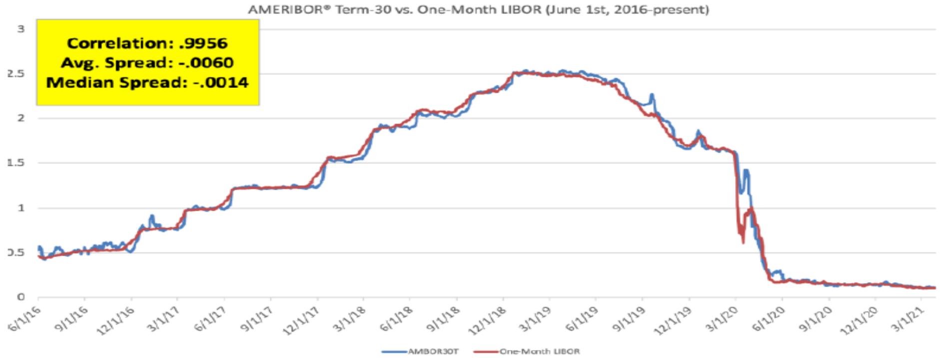
How is it Calculated?

- It is a weighted average of executed unsecured borrowing transactions between smaller banks.
  - Ameribor thus considers the credit spread that SOFR is missing.
  - Ameribor's average rate is historically higher than LIBOR because of the credit impact of smaller banks.

Issues with AMERIBOR as a LIBOR Replacement

- There are listings for seven-day and three-month AMERIBOR futures, but the market is relatively illiquid which, like SOFR, means an inability to create a viable term rate.
- While AMERIBOR does fulfill the needs of bank loans by incorporating a corporate spread and establishing a term, it may be difficult to utilize this as a generalized benchmark.

AMERIBOR Term-30 [Days] vs. One-Month LIBOR (June 1st, 2016-present)



Source: Bloomberg/Citi Research – Libor Transition Overview

Alternative Rate: Bloomberg Short Term Bank Yield Index (BSBY)

What is BSBY?

- BSBY was launched by Bloomberg at the beginning of this year and was accepted by the International Organization of Securities Commissions (IOSCO) as a compliant index rate.
- IOSCO provides market oversight, enforcement when necessary and aims to create efficient global capital markets.
- The BSBY index is established as an all-in yield with overnight, 1-month, 3-month, 6-month and 12-month tenors.
- BSBY measures the average yields investors are willing to invest on a senior unsecured basis.
- The market conventions of BSBY are similar to LIBOR's, which implicates an easier adoption by the market. Market makers are already seeing an appetite for a BSBY derivative market.

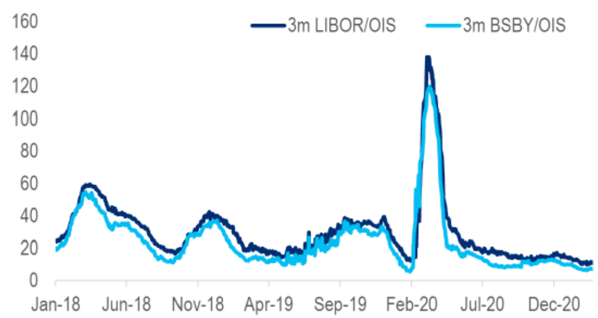
How is it Calculated?

- Using a time series on bank spreads, including data on deposit, commercial paper (CP) and certificates of deposit (CDs) from a dataset starting in 2016. Data points reflect a span of three days and selects only maturities that fall in a defined date range for each tenor. Transactions greater than $500 million are excluded.
- A strength of BSBY is that it utilizes a volume weighted average whereas USD LIBOR is a simple average.
- Tends to track LIBOR, its term structure tends to be flatter due to the overall higher average BSBY credit ratings of the dataset and covers a broader marketplace. LIBOR data is from 16 banks, while BSBY uses about double.

Issues with BSBY as a LIBOR Replacement

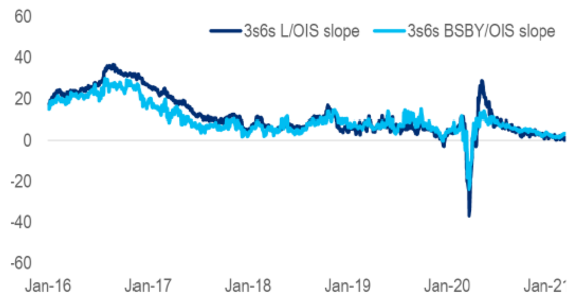
- If the volume of either CD or CP transactions falls materially, BSBY could be called into question.

3m BSBY tends to print below 3m LIBOR because BSBY banks are higher quality



Source: Bloomberg/Citi Research – Libor Transition Overview

BSBY's term structure tends to be flatter than that of LIBOR's



Alternative Rate: ICE Bank Yield Index (BYI)

What is ICE BYI ?

- The ICE Bank Yield Index will be a forward-looking, credit-sensitive benchmark, developed specifically as a potential replacement of LIBOR for dollar lending activity.

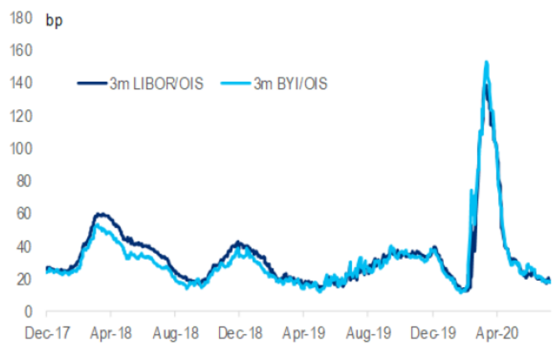
How is it Calculated?

- BYI is based on transaction data for a rolling five-day collection window, which may be extended to additional days, to collect sufficient data. The calculation includes Primary market bank funding transactions sourced form designated data provider banks, and secondary market bond transactions from FINRA TRACE (minimum lot size: $5 million, minimum deal size: $500 million). The minimum volume required for index inclusion is $15 billion (or 100 transactions) across all maturities, if dollars or transactions are "short," the examination period is extended a day.
- The methodology for this index has not been finalized yet. Since 2019, ICE has refined their methodology four times.

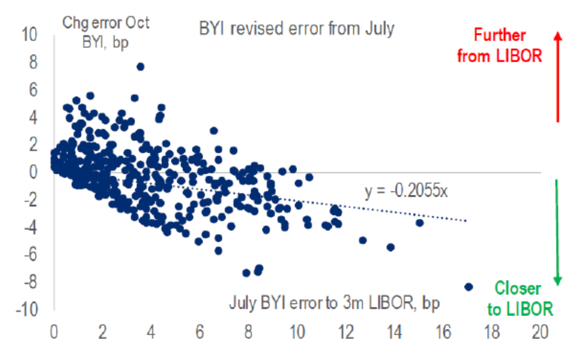
Issues with BYI as a LIBOR Replacement

- Unfortunately, there was a significant discrepancy between the BYI and LIBOR in March 2020.
- There has been significant volatility between each of the four releases, so more time spent on testing this index outside of its sample space will be required before its reliability can be confirmed.

3m BYI is relatively in line with 3m LIBOR especially when normalized by OIS



The Ice Benchmark Administration's (IBA) 3rd BYI release appeared significantly calibrated to USD LIBOR



Source: IBA/Citi Research – Libor Transition Overview