

## LIBOR'S BORROWED TIME?

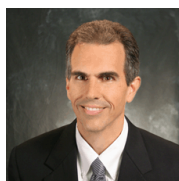
*The London Interbank Offered Rate (LIBOR)<sup>1</sup> permeates nearly every aspect of financial markets (as shown in Figure 1), including consumer and corporate borrowing, interest rate and currency hedging, and investment portfolio and benchmark construction. The British Bankers' Association dubbed LIBOR "the most important number" given its linkage to approximately \$370 trillion of financial products across the globe and the significant role it has played in the development of financial markets over the past 30+ years.*

*While LIBOR has become synonymous with the cost of borrowing, the time has come for a replacement benchmark interest rate. Financial market participants have contemplated replacing LIBOR since the bid-rigging scandal broke during the financial crisis, which served to highlight inherent weaknesses in LIBOR's construction. Given LIBOR's prevalence, a smooth transition to a robust and sustainable replacement is crucial to avoiding significant market disruption. Yet, even with a seamless transition, there will be differences between LIBOR and its replacement.*

*This whitepaper will provide a description of the anticipated replacement index, a comparison to LIBOR, and also discuss the deficiencies with its replacement. We also highlight the phased transition plan and the potential implications of the new index on floating rate bonds, portfolio hedges, and benchmarks.*

*Additionally, PGIM Fixed Income outlines some key conclusions regarding the planned replacement for LIBOR (Secured Overnight Financing Rate - SOFR), particularly:*

- *SOFR is a risk-free rate and will require a risk-premium add-on in order to approximate LIBOR.*
- *SOFR is based upon observable transactions totaling nearly \$800B daily vs. less than \$1B of daily volume supporting 3-month LIBOR.*
- *Initially, SOFR will only be quoted on an overnight basis and the subsequent development of a term curve is critical to ensure widespread adoption.*
- *Legacy bonds that reference LIBOR will not transition easily to SOFR given often inadequate fallback language.*
- *As the market begins to transition to SOFR, LIBOR liquidity might be impacted and may lead to unintended consequences.*



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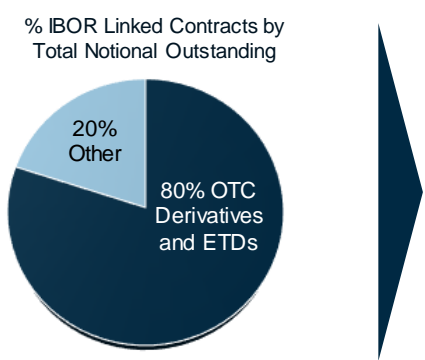
<sup>1</sup> LIBOR reflects the average cost of borrowing for approximately twenty AA- and A-rated banks across seven different maturities, five currencies, and is based upon a combination of observed transactions and estimates/judgement.



FIGURE 1: LIBOR'S MARKET PRESENCE



The main categories of contracts indexed to IBORs include OTC derivatives and ETDs, syndicated loans, securitized products, business loans, retail loans, floating rate bonds and deposits.



Product	Product Examples
OTC Derivatives	• Interest rate swaps, FRAs, cross-currency swaps
ETDs	• Interest rate options, interest rate futures
Loans	• Syndicated loans, business loans, mortgages, credit cards, auto loans, consumer loans, student loans
Bonds and FRNs	• Corporate and non-US government bonds, agency notes, leases, trade finance, FRNs, covered bonds, capital securities, perpetuals
Short Term Instruments	• Repos, reverse repos, time deposits, CDS, commercial paper
Securities Products	• MBS, ABS, CMBS, CLO, CMO
Other	• Late payments, discount rates, overdraft

Source: IBOR Global Benchmark Survey 2018 Transition Roadmap, ISDA February 2018. TIBOR is based upon interbank lending amongst Japanese banks; ETDs = exchange-traded derivatives

## SECTION 1: REPLACEMENT INDEX IN THE U.S.

The discussion and planning for a LIBOR replacement has accelerated recently following a speech by the head of the Financial Conduct Authority (FCA, which began regulating LIBOR in 2013) in July of 2017 indicating that the FCA would no longer compel banks to sustain LIBOR after 12/31/2021.<sup>2</sup> While this announcement doesn't mean that LIBOR will necessarily cease to exist, it does make its future highly uncertain.

While regulators, including the FCA and the Federal Reserve, have expressed a strong interest in transitioning away from LIBOR, several market participants, including the current LIBOR administrator (Intercontinental Exchange Benchmark Administration—ICE BMA) seem to prefer that LIBOR continue to be reported post-2021 even if the method for developing the rate is changed. Despite the significant uncertainty regarding the future of LIBOR, work towards its replacement has begun. On June 22, 2017, the Alternative Reference Rates Committee (ARRC), a Federal Reserve-sponsored industry working group, identified the Secured Overnight Financing Rate (SOFR) as “the most appropriate for wide-spread and long-term adoption as a reference rate.”

SOFR will reflect the volume-weighted median of the previous day's Treasury repo transactions across three categories, which excludes all trades longer than overnight. The specific transaction categories are as follows:

**Tri-party general collateral (GC) repo**, where the counterparties know each other's identity at the time of trade. This accounts for approximately \$280B of daily volume.

**GC Financing (GCF) repo** trades, which are on an anonymous basis and the specific securities provided as collateral are not identified in advance. This represents approximately \$15B of daily volume.

<sup>2</sup> Bailey, A. (2017, July 27). *The Future of LIBOR*. Speech presented at Bloomberg London, London UK. <https://www.fca.org.uk/news/speeches/the-future-of-libor>

**Bilateral** repo market trades that include both GC and security-specific (“specials”) collateral, which will make up approximately \$500B of daily volume. This data set will be trimmed to exclude the lowest quartile of bilateral transaction volume to eliminate the potential distortion of special repos.

SOFR will also exclude bilateral and tri-party repos where the Federal Reserve is a counterparty since those trades are priced at a “policy” rate rather than a market rate. On April 3, 2018 at 8:00 am, the New York Federal Reserve (NY Fed) began its daily reporting of SOFR, which is based upon the prior day’s trading activity. The first reported SOFR rate was set at 1.80%.

## SECTION 2: SOFR VS. LIBOR

When comparing SOFR to LIBOR, it’s clear that SOFR offers several benefits over LIBOR as a benchmark, most notably its construction on the basis of observable transactions. SOFR also has the edge over LIBOR in several other index construction variables, which are bolded in Figure 2 below.

FIGURE 2: INDEX CONSTRUCTION ADVANTAGE: SOFR

<i>Index</i>	<b>Transaction Based</b>	<b>Reliance on “Expert Judgement”</b>	<b>Underlying Volume</b>	<b>Other Short-Term Rate Correlation</b>	<b>Adaptability with Changing Markets</b>
SOFR	<b>100%</b>	<b>0%</b>	<b>&gt;\$800B per day</b>	Yes	<b>Yes</b>
LIBOR <sup>1</sup>	25%	75%	<\$1B per day	Yes	No

1. 3-Month LIBOR between 10/15/2016 through 06/30/2017. Source: IBA 2017 Q3 Report on Volumes; Federal Reserve Governor Jerome H. Powell speech at the Roundtable of the Alternative Reference Rates Committee 11/2/2017

SOFR is less vulnerable to manipulation given substantial volumes of actual/verifiable trades, as depicted in Figure 3. Conversely, LIBOR—despite recent improvements—continues to significantly rely on “expert judgement” or “market-data based” observations in setting borrowing costs in the absence of relevant actual transactions, as shown in Figure 4. Additionally, as markets evolve, SOFR can easily be adjusted to include/exclude additional short-term transactions. LIBOR is also quite rigid, and absent material restructuring, will continue to reflect the results of a survey of large banks that asks a single question “At what rate could you borrow funds...by accepting interbank offers in a reasonable market size?”.

FIGURE 3: AGGREGATE VOLUMES UNDERLYING SELECT MONEY MARKET RATES (\$ BILLIONS)

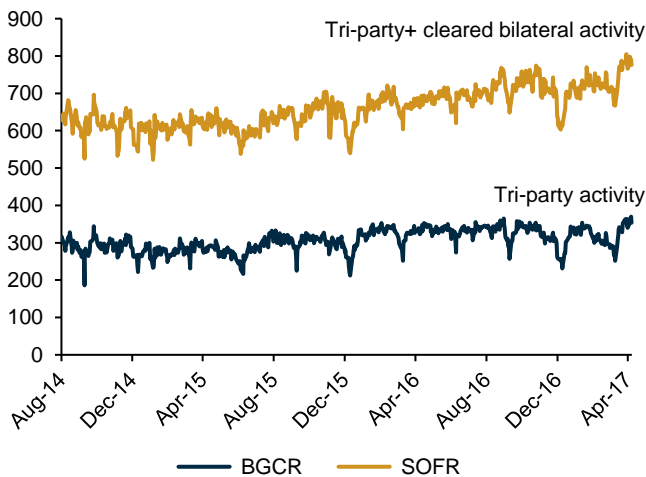
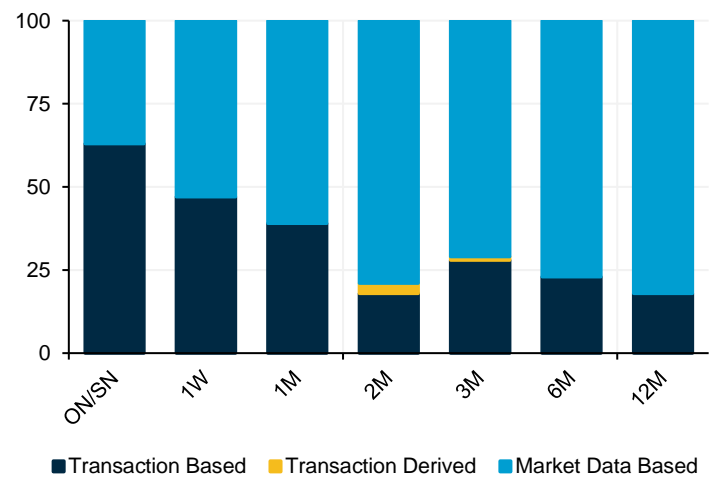


FIGURE 4: SUBMISSION TYPES FOR USD LIBOR PANEL IN Q4 2017 (%)



Source: Figure 3 - NYFED “Introducing the Secured Overnight Financing Rate (SOFR)”, November 2, 2017; BGCR = Broad General Collateral Rate. Historical SOFR data dates back to April 2014 based on a reconstruction of the rate by the NY Fed. Figure 4 - ICE Libor Rate Quarterly Volume Report Q4 2017

While LIBOR has clear deficiencies—relative to SOFR—in its construction, the bolded observations within the variables shown in Figure 5 below demonstrate LIBOR’s superiority in terms of usage flexibility.

The scope of SOFR is quite limited when compared to LIBOR and additional work will be required to enhance SOFR before it can effectively replace LIBOR. LIBOR is currently quoted in seven different tenors (1-day, 7-day, 1-month, 2-month, 3-month, 6-month, and 1-year) across five different currencies. LIBOR also reflects a credit spread that corresponds to double-A/single-A bank risk, while SOFR is only quoted on an overnight basis and represents a risk-free rate.

FIGURE 5: USAGE FLEXIBILITY ADVANTAGE: LIBOR

Index	Tenors	Currencies	Number of Rates Produced Daily	Reflects Changes in Risk-Free Rate	Reflects Changes in Credit Spreads
SOFR	1 (overnight)	1	1	Yes	N/A
LIBOR	<b>7</b>	<b>5</b>	<b>35</b>	Yes	<b>AA/A Bank Credit Spreads</b>

1. 3-Month LIBOR between 10/15/2016 through 06/30/2017. Source: IBA 2017 Q3 Report on Volumes; Federal Reserve Governor Jerome H. Powell speech at the Roundtable of the Alternative Reference Rates Committee 11/2/2017

SOFR also has some unique volatility- and correlation-characteristics. Specifically, SOFR is more volatile than LIBOR, most likely due to the nature of the benchmarks, as Figure 6 highlights. SOFR represents actual trades while LIBOR maintains an “appraisal bias” given reliance on estimates and expert judgement which serves to dampen volatility. Additionally, SOFR demonstrates significant quarter-end volume and rate changes. As shown in Figure 7, quarter-end SOFR rates spike (and volumes decline by 11%), most likely reflecting balance sheet pressures and leverage ratio management.

FIGURE 6: ONE MONTH ROLLING VOLATILITY (BPS)

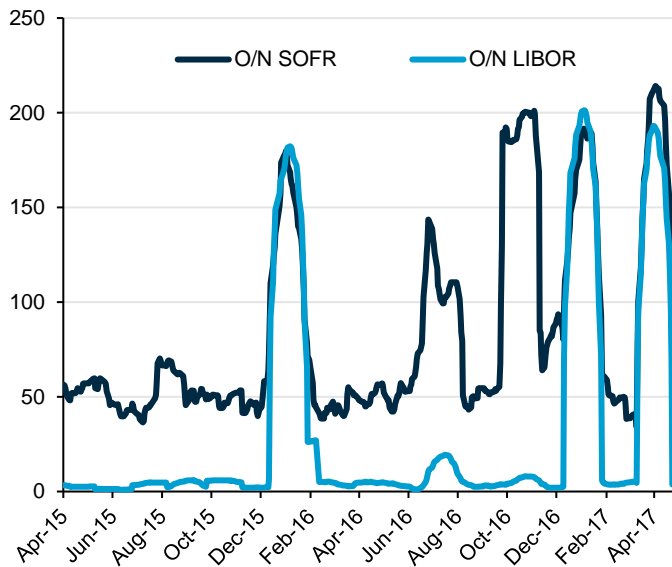


FIGURE 7: QUARTER-END RATES (BPS)

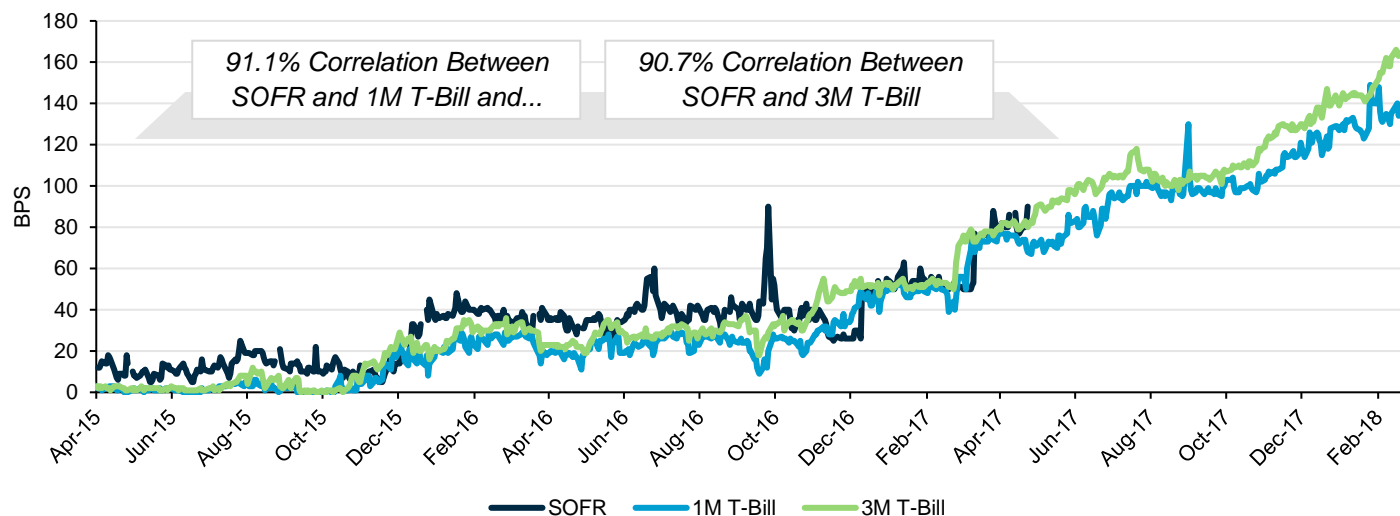
	O/N SOFR	O/N Libor	Difference
Q3 2014	4.0	1.0	3.0
Q4 2014	2.0	3.1	-1.1
Q1 2015	8.0	0.9	7.2
Q2 2015	6.0	1.3	4.7
Q3 2015	12.0	1.8	10.2
Q4 2015	10.0	9.2	0.8
Q1 2016	6.0	0.8	5.2
Q2 2016	20.0	1.0	19.0
Q3 2016	45.0	0.4	44.6
Q4 2016	7.0	0.9	6.1
Q1 2017	12.0	0.8	11.2
<b>Average</b>	<b>12.0</b>	<b>1.9</b>	<b>10.1</b>

Source: Bloomberg as of April 2018. Historical SOFR data dates back to April 2014 based on a reconstruction of the rate by the NY Fed.

SOFR is highly correlated with Treasury bill (T-bill) rates and issuance, shown in Figure 8. As T-bill volume ramps higher, the T-bill rate (and SOFR) should rise to attract sufficient demand. Given the recent suspension of the debt ceiling, the Treasury has indicated plans for record issuance volume in 2018, which should pressure T-bill rates (and SOFR) higher. LIBOR, while influenced by supply in short-term markets, is often more reflective of movements in bank credit spreads, particularly during times of financial stress.



FIGURE 8: TREASURY BILLS AND SOFR YIELD COORELATION



Source Bloomberg as of April 2018. Historical SOFR data dates back to April 2014 based on a reconstruction of the rate by the NY Fed.

### SECTION 3: THE ROAD AHEAD FOR SOFR

SOFR has been recognized as a leading LIBOR replacement candidate, however three material deficiencies need to be addressed before SOFR can effectively serve as a LIBOR replacement.

#### Need to Derive a Replacement Index for Each LIBOR Currency

A separate LIBOR curve exists for each of five currencies including U.S. dollar (USD), Euro (EUR), pound sterling (GBP), Japanese yen (JPY), and Swiss franc (CHF). Rather than create a single replacement index, each jurisdiction is working towards its own unique solution. For example, a Bank of England working group has recommended SONIA (Sterling Overnight Index Average Rate) as a replacement for GBP LIBOR.

#### Need to Derive a “SOFR Term Curve”

The vast majority of LIBOR-related instruments reference a tenor greater than the overnight rate. If SOFR is to replace LIBOR, market participants/regulators need to derive a “SOFR term curve” with tenors corresponding to LIBOR. For example, the interest rate on a bank loan that references 3-month LIBOR will need to be replaced by the equivalent of 3-month SOFR.

Market participants expect to derive a term curve based upon liquid trading in new financial products including SOFR-based swaps, SOFR futures, and SOFR-LIBOR-Fed Funds basis swaps. If sufficient liquidity develops in these products, various SOFR tenors could simply be observed from rates on longer-term trades in these products (equate to market expectations of daily-compounded SOFR at various tenors). This method of deriving a term curve already exists for the Effective Fed Funds Rate (EFFR), where an EFFR term out to 30 years is derived from trading in EFFR overnight indexed swaps (OIS). The Chicago Mercantile Exchange (CME) has announced that it will launch monthly and quarterly SOFR futures on May 7, 2018.

#### Need to Reflect a SOFR Compensating Spread (risk premium)

SOFR is a risk-free rate while LIBOR reflects both a risk-free rate plus a risk premium that is consistent with the underlying double-A/single-A credit ratings of the LIBOR-panel banks. As a result, a “compensating spread” needs to be added to SOFR in order for it to approximate LIBOR. This compensating spread should ideally vary based upon current credit conditions.

As shown in Figure 9, the overnight SOFR/LIBOR basis has averaged around 4 bps but has been as wide as +25 bps over the past three years (SOFR history is only available from 2014). The 3-month geometric mean of SOFR (meant to approximate a 3-month SOFR rate) is approximately 34 bps less than 3-month LIBOR but the spread would have been far wider (+365 bps) during the financial crisis as illustrated in Figure 10 (EFFR OIS is used as a substitute for SOFR).

FIGURE 9: OVERNIGHT SOFR/LIBOR BASIS (BPS)

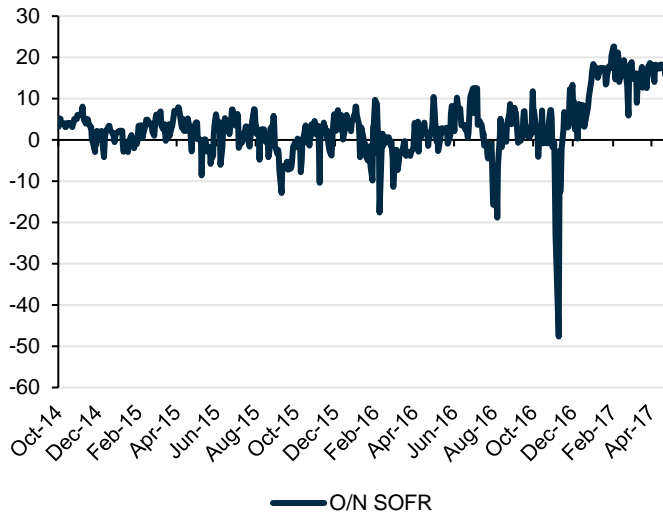
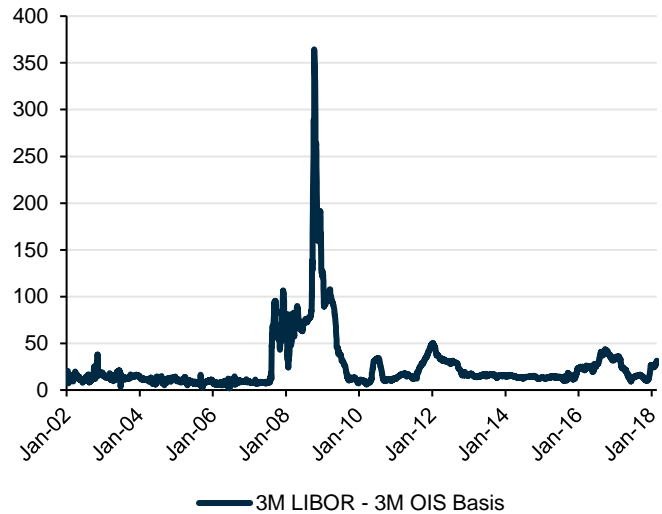


FIGURE 10: 3-MONTH LIBOR/3-MONTH OIS BASIS (BPS)



EFFR OIS is used as a substitute for SOFR. Historical SOFR data dates back to April 2014 based on a reconstruction of the rate by the NY Fed. Source: Bloomberg as of April 2018.

The International Swaps and Derivatives Association (ISDA) has proposed a method of defining the basis between SOFR and LIBOR over the next several years as a risk-premium proxy. A “snapshot” will be taken of the SOFR/LIBOR basis at some point and the resulting “Snapshot Basis” may remain fixed (Credit Adjusted SOFR = SOFR + Snapshot Basis). The Snapshot Basis would likely be an average of the SOFR/LIBOR basis over some period of time to reduce the potential for manipulation and to make the Snapshot Basis less reliant on a particular credit spread environment.<sup>3</sup>

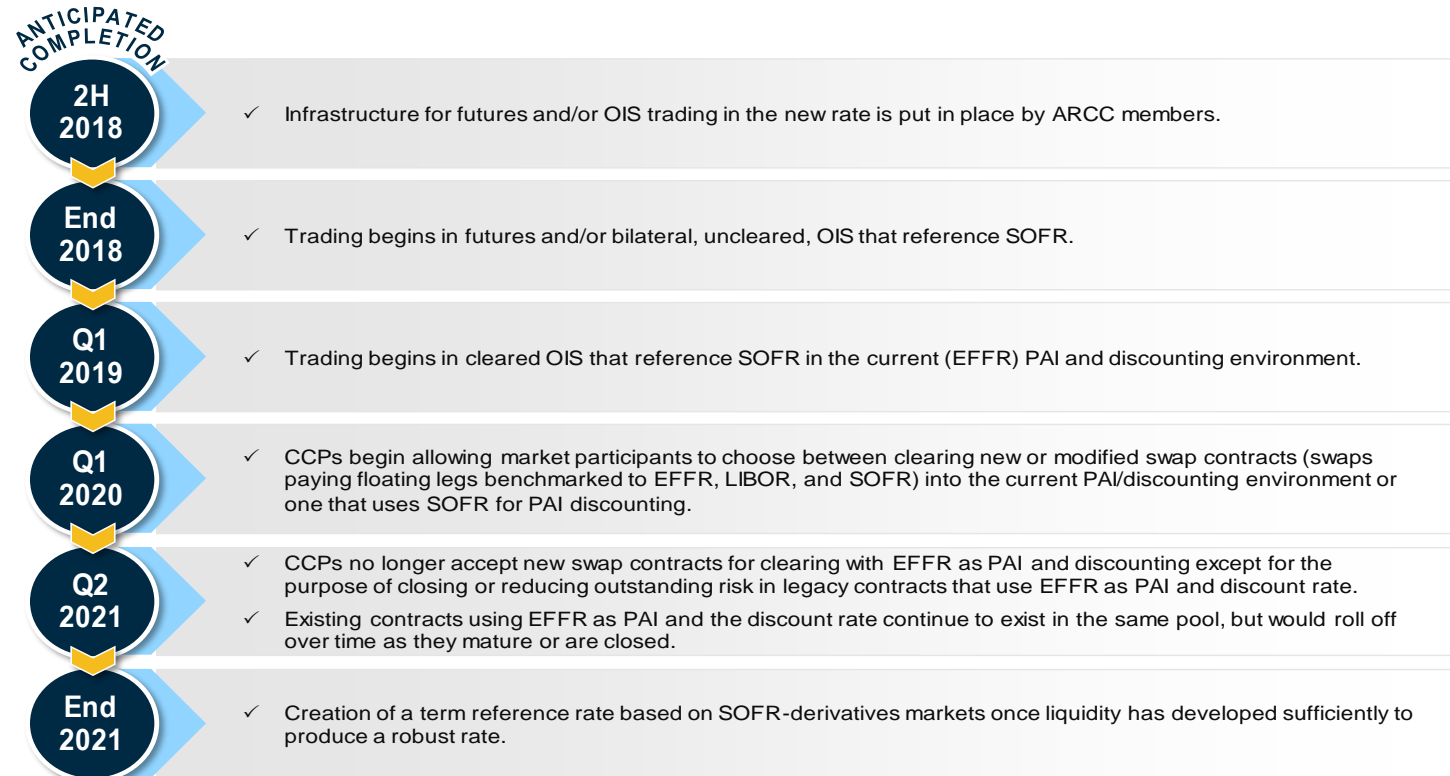
If the compensating spread is fixed, SOFR will not approximate the dynamic credit spread volatility exhibited by current-day LIBOR. For example, LIBOR rose relative to Treasury repo rates given substantial (but short-lived) market stress in late-2016, a trend which recently reemerged during the recent bout of market volatility. This spike benefitted investors in floating-rate bonds (and fixed-rate swap payers) but the benefit would not have been realized under a static compensating spread regime. If investors rely on LIBOR to hedge credit risk, a SOFR + a fixed compensating spread might be a poor replacement.

#### SECTION 4: TRANSITION PLAN TO THE NEW INDEX

The ARRC has established the following timeline (Figure 11) for the transition to SOFR. Note that the ARRC doesn’t expect term SOFR rates to be produced until the end of 2021, which coincides with the timeframe when the FCA will no longer compel banks to make LIBOR submissions, leaving no room for error. Additionally, there is some market skepticism that sufficient liquidity will develop in the new SOFR-based products, which is a prerequisite to deriving longer-tenor SOFR rates.

<sup>3</sup> - <https://www.fca.org.uk/n> <https://www.isda.org/a/vKiDE/development-of-fallbacks-for-libor-and-other-key-ibors.pdf>

FIGURE 11: PACED TRANSITION PLAN



CCP = Central Counterparty; PAI = Price Alignment Interest. Source: U.S. Alternative Reference Rates Committee, IBOR Global Benchmark Survey 2018 Transition Roadmap

## SECTION 5: POTENTIAL INVESTMENT IMPLICATIONS

The timing and path of a transition to a LIBOR replacement remains highly uncertain despite detailed planning by the ARRC, ISDA, and the CME. While it's still very early in the process and the form of an "ultimate solution" is still unknown, fixed income investors should continue to monitor developments in LIBOR and SOFR with a focus on the following:

### Are the SOFR derivative products embraced by market participants, and is liquidity sufficient?

The development of an active and liquid SOFR derivative market is the most critical milestone in the ARRC transaction plan and is a prerequisite for the development of a SOFR-term curve. Floating rate cash products (as opposed to derivatives) that reference a LIBOR tenor longer than overnight, including structured products, consumer loans, and business loans, are estimated to exceed \$8 trillion. If the ARRC plan to develop a SOFR term curve based upon derivative trading fails or is otherwise delayed, the interest rate benchmark and reset mechanism for these products may become highly uncertain and credit spreads may widen in response, particularly if it appears that LIBOR will cease to be published post-2021.

### Has the market agreed on a SOFR compensating (credit) spread and is that spread static or dynamic?

#### Option 1 – no compensating spread

The replacement interest rate would decline relative to LIBOR and would trigger a transfer of value from floating rate receivers/floating rate bondholders to floating rate payers/floating rate borrowers. Investors with exposure to floating rate bonds, loans, and benchmarks would lose economic value. *This is the least attractive of the proposed solutions, and given the potential market disruption that this option may cause, we do not believe it will be the chosen alternative.*

## Option 2 – static compensating spread

Any transfer of value might be minimal depending upon the level of the spread but investors would lose a dynamic hedge against future credit environments that differed from the period when the static spread was derived.

## Option 3 – dynamic compensating spread

Minimal impact on investors given no value transfer and a reference rate that dynamically adjusts to current-day credit conditions. *This option is PGIM Fixed Income's preferred solution, however it's adoption seems unlikely.*

### LIBOR fallback language for derivatives and floating rate assets

#### 1. Inconsistent and often inadequate fallback provisions

Investors, with help from their investment managers, should understand the implications for legacy derivatives and bonds if LIBOR ceases to exist in its current form. Legacy bonds (floating rate notes, floating rate structured products, floating rate mortgages, and loans) are more problematic than derivatives since no standard exists for “fallback language” that describes the process of determining a reference rate without LIBOR. In the absence of LIBOR, many legacy bonds will transition to a fixed rate (continue to reference the most recent LIBOR quote prior to its cessation) while other bonds will transition to the Prime Rate, and still others are “undetermined” given a lack of fallback language. PGIM Fixed Income has been particularly active in drafting new fallback language for structured product transactions that allows flexibility given the uncertain nature of the ultimate replacement index while ensuring debt investors are paid an appropriate rate. As an example, PGIM Fixed Income has created a LIBOR fallback template for CLO transactions that has received some traction in the market and has been adopted by some issuers.

#### 2. Need for more flexible fallback triggers

Legacy bonds typically require that LIBOR no longer be published (“fallback trigger”) before reverting to a fallback interest rate. As a result, a potential solution for inadequate fallback language in legacy bonds is to ensure that LIBOR simply continues to be published post-2021. In fact, the current administrator of LIBOR (ICE BMA) does intend to continue to publish LIBOR even after the FCA will no longer compel banks to make LIBOR submissions, although it has not specified how a “post-2021 LIBOR” would be constructed. The continuation of LIBOR post-2021 would be problematic if its construction resulted in a far weaker and even less relevant interest rate (perhaps based upon submissions from a single panel bank). Under this scenario, legacy bonds would continue to reference this “zombie LIBOR” since the fallback language would not be triggered, even though a far more robust alternative interest rate might be available.

To avoid this risk in new transactions, fallback triggers should be expanded to include (a) a change in the calculation of LIBOR and/or (b) the creation of an alternative benchmark that has been recognized as an industry standard. As a result, a transaction that incorporated these additional triggers would switch to a more robust interest rate as soon as that rate becomes available even though LIBOR might continue to be published, thereby avoiding the potential “zombie LIBOR” problem.

### Potential interest rate mismatch (basis risk) in structured product transactions

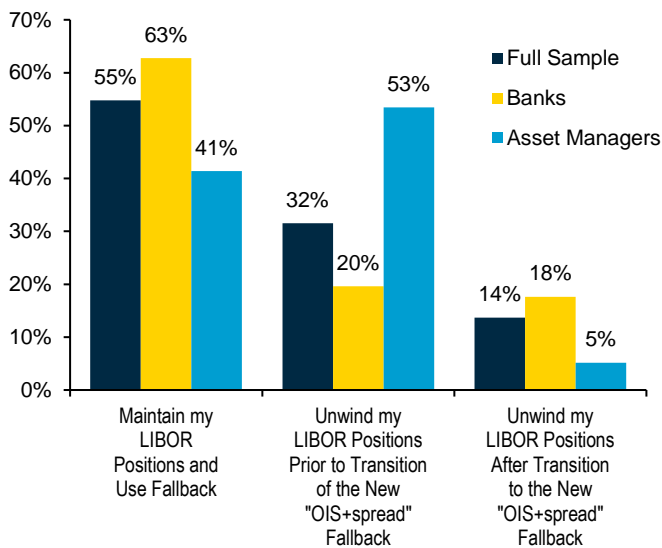
Even if fallback language is enhanced to ensure structured product bondholders receive fair compensation in the absence of LIBOR, a mismatch within the transaction could result if the interest rate on the underlying assets in those structured product transactions doesn't adjust in a similar fashion. For example, if the bonds issued from a particular CLO transition from 3-month LIBOR to 3-month SOFR + a fixed compensating spread but the underlying corporate loans continue to reference 3-month LIBOR, the potential for a mismatch between the two measures of interest rates will result, and any differences could negatively impact credit performance of the CLO bonds. In order to prevent this “basis risk”, the investment community needs to ensure the fallback triggers and fallback provisions for floating rate assets (corporate loans, commercial real estate loans, auto loans, etc.), and floating rate liabilities (CLO bonds, CMBS bonds, auto bonds) are identical. This goal could be difficult to achieve since the borrowers on the underlying assets have different economic incentives than bondholders and may not agree to similar provisions.



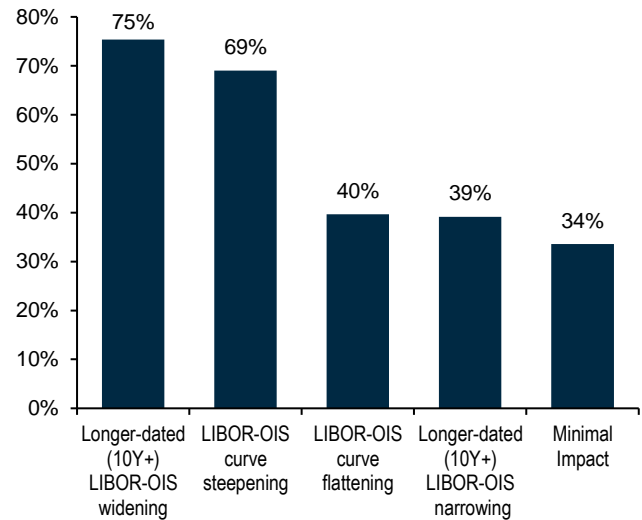
**LIBOR liquidity issues**

As liquidity in the SOFR derivative market improves, liquidity in the LIBOR derivative market may deteriorate. Market participants, (in anticipation of reduced LIBOR liquidity), might consider replacing interest rate and foreign exchange swaps with OIS (more akin to SOFR), futures, or other derivative positioning in advance of SOFR derivatives that may hasten LIBOR liquidity problems. While it's difficult to estimate the impact of such a scenario, one possible outcome is a widening of swap spreads particularly at the long end given reduced "receive fixed" demand. In fact, the results from a recent investor survey, shown in Figures 12 and 13, highlight this market expectation:

**FIGURE 12: IF LIBOR IS DISCONTINUED IN YOUR CURRENCY AND FALLS BACK TO "OIS+SPREAD", WHAT IS YOUR LIKELY RESPONSE? (%)**



**FIGURE 13: WHAT DO YOU EXPECT TO BE THE MARKET IMPACT OF A MOVE AWAY FROM LIBOR? (%)**



Source: Bank of America Merrill Lynch as of October 2017.

**Conclusion**

*Despite its shortcomings, LIBOR's footprint on the financial markets remains immense, which further underscores the importance of a smooth transition to a new benchmark interest rate. And while SOFR has been pegged as the most suitable replacement, several associated frailties will need to be reconciled in order for SOFR to adequately serve as LIBOR's replacement. Undoubtedly, the transition to a more robust replacement index promises to be long, but the resolution of these deficiencies, along with thorough planning on the part of regulators and market participants should help to ensure that the path to the target phase-out date for LIBOR is not too difficult.*

*Regardless, investors should track progress on key milestones in the ARRC transition plan and reassess expectations if the plan changes.*

*PGIM Fixed Income remains actively involved in the transition to a new market reference rate and has assumed active and leading roles in various trade association LIBOR working groups (Commercial Real Estate Finance Council (CREFC), Loan Syndication and Trading Association (LSTA), and the Structured Finance Industry Group (SFIG) along with active involvement with the ARRC, the International Swaps and Derivatives Association (ISDA), and the Securities Industry and Financial Markets Association (SIFMA).*

**NOTICE: IMPORTANT INFORMATION**

Source(s) of data (unless otherwise noted): PGIM Fixed Income as of April 2018.

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2018-1409