EXPERT REPORT OF DR. FATEN SABRY

10 April 2024

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I. ASSIGNMENT AND SUMMARY OF OPINIONS

1. I have been retained and instructed by Slaughter and May on behalf of Standard Chartered PLC ("**Standard Chartered**") to provide an expert opinion relating to the rate of dividends payable on certain preference shares that Standard Chartered issued. The rate of dividends payable on the preference shares is indexed to 3-month U.S. Dollar London Interbank Offered Rate ("**3-month USD LIBOR**"). I have been asked to opine on the possible alternative benchmark rates that could replace LIBOR as the reference rate for the preference shares. A benchmark rate is a publicly accessible interest rate that may be used as a reference rate in financial products.

2. On December 8, 2006, Standard Chartered issued 7,500 dollar-denominated perpetual preference shares with a total paid up amount of $100,000 (nominal value of $5 plus a premium of $99,995) per share ("**Preference Shares**") that were sold in the form of American Depository Shares ("**ADSs**") to raise capital for general business purposes.[1] The Preference Shares rank "*pari passu inter se and pari passu*" with certain pre-existing preference shares (subject to certain exceptions), and in priority to ordinary shares.[2] The Preference Shares are redeemable with the paid up amount of $100,000 payable on redemption, plus any accrued and unpaid dividends at the time of redemption.[3] The ADSs trade over the counter through a network of dealers.[4] The ADSs representing the Preference

[1] Standard Chartered, PLC, *7,500 American Depositary Shares Representing 7,500 Non-Cumulative Redeemable Preference Shares*, December 2006 ("**2006 Offering Circular**"), 8.

American Depository Shares represent an interest in the shares of a non-U.S. company. See, Office of Investor Education and Advocacy, *Investor Bulletin: American Depository Receipts*, Securities and Exchange Commission, August 2012, 1.

Unless otherwise stated, all references to "$" means U.S. Dollars.

[2] 2006 Offering Circular, 8.

[3] 2006 Offering Circular, 9-10.

[4] The Preference Shares are offered and sold in two tranches, the Rule 144A tranche and the Regulation S tranche, with identical terms. The Rule 144A tranche is offered only to qualified institutional buyers (QIBs) in the U.S. and the Regulation S tranche is offered to investors outside of the U.S.

As of February 14, 2024, the Rule 144A shares could be purchased at 96.76 percent of par ($100,000) and sold at 95.69, based on Bloomberg quotes supplied by six dealers. The Regulation S shares could be bought at 96.44 and sold at 96.14, based on Bloomberg quotes by 14 dealers. Past volume information for the Rule 144A shares is not available, while for the Regulation S shares, Bloomberg reported for the month of December 2023, there were 28 trades with a total face value of $30,900,000 (309 shares traded).

CUSIP and the ISIN number for the Rule 144A tranche are 853254AA8 and US853254AA86, respectively. The CUSIP and the ISIN number for the Regulation S tranche are G84228AT5 and USG84228AT58, respectively. See, 2006 Offering Circular, 11, 64.

Shares are also admitted to the Financial Conduct Authority's ("**FCA**") Official List and to the London Stock Exchange's Professional Securities Market.[5]

3. Dividend payments are calculated on the paid up amount of $100,000 per share. The dividend rate is similar to an interest rate used to calculate a coupon for a bond. Between the issuance date of December 8, 2006 until, but excluding, January 30, 2017, dividends were calculated at a fixed rate of 6.409 percent per annum, payable semi-annually in equal installments in arrears.[6] From January 30, 2017 until, but excluding, the date the Preference Shares are redeemed, dividends are calculated on the paid up amount of $100,000 per share at the rate of 1.51 percent per annum plus 3-month USD LIBOR, payable quarterly in arrears.[7]

4. The Preference Shares are currently in the floating rate dividend period, where dividends are to be calculated with reference to 3-month USD LIBOR. The offering document defines 3-month USD LIBOR as the "*three month London interbank offered rate for deposits in US dollars which appears on page 3750 of Moneyline Telerate as of 11:00 a.m., London time, on the second business day in London prior to the first day of the relevant Dividend Period*."[8] If 3-month USD LIBOR is not available, then Standard Chartered should use a rate based on quotations for deposits for three months in U.S. Dollars ("**USD**") requested from principal London offices of four major reference banks in the London interbank market. If Standard Chartered does not receive at least two quotations from banks in London, then Standard Chartered should obtain quotes for three-month loans in USD to leading European banks from three major banks in New York. If no such quotations are available from banks in New York, then Standard Chartered should use the "*three month US*

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[5] "The Official List," Financial Conduct Authority, https://marketsecurities.fca.org.uk/officiallist. (Accessed March 7, 2024).

See, also, "STANDARD CHARTERED PLC," London Stock Exchange, https://www.londonstockexchange.com/stock/58HA/standard-chartered-plc/company-page. (Accessed March 7, 2024).

[6] 2006 Offering Circular, 28. The semi-annual dividend payment on each Preference Share amount to $3,204.50, except the first payment which amount to $4,130.24.

[7] 2006 Offering Circular, 28.

[8] 2006 Offering Circular, 34.

dollar LIBOR in effect on the second business day in London prior to the first day of the relevant Dividend Period."[9]

5. On November 8, 2022, Standard Chartered launched a consent solicitation process to amend the terms of the Preference Shares under which dividend payments are calculated for each dividend period commencing on or after January 30, 2023.[10] At the time, the publication of 3-month USD LIBOR was expected to cease on June 30, 2023, and it did in fact cease on that date.[11] Specifically, the proposal put forward in the consent solicitation process provided that the calculation of dividends with reference to 3-month USD LIBOR would be limited to the period between January 30, 2017 to January 30, 2023. After January 30, 2023, dividends, payable quarterly, would be calculated on the paid up amount of $100,000 at the rate of 1.51 percent per annum, plus a credit adjustment spread of 26.161 basis points per annum, plus Secured Overnight Financing Rate ("**SOFR**") compounded over the quarterly dividend period.[12] SOFR is a rate that is based on secured, overnight repurchase agreement transactions.[13] In an overnight repurchase agreement transaction, the securities sold are bought back the following day at a higher price.[14] SOFR compounded over the period is a backward-looking rate since it is calculated using historical daily SOFR values to reflect a sequence of realized overnight rates for a specific "term," in this case, over the quarterly dividend period. Under compounded averages, interest earnings are left to earn more interest.[15] Each day, interest is calculated on the principal borrowed and the accumulated unpaid interest.[16]

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[9] 2006 Offering Circular, 34.

[10] Standard Chartered, PLC, *Consent Solicitation Memorandum and Notices of Class Meeting*, November 8, 2022 ("**Consent Solicitation Memorandum**"), 48, 56.

[11] "Announcements on the end of LIBOR," Financial Conduct Authority, March 5, 2021, https://www.fca.org.uk/news/press-releases/announcements-end-libor. (Accessed March 7, 2024).

See, also, "The US dollar LIBOR panel has now ceased," Financial Conduct Authority, July 3, 2023, https://www.fca.org.uk/news/news-stories/us-dollar-libor-panel-has-now-ceased. (Accessed March 7, 2024).

[12] Consent Solicitation Memorandum, 10, 48-49.

100 basis points (bps) is equal to 1 percent.

[13] "Secured Overnight Financing Rate Data," Federal Reserve Bank of New York, https://apps.newyorkfed.org/markets/autorates/SOFR. (Accessed March 7, 2024).

[14] Michael J. Fleming and Kenneth D. Garbade, "The Repurchase Agreement Refined: GCF Repo," Federal Reserve Bank of New York: Current Issues in Economics and Finance, Volume 9, No. 6 (2003): 1-7, 1.

[15] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 116.

[16] Alternative Reference Rates Committee, *A User's Guide to SOFR*, April 16, 2019, 5.

6. On January 4, 2023, Standard Chartered announced that despite 67 percent of the votes being cast in favor of the proposal, the resolution was not passed. As a result, the amendments were not implemented.[17]

7. On April 3, 2023, the FCA announced that based on a survey of responses from market participants, it would require the Intercontinental Exchange's Benchmark Administration Limited ("**IBA**") to continue publication of 1-, 3- and 6-month USD LIBOR settings "*using an unrepresentative 'synthetic' methodology*" ("**Synthetic LIBOR**").[18] The methodology is synthetic because it is not based on interest rates from LIBOR panel banks. As a result, the rate is not representative of the underlying market that LIBOR was intended to measure.[19] The IBA started publishing 1-, 3- and 6-month synthetic USD LIBOR on July 3, 2023, calculated using a forward-looking term rate plus a spread adjustment, following the cessation of USD LIBOR on June 30, 2023.[20] The FCA selected the term SOFR rate published by the Chicago Mercantile Exchange ("**CME**") Group Benchmark Administration, ("**CME Term SOFR**"). CME Term SOFR is a forward-looking rate for SOFR over a specific time period, such as 3 months, that is calculated based on market expectations for SOFR in the future.[21] The CME Group Benchmark Administration is a benchmark administrator that is regulated by the FCA. As a benchmark administrator, it provides various products and benchmarks using data from CME Group's markets.[22] CME Group is a

[17] Standard Chartered, PLC, *Results of Class Meetings*, January 4, 2023, 1-2.

Although 67 percent of 1,057 submitted votes were in favor of the resolution, there were no votes for 6,443 shares.

[18] "FCA announces decision on synthetic US dollar LIBOR," Financial Conduct Authority, April 3, 2023, https://www.fca.org.uk/news/news-stories/fca-announces-decision-synthetic-us-dollar-libor. (Accessed March 7, 2024).

[19] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.ice.com/IBA/LIBOR. (Accessed March 7, 2024).

[20] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.ice.com/IBA/LIBOR. (Accessed March 7, 2024).

[21] "CME Term SOFR Reference Rates – Frequently Asked Questions," Chicago Mercantile Exchange Group, April 26, 2023, https://www.cmegroup.com/articles/faqs/cme-term-sofr-reference-rates.html. (Accessed March 7, 2024).

[22] "CME Group Benchmark Administration," Chicago Mercantile Exchange Group, https://www.cmegroup.com/market-data/cme-group-benchmark-administration.html#money-market. (Accessed March 7, 2024).

derivatives marketplace offering a wide range of products, including futures and options.[23] Synthetic 3-month USD LIBOR ("**3-month Synthetic LIBOR**") is calculated as 3-month CME Term SOFR plus a fixed spread adjustment of 26.161 basis points ("**3-month ISDA Spread Adjustment**"), as determined by International Swaps and Derivatives Association ("**ISDA**") guidelines.[24] Like USD LIBOR, CME Term SOFR is a forward-looking rate and is calculated and published for 1-month, 3-month, 6-month and 12-month tenors.[25] The FCA has stated that synthetic LIBOR is a "*fair and reasonable approximation of what LIBOR might have been had it continued to exist*" and would allow for an orderly wind-down of LIBOR.[26] Synthetic LIBOR would also allow legacy contracts to continue to function and consumers could achieve fair outcomes under a "*robust, synthetic methodology that provides a fair approximation of the value panel-bank US dollar LIBOR.*"[27]

8. Following the FCA notice, Standard Chartered announced on June 19, 2023 that dividends would be calculated by reference to 3-month Synthetic LIBOR for the

[23] "CME Group Benchmark Administration," Chicago Mercantile Exchange Group, https://www.cmegroup.com/market-data/cme-group-benchmark-administration.html#money-market. (Accessed March 7, 2024).

A derivative is a contract whose value is derived from an underlying financial instrument, index, or interest rate. See, Frank J. Fabozzi, *The Handbook of Financial Instruments* (Hoboken: John Wiley & Sons, Inc., 2002, 2nd Edition), 12.

A futures contract is an agreement to buy or sell an asset at a pre-determined price at a specified time in the future. See, Frank J. Fabozzi, *The Handbook of Financial Instruments* (Hoboken: John Wiley & Sons, Inc., 2002, 2nd Edition), 13.

An option contract represents the right, but not obligation, to buy or sell a financial product at an agreed-upon price. See, Frank J. Fabozzi, *The Handbook of Financial Instruments* (Hoboken: John Wiley & Sons, Inc., 2002, 2nd Edition), 13.

[24] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.ice.com/IBA/LIBOR. (Accessed March 7, 2024).

[25] "CME Term SOFR Reference Rates – Frequently Asked Questions," Chicago Mercantile Exchange Group, April 26, 2023, https://www.cmegroup.com/articles/faqs/cme-term-sofr-reference-rates.html. (Accessed March 7, 2024).

[26] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 4.

[27] Financial Conduct Authority, *Article 23D Benchmarks Regulation – Draft Notice of Requirement*, April 3, 2023, 6.

dividend period commencing on July 31, 2023.[28] Publication of synthetic LIBOR is expected to cease on September 30, 2024.[29]

9. I have been asked by my instructing solicitors to address the following questions.

a. Why was LIBOR used in the financial markets and what are the main attributes and challenges with LIBOR as a reference rate? How have the problems with LIBOR been addressed and what part has been played by the use of Synthetic LIBOR?

b. What alternative benchmark rates have emerged to replace LIBOR? What features do these alternative benchmark rates have, and how do they differ from LIBOR?

c. What adjustments, for term and spread relative to LIBOR, are appropriate to account for differences in tenor, credit risk, and other key attributes of the alternative benchmark rates?

d. How well have the alternative benchmark rates, with term and spread adjustments, tracked LIBOR?

e. Are the alternative benchmark rates supported by liquidity in their respective underlying markets and transaction volume?

f. How suitable are the alternative benchmark rates in the context of replacing LIBOR for the Preference Shares? Is there a general consensus in the market, among industry participants or regulators, as to the main alternatives?

10. My opinions are summarized as follows:

[28] Standard Chartered, PLC, *Announcement on move to synthetic 3 month USD LIBOR for Standard Chartered PLC's 6.409% non-cumulative redeemable preference shares*, June 19, 2023, 1.

[29] "FCA announces decision on synthetic US dollar LIBOR," Financial Conduct Authority, April 3, 2023, https://www.fca.org.uk/news/news-stories/fca-announces-decision-synthetic-us-dollar-libor. (Accessed March 7, 2024).

a. LIBOR grew in prominence and popularity and was widely used as a reference rate from the 1980s. In 2006, the year the Preference Shares were issued, floating and variable rate debt issuances indexed to USD LIBOR were $1,038 billion, or 78 percent of the total USD floating and variable rate debt issuances of $1,338 billion. At the time, LIBOR was indicative of the cost of interbank unsecured lending based on a qualitative survey from a select group of major international banks referred to as the panel banks. Following the financial crisis, the status and credibility of LIBOR came into question. For example, there was a continuing decline in the transaction volumes on which LIBOR was based and there were concerns about the sensitivity of LIBOR to liquidity conditions. In addition, allegations of collusion among panel banks to manipulate rates beginning in 2008 led to criminal and regulatory investigations and resulted in fines being imposed on various banks and traders between 2012 and 2019. As noted above, LIBOR was discontinued on June 30, 2023. Subsequently, the IBA has published synthetic USD LIBOR as a temporary replacement for USD LIBOR in certain cases. The publication of synthetic USD LIBOR is expected to cease on September 30, 2024. See Section III.

b. I examined nine alternative benchmark rates to USD LIBOR that have been considered by the Alternative Reference Rates Committee ("**ARRC**"), various regulators, academics, and industry experts. These rates include a) overnight transaction rates (SOFR, effective federal funds rate ("**EFFR**"), overnight bank funding rate ("**OBFR**"), American interbank offered rate ("**AMERIBOR**")); b) term rates (CME Term SOFR, AA financial commercial paper rate, Treasury rate, term overnight indexed swap ("**OIS**") rate); and c) a survey-based rate (U.S. prime rate). Similarly to LIBOR, the alternative benchmark rates are also used as reference rates for various products such as floating rate debt, adjustable rate mortgages, business and student loans, corporate debt and interest rate swaps. Differences between LIBOR and these alternative benchmark rates include the underlying source of the data on each rate (whether they are transactions-based or survey-based), the term of the rates (whether they are

overnight or have longer tenors), the perspective of the rates (whether they are forward-looking, current, or backward-looking), the risk reflected in the rates (whether they are risk-free or account for credit risk of issuers of the underlying instruments), and the security reflected in the rates (whether the underlying transactions are secured by collateral or unsecured). See Section IV.

c. The alternative benchmark rates differ from LIBOR in a number of ways, including in terms of both tenor and credit risk. This means that certain adjustments need to be made in order to appropriately compare the performance of benchmark rates against 3-month USD LIBOR. I consider two types of adjustments to account for differences between LIBOR and the alternative benchmark rates: (i) term adjustment and (ii) spread adjustment. See Section V.

    i. A term adjustment is needed to convert overnight rates, such as SOFR, and survey rates, such as U.S. prime rate, to term rates that provide a rate for three months to be comparable to 3-month USD LIBOR. Overnight rates tend to be lower than term rates because shorter tenor debt is deemed less risky by investors. I calculate term adjusted alternative benchmark rates as compounded averages over 90 days, using both in arrears and in advance methodologies. The term adjustment is not sensitive to the length of historical time period that I examine. This means that the term adjustment will not change if I estimate it using a 5-year historical period or a 2-year historical period. Under the in arrears methodology, the rate is calculated at the end of the payment accrual period, whereas under the in advance methodology, the rate is calculated at the beginning of the payment accrual period using data from the previous payment accrual period. The main distinction is that payments can be known well ahead of time in the in advance scenario; however, by the time the payment is due, the underlying rate may have changed substantially. On the other hand, an in arrears convention will more closely track changes based on the

current rate environment, but the rate and size of the payment will only be known at the end of the accrual period.

ii. In addition to the term adjustment, I also calculate a spread adjustment as of March 5, 2021 ("**Transition Date**"), when the FCA announced the cessation of 3-month USD LIBOR, to account for historical differences between 3-month USD LIBOR and the alternative benchmark rates. Historical differences can include differences in credit risk, differences in the rates' responses to market events, and differences in supply and demand market conditions. The spread adjustment is calculated in order to minimize the expected change in value arising from the transition from a LIBOR rate to an alternative rate. To do this, I rely on the ARRC and the ISDA recommendations to use a 5-year lookback period. For each alternative benchmark rate, I estimate the historical median difference between each of the benchmark rates (after adjusting for term) and 3-month USD LIBOR between March 5, 2016 and March 4, 2021 ("**5-year Lookback Period**"). For 3-month CME Term SOFR, I rely on a 26.161 basis points spread adjustment. This adjustment is based on the ISDA guidelines using a 5-year lookback period, and it is the adjustment that was selected to calculate the 3-month Synthetic LIBOR by the FCA. In addition, the ARRC reviewed a 2-year lookback period, and I also use a 2-year lookback period of March 5, 2019 to March 4, 2021 ("**2-year Lookback Period**") to calculate the spread adjustment for each of the alternative benchmark rates as a sensitivity analysis. For 3-month CME Term SOFR, I estimate a spread adjustment of 22.102 basis points based on the ISDA guidelines and calculations when using a 2-year lookback period ("**2-year Estimated ISDA Spread Adjustment**"). I estimate fixed spread adjustments and do not consider spread adjustments that change over time. ARRC noted that dynamic spread adjustments rely on the same wholesale unsecured funding markets underlying LIBOR, given concerns about low transaction volumes and illiquidity in recent years.

d. After adjusting the alternative benchmark rates for both term and spread, I examine how well they track 3-month USD LIBOR. I consider three quantitative metrics: (i) mean absolute error ("**MAE**"); (ii) degree of association in the movement or correlation; and (iii) uncertainty or volatility. See Section VI.

   i. The MAE quantifies the average difference in the rates between 3-month USD LIBOR and each of the alternative benchmark rates (after being adjusted for term and spread). I consider both the 5-year Lookback Period and 2-year Lookback Period for the spread adjustment, and calculate the MAE as the average of the daily absolute difference between 3-month USD LIBOR and each of the alternative benchmark rates over the time period March 5, 2021 to June 30, 2023 ("**MAE Calculation Period**"). A smaller MAE means that the benchmark rate better tracked 3-month USD LIBOR. I also estimate the 95 percent confidence interval of the difference in MAEs between the alternative benchmark rates. Confidence intervals provide an estimated range of values that are likely to include the true difference in the MAE. If the confidence interval of the difference in MAEs between two benchmark rates includes zero, this means that the MAEs of the two benchmark rates are not statistically significantly different from each other and that the benchmark rates tracked 3-month USD LIBOR equally well in a statistical sense. Using the 5-year Lookback Period for the spread adjustment, I find that 90-day AA financial commercial paper rate demonstrates the smallest estimated MAE and 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment exhibits the second smallest estimated MAE. However, there is no statistically significant difference between the estimated MAEs of these two rates. In other words, 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment tracks 3-month USD LIBOR just as well as 90-day AA financial commercial paper rate. Using the 2-year Lookback Period as a sensitivity analysis for the spread adjustment, I find that 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment has the smallest estimated

MAE, which means that it tracks 3-month USD LIBOR the best among all the alternative benchmark rates I analyzed.

ii. A correlation coefficient is a measure of the strength of the association between two variables and ranges from negative one to positive one. A correlation coefficient that is close to positive one means that 3-month USD LIBOR and the alternative benchmark rate generally move in the same direction and by a similar, relative magnitude. I calculate the correlation coefficient between 3-month USD LIBOR and each of the term adjusted alternative benchmark rates over three time periods: (1) the 5-year Lookback Period; (2) the 2-year Lookback Period; and (3) the MAE Calculation Period. I find that 90-day AA financial commercial paper rate has the highest correlation to 3-month USD LIBOR over the first two time periods analyzed, 0.992 and 0.989, respectively, and 3-month CME Term SOFR has the highest correlation at 0.999 over the third time period. For both the second and third time periods, 3-month CME Term SOFR has a correlation coefficient of near positive one, which means that 3-month CME Term SOFR tracked 3-month USD LIBOR nearly identically and exhibited similar sensitivities to market conditions as 3-month USD LIBOR. A correlation coefficient for the 5-year Lookback Period could not be calculated as CME Term SOFR was not published for the full duration of that period.

iii. I measure volatility of 3-month USD LIBOR and each of the term adjusted alternative benchmark rates by calculating the standard deviation, which is a measure of how dispersed a sample of values is from the average value in the sample. A greater standard deviation means there is greater uncertainty about the value of the measure in question. A standard deviation that is similar to the standard deviation of 3-month USD LIBOR means that the dispersion of values, or the volatility, is similar. Consistent with the calculation of the correlation coefficients, I measure volatility over the three same time periods: (1) 5-year Lookback Period; (2) 2-year Lookback Period; and (3) MAE

Calculation Period. I find that all of the alternative benchmark rates had similar volatilities to that of 3-month USD LIBOR over these time periods. In particular, for the 2-year Lookback Period, the volatility of 3-month USD LIBOR is 14.9 percent and the volatility of 3-month CME Term SOFR is similar at 15.4 percent. For the MAE Calculation period, the volatility of 3-month USD LIBOR is 33.4 percent and the volatility of 3-month CME Term SOFR is similar at 32.8 percent. A standard deviation for the first time period could not be calculated as CME Term SOFR was not published for the full duration of that period.

e. One of the key factors in the assessment of an alternative benchmark rate is the liquidity of the benchmark rates as measured by the number and volume of transactions underlying each rate. See Section VII.

   i. The ARRC provided estimates of the underlying market for 3-month USD LIBOR and other reference rates during the first half of 2017. The average daily volume for the market underlying 3-month USD LIBOR was estimated to be $500 million during the first half of 2017, which was dwarfed by the size of the underlying markets for most of the alternative benchmark rates. During the same time period, the underlying market for 3-month Treasury bills was $13 billion or 26 times larger than LIBOR, the underlying market for EFFR was $79 billion or 158 times larger than LIBOR, the underlying market for OBFR was $197 billion or 394 times larger than LIBOR, and the underlying market for overnight SOFR was $754 billion or 1,508 times larger than LIBOR.

   ii. To assess the growth and current size of the underlying markets for the alternative benchmark rates, I consider data for the fourth quarter of 2023, the most recent time period for which I have data for CME Term SOFR. For the overnight transaction rates, the largest underlying market was for overnight SOFR at $1,573.3 billion in average daily transaction volume, which more than doubled in size since the first half of 2017. The underlying markets for EFFR and OBFR were $97.0

billion and $244.0 billion. The underlying market for AMERIBOR was estimated to be $2.0 billion. For the term rates, the largest underlying market was for 3-month CME Term SOFR at $981.0 billion in average daily transaction volume. The underlying markets for the other term rates were smaller than the underlying market for 3-month CME Term SOFR. For example, for 90-day AA financial commercial paper, the average daily issuance volume was estimated to be $0.02 billion.

f. Based on my analysis of how well the alternative benchmark rates tracked 3-month USD LIBOR in terms of MAE, correlation, and volatility, my analysis of the size of the underlying markets of the rates, my research of the characteristics of the rates, and the commentary provided by regulators, including the ARRC and the FCA, I find that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment of 26.161 basis points is the most suitable replacement for 3-month USD LIBOR for the Preference Shares. See Section VIII.

    i. 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment of 26.161 basis points tracked 3-month USD LIBOR at least as well as other alternative benchmark rates, after adjusting for term and spread. Using the ARRC's recommendation to rely on a 5-year lookback period, 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment has the second smallest estimated MAE and there is no statistically significant difference between its estimated MAE and the estimated MAE of 90-day AA financial commercial paper rate, which exhibits the smallest estimated MAE. As a sensitivity test, conducting the analysis using the 2-year Lookback Period and the 2-year Estimated ISDA Spread Adjustment, 3-month CME Term SOFR has the smallest estimated MAE. In addition, 3-month CME Term SOFR has a high degree of association with 3-month USD LIBOR as it has a correlation of nearly positive one: 0.970 during the 2-year Lookback Period and 0.999 during the MAE Calculation Period (the highest among the alternative benchmark rates). Further, the volatility of 3-month CME Term LIBOR is similar to the volatility of

3-month USD LIBOR for these two time periods. Correlation and volatility, combined with the MAE analysis, show that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment has a similar risk and return profile to 3-month USD LIBOR.

ii. 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment shares some of the advantages of 3-month USD LIBOR and avoids some of the disadvantages. Like LIBOR, 3-month CME Term SOFR is an in advance rate that allows investors and the market to know the interest rate at the start of the payment accrual period, which is an advantage over in arrears rates that would not be known until the end of the payment accrual period. While rates compounded in advance would also be known at the start of the payment accrual period, such rates are backward-looking rates that may result in out-of-date values. By contrast, 3-month CME Term SOFR is a forward-looking term rate like LIBOR and captures market expectations of the rate over the payment accrual period. Unlike LIBOR, 3-month CME Term SOFR is supported by liquidity in the underlying market with an average daily transaction volume of $981.0 billion between October and December 2023. Unlike LIBOR, 3-month CME Term SOFR is a transactions-based rate that is less vulnerable to manipulation and influence than LIBOR, which was a survey-based rate.

iii. In 2021, the ARRC recommended the use of CME Term SOFR as the rate to which cash market transactions (which include securities such as the Preference Shares) should switch ahead of the cessation of LIBOR. The ARRC also recommended the use of the 3-month ISDA Spread Adjustment. In 2022, the FCA selected CME Term SOFR and the spread adjustments from the ISDA to calculate synthetic USD LIBOR as a temporary replacement for USD LIBOR. Additionally, in 2022, the U.S. LIBOR Act identified CME Term SOFR as the benchmark replacement for cash transactions in addition to the spread adjustments from the ISDA. Broadly, the effect of the LIBOR Act is that cash transaction contracts governed by U.S. law that still reference

USD LIBOR and do not include adequate provision to transition to an alternative rate are deemed amended to refer instead to CME Term SOFR plus the relevant ISDA spread adjustment. CME Term SOFR has also been adopted as a reference rate by many market participants, including for loans, debt, and preferred stock. For example, banks such as JPMorgan Chase, Truist Financial Corporation and Bank of America have adopted CME Term SOFR with the ISDA Spread Adjustment for outstanding floating rate debt and preferred stock.

iv. I find that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment is a better replacement for 3-month USD LIBOR compared to overnight SOFR even after term and spread adjustments. While the average daily volume of transactions underlying overnight SOFR was higher at around $1,573.3 billion as compared to $981.0 billion for 3-month CME Term SOFR during the last quarter of 2023, the ARRC noted that the drawback of an overnight rate is that it may make the LIBOR transition more difficult for cash products with longer terms. My analysis of the MAE also shows that after adjusting for term (whether in arrears or in advance) and spread (whether using a 5-year or a 2-year lookback period), compounded average SOFR does not track 3-month USD LIBOR as well as 3-month CME Term SOFR. Furthermore, unlike LIBOR and CME Term SOFR, which are forward-looking rates, compounded average SOFR, whether in arrears or in advance, is backward-looking. Although SOFR compounded in advance would be known at the start of the payment accrual period, one of its key drawbacks is that it is out of date and lags 3-month CME Term SOFR in tracking 3-month USD LIBOR. By contrast, SOFR compounded in arrears tracks 3-month USD LIBOR better than SOFR compounded in advance, but the in arrears calculation would only be known at the end of the payment accrual period.

v. The other term and spread adjusted alternative benchmark rates, including EFFR, OBFR, AMERIBOR, Treasury rate, OIS rate, and U.S. prime rate, generally have larger estimated MAEs than that of 3-

month CME Term SOFR during the MAE Calculation Period. For MAEs using a spread adjustment based on the 5-year Lookback Period, 90-day AA financial commercial paper rate exhibits the lowest estimated MAE (albeit it is not statistically significantly different from the estimated MAE of 3-month Term SOFR with the 3-month ISDA Spread Adjustment). However, 90-day AA financial commercial paper rate suffers from liquidity concerns, especially during stress market conditions, and the underlying volume of transactions cannot always support reporting of an interest rate on a daily basis. For example, in 2023, the lack of market liquidity led to 90-day AA financial commercial paper rate not being calculated for 48 percent of the trading days. As noted by the ARRC, AA financial commercial paper rate shares many of the same structural challenges as LIBOR, namely, the transactions underlying the commercial paper rates dry up during periods of market turmoil. Furthermore, the volume of transactions underlying the other alternative benchmark rates, including 90-day AA financial commercial paper rate, have been much lower than that of 3-month CME Term SOFR in recent times between October and December 2023.

II. QUALIFICATIONS AND MATERIALS RELIED UPON

11. I understand that my duty is to the Court and I confirm that I have complied and will continue to comply with that duty. I am aware of and have complied with the requirements of Part 35 of the Civil Procedure Rules (and the accompanying Practice Direction 35), the Civil Justice Council's Guidance for the Instruction of Experts in Civil Claims, and Appendix 8 of the Commercial Court Guide. I confirm that I have no actual or potential conflict of interest in relation to my instructions in this matter.

A. Qualifications

12. I am a Senior Managing Director in the Securities and Finance Practice at NERA and the Chair of the Global Securities and Finance Practice. I have over twenty years of experience in economic and financial consulting in the valuation of fixed income securities, derivatives, illiquid assets, businesses and litigation settlements. I have consulted

in disputes involving, among other issues, investment management firms, leveraged buyouts, distressed exchanges, options, swaps, and hedging strategies.

13. I have testified as an expert in U.S. State and Federal Courts on issues relating to, among other topics, credit default swaps, collateralized debt obligations, residential mortgage-backed securities, mortgage derivatives, options, swaps, and derivatives.

14. I am the author of various articles on, among other things, the credit crisis, mortgage defaults, credit default swaps, LIBOR transition, the impact of securitization on the cost and availability of credit to consumers, and claiming behavior.[30] My research has been published as a chapter in *The Handbook of Mortgage-Backed Securities*, edited by Dr. Frank J. Fabozzi. My research examining how alternative benchmark rates compare to LIBOR has been published in the *Journal of Fixed Income*. My other research has been published in the *Journal of Structured Finance*, *Journal of Real Estate Practice*, *Journal of Investment Compliance*, *Journal of Alternative Investments*, *Business Economics*, *International Trade Journal*, the *ABA Section of Litigation*, and other periodicals.

15. I am a member of the American Finance Association and the American Statistics Association. I have been accredited as a professional statistician by the American Statistics Association. I received my Ph.D. in Business from Stanford Business School and prior to joining NERA, I was a Post-Doctoral Fellow at the International Food Policy Research Institute and an assistant professor of economics at the American University in Cairo, where I taught graduate and undergraduate economic courses.

16. My curriculum vitae, attached as Appendix A, summarizes my qualifications and professional experience, testimony history, and publications I have authored.

[30] My articles and publications on the LIBOR transition were written prior to the March 5, 2021 announcement on the cessation of LIBOR and prior to the launch of CME Term SOFR on April 21, 2021. The findings in these articles and publications are not inconsistent with my opinions in this expert report. One article focused on mortgage products, which are not the focus of this expert report. See, Faten Sabry et al., *How Will the LIBOR Transition Affect Mortgage Consumers?,* NERA, August 12, 2022. Another publication relied on data through November 2020, which was prior to the publication of CME Term SOFR. See, Faten Sabry et al., *How Do Alternatives to LIBOR Measure Up?,* The Journal of Fixed Income, Spring 2024. In addition, the ICE Bank Yield Index that I analyzed is no longer being developed and not being put forth to be used as a replacement rate to LIBOR.

B. Materials Relied Upon

17. The materials relied upon in the preparation of this report, including materials provided to me by my instructing solicitors, are listed in Figure 1.

Figure 1. *Materials Relied Upon – See Attached*

18. I have included a glossary of key terms in Appendix B.

III. BACKGROUND ON LIBOR

A. Origins of LIBOR as a Floating Reference Rate

19. LIBOR was first conceived by London-based banker Minos Zombanakis in 1969 as he searched for a way to arrange for an $80 million loan to the Shah of Iran.[31] As he realized that no single firm would lend to a developing nation without enough foreign currency in its reserves to provide collateral, Mr. Zombanakis set up a deal to fund the loan through a syndicate of foreign and domestic banks which were willing to take on a portion of the risk. At that time, the Bank of England base rate was near 8 percent and inflation was accelerating.[32] Banks were hesitant to fund long-term loans that were linked to fixed interest rates since they would be left exposed to fluctuations in their borrowing costs over time. As a solution, Mr. Zombanakis proposed an interest rate that would be recalculated every few months and could be applied through a series of rolling loans. The rate would be calculated as the weighted average of borrowing costs reported by each reporting bank in the syndicate just before the loan rollover date plus a fixed spread for profit, and it would be called London Interbank Offered Rate.[33]

20. LIBOR was successful in facilitating syndicated loans because it increased the transparency of their pricing.[34] Though first developed as an ad hoc solution, LIBOR grew quickly beyond bespoke loan products into the emerging derivatives market. Eventually, the very banks that reported the rates underlying LIBOR began relying heavily on LIBOR-based

[31] Kirstin Ridley and Huw Jones, "A Greek banker, the Shah and the birth of Libor," Reuters, August 7, 2012, https://www.reuters.com/article/idUSBRE877023/. (Accessed March 7, 2024).

[32] Liam Vaughan and Gavin Finch, *The Fix: How Bankers Lied, Cheated and Colluded to Rig the World's Most Important Number* (West Sussex: John Wiley & Sons, 2017), 27.

[33] Liam Vaughan and Gavin Finch, *The Fix: How Bankers Lied, Cheated and Colluded to Rig the World's Most Important Number* (West Sussex: John Wiley & Sons, 2017), 27.

[34] Intercontinental Exchange Benchmark Administration, *ICE LIBOR Evolution*, April 25, 2018, 4.

contracts for their own borrowing.[35] The British Bankers' Association ("**BBA**") took control of the administration of LIBOR in 1986 (published as BBA LIBOR) and began standardizing the data collection processes while developing new LIBOR rates for foreign currencies and maturity terms, including overnight, one-week, one-month, two-month, three-month, six-month, and one-year tenors.[36]

21. Figure 2 illustrates the volume by year for all terms of USD LIBOR-indexed floating and variable rate debt issuances from January 1983 to December 2023.[37] Overall, the yearly volume steadily increased from $255 million in 1983 to $1,057 billion in 2007. The volume of issuance declined during and after the financial crisis and then peaked at $1,432 billion in 2017.[38] This historical time-series documents the adoption of LIBOR over time and its importance as a reference benchmark until reporting ceased in June 2023.

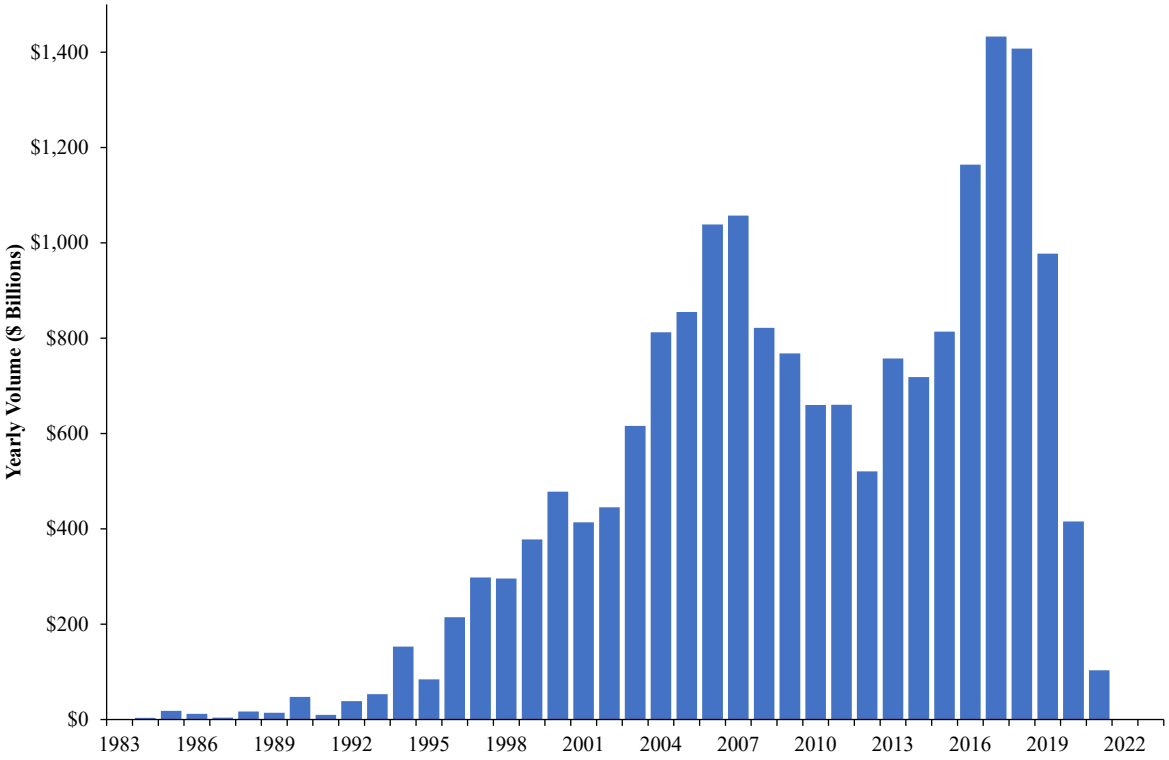
[35] David Hou and David Skeie, *LIBOR: Origins, Economics, Crisis, Scandal, and Reform*, Federal Reserve Bank of New York Staff Reports, No. 667, March 2014, 1.

[36] David Hou and David Skeie, *LIBOR: Origins, Economics, Crisis, Scandal, and Reform*, Federal Reserve Bank of New York Staff Reports, No. 667, March 2014, 1-2.

[37] The data is from Bloomberg L.P. Bloomberg classifies Standard Chartered's ADSs as debt securities and they are included within the USD LIBOR-indexed debt issuances.

[38] I consider the financial crisis to span the period between the bankruptcy of mortgage lender New Century on April 2, 2007 and the end of the U.S. recession on June 30, 2009. See, "New Century files for Chapter 11 bankruptcy," NBC News, April 2, 2007, https://www.nbcnews.com/id/wbna17912595. (Accessed March 7, 2024). See, also, "June 2009 business cycle trough/end of last recession," National Bureau of Economic Research, September 20, 2010, https://www.nber.org/news/business-cycle-dating-committee-announcement-september-20-2010. (Accessed March 7, 2024).

Figure 2. *Yearly Volume of USD-Denominated Floating and Variable Rate Debt Securities Issuances Linked to USD LIBOR for January 1983 through December 2023*

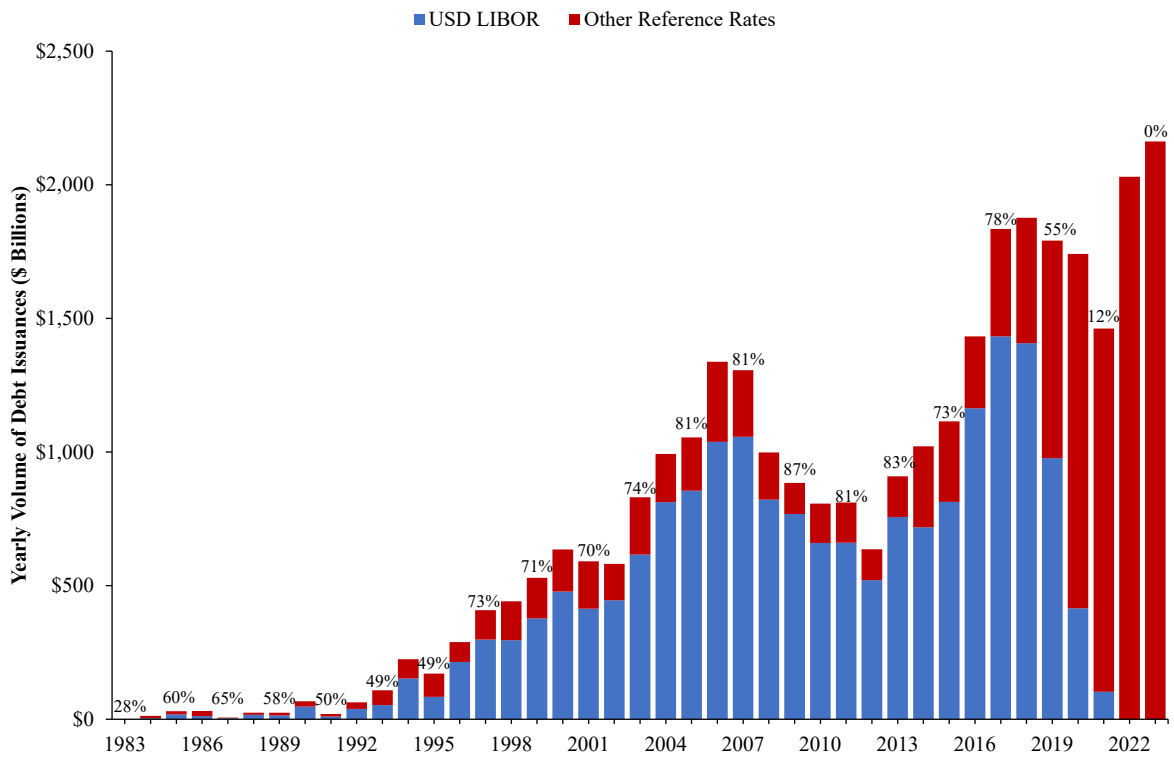


Notes and Sources:
-Data are from Bloomberg accessed as of February 29, 2024.
-USD denominated floating and variable rate debt securities include government and corporate debt issuances.

22. LIBOR grew in prominence and popularity and was widely used as a reference rate.[39] Figure 3 presents the volume of debt issuances that rely on USD LIBOR as the benchmark as compared to all floating and variable rate debt issuances from January 1983 to December 2023. In 2006, the year the Preference Shares were issued, floating and variable rate debt issuances indexed to USD LIBOR were $1,038 billion, or 78 percent of the floating and variable rate debt issuances of $1,338 billion in that year. From 1987 to 2019, floating and variable rate debt issuances indexed to USD LIBOR made up 72 percent of floating and variable rate debt issuances each year, on average, and was as high as 87 percent of floating and variable rate debt issuances in 2009.

[39] David Hou and David Skeie, *LIBOR: Origins, Economics, Crisis, Scandal, and Reform*, Federal Reserve Bank of New York Staff Reports, No. 667, March 2014, 3.

Figure 3. *Share of Yearly Volume of USD-Denominated Floating and Variable Rate Debt Securities Issuances Linked to USD LIBOR and All Other Reference Rates for January 1983 through December 2023*



Notes and Sources:
-Data are from Bloomberg accessed as of February 29, 2024.
-USD denominated floating and variable rate debt securities include government and corporate debt issuances.

B. Methodology For Determining LIBOR Rates

23. Prior to 2016, LIBOR was based on the cost of interbank unsecured lending. The interbank unsecured lending market is a market for loans among banks with specific terms that are not protected by a guarantor or collateralized by an asset. The determination of LIBOR rates was based on a qualitative survey from a select group of between 11 and 18 banks referred to as the panel banks where each bank responded to questions about the cost of interbank unsecured loans for a given period in a given currency.[40] The question that each bank responded to was, "*At what rate could you borrow funds, were you to do so by asking for and then accepting inter-bank offers in a reasonable market size just prior to 11 am*?"[41]

[40] Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 5.

[41] Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 18.

24. The LIBOR administrator would then rank the submissions by the panel banks and remove those on the perimeters in a process called "trimming." The exact number or submissions removed from the LIBOR calculation depended on the number of contributing panel banks. For example, if 15 panel banks contributed rates, the LIBOR administrator would remove the four highest and four lowest submissions and calculate LIBOR as the average (arithmetic mean) of the remaining seven contributed rates.[42]

25. Figure 4 presents an example of the calculation of 3-month USD LIBOR based on hypothetical submissions by 15 panel banks. In this example, Bank of America, Barclays, Citibank and Rabobank submitted the four highest rates and hence are removed from the LIBOR calculation. Similarly, Royal Bank of Canada, SMBC, Norinchukin and UBS submitted the four lowest rates and are also removed from the LIBOR calculation. The average of the remaining seven submissions results in 3-month USD LIBOR, namely 2.15072 percent.

[42] "LIBOR," Intercontinental Exchange Benchmark Administration, https://web.archive.org/web/20210925035856/https://www.ice.com/iba/libor. (Accessed March 7, 2024).

Figure 4. *Hypothetical Example of 3-month USD LIBOR Submissions by Panel Banks*

	USD LIBOR Panel Bank	Panel Submission Rate
	(1)	**(2)**
1	~~Bank of America N.A.~~	~~2.55432~~ %
2	~~Barclays Bank plc~~	~~2.45985~~
3	~~Citibank N.A.~~	~~2.42346~~
4	~~Cooperatieve Rabobank U.A.~~	~~2.35239~~
5	Crédit Agricole Corporate & Investment Bank	2.30932
6	Credit Suisse AG	2.25392
7	Deutsche Bank AG	2.11023
8	HSBC Bank plc	2.10123
9	JPMorgan Chase Bank, N.A.	2.10023
10	Lloyds Bank plc	2.10000
11	MUFG Bank, Ltd	2.08012
12	~~Royal Bank of Canada~~	~~2.05023~~
13	~~SMBC Bank International plc~~	~~2.01001~~
14	~~The Norinchukin Bank~~	~~1.98002~~
15	~~UBS AG~~	~~1.95001~~
	USD LIBOR	**2.15072 %**

Notes and Sources:
- Data are from ICE LIBOR as of September 29, 2022 accessed using the Wayback Machine.

26. The idea behind LIBOR's methodology was to capture estimates by the panel banks of their cost of unsecured wholesale funding on a daily basis. Wholesale funding refers to a firm's use of deposits and other liabilities from other financial intermediaries.[43] Transactions in the unsecured wholesale market are expected to reflect the credit risk of the borrowing banks.[44] The credit risk component of LIBOR would capture the general risk of the panel banks' funding costs. As a result, using such rates in loan contracts would enable

[43] "Conference Announcement Workshop on the Risks of Wholesale Funding," Federal Reserve Bank of New York, August 13, 2014, https://www.newyorkfed.org/research/conference/2014/risks_wholesale_funding. (Accessed March 7, 2024).

Unsecured wholesale funding transactions are the means by which banks seek finance from professional counterparties—not retail—through transactions that are not secured. See, Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 25.

[44] Jason Amster, "Secured Overnight Financing Rate in Loan Transactions," LexisNexis, June 14, 2019, https://www.lexisnexis.com/community/insights/legal/practical-guidance-journal/b/pa/posts/secured-overnight-financing-rate-in-loan-transactions. (Accessed March 7, 2024).

the bank to pass on some of that risk to its borrowers.[45] This feature of LIBOR also led to its widespread use as a reference rate, since it helped banks to, "*facilitate the management of bank funding risk*" and "*share the risk of future changes in their funding costs with borrowers*."[46] LIBOR was among the first such rates to be introduced in the market and became a standard especially for "*loan and interest rate derivatives contracts*."[47]

27. Before its cessation on June 30, 2023, LIBOR was published and administered by the IBA and regulated by the FCA.[48] LIBOR reflected a range of rates based on different currencies and intervals of time, referred to as the LIBOR tenor, including overnight, one week, one month, two month, three month, six month, and one year.[49] Around its peak in 2012, LIBOR rates were being calculated for over ten currencies and fifteen tenors ranging from overnight to one year and were referenced by contracts valued upwards of $300 trillion, acting as benchmarks for interest rates underlying mortgages, loans, and derivatives.[50]

C. Uses and Benefits of Floating Reference Rates

28. LIBOR rates belong to a class of rates called "floating rates" that vary over the life of a financial instrument.[51] The payments reset periodically based on a designated reference rate.[52] Reference rates are "*interest rates that link payments in a financial contract*

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[45] Bank for International Settlements, *Towards better reference rate practices: a central bank perspective,* March 2013, 5.

[46] Bank for International Settlements, *Towards better reference rate practices: a central bank perspective,* March 2013, 3, 6.

Mark Zandi, Chief Economist of Moody's Analytics, described LIBOR as an "*'historical artifact'*" and attributed LIBOR's popularity to "*convention*" as banks "*continue[d] to use it because they [had] done so in the past*." See, "The LIBOR Mess: How Did It Happen — and What Lies Ahead?" Knowledge at Wharton, July 18, 2012, https://knowledge.wharton.upenn.edu/article/the-libor-mess-how-did-it-happen-and-what-lies-ahead/. (Accessed March 7, 2024). The authors make similar arguments, adding that "*London's dominance in the world financial markets, a certain pack mentality and tradition*" contributed to LIBOR's popularity.

[47] Bank for International Settlements, *Towards better reference rate practices: a central bank perspective,* March 2013, 3.

[48] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.theice.com/iba/libor. (Accessed March 7, 2024).

[49] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.theice.com/iba/libor. (Accessed March 7, 2024).

[50] David Hou and David Skeie, *LIBOR: Origins, Economics, Crisis, Scandal, and Reform*, Federal Reserve Bank of New York Staff Reports, No. 667, March 2014, 1-2.

[51] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 373.

[52] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 373.

to standard money market interest rates."[53] The resets can happen weekly, monthly, quarterly, semiannually, or otherwise and payments can vary based on some market or constructed interest rate, a price of some asset, or be determined at the discretion of the issuer.[54] A typical formula for expressing the variable rate is "reference rate" plus a "margin."[55] For example, a bond can deliver periodic payments based on a coupon rate that resets quarterly to 3-month USD LIBOR plus 0.5 percent. In this example, 3-month USD LIBOR is the reference rate, and the margin is 0.5 percent.

29. Floating rate instruments typically intend to protect against interest rate risk.[56] Fixed-rate securities have interest rates that do not change or change by a preset amount and typically decline in value when interest rates rise and increase in value when interest rates fall. Floating rate securities mitigate this issue by keeping the periodic payments aligned with reference interest rates.[57] For example, using LIBOR as a reference rate allowed banks to tie payments to the cost of funds for financial institutions.[58] However, prices of floating rate securities can still be affected by interest rate changes if the interest rates change while there is still time until the next interest rate reset date for the security or if the margin no longer reflects the market conditions.[59] The longer the time to the next reset date and the bigger the discrepancy between the interest rate margin of the security and the margin required by the market, the greater the potential price fluctuations.[60] Nevertheless, floating rate securities offer a hedge against increasing interest rates to the investors / lenders and a hedge against decreasing interest rates to the issuers / borrowers.

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[53] Bank for International Settlements, *Towards better reference rate practices: a central bank perspective,* March 2013, 3.

[54] Frank J. Fabozzi and Steven V. Mann*, Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 1.

[55] Frank J. Fabozzi and Steven V. Mann*, Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 2.

[56] Annette Thau, *The Bond Book* (New York: McGraw Hill, 2001), 205.

[57] Annette Thau, *The Bond Book* (New York: McGraw Hill, 2001), 205.

[58] Frank J. Fabozzi and Steven V. Mann*, Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 21.

[59] Frank J. Fabozzi and Steven V. Mann*, Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 11.

[60] Frank J. Fabozzi and Steven V. Mann*, Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 11.

30. The choice of a reference rate is essential to the performance of the floating rate instrument over time.[61] The most common reference rates have historically been LIBOR, Treasury bill yields, U.S. prime rate, and interest rates on certificate of deposits.[62] Treasury rates are the interest paid on U.S. Treasury securities of different tenors.[63] U.S. prime rate is determined by a survey of individual banks.[64] U.S. prime rate is often used as a benchmark for loans such as credit cards and small-business loans and is the rate at which individual banks and credit unions lend to their customers, including large corporations.[65] Many financial institutions in the U.S. charge their "*best customers*" who have "*excellent credit*" U.S. prime rate as their loans would carry the lowest risks for financial institutions.[66] Some special markets rely on other rates, for example, some mortgages and collateralized mortgage obligations determine the monthly payments based on constant maturity Treasury rates, and cost of funds indices. There are various cost of funds indices, such as the federal cost of funds index, which is the monthly average of Treasury bill rates, and the 11th District Cost of Funds Index, which reflects the monthly interest expenses on deposit accounts and other borrowings for saving institutions in Arizona, California and Nevada.[67]

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[61] Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 19.

[62] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 374.

For the details on the reference rates, see, Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 20–22.

[63] "Investment Products: Bonds," Financial Industry Regulatory Authority, https://www.finra.org/investors/learn-to-invest/types-investments/bonds/types-of-bonds/us-treasury-securities. (Accessed March 7, 2024).

[64] "What is the prime rate, and does the Federal Reserve set the prime rate?" Board of Governors of the Federal Reserve System, updated August 2, 2013, https://www.federalreserve.gov/faqs/credit_12846.htm. (Accessed March 7, 2024).

[65] Matt Kelley, "A Primer on the Prime Rate," ESL Federal Credit Union, https://www.esl.org/resources-tools/educational-resources/understanding-the-prime-rate. (Accessed March 7, 2024).

[66] Amanda Hicks, "What Is the Prime Rate and Why Does It Matter?" Clearview Federal Credit Union, https://www.clearviewfcu.org/Resources/Learn/Blog/What-Is-the-Prime-Rate-and-Why-Does-It-Matter. (Accessed March 7, 2024).

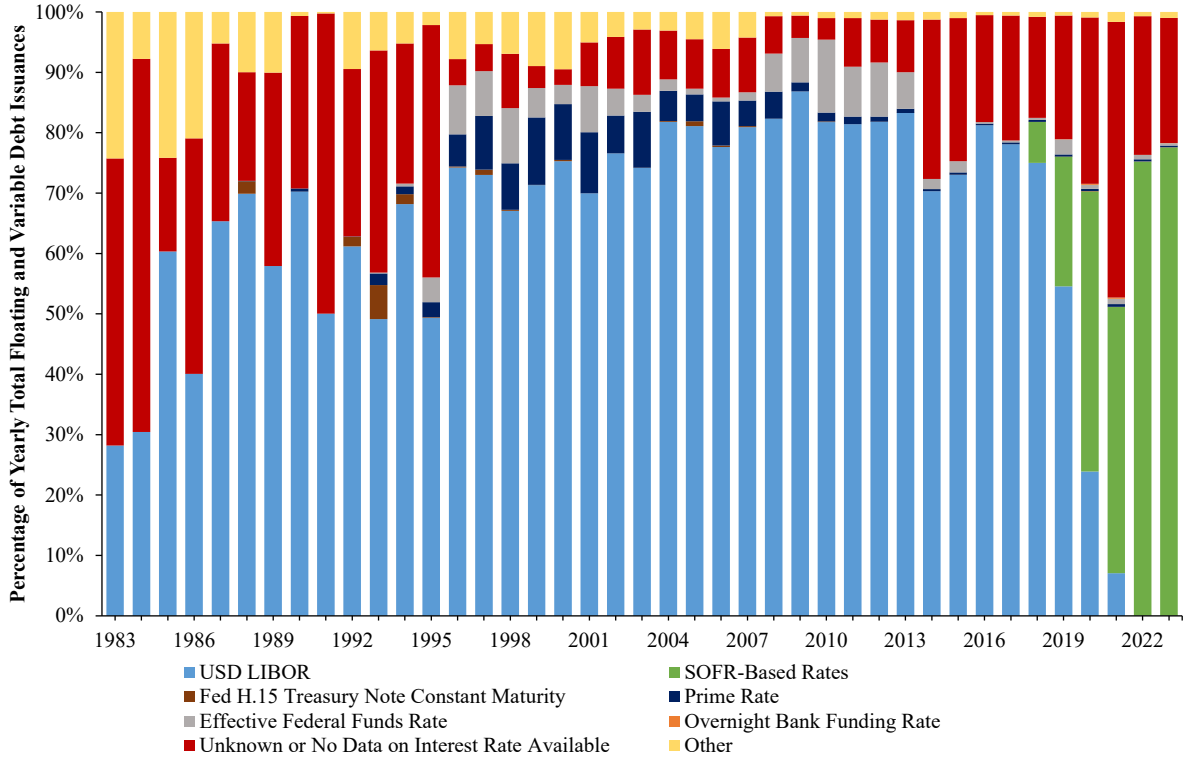
[67] "Federal Cost of Funds Index," Freddie Mac, https://www.freddiemac.com/research/datasets/cofi. (Accessed March 7, 2024).

"COFI: Frequently Asked Questions," Federal Home Loan Bank San Francisco, https://www.fhlbsf.com/resources/cofi/faq. (Accessed March 7, 2024).

The 11th District Cost of Funds Index has been discontinued since January 31, 2022. "Cost of Funds Indices (COFI)," Federal Home Loan Bank San Francisco, https://www.fhlbsf.com/resources/cofi. (Accessed March 7, 2024).

31. Figure 5 illustrates the distribution of USD floating and variable rate debt issuances for January 1983 through December 2023 by reference rate. As noted above, LIBOR made up 72 percent of the market from 1987 to 2019, on average. In 2006, LIBOR made up 78 percent of floating and variable rate debt issuances, and U.S. prime rate made up 7 percent of the issuances. From 1996 through 2008, U.S. prime rate made up at least 4 percent of issuances and was as high as 11 percent of the market. Since then, U.S. prime rate made up 2 percent or less of the market. EFFR was referenced more in the years of and after the financial crisis and made up 6 to 12 percent of the market from 2008 to 2013. Since then, EFFR has been 3 percent or less of the market. SOFR-based rates, including overnight, average, and term SOFR, have been referenced more in recent years. SOFR-based rates made up 21 percent of the market in 2019 and made up 78 percent of the market in 2023.

Figure 5. *Distribution of Yearly Volume of USD-Denominated Floating and Variable Rate Debt Securities Issuances for January 1983 to December 2023*



Notes and Sources:
-Data are from Bloomberg accessed as of February 29, 2024.
-USD denominated floating and variable rate debt securities include government and corporate debt issuances.
-SOFR-Based Rates include SOFR, SOFR Index, SOFR Averages and SOFR Term.

32. From the perspectives of investors, the reference rate is an important determinant of the security's price performance: floating and variable rate securities will

under- or overperform comparable securities based on the dynamics of spreads between the securities' reference rates.[68] For example, the spread between 3-month USD LIBOR and 3-month Treasury bill yields tends to increase during the times of market uncertainty, such as recessions and financial crises, and decrease during the times of stability.[69]

D. Shortcomings of LIBOR

33. The financial crisis that began in April 2007 had a substantial effect on the short-term funding for many financial institutions. The prices of almost all assets and securities collapsed as financial institutions tried to sell their positions. The liquidity crunch in the summer of 2007 quickly turned into a credit crisis with fears of insolvency of major financial institutions. The bankruptcy of Lehman Brothers in September 2008 triggered worldwide panic.[70]

34. As a result of the financial crisis, banks and other market participants faced difficulties in accessing funding, which was reflected as a jump in the credit risk component of LIBOR.[71] Figure 6 presents the USD LIBOR rates between February 20, 1998 and June 30, 2023 for four tenors: overnight, 1-month, 3-month, and 1-year. The jump in overnight USD LIBOR from 3.11 percent to 6.44 percent in the one day following the bankruptcy of Lehman Brothers on September 15, 2008 reflected the increased concerns about the credit risk of the panel banks. The increase in overnight USD LIBOR signaled increased uncertainty about the creditworthiness of the banks.[72]

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[68] Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 24.

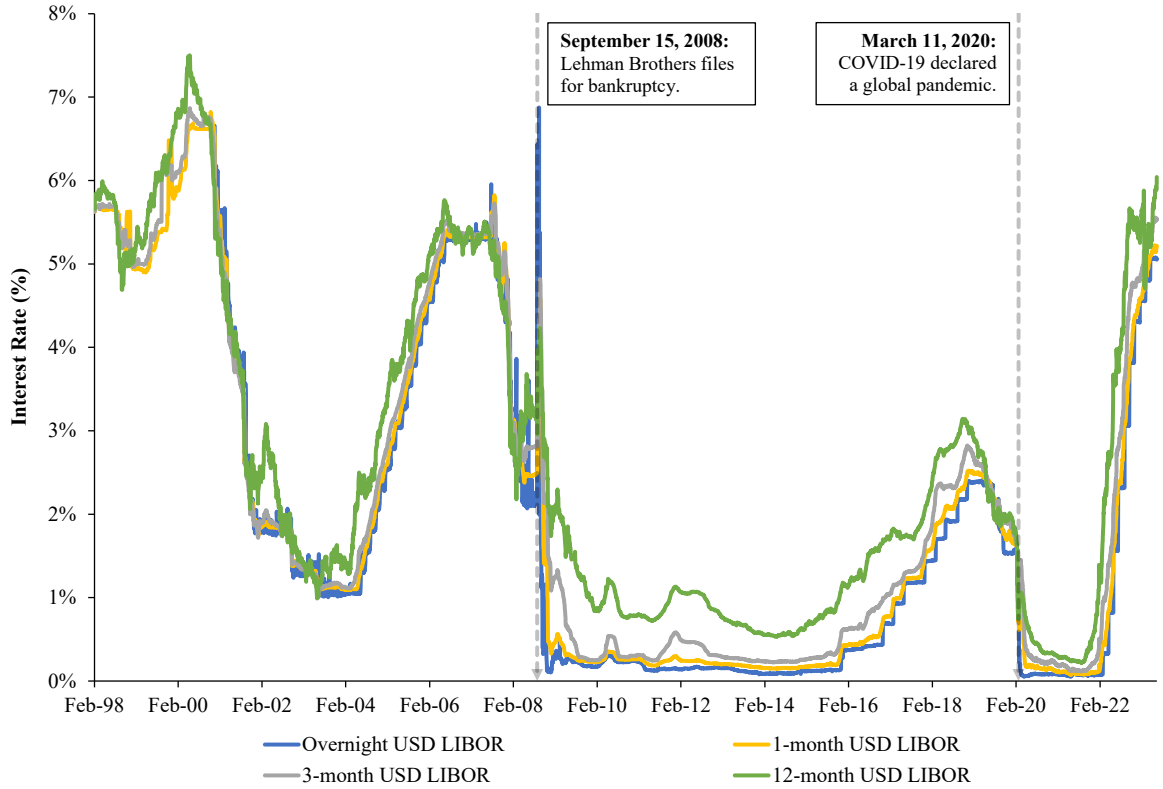
[69] Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 26.

[70] Andrew W. Lo, "Reading about the Financial Crisis: A Twenty-One-Book Review," *Journal of Economic Literature*, Volume 50, No. 1 (2012): 151-178, 158.

[71] David Hou and David Skeie, *LIBOR: Origins, Economics, Crisis, Scandal, and Reform*, Federal Reserve Bank of New York Staff Reports, No. 667, March 2014, 6.

[72] Simon Kwan, *Behavior of Libor in the Current Financial Crisis*, Federal Reserve Board of San Francisco RBSF Economic Letter, January 23, 2009, 2.

Figure 6. *USD LIBOR for Different Tenors between February 20, 1998 and June 30, 2023*



Notes and Sources:
- Data are from Bloomberg.

35. Another key metric for heightened concerns about the credit risk of financial institutions is the 3-month USD LIBOR-OIS (overnight indexed swap) spread. The LIBOR-OIS spread is defined as the excess of 3-month USD LIBOR over 3-month overnight indexed swap rate and is usually used as a measure of stress in financial markets. An OIS is a swap between a fixed and floating interest rate.[73] In an interest rate swap, "*one party agrees to pay the other party interest at a fixed rate on a notional principal for a number of years. In return, it receives interest at a floating rate on the same notional principal for the same period of time.*[74]

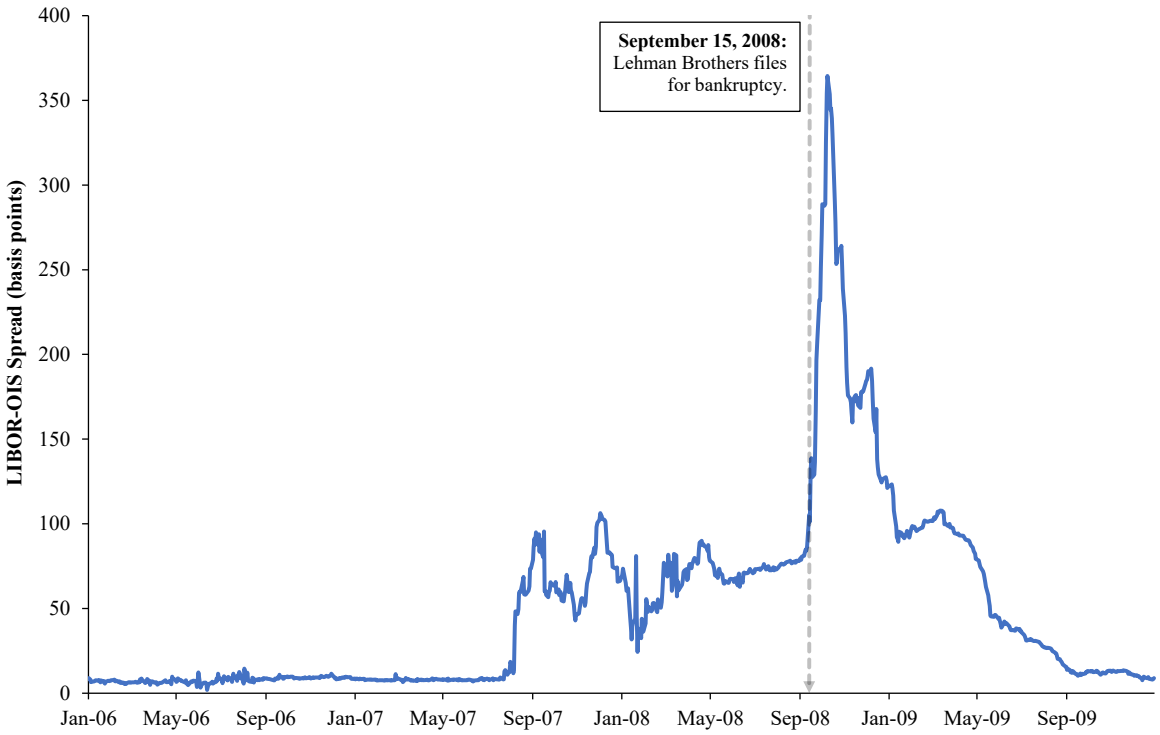
36. Figure 7 presents 3-month USD LIBOR-OIS spread for January 2006 through December 2009. Before the financial crisis, the spread was between 2 and 15 basis points during 2006 and the first quarter of 2007. The spread jumped to about 95 basis points in

[73] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 1276-1277.

[74] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015, 9th Edition), 180.

September 2007 and further peaked at 364 basis points by October 2008 as banks "*became less willing to lend to each other*."[75] The greater the spread, the greater the uncertainty among investors about the creditworthiness of financial institutions, and the high spread was "*an indication of problems in the banking industry*."[76] By the end of 2009, the spread was 9 basis points and had returned to pre-crisis levels.

Figure 7. *3-month USD LIBOR-OIS Spread for January 1, 2006 through December 31, 2009*



Notes and Sources:
- Data are from Bloomberg.

37. The status of LIBOR as a credible estimate of the unsecured cost of borrowing came into question as allegations of collusion among the panel banks broke in 2008. The U.S. Federal Reserve Board of Governors ("**Fed**") received information from a Barclays employee

[75] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015, 9th Edition), 203.

[76] Daniel L. Thornton, *What the Libor-OIS Spread Says*, Federal Reserve Bank of St. Louis, May 11, 2009, 1.

that "*Barclays was underreporting its rate to 'avoid the stigma associated with being an outlier with respect to its LIBOR submissions, relative to other participating banks.*"[77]

38. In March 2011, U.S. regulators were already examining "*whether some banks deliberately tried to skew Libor by deliberately submitting inaccurate data.*"[78] In February 2012, this suspicion led to a U.S. Department of Justice ("**DOJ**") investigation into alleged manipulations of LIBOR.[79] The investigation then developed into a criminal probe.[80] Between 2012 and 2015, multiple LIBOR panel banks were fined for inappropriate conduct with regard to their LIBOR submissions.[81]

a. The DOJ led the first LIBOR manipulation case against Barclays and entered into a $160 million agreement in 2012.[82]

b. Later in 2012, the DOJ investigated UBS, which pled guilty to wire fraud for its manipulation of LIBOR, and was fined over $1.5 billion.[83] Additionally, alongside the FBI, the DOJ charged Roger Darin and Tom

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[77] Joint Economic Committee, *The LIBOR Scandal: What We Know, What We Don't, and What to Expect*, August 2, 2012, 7.

[78] David Enrich, et al., "U.S. Libor Probe Includes BofA, Citi, UBS," The Wall Street Journal, March 18, 2011, https://www.wsj.com/articles/SB10001424052748703818204576205991698548286. (Accessed March 7, 2024).

[79] David Enrich, et al., "U.S. Libor Probe Includes BofA, Citi, UBS," The Wall Street Journal, March 18, 2011, https://www.wsj.com/articles/SB10001424052748703818204576205991698548286. (Accessed March 7, 2024). See, also, "Barclays Bank PLC Admits Misconduct Related to Submissions for the London Interbank Offered Rate and the Euro Interbank Offered Rate and Agrees to Pay $160 Million Penalty," U.S. Department of Justice, June 27, 2012, https://www.justice.gov/opa/pr/barclays-bank-plc-admits-misconduct-related-submissions-london-interbank-offered-rate-and. (Accessed March 7, 2024).

[80] Carrick Mollenkamp, "U.S. conducting criminal Libor probe," Reuters, February 28, 2012, https://web.archive.org/web/20150924162548/http://www.reuters.com/article/2012/02/28/us-libor-probe-idUSTRE81R1ZG20120228. See, also, "Barclays Bank PLC Admits Misconduct Related to Submissions for the London Interbank Offered Rate and the Euro Interbank Offered Rate and Agrees to Pay $160 Million Penalty," U.S. Department of Justice, June 27, 2012, https://www.justice.gov/opa/pr/barclays-bank-plc-admits-misconduct-related-submissions-london-interbank-offered-rate-and. (Accessed March 7, 2024).

[81] "Tracking the Libor Scandal," The New York Times, updated March 23, 2016, https://www.nytimes.com/interactive/2015/04/23/business/dealbook/db-libor-timeline.html. (Accessed March 7, 2024).

[82] "Barclays Bank PLC Admits Misconduct Related to Submissions for the London Interbank Offered Rate and the Euro Interbank Offered Rate and Agrees to Pay $160 Million Penalty," U.S. Department of Justice, June 27, 2012, https://www.justice.gov/opa/pr/barclays-bank-plc-admits-misconduct-related-submissions-london-interbank-offered-rate-and. (Accessed March 7, 2024).

[83] "UBS Securities Japan co. Ltd. To Plead Guilty to Felony Wire Fraud for Long-running Manipulation of LIBOR Benchmark Interest Rates," U.S. Department of Justice, December 19, 2012, https://www.justice.gov/opa/pr/ubs-securities-japan-co-ltd-plead-guilty-felony-wire-fraud-long-running-manipulation-libor. (Accessed March 7, 2024).

Hayes, two former senior UBS traders, with conspiracy in a criminal complaint.[84]

c. Rabobank received a $1 billion fine from U.S., British, and Dutch regulators.[85] These fines were accompanied by an FBI investigation with help from the Commodity Futures Trading Commission and the FCA that resulted in Anthony Allen and Anthony Conti, two Rabobank traders, being sentenced to prison.[86]

d. In April 2015, Deutsche Bank received the largest fine at $2.5 billion.[87]

e. In addition, the Serious Fraud Office ("**SFO**") charged 13 individuals with conspiracy to defraud.[88]

f. In October 2014, "Peter Johnson pleaded guilty to manipulating the US Dollar LIBOR, the first criminal conviction for a LIBOR offence in the UK."[89] In the following two years, three more individuals were convicted on the same charges.[90]

[84] "UBS Securities Japan co. Ltd. To Plead Guilty to Felony Wire Fraud for Long-running Manipulation of LIBOR Benchmark Interest Rates," U.S. Department of Justice, December 19, 2012, https://www.justice.gov/opa/pr/ubs-securities-japan-co-ltd-plead-guilty-felony-wire-fraud-long-running-manipulation-libor. (Accessed March 7, 2024).

[85] Sara Webb, "Dutch Rabobank fined $1 billion over Libor scandal," Reuters, October 29, 2013, https://www.reuters.com/article/idUSBRE99S0L5/. (Accessed March 7, 2024).

[86] "Two Former Rabobank Traders Sentenced to Prison for Manipulating U.S. Dollar and Japanese Yen LIBOR Interest Rates," U.S. Department of Justice, March 10, 2016, https://www.justice.gov/opa/pr/two-former-rabobank-traders-sentenced-prison-manipulating-us-dollar-and-japanese-yen-libor. (Accessed March 7, 2024).

[87] "Tracking the Libor Scandal," The New York Times, updated March 23, 2016, https://www.nytimes.com/interactive/2015/04/23/business/dealbook/db-libor-timeline.html. (Accessed March 7, 2024).

[88] "SFO concludes investigation into LIBOR manipulation," Serious Fraud Office, October 18, 2019, https://www.sfo.gov.uk/2019/10/18/sfo-concludes-investigation-into-libor-manipulation/. (Accessed March 7, 2024).

[89] "SFO concludes investigation into LIBOR manipulation," Serious Fraud Office, October 18, 2019, https://www.sfo.gov.uk/2019/10/18/sfo-concludes-investigation-into-libor-manipulation/. (Accessed March 7, 2024).

[90] "SFO concludes investigation into LIBOR manipulation," Serious Fraud Office, October 18, 2019, https://www.sfo.gov.uk/2019/10/18/sfo-concludes-investigation-into-libor-manipulation/. (Accessed March 7, 2024).

g. In August 2015, Tom Hayes, the UBS trader in the FBI and DOJ criminal complaints, was also convicted on eight counts of conspiracy to defraud.[91]

h. As of October 2019, all strands of the SFO's investigation into LIBOR manipulation were closed.[92]

E. Moving On from LIBOR – 2016 until 2023

39. Following the financial crisis and the LIBOR scandal, the administration of LIBOR was handed over to the IBA. The IBA began publishing Intercontinental Exchange ("**ICE**") LIBOR in 2014 and continued through June 30, 2023. In 2016, the IBA acknowledged that the interbank unsecured market for borrowing for a specified term had decreased noticeably following the financial crisis and later confirmed that as of July 2020 "*the level of activity still remain[ed] too low in some tenors to support an entirely transaction-based rate*."[93]

40. The stress on this market in 2016 was driven, according to the IBA, by several factors including the increase in the perceived risk of bank counterparty default, regulatory changes to shift banks' funding to more stable sources, and the increase in liquidity available to the banks from central banks. Due to the decline in the interbank lending market, the IBA updated the LIBOR definition in 2016 to also include unsecured lending between banks and non-financial corporations.[94]

41. The updated definition established that LIBOR would be the "*wholesale funding rate anchored in LIBOR panel banks' unsecured wholesale transactions to the greatest extent possible*."[95] In its last form, LIBOR measured the cost of term unsecured

[91] "SFO concludes investigation into LIBOR manipulation," Serious Fraud Office, October 18, 2019, https://www.sfo.gov.uk/2019/10/18/sfo-concludes-investigation-into-libor-manipulation/. (Accessed March 7, 2024).

[92] "SFO concludes investigation into LIBOR manipulation," Serious Fraud Office, October 18, 2019, https://www.sfo.gov.uk/2019/10/18/sfo-concludes-investigation-into-libor-manipulation/. (Accessed March 7, 2024).

[93] Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 8. See, also, Intercontinental Exchange Benchmark Administration, *ICE LIBOR Benchmark Statement*, May 14, 2018 (updated May 21, 2021), 6.

[94] Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 8.

[95] Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 19.

funding for banks, whether provided by other banks or non-financial corporations.[96] For their 3-month USD LIBOR submissions, the panel banks were required by ICE to rely on short-term unsecured wholesale funding alternatives with a tenor between 80 and 100 days including: 1) commercial paper, 2) certificates of deposit, and 3) unsecured deposits.[97]

42. In addition, the ARRC estimated the dollar volume of transactions underlying the LIBOR submissions in a March 2018 report.[98] During the period October 15, 2016 to June 30, 2017, "*[t]he median daily volume of three-month funding transactions (three-month LIBOR [was] the most heavily referenced tenor of USD LIBOR) [was] less than $1 billion, and there [were] many days with volumes of less than $500 million*."[99] For the first half of 2017 specifically, average daily volume for 3-month USD LIBOR was estimated to be $500 million, in contrast to a $13 billion market for 3-month Treasury bills, a $79 billion market underlying EFFR, a $197 billion market underlying OBFR and a $754 billion market underlying SOFR.[100]

43. During the years from 2018 to 2021, the degree to which the determination of LIBOR was supported by transactions of participating financial institutions diminished and continued to decline leading to the discontinuation of LIBOR publications as of June 2023. The FCA announced in March 2021 that 1-week and 2-month USD LIBOR settings would cease, or no longer be representative, immediately after December 31, 2021, while the remaining USD LIBOR settings would cease, or no longer be representative, after June 30, 2023.[101] In July 2021, the Bank of England also highlighted that "*the wholesale term funding markets – on which Libor is based – are prone to becoming volatile and unreliable in stressed periods.*"[102]

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[96] "*ICE LIBOR is the benchmark published under that name or as 'LIBOR' and calculated by ICE Benchmark Administration Limited (IBA) on London business days. It is a wholesale funding rate anchored in LIBOR panel banks' unsecured wholesale transactions to the greatest extent possible, with a waterfall to enable a rate to be published in all market circumstances*." Intercontinental Exchange Benchmark Administration, *Roadmap for ICE LIBOR*, March 18, 2016, 19.

[97] Intercontinental Exchange Benchmark Administration, *USD LIBOR Methodology*, 4-5.

[98] Alternative Reference Rates Committee, *Second Report*, March 5, 2018.

[99] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 1.

[100] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

[101] "Announcements on the end of LIBOR," Financial Conduct Authority, March 5, 2021, https://www.fca.org.uk/news/press-releases/announcements-end-libor. (Accessed March 7, 2024).

[102] Bank of England, *Financial Stability Report*, July 2021, 13.

F. Temporary Publishing of Synthetic LIBOR

44. Since July 2023, the IBA has published synthetic rates for 1-, 3-, and 6-month USD LIBOR as a temporary replacement for USD LIBOR, to enable the transition from LIBOR, and the synthetic rates are expected to continue through September 30, 2024.[103] Synthetic LIBOR is calculated as the "*relevant CME Term SOFR Reference Rate plus the ISDA Spread Adjustment for the corresponding setting*."[104] The spread adjustment represents the median difference over a five-year lookback period between LIBOR and CME Term SOFR for the same term.[105] For example, 3-month Synthetic LIBOR is calculated as 3-month CME Term SOFR plus a fixed spread adjustment of 26.161 basis points, the 3-month ISDA Spread Adjustment.[106] The ARRC did not consider dynamic spread adjustments because these would rely on the same wholesale unsecured funding markets underlying LIBOR, given concerns about low transaction volumes and illiquidity in recent years.[107]

45. Figure 8 presents 3-month USD LIBOR, 3-month Synthetic LIBOR, and 3-month CME Term SOFR from January 3, 2019 (the start of available data for 3-month CME Term SOFR) to December 31, 2023. The last published 3-month USD LIBOR rate was 5.55 percent on June 30, 2023. The first 3-month Synthetic LIBOR rate published by the IBA was 5.53 percent on July 3, 2023. This was calculated as 3-month CME Term SOFR of 5.27 percent on July 3, 2023 plus the 3-month ISDA Spread Adjustment. The difference between 3-month CME Term SOFR and 3-month Synthetic LIBOR in the chart is the 3-month ISDA Spread Adjustment.

[103] "The USD LIBOR panel ceases at end-June 2023: Are you ready?" Financial Conduct Authority, April 12, 2023, https://www.fca.org.uk/news/news-stories/usd-libor-panel-ceases-end-june-2023-are-you-ready. (Accessed March 7, 2024).

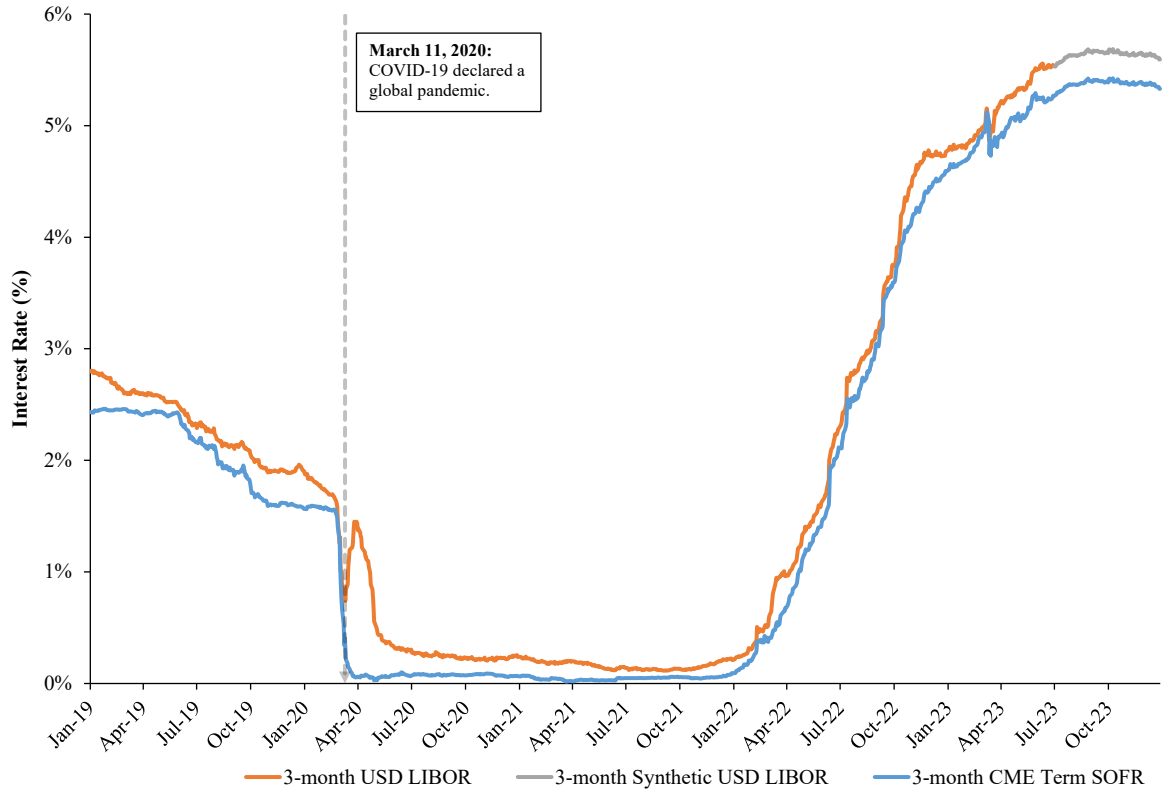
[104] Financial Conduct Authority, *Article 23D Benchmarks Regulation – Notice of Requirements*, July 1, 2023, 8.

[105] International Swaps and Derivatives Association, *Bloomberg published Fallback Rates: Interaction between RFR publications, IBOR Fallback publications and the ISDA Definitions*, September 8, 2022, 2.

[106] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.ice.com/IBA/LIBOR. (Accessed March 7, 2024).

[107] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR*, January 21, 2020, 7-8.

Figure 8. *3-month USD LIBOR, 3-month Synthetic LIBOR, and 3-month CME Term SOFR between January 3, 2019 to December 31, 2023*



Notes and Sources:
- Data are from Bloomberg.

G. Fallback Language for the Preference Shares and Challenges to Obtaining Quotations

46. The offering document for the Preference Shares contains fallback language in the event that LIBOR is unavailable. I understand that the fallback language requires Standard Chartered to request quotations from major London or New York banks for 3-month lending or borrowing in USD.[108] In particular, Standard Chartered would be required to request four major banks in the London interbank market to submit their quotations for 3-month deposits in USD and if fewer than two such quotations are submitted, Standard Chartered would be required to ask three major banks in New York to provide their rates for 3-month loans in USD to leading European banks.[109]

[108] 2006 Offering Circular, 34.

[109] 2006 Offering Circular, 34.

47. Martin Wheatley, then a Managing Director of the Financial Services Authority, was commissioned by the U.K. government "*to establish an independent review into a number of aspects of the setting and usage of LIBOR*."[110] The final report, published in 2012 ("**Wheatley Review**"), found that fallback provisions, such as the ones for the Preference Shares, were "*intended to be used in the event of occasional operational problems, or other market disruptive events, which lead to LIBOR not being published in the usual manner*."[111]

48. The Wheatley Review highlighted a number of problems with fallback language that relied on indicative quotes for deposit rates from reference banks. Specifically, since the reference banks can be the same banks that were part of the LIBOR panel and made submissions for LIBOR rates, "*there is a risk that these banks may not be prepared to provide quotes in a circumstance where LIBOR has failed*."[112] The established contingency plan in the event that LIBOR fails "*relies on the same inputs that one could expect to be unavailable in the instance of LIBOR being unavailable*."[113] The Wheatley Review also stated that "*given the huge volume of contracts that reference LIBOR, it is likely that, in the event that LIBOR was unavailable, the sheer volume of existing contracts would make this approach unworkable.*"[114]

49. Another potential hurdle with receiving quotes from the participants of the interbank lending market is diminishing liquidity. The U.K. has seen a decline in the share of interbank loans in the assets of the domestic banks from 6 percent, as of the last quarter of 2014, to 3.8 percent, as of the last quarter of 2019, according to the data by the European Central Bank.[115] In the U.S., interbank funding as a share of assets of domestically chartered banks declined from 5.5 percent in 1990 to 0.3 percent at the start of 2018, after which the

[110] Her Majesty's Treasury, *The Wheatley Review of LIBOR: final report*, September 2012, 5.

[111] Her Majesty's Treasury, *The Wheatley Review of LIBOR: final report*, September 2012, 39.

[112] Her Majesty's Treasury, *The Wheatley Review of LIBOR: final report*, September 2012, 40.

[113] Her Majesty's Treasury, *The Wheatley Review of LIBOR: final report*, September 2012, 40.

[114] Her Majesty's Treasury, *The Wheatley Review of LIBOR: final report*, September 2012, 39.

[115] "Interbank loans (% of total assets)," European Central Bank Data Portal, https://data.ecb.europa.eu/data/datasets/CBD2/CBD2.Q.GB.W0.11.S122Z._Z.A.A.I3015._Z._Z._Z._Z._Z._Z.PC. (Accessed March 7, 2024).

Fed no longer reported interbank lending as a separate category of assets.[116] A study by the Fed concluded that the share of unsecured funding, in general, "*makes up an increasingly small part of U.S. banks' liabilities*."[117] This declining liquidity may make it more difficult to receive such quotations from U.K. and U.S. banks.

50. I am not aware of any publicly available data sources that record information on quotations of interbank lending rates of individual banks in the U.K. or U.S. In addition, even if such a data source were to exist, it may be the case that individual banks would not quote interbank lending rates, especially after the cessation of USD LIBOR.[118] Banks may be uncomfortable taking on the role of a reference bank to provide indicative quotes and expose themselves to the risk of being challenged on the accuracy of the quoted rates.[119] This discomfort may be magnified if the quoted rate were to be relied upon for the calculation of interest rates or dividends.

51. It is my understanding that Standard Chartered does not have data on quotations of interbank lending rates from bank offices in the U.K. and U.S. that would meet the qualifications under the fallback language of the Preference Shares. The ability of Standard Chartered to obtain such quotations and the quality of the quotes received would depend on the cooperation of the largest U.K. and U.S. banks as well as on the liquidity of the interbank lending market, in circumstances where there has been a "*significant decline in activity in interbank deposit markets*."[120] In addition, Standard Chartered would be required to obtain quotations indefinitely, as the Preference Shares are perpetual securities.

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[116] Steve Cecchetti and Kim Schoenholtz, "Bank Financing: The Disappearance of Interbank Lending," Money, Banking and Financial Markets, March 5, 2018, https://www.moneyandbanking.com/commentary/2018/3/4/bank-financing-the-disappearance-of-interbank-lending. (Accessed March 7, 2024).

[117] David Bowman, et al., "How Correlated is LIBOR with Bank Funding Costs?" Board of Governors of the Federal Reserve System FEDS Notes, June 29, 2020, https://www.federalreserve.gov/econres/notes/feds-notes/how-correlated-is-libor-with-bank-funding-costs-20200629.html. (Accessed March 7, 2024).

[118] For example, the ICE LIBOR Code of Conduct contained provisions regarding disclosure of LIBOR submission rates and required that a panel bank not disclose "*rates which will be submitted in the future or have been submitted to IBA but not yet published*." Intercontinental Exchange Benchmark Administration, *ICE LIBOR Code of Conduct*, May 21, 2021, 18.

[119] "Reference banks a dying breed," Dentons, July 30, 2014, https://www.dentons.com/en/insights/newsletters/2014/july/30/bank-notes/bank-notes-july-2014/reference-banks-a-dying-breed. (Accessed March 7, 2024).

[120] Andreas Schrimpf and Vladyslav Sushko, *Beyond LIBOR: a primer on the new reference rates,* Bank for International Settlements Quarterly Review, March 2019, 29.

IV. ALTERNATIVE BENCHMARK RATES AS LIBOR REPLACEMENTS

52. On November 17, 2014, the Federal Reserve Bank of New York ("**FRBNY**" or "**New York Fed**") convened the ARRC to "*(a) consider the range of existing and potential reference interest rates and identify a risk-free rate or rates that in the consensus view of the group represent best practice for use; (b) identify best practices to ensure that contracts are resilient to the possible cessation or material alteration of a benchmark; and (c) develop plans to promote the adoption of the ARRC's best practice recommendations and timelines for implementation of these plans*."[121] The focus on identifying "*one or more alternative risk-free or nearly risk-free USD reference rates*" to replace USD LIBOR originated from the recommendation that "*[u]sing largely risk-free rates for [derivatives transactions or other products where credit risk plays a smaller role] would lower the risks to financial institutions and to financial stability from a further decline in the unsecured interbank market*."[122]

53. The ARRC consisted of a group of private-sector participants, including "*banks, asset managers, insurers, and industry trade organizations*," such as JPMorgan Chase, Pacific Investment Management Company (PIMCO), MetLife, and the ISDA, and "*official-sector ex-officio members*," such as the Fed, the U.S. Securities and Exchange Commission, and the U.S. Treasury Department.[123]

54. The ARRC published its first report in May 2016. The report examined a set of alternative benchmark rates to be considered as potential replacements for LIBOR, including secured and unsecured overnight rates, unsecured term lending rates, policy rates, and treasury rates, among others.[124]

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[121] Alternative Reference Rates Committee, *ARRC Closing Report: Final Reflections on the Transition from LIBOR*, November 2023, 2.

[122] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 4. See, also, Financial Stability Oversight Council, *FSOC 2014 Annual Report*, May 7, 2014, 118.

[123] The ARRC disbanded in November 2023. See, "About," Alternative Reference Rates Committee, https://www.newyorkfed.org/arrc/about. (Accessed March 7, 2024).

[124] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 13.

The list of considered rates is similar to the ones discussed earlier by the Financial Stability Board ("**FSB**"). Financial Stability Board, *Market Participants Group on Reforming Interest Rate Benchmarks: Final Report*, March 2014.

a. An unsecured rate is the cost of borrowing when no collateral is provided to support the borrowing and a secured rate is the cost of borrowing when collateral is pledged.

b. An overnight rate is the cost of borrowing for a single day and term rates are the cost of borrowing over defined time periods, such as three months. All else equal, overnight rates tend to be lower than term rates because shorter tenors are repaid earlier and thus deemed less risky.[125]

c. A policy rate is a rate set by a monetary authority, such as a country's central bank. For example, a policy rate in the U.K. would be the Bank of England base rate.

d. Treasury rates refer to interest rates on U.S. sovereign debt, known as U.S. Treasuries.

55. In the May 2016 report, the ARRC identified the two "*strongest alternatives*" to replace LIBOR as overnight Treasury general collateral repo rate (to be called SOFR) and OBFR.[126] SOFR is a secured overnight rate which is a measure of the "*cost of borrowing cash overnight collateralized by Treasury securities*."[127] OBFR is an unsecured overnight rate that is a measure of "*wholesale, unsecured, overnight bank funding costs*."[128]

56. In addition to the ARRC's research, academics and industry experts examined the transition and considered potential LIBOR replacement rates, including credit sensitive rates. For example, Crabb (2020) presented a case for the replacement of LIBOR by multiple rates in order to enhance market efficiency. The author argued that, unlike SOFR, AMERIBOR "*contains a credit spread component based on unsecured loans*" and that this means that AMERIBOR "*is more suitable for small to midsized banks that are less likely to*

[125] Joshua Rosenbaum and Joshua Pearl, *Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions* (Hoboken: Wiley & Sons, Inc., 2013, 2nd Edition), 233.

[126] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 1.

[127] "Secured Overnight Financing Rate Data," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/reference-rates/sofr. (Accessed March 7, 2024).

[128] "Overnight Bank Funding Rate," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/reference-rates/obfr. (Accessed March 7, 2024).

use secured loans."[129] Similarly, Tuckman (2023) contended that regional and smaller banks preferred to link their interest rate to credit-sensitive rates, especially during times of crises, and investigated credit-sensitive rates, including AMERIBOR and Bloomberg Short-Term Bank Yield ("**BSBY**") Index, which have several available tenors.[130] The ARRC concluded that "*a term unsecured lending rate would not be a robust alternative to LIBOR given the limited transactions, unstable samples of borrowers, and sensitivity to market stress that these markets exhibit*."[131]

57. Separately but relatedly, various regulators including the Federal Deposit Insurance Corporation, the Fed, and the U.S. Treasury Department held discussions with banks and other market participants regarding a credit-sensitive supplement to SOFR.[132] These credit sensitivity group workshops discussed a "*credit sensitive component that aligns with bank funding costs*" as banks that borrow short term may invest in floating rate products with a reference rate that is not the same as the reference rate for their funding.[133] This type of exposure is defined as "*basis*" risk and is the risk that was meant to be reduced or eliminated through the creation of a credit-sensitive supplement to SOFR.[134] Some

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[129] John Crabb, "PRIMER, Ameribor and its role in the LIBOR transition," International Financial Law Review, August 25, 2020, https://www.iflr.com/article/2a6459hr8l17lndye1728/primer-ameribor-and-its-role-in-the-libor-transition. (Accessed March 7, 2024).

AMERIBOR, or the American Interbank Offered Rate, is an unsecured overnight rate that contains a credit spread component and "*reflects the actual unsecured borrowing costs of banks and financial institutions, [largely in the small to midsize category]*" based on unsecured loans for members of the American Financial Exchange. AMERIBOR is also offered as 30- and 90-day term rates. See, "AFX AMERIBOR," American Financial Exchange, https://theafex.com/ameribor/. (Accessed March 7, 2024).

[130] The BSBY Index will not be published after November 15, 2024. Polo Rocha, "RIP BSBY: Bloomberg to shut down its lagging Libor replacement," American Banker, https://www.americanbanker.com/news/rip-bsby-bloomberg-to-shut-down-its-lagging-libor-replacement. (Accessed March 7, 2024). See, also, Bruce Tuckman, "Short-Term Rate Benchmarks: The Post-LIBOR Regime," Annual Review of Financial Economics 15 (2023): 1-21, 8-9.

The BSBY Index measures unsecured wholesale funding costs for "*systemically important banks*" based on transactions quotes and contains a credit spread component. The BSBY Index is a forward-looking rate with terms of overnight and 1-, 3-, 6-, and 12-month tenors. See, "Bloomberg Short-Term Bank Yield Index," Bloomberg L.P, https://assets.bbhub.io/professional/sites/10/BSBY-Fact-Sheet_231025.pdf. (Accessed March 7, 2024).

[131] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 22.

[132] Meeting minutes and presentations are available on the Federal Reserve Bank of New York website. "Transition from LIBOR: Credit Sensitivity Group Workshops," Federal Reserve Bank of New York, February 4, 2021. https://www.newyorkfed.org/newsevents/events/markets/2020/0225-2020. (Accessed March 7, 2024).

[133] Federal Reserve Bank of New York, *Credit Sensitivity Group Workshop 1: Meeting Minutes; Next Steps*, June 4, 2020, 3.

[134] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015, 9th Edition), 54-56.

participants expressed concerns around introducing a credit-sensitive rate alongside SOFR, not wanting to create confusion around the transition. Additionally, participants were concerned about the credit-sensitive rates being used for broader purposes for which they are not designed, including in derivatives markets.[135] Rather than endorsing a credit-sensitive rate, the ARRC recommended a spread adjustment to SOFR for commercial cash products that was consistent with ISDA's spread adjustment based on a "*5-year historical median difference between USD LIBOR and SOFR*" and calculated for each LIBOR tenor.[136] Following the March 5, 2021 announcement by the FCA that USD LIBOR would end, Bloomberg, as vendor for fallback rates in ISDA documentation, published the spread adjustment between 3-month USD LIBOR and compounded average SOFR at 26.161 basis points.[137]

58. This section examines the potential LIBOR replacement rates that have been considered by the ARRC, regulators, academics, and industry experts, and compares and contrasts them to LIBOR.[138] The examined rates include a) overnight transaction rates (SOFR, EFFR, OBFR, AMERIBOR); b) term rates (CME Term SOFR, AA financial commercial paper rate, Treasury rate); and c) survey-based rate (U.S. prime rate).[139] An overnight rate is the cost of borrowing for a single day and term rates are the cost of borrowing over defined time periods, such as three months. Survey-based rates, such as LIBOR and U.S. prime rate, are not supported by an underlying transactions market. Instead, these rates are based on a survey process, similar to how LIBOR had been determined, and can pose many of the same risks and vulnerabilities as LIBOR. The ARRC did not consider

[135] "Transition from LIBOR: Credit Sensitivity Group Workshops," Federal Reserve Bank of New York, February 4, 2021, https://www.newyorkfed.org/newsevents/events/markets/2020/0225-2020. (Accessed March 7, 2024).

[136] Alternative Reference Rates Committee, *Summary of the ARRC's Fallback Recommendations*, October 6, 2021, 4.

[137] Alternative Reference Rates Committee, *Summary of the ARRC's Fallback Recommendations*, October 6, 2021, 4.

[138] I reviewed the reports, commentary, and press releases of the Alternative Reference Rates Committee, the Financial Conduct Authority, the Federal Reserve Board, the Financial Stability Board, the International Organization of Securities Commissions ("**IOSCO**"), the International Swaps and Derivatives Association, the World Bank, and others on the LIBOR transition and alternative reference rates.

[139] The ARRC determined that policy rates, such as central bank rates, were not viable for several reasons, including that there is no guarantee that the current monetary framework that the rates are a part of would remain unchanged over time. See, Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 19.

survey-based rates as they were tasked with "*identify[ing] a set of alternative USD reference rates that [were] more firmly based on transactions from a robust underlying market.*"[140]

A. Overnight Transaction Rates

1. Secured Overnight Funding Rate (SOFR)

59. SOFR is a rate that is based on secured, overnight repurchase agreement transactions.[141] A repurchase agreement, or repo, is a sale of securities which is associated with an agreement to repurchase the same securities on a later date at a higher price.[142] The effect is that the seller borrows funds, using the securities as collateral. SOFR is based on secured overnight Treasury general collateral repurchase agreements. In an overnight Treasury general collateral repurchase agreement, the borrower of funds provides a variety of Treasury securities as collateral and agrees to repurchase the securities on the following day.[143] Securities dealers, primary dealers, banks, insurance companies, mutual funds, pension funds, hedge funds, central banks, government entities and agencies, and corporations all participate in the repo market.[144] With the transactions data, the FRBNY prepares and publishes overnight SOFR each U.S. business day at approximately 8:00 a.m. EST on the FRBNY's website.[145] Overnight SOFR is calculated as the volume-weighted median of the interest rates on the transactions discussed above.

60. The FRBNY also publishes compounded average SOFR, which is calculated using daily overnight SOFR rates and allows for SOFR to be used over longer tenors. Further discussion of how SOFR is compounded can be found in Section V.

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[140] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 4.

[141] "Secured Overnight Financing Rate Data," Federal Reserve Bank of New York, https://apps.newyorkfed.org/markets/autorates/SOFR. (Accessed March 7, 2024).

[142] Michael J. Fleming and Kenneth D. Garbade, "The Repurchase Agreement Refined: GCF Repo," Federal Reserve Bank of New York: Current Issues in Economics and Finance, Volume 9, No. 6 (2003): 1-7, 1.

[143] Michael J. Fleming and Kenneth D. Garbade, "The Repurchase Agreement Refined: GCF Repo," Federal Reserve Bank of New York: Current Issues in Economics and Finance, Volume 9, No. 6 (2003): 1-7, 6.

[144] Securities Industry and Financial Markets Association, *SIFMA Research The US Repo Markets: A Chart Book,* February 7, 2022.

[145] "Secured Overnight Financing Rate Data," Federal Reserve Bank of New York, https://apps.newyorkfed.org/markets/autorates/SOFR. (Accessed March 7, 2024).

61. Additionally, the CME Group publishes CME Term SOFR, which is based on SOFR futures and is forward-looking. I discuss CME Term SOFR later in Section IV.B.1.

62. Though overnight SOFR was first published in April 2018, the Fed also released a range of historical *indicative* data from August 2014 to March 2018 based on "*modeled, pre-production estimates of SOFR*" which rely on the same underlying data and methodology of the published rate.[146] In addition, a range of data extending back to February 20, 1998 was released based on a survey of primary dealers of their borrowing activity in the Treasury general collateral repurchase agreement market, which is administered by FRBNY's open market trading desk.[147] Using responses from these surveys, the Fed constructed a survey rate as the volume-weighted mean rate of the primary dealers' overnight Treasury general collateral repo borrowing activity ("**Proxy SOFR**"). Though less transparent, Proxy SOFR provides a meaningful counterpart to SOFR because it is based on the borrowing activity each morning of primary dealers in the Treasury general collateral repo market—the market that underlies SOFR.[148]

63. Figure 9 compares the daily values for 3-month USD LIBOR and overnight SOFR from February 20, 1998 (the start of available data for Proxy SOFR) to June 30, 2023.[149] In general, 3-month USD LIBOR and overnight SOFR move together. When comparing overnight SOFR to 3-month USD LIBOR, overnight SOFR is generally lower since it is a secured rate and an overnight rate. In times of financial stress, such as the financial crisis and the COVID-19 pandemic crisis, the difference between overnight SOFR and LIBOR widened. Rates based on secured transactions involving Treasuries, such as overnight SOFR, may move in the opposite direction to rates based on unsecured transactions

[146] David Bowman, "Historical Proxies for the Secured Overnight Financing Rate," Board of Governors of the Federal Reserve System FEDS Notes, July 15, 2019, https://doi.org/10.17016/2380-7172.2386. (Accessed March 7, 2024).

[147] "*Primary dealers are trading counterparties of the New York Federal Reserve in its implementation of monetary policy. They are also expected to make markets for the New York Federal Reserve on behalf of its official accountholders as needed, and to bid on a pro-rata basis in all Treasury auctions at reasonably competitive prices*." See, "Primary Dealers," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/primarydealers. (Accessed March 7, 2024). See, also, "Statement Regarding the Publication of Historical Repo Rate Data," Federal Reserve Bank of New York, March 9, 2018, https://www.newyorkfed.org/markets/opolicy/operating_policy_180309. (Accessed March 7, 2024).

[148] "Statement Regarding the Publication of Historical Repo Rate Data," Federal Reserve Bank of New York, March 9, 2018, https://www.newyorkfed.org/markets/opolicy/operating_policy_180309. (Accessed March 7, 2024).

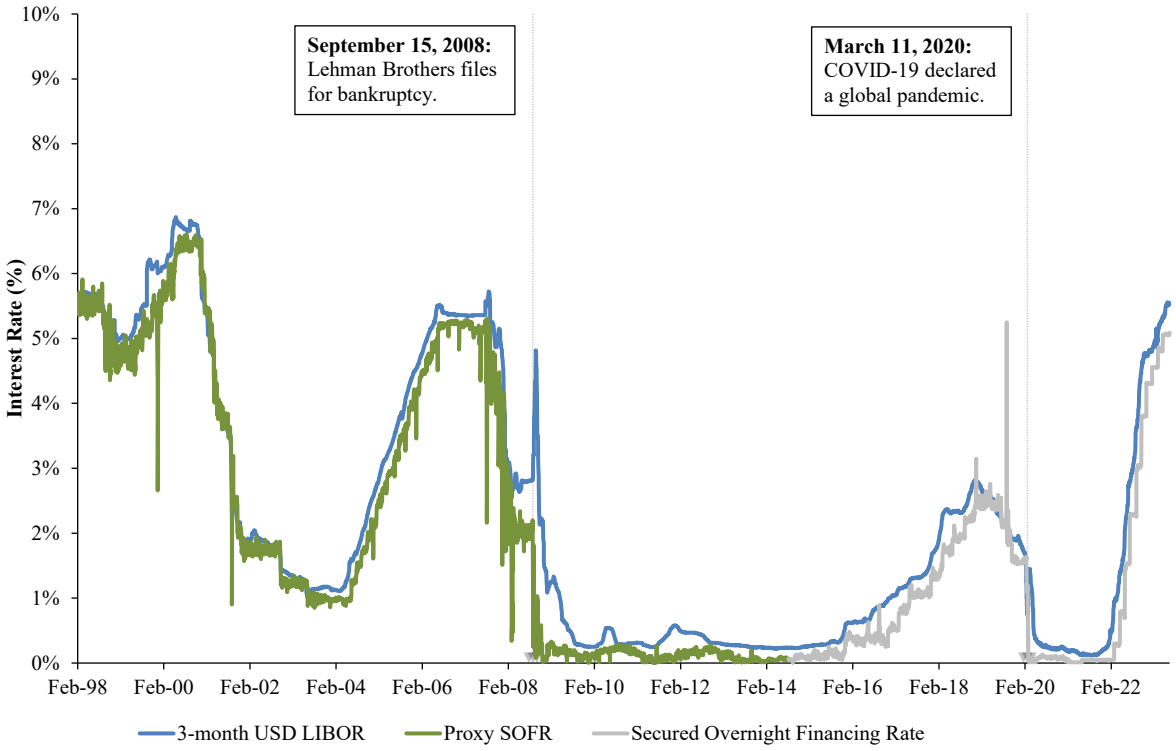
[149] I show the historical data for the alternative benchmark rates starting on February 20, 1998 because this is the first available data for Proxy SOFR.

when markets are under stress as investors seek the safe haven of U.S. Treasury securities.[150] On September 17, 2019, overnight SOFR rose drastically from 2.43 percent to 5.25 percent, and then decreased to 2.55 percent on the following day. This occurred due to a cash crunch caused by corporate tax payments due on September 16, as well as $54 billion in long-term Treasury debt that settled on the same date.[151] This is one reason why an overnight alternative benchmark rate has to be adjusted and averaged to avoid a rise in the rate on specific days.

[150] David Bowman, et al., "How Correlated is LIBOR with Bank Funding Costs?" Board of Governors of the Federal Reserve System FEDS Notes, June 29, 2020, https://www.federalreserve.gov/econres/notes/feds-notes/how-correlated-is-libor-with-bank-funding-costs-20200629.html. (Accessed March 7, 2024). I consider the COVID-19 pandemic to span the period between when the World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020 and the end of the U.S. recession on April 30, 2020. See, "WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020," World Health Organization, March 11, 2020, https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020. (Accessed March 7, 2024). See, also, "Business Cycle Dating Committee Announcement July 19, 2021," National Bureau of Economic Research, July 19, 2021, https://www.nber.org/news/business-cycle-dating-committee-announcement-july-19-2021. (Accessed March 7, 2024).

[151] Alyssa Anderson et.al, "What Happened in Money Markets in September 2019?" Board of Governors of the Federal Reserve System FEDS Notes, February 27, 2020, https://www.federalreserve.gov/econres/notes/feds-notes/what-happened-in-money-markets-in-september-2019-20200227.html. (Accessed March 7, 2024).

Figure 9. *3-month USD LIBOR and SOFR between February 20, 1998 and June 30, 2023*



Notes and Sources:
- Data are from Bloomberg, the Federal Reserve Bank of New York, and the Federal Reserve Bank of St. Louis.

2. Effective Federal Funds Rate (EFFR)

64. EFFR is a rate that is based on the overnight federal funds transactions. Federal funds are excess reserves held at Federal Reserve Banks.[152] Excess reserves are cash funds held by banks above the requirements of the Fed.[153] In cases of surplus, banks may lend their excess reserves to other financial institutions that have an account at a Federal Reserve Bank.[154] These transactions are usually conducted on an overnight basis and are unsecured. The institutions that borrow funds refer to this transaction as "*federal funds*

[152] "Trading and Capital-Markets Activities Manual," Board of Governors of the Federal Reserve System, updated July 2011, https://www.federalreserve.gov/publications/supervision_trading.htm. (Accessed March 7, 2024).

[153] Ben R. Craig and Matthew Koepke, *Excess Reserves: Oceans of Cash,* Federal Reserve Bank of Cleveland: Economic Commentary Number 2015-02, February 12, 2015, 1.

[154] "Trading and Capital-Markets Activities Manual," Board of Governors of the Federal Reserve System, updated July 2011, https://www.federalreserve.gov/publications/supervision_trading.htm. (Accessed March 7, 2024).

purchased," and typically do so to help manage daily liquidity needs.[155] EFFR is based on the volume-weighted median rate of these transactions. The FRBNY publishes EFFR for the previous day daily at 9:00 a.m. on their website.[156] EFFR is used as a reference rate for interest rate swaps.[157]

65. EFFR acts as a step-function due to the Fed setting two administered rates, interest on reserve balances ("**IORB**") and overnight reverse repo facility ("**ON RRP**"), at levels which will help keep the federal funds rate within a target range. [158] This helps support smooth functioning of short-term funding markets.[159] IORB is set by the Fed and is the rate paid to banks and other eligible entities on account balances, or reserves, at the Federal Reserve Banks.[160] IORB sets a floor at which banks are willing to lend excess cash to their reserve accounts.[161] ON RRP is set by the Federal Open Market Committee ("**FOMC**") and is the interest rate the Fed pays on an overnight reverse repo facility operation.[162] An overnight reverse repo facility is a repurchase agreement through which eligible institutions can invest overnight with the Fed.[163] In general, counterparties would be unwilling to invest

[155] "Trading and Capital-Markets Activities Manual," Board of Governors of the Federal Reserve System, updated July 2011, https://www.federalreserve.gov/publications/supervision_trading.htm. (Accessed March 7, 2024).

[156] "Effective Federal Funds Rate," Federal Reserve Bank of New York, https://apps.newyorkfed.org/markets/autorates/fed%20funds. (Accessed March 7, 2024).

[157] Daniel L. Thornton, *What the Libor-OIS Spread Says*, Federal Reserve Bank of St. Louis Economic Synopses, No. 24, May 11, 2009, 1.

[158] "Monetary Policy Implementation," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/domestic-market-operations/monetary-policy-implementation. (Accessed March 7, 2024).

[159] "Monetary Policy Implementation," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/domestic-market-operations/monetary-policy-implementation. (Accessed March 7, 2024).

[160] "Monetary Policy Implementation," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/domestic-market-operations/monetary-policy-implementation. (Accessed March 7, 2024).

[161] "Monetary Policy Implementation," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/domestic-market-operations/monetary-policy-implementation. (Accessed March 7, 2024).

[162] "Monetary Policy Implementation," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/domestic-market-operations/monetary-policy-implementation. (Accessed March 7, 2024).

[163] Gara Afonso, et al., "How the Fed's Overnight Reverse Repo Facility Works," Federal Reserve Bank of New York: Liberty Street Economics, January 11, 2022, https://libertystreeteconomics.newyorkfed.org/2022/01/how-the-feds-overnight-reverse-repo-facility-works/. (Accessed March 7, 2024).

funds overnight in money markets at rates below ON RRP.[164] The FOMC is comprised of twelve members, which includes seven members from the Fed, the president of the FRBNY, and presidents from four other Federal Reserve Banks.[165] The FOMC reviews economic and financial conditions, determines the monetary policy stance, and assesses the risks to long-run goals of price stability and economic growth.[166]

66. Figure 10 compares the daily values of 3-month USD LIBOR and overnight EFFR from February 20, 1998 (the start of available data for Proxy SOFR) to June 30, 2023. EFFR is generally lower than 3-month USD LIBOR because it is an overnight rate. The spread or difference between EFFR and LIBOR rose to 403 basis points in October 2008, following the Lehman Brothers bankruptcy filing, as wholesale unsecured funding costs increased due to counterparty credit risk concerns.[167]

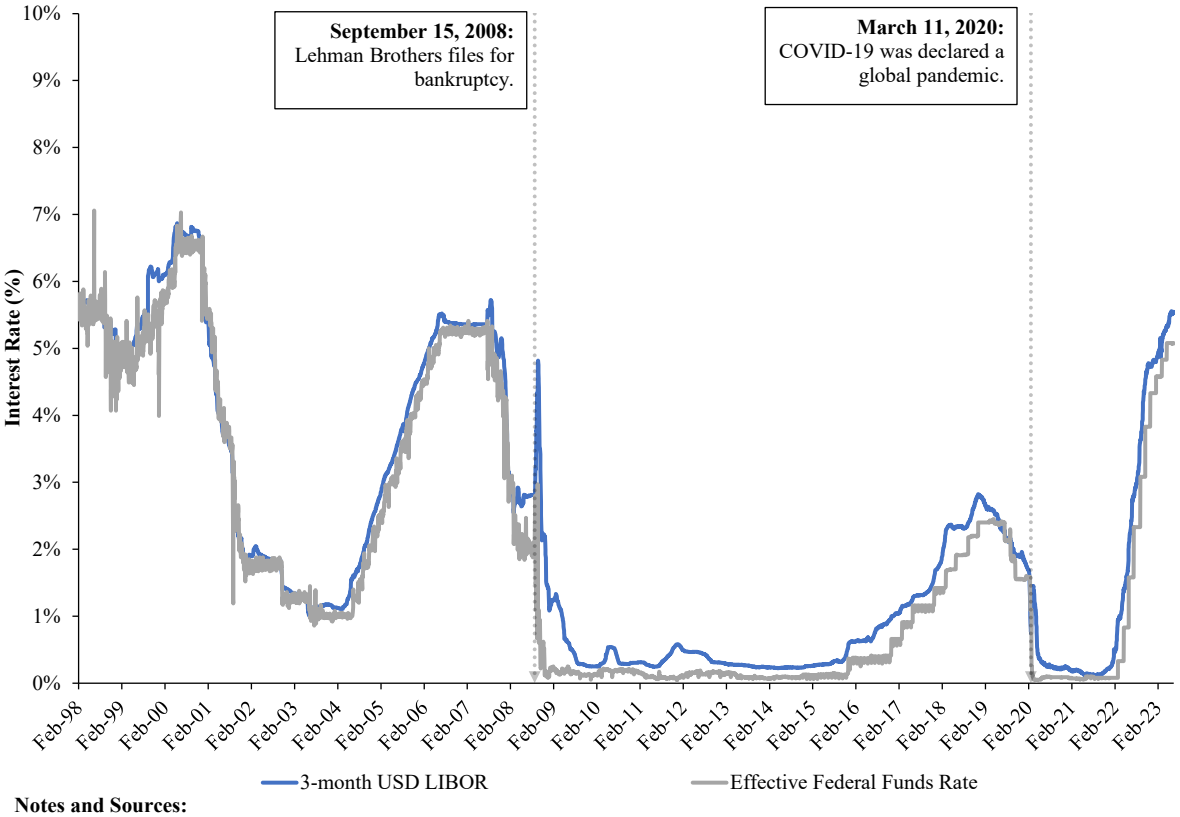
[164] "Monetary Policy Implementation," Federal Reserve Bank of New York, https://www.newyorkfed.org/markets/domestic-market-operations/monetary-policy-implementation. (Accessed March 7, 2024).

[165] "About the FOMC," Board of Governors of the Federal Reserve System, updated February 21, 2024, https://www.federalreserve.gov/monetarypolicy/fomc.htm. (Accessed March 7, 2024).

[166] "About the FOMC," Board of Governors of the Federal Reserve System, updated February 21, 2024, https://www.federalreserve.gov/monetarypolicy/fomc.htm. (Accessed March 7, 2024).

[167] David Bowman, et al., "How Correlated is LIBOR with Bank Funding Costs?" Board of Governors of the Federal Reserve System FEDS Notes, June 29, 2020, https://www.federalreserve.gov/econres/notes/feds-notes/how-correlated-is-libor-with-bank-funding-costs-20200629.html. (Accessed March 7, 2024).

Figure 10. *3-month USD LIBOR and EFFR between February 20, 1998 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

3. Overnight Bank Funding Rate (OBFR)

67. OBFR draws from the same overnight federal funds transactions data that underlie EFFR but also incorporates Eurodollar transactions data. The transactions underlying OBFR involve unsecured borrowing. Eurodollars refer to unsecured USD deposits not subject to U.S. banking regulations—i.e. held in banks or branches outside the U.S. or domestic deposits taken through international banking facilities.[168] Money market funds, corporations, and foreign central banks are all active lenders in the Eurodollar market.[169] Eurodollars and federal funds are close substitutes as funding sources.[170] OBFR also relies on

[168] "Overnight Bank Funding Rate," Federal Reserve Bank of New York, https://apps.newyorkfed.org/markets/autorates/obfr. (Accessed March 7, 2024).

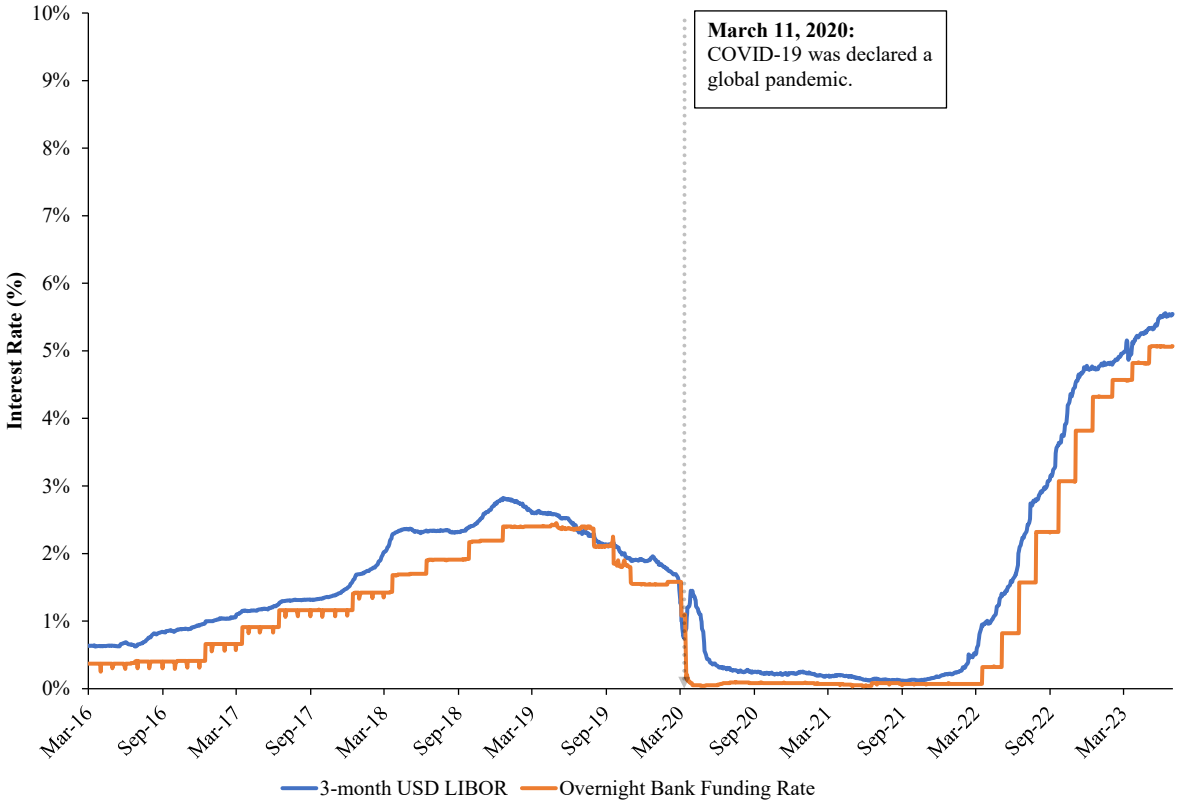
[169] Marco Cipriani and Julia Gouny, "The Eurodollar Market in the United States," The Federal Reserve Bank of New York: Liberty Street Economics, https://libertystreeteconomics.newyorkfed.org/2015/05/the-eurodollar-market-in-the-united-states/. (Accessed March 7, 2024).

[170] Marco Cipriani and Julia Gouny, "The Eurodollar Market in the United States," The Federal Reserve Bank of New York: Liberty Street Economics, https://libertystreeteconomics.newyorkfed.org/2015/05/the-eurodollar-market-in-the-united-states/. (Accessed March 7, 2024).

select overnight deposit transactions that are placed at domestic bank branches. OBFR is calculated as the volume-weighted median of these transactions and is published by the FRBNY for the previous day's transactions at 9:00 a.m. EST every day.

68. Figure 11 compares the daily values of 3-month USD LIBOR and overnight OBFR from March 1, 2016 (when OBFR first became available) to June 30, 2023. OBFR behaves like a step function given "*the similarity of the OBFR and the [fed funds rate]*."[171] OBFR is generally lower than 3-month USD LIBOR because it is an overnight rate.

Figure 11. *3-month USD LIBOR and OBFR between March 1, 2016 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

4. AMERIBOR

69. AMERIBOR is an interest rate that is based on daily transactions in the overnight unsecured loan market on the American Financial Exchange, LLC ("**AFX**"). The

[171] "Minutes of the Federal Open Market Committee," Board of Governors of the Federal Reserve System: Federal Open Market Committee, November 7-8, 2018, https://www.federalreserve.gov/monetarypolicy/fomcminutes20181108.htm. (Accessed March 7, 2024).

AFX provides an electronic platform for banks and financial institutions to conduct overnight, unsecured lending and borrowing.[172] According to AFX, AMERIBOR "*reflects the actual unsecured borrowing costs of more than 1,000 American banks and financial institutions, that together represents 25% of the U.S. banking sector's total assets.*"[173] AMERIBOR is calculated as the transaction volume-weighted average interest rate based on the overnight, unsecured transactions that occur on the exchange.[174]

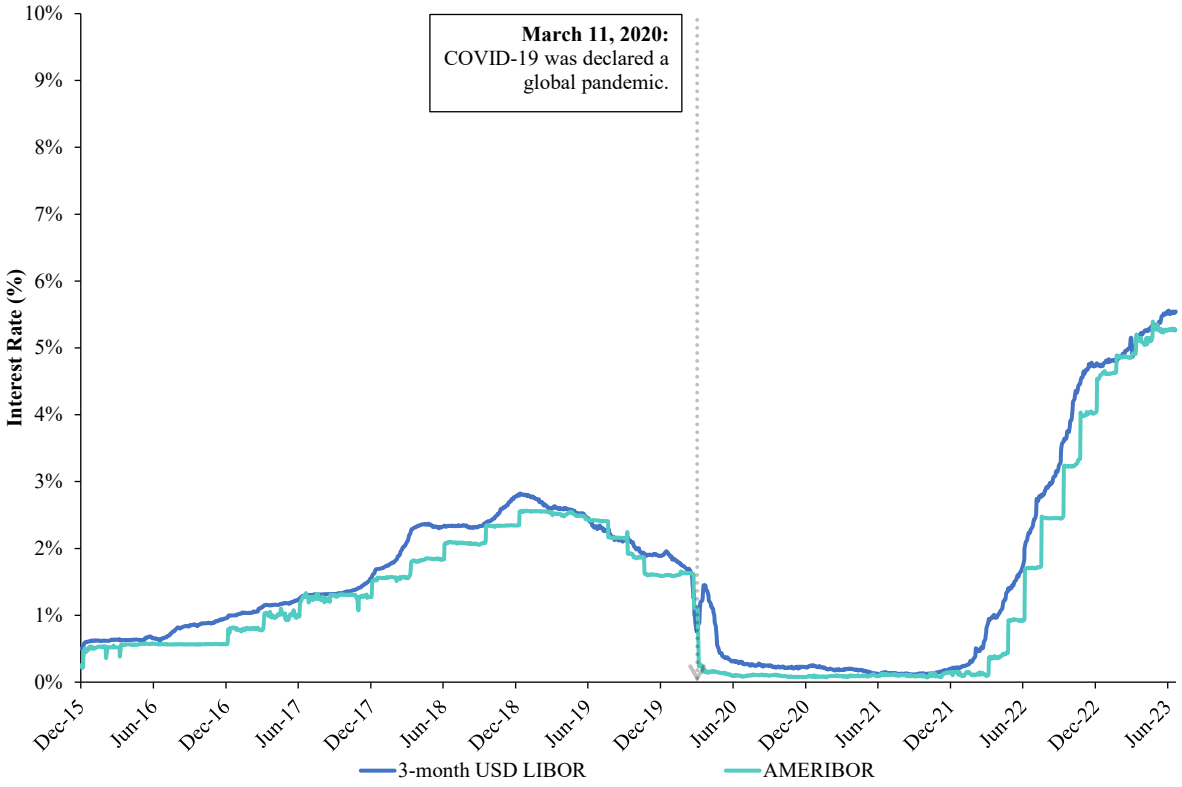
70. Figure 12 compares the daily values of 3-month USD LIBOR and overnight AMERIBOR from December 11, 2015 (the start of available data for AMERIBOR) to June 30, 2023. When COVID-19 was declared a pandemic, there was a notable deviation between AMERIBOR and LIBOR, where AMERIBOR consistently declined, while 3-month USD LIBOR initially increased. The spread between AMERIBOR and LIBOR is expected to increase when markets are under stress as AMERIBOR is an overnight rate.

[172] "Innovating the Interbank Loan Market," American Financial Exchange, https://theafex.com/marketplace/. (Accessed March 7, 2024).

[173] "American Financial Exchange Appoints Veteran Financial Services Executive John Shay as CEO," American Financial Exchange via PR Newswire, May 2, 2023, https://www.prnewswire.com/news-releases/american-financial-exchange-appoints-veteran-financial-services-executive-john-shay-as-ceo-301812914.html. (Accessed March 7, 2024).

[174] American Financial Exchange, *AMERIBOR Methodology*, 1.

Figure 12. *3-month USD LIBOR and AMERIBOR between December 11, 2015 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

B. Term Rates

1. CME Term SOFR

71. SOFR is an overnight rate, and compounded average SOFR, which is calculated for specific tenors using historical overnight SOFR, is a backward-looking rate. By contrast, CME Term SOFR is a set of forward-looking term SOFR reference rates by maturity that reflects market expectations for SOFR in the future.[175] Since May 7, 2018, the CME Group began to offer 1-month and 3-month SOFR futures contracts, which CME Term SOFR is derived from.[176] A futures contract is an agreement to buy or sell an asset at a pre-determined price at a specified time in the future.[177] These interest rate futures contracts

[175] Financial Conduct Authority, *Article 23D Benchmarks Regulation – Draft Notice of Requirement*, April 3, 2023, 3.

[176] Chicago Mercantile Exchange Group, *CME SOFR Futures*, 2019, 5.

[177] Frank J. Fabozzi, *The Handbook of Financial Instruments* (Hoboken: John Wiley & Sons, Inc., 2002, 2nd Edition), 13.

allow market participants to lock in an interest rate to be paid in the future. Hence, SOFR futures are derivatives contracts that allow investors to manage future interest rates, such as hedging against future movements of SOFR.[178] A derivative is a contract whose value is derived from the performance of underlying market factors.[179] The futures contracts reflect the market expectations on average daily SOFR during the contract reference period.[180] On April 21, 2021, the CME Group announced that it would be publishing CME Term SOFR reference rates for 1-, 3-, and 6-month tenors based on the "*deep and liquid underlying [CME] SOFR futures*" and the daily data has been available since January 3, 2019.[181] On July 29, 2021, following continued growth in the SOFR cash and derivatives markets, the ARRC recommended the use of CME Term SOFR to replace LIBOR, mostly for cash market transactions.[182] In September 2021, the CME Group added a 12-month tenor for term SOFR, and the ARRC endorsed 12-month CME Term SOFR on May 19, 2022.[183]

72. CME Term SOFR uses transaction data from thirteen consecutive 1-month CME SOFR futures contracts and five consecutive 3-month (quarterly) CME SOFR futures

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[178] David Gibbs et al., "CME SOFR Futures and SOFR Volatility," Chicago Mercantile Exchange Group, June 7, 2019, https://www.cmegroup.com/education/articles-and-reports/cme-sofr-futures-and-sofr-volatility.html. (Accessed March 7, 2024).

[179] "Derivatives," Office of the Comptroller of the Currency, https://www.occ.treas.gov/topics/supervision-and-examination/capital-markets/financial-markets/derivatives/index-derivatives.html. (Accessed March 7, 2024).

[180] "Secured Overnight Financing Rate (SOFR) Futures," Chicago Mercantile Exchange Group, https://www.cmegroup.com/trading/interest-rates/secured-overnight-financing-rate-futures.html. (Accessed March 7, 2024).

[181] "CME Group Announces Launch of CME Term SOFR Reference Rates," Chicago Mercantile Exchange Group Press Release, April 21, 2021, https://www.cmegroup.com/media-room/press-releases/2021/4/21/cme_group_announceslaunchofcmetermsofrreferencerates.html. (Accessed March 7, 2024).

[182] Alternative Reference Rates Committee, *ARRC Formally Recommends Term SOFR*, July 29, 2021, 1.

On March 16, 2022, ICE launched its own term SOFR for 1-, 3-, 6-, and 12-month tenors. I did not consider the ICE term SOFR as the data are not available for the time periods that I analyzed. See, Intercontinental Exchange, *ICE Benchmark Administration Launches ICE Term SOFR Reference Rates as a Benchmark for use in Financial Instruments*, Intercontinental Exchange News Release, March 16, 2022, 1.

In addition, the FCA determined that the CME Term SOFR "*will better satisfy our policy consideration of market support and the likely effect outside the UK, in light of the ARRC's recommendation and the proposed regulation by the FRB to implement the US' LIBOR Act*" as compared to the ICE term SOFR. See, Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 15.

[183] Chicago Mercantile Exchange Group, *3Q 2021 Earnings Commentary*, 4.

"*The ARRC has taken the further continued development of CME SOFR futures markets into account in its consideration of the 12-month rate and believes that market conditions are such that an endorsement of this rate is now in line with the ARRC's key principles*." Alternative Reference Rates Committee, *ARRC Provides Update Endorsing CME 12-Month SOFR Term Rate*, May 19, 2022, 1.

contracts.[184] Using the transactions found in these SOFR futures, there are fourteen observation periods throughout the day, each 30 minutes long, where a set of volume weighted average prices are calculated using transaction prices observed during these periods.[185] The volume weighted average prices are then used in a projection model to determine CME Term SOFR.[186]

73. Since the cessation of the USD LIBOR panel on June 30, 2023, synthetic LIBOR has been calculated by reference to the "*relevant CME Term SOFR Reference Rate plus the ISDA Spread Adjustment for the corresponding setting*."[187] For 3-month Synthetic LIBOR, the 3-month ISDA spread adjustment is 26.161 basis points.[188] The FCA has stated that synthetic LIBOR is a "*fair and reasonable approximation of what LIBOR might have been had it continued to exist.*"[189]

74. Figure 13 compares the daily rates of 3-month USD LIBOR and 3-month CME Term SOFR from January 3, 2019 (the start of available data for 3-month CME Term SOFR) to June 30, 2023. When COVID-19 was declared a pandemic, there was a notable deviation between CME Term SOFR and LIBOR, where CME Term SOFR consistently declined, while 3-month USD LIBOR initially increased. Shortly following the declaration of COVD-19 as a pandemic, 3-month USD LIBOR peaked at the end of March 2020 with a rate of 1.45 percent while 3-month CME Term SOFR declined to 0.06 percent. In light of such events, the Bank of England has highlighted that "*the wholesale term funding markets – on which Libor is based – are prone to becoming volatile and unreliable in stressed periods.*"[190]

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[184] Chicago Mercantile Exchange Group, *CME Term SOFR Reference Rates Benchmark Methodology*, June 28, 2023, 6.

[185] Chicago Mercantile Exchange Group, *CME Term SOFR Reference Rates Benchmark Methodology*, June 28, 2023, 8.

[186] Chicago Mercantile Exchange Group, *CME Term SOFR Reference Rates Benchmark Methodology*, June 28, 2023, 16.

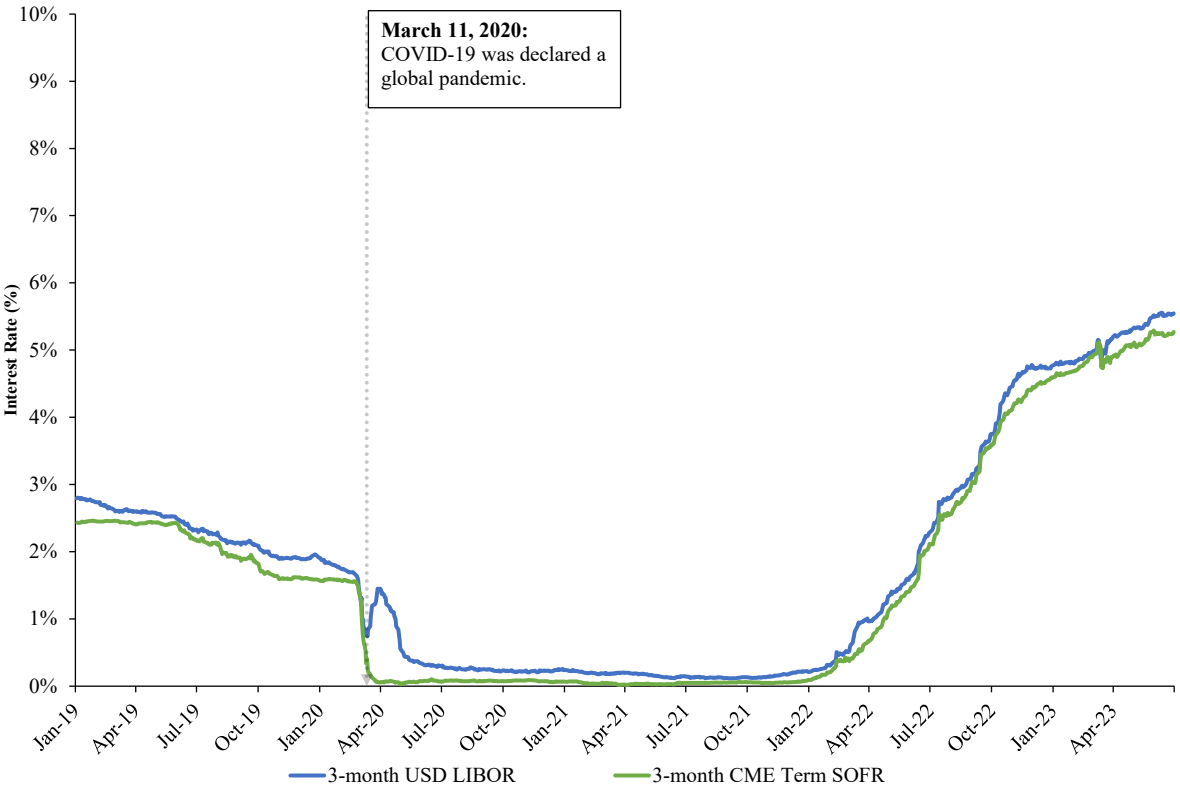
[187] Financial Conduct Authority*, Article 23D Benchmarks Regulation – Notice of Requirements*, July 1, 2023, 8.

[188] "LIBOR," Intercontinental Exchange Benchmark Administration, https://www.ice.com/IBA/LIBOR. (Accessed March 7, 2024).

[189] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 4.

[190] Bank of England, *Financial Stability Report*, July 2021, 13.

Figure 13. *3-month USD LIBOR and 3-month CME Term SOFR between January 3, 2019 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

2. AA Financial Commercial Paper Rate

75. Commercial papers are short-term promissory notes mainly issued by corporations and financial institutions.[191] A promissory note is a written agreement between one party to pay back the loan issued by another party.[192] Commercial paper provides short-term funding for financial and non-financial firms.[193] Other major participants in the commercial paper market include money market funds, mutual funds, and state and local

[191] "Commercial Paper Rates and Outstanding Summary," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/default.htm. (Accessed March 7, 2024). See, also, Frank J. Fabozzi, *The Handbook of Financial Instruments* (Hoboken: John Wiley & Sons, Inc., 2002, 2nd Edition), 158-159.

[192] "Promissory Notes Can Be Less Than Promised," Financial Industry Regulatory Authority, July 5, 2023, https://www.finra.org/investors/insights/promissory-notes-can-be-less-promised. (Accessed March 7, 2024).

[193] Nina Boyarchenko, et al., "The Commercial Paper Funding Facility," Federal Reserve Bank of New York: Liberty Street Economics, May 15, 2020, https://libertystreeteconomics.newyorkfed.org/2020/05/the-commercial-paper-funding-facility/. (Accessed March 7, 2024).

governments.[194] AA financial commercial paper rates are produced and overseen by the Fed and published daily with a one day-lag at approximately 1:00 p.m. EST on the Fed's website.[195] The Fed reports AA financial commercial paper rates for specific maturities, including 30-, 60- and 90-day terms.[196] To produce these rates, the Fed uses the aggregation of many trades of commercial paper of different AA-rated financial issuers to estimate a relation between interest rates and maturities using statistical methods.[197] The transactions which are used in the calculation of commercial paper rates are weighted by the face value of the commercial paper.[198] Commercial paper rates are used as reference rates for various products. This includes floating rate debt securities issued by U.S. and foreign corporations as well as federal agencies and sovereign countries, interest rate swaps where commercial paper rates are used for floating rate payments, and also as a benchmark for preferred stock dividend rates.[199]

76. Figure 14 compares the daily values for 3-month USD LIBOR and 90-day AA financial commercial paper rate from February 20, 1998 (the start of available data for Proxy SOFR) to June 30, 2023. The rates mostly track each other closely during this period, though 3-month USD LIBOR rate is generally slightly higher. However, in March 2020, the commercial paper markets experienced disruptions related to uncertainties during the COVID-19 pandemic crisis.[200] As investors grew reluctant to buy new commercial paper, the rate on AA financial commercial paper rose to 2.1 percent on March 20, 2020, compared to 0.6 percent on March 19, 2020, reflecting increased cost of borrowing for financial issuers.

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[194] Viktoria Baklanova, et al., *Primer: Money Market Funds and the Commercial Paper Market*, Securities and Exchange Commission, November 9, 2020, 1-2.

[195] "Commercial Paper Rates and Outstanding Summary," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/default.htm. (Accessed March 7, 2024).

[196] "About Commercial Paper," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/about.htm. (Accessed March 7, 2024).

[197] "About Commercial Paper," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/about.htm. (Accessed March 7, 2024).

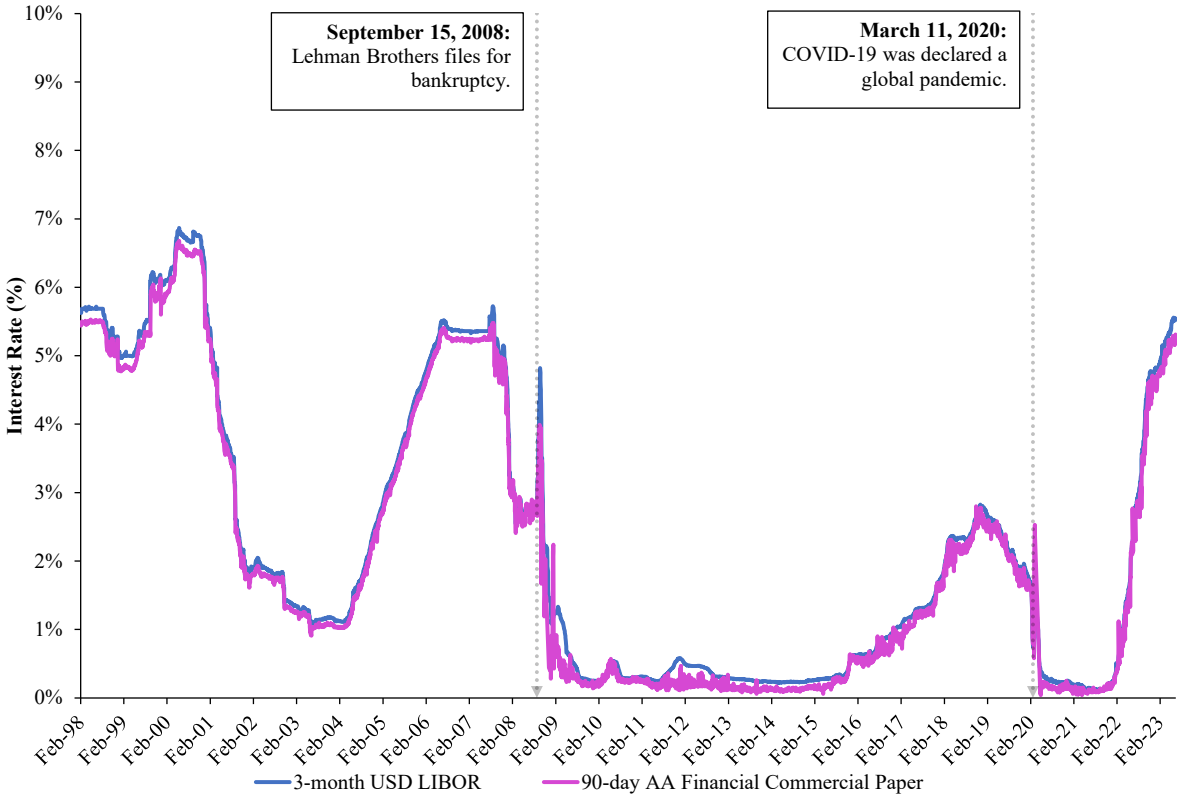
[198] "Commercial Paper Rates and Outstanding Summary," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/default.htm. (Accessed March 7, 2024).

See, also, "About Commercial Paper," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/about.htm. (Accessed March 7, 2024).

[199] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 348, 389, 1250.

[200] Congressional Research Service, *COVID-19: Commercial Paper Market Strains and Federal Government Support*, April 13, 2020, 1.

Figure 14. *3-month USD LIBOR and 90-day AA Financial Commercial Paper Rate between February 20, 1998 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

3. Treasury Rate

77. Treasury rates are the interest rates paid on U.S. Treasury securities of different tenors.[201] U.S. Treasury securities are issued by the federal government and are considered the safest instruments as they are backed by the U.S. government.[202] Hence they are seen as a safe haven, especially during times of crisis.[203] The Treasury market is generally regarded as the most liquid or actively traded market in the world.[204] The largest holders of

[201] "Investment Products: Bonds," Financial Industry Regulatory Authority, https://www.finra.org/investors/learn-to-invest/types-investments/bonds/types-of-bonds/us-treasury-securities. (Accessed March 7, 2024).

[202] "Investment Products: Bonds," Financial Industry Regulatory Authority, https://www.finra.org/investors/learn-to-invest/types-investments/bonds/types-of-bonds/us-treasury-securities. (Accessed March 7, 2024).

[203] Bryan Noeth and Rajdeep Sengupta, *Flight to Safety and U.S. Treasury Securities*, Federal Reserve Bank of St. Louis The Regional Economist, July 2010, 18.

[204] "Investment Products: Bonds," Financial Industry Regulatory Authority, https://www.finra.org/investors/learn-to-invest/types-investments/bonds/types-of-bonds/us-treasury-securities. (Accessed March 7, 2024).

U.S. Treasury securities are firms in the foreign sector and the U.S. financial sector, though state and local governments, households, and non-financial firms also hold U.S. Treasury securities.[205] Constant maturity rates provide estimates of rates for U.S. Treasury securities at fixed bond life, such as daily estimates of the rate for a U.S. Treasury with 3 months until maturity, and are derived from the daily yield curve which expresses the relationship between the yield of a security to its time to maturity.[206] There are three main types of securities: bills, notes and bonds.[207] Treasury bills are typically sold at a discount from the face value.[208] The investor will receive the face value when the bill matures.[209] The difference between the face value and the purchased price is the interest earned.[210] Notes and bonds earn interest at a set rate on the face value and pay the face value at maturity.[211]

78. Figure 15 compares the daily values from 3-month USD LIBOR and U.S. Treasury Securities at 3-month constant maturity from February 20, 1998 (the start of available data for Proxy SOFR) to June 30, 2023. 3-month Treasury rate is typically below 3-month USD LIBOR, reflecting the lower risk of U.S. Treasury Securities. During times of stress, the rates diverged. In early October 2008, shortly after the Lehman Brothers bankruptcy, LIBOR increased to over 4 percent while the Treasury rate dropped below 0.5

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[205] Bryan Noeth and Rajdeep Sengupta, *Flight to Safety and U.S. Treasury Securities*, Federal Reserve Bank of St. Louis, 19.

[206] "Interest Rate Statistics," U.S. Department of the Treasury, https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield. (Accessed March 7, 2024).

"*A 'yield curve' is a comparison between long-term and short-term bonds that depicts the relationship between their rates of interest. The rate for a longer-term bond is usually higher than the rate for a shorter-term bond. This is because of the term premium, which reflects the amount investors expect to be compensated for lending for longer periods."* "The Yield Curve: The Basics," Economic Research Federal Reserve Bank of St. Louis, https://research.stlouisfed.org/publications/yield-curve/what-is-the-yield-curve. (Accessed March 7, 2024). See, also, Zvi Bodie, et al., *Investments* (New York: McGraw-Hill Education, 2014, 10th Edition), 487.

[207] "Investment Products: Bonds," Financial Industry Regulatory Authority, https://www.finra.org/investors/learn-to-invest/types-investments/bonds/types-of-bonds/us-treasury-securities. (Accessed March 7, 2024). Treasury bills are Treasury securities with maturities up to 52 weeks, and Treasury notes are Treasury securities with maturities between two and ten years. Treasury bonds are Treasury securities with terms of ten to thirty years.

[208] "Understanding Pricing and Interest Rates," TreasuryDirect, https://www.treasurydirect.gov/marketable-securities/understanding-pricing/. (Accessed March 7, 2024).

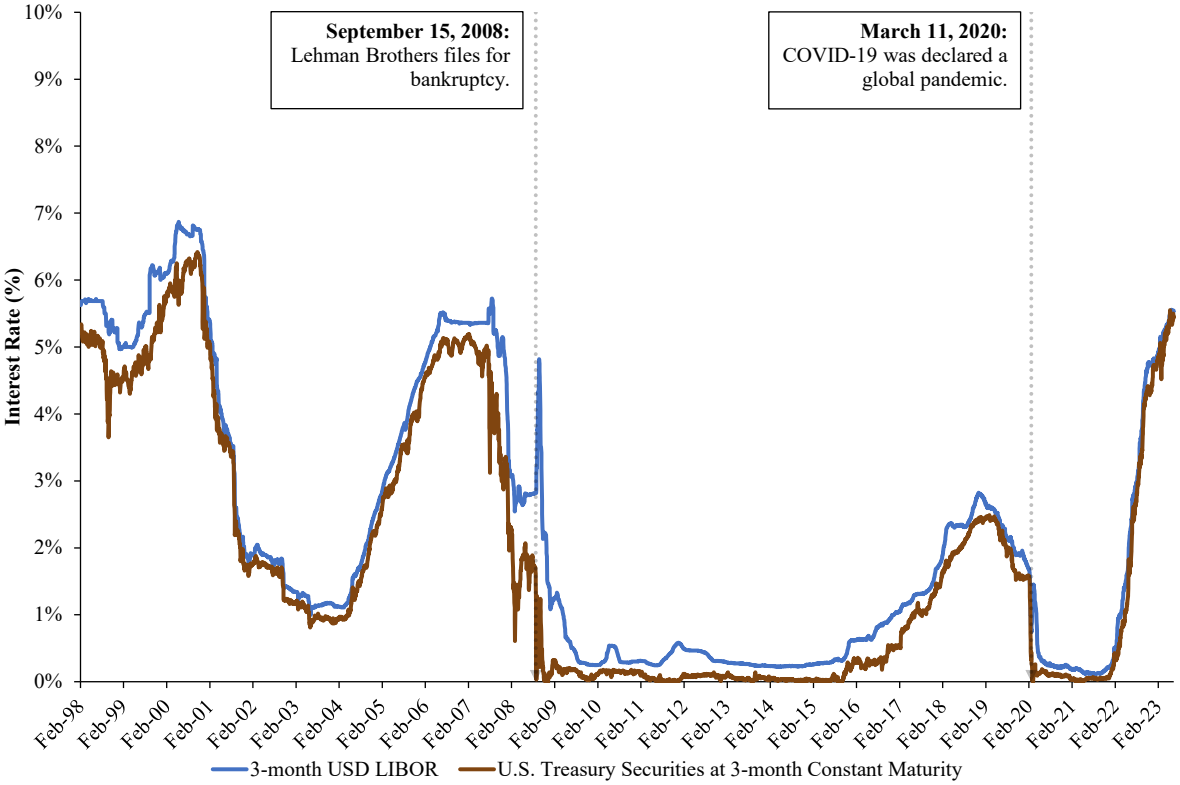
[209] "Understanding Pricing and Interest Rates," TreasuryDirect, https://www.treasurydirect.gov/marketable-securities/understanding-pricing/. (Accessed March 7, 2024).

[210] "Understanding Pricing and Interest Rates," TreasuryDirect, https://www.treasurydirect.gov/marketable-securities/understanding-pricing/. (Accessed March 7, 2024).

[211] "Understanding Pricing and Interest Rates," TreasuryDirect, https://www.treasurydirect.gov/marketable-securities/understanding-pricing/. (Accessed March 7, 2024).

percent. During the COVID-19 pandemic, the average spread between the rates increased initially from 13 basis points in February 2020 to 81 basis points in March 2020. The spread between the rates reached a peak at 142 basis points on March 27, 2020. The increase in the spread means that during times of stress, like the COVID-19 pandemic crisis, the rates react differently because investors seek the safe haven of U.S. Treasury Securities.[212]

Figure 15. *3-month USD LIBOR and 3-month Treasury Securities between February 20, 1998 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

4. Term USD Overnight Indexed Swap Rate (OIS)

79. An overnight indexed swap or OIS is a swap between a fixed and floating interest rate.[213] In an OIS swap, the floating rate is the overnight rate, which in the U.S. is

[212] David Bowman et al., "How Correlated is LIBOR with Bank Funding Costs?" Board of Governors of the Federal Reserve System FEDS Notes, June 29, 2020, https://doi.org/10.17016/2380-7172.2539. (Accessed March 7, 2024).

[213] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 1276-1277.

EFFR, and the fixed rate is the OIS rate.[214] The OIS rate reflects the expectation of the federal funds rate over the contract term, and is considered to be "*very close*" to a risk-free rate given the slim chances of a default on an overnight loan or on the swap itself.[215] OIS swaps are conducted between financial institutions.[216]

80. Data on traded overnight indexed swaps are available from the DTCC Derivatives Repository PLC interest rates derivative trade repository.[217] As of 2012, the daily average volume for OIS transactions was $266 billion.[218] The over-the-counter derivatives market, including overnight indexed swaps, allows market participants to hedge risk and take positions on future price movements.[219]

81. Figure 16 compares the daily values of 3-month USD LIBOR and 3-month OIS from December 4, 2001 (the start of available data for 3-month OIS) to June 30, 2023. The rates track each other closely but begin to diverge prior to the Lehman Brothers bankruptcy. The average difference between 3-month USD LIBOR and 3-month OIS rate was 69 basis points from January 1, 2008 to September 15, 2008. On October 10, 2008, the 3-month OIS rate stood at 1.17 percent while 3-month USD LIBOR reached 4.82 percent, a peak difference of 364 basis points.

[214] Daniel L. Thornton, *What the Libor-OIS Spread Says*, Federal Reserve Bank of St. Louis Economic Synopses, No. 24, May 11, 2009, 1.

[215] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015 9th Edition), 203.

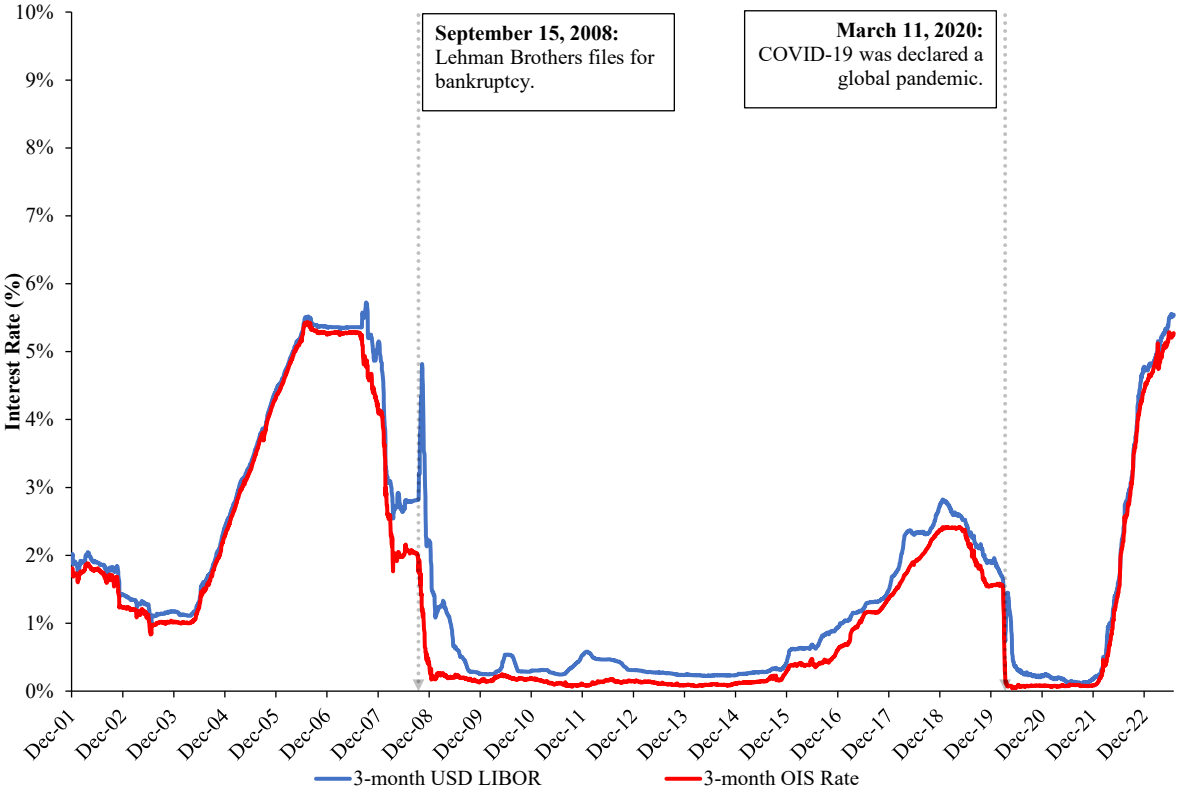
[216] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015 9th Edition), 202.

[217] "DTCC Launches Global OTC Interest Rate Trade Repository," Business Wire, December 7, 2011, https://www.businesswire.com/news/home/20111207005940/en/DTCC-Launches-Global-OTC-Interest-Rate-Trade-Repository. (Accessed March 7, 2024).

[218] Michael Fleming, et al, *An Analysis of OTC Interest Rate Derivatives Transactions: Implications for Public Report*, Federal Reserve Bank of New York Staff Reports, No. 557, October 2012, 7.

[219] Michael Fleming, et al, *An Analysis of OTC Interest Rate Derivatives Transactions: Implications for Public Report*, Federal Reserve Bank of New York Staff Reports, No. 557, October 2012, 2.

Figure 16. *3-month USD LIBOR and 3-month OIS Rate between December 4, 2001 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

C. Survey-Based Rate – U.S. Prime Rate

82. U.S. prime rate is determined by a survey of individual banks, similar to the process for determining LIBOR, and hence is not transaction-based. The Fed reports U.S. prime rate "*posted by the majority of the largest twenty-five banks*."[220] Many banks simply choose to set their prime rate submission based on the target federal funds rate plus a 300 basis points spread.[221] U.S. prime rate has historically closely tracked overnight rates like the

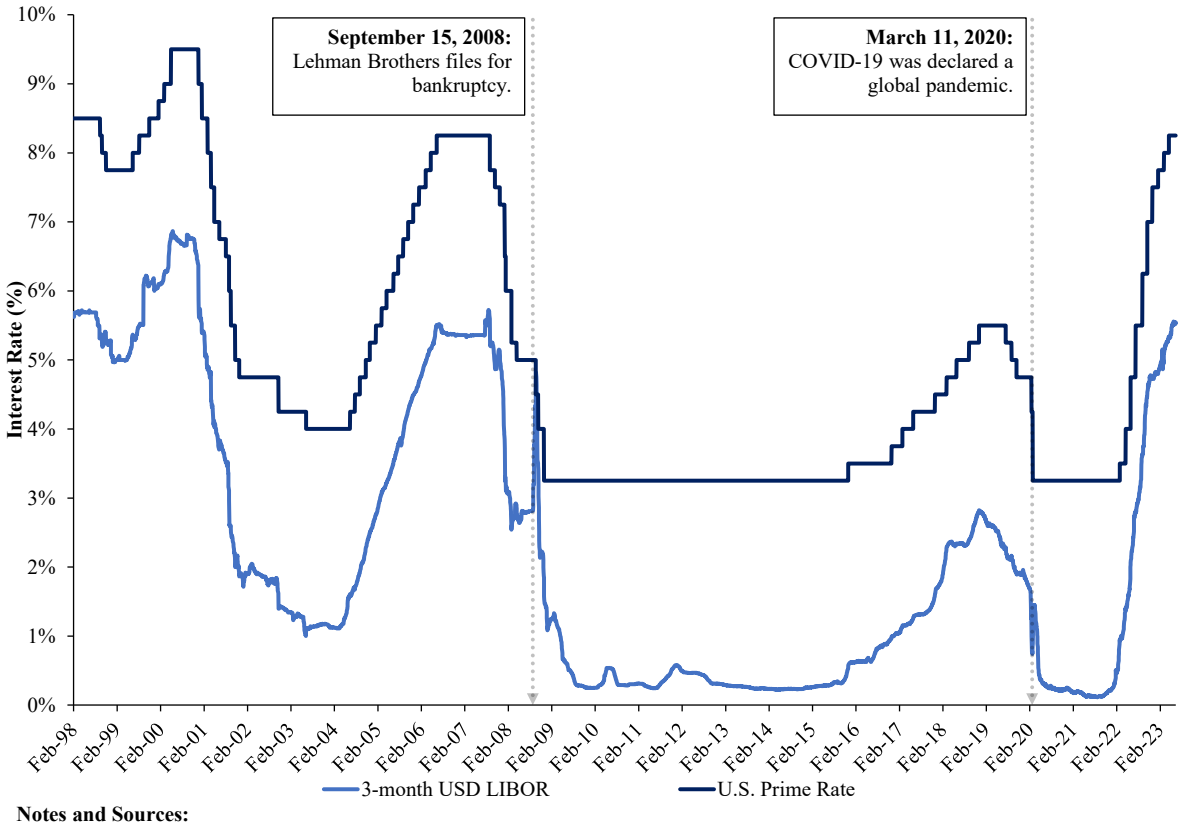
[220] "What is the prime rate, and does the Federal Reserve set the prime rate?" Board of Governors of the Federal Reserve System, updated August 2, 2013, https://www.federalreserve.gov/faqs/credit_12846.htm. (Accessed March 7, 2024).

[221] "What is the prime rate, and does the Federal Reserve set the prime rate?" Board of Governors of the Federal Reserve System, updated August 2, 2013, https://www.federalreserve.gov/faqs/credit_12846.htm. (Accessed March 7, 2024). See, also, Joseph Friedman and Yochanan Shachmurove, "The responses of the prime rate to change in policies of the Federal Reserve," Economic Modelling 46 (2015): 407-411.

federal funds rate, and is more commonly used by small domestic banks, for small business loans under one million dollars, and for securitized loans.[222]

83. Figure 17 compares 3-month USD LIBOR to U.S. prime rate from February 20, 1998 (the start of available data for Proxy SOFR) to June 30, 2023. U.S. prime rate is consistently higher than 3-month USD LIBOR while also exhibiting long periods where it is flat and tracks the target federal funds rate plus a 300 basis points spread. Around the time of the bankruptcy of Lehman Brothers, LIBOR rose and U.S. prime rate did not. Similarly, during the COVID-19 pandemic crisis, LIBOR rose shortly after the declaration of the pandemic while U.S. prime rate did not.

Figure 17. *3-month USD LIBOR and U.S. Prime Rate between February 20, 1998 and June 30, 2023*



Notes and Sources:
-Data are from Bloomberg.

[222] "What is the prime rate, and who borrows at that interest rate?" Federal Reserve Bank of San Francisco, June 1, 2005, https://www.frbsf.org/research-and-insights/publications/doctor-econ/2005/06/prime-interest-rate/. (Accessed March 7, 2024).

D. Comparison of the Use of Alternative Benchmark Rates

84. The alternative benchmark rates considered above serve various purposes, especially as a reference rate, similarly to the way LIBOR was used as a reference rate.

a. Compounded average SOFR, which is calculated for specific tenors, is used as a reference rate for floating rate payments, including floating rate debt issuances, adjustable-rate mortgages, and business and student loans.[223] In addition, the U.S. Commodity Futures Trading Commission ("**CFTC**"), the FCA, and the Bank of England recommended that SOFR replace LIBOR in USD linear interest rate swaps.[224]

b. EFFR is used as a reference rate for interest rate swaps, including OIS, where the floating payments are linked to EFFR.[225]

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[223] Alternative Reference Rates Committee, *An Updated User's Guide to SOFR*, February 2021, 24.

[224] "CFTC's Interest Rate Benchmark Reform Subcommittee Recommends July 26 for Transitioning Interdealer Swap Market Trading Conventions from LIBOR to SOFR," Commodity Futures Trading Commission, Release Number 8394-21, June 8, 2021, https://www.cftc.gov/PressRoom/PressReleases/8394-21. (Accessed March 7, 2024). See, also, "The FCA and the Bank of England encourage market participants in a switch to SOFR in US dollar interest rate swap markets from 26 July," Financial Conduct Authority, June 16, 2021, https://www.fca.org.uk/news/news-stories/fca-bank-england-sofr-us-dollar-interest-rate-swap-markets. (Accessed March 7, 2024).

The CFTC defines linear interest rate swaps to include "*outright swaps, swap spreads and curve trades*." See, Commodity Futures Trading Commission, *CFTC's MRAC Subcommittee on Interest Rate Benchmark Reform Responses to Frequently Asked Questions (FAQs) on "SOFR First" Transition Initiative,* June 8, 2021, 1.

A swap rate *"incorporate[s] a snapshot of the forward expectations for LIBOR and also reflect[s] the market's* perception *of credit quality of these AA-rated banks."* Outright swap rates are generally higher than Treasury yields due to *"the incremental credit risk associated with the banks that provide swaps compared to Treasuries, which are viewed as risk free."* See, Pacific Investment Management Company, *PIMCO: What are Interest Rate Swaps and How Do They Work?,* January 2008.

A swap spread is *"[t]he spread paid by the fixed-rate payer of an interest rate swap over the rate of the relevant sovereign bond with the same maturity as the swap."* See, "Understanding Investing: Interest Rate Swaps," Pacific Investment Management Company, https://www.pimco.com/gbl/en/resources/education/understanding-interest-rate-swaps. (Accessed March 7, 2024).

A Curve Trade is *"a swap that is traded versus another swap with a different maturity."* See, Chris Barnes, "Curve Trading in USD Swaps," Clarus: An ION Company, August 22, 2017, https://www.clarusft.com/curve-trading-in-usd-swaps/. (Accessed March 7, 2024).

[225] Daniel L. Thornton, *What the Libor-OIS Spread Says*, Federal Reserve Bank of St. Louis Economic Synopses, No. 24, May 11, 2009, 1.

c. AMERIBOR is mainly concerned with the interbank market between smaller, regional U.S. banks and aims to serve the needs of small, medium and regional banks across the U.S.[226]

d. CME Term SOFR is recommended by the ARRC for use in fallback language for new and legacy LIBOR cash products, such as business loans and securitizations.[227] Similarly, the U.S. LIBOR Act identified CME Term SOFR as the benchmark replacement for cash transactions.[228]

e. Commercial paper rates are used in medium-term notes. Medium-term notes are a type of senior debt security and are a major source of funding for U.S. and foreign corporations as well as federal agencies and sovereign countries. [229] Rates such as the federal funds rate, LIBOR, commercial paper rates, or U.S. prime rate have been used as reference rates for floating rate medium-term notes. [230]

f. Historically, constant maturity treasuries have often been used as the reference rate for adjustable-rate mortgages.[231]

g. OIS swaps are used extensively by commercial and investment banks. [232] There is a long history of the use of overnight rates in cash instruments, and in a number of currency areas OIS swaps have traded for almost 20 years. Futures markets based on overnight rates are also developing.[233]

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[226] Chris Barnes, "Ameribor: The $1.5bn Index That You Need to Know About," Clarus: An ION Company, April 24, 2019, https://www.clarusft.com/ameribor/. (Accessed March 7, 2024).

[227] Alternative Reference Rates Committee, *Summary and Update of the ARRC's Term SOFR Scope of Use Best Practice Recommendations*, April 21, 2023, 4.

[228] "Regulations Implementing the Adjustable Interest Rate (LIBOR) Act," Federal Register Volume 88, No. 17 (2023): 5204-5243.

[229] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 339-340, 348.

[230] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 1250.

[231] Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope: Frank J. Fabozzi Associates, 2000), 22.

[232] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 1277.

[233] Financial Stability Board, *Overnight Risk-Free Rates: A User's Guide,* June 4, 2019, 2.

h. U.S. prime rate is more commonly used by small domestic banks, for small business loans under one million dollars, and for securitized loans.[234]

i. U.S. prime rate, Treasury bill rates, and commercial paper rates have been used as the floating rate leg in interest rate swaps.[235]

V. PROPOSED ADJUSTMENTS TO LIBOR REPLACEMENT RATES BASED ON HISTORICAL DISCREPANCIES

85. The potential alternative benchmark rates differ from LIBOR in terms of tenor, credit risk, and other components. This means that certain adjustments need to be made in order to compare the alternative benchmark rates against 3-month USD LIBOR when evaluating a replacement rate. Accordingly, in this section, I focus on two types of adjustments: term adjustment and spread adjustment.[236]

A. Term Adjustment

86. LIBOR is a term rate which means it measures borrowing costs over a specific time period, such as 1 month or 3 months, while other rates, like SOFR, are overnight rates. Hence, benchmark rates that are overnight rates require a term adjustment to make them consistent with a term rate like 3-month USD LIBOR. All else equal, shorter tenor debt is considered less risky than longer tenor debt, since it is required to be repaid earlier.[237] Therefore, overnight rates tend to be lower than term rates. The term adjustment requires some level of aggregation, such as averaging over a given number of days, to be comparable to 3-month USD LIBOR. No term adjustment would be necessary for term rates such as 3-month OIS rates, 3-month constant treasury rates or 3-month CME Term SOFR.

87. In order to make the overnight benchmark rates, such as SOFR, EFFR, OBFR, and AMERIBOR consistent with 3-month USD LIBOR on a term basis, I calculated

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[234] "What is the prime rate, and who borrows at that interest rate?" Federal Reserve Bank of San Francisco, June 1, 2005, https://www.frbsf.org/research-and-insights/publications/doctor-econ/2005/06/prime-interest-rate/. (Accessed March 7, 2024).

[235] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 1250.

[236] Although there is no single adjustment (or a set of adjustments) that will make the difference between 3-month USD LIBOR and the alternative benchmark rates consistently equal to zero, the term adjustment and spread adjustment rely on historical data to minimize the differences to LIBOR.

[237] Joshua Rosenbaum and Joshua Pearl, *Investment Banking: Valuation, Leveraged Buyouts, and Mergers & Acquisitions* (Hoboken: Wiley & Sons, Inc., 2013, 2nd Edition), 233.

compounded averages of each of the overnight benchmark rates over a 90-day period.[238] The term adjustment is not sensitive to the length of historical time period that I examine. This means that the term adjustment will not change if I estimate it using a 5-year historical period or a 2-year historical period. Under compounded averages, interest earnings are left to earn more interest.[239] Each day the interest is calculated on the principal borrowed and the accumulated unpaid interest.[240] Compounded interest is the appropriate approach to the application of overnight rates to generate a 3-month term rate as interest would not be distributed overnight but following each quarterly distribution period. The ARRC observed that a compounded average would more accurately reflect the time value of money than a simple average. Compounded interest recognizes that the borrower does not pay back interest owed on a daily basis and it keeps track of the accumulated interest owed but not yet paid.[241]

88. Compounded averages over a specific term, such as 90 days, can be calculated using either an "in arrears" or an "in advance" methodology. Most contracts, such as the Preference Shares, that reference LIBOR as the benchmark for floating rates are based on the value of LIBOR at the beginning of the payment accrual period.[242] This is a convention termed as "in advance." Some contracts, on the other hand, reference rates that occur at the end of the payment accrual period, a convention termed as "in arrears." The main distinction is that payments can be known well ahead of time in the in advance scenario; however, by the time the payment is due, the underlying rate may have changed substantially. In this scenario, the in advance rate may appear out of date at the payment date, while an in arrears convention will more closely track changes based on the current rate environment.

89. The ARRC has noted that many borrowers prefer to know their payments ahead of time and therefore would prefer rates set in advance, whereas investors would prefer

[238] I am not aware of data sources that provide compounded averages for EFFR, OBFR, or AMERIBOR.

AFX publishes 30-day and 90-day term AMERIBOR but the start of available data is June 22, 2021. See, "American Financial Exchange® Launches AMERIBOR® Term Structure of Interest Rates Based on Overnight AMERIBOR Cash and Futures Prices," Numerix, June 22, 2021, https://www.numerix.com/press-release/american-financial-exchange-launches-ameribor-term-structure-of-interest-rates. (Accessed March 7, 2024). See, also, "AMERIBOR® Rates," American Financial Exchange, https://www.ameribor.net/. (Accessed March 7, 2024).

[239] Frank J. Fabozzi and Steven V. Mann, *The Handbook of Fixed Income Securities* (New York: McGraw-Hill Education, 2005, 7th Edition), 117.

[240] Alternative Reference Rates Committee, *A User's Guide to SOFR*, April 16, 2019, 5.

[241] Alternative Reference Rates Committee, *A User's Guide to SOFR*, April 16, 2019, 5.

[242] Alternative Reference Rates Committee, *A User's Guide to SOFR*, April 16, 2019, 7.

rates set in arrears so their returns would reflect current interest rates that are not out of date.[243] There are certain instruments that are better suited for in advance compounding as the rate would be known ahead of time, for example, intercompany loans, student loans, and adjustable-rate mortgages.[244] In arrears compounding reflects what actually happened during the interest rate period. For instruments where needing to know the interest rate ahead of time is not important, such as floating rate notes, or syndicated and bilateral business loans, in arrears compounding can provide a more accurate interest rate.[245]

90. Figure 18 presents an example of the calculation of 90-day SOFR compounded in arrears as of August 1, 2023, which represents the payment accrual period of 90 days starting with August 1 and ending on October 29, 2023. This is equivalent to 90-day SOFR compounded in advance as of October 30, 2023. For the compounding calculation, I followed the New York Fed's approach that applies compounding on each business day and simple interest on any day that is not a business day.[246] The impact of compounding SOFR is the result of applying each daily rate to both the principal and the cumulative unpaid interest. The same calculation may be used to find the term adjustment for overnight rates other than SOFR.

[243] Alternative Reference Rates Committee, *A User's Guide to SOFR*, April 16, 2019, 7.

[244] Alternative Reference Rates Committee, *An Updated User's Guide to SOFR*, February 2021, 24.

[245] Alternative Reference Rates Committee, *An Updated User's Guide to SOFR*, February 2021, 10, 24.

[246] "Additional Information about Reference Rates Administered by the New York Fed," Federal Reserve Bank of New York, updated January 24, 2022, https://www.newyorkfed.org/markets/treasury-repo-reference-rates-information. (Accessed March 7, 2024).

Figure 18. *Example of Calculation of 90-day SOFR Compounded in Arrears as of August 1, 2023 and Compounded in Advance as of October 30, 2023*

Date (1)	SOFR (2)	Number of Days SOFR Applies (3)	Compounding Term (4) =1+(2)*(3)/360	Cumulative SOFR Compounded (5) =[1+prev(5)]*(4)-1
Tuesday, August 1, 2023	5.31 %	1	1.00015	0.01475 %
Wednesday, August 2, 2023	5.30	1	1.00015	0.02947
Thursday, August 3, 2023	5.30	1	1.00015	0.04420
Friday, August 4, 2023	5.30	3	1.00044	0.08839
Monday, August 7, 2023	5.30	1	1.00015	0.10312
Tuesday, August 8, 2023	5.30	1	1.00015	0.11786
Wednesday, August 9, 2023	5.30	1	1.00015	0.13260
Thursday, August 10, 2023	5.30	1	1.00015	0.14734
Friday, August 11, 2023	5.30	3	1.00044	0.19157
Monday, August 14, 2023	5.30	1	1.00015	0.20632
Tuesday, August 15, 2023	5.30	1	1.00015	0.22108
Wednesday, August 16, 2023	5.30	1	1.00015	0.23583
Thursday, August 17, 2023	5.30	1	1.00015	0.25059
Friday, August 18, 2023	5.30	3	1.00044	0.29486
Monday, August 21, 2023	5.30	1	1.00015	0.30963
Tuesday, August 22, 2023	5.30	1	1.00015	0.32440
Wednesday, August 23, 2023	5.30	1	1.00015	0.33917
Thursday, August 24, 2023	5.30	1	1.00015	0.35394
Friday, August 25, 2023	5.30	3	1.00044	0.39826
Monday, August 28, 2023	5.30	1	1.00015	0.41304
Tuesday, August 29, 2023	5.30	1	1.00015	0.42783
Wednesday, August 30, 2023	5.30	1	1.00015	0.44261
Thursday, August 31, 2023	5.31	1	1.00015	0.45743
Friday, September 1, 2023	5.31	4	1.00059	0.51670
Tuesday, September 5, 2023	5.31	1	1.00015	0.53152
Wednesday, September 6, 2023	5.30	1	1.00015	0.54632
Thursday, September 7, 2023	5.31	1	1.00015	0.56116
Friday, September 8, 2023	5.30	3	1.00044	0.60557
Monday, September 11, 2023	5.30	1	1.00015	0.62038
Tuesday, September 12, 2023	5.30	1	1.00015	0.63519
Wednesday, September 13, 2023	5.30	1	1.00015	0.65001
Thursday, September 14, 2023	5.30	1	1.00015	0.66483
Friday, September 15, 2023	5.31	3	1.00044	0.70937
Monday, September 18, 2023	5.31	1	1.00015	0.72423
Tuesday, September 19, 2023	5.31	1	1.00015	0.73908
Wednesday, September 20, 2023	5.30	1	1.00015	0.75391
Thursday, September 21, 2023	5.30	1	1.00015	0.76875
Friday, September 22, 2023	5.30	3	1.00044	0.81325
Monday, September 25, 2023	5.31	1	1.00015	0.82812
Tuesday, September 26, 2023	5.31	1	1.00015	0.84300
Wednesday, September 27, 2023	5.32	1	1.00015	0.85790
Thursday, September 28, 2023	5.31	1	1.00015	0.87278
Friday, September 29, 2023	5.31	3	1.00044	0.91741
Monday, October 2, 2023	5.32	1	1.00015	0.93232
Tuesday, October 3, 2023	5.33	1	1.00015	0.94727
Wednesday, October 4, 2023	5.32	1	1.00015	0.96219
Thursday, October 5, 2023	5.32	1	1.00015	0.97711
Friday, October 6, 2023	5.31	4	1.00059	1.03668
Tuesday, October 10, 2023	5.31	1	1.00015	1.05159
Wednesday, October 11, 2023	5.31	1	1.00015	1.06649
Thursday, October 12, 2023	5.31	1	1.00015	1.08140
Friday, October 13, 2023	5.31	3	1.00044	1.12613
Monday, October 16, 2023	5.31	1	1.00015	1.14104
Tuesday, October 17, 2023	5.31	1	1.00015	1.15596
Wednesday, October 18, 2023	5.30	1	1.00015	1.17085
Thursday, October 19, 2023	5.30	1	1.00015	1.18575
Friday, October 20, 2023	5.30	3	1.00044	1.23044
Monday, October 23, 2023	5.30	1	1.00015	1.24534
Tuesday, October 24, 2023	5.30	1	1.00015	1.26025
Wednesday, October 25, 2023	5.30	1	1.00015	1.27515
Thursday, October 26, 2023	5.31	1	1.00015	1.29009
Friday, October 27, 2023	5.31	3	1.00044	**1.33491 %**
		Total Days: 90		***x 4***
90-day SOFR Compounded in Arrears as of Tuesday, August 1, 2023 and Compounded in Advance as of Monday, October 30, 2023				**5.33966 %**

Notes and Sources:

- SOFR and compounding methodology are from the Federal Reserve Bank of New York.

91. Even though the in arrears calculation is for a payment accrual period starting on August 1, 2023, the compounded average would not be known until the end of the period on October 30, 2023.[247] This is distinct from the in advance calculation as of the same day of August 1, 2023 in which the compounded average would be known, as it is based on looking 90 days backward from August 1, which would be May 3, 2023 to July 31, 2023. Since compounding in advance is calculated at the end of the previous payment accrual period, 90-day SOFR compounded in advance is a 90-day lagged version of 90-day SOFR compounded in arrears.

B. Spread Adjustment

92. In addition to matching the alternative benchmark rates to 3-month USD LIBOR using term adjustments, I also consider a spread adjustment. The purpose of a spread adjustment is to "*reflect and adjust for the historical differences*" between LIBOR and the alternative benchmark rate.[248] Historical differences can include differences in credit risk, differences in the responses of the rates to market events, differences in supply and demand in the markets underlying each rate, and other factors.[249] For example, SOFR is supported by secured transactions which makes it a nearly risk-free rate, while transactions in the unsecured wholesale funding market underlying LIBOR are not collateralized and therefore reflect a higher interest rate, all else equal.[250] Unlike risk-free or nearly risk-free rates,

[247] The SOFR applies on most days to only one calendar day. However, the overnight rate for Fridays would generally apply to three calendar days (Friday, Saturday and Sunday) and the one on the business day before a holiday would generally apply to two calendar days. See, for example, David Bowman, *A User's Guide to SOFR*, Alternative Reference Rates Committee, 18.

[248] Alternative Reference Rates Committee, *Frequently Asked Questions*, August 27, 2021, 17.

[249] For example, in a 2020 report by the ARRC describing why a spread adjustment is required, the ARRC states, "*[b]ecause LIBOR is unsecured and therefore includes an element of bank credit risk, it may be higher than SOFR. LIBOR may also include term premia and reflect supply and demand conditions in wholesale unsecured funding markets that also could lead to differences with SOFR*." Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR*, January 21, 2020, 7.

Financial Stability Board, *FSB OSSG Supports Use of the ISDA Spread Adjustments in Cash Products*, June 2, 2021, 1.

[250] David Hou and David Skeie, *LIBOR: Origins, Economics, Crisis, Scandal and Reform*, Federal Reserve Bank of New York Staff Reports, No. 667, March 2014, 4.

LIBOR embeds some credit risk which more accurately reflects the ways banks fund themselves.[251]

93. In November 2019, ISDA reported the responses from its consultation of spread and term adjustments with market participants, where a majority of all respondents (61 percent) "*preferred a calculation of a spread adjustment based on a historical median over a five-year lookback period*" compared to "*a historical trimmed mean over a ten-year lookback period.*"[252] The respondents stated that a median is "*a simple, transparent and more stable method that is less sensitive to outliers and would not require complicated data treatments like trimming*" and that "*a five-year lookback period would be more reflective of current market conditions*."[253] When looking at various time periods and ranges, the ARRC stated that they found that "*5- or 10-year lookback period[s] would have historically performed a bit better than a shorter period*."[254]

94. Other than using the historical median, there are other statistics that have been analyzed for spread adjustments: unweighted means, trimmed means and exponentially weighted means.[255] The ARRC stated that the results for using exponentially weighted means for spread adjustment "*were not strong enough to justify the additional complexity of the calculations.*"[256] The ARRC found that "*using a simple average would historically have generated larger errors than using either a median or trimmed mean, and the errors generated using a median or trimmed mean would generally have been similar*."[257]

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[251] Jason Amster, "Secured Overnight Financing Rate in Loan Transactions," LexisNexis, June 14, 2019, https://www.lexisnexis.com/lexis-practical-guidance/the-journal/b/pa/posts/secured-overnight-financing-rate-in-loan-transactions. (Accessed March 7, 2024).

[252] International Swaps and Derivatives Association, *Summary of Responses to the ISDA Consultation on Final Parameters for the Spread and Term Adjustments Prepared for International Swaps and Derivatives Association*, November 15, 2019, 2-3.

[253] International Swaps and Derivatives Association, *Summary of Responses to the ISDA Consultation on Final Parameters for the Spread and Term Adjustments Prepared for International Swaps and Derivatives Association*, November 15, 2019, 3.

[254] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR,* January 21, 2020, 13.

[255] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR,* January 21, 2020, 12-13.

[256] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR,* January 21, 2020, 13.

[257] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR,* January 21, 2020, 19.

95. In January 2020, the ARRC conducted public consultation on whether "*the ISDA methodology of a 5-year median of the historical difference*" was the best choice for LIBOR replacement.[258] The ARRC received responses from banks, asset managers, industry associations and government sponsored entities, among others.[259] The respondents considered ISDA's approach to be the best choice for floating rate notes.[260] Respondents generally cited the "*importance of consistency with ISDA values from a hedging perspective*" as the reason for their views.[261]

96. To calculate the spread adjustment, I rely on the ARRC and the ISDA guidelines to use a 5-year lookback period and estimate the historical median spread between each of the term-adjusted benchmark rates and 3-month USD LIBOR.[262] I use a 5-year lookback period ending on the Transition Date of March 5, 2021, when the FCA announced that 3-month USD LIBOR setting would be ceasing immediately after June 30, 2023.[263]

97. For the overnight alternative benchmark rates, which include SOFR, EFFR, OBFR, AMERIBOR and U.S. prime rate, I first adjust the term to be consistent with 3-month USD LIBOR, using compounding in arrears. For SOFR, I also consider compounding in advance. 3-month CME Term SOFR, 90-day AA financial commercial paper rate, 3-month treasury rate, and 3-month OIS rate are already term rates.

98. After adjusting the term for the overnight rates, I calculate the difference between 3-month USD LIBOR and each of the term-adjusted alternative benchmark rates. Finally, I calculate the median of the daily difference over the 5-year Lookback Period of March 5, 2016 to March 4, 2021.

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[258] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR*, January 21, 2020, 28.

[259] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products*, June 30, 2020, 1.

[260] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products*, June 30, 2020, 1.

[261] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products*, June 30, 2020, 1.

[262] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products*, June 30, 2020, 1-2.

[263] "Announcements on the end of LIBOR," Financial Conduct Authority Press Release, March 5, 2021, https://www.fca.org.uk/news/press-releases/announcements-end-libor. (Accessed March 7, 2024).

99. As a sensitivity analysis, I also consider the 2-year Lookback Period of March 5, 2019 to March 4, 2021 for the spread adjustment. The ARRC reviewed a 2-year lookback period in their evaluation of benchmark rates and noted that "*a very short lookback, of 2 years or less, tended to be less accurate, and that ISDA's choice of a 5-year lookback seemed reasonable.*"[264]

100. Figure 19 presents my calculations of the median spreads for the benchmark rates as of the Transition Date, using both the 5-year Lookback Period and the 2-year Lookback Period. For 3-month CME Term SOFR, I rely on the 3-month ISDA Spread Adjustment of 26.161 basis points, which is used in estimating 3-month Synthetic LIBOR with CME Term SOFR, and is based on a 5-year lookback period.[265] The 3-month ISDA Spread Adjustment of 26.161 basis points is supported by many regulators, such as the ARRC, the FSB and the FCA. For the analysis that uses spread adjustments based on the 2-year Lookback Period, I estimate a spread adjustment of 22.102 basis points using ISDA's guidelines and calculations, and apply this 2-year Estimated ISDA Spread Adjustment to 3-month CME Term SOFR.[266] For the remaining rates, using the 5-year Lookback Period, the median spread adjustment ranges from -288.7 basis points for 90-day U.S. prime rate compounded in arrears to 31.2 basis points for 90-day SOFR compounded in advance. If I use the 2-year Lookback Period, the spread adjustment ranges from -295.6 basis points for 90-day U.S. prime rate compounded in arrears to 21.0 basis points for 90-day OBFR compounded in arrears.

[264] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR*, January 21, 2020, 20.

[265] Bloomberg, *IBOR Fallbacks Technical Notice – Spread Fixing Event for LIBOR*, Bloomberg Professional Services, 2. The ISDA Spread Adjustment of 26.161 basis points is calculated over a 5-year lookback period of December 3, 2015 to December 3, 2020.

[266] The estimated ISDA spread adjustment for a 2-year lookback period is based on the same methodology used to calculate the ISDA Spread Adjustment of 26.161 basis points. Specifically, I calculate the 2-year Estimated ISDA Spread Adjustment of 22.102 basis points as the median difference between 3-month USD LIBOR and Bloomberg's 3-month SOFR in arrears calculation for the time period between December 3, 2018 to December 3, 2020.

Figure 19. *Historical 5-Year and 2-Year Median Spreads between 3-month USD LIBOR and Term Adjusted Alternative Benchmark Rates as of March 5, 2021*

No.	Alternative Benchmark Rate	Spread Adjustment: 5-year Lookback Period (March 5, 2016 to March 4, 2021)	Spread Adjustment: 2-year Lookback Period (March 5, 2019 to March 4, 2021)
(1)	(2)	(3)	(4)
		---------- in bps ----------	
1.	90-day SOFR Compounded in Advance	31.2	12.8
2.	90-day SOFR Compounded in Arrears	25.7	18.3
3.	90-day EFFR Compounded in Arrears	24.5	19.7
4.	90-day OBFR Compounded in Arrears	24.7	21.0
5.	90-day AMERIBOR Compounded in Arrears	14.8	16.7
6.	3-month CME Term SOFR	26.2 [1]	22.1 [2]
7.	90-day AA Financial Commercial Paper Rate	10.5	9.9
8.	U.S. Treasury Securities at 3-month Constant Maturity	28.3	15.8
9.	3-month OIS Rate	24.6	19.7
10.	90-day U.S. Prime Rate Compounded in Arrears	-288.7	-295.6

Notes and Sources:

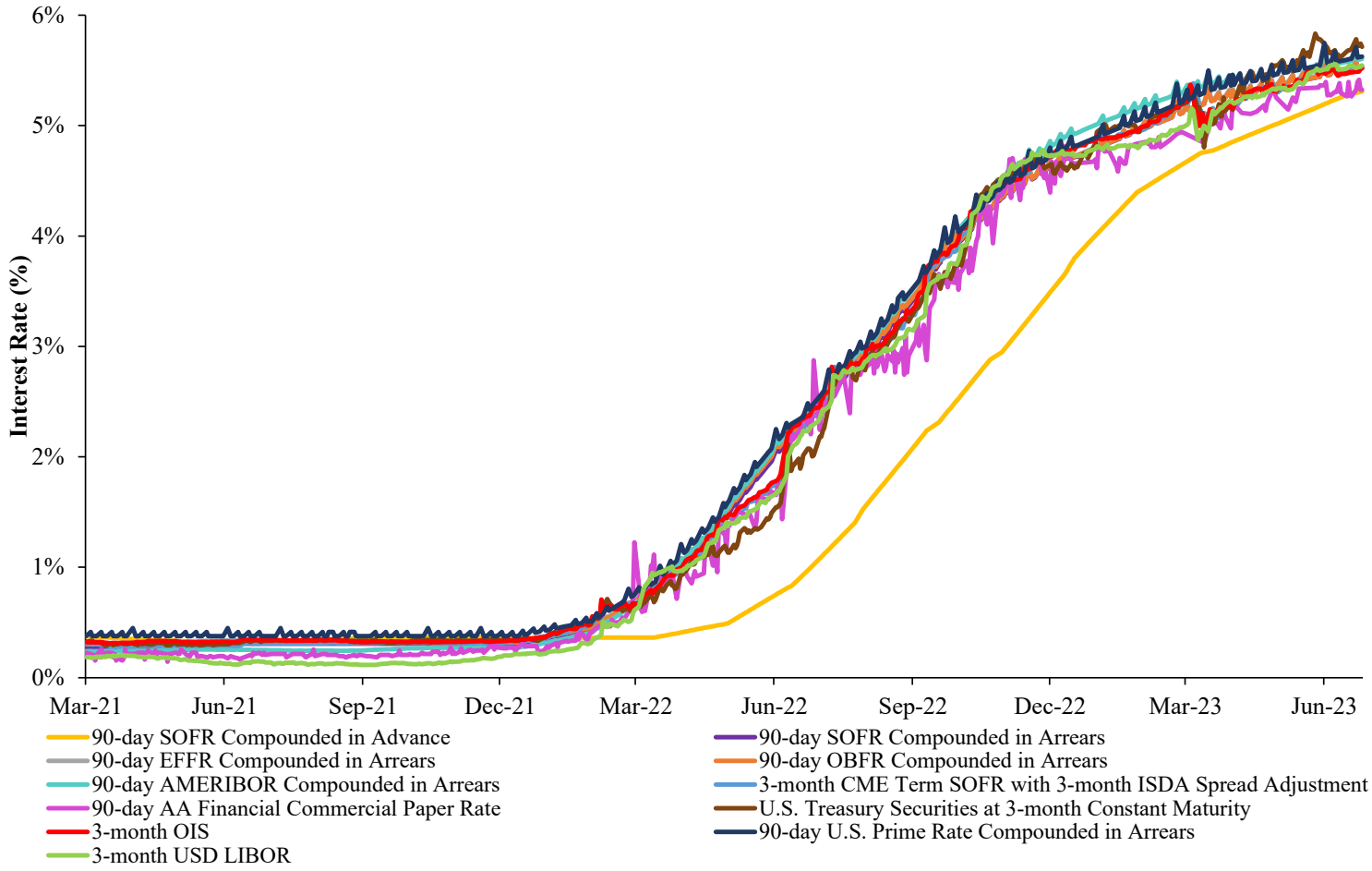
- Data are from Bloomberg, the Federal Reserve Bank of New York and the Federal Reserve Bank of St. Louis.

[1] The ISDA Spread Adjustment is 26.161 basis points for a 5-year lookback period from December 3, 2015 to December 3, 2020.

[2] The Estimated ISDA Spread Adjustment for a 2-year lookback period from December 3, 2018 to December 3, 2020, which is estimated as the median difference between 3-month USD LIBOR and Bloomberg's 3-month SOFR in Arrears calculation, is 22.1015 basis points.

101. Figure 20 compares 3-month USD LIBOR to term- and spread-adjusted alternative benchmark rates for the MAE Calculation Period of March 5, 2021 to June 30, 2023. I calculate the term adjustment using compounding in arrears for the overnight rates, that is, SOFR, EFFR, OBFR, AMERIBOR, and U.S. prime rate. For SOFR, I also calculate the term adjustment using compounding in advance. Next, I add the spread adjustment calculated above using the 5-year Lookback Period as of the Transition Date to each of the term adjusted rates. I also include 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment of 26.161 basis points. The figure shows that, after adjusting for both term and spread, most of the alternative benchmark rates are close to 3-month USD LIBOR, except for 90-day SOFR compounded in advance, which naturally trailed 3-month USD LIBOR and the other benchmark rates. Since compounding in advance is calculated at the end of the previous interest rate period, 90-day SOFR compounded in advance is a 90-day lagged version of 90-day SOFR compounded in arrears.

Figure 20. *3-month USD LIBOR and Term and Spread Adjusted Alternative Benchmark Rates for the Period March 5, 2021, to June 30, 2023*



Notes and Sources:
-Data are from Bloomberg, the Federal Reserve Bank of New York and the Federal Reserve Bank of St. Louis.
-All rates are spread adjusted by adding the median difference between 3-month USD LIBOR and each alternative benchmark rate over a 5-year lookback period of March 5, 2016 to March 4, 2021.
-The 3-Month ISDA Spread Adjustment is 26.161 basis points.

VI. COMPARISON OF THE PERFORMANCE OF ALTERNATIVE BENCHMARK RATES TO LIBOR

102. This section analyzes how well the potential benchmark rates, with term and spread adjustments, have tracked 3-month USD LIBOR. I compare the various alternative benchmark rates to 3-month USD LIBOR using an objective measure known as the MAE. or mean absolute error. The MAE quantifies the difference, on average, between 3-month USD LIBOR and alternative benchmark rates after adjusting for term and spread. All else equal, a lower MAE means that the alternative benchmark rate more closely followed 3-month USD LIBOR. MAE is also a measure that the ARRC employed in evaluating reference rates to replace LIBOR.[267]

103. To assess whether the differences between the estimated MAEs of the alternative benchmark rates are statistically significant, I estimated the 95 percent confidence interval around the difference in the estimated MAEs of the alternative benchmark rates. The 95 percent confidence interval is an interval of a certain width such that it will, with 95 percent confidence, contain the true value of the difference in the estimated MAEs of the alternative benchmark rates.[268] If this confidence interval includes zero, this would mean that the benchmark rates have estimated MAEs that are not statistically significantly different from each other and that the benchmark rates track 3-month USD LIBOR equally well. If the confidence interval does not include zero, this means that the benchmark rates have estimated MAEs that are statistically significantly different from one another and that the benchmark rates track 3-month USD LIBOR at differing levels of accuracy (i.e., one benchmark rate tracks 3-month USD LIBOR better than the other in a statistically significant manner).

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[267] In this section, with the exception of SOFR, I compare the overnight rates compounded in arrears, rather than in advance, to LIBOR. I calculated the MAEs for both types of compounding, and the in arrears calculations generally result in smaller estimated MAEs. This is what I expected; since LIBOR is forward-looking as of the start of the payment accrual period, it reflects market expectations of the interest rate during the payment accrual period. This is in contrast to in advance compounding, which is backward-looking and reflects a compounded average of interest rates from before the start of the payment accrual period. While in arrears compounding is also backward-looking, the in arrears calculation considers interest rates during the payment accrual period and uses more recent information than the in advance calculations.

[268] See, Sherri L. Jackson, *Research Methods and Statistics: A Critical Thinking Approach*, (Belmont: Wadsworth Cengage Learning, 2009, 3rd Edition), 182-183. See, also, National Research Council, *Reference Manual on Scientific Evidence* (Washington, DC: The National Academies Press, 2011, 3rd Edition), 244. "*Usually, a confidence interval for the population average is centered at the sample average; the desired confidence level is obtained by adding and subtracting a suitable multiple of the standard error. Statisticians who say that the population average falls within 1 standard error of the sample average will be correct about 68% of the time. Those who say, 'within 2 standard errors' will be correct about 95% of the time, and those who say, 'within 3 standard errors' will be correct about 99.7% of the time, and so forth*."

104. I also examine the degree of association in the movement (or correlation) between 3-month USD LIBOR and alternative benchmark rates, after adjusting for term only, over time.[269] All else equal, a higher correlation means that the alternative benchmark rate moved in the same direction more often and in a constant relative magnitude as 3-month USD LIBOR. In addition, I examine the uncertainty or volatility of the alternative benchmark rates, after adjusting for term only, relative to 3-month USD LIBOR over time. All else equal, an alternative benchmark rate with a similar volatility as 3-month USD LIBOR would mean that the rate has a similar amount of dispersion or movement as 3-month USD LIBOR.

105. In general, investors consider the risk, which can be measured as volatility, and expected returns, which can be measured by correlation, when making investment decisions.[270] Investors typically expect higher expected returns for an investment with higher expected risk.[271] Thus, a suitable replacement for LIBOR that has similar risk (volatility) should track LIBOR closely (MAE and correlation). An evaluation of the alternative benchmark rates would include identifying the rates with the smallest estimated MAEs, strongest positive correlations, and most similar volatilities to 3-month USD LIBOR.

106. However, there are additional considerations to be made in assessing LIBOR replacement rates, such as the size of the underlying market for the reference rate, which I will discuss in Section VII.

107. I examine the MAE between 3-month USD LIBOR and the alternative benchmark rates (after adjusting the rates for term and spread to be comparable) over the period March 5, 2021 to June 30, 2023, or the MAE Calculation Period. While 90-day AA financial commercial paper rate exhibits the smallest estimated MAE using the 5-year Lookback Period, there is no statistically significant difference between its estimated MAE and the estimated MAE of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment. My analysis of the 95 percent confidence interval of the difference between the estimated MAE of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment

[269] The spread is a fixed adjustment to each alternative benchmark rate. This means that the rate with or without the spread adjustment would be moving in parallel to each other. Since I am examining the levels of correlation and volatility, including a fixed spread adjustment would not change the estimates.

[270] Sergio M. Focardi and Frank J. Fabozzi, *The Mathematics of Financial Modeling and Investment Management* (Hoboken: John Wiley & Sons, Inc., 2004), 88.

[271] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015, 9th Edition), 125.

and the estimated MAE of 90-day AA financial commercial paper rate shows that the confidence interval includes zero. This means that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment tracks 3-month USD LIBOR just as well as 90-day AA financial commercial paper rate. In addition, 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment has a smaller estimated MAE than 90-day SOFR compounded in arrears and 90-day SOFR compounded in advance and the 95 percent confidence intervals around the difference in estimated MAEs between 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment and these benchmark rates do not include zero. Under the 2-year Lookback Period sensitivity analysis, I find that 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment of 22.102 has the smallest MAE.[272]

108. In addition, I examine the correlation for each of the term-adjusted alternative benchmark rates over three different time periods: (1) 5-year Lookback Period; (2) 2-year Lookback Period; and (3) MAE Calculation Period. I find that 90-day AA financial commercial paper rate exhibits the highest correlation to 3-month USD LIBOR over the 5-year Lookback Period and the 2-year Lookback Period, and that 3-month CME Term SOFR has the highest correlation over the MAE Calculation Period. For the 2-year Lookback Period and the MAE Calculation Period, 3-month CME Term SOFR has a correlation of almost positive 1, which means that 3-month CME Term SOFR tracked LIBOR nearly perfectly. I could not calculate the correlation for 3-month CME Term SOFR for the 5-year Lookback Period due to the data for 3-month CME Term SOFR starting in January 2019 and the 5-year Lookback Period starting in March 2016.

109. I also examine the volatility for each of the term-adjusted alternative benchmark rates over the three same time periods as I used for correlation: the (1) 5-year Lookback Period; (2) 2-year Lookback Period; and (3) MAE Calculation Period. Most of the alternative benchmark rates exhibit similar volatility to 3-month USD LIBOR for the same three time periods and no benchmark rate exhibits notably higher volatility. The volatility for 3-month CME Term SOFR during the 2-year Lookback Period and MAE Calculation Period is similar to that of 3-month USD LIBOR. I could not calculate the volatility for 3-month

[272] The 2-year Estimated ISDA Spread Adjustment is estimated as 22.102 basis points by taking the median difference between 3-month LIBOR and Bloomberg's 3-month SOFR in arrears calculation from December 3, 2018 to December 3, 2020.

CME Term SOFR for the 5-year Lookback Period due to the data for 3-month CME Term SOFR starting in January 2019 and the 5-year Lookback Period starting in March 2016.

A. Measures of How Alternative Benchmark Rates Tracked LIBOR

110. One of the measures that the ARRC used to evaluate different alternatives is an examination of the historical performance of each proposed rate relative to LIBOR through the MAE. The MAE quantifies the difference between 3-month USD LIBOR and each of the alternative benchmark rates (after being adjusted for term and spread).

111. The MAE is a metric employed by the ARRC and academics to measure the difference between LIBOR and alternative benchmark rates.[273] According to the ARRC, a benchmark rate with a smaller MAE to LIBOR would be preferable, all else equal:

> *[MAEs] measure the size of differences between LIBOR and the spread-adjusted rate. Smaller values mean that the size of differences are smaller. Assuming that market participants would prefer a spread adjustment that minimizes the difference between LIBOR and the spread-adjusted successor rate, the ideal spread adjustment is one that historically would have produced a MAE of zero. In reality, any spread adjustment will have some difference with LIBOR, so the MAE will be larger than zero, but adjustments that historically would have produced smaller MAEs may be preferred.*[274]

112. To assess how well the alternative benchmark rates would have tracked 3-month USD LIBOR, I evaluate the MAE during the MAE Calculation Period. For overnight benchmark rates including SOFR, EFFR, OBFR, and AMERIBOR, as well as for U.S. prime rate, I calculated the 90-day compounded average in arrears to adjust for the differences in term relative to 3-month USD LIBOR. For SOFR, I also analyzed the 90-day compounded average in advance. Next, I applied the spread adjustment as calculated in Section V to each alternative benchmark rate. The spread adjustment adds a fixed amount to the alternative benchmark rate based on the median difference between LIBOR and the benchmark rate as of the Transition Date using both the 5-year Lookback Period and the 2-year Lookback Period.

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[273] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR*, January 21, 2020, 16. See, also, Laurie Goodman and Edward Golding, *The Termination of LIBOR*, Urban Institute House Finance Policy Center, March 2020, 3.

[274] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR*, January 21, 2020, 16.

The purpose of the spread adjustment is to adjust for historical differences between LIBOR and the alternative benchmark rate.[275]

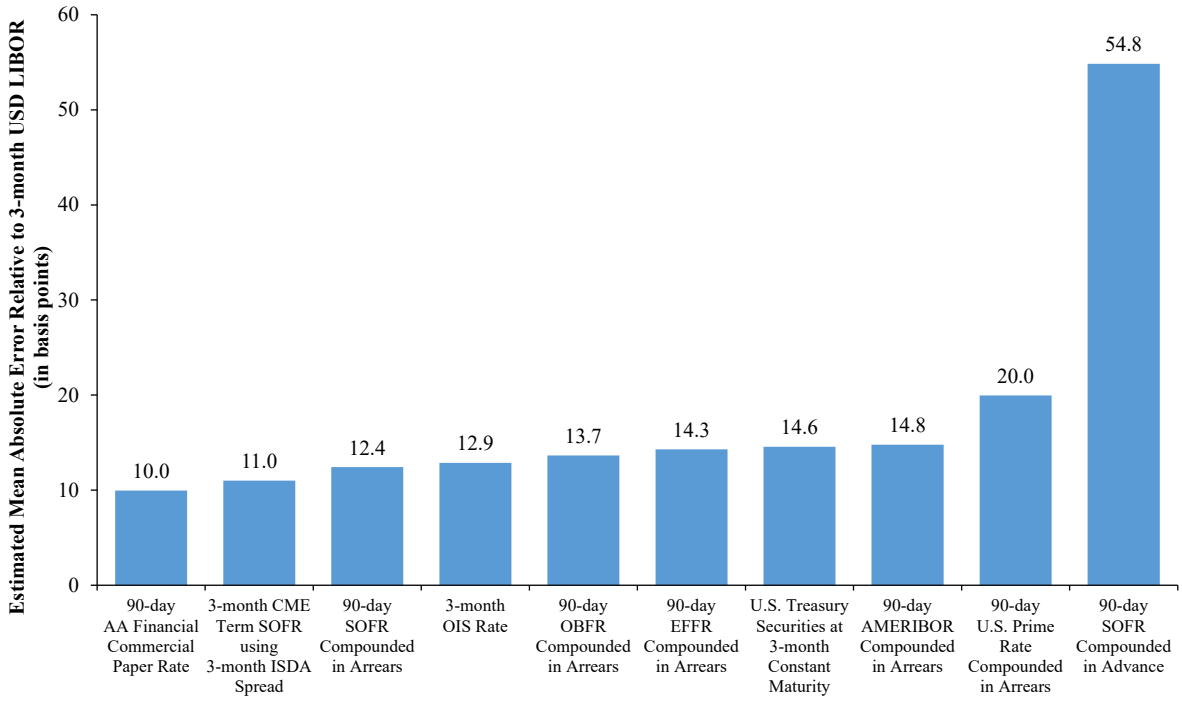
113. For my primary analysis, I used the 5-year Lookback Period to calculate the spread adjustment and estimate the MAE for the MAE Calculation Period. For example, I calculated the median spread between 3-month USD LIBOR and 90-day SOFR compounded in arrears between March 5, 2016 to March 4, 2021 to be 25.7 basis points. I then added this fixed 25.7 basis points spread to the daily values for 90-day SOFR compounded in arrears from March 5, 2021 onwards to develop the term and spread adjusted rate. I applied the same methodology for the other alternative benchmark rates in the analysis.

114. Next, I calculated the daily absolute difference between 3-month USD LIBOR and each of the term and spread adjusted alternative benchmark rates during the MAE Calculation Period. The MAE is then the average of the daily average absolute differences.

115. Figure 21 presents the average difference as measured by the estimated MAE between 3-month USD LIBOR and the term and spread adjusted alternative benchmark rates over the MAE Calculation Period using the spread adjustment based on the 5-year Lookback Period. The estimated MAEs ranged from 10.0 basis points for 90-day AA financial commercial paper rate to 54.8 basis points for 90-day SOFR compounded in advance. The figure reports that 90-day AA financial commercial paper rate has the lowest difference from 3-month USD LIBOR at 10.0 basis points, followed by 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment at 11.0 basis points, and then 90-day SOFR compounded in arrears at 12.4 basis points.

[275] Alternative Reference Rates Committee, *Frequently Asked Questions*, August 27, 2021, 17.

Figure 21. *Estimated MAEs between 3-month USD LIBOR and Term and Spread Adjusted Alternative Benchmark Rates for the Period March 5, 2021 to June 30, 2023 Using the Spread Adjustment for the 5-Year Lookback Period*



Notes and Sources:
-Data are from Bloomberg, the Federal Reserve Bank of New York and the Federal Reserve Bank of St. Louis.
-All rates are spread adjusted by adding the median difference between 3-month USD LIBOR and each alternative benchmark rate over a 5-year lookback period of March 5, 2016 to March 4, 2021.
-Mean absolute error is computed as the mean absolute difference between 3-month USD LIBOR and each term and spread adjusted alternative benchmark rate over the period of March 5, 2021 to June 30, 2023.
-The 3-month ISDA Spread Adjustment is 26.161 basis points.

116. To test for statistical significance, I estimate the 95 percent confidence intervals around the difference between the estimated MAE of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment and the estimated MAEs for each term and spread adjusted benchmark rate.[276] If the 95 percent confidence interval of the difference

[276] I apply a widely accepted, recognized, and used statistical technique called bootstrapping to estimate the 95 percent confidence intervals. Bootstrapping is a simulation approach to make inferences about the distribution of an estimator, which is the difference in estimated MAEs in this case. To do so, I draw a simple random sample with replacement from the daily absolute differences between the term and spread adjusted benchmark rates and LIBOR during the MAE Calculation Period using the same number of observations. I then calculate the difference between the estimated MAE of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment and the estimated MAE of another adjusted benchmark rate. I make these draws 10,000 times, generating 10,000 samples, and then evaluate the distribution of the differences from the 10,000 samples. Lastly, I estimate the 95 percent confidence interval as the 2.5th and 97.5th percentile of the differences from the 10,000 samples. The 2.5th percentile represents the difference at which 2.5 percent of the 10,000 samples have a difference that is equal or smaller, and similarly for the 97.5th percentile.

See, William H. Greene, *Econometric Analysis* (Upper Saddle River: Prentice Hall, 2012, 7th Edition), 651-652. "*The technique of bootstrapping is used to obtain a description of the sampling properties of empirical*

between the estimated MAEs includes zero, then the results for those benchmark rates are not statistically significantly different from each other. In other words, the benchmark rates track 3-month USD LIBOR equally well. I find that the 95 percent confidence for the difference in estimated MAE of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment and the estimated MAE of 90-day AA financial commercial paper rate includes zero. Although the estimated MAE for 90-day AA financial commercial paper rate is smaller than that of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment, since the confidence interval around the difference between the estimated MAEs includes zero, one cannot say that the smaller estimated MAE for 90-day AA financial commercial paper rate is statistically significantly different than the estimated MAE for 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment. This means that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment tracks 3-month USD LIBOR just as well as 90-day AA financial commercial paper rate.

117. Furthermore, I used the 2-year Lookback Period to calculate the spread adjustment as of the Transition Date. I used the same methodology to calculate the MAE for the other benchmark rates, by adding the spread adjustment based on the 2-year Lookback Period of March 5, 2019 to March 4, 2021 to each of the term adjusted benchmark rates. For 3-month CME Term SOFR, I calculated the 2-year Estimated ISDA Spread Adjustment of 22.102 basis points by following ISDA's methodology.[277]

118. Then, I calculate the daily absolute difference between 3-month USD LIBOR and each of the term and spread adjusted alternative benchmark rates, using the spread adjustment based on the 2-year Lookback Period, during the MAE Calculation Period.

119. Figure 22 presents the estimated MAEs over the MAE Calculation Period and using the spread adjustment based on the 2-year Lookback Period. The estimated MAEs ranged from 8.6 basis points for 3-month CME Term SOFR with the 2-year Estimated ISDA

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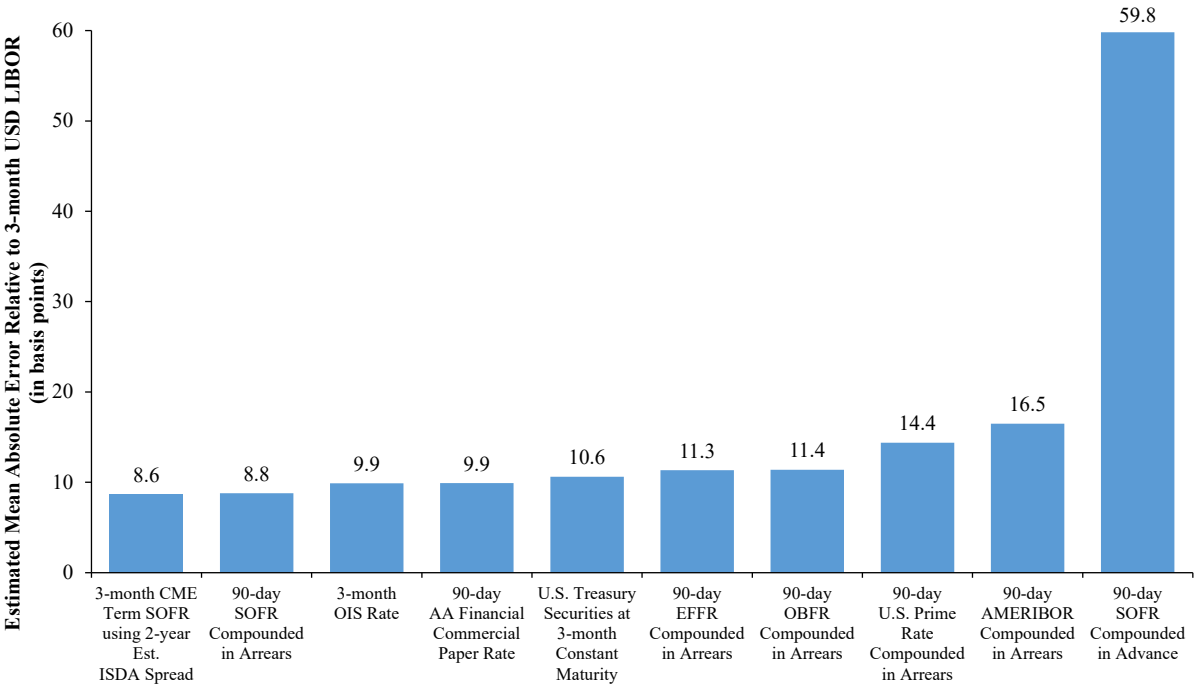
estimators using the sample data themselves, rather than broad theoretical results" (651). "*This technique was developed by Efron (1979) and has been appearing with increasing frequency in the applied econometrics literature*" (652).

[277] Bloomberg, *IBOR Fallbacks Technical Notice – Spread Fixing Event for LIBOR*, Bloomberg Professional Services, 1.

See, also, International Swaps and Derivatives Association, *Bloomberg published Fallback Rates: Interaction between RFR publications, IBOR Fallback publications and the ISDA Definitions,* September 8, 2022, 1-4.

Spread Adjustment to 59.8 basis points for 90-day SOFR compounded in advance. The results demonstrate that using the 2-year Lookback Period for the spread adjustment calculation, 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment has the smallest estimated MAE at 8.6 basis points, followed by 90-day SOFR compounded in arrears at 8.8 basis points, and then 3-month OIS and 90-day AA financial commercial paper rate, both at 9.9 basis points.

Figure 22. *Estimated MAEs between 3-month USD LIBOR and Term and Spread Adjusted Alternative Benchmark Rates for the Period March 5, 2021 to June 30, 2023 Using the Spread Adjustment for the 2-Year Lookback Period*



Notes and Sources:
-Data are from Bloomberg, the Federal Reserve Bank of New York and the Federal Reserve Bank of St. Louis.
-All rates are spread adjusted by adding the median difference between 3-month USD LIBOR and each alternative benchmark rate over a 2-year lookback period of March 5, 2019 to March 4, 2021.
- 2-year Estimated ISDA Spread Adjustment is estimated as 22.1015 basis points by taking the median difference between 3-month LIBOR and Bloomberg's 3-month SOFR in Arrears calculation from December 3, 2018 to December 3, 2020.
-Mean absolute error is computed as the mean absolute difference between 3-month USD LIBOR and each term and spread adjusted alternative benchmark rate over the period of March 5, 2021 to June 30, 2023.

B. Trends and Volatility of 3-month USD LIBOR and Alternative Benchmark Rates

120. In this section, I analyze how well the term-adjusted alternative benchmark rates tracked 3-month USD LIBOR in terms of correlation and volatility. I examine the correlation to 3-month USD LIBOR and volatility of the appropriately term adjusted alternative benchmark rates during three periods: (1) 5-year Lookback Period; (2) 2-year Lookback Period; and (3) MAE Calculation Period. My analysis shows that the alternative

benchmark rates tend to have strong and positive correlations with 3-month USD LIBOR and exhibit similar levels of volatility to 3-month USD LIBOR.

1. Correlation Between 3-month USD LIBOR and Term Adjusted Alternative Benchmark Rates

121. A correlation coefficient is a measure of the strength and direction of the relationship between two variables, and ranges between negative one to positive one. The correlation coefficient would be positive if two rates move in the same direction, and negative if the rates move in opposite directions. The closer the correlation coefficient is to positive one, the stronger the positive correlation would be and would mean that the two rates generally move in the same direction and in the same proportions. I estimated the correlation coefficients between daily values for 3-month USD LIBOR and the alternative benchmark rates, with term adjustments, during the 5-year Lookback Period, 2-year Lookback Period, and the MAE Calculation Period.[278] I find that all the term adjusted benchmark rates exhibit strong positive correlation with 3-month USD LIBOR.

122. Figure 23 presents the correlation coefficients between 3-month USD LIBOR and the term adjusted alternative benchmark rates for the three periods I analyzed. The term adjusted alternative benchmark rates all have high positive correlations (all nearly positive 1) with 3-month USD LIBOR. Specifically, I find that 90-day AA financial commercial paper rate had the highest correlation over the 5-year Lookback Period and the 2-year Lookback Period, and 3-month CME Term SOFR exhibited the highest correlation over the MAE Calculation Period of March 5, 2021 to June 30, 2023.

a. During the 5-year Lookback Period, the correlation coefficients ranged from a low of 0.946, for 90-day SOFR compounded in advance, to a high of 0.992, for 90-day AA financial commercial paper rate. There is not enough data for 3-month CME Term SOFR during this period to include it in the analysis, as the start of available data for 3-month CME Term SOFR is January 3, 2019 and the lookback period starts in March 2016.

[278] I cannot calculate the correlation coefficient for 3-month CME Term SOFR during the 5-year Lookback Period of March 5, 2016 to March 4, 2021, since the start of available data for 3-month CME Term SOFR is January 3, 2019.

b. During the 2-year Lookback Period, the correlation coefficients ranged from a low of 0.941, for 90-day SOFR compounded in arrears, to a high of 0.989, for 90-day AA financial commercial paper rate. During this period, 3-month CME Term SOFR had a correlation of 0.970 with 3-month USD LIBOR.

c. During the MAE Calculation Period, the correlation coefficients ranged from a low of 0.964, for 90-day SOFR compounded in advance, to a high of 0.999, for 3-month CME Term SOFR (and others).

Figure 23. *Correlation between 3-month USD LIBOR and Term Adjusted Alternative Benchmark Rates for Time Periods between March 5, 2016 and June 30, 2023*

No.	Rate	5-year Lookback Period (March 5, 2016 to March 4, 2021)	2-year Lookback Period (March 5, 2019 to March 4, 2021)	MAE Calculation Period (March 5, 2021 to June 30, 2023)
(1)	(2)	(3)	(4)	(5)
1.	90-day SOFR Compounded in Advance	0.946	0.986	0.964
2.	90-day SOFR Compounded in Arrears	0.964	0.941	0.999
3.	90-day EFFR Compounded in Arrears	0.962	0.942	0.999
4.	90-day OBFR Compounded in Arrears	0.962	0.943	0.999
5.	90-day AMERIBOR Compounded in Arrears	0.962	0.949	0.999
6.	3-month CME Term SOFR	n.a. [1]	0.970	0.999
7.	90-day AA Financial Commercial Paper Rate	0.992	0.989	0.999
8.	U.S. Treasury Securities at 3-Month Constant Maturity	0.977	0.970	0.998
9.	3-month OIS Rate	0.978	0.970	0.999
10.	90-day U.S. Prime Rate Compounded in Arrears	0.964	0.945	0.999

Notes and Sources:
- Data are from Bloomberg, the Federal Reserve Bank of New York and the Federal Reserve Bank of St. Louis.
[1] Data for 3-month CME Term SOFR is not available until January 3, 2019.

2. Volatility of Term Adjusted Alternative Benchmark Rates

123. To analyze the volatility of the alternative benchmark rates, I estimated the annualized standard deviation of daily values for 3-month USD LIBOR and the alternative benchmark rates, with term adjustments, during the 5-year Lookback Period, 2-year Lookback Period, and the MAE Calculation Period.[279] Standard deviation is a measure of

[279] I cannot calculate the standard deviation for 3-month CME Term SOFR during the 5-year Lookback Period of March 5, 2016 to March 4, 2021 since the start of available data for 3-month CME Term SOFR is January 3, 2019.

how dispersed a sample of values is from the average value in the sample. The greater the standard deviation, the more dispersed the sample is and the more uncertainty there is.[280]

124. While overnight rates may be more volatile than LIBOR on a day-to-day basis, adjusting the overnight rates to match the term of the LIBOR rate (in this case, three months) smooths the day-to-day variations. The ARRC stated in a March 2018 report that the 3-month average of overnight SOFR is less volatile than 3-month USD LIBOR.[281] The ARRC also stated that the 3-month average of overnight Treasury repurchase agreement rates have historically been less volatile than 3-month USD LIBOR.[282] This is consistent with my findings, described below.

125. Figure 24 demonstrates my results that no alternative benchmark rate exhibited notably higher volatility compared to 3-month USD LIBOR.

a. During the 5-year Lookback Period, the annualized standard deviation of 3-month USD LIBOR was 13.1 percent. The other rates I examined had annualized standard deviations ranging from 12.6 percent for 90-day AA financial commercial paper rate to 13.4 percent for 3-month Treasury yield. I do not have complete data for 3-month CME Term SOFR to calculate its annualized volatility during the 5-year Lookback Period.

b. During the 2-year Lookback Period, 3-month USD LIBOR had an annualized standard deviation of 14.9 percent. The other rates I examined had annualized standard deviations ranging from 14.8 percent for 90-day U.S. prime rate compounded in arrears to 16.0 percent for 90-day SOFR compounded in

[280] The annualized standard deviation is calculated by taking the standard deviation of daily values over each of the periods analyzed, and multiplying the standard deviation of daily values by the square root of 252, which is an estimate for the number of trading days in a year.

"*The variance of a distribution gives an indication as to whether the distribution is concentrated around some value or spread over a large interval of values. If the standard deviation of a distribution is high, it means that there is a high probability that the variable might take values significantly different from its mean. A high standard deviation, therefore, corresponds to a high risk. In the terminology of risk management, standard deviation represents unexpected loss.*" Sergio M. Focardi and Frank J. Fabozzi, *The Mathematics of Financial Modeling and Investment Management* (Hoboken: John Wiley & Sons, Inc., 2004), 747.

[281] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 14-15.

[282] Alternative Reference Rates Committee, *Frequently Asked Questions*, August 27, 2021, 10.

advance. 3-month CME Term SOFR had an annualized standard deviation of 15.4 percent.

c. During the MAE Calculation Period, 3-month USD LIBOR had an annualized standard deviation of 33.4 percent. The other rates I examined had annualized standard deviations ranging from 28.9 percent for 90-day SOFR compounded in advance to 34.0 percent for 90-day AMERIBOR compounded in arrears. 3-month CME Term SOFR had an annualized standard deviation of 32.8 percent.

Figure 24. *Volatility between 3-month USD LIBOR and Term Adjusted Alternative Benchmark Rates for Time Periods between March 5, 2016 and June 30, 2023*

		Annualized Standard Deviation		
No.	Alternative Benchmark Rate	5-year Lookback Period (March 5, 2016 to March 4, 2021)	2-year Lookback Period (March 5, 2019 to March 4, 2021)	MAE Calculation Period (March 5, 2021 to June 30, 2023)
(1)	(2)	(3)	(4)	(5)
1.	3-month LIBOR	13.1 %	14.9 %	33.4 %
2.	90-day SOFR Compounded in Advance	13.1	16.0	28.9
3.	90-day SOFR Compounded in Arrears	13.4	15.3	32.7
4.	90-day EFFR Compounded in Arrears	13.0	15.0	32.6
5.	90-day OBFR Compounded in Arrears	13.0	14.9	32.6
6.	90-day AMERIBOR Compounded in Arrears	13.3	15.2	34.0
7.	3-month CME Term SOFR	n.a. [1]	15.4	32.8
8.	90-day AA Financial Commercial Paper Rate	12.6	15.0	30.6
9.	U.S. Treasury Securities at 3-month Constant Maturity	13.4	15.2	33.1
10.	3-month OIS Rate	12.9	15.1	32.7
11.	90-day U.S. Prime Rate Compounded in Arrears	12.8	14.8	32.8

Notes and Sources:
- Data are from Bloomberg, the Federal Reserve Bank of New York, and the Federal Reserve Bank of St. Louis.
- Annualized standard deviation is calculated by taking the standard deviation of each of the alternative benchmark rates over the different time periods, and annualizing it by multiplying by the square root of 252, which is the estimated number of trading days in a year.

[1] Data is incomplete for 3-month CME Term SOFR for the 5-year lookback period as data starts on January 3, 2019.

VII. LIQUIDITY OF ALTERNATIVE BENCHMARK RATES AS COMPARED TO LIBOR

126. In this section, I examine the liquidity and underlying market of the alternative benchmark rates as compared to LIBOR. I measure liquidity in terms of volume of

transactions in the underlying market of the alternative benchmark rates, where a higher volume of transactions indicates greater liquidity.[283]

127. The ARRC, among others, noted that a key vulnerability of LIBOR was the limited activity in the wholesale unsecured funding market, which formed the basis for the LIBOR submissions since the financial crisis.[284] The Bank of England stated that the "*low volume of underlying transactions*" and reduced activity in the "*markets that LIBOR measures*" since the financial crisis "*means that LIBOR is no longer sustainable.*"[285] The FSB also pointed to the "*post-crisis decline in liquidity in interbank unsecured deposit markets*" as one of the factors that "*undermined confidence in the reliability and robustness*" of LIBOR and other major interest reference rates.[286]

128. The ARRC provided an estimate of the underlying market for 3-month USD LIBOR during the first half of 2017. The average daily volume for the market underlying 3-month USD LIBOR was estimated to be $500 million during the first half of 2017, which was dwarfed by the size of the underlying markets for the alternative benchmark rates. During the same time period, the underlying market for 3-month Treasury bills was $13 billion, or 26 times bigger than the underlying market for 3-month USD LIBOR, the underlying market for EFFR was $79 billion, or 158 times bigger, the underlying market for

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[283] Liquidity measures include "*volume-based measures that distinguish liquid markets by the volume of transactions compared to the price variability.*" See, Abdourahmane Sarr and Tonny Lybek, *Measuring Liquidity in Financial Markets*, International Monetary Fund Working Paper WP/02/32, December 2002, 8.

See, also, Frank J. Fabozzi, *The Handbook of Financial Instruments* (Hoboken: John Wiley & Sons, Inc., 2002, 2nd Edition), 8-9. "*[F]inancial markets provide a mechanism for an investor to sell a financial instrument. Because of this feature, it is said that a financial market offers 'liquidity,' an attractive feature when circumstances either force or motivate an investor to sell. If there were not liquidity, the owner would be forced to hold a financial instrument until the issuer initially contracted to make the final payment (i.e., until the debt instrument matures) and an equity instrument until the company is either voluntarily or involuntarily liquidated. While all financial markets provide some form of liquidity, the degree of liquidity is one of the factors that characterize different markets.*"

[284] Alternative Reference Rates Committee, *ARRC Closing Report: Final Reflections on the Transition from LIBOR*, November 2023, 6.

[285] "Transition from LIBOR to risk-free rates," Bank of England, https://www.bankofengland.co.uk/markets/transition-to-sterling-risk-free-rates-from-libor. (Accessed March 7, 2024).

[286] Financial Stability Board, *Reforming Major Interest Rate Benchmarks*, July 22, 2014, 3. The Financial Stability Board is an international body that monitors and makes recommendations about the global financial system. See, also, "About the FSB," Financial Stability Board, updated November 16, 2020, https://www.fsb.org/about/. (Accessed March 7, 2024).

OBFR was $197 billion, or 394 times bigger, and the underlying market for overnight SOFR was $754 billion, or 1,508 times bigger.[287]

129. The ARRC remarked that "*sustainable trading volume and liquidity*" are important components to the "*credibility and reliability*" of benchmark rates.[288] As part of the process of recommending a LIBOR replacement rate, the ARRC focused on developing liquidity in a chosen alternative benchmark rate and designed the "*Paced Transition Plan*" to encourage voluntary adoption and expansion of the derivatives markets for the reference rate.[289]

130. Figure 25 illustrates how the underlying markets for the alternative benchmark rates have developed and grown by the fourth quarter of 2023 (when data is available for 3-month CME Term SOFR). As I described above, the underlying markets for overnight SOFR, OBFR, EFFR, and 3-month Treasury bills were between 26 to 1,508 times larger than the underlying market for 3-month USD LIBOR during the first half of 2017. When looking at a more recent time period of the fourth quarter of 2023, the underlying markets for the alternative benchmark rates have grown since the first half of 2017. In particular, for the overnight transaction rates, the largest underlying market was for overnight SOFR at $1,573.3 billion in average daily transaction volume, which more than doubled since the first half of 2017. The underlying markets for EFFR and OBFR grew as well, by 23 to 24 percent since the first half of 2017 to $97.0 billion and $244.0 billion, respectively, but paled in comparison to the underlying market for overnight SOFR, as SOFR was 16 times and 6 times larger than EFFR and OBFR, respectively. The underlying market for AMERIBOR was estimated to be $2.0 billion and the underlying overnight SOFR market was 787 times larger. Comparing SOFR in the last quarter of 2023 to LIBOR in the first half of 2017, the underlying market for overnight SOFR was 3,147 times larger than the estimate for 3-month USD LIBOR. For the term rates, the largest underlying market was for 3-month CME Term SOFR at $981.0 billion in average daily transaction volume. For 90-day AA financial commercial paper, the average daily issuance volume was estimated to be $0.02 billion, and

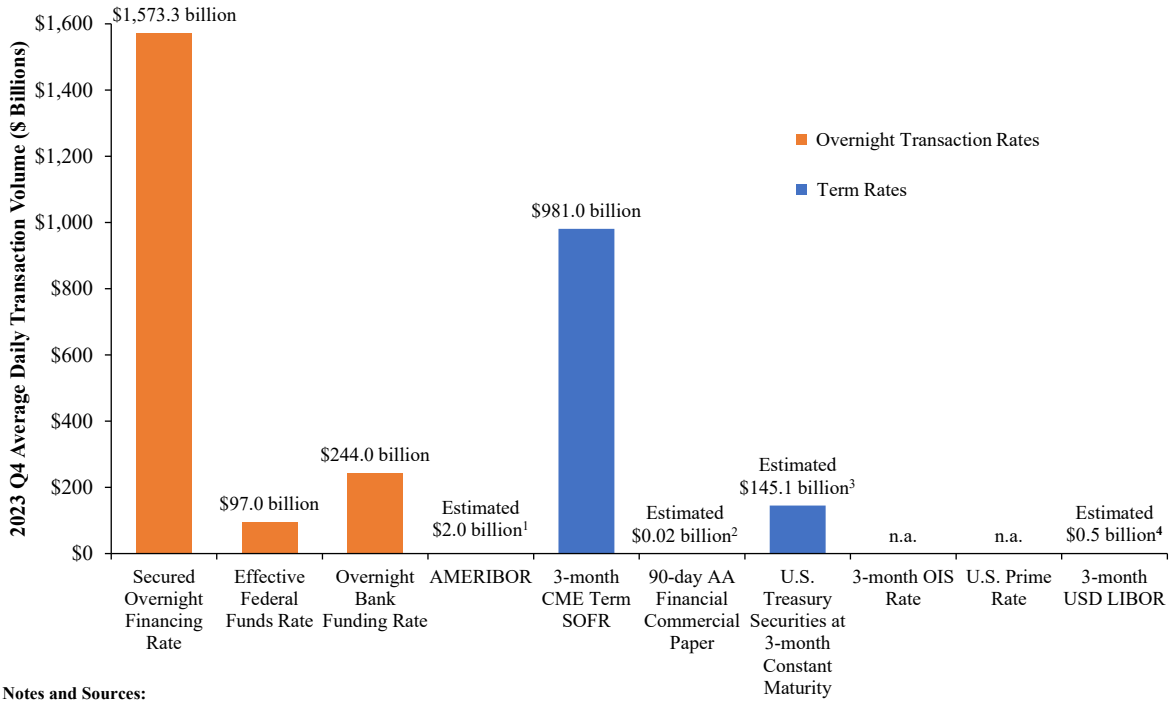
[287] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

[288] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 2.

[289] "Transition from LIBOR," Federal Reserve Bank of New York, https://www.newyorkfed.org/arrc/sofr-transition. (Accessed March 7, 2024).

the underlying market for 3-month CME Term SOFR was 43,540 times larger.[290] The underlying markets for the other term rates were also much smaller than the underlying market for 3-month CME Term SOFR.

Figure 25. *Volume of Underlying Markets for Alternative Benchmark Rates for 2023 Q4*



Notes and Sources:
- Data are from the Federal Reserve Bank of St. Louis, American Financial Exchange, ARRC, SIFMA, and the Federal Reserve.
[1] Data for AMERIBOR is estimated from the American Financial Exchange website.
[2] Data for 90-day AA Financial Commercial Paper represents the average daily volume for issuances with 41-80 days until maturity.
[3] Data for U.S. Treasury Securities at 3-month Constant Maturiity is estimated by the ARRC for the first half of 2017.
[4] Data for 3-month USD LIBOR is estimated by the ARRC for the first half of 2017.

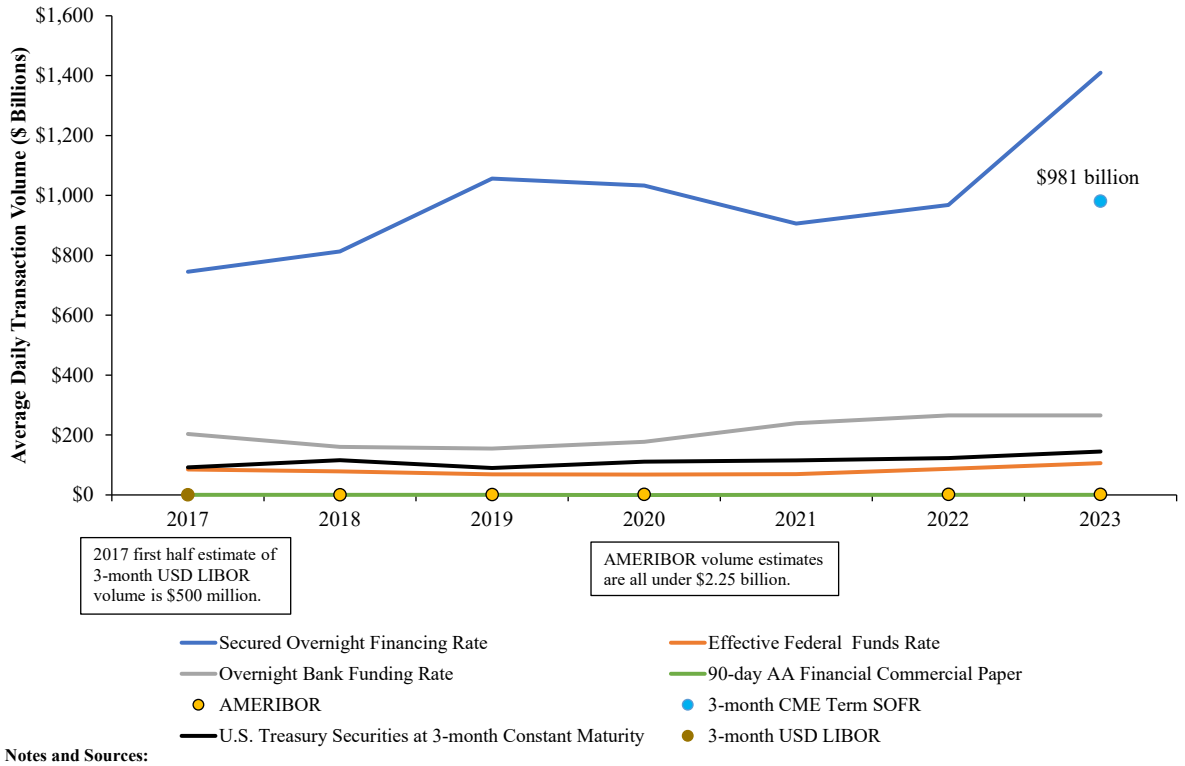
131. Figure 26 illustrates how the average daily volume of the underlying markets by year has changed for the alternative benchmark rates between 2017 and 2023.[291] The underlying market for SOFR grew the most over this time period as average daily transaction volume was $745 billion in 2017 and $1,410 billion in 2023, an 89 percent increase. For EFFR, the average daily transaction volume was $85 billion in 2017 and $106 billion in 2023, a 25 percent increase. For OBFR, average daily transaction volume was $204 billion in 2017 and $266 billion in 2023, a 30 percent increase. For AA financial commercial paper,

[290] For 3-month AA Financial CP rate I used the issuances which have 41-80 days until maturity. This is consistent with how the ARRC calculated 3-month CP rates. See, Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

[291] Regular data for the underlying markets for 3-month CME Term SOFR, 3-month Treasuries, term OIS rate, and 3-month USD LIBOR are not available.

average daily issuance volume was $102 million in 2017 and $82 million in 2023, a 20 percent decrease. For AMERIBOR, daily transaction volume has been about $2 billion during this time period.

Figure 26. *Average Daily Volume of Underlying Markets for Alternative Benchmark Rates by Year between 2017 and 2023*



Notes and Sources:
- Data are from the Federal Reserve Bank of St. Louis, American Financial Exchange, ARRC, SIFMA, and the Federal Reserve.
- Data for 90-day AA Financial Commercial Paper (CP) represents the average daily volume for issuances with 41-80 days until maturity.
- Data for U.S. Treasury Securities at 3-month Constant Maturity represents the average daily volume for issuances with 13-weeks until maturity.
- Data for 3-month USD LIBOR is estimated by the ARRC.

132. A key consideration in the selection of a LIBOR replacement rate is the extent of the liquidity of the underlying market that each potential replacement rate relies on, especially during market dislocations. I examine the number and volume of transactions as measures of liquidity underlying overnight transaction rates, term rates, and survey-based rates. As noted above, as of the fourth quarter of 2023, the largest underlying markets for the alternative benchmark rates are for SOFR and 3-month CME Term SOFR and these two markets eclipse the underlying markets for all other alternative benchmark rates.

A. Overnight Transaction Rates

1. Secured Overnight Funding Rate (SOFR)

133. The transactions underlying overnight SOFR are secured and collateralized by treasuries. The ARRC concluded in 2018 that the volume of transactions supporting the SOFR calculation is "*far larger than the transactions in any other U.S. money market*" and are much larger than "*the volumes underlying LIBOR or other term unsecured funding rates*."[292] The FSB reported similar findings in 2020, that the "*volume of overnight Treasury repo transactions underlying SOFR*" represented the "*largest rates market at a given maturity in the United States*."[293]

134. According to the ARRC, during the first half of 2017, the market underlying SOFR was $754 billion, which was 9.5 times larger than the underlying market for EFFR, 3.8 times larger than the underlying market for OBFR, and 1,508 times larger than the underlying market for 3-month USD LIBOR.[294]

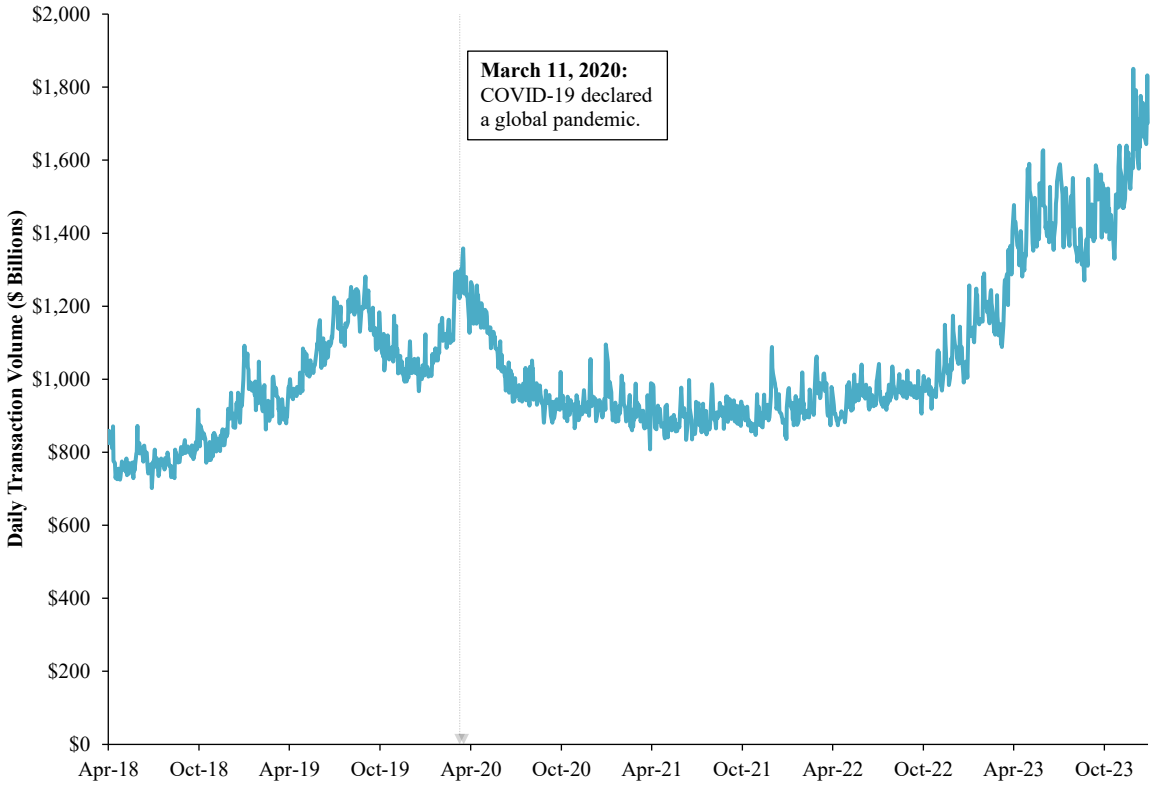
135. Figure 27 presents the average daily volume of transactions underlying SOFR from April 2018 (the start of available data for overnight SOFR) to December 2023. As mentioned earlier, SOFR is based on secured overnight Treasury general collateral repurchase agreements. From April 3, 2018 to December 31, 2018, the average daily transaction volume supporting the SOFR calculation was $805 billion. For 2019, the average daily transaction volume was $1,056 billion. During the COVID-19 pandemic crisis, identified as March 11, 2020 to April 30, 2020, the average daily transaction volume of the underlying market was $1,219 billion and was $971 billion for the rest of 2020. This demonstrates that there was resiliency during the COVID-19 pandemic crisis. The average daily transaction volume underlying SOFR for 2021, 2022, and 2023 was $906 billion, $968 billion, and $1,410 billion, respectively. For the fourth quarter of 2023, the underlying market for SOFR was $1,573.3 billion.

[292] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 7.

[293] Financial Stability Board, *Reforming Major Interest Rate Benchmarks: 2020 Progress Report*, November 20, 2020, 14.

[294] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

Figure 27. *Daily Volume of Transactions Underlying SOFR between April 3, 2018 and December 31, 2023*



Notes and Sources:
- Data are from the Federal Reserve Bank of St. Louis.

2. Effective Federal Funds Rate (EFFR)

136. The transactions underlying EFFR are unsecured and not collateralized. EFFR draws from fed funds transactions as its underlying market and the ARRC stated that the "*number of transactions underlying the EFFR is substantial*" but that "*the number of counterparties currently lending in this market is fairly limited*."[295]

137. According to the ARRC, during the first half of 2017, the market underlying EFFR was $79 billion which was larger than the estimated $500 million market underlying 3-month USD LIBOR but 9.5 times smaller than the $754 billion market underlying SOFR.[296]

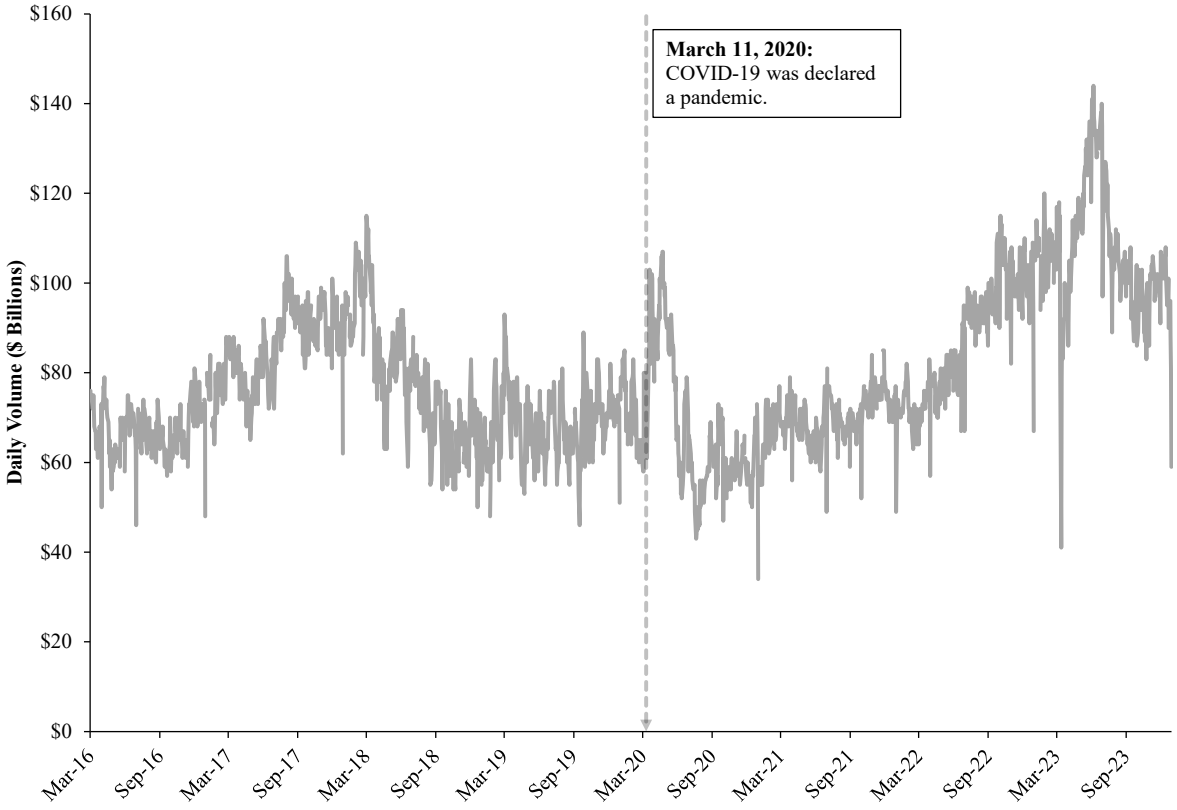
138. Figure 28 presents the average daily volume of transactions underlying EFFR between March 1, 2016 (the start of available transactions data for EFFR) and December 31,

[295] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 16.

[296] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

2023. From March 1, 2016 to December 31, 2016, the average daily transaction volume supporting the EFFR calculation was $67 billion. For 2017, 2018, and 2019, average daily transaction volume was $85 billion, $78 billion, and $68 billion, respectively. During the COVID-19 pandemic crisis, identified as March 11, 2020 to April 30, 2020, the average daily transaction volume of the underlying market was $91 billion and was $62 billion for the rest of 2020. This demonstrates that there was resiliency during the COVID-19 pandemic crisis. The average daily transaction volume underlying EFFR for 2021, 2022, and 2023 increased to $70 billion, $87 billion, and $106 billion, respectively. For the fourth quarter of 2023, the underlying market for EFFR was $97 billion, in contrast to $1,573.3 billion for SOFR.

Figure 28. *Average Daily Volume of Transactions Underlying EFFR between March 1, 2016 and December 31, 2023*



Notes and Sources:
-Data are from the Federal Reserve Bank of St. Louis.

3. Overnight Bank Funding Rate (OBFR)

139. The transactions underlying OBFR are unsecured and not collateralized. OBFR relies on overnight Eurodollar and fed funds transactions and the ARRC stated that OBFR has displayed "*ample liquidity and transactions volume*" despite a tendency "*to*

decline around quarter- and year-ends."[297] The daily transactions by a "*wide set of over 150 banks active in the United States*" support the calculation of OBFR.[298]

140. According to the ARRC, during the first half of 2017, the market underlying OBFR was $197 billion which was substantially larger than the estimated $500 million market underlying 3-month USD LIBOR but 3.8 times smaller than the $754 billion market underlying SOFR.[299]

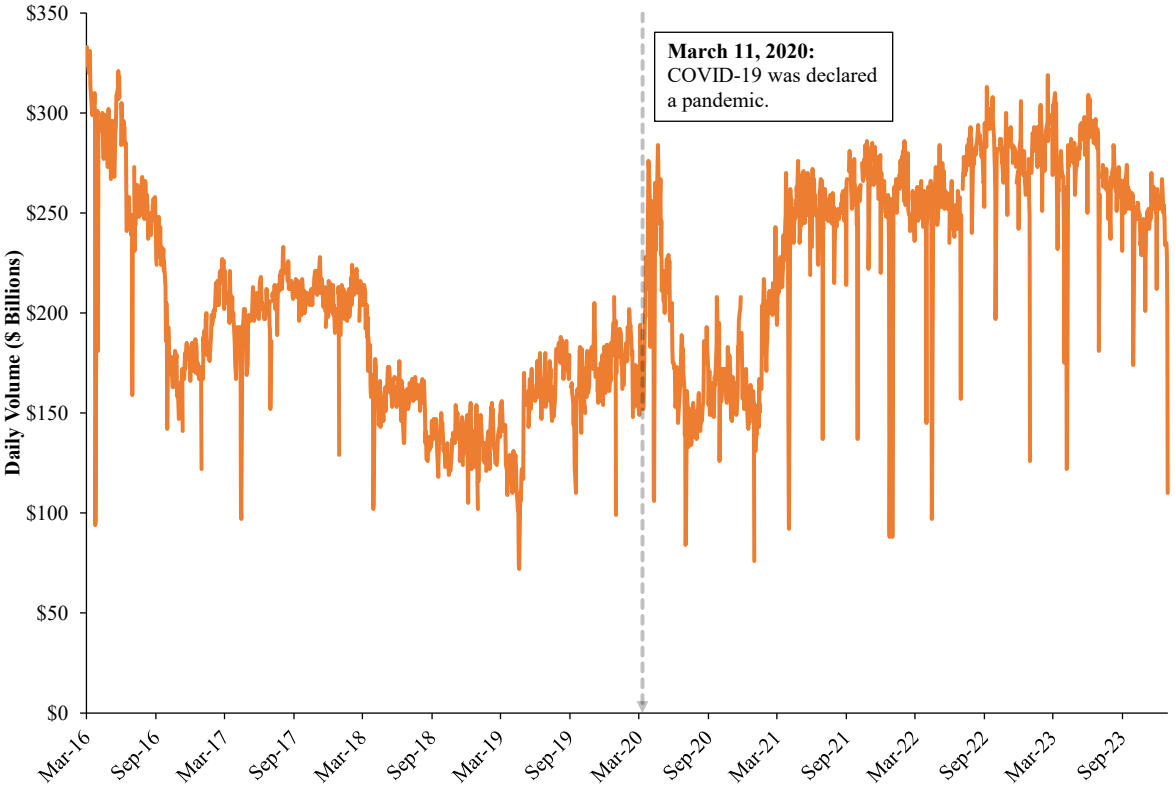
141. Figure 29 presents the daily volume of transactions underlying OBFR from March 1, 2016 (the start of available data for OBFR) to December 31, 2023. From March 1, 2016 to December 31, 2016, the average daily transaction volume supporting the OBFR calculation was $239 billion. For 2017, 2018, and 2019, average daily transaction volume declined to $204 billion, $160 billion, and $155 billion, respectively. During the COVID-19 pandemic crisis, as identified as March 11, 2020 to April 30, 2020, the average daily transaction volume of the underlying market increased to $227 billion and was $167 billion for the rest of 2020. This demonstrates that there was resiliency during the COVID-19 pandemic crisis. The average daily transaction volume underlying OBFR continued to grow in 2021, 2022, and 2023 and was $239 billion, $265 billion, and $266 billion, respectively. For the fourth quarter of 2023, the underlying market was $244 billion, in contrast to $1,573.3 billion for SOFR.

[297] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 15.

[298] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 15.

[299] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

Figure 29. *Daily Volume of Transactions Underlying OBFR between March 1, 2016 and December 31, 2023*



Notes and Sources:
-Data are from the Federal Reserve Bank of St. Louis.

142. As the ARRC noted, the daily transaction volume for OBFR often temporarily decreases on the last day of a quarter, such as March 31, and bounces back on the next day. For example, daily transaction volume for March 30, 2016 was $301 billion, $181 billion on March 31 (40 percent decline compared to the prior day), and $292 billion on April 1. Trading volumes in unsecured markets tend to decline at quarter-end because "*cash investment opportunities diminish somewhat as foreign banking organizations in particular reduce the size of their balance sheets.*"[300] There may be concerns to the extent that market participants would need to rely on quarter end values for OBFR.

[300] Alyssa Anderson et al., "What Happened in Money Markets after the Fed's December Rate Increase?" Board of Governors of the Federal Reserve System FEDS Notes, February 22, 2016 (updated March 1, 2016), https://www.federalreserve.gov/econresdata/notes/feds-notes/2016/what-happened-in-money-markets-after-the-feds-december-rate-increase-20160222.html. (Accessed March 7, 2024).

4. AMERIBOR

143. As noted above, AMERIBOR is a rate based strictly on overnight loans trading on the AFX and the start of available data is December 11, 2015.[301] While the AFX does not make its transaction volume data publicly available, the AFX reports that the overall average daily transaction volume is $2.0 billion and has periodically reported average daily transaction volume between $1.9 billion to $3.0 billion for April 2019 to the third quarter of 2022.[302]

144. The underlying market for AMERIBOR is larger than the $500 million estimate for the underlying market of 3-month USD LIBOR as of the first half of 2017 and is a small fraction of the size of the underlying market for SOFR, which was $1,573.3 billion in average daily transaction volume as of the fourth quarter of 2023.

B. Term Rates

1. CME Term SOFR

145. As noted above, the ARRC recommended the use of CME Term SOFR on July 29, 2021 as a forward-looking term SOFR rate to replace LIBOR, mainly to be used in cash products such as loans, securities, and securitizations.[303] In advance of the endorsement, the ARRC evaluated proposals for a forward-looking SOFR term rate administrator using four specific criteria: "*technical criteria, firm criteria, public policy criteria, and calculation*

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[301] American Financial Exchange, *AMERIBOR Methodology*, 2.

[302] "Innovating the Interbank Loan Market," American Financial Exchange, https://theafex.com/marketplace/. (Accessed March 7, 2024).

See, Richard L. Sandor, "American Financial Exchange (AFX) Announces a Record Day of $2.354 billion and Weekly, Monthly and Quarterly Record Transaction Volumes," LinkedIn, April 2, 2019, https://www.linkedin.com/pulse/american-financial-exchange-afx-announces-record-day-2354-sandor/. (Accessed March 7, 2024).

See, also, Will Acworth, "AFX founder says new interbank market will spark demand for Ameribor derivatives," Futures Industry Association, April 2, 2020, https://www.fia.org/marketvoice/articles/afx-founder-says-new-interbank-market-will-spark-demand-ameribor-derivatives. (Accessed March 7, 2024).

See, also, "In the Wake of Libor, New AFX Leadership Turns Attention to Growth," American Financial Exchange, September 18, 2023, https://theafex.com/in-the-wake-of-libor-new-afx-leadership-turns-attention-to-growth/. (Accessed March 7, 2024).

[303] Alternative Reference Rates Committee, *ARRC Formally Recommends Term SOFR*, July 29, 2021, 1.

Cash markets "*involve the immediate delivery of a security or instrument*," including preference shares or preferred stock. See, "Cash markets," Nasdaq, https://www.nasdaq.com/glossary/c/cash-markets. (Accessed March 7, 2024).

methodology criteria."[304] The ARRC had also identified market indicators that were "*designed to measure progress in establishing deep and liquid SOFR derivatives and cash markets—which are essential to a robust and stable term rate*."[305] The market indicators were related to liquidity and volume, including "*[c]ontinued growth in overnight SOFR-linked derivatives volumes*" and "*[v]isible progress to deepen SOFR derivatives liquidity*."[306] A key principle was also that the forward-looking SOFR term rate be "*rooted in a robust and sustainable base of derivatives transactions over time*."[307] The ARRC concluded that CME Term SOFR was the "*strongest proposal after a thorough evaluation of the RFP responses*" and that CME Term SOFR had most effectively met the specific criteria and market indicators.[308]

146. CME has reported data on the underlying market for calculating CME Term SOFR for the fourth quarter of 2023.[309] As noted above, the underlying market for CME Term SOFR is the CME SOFR futures market which includes the 1-month and 3-month SOFR futures markets.[310] The average volume used in the CME Term SOFR calculations was $890 billion, $1,012 billion, and $1,042 billion for October, November, and December 2023, respectively. CME notes that "*[o]nly outright futures transactions are used in the*

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[304] Alternative Reference Rates Committee, *ARRC Releases Update on its RFP Process for Selecting a Forward-Looking SOFR Term Rate Administrator*, May 21, 2021, 1.

The technical criteria allowed the ARRC to evaluate the capacity, operating model, and approach, process, governance and oversight of conduct of each firm. The firm criteria evaluated the suitability, financial perspective, and institutional and managerial capacity of the firm. The public policy criteria evaluated the data accessibility and likely robustness of publication. The ARRC had previously had a communications criteria which was aimed to evaluate how a firm would support the adoption of the rate and communicate their rate to customers. See, Alternative Reference Rates Committee, *RFP for Vendor to Publish ARRC-Recommended: LIBOR Fallback Spread Adjustments and Spread-Adjusted Rates*, September 2, 2020, 3-5.

[305] Alternative Reference Rates Committee, *ARRC Identifies Market Indicators to Support a Recommendation of a Forward-Looking SOFR Term Rate*, May 6, 2021, 1.

[306] Alternative Reference Rates Committee, *ARRC Identifies Market Indicators to Support a Recommendation of a Forward-Looking SOFR Term Rate*, May 6, 2021, 1.

[307] Alternative Reference Rates Committee, *ARRC Announces Key Principles for a Forward-Looking SOFR Term Rate*, April 20, 2021, 1.

[308] Alternative Reference Rates Committee, *ARRC Releases Update on its RFP Process for Selecting a Forward-Looking SOFR Term Rate Administrator*, May 21, 2021, 1.

RFP stands for request for proposal. The ARRC allowed firms to submit responses to their RFP in search of a firm that would publish daily forward-looking SOFR term rate in order to help guide the ARRC for conditions it believes are necessary to recommend a SOFR term rate. See, Alternative Reference Rates Committee, *ARRC Announces Key Principles for a Forward-Looking SOFR Term Rate,* April 20, 2021, 1.

[309] Chicago Mercantile Exchange Group*, CME Term SOFR Administrator Oversight Information Q4 2023*, 4.

[310] "Secured Overnight Financing Rate (SOFR) Futures," Chicago Mercantile Exchange Group, https://www.cmegroup.com/trading/interest-rates/secured-overnight-financing-rate-futures.html. (Accessed March 7, 2024).

calculation of Term SOFR" and that equates to using 42 to 44 percent of the total average SOFR futures volume when calculating CME Term SOFR.[311]

147. The average daily volume for the underlying market for 3-month CME Term SOFR was $981.0 billion in the fourth quarter of 2023, which was 43,540 times larger than the average daily issuance volume for 90-day AA financial commercial paper of $0.02 billion. The underlying market for 3-month CME Term SOFR was also approximately 68 times larger than an estimated $14 billion of average daily issuance volume for 3-month Treasuries.[312]

2. AA Financial Commercial Paper Rate

148. The determination of 3-month USD LIBOR and 90-day AA financial commercial paper rates is based on transactions of the term unsecured wholesale funding market, a market that has grown increasingly thin since the financial crisis as banks have increased their reliance on broader wholesale unsecured and secured financing.[313] The number and volume of transactions underlying 90-day AA financial commercial paper rate have recently remained below or at similar level as activities underlying 3-month USD LIBOR. Thus, relying on 90-day AA financial commercial paper rate would not address the limited activity underlying 3-month USD LIBOR rate that has been highlighted as a key vulnerability.

149. Following the bankruptcy of Lehman Brothers, the commercial paper market experienced "*considerable strain*."[314] Financial institutions that used commercial paper to fund their long-term liabilities by placing new issuances each month were unable to roll over

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[311] Chicago Mercantile Exchange Group, *CME Term SOFR Administrator Oversight Information Q4 2023,* 4.

An outright future instrument is "*a single purchase or sale of an underlying asset for delivery at a single future date*" with "*standardized terms for purchase or sale of an underlying security or physical commodity for future delivery*." See, "Instrument Types Available on CME Globex," Chicago Mercantile Exchange Group: Client Systems Wiki, https://www.cmegroup.com/confluence/display/EPICSANDBOX/Instrument+Types+Available+on+CME+Globex. (Accessed March 7, 2024).

[312] As shown in Figure 33 below, annual issuance volume for 3-month Treasuries for 2023 is $3,650 billion. I estimate an average daily issuance volume of around $14 billion using 252 business days.

[313] Financial Stability Board, *Reforming Major Interest Rate Benchmarks*, July 22, 2014, 13.

[314] Tobias Adrian et al., *The Federal Reserve's Commercial Paper Funding Facility*, Federal Reserve Bank of New York Economic Policy Review, May 2011, 1.

commercial paper as investors lost confidence.[315] Several financial institutions failed during the financial crisis due to their reliance on short-term funding including commercial paper.[316] To prevent a similar crisis in the future, policy makers implemented reforms including the introduction of liquidity coverage ratios so that banks would transition away from commercial paper into longer maturity funding. Regulatory capital changes and increased perceived credit risk of bank counterparty default have reduced the commercial paper market following the financial crisis.[317]

150. Figure 30 presents the average daily number of issuances of AA financial commercial paper by days to maturity from 2001 to 2023. The number of issuances across all maturities decreased from its peak of 1,050 in 2006 to 716 in 2007, after which it continued to decrease to 520 in 2008. The number of issuances continued to decrease each year between 2009 and 2012 when it dropped to 60. The period after 2012 witnessed changes in the number of issuances, reaching 185 in 2020, which represents an 82 percent decline from its peak in 2006. The number of AA financial commercial paper issuances with 41 to 80 days until maturity followed a similar trajectory as the total across all maturities.[318] The number of issuances in this maturity range declined from 58 in 2006 to its minimum of 1 in 2020, or a 98 percent decline.

[315] John C. Hull, *Options, Futures, and Other Derivatives* (Boston: Pearson, 2015, 9th Edition), 814.

[316] Marcin Kacperczyk and Philipp Schnabl, "When Safe Proved Risky: Commercial Paper During the Financial Crisis of 2007-2009," *Journal of Economic Perspectives,* Volume 24, Number 1, (2010): 29-50.

[317] Marcin Kacperczyk and Philipp Schnabl, "When Safe Proved Risky: Commercial Paper During the Financial Crisis of 2007-2009," *Journal of Economic Perspectives,* Volume 24, Number 1, (2010): 29-50.

[318] For 3-month AA Financial CP rate I used the issuances which have 41-80 days until maturity. This is consistent with how the ARRC calculated 3-month CP rates. See, Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 10.

Figure 30. *Simple Average of Daily Number of Issuances of AA Financial Commercial Paper by Days to Maturity by Year from 2001 to 2023*

	Days to Maturity						
Year	**1-4 days**	**5-9 days**	**10-20 days**	**21-40 days**	**41-80 days**	**80+ days**	**All Maturities**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
2001	604	92	64	101	55	46	962
2002	555	79	55	77	47	33	846
2003	617	68	45	80	49	33	892
2004	644	67	44	69	43	56	922
2005	629	77	49	77	48	49	929
2006	713	69	47	93	58	70	1,050
2007	387	63	51	91	47	77	716
2008	297	36	28	61	36	62	520
2009	307	22	19	40	11	24	422
2010	165	16	9	19	13	29	252
2011	81	10	6	15	11	28	151
2012	12	3	3	6	5	31	60
2013	26	3	2	6	6	29	72
2014	97	5	2	3	4	23	134
2015	28	4	2	4	5	21	64
2016	296	6	2	4	5	32	345
2017	309	11	3	5	5	14	348
2018	192	11	2	5	5	28	243
2019	143	14	3	5	4	19	189
2020	168	5	2	3	1	6	185
2021	161	6	1	1	1	8	178
2022	206	18	4	7	3	9	246
2023	178	18	3	3	2	5	209

Notes and Sources:
- Data are from the Federal Reserve Bank of New York, "Commercial Paper Rates and Outstanding Summary."

151. The number of AA financial commercial paper issuances in the range of 41 to 80 days is less than the estimated number of transactions underlying 3-month USD LIBOR during 2017 and 2018. The Fed estimated in a July 2018 presentation that the number of daily transactions underlying 3-month USD LIBOR submission by the panel bank remained within the 5 to 8 range between 2017 Q1 through 2018 Q2.[319] The number of AA financial commercial paper issuances in the 41 to 80 days range have been at or below 5 per day since 2014. The FSB noted in a 2020 report that "*[e]ven in normal times, issuance of commercial*

[319] Randal K. Quarles, "Introductory Remarks," Board of Governors of the Federal Reserve System, July 19, 2018, https://www.federalreserve.gov/newsevents/speech/quarles20180719a.htm. (Accessed March 7, 2024).

paper by banks is low, but during March 2020, the median number of trades and daily volumes declined by roughly three quarters."[320]

152. Similarly, the dollar volume of daily issuances of commercial paper has declined from 2001 to 2023 as demonstrated in Figure 31. The figure presents the average daily value of issuances of AA financial commercial paper by days to maturity. The dollar volume of issuances across all maturities decreased from $20.6 billion in 2001 to $12.5 billion in 2009, after which it declined even more rapidly to $8.0 billion in 2010. The volume of issuances reached its minimum in 2015 at $1.1 billion. It then recovered and reached $7.3 billion in 2020 and was $7.6 billion in 2023 (2023 is a 63 percent decline from 2001). The dollar volume of AA financial commercial paper issuances with 41 to 80 days until maturity followed a similar trajectory to the total AA financial commercial paper market across all maturities. The average daily volume of issuances in the 41 to 80 days maturity range was $787 million in 2001, $195 million in 2009, $106 million in 2015, $27 million in 2020, and $82 million in 2023 (2023 is a 90 percent decline from 2001).

[320] Financial Stability Board, *Reforming Major Interest Rate Benchmarks: 2020 Progress Report*, November 20, 2020, 6.

Figure 31. *Simple Average of Daily Value of Issuances of AA Financial Commercial Paper by Days to Maturity by Year from 2001 to 2023*

	Days to Maturity						
Year	**1-4 days**	**5-9 days**	**10-20 days**	**21-40 days**	**41-80 days**	**80+ days**	**All Maturities**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	(in millions)						
2001	$ 15,615	$ 1,307	$ 809	$ 1,351	$ 787	$ 760	$ 20,628
2002	14,700	1,086	679	969	635	515	18,584
2003	14,591	969	572	1,065	645	438	18,280
2004	13,421	911	524	888	633	568	16,945
2005	11,202	1,197	681	1,039	859	515	15,492
2006	13,841	1,013	591	1,226	1,013	885	18,569
2007	8,321	995	690	1,073	622	1,397	13,098
2008	6,907	659	505	955	498	1,319	10,844
2009	9,653	480	445	973	195	715	12,461
2010	5,906	456	213	414	292	673	7,955
2011	3,415	299	128	317	228	704	5,092
2012	440	69	78	118	101	638	1,445
2013	497	86	49	100	133	541	1,406
2014	2,185	148	33	66	107	444	2,983
2015	425	118	28	75	106	362	1,113
2016	10,283	193	46	83	98	429	11,132
2017	8,703	365	61	96	102	152	9,480
2018	5,328	339	66	89	80	268	6,169
2019	4,592	486	85	125	91	242	5,621
2020	6,829	176	72	74	27	106	7,284
2021	6,789	123	35	33	40	178	7,199
2022	8,408	596	118	224	88	128	9,562
2023	6,657	581	102	130	82	76	7,628

Notes and Sources:
- Data are from the Federal Reserve Bank of New York, "Commercial Paper Rates and Outstanding Summary."

153. The volume of AA financial commercial paper issuances in the 41 to 80 days range also falls short of the estimated volume of transactions underlying 3-month USD LIBOR. As discussed previously, the ARRC estimated in a March 2018 report that the average daily volume of transactions underlying 3-month USD LIBOR submission by the panel banks was about $500 million during the first half of 2017. The average daily volume of issuances for AA financial commercial paper in the 41 to 80 days range has been below $500 million since 2008.

154. The decline in the number and dollar volume of commercial paper issuances has limited the production and reporting of commercial paper rates by the Fed. Figure 32 summarizes evidence of the illiquidity of the AA financial commercial paper, using 2023 as an example. As indicated in the figure, the Fed indicated the percentage of days each month

where "*trade data was insufficient to support calculation*" of 90-day AA financial commercial paper rate.[321] There has been insufficient data to support the calculation of 90-day AA financial commercial paper rate in 124 out of the 260 trading days between January 1 and December 31, 2023—or about 48 percent. For example, in May 2023 and March 2023, the Fed could not compute 90-day AA financial commercial paper rate for 17 of the 23 trading days. The findings indicate that 90-day AA financial commercial paper rate may not be a suitable replacement for 3-month USD LIBOR given the recent insufficient daily trading. In fact, the IOSCO "*concluded that due to liquidity risks in the bank-issued commercial paper (CP) and certificates of deposit (CD) market data, they are not sufficiently deep, robust and reliable to underpin alternatives to USD LIBOR. Further, gaps in data and volatility related to reliance on a very small number of transactions mean that USD LIBOR alternatives based on these markets are unlikely to sufficiently implement the IOSCO's Principles relating to benchmark design*."[322]

[321] "Commercial Paper Rates and Outstanding Summary," Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/releases/cp/. (Accessed March 7, 2024).

[322] The Board of the International Organization of Securities Commissions, *Statement on Alternatives to USD LIBOR*, OICU-IOSCO, July 3, 2023, 1.

The International Organization of Securities Commissions develops, implements and promotes adherence to internationally recognized standards for securities regulation. "About IOSCO," International Organization of Securities Commissions, https://www.iosco.org/about/?subsection=about_iosco. (Accessed March 7, 2024).

Figure 32. *Publication of 90-day AA Financial Commercial Paper Rates by the Fed for 2023*

Month (1)	Days With Rate (2)	Days Without Rate (3)	Total Days (4) =(2) + (3)	Percentage of Days Without Rates (5) = (3) / (4)
January 2023	15	7	22	32 %
February 2023	9	11	20	55
March 2023	6	17	23	74
April 2023	9	11	20	55
May 2023	6	17	23	74
June 2023	21	1	22	5
July 2023	15	6	21	29
August 2023	15	8	23	35
September 2023	10	11	21	52
October 2023	9	13	22	59
November 2023	12	10	22	45
December 2023	9	12	21	57
Total	**136**	**124**	**260**	**48 %**

- Data are from the Federal Reserve Bank of New York, "Commercial Paper Rates and Outstanding Summary."

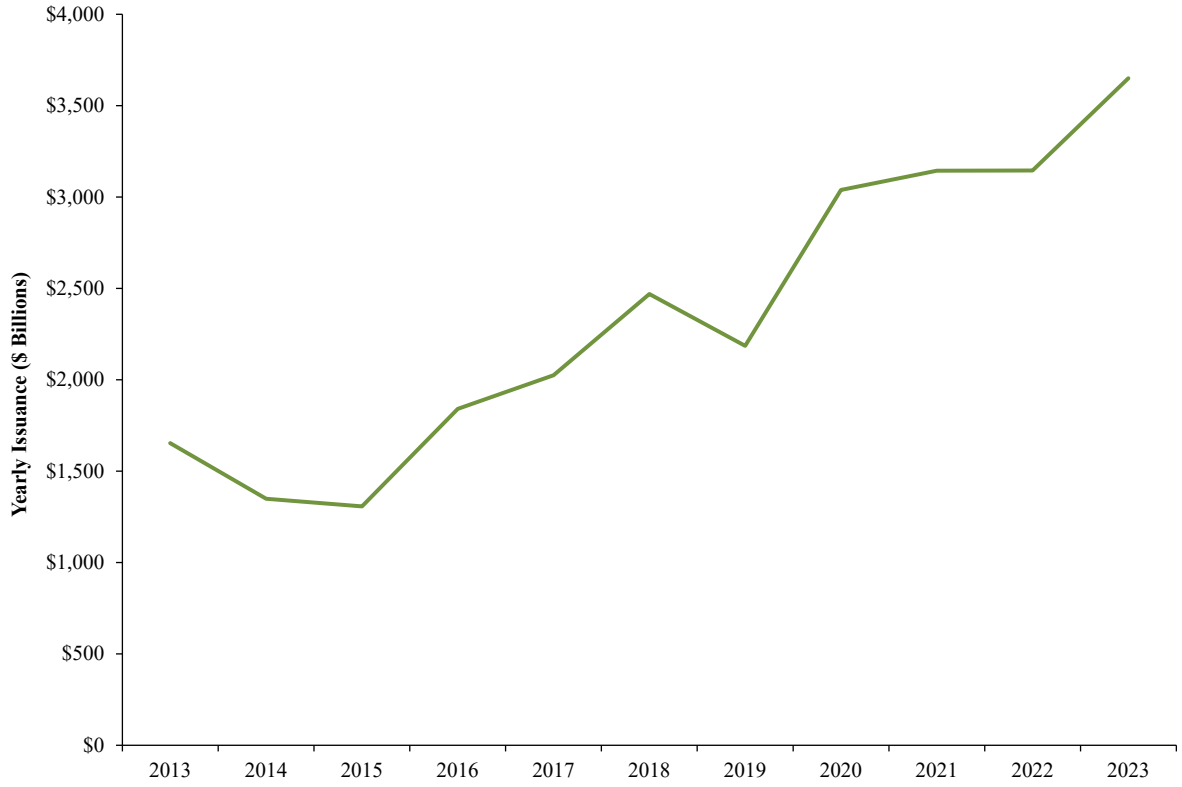
155. In summary, the number and volume of transactions underlying 90-day AA financial commercial paper rate have been limited and remained at or below the level of transactions underlying 3-month USD LIBOR. This means that 90-day AA financial commercial paper rate does not address the concern about the recently limited activity underlying 3-month USD LIBOR rate which the ARRC highlighted as one of LIBOR's key vulnerabilities.

3. Treasury Rate

156. Treasury bills are short term securities issued by the U.S. government which are non-interest bearing.[323] Figure 33 presents the annual issuances of 13-week Treasury bills from between 2013 and 2023. While annual issuance of 13-week Treasury bills went down from $1,653 billion in 2013 to $1,307 billion in 2015, it has generally trended up since 2016 from $1,840 billion to $3,650 billion 2023, with a dip in 2019.

[323] "Investment Products: Bonds," Financial Industry Regulatory Authority, https://www.finra.org/investors/learn-to-invest/types-investments/bonds/types-of-bonds/us-treasury-securities. (Accessed March 7, 2024).

Figure 33. *Annual Issuances Underlying 13-week Treasury Bills between 2013 and 2023*



Notes and Sources:
- Data are from SIFMA.

157. Figure 34 presents the average daily transaction volume of all Treasury bills between 2013 and 2023. The average daily volume ranges from $80.6 billion 2013 to $145.1 billion in 2023. At $115.9 billion, the average daily volume of Treasury bills in 2018 surpasses the volume supporting 3-month USD LIBOR which had been estimated at $500 million at the time.

Figure 34. *Average Daily Transaction Volume Underlying All Treasury Bills between 2013 and 2023*

Notes and Sources:
-Data are from SIFMA.

4. Term USD Overnight Indexed Swap Rate (OIS)

158. As discussed above, 3-month OIS swaps in USD are swaps where a fixed rate, defined as the OIS rate, is exchanged for the average EFFR over a 3-month period. In such a transaction, a party pays the other party the difference between the OIS rate and an average of EFFR, over the term of the contract.[324] The USD OIS market is "*highly liquid*" in that "*trades of good size may be executed with little price impact*."[325] However, the ARRC has stressed that "*on a daily basis, there are relatively few transactions in this market at any given maturity, making it impossible to calculate a robust, fully-transaction based OIS rate*."[326]

159. In a 2012 paper, the Fed noted that the "*frequency of trading activity affect[ed] the reliability of price reporting*" and OIS instruments "*were not traded with a*

[324] Daniel L. Thornton, *What the Libor-OIS Spread Says*, Federal Reserve Bank of St. Louis Economic Synopses, No. 24, May 11, 2009, 1.

[325] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 13.

[326] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 13.

high degree of frequency."[327] In fact, "*the most frequently traded instruments in OIS [] only traded an average of 25 [times per day]*."[328] According to data as of 2012, the daily average volume for OIS transactions was $266 billion.[329]

C. Survey-Based Rate – U.S. Prime Rate

160. I have not come across publicly available data on transaction volume underlying U.S. prime rate. As noted above, it is my understanding that U.S. prime rate represents an interest rate on corporate loans but is not calculated based on transactions data.[330] Instead, U.S. prime rate is similar to LIBOR in that it is determined from a survey.

VIII. CME TERM SOFR AS THE RECOMMENDED LIBOR REPLACEMENT RATE

161. The replacement rate for 3-month USD LIBOR can be evaluated along various dimensions, including the features of the rates, such as being a term or overnight rate or being a transactions-based rate, how closely the rates track 3-month USD LIBOR, correlation of rate movements to LIBOR, comparison of volatility of the rates to LIBOR, and size of the underlying market for each rate. After consideration of these factors and my analysis of the performance of the alternative benchmark rates, I have concluded that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment of 26.161 basis points is the most appropriate 3-month USD LIBOR replacement. 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment shares similarities with 3-month USD LIBOR, addresses some of the deficiencies of 3-month USD LIBOR, and has advantages over the alternative benchmark rates.

162. First, 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment tracks 3-month USD LIBOR better than most of the alternative benchmark rates in terms of estimated MAE. Statistically speaking, the estimated MAE of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment using the 5-year Lookback Period of March 5,

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[327] Michael Fleming et al., *An analysis of OTC interest rate derivatives transactions: implications for public reporting*, Federal Reserve Bank of New York Staff Reports, No. 557, October 2012, 3.

[328] Michael Fleming et al., *An analysis of OTC interest rate derivatives transactions: implications for public reporting*, Federal Reserve Bank of New York Staff Reports, No. 557, October 2012, 3.

[329] Michael Fleming et al., *An analysis of OTC interest rate derivatives transactions: implications for public reporting*, Federal Reserve Bank of New York Staff Reports, No. 557, October 2012, 7.

[330] "What is the prime rate, and does the Federal Reserve set the prime rate?" Board of Governors of the Federal Reserve System, https://www.federalreserve.gov/faqs/credit_12846.htm.. (Accessed March 7, 2024).

2016 to March 4, 2021 is no different than 90-day AA financial commercial paper rate which exhibits the smallest estimated MAE using the 5-year Lookback Period for the spread adjustment. However, 90-day AA financial commercial paper rate suffers from liquidity concerns and the underlying volume of transactions cannot always support reporting a rate on a daily basis especially during periods of market stress as evidenced during the financial crisis and the COVID-19 pandemic crisis. Using a 2-year Lookback Period of March 5, 2019 to March 4, 2021 for the spread adjustment as a sensitivity analysis, 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment has the smallest estimated MAE over the MAE Calculation Period.[331]

163. Second, 3-month CME Term SOFR is highly associated with 3-month USD LIBOR both during the 2-year Lookback Period (0.970) and the MAE Calculation Period (highest correlation of 0.999). 3-month CME Term SOFR also had annualized standard deviations that were consistent with 3-month USD LIBOR during the both the 2-year Lookback Period and the MAE Calculation Period. As discussed above, I cannot calculate correlation and volatility for 3-month CME Term SOFR during the 5-year Lookback Period of March 5, 2016 to March 4, 2021 since the start of available data for 3-month CME Term SOFR is January 3, 2019.

164. Third, my assessment of the transaction volume underlying the alternative benchmark rates shows that 3-month CME Term SOFR is supported by an average daily transaction volume of $981.0 billion between October and December 2023. This is second only to overnight SOFR which is supported by an average daily transaction volume of $1,573.3 billion during the same time period. However, the term adjustment for SOFR as compounded averages either in advance or in arrears are less ideal than CME Term SOFR as the rates may either be out-of-date, as in the case of an in advance rate, or would not be known until the end of the payment accrual period, as in the case of an in arrears rate. Market participants have also announced the adoption of CME Term SOFR with the ISDA Spread Adjustment as reference rates for loans, floating rate debt, and preferred stock.

[331] The ISDA Spread Adjustment of 26.161 basis points is based on a 5-year lookback period of December 3, 2015 to December 3, 2020 using Bloomberg's 3-month SOFR in arrears calculation from December 3, 2018 to December 3, 2020. Using the same methodology, I calculate the 2-year Estimated ISDA Spread Adjustment as 22.102 basis points by taking the median difference between 3-month LIBOR and Bloomberg's 3-month SOFR in arrears calculation from December 3, 2018 to December 3, 2020.

165. Finally, 3-month CME Term SOFR is a forward-looking term rate similar to 3-month USD LIBOR. It has been recommended by the ARRC for products and securities like the Preference Shares. In addition, the FCA stated that CME Term SOFR is "*robust and transparent*" and proposed that synthetic USD LIBOR be based on CME Term SOFR plus the ISDA Spread Adjustment.[332] The FCA has also stated that synthetic LIBOR is a "*fair and reasonable approximation of what LIBOR might have been had it continued to exist.*"[333] and noted the "*importance of maintaining international consistency to avoid market fragmentation or unwanted basis risk, where practicable*."[334] Furthermore, in 2021, the ARRC announced that it "*supports the use of SOFR Term Rates for business loan activity where adapting to an overnight rate could be more difficult.*"[335] The LIBOR Act identified CME Term SOFR plus the ISDA Spread Adjustment as the replacement rate for most legacy LIBOR contracts in the U.S.[336]

166. In this section, I discuss my evaluation of the alternative benchmark rates, the rationale for the selection of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment as 3-month USD LIBOR replacement rate, and why the other alternative benchmark rates would not make a suitable replacement for LIBOR.

A. Suitability of CME Term SOFR as 3-month USD LIBOR Replacement Rate

167. 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment possesses key attributes that make it suitable as the replacement rate for 3-month USD LIBOR for the Preference Shares. 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment is a forward-looking term rate like 3-month USD LIBOR. Since it is a term rate,

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[332] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 15-16.

[333] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 4.

[334] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 15.

[335] "ARRC Formally Recommends A Forward-Looking SOFR Term Rate," Practical Law Finance, August 1, 2021, https://content.next.westlaw.com/practical-law/document/If2729d01eef411ebbea4f0dc9fb69570/ARRC-Formally-Recommends-Forward-Looking-SOFR-Term-Rate?viewType=FullText&originationContext=document&transitionType=DocumentItem&ppcid=799b6677a6d3476988a2291bcfe1e7bc&contextData=(sc.DocLink). (Accessed March 7, 2024).

[336] "Regulations Implementing the Adjustable Interest Rate (LIBOR) Act," Federal Register Volume 88, No. 17 (2023): 5204-5243.

no term adjustments or calculations need to be made and the rate can be taken as published by the CME Group. In addition, it is an in advance rate and the interest rate is known at the beginning of the payment accrual period, instead of at the end of the period with an in arrears rate. This is useful because, as when using USD LIBOR, market participants using CME Term SOFR would have certainty of their interest rate obligations or entitlements prior to the period which would allow them to plan cash flows in advance.

168. On July 29, 2021, following continued growth in the SOFR cash and derivatives markets, the ARRC recommended the use of CME Term SOFR, mostly for cash market transactions.[337] Randal K. Quarles, Vice Chair for Supervision of the Fed and Chair of the FSB, stated that the formal recommendation of Term SOFR by the ARRC was "*an achievement for the USD LIBOR transition specifically and for financial stability overall*."[338]

169. Other entities, including the FCA, agreed with the ARRC's recommendation of CME Term SOFR. The FCA stated that CME Term SOFR is "*robust and transparent*" and proposed that synthetic USD LIBOR be based on CME Term SOFR plus the ISDA Spread Adjustment in a November 2022 report.[339] The FCA report discussed that market participants, mostly financial institutions and banks, "*highlighted the importance of international consistency*" when it came to selecting the basis for synthetic USD LIBOR, noting that in July 2022, the Fed proposed to "*use CME Term SOFR Reference Rates that incorporated spread adjustments specified in the LIBOR Act as benchmark replacement rates for LIBOR for non-derivative products.*"[340] In fact, in response to the FCA consultation related to synthetic USD LIBOR"*[f]ive respondents explicitly asked for a synthetic US dollar LIBOR to be based on the CME Term SOFR Reference Rate plus the respective ISDA fixed spread adjustment.*"[341]

170. Further, the ISDA spread adjustments are supported by many regulators, such as the ARRC, the FSB, and the FCA. The ARRC issued a consultation in 2020 seeking

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[337] Alternative Reference Rates Committee, *ARRC Formally Recommends Term SOFR*, July 29, 2021, 1.

[338] Alternative Reference Rates Committee, *ARRC Formally Recommends Term SOFR*, July 29, 2021, 1.

[339] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 15-16.

[340] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 15.

[341] Financial Conduct Authority, *Consultation on 'synthetic' US dollar LIBOR and feedback to CP22/11*, November 2022, 15.

feedback on the spread adjustment recommendations and received 49 responses.[342] A majority of the respondents favored the ISDA spread adjustment values and cited "*the importance of consistency with ISDA values from a hedging perspective.*"[343] In response, the ARRC recommended the same spread adjustments as ISDA had done for derivatives for cash products.[344] The ARRC later followed up recommending the use of ISDA's spread adjustments for consumer products as they believe this is the "*best way to ensure that contracts are converted fairly…because consumers will receive the same spread adjustment as every other market participant that has adopted those fallbacks, including the largest lenders and borrowers*."[345] When the ARRC recommended CME Term SOFR in June 2021, it retained the same spread adjustments as used by ISDA.

171. On March 15, 2022, the LIBOR Act was signed into law in the U.S. aiming to provide clarification and reduce uncertainty around the transition of legacy contracts away from LIBOR.[346] The Fed adopted a final rule on December 16, 2022, which implemented the LIBOR Act by identifying the replacement reference rates for LIBOR based on SOFR (where the contract itself does not adequately provide for transition).[347] Effective February 27, 2023, "*the final rule generally replaces references to overnight LIBOR in cash transactions with SOFR plus a spread adjustment specified in the LIBOR Act. With respect to references to one-, three-, six-, or 12-month LIBOR in cash transactions[,] the final rule generally identifies as the Board-selected benchmark replacement the corresponding tenor of CME Term SOFR plus a spread adjustment*."[348] The spread adjustments specified in the LIBOR Act are the same as those specified by the ISDA. Specifically, they are: "*0.644 basis points (bps) (0.00644 percent) for overnight LIBOR, 11.448 bps (0.11448 percent) for one-month*

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[342] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products,* June 30, 2020, 1.

[343] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products,* June 30, 2020, 1.

[344] Alternative Reference Rates Committee, *ARRC Announces Further Details Regarding Its Recommendation of Spread Adjustments for Cash Products,* June 30, 2020, 1.

[345] Alternative Reference Rates Committee, *Summary of the ARRC's Fallback Recommendations,* October 6, 2021, 10.

[346] "Regulations Implementing the Adjustable Interest Rate (LIBOR) Act," Federal Register, Volume 88, No. 17 (2023): 5204-5243.

[347] "Regulations Implementing the Adjustable Interest Rate (LIBOR) Act," Federal Register, Volume 88, No. 17 (2023): 5204-5243.

[348] "Regulations Implementing the Adjustable Interest Rate (LIBOR) Act," Federal Register, Volume 88, No. 17 (2023): 5204-5243.

LIBOR, 26.161 bps (0.26161 percent) for three-month LIBOR, 42.826 bps (0.42826 percent) for six-month LIBOR, and 71.513 bps (0.71513 percent) for 12-month LIBOR."[349] For Federal Housing Finance Agency-regulated-entity contracts, derivatives transactions, and asset-backed securitizations "*composed predominantly of Federal Family Education Loan Program (FFELP) loans*," the final rule implements replacements based on other SOFR-based rates depending on the tenor of LIBOR being replaced.[350] The ARRC supported the passage of the LIBOR Act. The ARRC Chairman, Tom Wipf, stated that "*President Biden and lawmakers have taken a vital step to protect investors, businesses, and consumers from LIBOR-related risks*." The approach taken in the LIBOR Act was similar to legislation proposed by the ARRC in 2020.[351] The effect of the LIBOR Act is, broadly, that references to USD LIBOR in cash transaction contracts governed by U.S. law that do not include adequate provision to transition to an alternative rate will be replaced by references to CME Term SOFR plus the ISDA Spread Adjustment.

172. In April 2023, the ARRC set guidelines and recommendations for limited use cases of CME Term SOFR for derivatives products. Since CME Term SOFR is the rate implied by transactions in the derivatives market, primarily the SOFR futures market, the liquidity of CME Term SOFR depends on the SOFR derivatives market being deep and liquid.[352] The guidelines are intended to ensure that the use of CME Term SOFR rates are proportionate to the depth of transactions in the underlying CME SOFR futures derivatives market.[353]

173. In addition to industry consensus, my analyses of the MAE, as well as the correlation and volatility of alternative benchmark rates relative to 3-month USD LIBOR, show that 3-month CME Term SOFR tracks 3-month USD LIBOR well during the period

[349] "Regulations Implementing the Adjustable Interest Rate (LIBOR) Act," Federal Register, Volume 88, No. 17 (2023): 5204-5243.

[350] Board of Governors of the Federal Reserve System, *Final Regulation Implementing the Adjustable Interest Rate (LIBOR) Act*, December 2, 2022, 5.

[351] Alternative Reference Rates Committee, *ARRC Welcomes Passage of Federal LIBOR Transition Legislation in Omnibus Spending Package*, March 15, 2022, 1.

[352] Alternative Reference Rates Committee, *Summary and Update of the ARRC's Term SOFR Scope of Use Best Practice Recommendations,* April 21, 2023, 1.

[353] Alternative Reference Rates Committee, *Summary and Update of the ARRC's Term SOFR Scope of Use Best Practice Recommendations*, April 21, 2023, 1-2.

between the 2-year Lookback Period, as well as during the MAE Calculation Period (those being the two periods I considered for which the data are available).

174. My analysis of the MAE shows that 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment is not statistically significantly different than 90-day AA financial commercial paper rate which has the smallest estimated MAE using the 5-year Lookback Period to calculate the spread adjustment.[354] As I will discuss below, 90-day AA financial commercial paper rate shares "*the same key structural difficulties as LIBOR*," such as low transaction volumes during times of financial distress.[355]

175. As a sensitivity analysis, I use the 2-year Lookback Period to calculate the spread adjustment and I find that 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment exhibited the smallest estimated MAE over the MAE Calculation Period.

176. Using both the 5-year Lookback Period and the 2-year Lookback Period as of the Transition Date of March 5, 2021, I find that 3-month CME Term SOFR with the ISDA Spread Adjustment tracks 3-month USD LIBOR well.

177. Furthermore, 3-month CME Term SOFR is highly correlated with 3-month USD LIBOR during the 2-year Lookback Period (0.970) and the MAE Calculation Period (highest correlation of 0.999).[356] During the 2-year Lookback Period, the correlation coefficients ranged from a low of 0.941, for 90-day SOFR compounded in arrears, to a high of 0.989, for 90-day AA financial commercial paper rate. During the MAE Calculation Period, the correlation coefficients ranged from a low of 0.964, for 90-day SOFR compounded in advance, to a high of 0.999, for 3-month CME Term SOFR and others.

178. CME Term SOFR also had annualized standard deviations that were consistent with 3-month USD LIBOR during the 2-year Lookback Period (15.4 percent as compared to 14.9 percent for 3-month USD LIBOR) and the MAE Calculation Period (32.8

[354] The ISDA Spread Adjustment of 26.161 basis points is based on a 5-year lookback period as of March 5, 2021.

[355] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 13.

[356] I cannot calculate the correlation coefficient for 3-month CME Term SOFR during the 5-year Lookback Period of March 5, 2016 to March 4, 2021, since the start of available data for 3-month CME Term SOFR is January 3, 2019.

percent and 33.4 percent for 3-month USD LIBOR).[357] This shows that 3-month CME Term SOFR has similar volatility or dispersion in interest rates as 3-month USD LIBOR during both the 2-year Lookback Period and the MAE Calculation Period.

179. Finally, 3-month CME Term SOFR is derived from CME SOFR futures which is "*robust and resilient*," and supported by a "*deep and diverse pool of market participants*," with average daily transaction volume for 3-month SOFR futures at $981.0 billion during the period between October through December 2023.[358] This volume is second only to that of overnight SOFR, which is discussed below. CME Term SOFR is a transaction-based rate, which does not rely on quotations or panel submissions, and given the liquidity in the underlying market and transaction volume, CME Term SOFR would be less vulnerable to manipulation and influence than USD LIBOR was.

180. As of the end of January 2023, market participants have relied on CME Term SOFR and have underwritten over 6,000 loans for over $3.2 trillion in notional amounts with CME Term SOFR as the reference rate.[359] By May 2023, more than 2,200 firms had executed over 8,000 real-time and historic licenses for CME Term SOFR.[360] There has also been evidence of banks using CME Term SOFR as a replacement to LIBOR for their preferred shares and debt. In June 2023, HSBC announced that they will transition to using CME Term SOFR with the ISDA Spread Adjustment for floating rate and fixed-to-floating rate notes linked to USD LIBOR.[361] JPMorgan Chase and Truist Financial Corporation have both adopted CME Term SOFR with a 26.161 basis points spread adjustment for 3-month tenors, the 3-month ISDA Spread Adjustment, which is the spread adjustment set forth in the LIBOR Act, for outstanding floating rate and fixed-to-floating rate debt securities, preferred stock

[357] I cannot calculate the standard deviation for 3-month CME Term SOFR during the 5-year Lookback Period of March 5, 2016 to March 4, 2021, since the start of available data for 3-month CME Term SOFR is January 3, 2019.

[358] "CME Term SOFR Rates," Chicago Mercantile Exchange Group, https://www.cmegroup.com/market-data/cme-group-benchmark-administration/term-sofr.html. (Accessed March 7, 2024).

[359] Eric Leininger, "CME Term SOFR Solidifies its Benchmark position ahead of LIBOR cessation," Chicago Mercantile Exchange Group, May 9, 2023, https://www.cmegroup.com/articles/whitepapers/cme-term-sofr-solidifies-its-benchmark-position.html. (Accessed March 7, 2024).

[360] Eric Leininger, "CME Term SOFR Solidifies its Benchmark position ahead of LIBOR cessation," Chicago Mercantile Exchange Group, May 9, 2023, https://www.cmegroup.com/articles/whitepapers/cme-term-sofr-solidifies-its-benchmark-position.html. (Accessed March 7, 2024).

[361] HSBC Holdings plc, *Update on USD LIBOR Transition for HSBC Holdings plc Securities*, HSBC News Release, June 22, 2023, 1-2.

and certificates of deposit.[362] Bank of America has also announced that they will be using CME Term SOFR with the same 26.161 basis points spread adjustment for certain outstanding floating or fixed-to-floating rate debt securities, preferred stock represented by depositary shares and trust preferred securities.[363]

B. Compounded Average SOFR as 3-month USD LIBOR Replacement Rate

181. SOFR is a secured rate and an overnight rate, and thus a nearly risk-free rate. This means that SOFR is only made up of the risk-free rate component and lacks both the term and credit component.[364] LIBOR, on the other hand, comprised three components: a risk-free rate, a tenor / term, and credit.[365] To account for the differences between LIBOR and overnight rates like SOFR, I applied a spread adjustment. LIBOR is an unsecured rate and therefore includes an element of credit risk. By contrast, SOFR and other secured rates do not have credit risk. LIBOR also includes a term premium and "*reflect[s] supply and demand conditions in wholesale unsecured funding markets that also could lead to differences.*"[366] A term premium is "*the compensation that investors require for bearing the risk that interest rate may change*" over the life of the instrument.[367] Spread adjustments would address these differences and allow for a more accurate comparison and easier transition. The use of a term

[362] "JPMorgan Chase Announces CME Term SOFR as Replacement Reference Rate for Outstanding U.S. Dollar LIBOR-Linked Securities and Other Instruments," Business Wire, March 1, 2023, https://www.businesswire.com/news/home/20230301005791/en/JPMorgan-Chase-Announces-CME-Term-SOFR-as-Replacement-Reference-Rate-for-Outstanding-U.S.-Dollar-LIBOR-Linked-Securities-and-Other-Instruments. (Accessed March 7, 2024).

[363] "Bank of America Corporation Announces CME Term SOFR as Benchmark Replacement Rate for Certain Outstanding USD LIBOR Securities After June 30, 2023," Bank of America Newsroom, March 31, 2023, https://newsroom.bankofamerica.com/content/newsroom/press-releases/2023/03/bank-of-america-corporation-announces-cme-term-sofr-as-benchmark.html. (Accessed March 7, 2024).

[364] The Board of the International Organization of Securities Commissions, *Statement on Communication and Outreach to Inform Relevant Stakeholders Regarding Benchmark Transition*, OICU-IOSCO, July 31, 2019, 4.

[365] The Board of the International Organization of Securities Commissions, *Statement on Communication and Outreach to Inform Relevant Stakeholders Regarding Benchmark Transition*, OICU-IOSCO, July 31, 2019, 4.

[366] Alternative Reference Rates Committee, *ARRC Consultation on Spread Adjustment Methodologies for Fallbacks in Cash Products Referencing USD LIBOR,* January 21, 2020, 7.

[367] "Treasury Term Premia," Federal Reserve Bank of New York, https://www.newyorkfed.org/research/data_indicators/term-premia-tabs#/overview. (Accessed March 7, 2024).

allowed for LIBOR to be a forward-looking rate which means that the interest rate could be set at the beginning of the payment accrual period and would reflect market expectations.[368]

182. A method to establish a term component for overnight SOFR is to compound the overnight rates over the relevant time period, such as 3 months, using either an "in arrears" or "in advance" methodology as described above.[369] However, the calculations from both methods result in a term period SOFR that are based on historical data and do not represent a forward-looking rate, unlike LIBOR which represents market expectations. This results in compounded average SOFR being a backward-looking rate, whether compounded in arrears or in advance. If SOFR compounded in arrears was used to calculate dividend payments for the Preference Shares, the amount would not be known until the end of the payment accrual period. This is in contrast to calculating dividend payments using a forward-looking rate such as 3-month USD LIBOR which would have allowed the payment to be known at the start of the payment accrual period. While SOFR compounded in advance would allow the amount of dividend payments for the Preference Shares to be known at the beginning of the payment accrual period, it would be based on out-of-date data and would not consider interest rates during the payment accrual period.

183. After adjusting for term and spread, I analyze how well both SOFR compounded in arrears and SOFR compounded in advance track 3-month USD LIBOR using the estimated MAE. My analysis of the MAE considers the calculation of the spread adjustment using both the 5-year Lookback Period and the 2-year Lookback Period.

184. I find that SOFR compounded in advance has the largest estimated MAE over the MAE Calculation Period of March 5, 2021 to June 30, 2023. In other words, my analysis shows that SOFR compounded in advance performs the worst compared to other benchmark rates using the 5-year Lookback Period and 2-year Lookback Period for the spread adjustments. By contrast, SOFR compounded in arrears has lower estimated MAEs using the 5-year Lookback Period and 2-year Lookback Period for the spread adjustments. However, SOFR compounded in arrears still underperforms 3-month CME Term SOFR with the 3-

[368] The Board of the International Organization of Securities Commissions, *Statement on Communication and Outreach to Inform Relevant Stakeholders Regarding Benchmark Transition*, OICU-IOSCO, July 31, 2019, 4.

[369] Financial Stability Board*, Interest rate benchmark reform: Overnight risk-free rates and term rates*, June 2, 2021, 8.

Month ISDA Spread Adjustment in terms of tracking 3-month USD LIBOR based on estimated MAE using the 5-year Lookback Period and the 2-year Lookback Period.

185. While 3-month CME Term SOFR performs better in terms of estimated MAE compared to SOFR compounded in advance and SOFR compounded in arrears, the volume of transactions underlying SOFR exceeded that of 3-month CME Term SOFR. The average daily volume of transactions underlying SOFR was around $1,573.3 billion during the last quarter as compared to $981.0 billion in average daily volume of transactions underlying 3-month CME Term SOFR during the same time period.

186. However, the ARRC has noted that a drawback of an overnight rate is that "*participants in many cash products may find use of an overnight rate unfamiliar*" making the LIBOR "*transition more difficult*."[370] Even after accounting for term adjustment, SOFR compounded in advance or in arrears remains a backward-looking rate. As an alternative, the ARRC recommended CME Term SOFR that reports rates for 1-, 3-, 6-, and 12-month tenors that have a term component and are forward-looking.[371]

C. Other Alternative Benchmark Rates as 3-month USD LIBOR Replacement Rate

187. My analysis, as well as the analysis of various industry participants, such as the ARRC and the IOSCO, examined various alternative benchmark rates and have concluded which alternative benchmark rate would be the best for a robust transition from LIBOR. In this section, I discuss the considerations by regulators that led them to not consider various alternative benchmark rates as suitable replacements for LIBOR.

1. Overnight Transaction Rates

188. In addition to SOFR discussed above, the overnight transaction rates include EFFR, OBFR and AMERIBOR. My analysis of the MAE using the 5-year Lookback Period for the spread adjustment shows that EFFR, OBFR, and AMERIBOR have higher estimated MAEs than that of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment. This also holds true if I instead consider the estimated MAE using a 2-year Lookback Period and 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment. This

[370] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 15.

[371] "CME Term SOFR Reference Rates – Frequently Asked Questions," Chicago Mercantile Exchange Group, April 26, 2023, https://www.cmegroup.com/articles/faqs/cme-term-sofr-reference-rates.html. (Accessed March 7, 2024).

means that EFFR, OBFR and AMERIBOR after term and spread adjustment do not track 3-month USD LIBOR as well as 3-month CME Term SOFR with the ISDA spread adjustments over the MAE Calculation Period. My conclusion holds whether I consider a spread adjustment based on the 5-year Lookback Period or the 2-year Lookback Period.

189. In addition, the ARRC viewed both EFFR and OBFR as weaker candidates for LIBOR replacement relative to SOFR. While the ARRC had initially considered OBFR as a leading candidate for LIBOR replacement in their May 2016 report, the ARRC ultimately noted that the transactions underlying OBFR involved "*a fairly limited set of cash providers.*"[372] The ARRC also noted that money market fund reforms have led to some decline in the volume of unsecured overnight transactions underlying OBFR since 2016.[373]

190. Regarding EFFR, the ARRC noted several considerations, including, "*overall market size, diversity of counterparties, robustness, and degree of potential constraint to the monetary policy framework*," that made EFFR a weak candidate as LIBOR replacement.[374] Specifically, the transaction volume underlying EFFR is lower than that of SOFR as well as OBFR, and the counterparties in the market underlying EFFR is limited with "*[o]ver 90 percent of overnight fed funds transactions [lent] by one of the government sponsored entities*."[375]

191. Finally, regulators such as the IOSCO expressed concerns that credit sensitive overnight rates such as AMERIBOR exhibit similar shortcomings as LIBOR and lack "*sufficient underlying transaction volumes*."[376] In particular, credit sensitive rates exhibit an "*inverted pyramid problem*" where the volume of transactions underlying the rate is disproportionately low compared to the higher volumes of activity in markets that reference them, which can make the rate vulnerable to manipulation.[377] The underlying markets for credit sensitive rates include transactions in the commercial paper and certificate of deposit

[372] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 8.

[373] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 8.

[374] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 15.

[375] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 18.

[376] The Board of the International Organization of Securities Commissions, *Statement on Credit Sensitive Rates*, OICU-IOSCO, September 8, 2021, 1.

[377] The Board of the International Organization of Securities Commissions, *Statement on Alternatives to USD LIBOR*, OICU-IOSCO, July 3, 2023, 1-2.

markets.[378] Liquidity in these markets are not robust to stress, and Edwin Schooling Latter, the Director of Markets and Wholesale Policy at the FCA, stated that this was shown in March 2020 when "*when liquidity in [Commercial Paper] markets dried up, and yields spiked.*"[379] Due to these reasons, "*[The FCA] ask[s] that any regulated UK market participants looking to use these so-called 'credit sensitive' rates in UK-based business consider the risks carefully,*" as it is "*hard to see how [credit sensitive rates] would be suitable to use… in products aimed at less sophisticated borrowers who might not understand the complex and relatively opaque risks they present.*"[380]

2. Term Rates

192. Term rates include 3-month CME Term SOFR, which is the ARRC recommended replacement to LIBOR for cash products, as well as additional rates such as 90-day AA financial commercial paper rate, 3-month treasury rate, and 3-month OIS rate.

193. 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment and 90-day AA financial commercial paper rate exhibited the lowest estimated MAEs that were not statistically significantly different from one another based on a spread adjustment using the 5-year Lookback Period. However, the ARRC did not consider AA financial commercial paper rates as leading alternatives to LIBOR since they share "*the same key structural difficulties as LIBOR*."[381] Specifically, the transactions underlying commercial paper rates have dried up during periods of market turmoil. The ARRC reports that "*Federal Reserve was able to publish its three-month AA-rated financial commercial paper rate series for only 10 of the 40 trading days over November and December 2008.*"[382] Other regulators such as the IOSCO concluded that there are liquidity risks in the commercial paper markets, and that these markets are "*not sufficiently deep, robust and reliable to underpin alternatives to USD LIBOR*."[383] Specifically, I find that the daily average volume of transactions underlying 90-

[378] Edwin Schooling Latter, "LIBOR – 6 months to go," Financial Conduct Authority, July 5, 2021, https://www.fca.org.uk/news/speeches/libor-6-months-to-go. (Accessed March 7, 2024).

[379] Edwin Schooling Latter, "LIBOR – 6 months to go," Financial Conduct Authority, July 5, 2021, https://www.fca.org.uk/news/speeches/libor-6-months-to-go. (Accessed March 7, 2024).

[380] Edwin Schooling Latter, "LIBOR – 6 months to go," Financial Conduct Authority, July 5, 2021, https://www.fca.org.uk/news/speeches/libor-6-months-to-go. (Accessed March 7, 2024).

[381] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 13.

[382] Alternative Reference Rates Committee, *Second Report*, March 5, 2018, 13.

[383] The Board of the International Organization of Securities Commissions, *Statement on Alternatives to USD LIBOR*, OICU-IOSCO, July 3, 2023, 1.

day AA financial commercial paper rate is estimated to be $22.5 million during the last quarter of 2023, compared to $981 billion for 3-month CME Term SOFR during the same period.[384]

194. My analysis of the MAE shows that 3-month Treasury rate, using the 5-year Lookback Period for the spread adjustment, did not track 3-month USD LIBOR as well as 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment, that is, the estimated MAE for 3-month Treasury rate is higher than that of 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment. My results also hold if I consider a spread adjustment based on the 2-year Lookback Period.

195. Furthermore, while Treasury securities have a wide variety of maturity rates, which is useful as providing a term structure, market participants have historically shifted away from reference rates based on Treasury securities, in part because Treasury securities serve as a safe haven asset and rates usually fall during periods of stress as indication of flight to quality, while other borrowing costs usually rise.[385]

196. Finally, I find that the estimated MAE of 3-month OIS rate is higher than that of 3-month CME Term SOFR with ISDA spread adjustments over the MAE Calculation Period. Using a spread adjustment under the 5-year Lookback Period, the estimated MAE for 3-month OIS rate is 12.9 basis points, compared to 11.0 basis points for 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment. My conclusion remains the same if I instead estimate the spread adjustment using the 2-year Lookback Period. The estimated MAE for 3-month OIS rate is 9.9 basis points, greater than for 3-month CME Term SOFR with the 2-year Estimated ISDA Spread Adjustment at 8.6 basis points. In addition, since the floating rate in an OIS is EFFR, 3-month OIS rate has similar challenges as EFFR itself, namely that the federal funds transactions underlying EFFR provide funding to a narrow range of market participants.[386]

[384] The average volume for 90-day AA Financial CP rate was calculated using the issuances which had 41-80 days until maturity.

[385] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 19.

[386] Alternative Reference Rates Committee, *Interim Report and Consultation*, May 2016, 16.

3. Survey-Based Rate – U.S. Prime Rate

197. U.S. prime rate is not transactions-based and is instead survey-based, similar to how LIBOR was determined. This means that U.S. prime rate may not react to market dislocation as a transactions-based rate would. LIBOR, being a survey-based rate was susceptible to manipulation and although it could apply to U.S. prime rate as well, prime rate survey submissions from banks often are the same and equal to the target federal funds rate plus a 300 basis spread. Given that the target federal funds rate is only updated periodically based on decisions of the Fed, U.S. prime rate may remain flat and not change for long periods of time. Furthermore, the estimated MAE for U.S. prime rate during the MAE Calculation Period, whether I calculate the spread adjustment using the 5-year Lookback Period or the 2-year Lookback Period, was amongst the three largest estimated MAEs out of all the alternative benchmark rates. In other words, the term and spread adjusted U.S. prime rate did not track 3-month USD LIBOR as well as other benchmark rates such as 3-month CME Term SOFR with the 3-month ISDA Spread Adjustment.

198. As described above, these other alternative benchmark rates are not suitable replacements for USD LIBOR for a variety of reasons.

IX. CONFIRMATIONS AND STATEMENT OF TRUTH

199. I confirm that I have made clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

200. I understand that proceedings for contempt of court may be brought against anyone who makes, or causes to be made, a false statement in a document verified by a statement of truth without an honest belief in its truth.

X. MISCELLANEOUS

201. My work is ongoing, and my opinions are subject to revision based on new information, which subsequently may be provided to, or obtained by, me.

Dr. Faten Sabry

Position: Senior Managing Director

Date: 10 April 2024

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APPENDIX A
CURRICULUM VITAE OF FATEN SABRY, PH.D.
(EXPERIENCE IN THE PAST FIVE YEARS: 2019-2024)

FATEN SABRY
SENIOR MANAGING DIRECTOR
CHAIR OF GLOBAL SECURITIES & FINANCE PRACTICE

I am a Senior Managing Director in the Securities and Finance Practice at NERA and Chair of the Global Securities and Finance Practice. I have over twenty years of experience in economic and financial consulting in the valuation of fixed income securities, derivatives, illiquid assets, businesses and litigation settlements. I have consulted in disputes involving, among other issues, investment management firms, leveraged buyouts, distressed exchanges, options, swaps, and hedging strategies.

I have testified as an expert in U.S. State and Federal Courts on issues relating to, among other topics, credit default swaps, collateralized debt obligations, residential mortgage-backed securities, mortgage derivatives, options, swaps, and derivatives.

I am the author of various articles on, among other things, the credit crisis, mortgage defaults, credit default swaps, LIBOR transition, the impact of securitization on the cost and availability of credit to consumers, and claiming behavior. My research has been published as a chapter in *The Handbook of Mortgage-Backed Securities*, edited by Dr. Frank J. Fabozzi. My research examining how alternative benchmark rates compare to LIBOR has been published in the *Journal of Fixed Income*. My other research has been published in the *Journal of Structured Finance*, *Journal of Real Estate Practice*, *Journal of Investment Compliance*, *Journal of Alternative Investments*, *Business Economics*, *International Trade Journal*, the *ABA Section of Litigation*, and other periodicals.

I am a member of the American Finance Association and the American Statistics Association. I have been accredited as a professional statistician by the American Statistics Association. I received my Ph.D. in Business from Stanford Business School and prior to joining NERA, I was a Post-Doctoral Fellow at the International Food Policy Research Institute and an assistant professor of economics at the American University in Cairo, where I taught graduate and undergraduate economic courses.

Education

1996	**Stanford University, Graduate School of Business** Ph.D., Business
1991	**American University in Cairo, Egypt** M.A., *magna cum laude*, Economics
1988	**American University in Cairo, Egypt** B.A., *GPA 4.0*, Economics

Professional Experience

NERA

2010 -	*Senior Managing Director*
2002 – 2010	*Vice President*
2000 – 2002	*Senior Consultant*
1998 – 2000	*Consultant*

1997 - 1998 **American University in Cairo**
Assistant Professor of Economics
Taught graduate and undergraduate macroeconomics, economic development, and project valuation courses.

1997 - 1998 **International Food Policy Research Institute**
Post-Doctoral Fellow
Developed and estimated econometric almost ideal demand systems (AIDS) models for the demand for food commodities using a national survey data. Prepared a report on the subsidy system based on the results of the econometric analysis.

1991 - 1996 **Stanford University, Graduate School of Business**
Research and Teaching Assistant
Conducted statistical analysis for stochastic models of multi-party decision making. Designed a survey assessing moral responsibility of providing public goods in organizations. Developed case studies on the trade dispute between Fuji and Eastman Kodak. Also worked as a teaching assistant for graduate courses on negotiation and conflict resolution.

Honors and Professional Activities

Post-Doctoral Fellow, International Food Policy Research, 1997.
J. M. Olin Research Fellowship, Stanford Law School, 1995.
Stanford University Graduate School of Business Fellowship, 1991-1996.
Ford Foundation Scholarship, 1990-1991.

Expert Reports, Deposition and Testimony

Declaration, in the United States District Court for the Eastern District of New York in *In Re Dentsply Sirona, Inc. Securities Litigation*, addressing price impact. February 8, 2024.

Declaration, in the United States District Court for the District of Nevada in *John V. Ferris, et al., v. Wynn Resorts Limited, et al.* Rebuttal analysis of class certification issues in a securities class action. December 17, 2023.

Declaration, in the United States District Court for the District of Nevada in *John V. Ferris, et al., v. Wynn Resorts Limited, et al.* addressing whether alleged corrective disclosures caused losses to Wynn Resorts' shareholders. November 14, 2023.

Affidavit, before the Supreme Court of the State of New York for the County of New York, in *Securitized Asset Funding 2011-2, Ltd. v. Canadian Imperial Bank of Commerce / Canadian Imperial Bank of Commerce v. Securitized Asset Funding 2011-2, Ltd. and Securitized Asset Funding 2009-1, Ltd., Promontoria Europe Investments XXIII LDC, and CSMC 2012-8R, Ltd*, regarding prejudgment interest, 2023.

Expert Report, and Deposition Testimony, United States District Court, District of Nevada, *John V. Ferris, et. al., Plaintiffs - v. – WYNN Resorts Limited, et. al., Defendants*, Case No.: 2:18-cv-00479-APG-EJY, October and November 2022.

Expert Report, Declaration, and Deposition Testimony, United States District Court, Eastern District of New York, *In re NIO, Inc. Securities Litigation*, Case No. 1:19-cv-01424-NGG-VMS, October and November 2022.

Expert Report, United States District Court, Southern District of New York, *United States of America - v. - James Velissaris* (22 Cr. 105 (DLC)), September 2022.

Trial Testimony, Deposition Testimony, Affirmative Report and Expert Rebuttal Report, before the Supreme Court of the State of New York for the County of New York, in *Securitized Asset Funding 2011-2, Ltd. v. Canadian Imperial Bank of Commerce / Canadian Imperial Bank of Commerce v. Securitized Asset Funding 2011-2, Ltd. and Securitized Asset Funding 2009-1, Ltd., Promontoria Europe Investments XXIII LDC, and CSMC 2012-8R, Ltd,* on economic analysis of damages involving credit default swaps, 2021.

Expert Rebuttal Report, in the Superior Court of Justice (Commercial List) for the Province of Ontario, in *The Mangrove Partners Master Fund, Ltd. v. TransAlta Corporation, Brookfield BRP Holdings (Canada) Inc., Rona H. Ambrose, John P. Dielwart, Timothy W. Faithfull, Dawn L. Farrell, Alan J. Forrer, Gordon D. Griffin, Yakout Mansour, Georgia Nelson, Beverlee F. Park and Bryan D. Pinney*, on rebuttal analysis of damages related to a financial transaction with the option to convert debt to minority equity interest in hydro assets, 2021.

Trial Testimony, in the Superior Court of Justice (Commercial List) for the Province of Ontario, in *Duo Bank of Canada v. Fairstone Financial Holdings Inc., J.C. Flowers IV Coinvest Canada L.P., J.C. Flowers IV L.P. and VP Canada Acquisition, LP* and *Fairstone Financial Holdings Inc., J.C. Flowers IV L.P. and VP Canada Acquisition, LP v. Duo Bank of Canada*, on economic analysis of roll rate models, loan loss reserves and amortization events for consumer loans collateral in asset-backed securities, 2020.

Rebuttal Report, Expert Report, in the Superior Court of Justice (Commercial List) for the Province of Ontario, in *Duo Bank of Canada v. Fairstone Financial Holdings Inc., J.C. Flowers IV Coinvest Canada L.P., J.C. Flowers IV L.P. and VP Canada Acquisition, LP / Fairstone Financial Holdings Inc., J.C. Flowers IV L.P. and VP Canada Acquisition, LP v. Duo Bank of Canada*, on projections of losses on consumer loans and impact of macroeconomic factors, 2020.

Deposition Testimony, Expert Rebuttal Report, in the United States District Court for the Southern District of New York, in *Pacific Life Insurance Company et al v. The Bank of New York Mellon*, on alleged damages in a mortgage-backed securities case, 2020.

Declaration, in the United States District Court for the Southern District of New York, in *Phoenix Light SF Limited, et. al. v. the Bank of New York Mellon*, on alleged damages in a mortgage-backed securities case, 2019.

Deposition, Expert Rebuttal Report and Expert report, in the United States District Court for the District Court of Puerto Rico in *The Financial Oversight and Management Board for Puerto Rico As A Representative of The Commonwealth of Puerto Rico, et al. Debtor and The Financial Oversight and Management Board for Puerto Rico As A Representative of The Employees Retirement System of The Government of Puerto Rico, Debtor,* on evaluation of PR bonds, 2019.

Deposition, in the United States District Court for the Southern District of New York, in *Phoenix Light SF Limited, et. al. v. the Bank of New York Mellon*, on alleged damages in a mortgage-backed securities case, 2019.

Publications

"How Do Alternatives to LIBOR Measure Up?" (with Frank J. Fabozzi and Ramisa Roya), *Journal of Fixed Income*, Spring 2024.

"What Happened to SVB? Not a 2008 Repeat Story" (co-authored with William Hrycay and Sungi Lee), *Law360*, March 24, 2023.

"Cryptos Are Not All the Same, and the Market Knows It," (co-authored with Ignacio Franceschelli), *American Bar Association: Business Law Today,* January 12, 2023.

"How Will the LIBOR Transition Affect Mortgage Consumers?" (co-authored with Ignacio Franceschelli and Ramisa Roya), August 15, 2022.

"Expert Pitfalls – And Ways to Avoid Them," (with William Q. Derrough, Jeffrey Dunn, Thomas J. Moloney, and David M. Zensky) summary of VALCON 2020 panel discussion, *AIRA Journal,* Vol. 33, No. 3, November 2020.

"Hey Google: When Did People Stop Going to Work?" (co-authored with Linh Nguyen, and Aakash Bhalothia), NERA Working Paper, May 2020.

"Manufactured Defaults and the Use of Credit Default Swaps," (co-authored with Ignacio Franceschelli and David Cen), NERA Working Paper, December 2019.

Presentations

"Economic Analysis in Crypto Disputes" webinar at Shearman & Sterling, April 2023.

"Trends in Securities and Finance Issues in Arbitration" presentation during Paris Arbitration Week, March 2023.

"Insight in Economics and trends in securities class actions" FinPro Innovations panel discussion, Marsh, November 2022.

"Two Sides of the Coin: Future Cryptocurrency Regulatory and Litigation Risks," panel discussion, NERA Insights Webinar, March 2021.

"A View of Bankruptcies on Both Sides of the Atlantic," panel discussion, NERA Insights Webinar, December 2020.

"Expert Pitfalls – And Ways to Avoid Them," (with William Q. Derrough, Jeffrey Dunn, Thomas J. Moloney, and David M. Zensky) panel presented at VALCON, February 2020.

"Use of Credit Default Swaps in Valuation Disputes," presented at *American Bankruptcy Institute Conference*, New York, NY, May 2019.

"How Do Market Efficiency and Market Evidence Factor in Valuation Disputes?," presented at *VALCON 2019*, hosted by the American Bankruptcy Institute (ABI): Las Vegas, NV, February 2019.

"2018 Claim Trends and NERA Capabilities," presentation hosted by *FINPRO Global Advisory Board*, New York, NY, February 2019.

APPENDIX B

Glossary of Key Terms

General Terms

2-year Estimated ISDA Spread Adjustment – The 2-year Estimated ISDA Spread Adjustment is my estimated spread adjustment of 22.102 basis points based on the ISDA guidelines and Bloomberg calculations using the median difference between 3-month USD LIBOR and Bloomberg's 3-month SOFR in arrears calculation for the time period between December 3, 2018 to December 3, 2020.

3-month ISDA Spread Adjustment – The 3-month Spread Adjustment is a fixed spread adjustment of 26.161 basis points, as determined by the ISDA guidelines using the median difference between 3-month USD LIBOR and Bloomberg's 3-month SOFR in arrears calculation for the time period between December 3, 2015 to December 3, 2020.

American Depository Shares, also ADSs – ADSs represent an interest in the shares of a non-U.S. company.

Benchmark rate – A benchmark rate is a publicly accessible interest rate that may be used as a reference rate in financial products.

Compound interest / average – Compound interest recognizes that the borrower does not pay back interest owed on a daily basis and it therefore keeps track of the accumulated interest owed but not yet paid. The additional amount of interest owed each day is calculated by applying the daily rate of interest both to the principal borrowed and the accumulated unpaid interest. For example, assume a rate calculated over 2 days, with an interest rate of 2% on day 1 and 3% on day 2. The principal is $100. Day 1: $100 + ($100 * 2%) = $102. Day 2: $102 + ($102 * 3%) = $105.06. Compound average = ($105.06 / $100) – 1 = 5.06% / 2 days = 2.53%.

Floating rate – A floating rate is one which will vary over the life of a financial instrument.

In advance – In advance compounding is backward-looking and reflects a compounded average of interest rates from before the start of the payment accrual period. For example, to get the 90-day in advance rate on day x, I would take the compounded average starting on 90 days prior to day x and ending 1 day before day x.

In arrears – In arrears compounding is backward-looking and the calculation considers interest rates during the payment accrual period and uses more recent information than the in advance calculation. For example, to get the 90-day in arrears rate on day x, I would take the compounded average starting on day x and ending 89 days after day x.

Interbank unsecured lending market – The interbank unsecured lending market is a market for loans among banks with specific terms that are not protected by a guarantor or collateralized by an asset.

Mean absolute error, also MAE – The MAE quantifies the average of absolute difference in the rates between 3-month USD LIBOR and each of the alternative benchmark rates (after being adjusted for term and spread).

Overnight repurchase agreement transaction – In an overnight repurchase agreement transaction, the securities sold are bought back the following day at a higher price.

Policy rate – A policy rate is a rate set by a monetary authority, such as a country's central bank.

Preference Shares – On December 8, 2006, Standard Chartered issued 7,500 dollar-denominated perpetual preference shares with a total paid up amount of $100,000 (nominal value of $5 plus a premium of $99,995) per share that were sold in the form of American Depository Shares to raise capital for general business purposes.

Regulation S – The Preference Shares are offered and sold in two tranches, the Rule 144A tranche and the Regulation S tranche, with identical terms. The Regulation S tranche is offered to investors outside of the U.S.

Rule 144A – The Preference Shares are offered and sold in two tranches, the Rule 144A tranche and the Regulation S tranche, with identical terms. The Rule 144A tranche is offered only to qualified institutional buyers (QIBs) in the U.S.

Simple interest / average – Simple interest is calculated by applying the daily interest rate to the principal and the payment at the end of the period is the sum of these amounts. The simple average of a rate assumes interest is taken only on the principal throughout the period being averaged. For example, assume a rate calculated over 2 days, with an interest rate of 2% on day 1 and 3% on day 2. The principal is $100. Day 1: $100 + ($100 * 2%) = $102. Day 2: $102 + ($100 * 3%) = $105. Simple average = ($105 / $100) – 1 = 5% / 2 days = 2.5%. The simple average can also be calculated as (3% + 2%) / 2 days = 2.5%.

Spread – The spread is the difference between two rates or other financial quantities.

Spread adjustment – The purpose of a spread adjustment is to reflect and adjust for the historical differences between LIBOR and the alternative benchmark rate. Historical differences can include differences in credit risk, differences in the responses of the rates to market events, and differences in supply and demand in the markets underlying each rate.

Survey rate – Survey-based rates, such as LIBOR and U.S. prime rate, are not supported by an underlying transactions market. Instead, these rates are based on a survey process.

Term, also tenor – A term rate means it measures borrowing costs over a specific time period, such as 1 month or 3 months. The specific time period is referred to as a term or a tenor.

Term adjustment – A term adjustment is necessary for benchmark rates that are overnight rates to make them consistent with a term rate like 3-month USD LIBOR.

Unsecured wholesale funding – Unsecured wholesale funding transactions are the means by which banks seek finance from professional counterparties—not retail—through transactions that are not protected by a guarantor or collateralized by an asset.

Wholesale funding – Wholesale funding refers to a firm borrowing from a depository institution, such as a bank, or another depository institution.

Dates and Time Periods

2-year Lookback Period – The 2-year Lookback Period is from March 5, 2019 to March 4, 2021 (two years prior to March 5, 2021 when the FCA announced that 3-month USD LIBOR setting, among other LIBOR tenors and currencies, would be ceasing immediately after June 30, 2023).

5-year Lookback Period – The 5-year Lookback Period is from March 5, 2016 to March 4, 2021 (five years prior to March 5, 2021 when the FCA announced that 3-month USD LIBOR setting, among other LIBOR tenors and currencies, would be ceasing immediately after June 30, 2023).

COVID-19 Pandemic Crisis – I consider the COVID-19 pandemic to span the period between when the World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020 and the end of the U.S. recession on April 30, 2020.

Financial crisis – I consider the financial crisis to span the period between the bankruptcy of mortgage lender New Century on April 2, 2007 and the end of the U.S. recession on June 30, 2009.

Lehman Brothers bankruptcy – Lehman Brothers filed for bankruptcy on September 15, 2008.

LIBOR cessation date – LIBOR ceased to be published on June 30, 2023.

MAE Calculation Period – The MAE Calculation Period is from March 5, 2021, the date the FCA announced that 3-month USD LIBOR setting would be ceasing immediately after June 30, 2023, to June 30, 2023, when 3-month USD LIBOR was no longer being published.

Transition Date – The Transition Date is March 5, 2021**,** when the FCA announced that 3-month USD LIBOR setting would be ceasing immediately after June 30, 2023.

Benchmark Rates

3-month Synthetic USD LIBOR –The FCA has required that the IBA to publish 1-, 3- and 6-month synthetic USD LIBOR through at least September 30, 2024. Synthetic 3-month USD LIBOR is calculated as 3-month CME Term SOFR plus the 3-month ISDA fixed spread adjustment of 26.161 basis points.

3-month U.S. dollar LIBOR, also 3-month USD LIBOR – 3-month USD LIBOR is the USD LIBOR rate with a tenor of 3-months. The determination of the 3-month USD LIBOR rates was based on a qualitative survey from a select group of between 11 and 18 banks, referred to as the panel banks, where each bank responded to questions about the cost of USD-denominated interbank unsecured loans for 3-months.

AA financial commercial paper rate – Commercial paper is short-term promissory notes mainly issued by corporations and financial institutions which provides short-term funding for financial and non-financial firms. AA financial commercial paper rates are based on trades of commercial paper issued by AA-rated financial institutions and produced and overseen by the Fed.

American Interbank Offered Rate, also AMERIBOR – AMERIBOR is an interest rate that is based on daily transactions in the overnight unsecured loan market on the American Financial Exchange, LLC.

Bloomberg Short-Term Bank Yield, also BSBY – The BSBY Index measures unsecured wholesale funding costs for systemically important banks based on transactions quotes.

CME Term SOFR – CME Term SOFR is a set of forward-looking rates published by the Chicago Mercantile Exchange that reflects market expectations for SOFR over various maturities.

Effective federal funds rate, also EFFR – EFFR is a rate published by the Fed that is based on the overnight federal funds transactions.

Interest on reserve balances, also IORB – IORB is set by the Fed and is the rate paid to banks and other eligible entities on account balances, or reserves, at the Federal Reserve Banks.

Overnight bank funding rate, also OBFR – OBFR draws from the same overnight federal funds transactions data that underlie EFFR but also incorporates Eurodollar transactions data. The transactions underlying OBFR involve unsecured borrowing.

Overnight indexed swap rate, also OIS – An OIS is a swap between a fixed and floating interest rate.

Overnight reverse repo facility, also ON RRP – ON RRP is set by the Federal Open Market Committee and is the interest rate the Fed pays on an overnight reverse repo facility operation. An overnight reverse repo facility is a repurchase agreement through which eligible institutions can invest overnight with the Fed.

Proxy Secured Overnight Financing Rate, also Proxy SOFR – Proxy SOFR was a survey rate published by the Fed using responses from surveys and constructed as the volume-weighted mean rate of the primary dealers' overnight Treasury general collateral repo borrowing activity. First available Proxy SOFR data is as of February 20, 1998.

Secured Overnight Financing Rate, also SOFR – SOFR is a rate that is based on secured, overnight repurchase agreement transactions.

Treasury rate – Treasury rates are the interest rates paid on U.S. Treasury securities of different tenors.

U.S. prime rate –U.S. prime rate is determined by a survey of individual banks and is not transaction-based. The Fed reports U.S. prime rate posted by the majority of the largest twenty-five banks in the U.S.

U.K. Regulators and Government Entities

Bank of England – The Bank of England is the central bank of the United Kingdom.

British Bankers' Association, also BBA – The BBA was a trade association for the U.K. banking and financial services sector. The BBA published LIBOR starting in 1986 until 2014.

Financial Conduct Authority, also FCA – The FCA regulates financial services firms and financial markets in the U.K.

Serious Fraud Office, also SFO – The SFO is an independent government department which investigates and prosecutes serious or complex fraud and corruption.

U.S. Regulators and Government Entities

Alternative Reference Rates Committee, also ARRC – The ARRC was convened by the Federal Reserve Bank of New York on November 17, 2014 to identify a replacement for USD LIBOR.

Department of Justice, also DOJ – The DOJ is a federal agency that upholds the rule of law, protects civil rights, and enforces the law in the U.S.

Federal Open Market Committee, also FOMC – The FOMC is comprised of twelve members, which includes seven members from the Fed, the president of the FRBNY, and presidents from four other Federal Reserve Banks. The FOMC reviews economic and financial conditions, determines the monetary policy stance, and assesses the risks to long-run goals of price stability and economic growth.

Federal Reserve Bank of New York, also FRBNY or New York Fed – The New York Fed is one of 12 regional Reserve Banks which together are a part of the Federal Reserve System, along with the Fed. The New York Fed oversees the Second Federal Reserve District which includes New York state, the 12 northern counties of New Jersey, Fairfield County in Connecticut, Puerto Rico and the U.S. Virgin Islands.

Federal Reserve Board of Governors, also Fed – The Fed is the central bank of the United States.

U.S. Commodity Futures Trading Commission, also CFTC – The CFTC is an independent agency that regulates the U.S. derivatives markets, which includes futures, swaps and certain kinds of options.

Market Participants and International Entities

American Financial Exchange, LLC, also AFX – The AFX provides an electronic platform for banks and financial institutions to conduct overnight, unsecured lending and borrowing.

Bank for International Settlements – The Bank of International Settlements promotes global monetary and financial stability through international cooperation and acts as a bank for central banks.

Chicago Mercantile Exchange, also CME –The CME is a derivatives marketplace offering a wide range of products, including futures and options.

CME Group Benchmark Administration – The CME Group Benchmark Administration is a benchmark administrator that provides various products and benchmarks using data from CME Group's markets.

Financial Stability Board, also FSB – The FSB is an international body that monitors and makes recommendations about the global financial system. The FSB promotes international financial stability by coordinating with national financial authorities and international standard-setting bodies.

ICE Benchmark Administration Limited, also IBA – The IBA is an administrator which began publishing Intercontinental Exchange LIBOR in 2014 and continued through June 30, 2023.

Intercontinental Exchange, also ICE – The ICE is a marketplace for derivatives and financial securities, including futures, equities, fixed income, and U.S. residential mortgages.

International Organization of Securities Commissions, also IOSCO – The IOSCO is an international body which brings together the world's securities regulators. Their "2013 Principles for Financial Benchmarks" have been used to determine if a benchmark is suitable.

International Swaps and Derivatives Association, also ISDA – The ISDA fosters safe and efficient derivatives markets to facilitate effective risk management for all users of derivative products.