



# Can companies afford lethargy in replacing discharged interest rates?

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## **Abstract**

Traditional interbank-offered rates are on the verge of discontinuation and will be replaced by currency-specific risk-free interest rates. For US Dollar, SOFR is chosen as successor to LIBOR post June 2023. SOFR is conceptually different from LIBOR as daily publication only consists of a backward-looking overnight rate that does not inherit a credit component. While publication of LIBOR rates will cease immediately in July 2023, existing financial contracts will still reference LIBOR beyond cessation. A fallback mechanism will become effective for contracts that had not been switched proactively to any available replacement rate. This analysis outlines if a proactive shift away from LIBOR had offered advantages in the past by comparing spreads between LIBOR and the available replacement options, resulting cash flows from the different rates and the impact on derivative valuation. Especially the fixing of a Spread Adjustment in the fallback rate computation and the overall level of interest received have been identified as the main drivers impacting such decision. While the fallback rate is more robust to outliers in the underlying rate, the Spread Adjustment can be identified as not representative of market reality after its ultimate fixing. The cash flow analysis underlines that the fallback rate had been disadvantageous to borrowers in the past and particularly in an environment of low market interest.

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## **Resumo**

As taxas interbancárias tradicionais estão à beira da descontinuidade e serão substituídas por taxas de juro sem risco específicas da moeda. Para o dólar americano, a SOFR é escolhida como sucessora da LIBOR após Junho de 2023. A SOFR é conceptualmente diferente da LIBOR, uma vez que a publicação diária consiste apenas numa taxa overnight retrospectiva que não herda uma componente de crédito. Embora a publicação das taxas LIBOR cesse imediatamente em Julho de 2023, os contratos financeiros existentes continuarão a fazer referência à LIBOR após a sua cessação. Um mecanismo de recurso entrará em vigor para os contratos que não tenham sido alterados proactivamente para qualquer taxa de substituição disponível. Esta análise indica se um afastamento proactivo da taxa LIBOR ofereceu vantagens no passado, comparando os spreads entre a LIBOR e as opções de substituição disponíveis, os fluxos de caixa resultantes das diferentes taxas e o impacto na avaliação dos derivados. Em especial, a fixação de um ajustamento do diferencial no cálculo da taxa de recurso e o nível global dos juros recebidos foram identificados como os principais factores que influenciam essa decisão. Enquanto a taxa de recurso é mais resistente a valores atípicos na taxa subjacente, o ajustamento do diferencial pode ser identificado como não representativo da realidade do mercado após a sua fixação final. A análise dos fluxos de tesouraria sublinha que a taxa de recurso foi desvantajosa para os mutuários no passado, em especial num contexto de baixas taxas de juro do mercado.

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**List of abbreviations**

ARR..... Alternative Reference Rates  
 ARRC ..... Alternative Reference Rate Committee  
 BBA..... British Bankers Association  
 bps ..... basis points  
 BSBY ..... Bloomberg Short-Term Bank Yield Index  
 CD ..... Certificate of Deposits  
 CHF ..... Swiss Franc  
 CME ..... Chicago Mercantile Exchange  
 CP ..... Commercial Paper  
 EFFR ..... Effective FED Funds Rate  
 FCA ..... Financial Conduct Authority  
 FED ..... Federal Reserve Bank of New York  
 FOMC..... Federal Open Market Committee  
 GBP ..... British Pound Sterling  
 GSIB..... Global Systematically Important Banks  
 IBA ..... ICE Benchmark Association  
 ICE ..... Intercontinental Exchange  
 IRS..... Interest Rate Swap  
 ISDA..... International Swap and Derivative Association  
 JPY ..... Japanese Yen  
 LIBOR..... *See* London Interbank Offered Rate  
 OIS ..... Overnight Index Swap  
 RFR ..... Risk-free rate  
 SOFR..... Secured Overnight Financing Rate  
 USD ..... US-Dollar

## **1. Introduction**

Since the Financial Conduct Authority (FCA) announced in 2017 to discontinue the publication of the London Interbank Offered Rate (LIBOR) in the future (Andrew Bailey, 2017), there has been ongoing debate on how the transition to Alternative Reference Rates (ARRs) may take place. LIBOR has served as the main interest rate for interbank lending since the 1970s and was considered a generic estimate of banks' marginal costs of short-term unsecured wholesale funding (Marquit & Curry, 2023). Total USD LIBOR exposure amounted to approximately 223 trillion USD in March 2021 with 74 trillion thereof maturing after the ultimate LIBOR cessation set in June 2023 (The Alternative Reference Rates Committee, 2021). ARRs are the rates determined by the different administrators to replace the formerly widely accepted IBOR rates. For US Dollar (USD), the Secured Overnight Financing Rate (SOFR) was deemed the most suitable to replace USD LIBOR and all companies and practitioners were recommended quoting SOFR, or a modification of it, in its financial contracts or derivatives (ARRC, 2020). Since SOFR is by nature conceptually different from LIBOR, the mere SOFR rate does not inherit all the characteristics that were evident in LIBOR. Especially, a term component and credit sensitivity are what constitutes the major differences between the two rates. Borrowers that seek to proactively tackle the transition away from discharged interest rates find themselves in a position to choose which possible replacement rate most adequately covers their needs in financial contracts. If such transfer from a discharged interest rate is not dealt with proactively and indexation remains in place beyond the end of the IBOR rate, a fallback mechanism is designed that covers all formerly IBOR-quoted financial contracts. For USD LIBOR, which will be at the core of this work, the International Swap and Derivative Association (ISDA) designed the ISDA Fallback USD LIBOR, which compounds SOFR over the respective tenor and includes a Spread Adjustment that is meant to cover the evident difference between SOFR and LIBOR for the specific tenor. This difference stems from the lack of term component and credit spread in SOFR and the aspiration to account for it at a point in time when LIBOR's liquidity still suffices an appropriate calculation. Especially the adequacy of such fixed Spread Adjustment will be critically assessed.

This work seeks to examine the possible LIBOR replacement options in terms of spreads, cash flows and changes in derivative valuation with a special focus on the fallback rate and whether it would have been advantageous in the past to shift away from LIBOR proactively. Insights upon this transitional development are worth extracting, as virtually all borrowers or lenders find themselves in need of answering the question how discharged interest rates can be replaced

in the future. Preferably, such transition is designed in a way that prevents suffering potential disadvantages or major disturbances in market participant's funding or derivative portfolios. While the analysis of spreads intends to identify exposure to the underlying market's development, the cash flow analysis adds an operational perspective. Finally, the derivative valuation seeks to examine possible implications for financial instruments that rely on any of the underlying rates.

Especially during times of low market interest, a proactive shift would have been favorable from a borrower's position. The force driving such development is in most cases the Spread Adjustment of the fallback rate, which during the low interest period between 2020 and 2022 drove spreads negative for the ISDA Fallback USD LIBOR. The same observation holds for an analysis of cash flows, which compares total nominal cash flows for a floating rate quoted product. Again, the Spread Adjustment is the component that rises interest payments resulting from the ISDA fallback rate in times of low interest rates and especially since the Spread Adjustment had been fixed following an index cessation trigger event in March 2021.

The remainder of this thesis is structured as follows: a brief literature review summarizes existing literature dealing with the topic, supplemented by some broader insights on Interest Rate Swap (IRS) valuation. Subsequently, the relevant interest rates and their estimation methodology will be explained in detail, followed by a brief methodology on how spreads, cash flows and IRS valuation had been computed. The analyses on spreads, cash flows and IRS valuation will examine the major differences that result from the application of different interest rates and whether lethargic behavior had hypothetically been rewarded in the past. After a brief discussion of the aforementioned results, this thesis will close with a short conclusion on the investigation and what limitations must be kept in mind when transferring the results of this analysis.

## 2. Literature Review

Long-standing literature dealing with the IBOR-cessation is scarce due to the up-to-datedness of the topic. Analysis on possible discontinuation scenarios only emerged after the discontinuation announcement in 2017, when the Bank of England and the FCA declared that LIBOR rates would cease to be published after end-2021 for British Pound Sterling (GBP), Swiss Francs (CHF), and Japanese Yen (JPY), with USD being ultimately discontinued after June 30<sup>th</sup>, 2023 (Financial Conduct Authority, 2021).

Available literature thus mostly consists of retro perspective analyses of the topic, guidelines, and publications from administrators to support or explain the transition taking place. Further, possible implications that the transition may have on different areas of Corporate Finance, particularly the usage and quotation of interest rates in financial contracts will be laid out.

Jermann (2021) undertakes a comparison of LIBOR versus hypothetical SOFR rates during the financial crises and how this would have impacted interest income of banks during the crisis. While Jermann (2021) subdivides potential SOFR loans into Term SOFR and Compound SOFR, this analysis accounts for the latter by analyzing the ISDA Fallback USD LIBOR. The fallback rate essentially is a compound rate that is supplemented by a Spread Adjustment that shall indicate the historical spread between secured and unsecured lending. The difference between the Compound SOFR in Jermann (2021) and the ISDA Fallback USD LIBOR in this paper therefore amounts to such Spread Adjustment that had been fixed from March 2021 onwards, which will be explained in the following sections. Jermann (2021) derives Term SOFR from USD Overnight Index Swaps (OIS) rates and Compound SOFR by compounding daily quoted SOFR rates over the respective time horizon. The two main findings relating to the topic of this paper are that LIBOR-indexed loans had earned an additional 1% to 2% of interest against SOFR-indexed loans and that a compounded SOFR does not provide the same insurance during a crisis as LIBOR does. The latter is due to the different computation of the two as the compounding approach incorporates lower interest rates faster than the term approach. One of the main distinctions between Jermann (2021) and this work is the contrasting development of Overnight Treasury Repo rates, respectively SOFR, as the period under observation in this work contains both declining and increasing secured rates.

Guggenheim & Schrimpf (2020) discusses the advantageousness of using backward-looking *in advance* term rates when a switch to *in arrears* term rates is not feasible for market participants. *In Arrears* and *in advance* refers to the point of time at which the applicable interest rate is

known for a given tenor. While an *in advance* rate offers the possibility to quote the interest rate at the beginning of the interest period, an *in arrears* rate is only determined at the end of any interest period by taking realized rates over that tenor into account. Particularly smaller financial market participants and retail companies were to suffer from the uncertainty in interest payment cash flows if overnight rates were used. In contrast to tying a company's interest payments to pre-determined reference rates like LIBOR, the payable interest amount can no longer be quantified until the end of the respective interest period when a compounded approach is to be applied. Difficulties for companies may arise, amongst others, relating to a company's cash flow management, their IT landscape, their hedging mechanisms, and legal restrictions. They examine two approaches to overcome such uncertainty, both based on taking past realized reference rates into consideration: their first proposal is at inception the computation of an "adjustment factor", that equalizes the present value of any *in advance* product to that of an *in arrears* product. As such adjustment factor cannot be derived prior to the contract in question, their proposition is the derivation through market-quoted OIS rates that are supposed to incorporate market expectations of the future regarding the underlying interest rate. Such approach is consequently prone to unexpected interest rate fluctuations that are not incorporated in the OIS rate used for the computation of the adjustment factor. Effective protection against the latter can again be designed through hedging instruments that reference the same underlying OIS rate. Their second approach suggests the application of a shorter observation period for every interest payment period. While the first approach incorporates the entire previous period, the shorter observation period suggests taking only interest rates of the previous week into consideration, thereby capturing changes in the underlying reference rates more appropriately. However, an *in advance* rate determined by a shortened observation period faces a higher exposure to interest rate spikes, hence resulting in a more volatile term rate. Their final recommendation is the application of the second method, as a shortened observation period offered the smallest spread compared to the ex-post *in arrears* approach while standard deviation was still reasonably low.

While Guggenheim & Schrimpf (2020) proposes term rates that incorporate realized past reference rate returns, Heitfeld and Park (2019) seeks to exploit ARR forward rates quoted in futures traded on the Chicago Mercantile Exchange (CME) or the Intercontinental Exchange (ICE). However, unlike the adjustment factor approach presented in Guggenheim and Schrimpf (2020), past realized reference rates are disregarded and merely the implied forward rate of quoted futures serves as a basis for term rate estimation. Despite the acknowledgement of

potential reference rate movements following meetings of the Federal Open Market Committee (FOMC) and a stable path in-between, the quality of their prediction again relies on how accurate future estimations of interest rate movements are. The latter is challenged in particular when compared to an ex-post comparison with compounded reference rates over the contract period. Heitfeld and Park (2019) further acknowledges the possibility of tracking implied term rates through OIS rates and find that future- and OIS-implied term rates move closely together except for the financial crisis between 2007 and 2009. In summary, their estimated futures-implied term rates track compounded interest rates and OIS-implied rates over the same interest period closely. Their close co-movement serves as justification for solely deriving Term SOFR from market quotes in OIS products in this work.

The IRS valuation performed in this analysis follows the commonly applied methodology that has been in place since the inception of IRSs in the early 1980s. One of the earliest works surrounding the opportunities of application for IRS and how to value them correspondingly is outlined in Bicksler and Chen (1986). While the presented procedure for IRS valuation stems from a time when LIBOR was the main benchmark to follow in swap pricing, the main mechanics described still apply to IRS today, except for changed characteristics that arise when valuing an OIS swap compared to a plain-vanilla IRS. Further Bicksler and Chen (1986) outlines areas of application for IRS, which by nature are tied to market reference rates and hence either diminish or create exposure to the same. Amongst others, it presents possible usage of IRS to improve gap management, lower fixed-rate costs, restructuring of a company's debt mix and management of basis risks. While the possibilities of application go beyond that list, the basic mechanisms for the valuation of IRS still apply. Bicksler and Chen (1986) suggests the perception of exchanging a fixed-rate with a floating-rate bond and valuing the floater. The logical implication is that the value of the swap at inception must be equal to zero, which is determined by extracting the fixed-rate such that discounted cash flows of fixed- and floating-rate bond even out. A more in-depth description of IRS valuation can be found in the methodology section.

Smith (2013) outlines the appropriate procedure when valuing IRS that are no longer discounted by forward-looking rates but rather by OIS. The basic principles remain the same, e.g., bootstrapping and the derivation of forward rates for the various future payments is still performed following the logic that had been in place to value LIBOR-based IRS. Smith (2013) rather identifies the main deviation from the formerly accepted procedure in the shift away from swap rates used for discounting that rely on non-collateralized trades instead of collateralized

deals. He further confirms Johannes and Sundaresan (2007) in their hypothesis that a fixed rate on a collateralized swap is meant to exceed the fixed rate of an uncollateralized swap. The rationale for the letter stems from the implied higher costs of posting collateral. Going further, he claims that the cost of posting collateral is asymmetrical to the parties, thereby exposing payer and receiver of the fixed rate differently to volatility in the underlying. Precisely, the holder of a collateralized payer-swap benefitted in the case of increased interest rate volatility. The following analysis of an IRS valuation over the time span of 2020 to 2022 will thus take place from the perspective of such payer-swap holder and will pay special attention to periods of interest rate volatility.

For further investigation, and due to the lack of comprehensive literature on a still evolving topic, several issuances of market administrators, reference rate committees, providers of financial indices and other profound analysis on the topic is taken into consideration.

The Bloomberg Short-Term Bank Yield Index (BSBY) is one of the possible replacement rates that is looked upon closely in the analysis since it is designed to closely resemble the characteristics of LIBOR. Its estimation methodology and characteristics are thoroughly explained in a product sheet published by Bloomberg (Bloomberg L.P., 2020). Further explanation of the BSBY rate is given in the subsequent data description.

The ISDA Fallback USD LIBOR, which constitutes the rate that is applied by default upon cessation of the original USD LIBOR, is administered by ISDA, which selected Bloomberg as the vendor to daily publish the fallback rate for the different tenors. Hence, several publications from Bloomberg surrounding the ISDA Fallback USD LIBOR are taken into consideration. Especially, information from the IBOR Fallbacks Fact Sheet (Bloomberg L.P., 2023) and the IBOR Fallback Rate Adjustments Rule Book (Bloomberg L.P., 2023) were considered. Again, the exact methodology and characteristics will be explained exhaustively in the data description.

### **3. Data and Methodology**

#### **3.1. Interest Rates**

##### **3.1.1. Unsecured Term Interest Rates**

###### **3.1.1.1. *London Interbank Offered Rate (LIBOR)***

The LIBOR served as the prevalent short-term interest rate for financial market participants since the mid-1980s, when the emergence of the syndicated loan market led financial institutions to fund their participation in such syndicated loans in the interbank deposit market. In order to tie such interbank lending to a reasonable benchmark and future diminishment of misconduct in funding, the British Bankers Association (BBA) was assigned responsibility for the daily publication of LIBOR rates in 1986 and remained in charge until 2014. As of then, the ICE Benchmark Administration (IBA), itself regulated by the FCA, was declared the authorized administrator of LIBOR (Campbell, 2018). The aim of the IBA's methodology, which will briefly be set out in the following for USD LIBOR, is to provide "an average rate that is representative of the rates at which large, leading internationally active banks with access to the wholesale, unsecured funding market could fund themselves in such market in US dollars for certain tenors." (ICE Benchmark Administration) For the determination of such rate, a consortium of panel banks committed themselves to daily submission of an Output Statement, which includes the respective bank's estimate for an appropriate USD LIBOR rate following a waterfall methodology. Such waterfall submission includes actual interest rates charged in transactions on the respective day on Level 1, transaction-derived data on Level 2, and historically charged rates adjusted to the current market environment supplemented by expert judgement on the current expected cost of funding of the bank on Level 3. Following the intention stated above, panel banks are required to submit data on wholesale unsecured funding and fulfill certain requirements in terms of quality, accuracy, quantity, and prioritization. Eligible trades include unsecured term deposits, Commercial papers (CPs), and Certificates of deposits (CDs) with a minimum value of 10 million USD. Additionally, sorting the submitted trades or expert judgements into tenor buckets allows the creation of USD LIBOR tenor rates for 1-month, 3-months, 6-months and 12-months interest periods (ICE Benchmark Administration).

Flaws in the aforementioned methodology became apparent in the financial crisis 2007-2009 and the LIBOR scandal in 2012, ultimately leading to the decision to phase out LIBOR and a shift towards an alternative risk-free rate (RFR). Especially the instability of LIBOR against a drying up interbank lending environment (financial crisis) and manipulated submissions of panel banks (LIBOR scandal) led to the decision to establish SOFR as future reference rate for

financial market transactions (Marquit & Curry, 2023). While publication of 1-week and 2-month USD LIBOR ceased end-2021, the remaining tenors are scheduled for cessation by 30<sup>th</sup> of June 2023. Regardless of the ultimate cessation date for USD LIBOR publication, several financial market transactions are ought to reference the most liquid available rate, thus requiring market participants to shift towards alternative reference rates prior to the cessation date (IFRS Foundation, 2011). Figure 7 in the appendix provides a detailed depiction of the main events surrounding the LIBOR cessation.

For the cause of this work and the implied differentiation between discharged and emerging interest rates, the nature of LIBOR as a credit-sensitive rate that also incorporates a term component is of crucial importance. Its credit-sensitivity stems from its build, by only incorporating unsecured trading of the specified instruments in the interbank market. The term component allows for market participants to price ordinary and secondary financial instruments *in advance* of the upcoming interest period. That is, financial institutions and their counterparties have certainty about their payment obligation for the coming interest period before its start.

#### **3.1.1.2. *Bloomberg Short-Term Bank Yield Index (BSBY)***

Coming back to the challenges presented for an adequate LIBOR replacement, the Term SOFR rate offers a solution to overcoming the lack of a term component in an underlying reference rate for financial contracts. The absence of credit-sensitivity remains however since the mere Term SOFR is derived from swap rates that again are collateralized. Demand for such credit-sensitivity stems from banks that seek to maintain a positive spread between their cost of funding and interest received for their loans. Especially, the potential drift apart during times in which investors rush to safe havens bears the risk of a balance sheet mismatch for banks since spreads in the interbank market are typically expected to increase simultaneously (Bloomberg L.P., 2020). The BSBY was designed to close the gap between Term SOFR and a credit-sensitive benchmark, or put differently, to provide the market with a successor rate to LIBOR. The methodology follows an approach that is conceptually comparable to LIBOR by incorporating CPs, CDs, USD Bank deposits and corporate bonds as source for the derivation of applicable spreads in the US interbank market. By abolishing the panel-banks' output statement and hence reducing the influence of expert judgement and exposure to a shrinking underlying market for LIBOR, BSBY appears to be more robust than LIBOR. Said robustness is to a larger extent due to its estimation methodology, which is performed under the umbrella of one of the market's largest providers of financial indices. Especially a fallback mechanism

stabilizing the curve in the event of reduced trading volume and an elaborated curve-fitting methodology favors the creation and application of BSBY. In a hypothetical retro perspective, BSBY tracked the development of LIBOR closely for all available tenors (Bloomberg L.P., 2020).

The BSBY rates for ON, 1-month, 3-month, 6-month, and 12-month tenors were extracted directly from the Bloomberg webpage (Bloomberg Professional Services, 2023). Different from LIBOR, SOFR, Compound SOFR and Term SOFR, BSBY is not published on US bank holidays and thus projected forward from the latest available preceding rate.

### **3.1.2. Secured Interest Rates**

#### **3.1.2.1. *Secured Overnight Financing Rate (SOFR)***

With the recognition of LIBOR's shortcomings in the aftermaths of financial crisis and LIBOR scandal, SOFR was declared the preferred USD alternative reference rate for replacement by the Alternative Reference Rate Committee (ARRC). SOFR is published daily by the Federal Reserve Bank of New York (FED) (FED, 2023).

Different from LIBOR, SOFR intends to indicate the cost of overnight borrowing in USD, collateralized by U.S. Treasury securities. Consequently, the mere SOFR rate only provides information on how much interest would have been paid or received for a borrowing from the previous day until today and thus lacks a term component. SOFR was deemed a more appropriate measure of a market-quoted RFR, because it not only relies solely on actual transactions taking place in the secured treasury repo market, but also is assembled from the vastest available transaction basis in terms of number and volumes of trades. Repo market participants, on whose trades the SOFR calculation is based, consist of Global Systematically Important Banks (GSIBs), Non-GSIBs, independent dealers, brokers and government sponsored enterprises. The average daily volume of SOFR-underlying transactions exceeded 1 trillion USD throughout 2020. The rate itself is calculated as a volume-weighted median of transaction-level data over the course of one business day and consequently published on the following day (The Alternative Reference Rates Committee, 2021).

Despite its robust and extensive transaction basis, daily SOFR rates may spike on days when either the amount of treasury securities that needs to be purchased increases or the available cash in banks and money market mutual funds to conduct such transactions shrink. In September 2019, both occurred simultaneously when quarterly corporate tax payments of 120 billion USD were due on September 16, accompanied by a 54 billion USD settlement of long-

term treasury debt. The FED responded by offering 75 billion USD in overnight repo, which led to an immediate decline of the Effective FED Funds Rate (EFFR) and consequently SOFR, which closely resembles the EFFR (Anbil, Anderson, & Senyuz, 2020). However, such supply-demand mismatches may reappear in the future and are to a lesser extent apparent whenever quarterly corporate tax payments are due, thus making SOFR on a daily basis per se a more volatile rate than e.g., LIBOR.

### **3.1.2.2. Compound and Term SOFR**

As the basic application of interest rates in financial products, such as loans and derivatives, is still persistent, the issue of how newly created overnight ARR's can be referenced in such products arises. While formerly applied IBOR rates fixed the floating rate payments at the beginning of the interest period, a backward-looking overnight RFR allows the fixing of contractual cash flows only ex-post, meaning on the day the interest payment is due and all daily RFRs of the interest period are known.

In practice, two essentially similar approaches can be followed for such *in arrears* computation of the payable interest amount: when the simple interest approach is used, the daily SOFR rate is applied to the principal amount and the payment at the end of the period is the sum of all daily interest payments calculated. For compound interest, the payment at the end of the interest period is determined by compounding the daily rates over the respective tenor and thus applying it to the unpaid interest as well (The Alternative Reference Rates Committee, 2021).

While this allows contract partners to benefit from a quoted riskless rate, they also face risk that may result from prompt movements in the interest rate during the interest period. This poses a challenge not only from an economic standpoint, as companies' payment operations, IT systems, accounting and so forth are generally designed to know the interest amount payable in advance (Slaughter and May, 2020). This problem can be overcome by contractually agreeing the use of an *in advance* SOFR-based rate. An *in advance* rate can again be derived from two methodologies, which are, unlike the *in arrears* term rates, conceptually different. If one seeks to contractually agree on using actual SOFR rates but determine the cash flow in advance, the compounded interest rate of period t-1 is applied to the upcoming interest rate period, thus lagging the quoted SOFR rates by one period. Consequently, this evens out during the time of the financial contract when compared to an *in arrears* quote and only the difference between the final and the initial period remains as difference between the two. In the past, the differences between an *in advance* and an *in arrears* compounded rate have proven to be not significant

when interest rates are low (Guggenheim & Schrimpf, 2020). The second approach to fix a Term SOFR rate *ex-ante* is by derivation from exchange-traded futures or OTC-traded OIS swap rates. Different from all approaches presented before, such term rate only incorporates market expectations about the future movement of the underlying interest rate. The difference between futures- and forward-implied term rates stems from a different estimation approach as the proposed methodology for future-implied rates incorporates future rate movements following FOMC meetings and a stable course in-between (Heitfeld & Park, 2019). For the cause of this work, only rates denoted by OIS will be taken into consideration, as these are thought to incorporate expectations of future interest rate movements, e.g., following FOMC meetings, by nature (Jermann, 2021).

All rates referred to as Term SOFR rates are extracted from Refinitiv Eikon Datastream and are essentially offered rates for OIS quoted on the American Money Market.

### **3.1.2.3. ISDA Fallback LIBOR**

If none of the aforementioned versions of an USD alternative reference rate is proactively agreed upon in a financial contract, the ISDA has decided to implement a fallback rate based on risk-free reference rates to become effective after the ultimate cessation of LIBOR in June 2023. The methodology follows an *in arrears* approach, thus quoting the compound rate of the relevant period *ex-post*. To assess the market's need for scheduling the resulting interest payments, a currency-specific offset lag is in place, which for USD is two reference rate business days. The accrual period thus ends two days prior to the payment date and, depending on the currency, starts prior or on the same day as the original IBOR rate record day. The exact timeline for ISDA Fallback USD LIBOR determination is depicted in Figure 8 in the appendix. What differentiates the ISDA Fallback USD LIBOR from a compound rate as quoted by Refinitiv or Bloomberg is an additional Spread Adjustment added to the compound rate. Such Spread Adjustment shall, prior to an "index cessation event" (ISDA, 2021), equal the median spread between the IBOR and the Adjusted RFR over a period starting five years prior the original IBOR rate record day, lagged by the tenor plus an additional two reference rate business days. Per ISDA definition, an index cessation event constitutes the announcement of a planned discontinuation or reaching a status of non-representativeness of IBOR for a specific currency. For USD LIBOR, such index cessation trigger became effective as of March 5<sup>th</sup>, 2021, when the FCA and LIBOR administrator announced the discontinuation of USD LIBOR past June 2023 (Financial Conduct Authority, 2021). For all contracts quoting LIBOR and applying the fallback mechanism provided by ISDA, the Spread Adjustment is fixed for interest payments

past 5<sup>th</sup> of March 2021. The fallback rate is computed as the sum of Spread Adjustment and adjusted RFR over the relevant tenor. Note that the Spread Adjustment is variable until 5<sup>th</sup> of March 2021 and fixed afterwards, which might result in a deviation from market reality if the fixed median spread computation period is significantly different from the contemporary period. Table 1 provides an overview of the ISDA Fallback Rate Spread Adjustment for the different tenors.

Tenor	Spread Adjustment in %
ON	0.00644
1W	0.03839
1M	0.11448
2M	0.18456
3M	0.26161
6M	0.42826
12M	0.71513

Table 1 ISDA Fallback USD LIBOR Spread Adjustment

**3.2. Methodology**

The analysis of different applicable interest rates will be performed by comparing the relevant rates with one another in terms of spreads, resulting cash flows and how the application of the various rates had impacted the value of an IRS over that period.

The spread is calculated as the simple difference in the relevant rates for every relevant rate report day. For the spread analysis between LIBOR and the available ARRs, the following spreads are taken into consideration:

- (1) LIBOR over ISDA Fallback USD LIBOR:

$$S_{LIB-ISDA} = L_{t,c} - ISDA_{t,\Pi_t^{t+c}(SOFR)+Spread Adj.}$$

Equation 1 Spread LIBOR - ISDA Fallback USD LIBOR

Where  $L_{t,c}$  denotes the LIBOR rate for the respective tenor c and is subtracted by the ISDA Fallback USD LIBOR, determined for date t as compound SOFR rate over the period from t to t+c, supplemented by the applicable Spread Adjustment.

- (2) LIBOR over Term SOFR

$$S_{LIB-TSOFR} = L_{t,c} - T_{t,c} ,$$

Equation 2 Spread LIBOR - Term SOFR

Where T denotes the Term SOFR rate for the respective tenor c.

(3) LIBOR over BSBY

$$S_{LIB-BSBY} = L_{t,c} - B_{t,c} ,$$

Equation 3 Spread LIBOR - BSBY

Where B denotes the BSBY rate for the respective tenor c.

Secondly, the spreads calculated for the comparison of the by default fallback rate versus the available replacement options, the following spreads are calculated and interpreted:

(4) Term SOFR – ISDA Fallback USD LIBOR

$$S_{TSOFR-ISDA} = T_{t,c} - ISDA_{t, \Pi_t^{t+c}(SOFR)+Spread Adj.}$$

Equation 4 Spread Term SOFR - ISDA Fallback USD LIBOR

(5) BSBY – ISDA Fallback USD LIBOR

$$S_{BSBY-ISDA} = B_{t,c} - ISDA_{t, \Pi_t^{t+c}(SOFR)+Spread Adj.}$$

Equation 5 Spread BSBY - ISDA Fallback USD LIBOR

For a comparison of cash flows resulting from the application of different reference rates, a plain floating rate payment schedule indexed to the applicable tenors of the respective reference rate is being looked upon. Such payment schedule may e.g., be applicable in a floating rate bond or IRS. Following the different characteristic of the interest rates in the comparison, any payment is either determined prior to the interest period (*in advance*) or at the end (*in arrears*) but paid at the end of the period either way. Due to the comparison by contract start date, the interest amounts payable are not lagged by one interest period even if the rate for every *in-arrears* interest payment is not known until the end of the period. The interest amounts payable are calculated per interest period, which for simplicity is identical to the respective tenor. Further, to enhance comparability, all interest payments are calculated using the ACT/360 day count convention. This is especially noteworthy, since the ISDA Fallback USD LIBOR methodology accounts for differences in day count conventions between conventional IBOR rates and Adjusted RFRs. The sum of all such interest payments over a contract lifecycle is compared between different interest rates and composed as follows:

$$TNCF_{I,c,t} = \sum_{t_0}^T N * r_c * \frac{\Delta d_{t,t+c}}{360},$$

Equation 6 Total Nominal Cash Flows

Where  $I$  denotes the interest rate used,  $N$  a fixed nominal amount applicable to all rates alike,  $r$  the applicable interest rate for each interest period and  $\frac{\Delta d_{t,t+c}}{360}$  the de-annualizing factor for the time delta of  $c$  between two interest payments. Whenever Total Nominal Cash Flows are being compared, their relation will be expressed as a relative quote.

Finally, to extend the analysis by a valuation component, an IRS valuation is computed for the different interest rates available over time with the goal to identify sources for fluctuations within each rate individually and between different possible rates. Therefore, a plain vanilla fixed-for-floating IRS is entered, which is revalued every day during the contract lifecycle. The valuation of such derivative follows the commonly applied methodology, where the value of the IRS is derived as:

$$V_{IRS} = V_{Fix} - V_{Float}$$

Equation 7 Value Interest Rate Swap

At inception, such  $V_{IRS}$  must equal zero, because the fixed rate of the swap, or *swap rate* is determined in a way that equals fixed and floating rate payments in terms of present value. The value of such IRS will however fluctuate in the future since a new discount curve requires the computation of a new swap rate virtually every day. The value to the *receive-fixed* party on date  $t_i$  is then determined as the difference between present values of the fixed rate at inception and the newly computed fixed rate times the notional:

$$V_{IRS,t_i} = N * r_{fix,t_0} * \sum_{n=1}^T PV_{t,t_i} - r_{fix,t_i} * \sum_{n=1}^T PV_{t,t_i}$$

Equation 8 Value Interest Rate Swap (continued)

The transition from LIBOR to SOFR in derivatives is meant to take place in a way that refrains from major changes in valuation. Precisely, a properly quoted SOFR IRS should equal a shadow derivative referencing LIBOR. Aligning these two is rather straightforward and can be achieved by including the daily spread between LIBOR and SOFR into such derivative. This equals daily calibration of the SOFR derivative towards the value of the LIBOR derivative. Implementing this approach proactively will thus result in zero exposure

to changes in the ARR, as the spread is calibrated daily. No such calibration takes place when the LIBOR vs. SOFR spread is fixed ultimately as is the case for the fallback rate. In the subsequent analysis, a plain-vanilla LIBOR swap, starting January 1<sup>st</sup>, 2020, and maturing three years later, will be evaluated against a SOFR-indexed swap that continuously quotes the Spread Adjustment as of March 2021. Note that prior to the index cessation event the Spread Adjustment was factually not fixed. The comparison rather intends to point out how a fixed Spread Adjustment had caused the value of an SOFR-indexed IRS to fluctuate over time.

#### **4. Spread, Cashflow and IRS Valuation Analysis**

The intention of the following section is to perform a retro perspective analysis of spreads, cash flows and IRS valuation between the former reference rate and the available replacement options. Especially the development of spreads between all relevant reference rates and the resulting cash flows will be studied to derive insights in how these develop based on the underlying reference rates. Firstly, spreads and cash flows between USD LIBOR and ARR's will be compared to enhance the understanding for past causes of deviating behavior and what should be kept in mind when shifting financial contract indexation from LIBOR to ARR's. Secondly, since traditional LIBOR will cease to exist as of July 2023, the ARR's will be compared to rates resulting from the fallback procedure implemented through ISDA. Note that especially the latter comparison is purely hypothetical, and the rates discussed were in practice barely competing against one another for application in financial contracts during a period prior to July 2023. A closer look on how the different reference rates react towards changing market conditions rather offers the possibility to anticipate their future movements, especially following benchmark movements or crisis scenarios.

For the cash flow comparison, I consider a notional of 1 billion USD and a contract period of 2 years for all available reference rates for simplicity. The comparison includes two-year floating rate contracts and the resulting payments with contract start dates between 2018 and early 2021, or put differently, until the contract start date for which the final applicable interest rate in 2023 is available. For the floating rate payment analysis, only the sum of notional cash flows is taken into consideration, which assembles from the tenor-based payments due in two years of the contract. Figure 13 and Figure 14 in the Appendix contain the comparison of cash flows for 1- and 3-months indexation for all interest rates.

The development of an IRS's value over said contract period is analyzed to derive implications for accountants that must report on financial derivatives and have exposure to fluctuations in the value of these (IFRS Foundation, 2020). Such analysis yields further insights into possible implications for corporations as not only one tenor rate is referred to, but the entire yield curve has an impact on the financial instrument's value.

##### **4.1. LIBOR vs. Alternative Reference Rates (ARRs) and BSBY**

Following the recommendation of the FCA from September 2020, financial contracts shall not rely on LIBOR post-2021 due to the shrinking trading volume in LIBOR markets. Companies are thus encouraged to perform the necessary shift for newly created and existing contracts until

the end of 2021 and ultimately cannot quote LIBOR after June 2023 (Andrew Bailey, 2017). However, moving away from LIBOR could have been done immediately after such recommendation and even would have been well justified given the exceeding trading volume of SOFR derivatives over LIBOR as of March 2022 (J.P. Morgan, 2022).

#### **4.1.1. LIBOR vs. ISDA Fallback USD LIBOR**

To understand the immediate effects of the LIBOR cessation on financial contracts, it is straightforward to analyze its spread over the ISDA Fallback USD LIBOR, which will by default be applied post LIBOR cessation if no alternative reference rate is agreed upon. As pointed out earlier, LIBOR and ISDA Fallback USD LIBOR constitute a different interest rate nature. Not only is LIBOR quoted in advance, but it also incorporates a credit spread that panel banks charge as mark up in interbank lending and which is thus incorporated in the estimation of the final LIBOR rate. The fallback rate seeks to account for such credit spread by including the median average spread between LIBOR and SOFR over a preceding five-year window. When comparing the two, the volatility of spreads in times of crisis stands out: Figure 1 indicates that not only during the outbreak of COVID-19, but also with the start of the global recession starting in early 2022, spreads for all tenors showed increased volatility. Additionally, due to the fallback rate's nature as ex-post rate, the spread of LIBOR over the Fallback rate tends to be high in times when the computation of the latter entails significantly diminished rates. Such spread behavior occurred e.g., during March 2020, when 1-, 3- and 6-month spread ranged between approximately 70 and 120 basis points (bps), because the fallback rate already accounted for the diminished SOFR rate as of April 2020. For the following two years, the spread for all tenors ranges between 0 and -50 bps. Such negative spreads seem to stem from the Spread Adjustment included in the computation of the fallback rate. The negative spread development for the time 2020 to 2022 justifies a critical assessment of said Spread Adjustment. Especially in comparison with a rate that is designed to be credit-sensitive and thus represents a reliable estimate of the market's expectation for a credit spread, one would expect the Spread Adjustment incorporated in a fallback rate to not exceed such factually quoted spread.

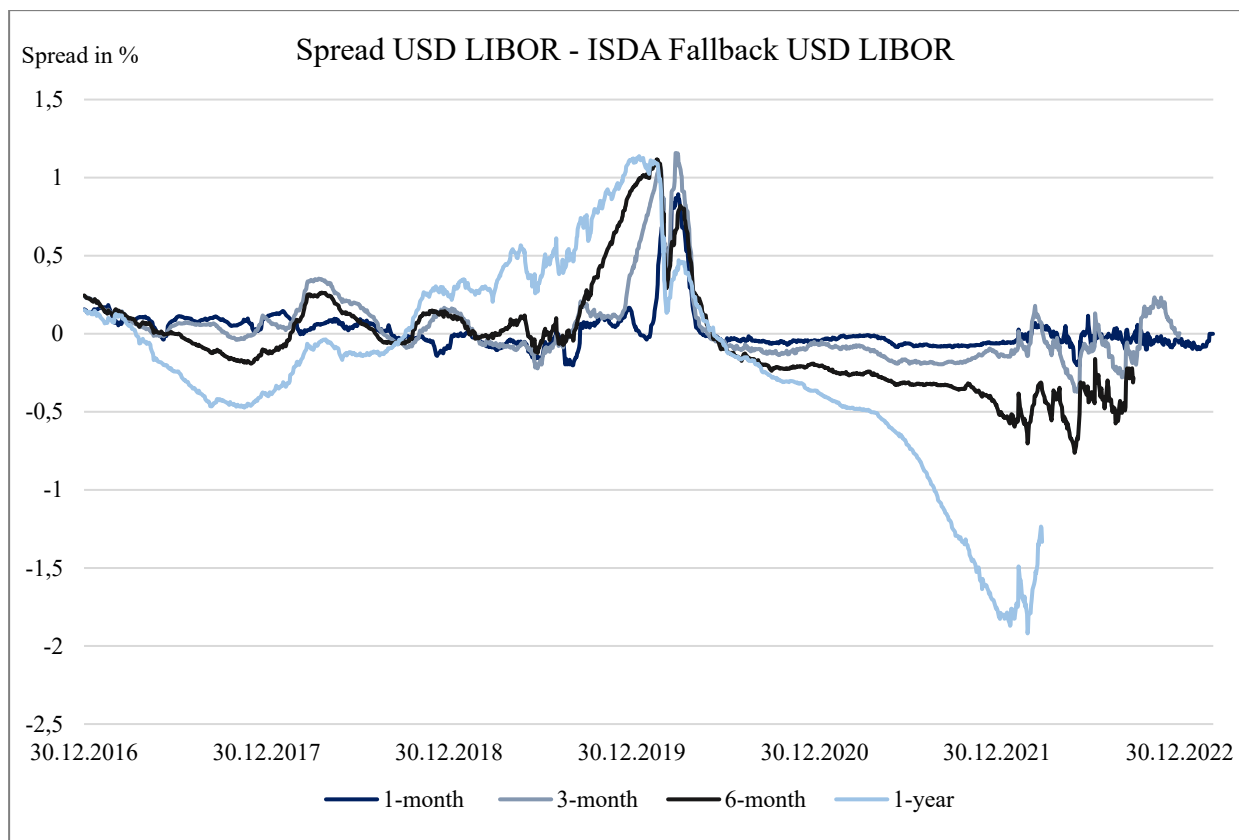


Figure 1 Spread USD LIBOR – ISDA Fallback USD LIBOR

Comparing cash flows that would have resulted from an indexation with either LIBOR or fallback rate yields insights on what can be expected in different market environments. Foremost the smoother development of total nominal cash flows for the fallback rate stands out and can be traced back to the applied methodology. Precisely, the compound calculation of the fallback rate lags the rate of the previous day by one compounded rate and is thus prone to rapid changes in the underlying SOFR rate. Payments resulting from LIBOR indexation on the other hand are exposed to wave-like behavior when spikes in the underlying rate are part of the payment schedule, as can be seen in Figure 13 and Figure 14. For the period of a constantly flat SOFR rate, also including the index cessation trigger event, the ISDA Fallback USD LIBOR payments exceed the LIBOR payments for 1- and 3-month quotation. Again, this spread in cash flows seems to stem from the Spread Adjustment evident in the fallback rate.

#### 4.1.2. LIBOR vs. Term SOFR

If LIBOR is replaced proactively and borrowers seek to have a term component present in their financial contracts, Term SOFR offers said opportunity. Figure 2 underlines the spread between LIBOR and Term SOFR for the period ranging from 2018 to 2023. The spread between the two can be interpreted as risk premium paid for unsecured funding, as both rates incorporate a term

component and are thus forward-looking quotes indicating the respective rate for the following period ex-ante. Such risk premium of LIBOR peaked during the early days of the COVID-19 pandemic in March 2022 but reverted to zero shortly after. At its peak, the spreads between LIBOR and Term SOFR amounted to roughly 90 bps (1-month spread), 110 bps (3-months) and 130 bps (6-months). This reversion to zero appears logical since the realization that COVID-19 was rather a supply chain and health crisis than a banking crisis did not take long to reflect in market reality (Ikeda, Kerry, Lewrick, & Schmieder, 2021). The spread for all tenors remained below 20 bps for the following two years until volatility of spreads started to increase again in early 2022, simultaneously to the invasion of Ukraine and a step-like increase of interest rates following a global recession (Guénette, Kose, & Sugawara, 2022).

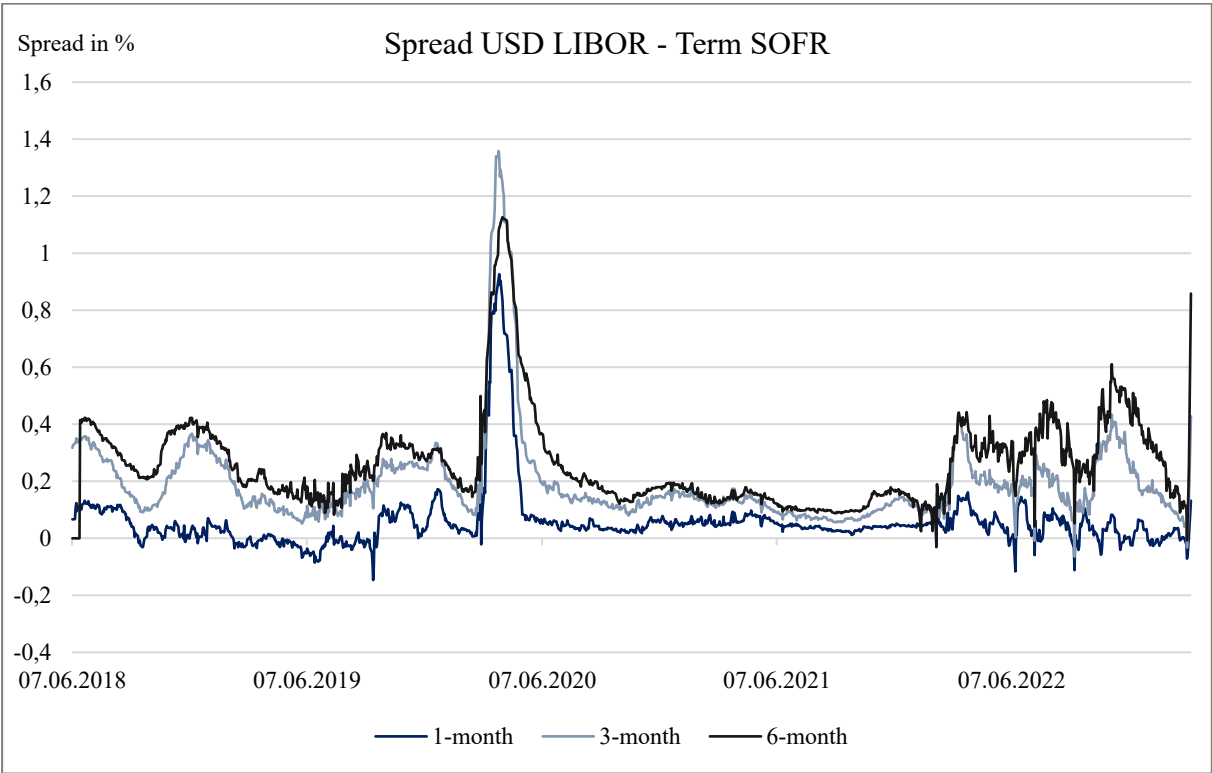


Figure 2 Spread USD LIBOR – Term SOFR

The risk premium analogously shows in the cash flow comparison resulting from indexation with the two interest rates. A constant spread of LIBOR over Term SOFR remains, and the total nominal cash flows develop, different from most other comparisons following in this analysis, in parallel.

**4.1.3. LIBOR vs. BSBY**

BSBY is the rate that by characteristics comes closest to LIBOR, because it not only possesses a term component but also adjusts for a credit spread evident in actual financial contracts.

Spreads and cash flows confirm the proximity of the two rates with the sole exception of the early COVID-19 pandemic days. Still marginally small, the spread of BSBY over LIBOR reaches up to 40 bps for 1- and 3-month tenor during March 2020, followed by a reverse movement shortly after. By early 2022, spreads started to rise again but remained below 50 bps for 1-month, 3-month and 6-month tenor.

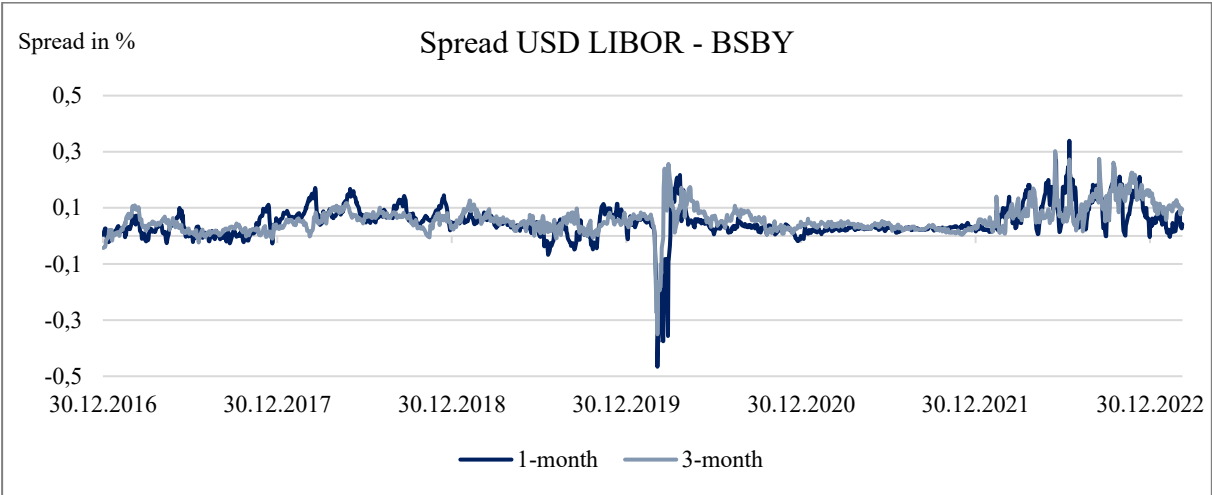


Figure 3 Spread USD LIBOR – BSBY (1)

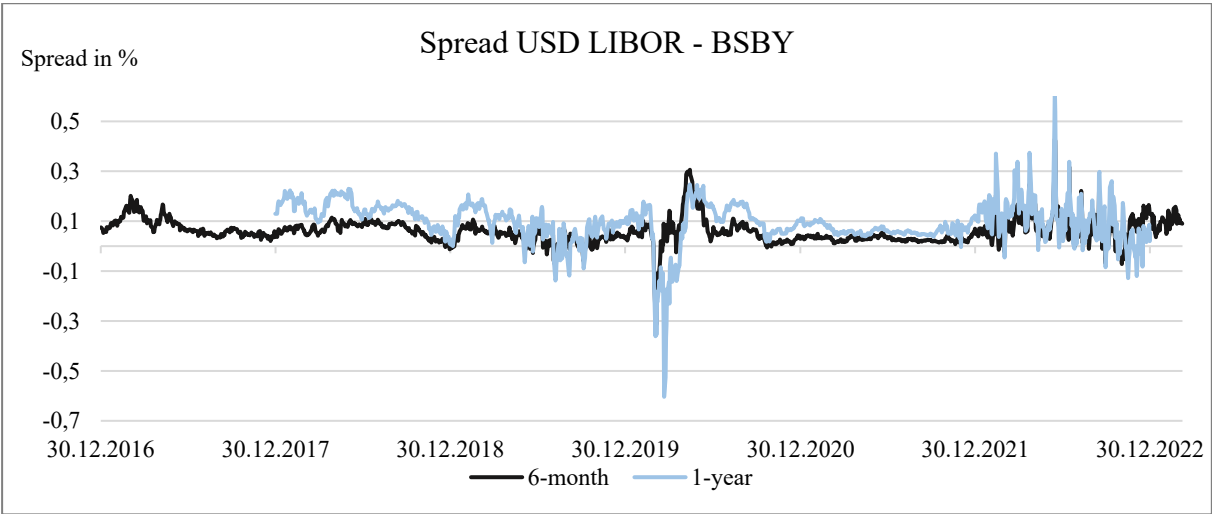


Figure 4 Spread USD LIBOR – BSBY (2)

**4.2. ISDA Fallback USD LIBOR vs. Alternative Reference Rates**

**4.2.1. Term SOFR vs. ISDA Fallback USD LIBOR**

Following the comparison of how the traditional rate had performed against its different replacement options, the following section compares said replacement options against the fallback rate that will automatically be quoted if no proactive handling of the situation is performed.

If borrowers or lenders seek to incorporate a term component into its USD loan or derivative contract while still having SOFR quoted as underlying reference rate, applying Term SOFR is a reasonable step. Derived from market quotes for SOFR futures or forwards, Term SOFR represents the market's expectation for future rate movements, thereby including all publicly available information and speculation as of today. Unlike LIBOR or BSBY, Term SOFR does by nature not include any credit spread. When comparing Term SOFR and the published ISDA Fallback USD LIBOR rate, one must keep in mind the lag between publication dates, as the fallback rate becomes available only ex-post the relevant interest period while Term SOFR is derived from OIS quotes on the respective day for the different tenors.

Analyzing the spread between Term SOFR and the ISDA Fallback USD LIBOR yields insights on how the two react differently to market disturbances, e.g., the outbreak of the COVID-19 pandemic in early 2020. Until the FED's rate cut in mid-March 2020, Term SOFR exceeded the fallback rate by up to 100 basis points. Even though the COVID-19 pandemic, unlike the financial crisis in 2007-2009, cannot be considered a banking crisis first and foremost (Ikeda, Kerry, Lewrick, & Schmieder, 2021), Term SOFR seemed to incorporate the expectation of increased yields for OIS trades for 1-, 3- and 6-month tenors. The ISDA Fallback USD LIBOR, by being published as compound rate with a delay corresponding to the respective tenor, can by nature not incorporate any market expectations about the future. Term SOFR thus logically will exceed the fallback rate for a period in which a policy rate cut occurs, as such one-time effects will be smoothed in a compound rate.

Following the rate cut in March 2020, the spread between Term SOFR and fallback rate remains considerably low but negative between 10 and almost 50 basis points during the period until early 2022. This appears reasonable at first sight due to the constantly low SOFR rate during that period but yields the question of why the ISDA Fallback rates constantly exceeds the Term rate that should incorporate all available information. Looking at the spreads (approximately 5-10 basis points for 1-month, 20-30 bp for 3-month and 40-50 bps for 6-month tenor) during the period, the answer most likely can be found in the Spread Adjustment present in the fallback rate. Such Spread Adjustment shall amount to the average median spread between IBOR and Adjusted RFR over a preceding five-year period and is fixed on an index cessation trigger event. For USD LIBOR, the applicable index cessation trigger event occurred on 5<sup>th</sup> of March 2021, when the FCA announced its intention to discontinue USD LIBOR past June 2023. Looking at the low-interest period between March 2020 and March 2022, the inclusion of a Spread Adjustment seems to result in an evident disadvantage of the fallback rate for borrowers.

Analogously to the SOFR increase following a step function from early 2022 onwards, the spread between Term SOFR and ISDA Fallback Rate shows greater volatility and e.g., indicates a peak negative spread of 50 bps (3-month spread) or 100 bps (6-month spread) for 6<sup>th</sup> of June 2022.

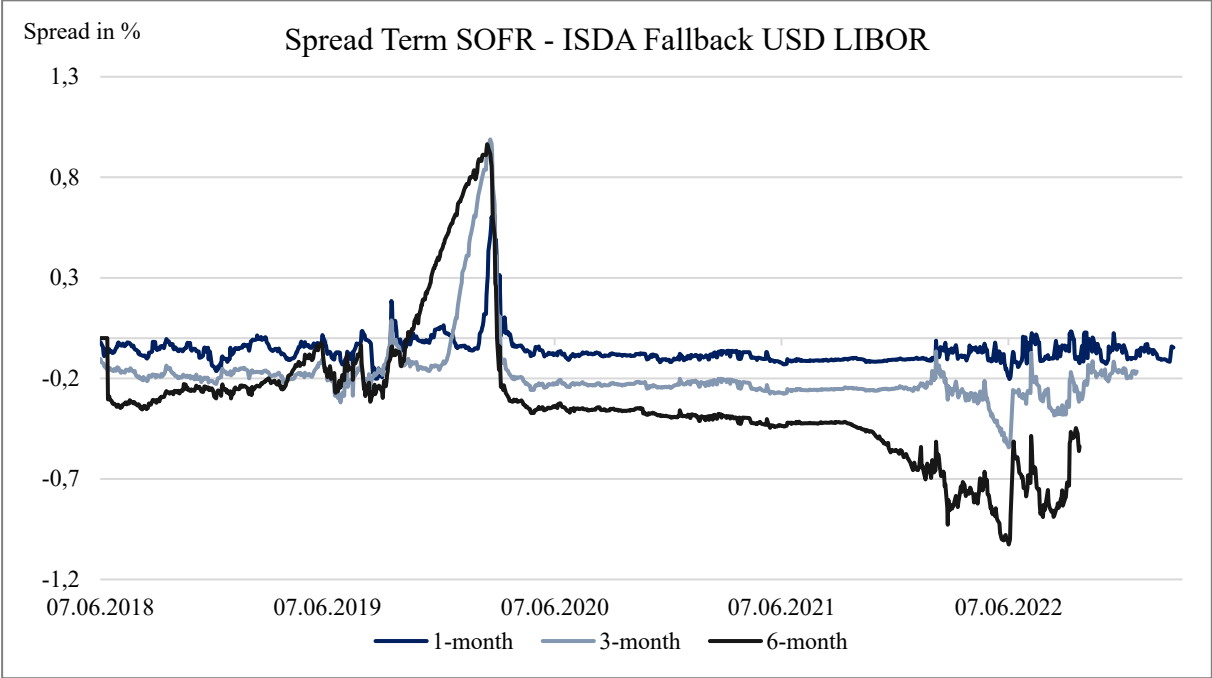


Figure 5 Spread Term SOFR – ISDA Fallback USD LIBOR

Comparing cash flows for floating rate notes indexed to either Term SOFR or the ISDA Fallback rate indicates a similar development throughout the entire 2018-2021 period as depicted in Figure 13 and Figure 14. During the entire period of observation, fallback rate indexed loans or derivatives would have paid more interest than an otherwise Term SOFR indexed contract. On average, cash flows tied to the ISDA Fallback Rate had exceeded 1-month Term SOFR payments by 14.68% and 3-month Term SOFR payments by 25.61%.

The total nominal cash flows resulting from mere Term SOFR indexation show wavelike behavior for contract start dates smaller than March 2020 if an interest payment is due on 2<sup>nd</sup> of March 2020. The rationale here seems to be increased uncertainty in the OIS market in the light of the impending COVID-19 pandemic. Such market-implied uncertainty cannot hold up in the calculation of the fallback rate as contemporary spikes or dips ease out in a compound calculation and are even less significant for longer tenors.

Note that tying a loan contract to Term SOFR would likely include any kind of credit spread and thus cannot represent a thorough rate quoted in a financial contract.

#### 4.2.2. BSBY vs. ISDA Fallback USD LIBOR

Comparing BSBY and the ISDA Fallback USD LIBOR seems reasonable as BSBY's methodology is somewhat similar to LIBOR and is designed to track LIBOR movements closely. Figure 3 and Figure 4 underline that between 2016 and 2022, BSBY's spread over LIBOR never exceeded 50 basis points and that volatility solely increases in times of impending crisis, e.g., during March 2020 (COVID pandemic) and the months following the onset of the Ukraine war in early 2022. In a situation where contract partners do not seek to shift away from an *in advance* determination of the applicable interest rate (LIBOR), it seems straightforward that BSBY is a rate of choice for future indexing of financial contracts as it also incorporates a credit spread, which for example is not accounted for by using Term SOFR. As the ISDA Fallback USD LIBOR is the rate that will become effective after the cessation of USD LIBOR per default, it is insightful to study the development of spreads between the two. Figure 6 outlines the development of spreads between BSBY and ISDA Fallback USD LIBOR for the period ranging from 2016 to 2022. Although the spread between BSBY and ISDA Fallback USD LIBOR generally remains below 100 basis points and is statistically not different from zero, it becomes obvious that deviations closely follow the development of the mere SOFR rate. During periods of stable RFR quotes, as in between March 2020 and March 2022, the overnight, 1-month and 3-month spread remained close to zero, while periods of crisis seem to increase volatility. Similar to the findings of Jermann (2020) for the financial crisis, uncertainty amongst lenders seems to increase the spread between a virtually RFR and one that is determined by incorporating rates quoted in debt securities. Following his rationale for such spread enhancement between LIBOR and a RFR, BSBY is equally driven up in times of uncertainty by featuring credit-sensitivity in its constituents, while the fallback rate's underlying repo transactions experience high liquidity and result in a diminished borrowing rate.

Again, another noteworthy observation is a continuous negative spread from BSBY over the fallback rate in the otherwise rather stable market environment between March 2020 and 2022. A closer look on the methodology for the ISDA Fallback USD LIBOR rate once more begs the question if the inclusion of a Spread Adjustment, still represents market reality. Especially the fixing of such Spread Adjustment following an index cessation trigger event should be questioned as it per default exposes a potential borrower to an additional 0.11% (1-month), 0.26% (3-month), 0.43% (6-month) 0.72% (12-month) of interest during times of stable RFRs.

Taking both into consideration, borrowers need to weigh the exposure towards increased credit spreads during times of market uncertainty against a systematic disadvantage that stems from a fixed Spread Adjustment during times of stable RFRs when quoting the ISDA Fallback USD LIBOR as underlying reference rate. The opposite holds for lenders, who had benefitted from quoting BSBY during times in which funding costs elevated but had suffered a systematic disadvantage during stable periods when shifting towards BSBY.

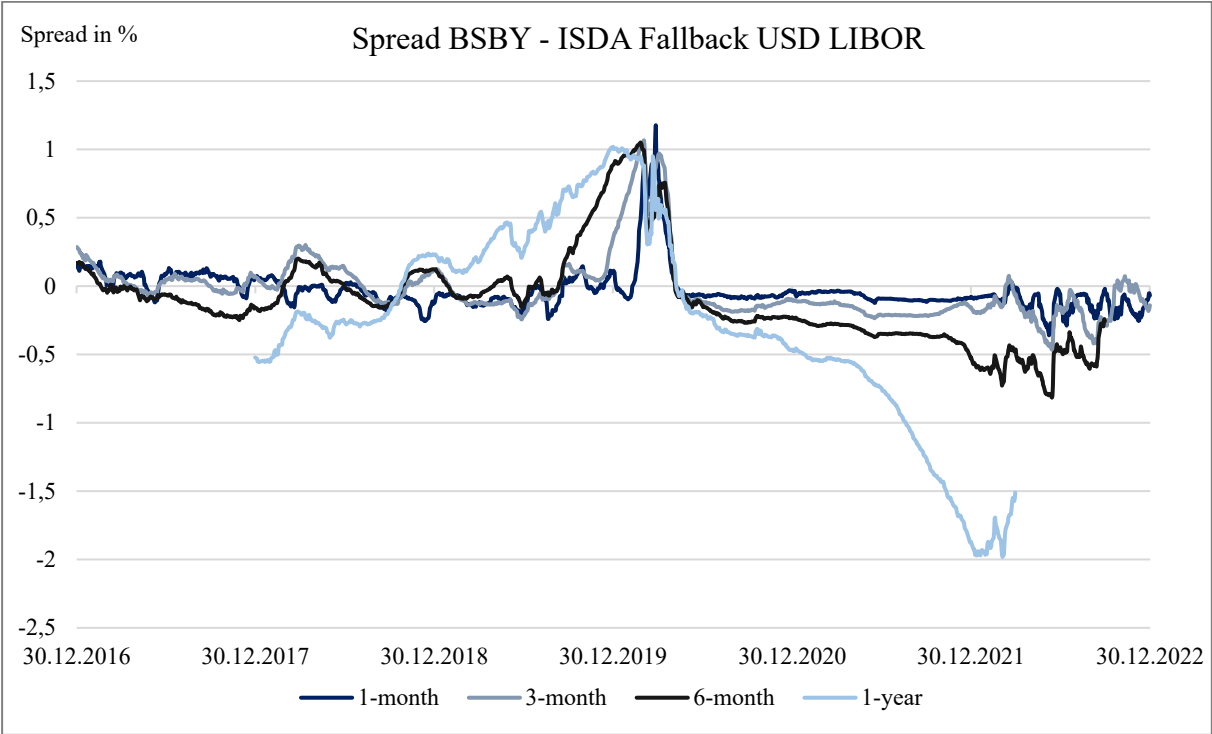


Figure 6 Spread BSBY – ISDA Fallback USD LIBOR

When comparing cash flows resulting from BSBY vs. fallback rate indexed floating rates for 1- and 3-month tenors, the observations made for spreads hold up for the different market environments. One can easily observe that the total interest amount payable, depending on the contract start date, fluctuates stronger for floating rate products that reference BSBY in the time preceding the COVID-19 pandemic’s outbreak. One can trace back dips in the total BSBY interest payable to all contract start dates that imply a floating interest rate fixing in the second week of March 2020, when LIBOR temporarily dropped by roughly 90 basis points and increased by 70 basis points in a week-on-week comparison. After such one-time effects fade out, volatility in interest amounts payable diminishes for BSBY and constantly remains below fallback rate interest payables. Precisely, payments tied to the 3-month BSBY rate had undercut those resulting from the allback rate on average by 9.05%. Remarkable is the difference between the time preceding the COVID-19 pandemic (+1.87% BSBY interest payments due)

and afterwards (-36.87% BSBY interest payments due). That observation holds for 1-month indexation as well: while BSBY interest payments had in fact exceeded those of fallback rate products (+6.15% interest due), the period past COVID had indicated the very opposite (-56.77% interest due).

The methodology of the ISDA Fallback USD LIBOR rate converts to a more smoothed curve path, as the effect of spikes or dips are less severe than in daily quotations of BSBY or LIBOR. Especially the stable low-interest period between March 2020 and March 2021 stands out with a constant spread of the fallback rate over BSBY as an alternative product. Following the findings of the spread analysis, the Spread Adjustment employable in the ISDA Fallback USD LIBOR again appears to be the driving factor, especially when RFRs are low or steadily increase over time of a loan contract.

In summary, one can conclude for this hypothetical back test of a default rate versus a product that is intended to embody LIBOR's credit sensitivity and term structure that the market environment is of crucial importance to evaluate if such replacement is favorable for lenders and borrowers. From a borrower's perspective, the fixed Spread Adjustment that for USD occurred with the LIBOR discontinuation announcement in March 2021, must be classified as major disadvantage because it no longer represents market reality and exposes borrowers to additional interest charges. Prior to the index cessation trigger event in March 2021, the compounded RFR, plus the then contemporary Spread Adjustment, offered a rather stable interest schedule and a smoother curve compared to rates that rely on shorter trading averages.

From a lender's perspective, the credit sensitivity embodied in BSBY offered a hedge towards increased interbank charges, comparable to LIBOR during the financial crisis. When it comes to the ISDA Fallback USD LIBOR connoted Spread Adjustment, lenders had benefitted from borrowers' lethargy in adapting towards alternative products for the time past the Spread Adjustment.

#### **4.3. Interest Rate Swap Valuation LIBOR vs. SOFR + Spread Adjustment**

As pointed out earlier, the following section will compare an IRS that pays interest as if it were tied to LIBOR and whose cash flows are consequently discounted with the same versus one tied to SOFR. So far, the Spread Adjustment included in the ISDA Fallback Rate was the main driver of discrepancies between the usage of the traditional IBOR rate and the various replacement options. To exploit said findings further, the SOFR derivative's valuation is performed by adding the fixed ISDA Spread Adjustment of March 2021 as a quoted margin to

the mere SOFR rate, respectively the SOFR swap rates for the other tenors. The swap rate for the LIBOR derivative was calibrated to be 1.723%, while the SOFR derivative paid fixed interest of 2.12% with 0.43% included as a quoted margin.

Figure 15 displays the value developments of IRSs indexed to LIBOR and SOFR with the letter being supplemented by the applicable Spread Adjustment for semi-annual interest payments. Overall, both swaps show a common value development for IRS: initially starting at zero, which is essentially due to the calibration for a fair fixed rate before agreeing on any IRS, the values of the two drop negatively to a value of approximately -3.5% of the notional. While steadily increasing in value as the swaps approach maturity, the value of the SOFR-indexed IRS closely follows the development of the LIBOR swap. After climaxing approximately at the point of the second to last interest payment, both swaps revert to zero at maturity. Looking at the development of the two graphs, two periods seem to stand out: the early months of the COVID-19 pandemic and the final seven to eight months of the swaps before maturity. Figure 16 depicts the development of the spread in value of the two IRS and emphasizes that impression: at the very beginning of the swaps' lifecycles, the LIBOR over SOFR valuation climaxes with the LIBOR derivative exceeding the SOFR derivative's value by approx. 5.2 million USD on 2<sup>nd</sup> of March 2020. Two weeks later, on 16<sup>th</sup> of March 2020, the LIBOR derivative's value had shrunk to -5.93 million USD less than the SOFR product. In the following period of low interest rates, the SOFR derivative constantly quoted above the LIBOR derivative. It is not until early 2022 that one can observe any major value fluctuation between the two derivatives. Again, the growing spread between the two seems to parallel the inception of the continuing increase of interest rates since early 2022 and the impending Ukraine war. When the entire lifecycle of the derivatives is being looked upon, the fixed Spread Adjustment for the SOFR Swap had resulted in a rather close mirroring of the LIBOR swap, with significant differences in valuation only arising during times of market turmoil, i.e. during the early pandemic days and the outbreak of the Ukraine conflict.

## 5. Discussion of results

Taking all the aforementioned into consideration, corporate borrowers and lenders can draw several conclusions for their own funding and lending behavior. The analysis shows that the answer to the question if companies should replace rates whose discontinuation can be anticipated proactively, is manifold and for the most part relies on the underlying interest rate markets.

For spreads between the soon to be discontinued LIBOR rate and its possible successors, in the period 2018 – 2023, three episodes with distinct outcomes can be identified: firstly, an episode of moderate spread volatility until March 2020 when spreads between the relevant rates spiked following the outbreak of the COVID-19 crisis. In times of crisis or uncertainty, this drift appears reasonable as LIBOR accounts for credit-sensitivity in interbank lending and proved in the past that it is not as prone to uncertainty within the market as treasury rates based on the repo market are designed to be. The spread between LIBOR and BSBY however, which still is not detrimental ( $< |50 \text{ bps}|$  for 1- and 3-month tenors), can barely be traced back to credit sensitivity as both share that characteristic and BSBY is designed to track LIBOR as close as possible. Given the intention of having a more robust methodology for estimation of credit-sensitive and term depicting interest, one could argue that BSBY indicated lending more appropriate than LIBOR during that short period of time. The second episode ranges from April 2020 until early 2022 or, put differently, covers the time of low interest rates on both underlyings. While spreads between LIBOR and Term SOFR or BSBY remained virtually at zero over the entire period, the spread  $s_{LIB-ISDA}$  remains somewhat constant between 0 and 50 bps with a tendency to the latter if longer tenors are taken into consideration. The reason, as it is for most spreads and cash flows that involve the ISDA Fallback Rate, seems to be the Spread Adjustment included in the fallback rate computation. Noteworthy is especially the index cessation trigger event that results in a, from then on, fixed Spread Adjustment for each tenor individually. The ISDA Spread Adjustment constitutes a conceptual disadvantage for borrowers if their financial contracts were formerly tied to LIBOR. The low-interest SOFR and LIBOR market environment during said second phase underlines this in particular, when the Spread Adjustment for the different tenors alone surpasses the actual rate by a multiple of 1 to 3 depending on the tenor. The final period was kicked off with the FED starting to raise SOFR stepwise in March 2022. Again, spreads began to show higher fluctuations. Possibly caused by yet again elevated levels of market and lending uncertainty because of a global recession

following the Ukraine war, but also anticipation about future SOFR rate movements might have driven the spread development in aforementioned period.

The three phases and incisive events are essentially the same for the comparison of the fallback rate against the possible replacement options. An isolated look at the spread  $S_{TSOFR-ISDA}$  yields insights on how tying financial contracts to a term rate derived through market-quoted swap rates affects a company's exposure to the market. Again, the ISDA Spread Adjustment drove the development of the spread during times of low interest rates. The comparison here is not entirely accurate as a financial contract quoting Term SOFR would very likely incorporate a credit component. BSBY overcomes the lack of such credit spread and thus gives the most appropriate comparison of two competing successor rates, where one is applied by default and the other one might be put in place proactively as replacement of the obsolete IBOR rate. That being said,  $S_{BSBY-ISDA}$  shows a parallel curve path to  $S_{TSOFR-ISDA}$  as expected and only adjusts for the not included credit sensitivity in the latter. The second episode, characterized by low interest rates, comprises the index cessation trigger event and drives both ISDA spreads negative for the period of time starting in March 2020. Comparing the different episodes and the underlying market environment, one could conclude that the ISDA Spread Adjustment is especially harmful to borrowers in times of low interest rates, while it generally does not overcompensate credit spreads in times of rising or volatile interest rates.

The analysis of cash flows resulting from different indexation of financial products added an operational perspective to the topic and yielded insights on how the floating rates' development had impacted an organization's cash flows. While the development of total nominal cash flows is a lot smoother and steadier than the development of spreads, the drivers essentially seem to be same. Different from the analysis of spreads, the cash flow comparison for 1- and 3-month term rates can be subdivided in two episodes: total nominal cash flows fell for all observed interest rates until contract start dates in April or May 2020. Such diminishing development for all interest rates can most likely be traced back to the continuously growing share of payments during low interest rate periods. The same holds for the second period, starting with contract start dates post April or May 2020. Total interest payments grew with the ongoing inclusion of rising interest rates as of early 2022. The second period is further characterized by the ISDA Fallback USD LIBOR indexed products systematically superseding the other available rates. This is somewhat justified given the fact that Term SOFR cannot be compared against the fallback Rate per se but demands some credit-sensitivity adjustment. For other rates, like BSBY or even LIBOR, one would expect the difference between total nominal cash flows to be close

to zero, which evidently is not the case. Following the results of the analysis of spreads performed earlier, the Spread Adjustment again appears to be the element that manifests the disadvantageousness from a borrower's perspective in times of low interest rates. Conversely, if the ISDA Fallback Rate became effective in times of high market uncertainty, when credit-sensitive indexes are characterized by an obvious upward thrust, the ISDA Fallback Rate theoretically had offered sort of a credit hedge during such period. For the period past the index cessation trigger event, the ISDA Fallback rate had at any time superseded its alternatives, even for periods that included rising interest rates starting in early 2022.

A conceptual advantage for fallback rate indexation stems from the much smoother development of total nominal cash flows for such compound rate compared to a rate that accounts for current market expectations (Term SOFR, LIBOR) or takes average lending in a short past period (LIBOR, BSBY) into account. Hence, borrowers that hypothetically were forced to pay interest based on the ISDA Fallback Rate were rewarded certainty that exposure to short-term spikes in the underlying rate are virtually impossible due its compound calculation.

Conversely to the findings for spread and cash flow analysis, the Spread Adjustment had not been the source for major disturbances in the valuation of IRS that either quote a traditional reference rate versus an overnight rate. Only during times of market uncertainty that reflects in the spread between secured and unsecured lending a relevant deviation between LIBOR and SOFR indexation has been identified. The SOFR derivative had for simplicity incorporated the fixed Spread Adjustment as of March 2021 throughout the lifespan of the product. The reasonably small spread between the two products is thus not surprising for the time surrounding the index cessation event. The observed increased spread between the two during the early COVID-19 pandemic had most likely not been observed to this extent if a daily calibration of the spread had been performed or the actual ISDA Spread Adjustment for that period had been applied. Following the rationale of the earlier chapters, a fixed Spread Adjustment had again resulted in a less accurate depiction of market reality but in this hypothetical view for the better from the perspective of a payer-swap holder. It is yet to see how the spread between the two had fluctuated in a crisis scenario that occurs further in the future and that the fixed Spread Adjustment is less accurate for. Another possible perspective on the spread between LIBOR and SOFR derivative was presented in the review of Smith (2013). By comparing an IRS that references an uncollateralized rate (LIBOR) versus one tied to a collateralized rate (SOFR), it appears reasonable that the fixed rate of the earlier is greater

than the second. In line with his findings, the collateralized derivative had benefited during the early days of the COVID-19 pandemic that were characterized through an elevated level of interest rate volatility.

For potential future derivatives that quote BSBY one can follow a similar approach by constructing a yield curve that is orientated towards BSBY money and swap market rates. In fact, as of late 2022, Bloomberg began publishing rates for fixed versus BSBY over different tenors. The lack of historical quotes and missing liquidity in related swaps however undermines a possible valuation.

## **6. Conclusion and extensions**

Summarizing the findings of spread, cash flow and IRS valuation analysis, the question whether borrowers should proactively shift their financial contracts from an IBOR-indexation to an ARR cannot be answered unambiguously. Two factors were identified as the driving forces in answering said question. Firstly, the Spread Adjustment present in the ISDA Fallback Rate computation constitutes a rather unjustified measure of the spread between LIBOR and SOFR the greater the distance to the index cessation event. The accuracy of the Spread Adjustment for future rate record days will strongly depend on the development of the credit spread between secured and unsecured lending. Such spread admittedly cannot be deducted from the gap between LIBOR and SOFR in the future due to the LIBOR cessation in 2023. The second factor influencing the decision of a proactive shift is the overall level of interest received and is strongly tied to the first factor. That is, borrowers would have faced disadvantages in terms of spread exposure and cash flows, had the USD LIBOR ceased to exist at any point in time during the low interest period between April 2020 and early 2022. Conversely, lethargic behavior would have been rewarded prior to the latter period due to an elevated level of credit spreads in times of uncertainty. Since the index cessation event for the USD LIBOR took place during the period of low interest rates it is hard to transfer insights to different interest levels and market environments.

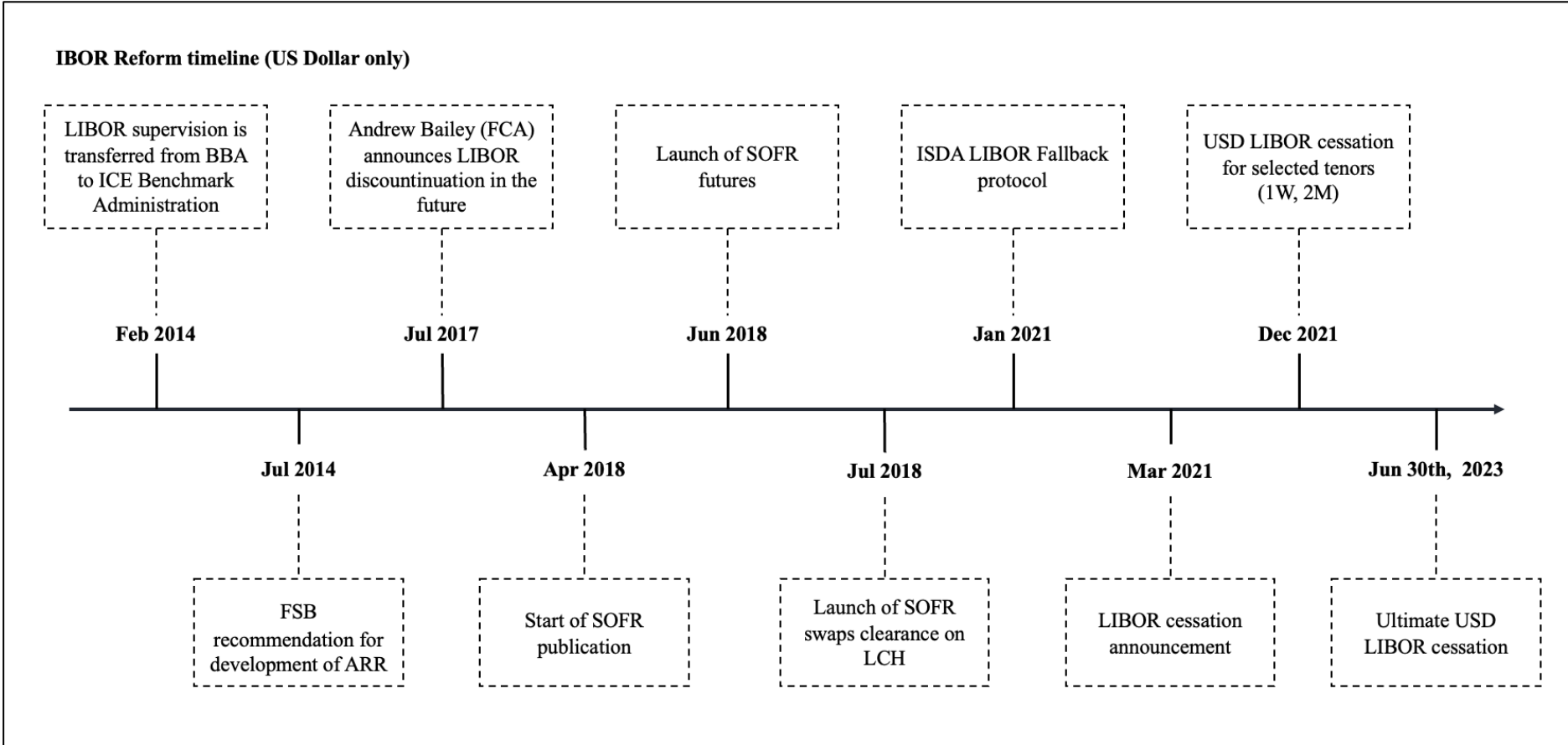
Looking into the future, when several other traditional IBOR or other reference rates will cease to exist, the foregoing analysis outlined that making a shift proactively had been favorable for the case of USD LIBOR. Such findings, however, only hold for low interest rate periods and similar fallback rate mechanisms and methodologies.

The IRS valuation performed essentially compared values for a derivative financial instrument, whose payments are tied to distinctly quoted interest rates and discounted by the respective interest rate yield curve. While the main difference between the two stems from the cash flows following such distinct rate quotation, the discount component were likely to be diminished following the recommendation of Smith (2013) to discount all such products by an OIS quoted yield curve. A valuation of a derivative quoting BSBY and being discounted by the OIS yield curve likewise would have been insightful.

Note that the foregoing analysis only assessed for purely financial matters and does not incorporate any obstacles or issues that may result from the transition aside of the financials. A possible extension of the topic might be the analysis of the impacts that a shift away from

formerly used rates has on ERP or Treasury Management Systems, especially in terms of the backward-looking nature of SOFR.

**Appendix**



*Figure 7 IBOR Reform timeline (US Dollar only)*  
*(Cf. Deutsche Bank, accessed May 25th, 2023; Illustration: author's own)*

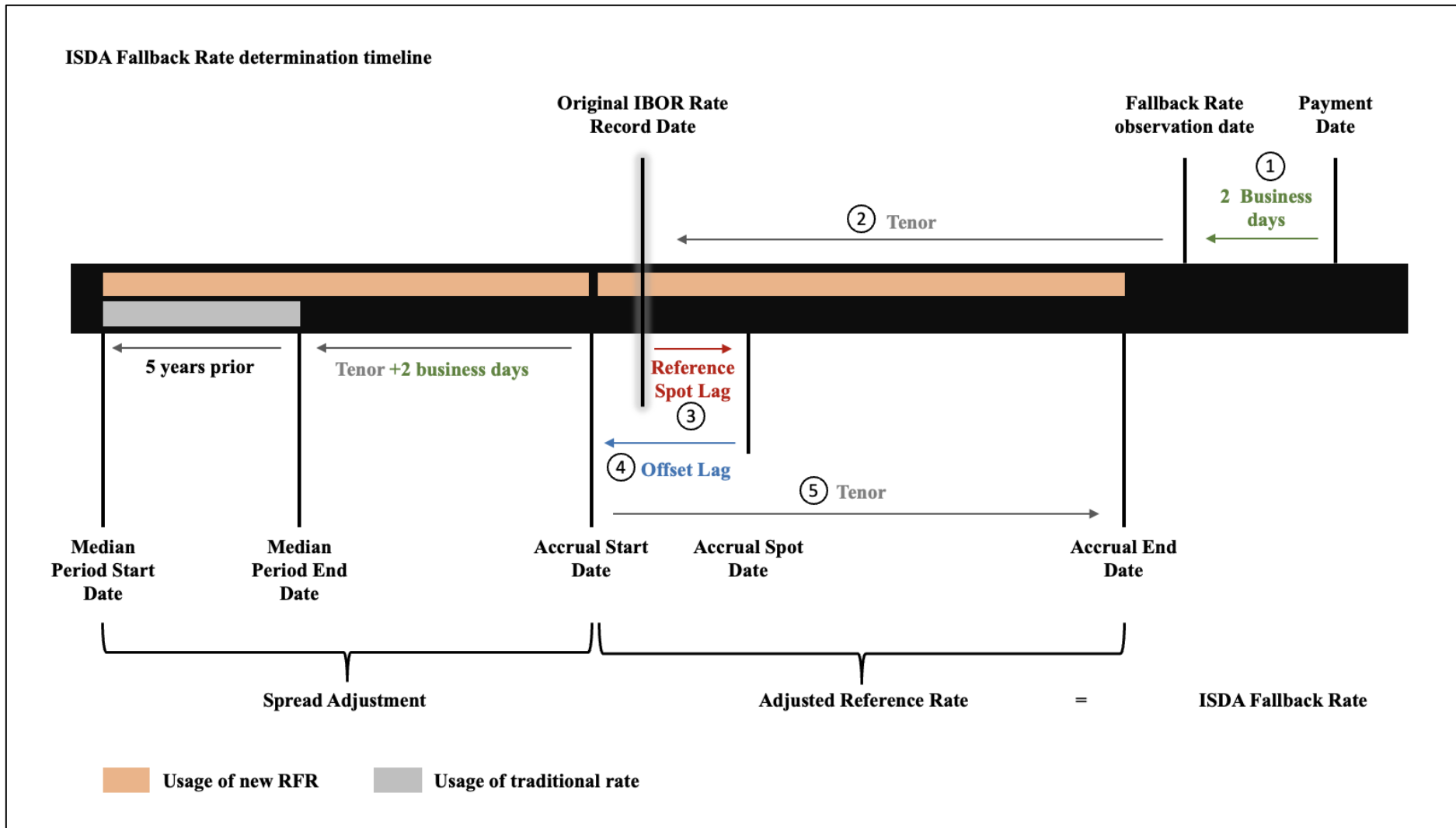


Figure 8 ISDA Fallback Rate determination timeline

(Cf. Bloomberg Professional Services, January 2023; Illustration: author's own)

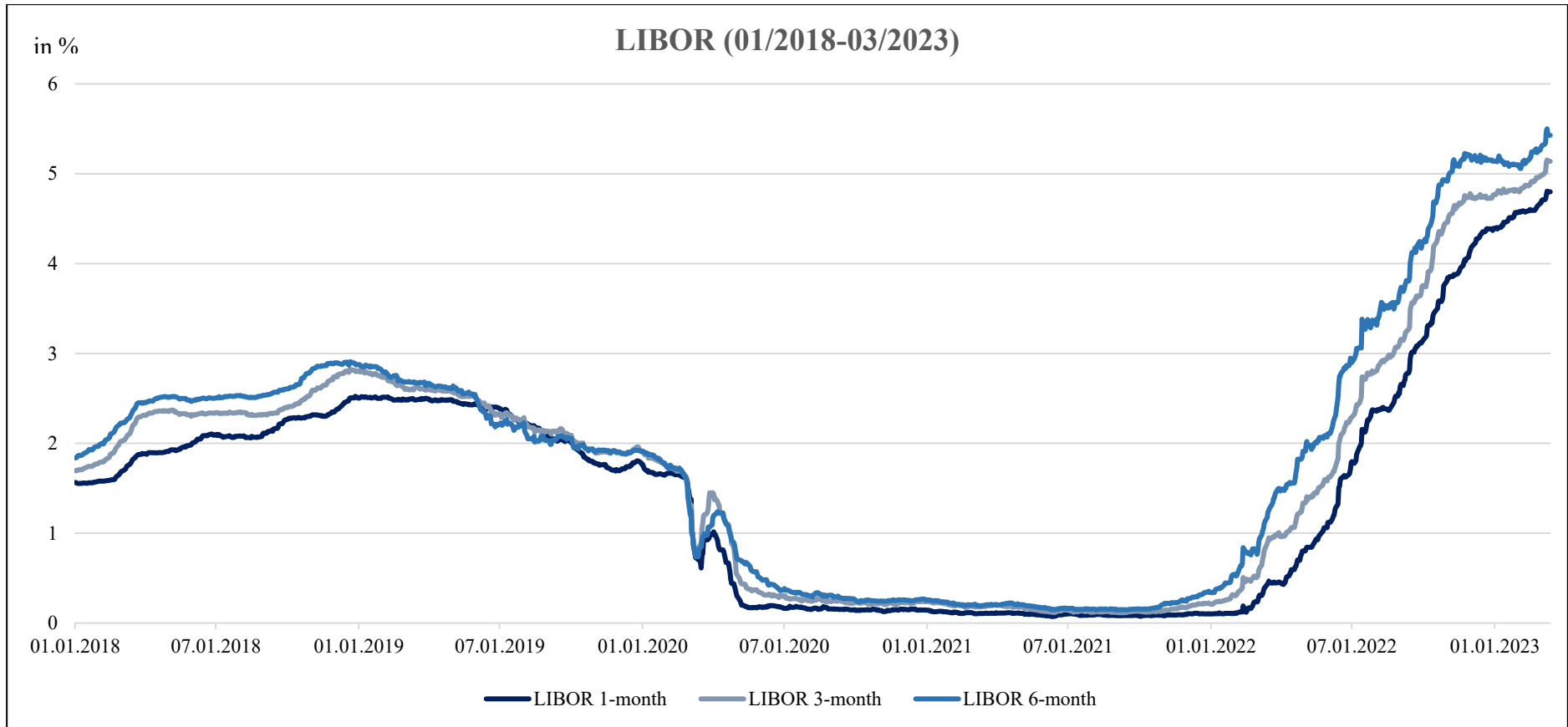


Figure 9 LIBOR (2018-2023)

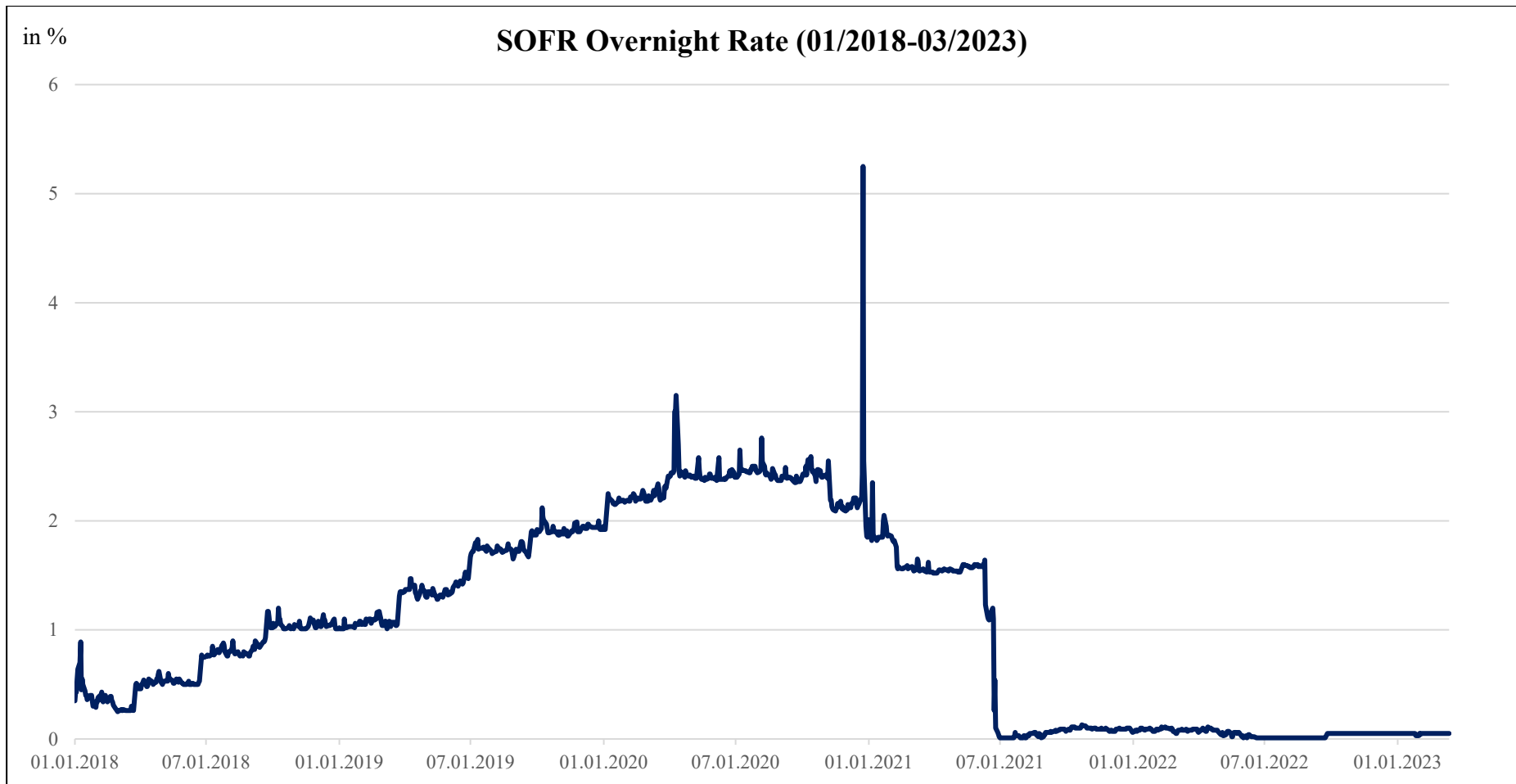


Figure 10 SOFR Overnight Rate (2018-2023)

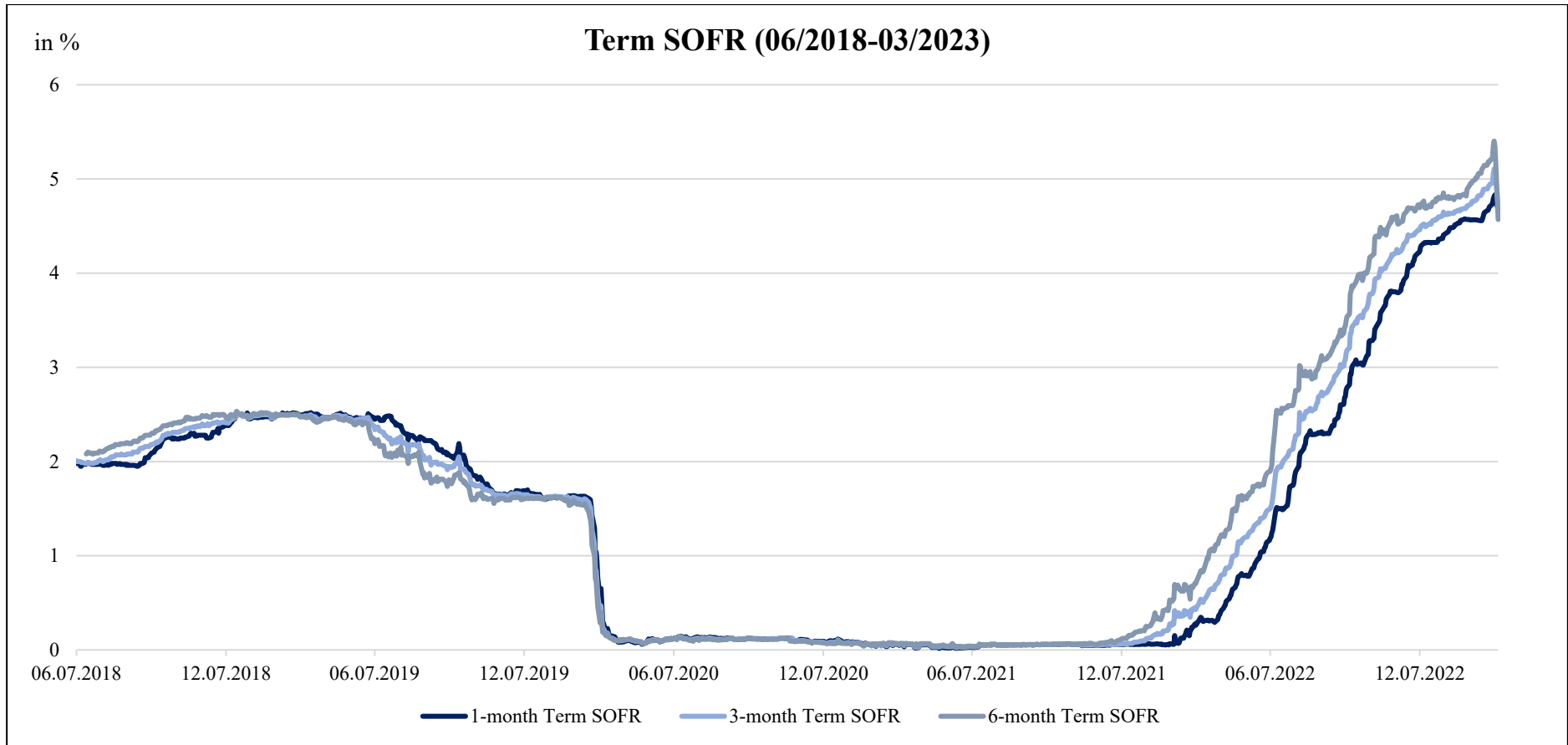


Figure 11 Term SOFR (2018-2023)

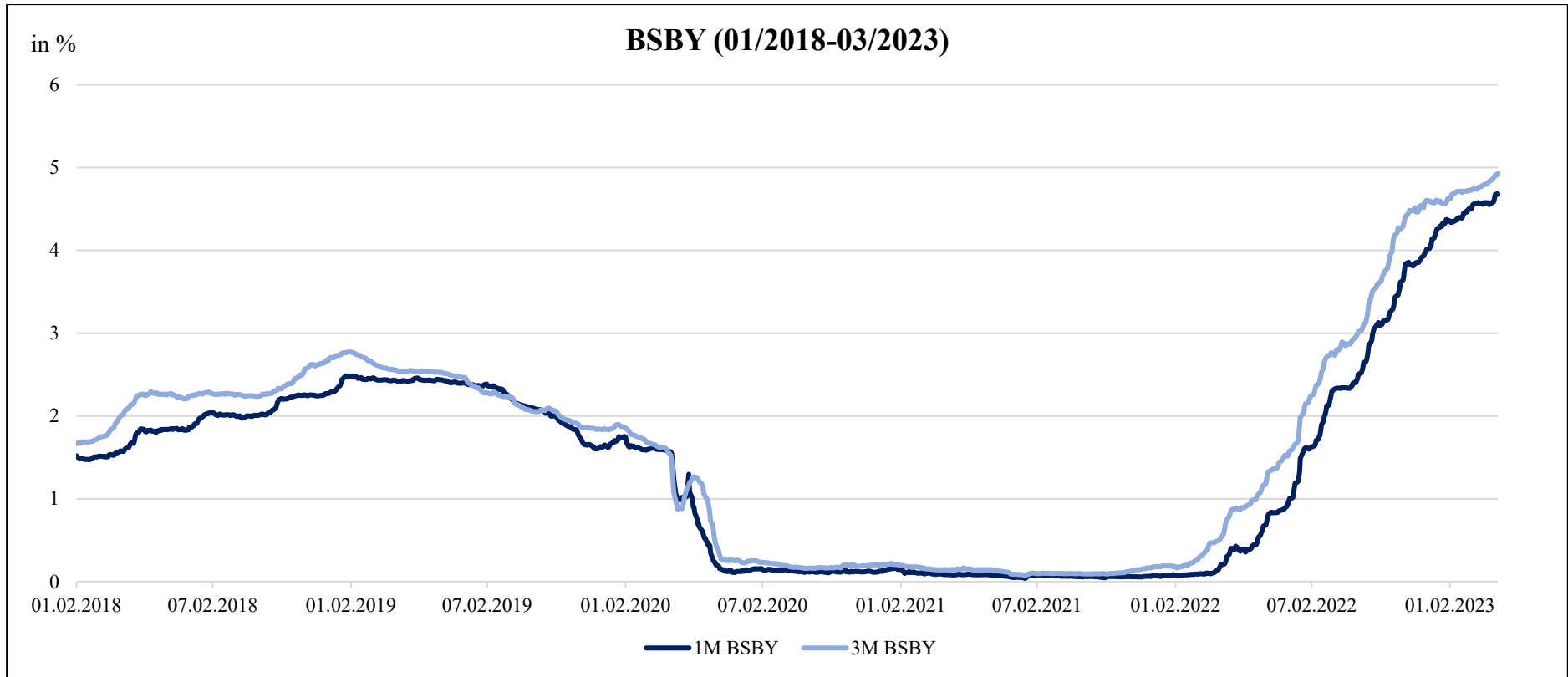


Figure 12 BSBY (2018-2023)

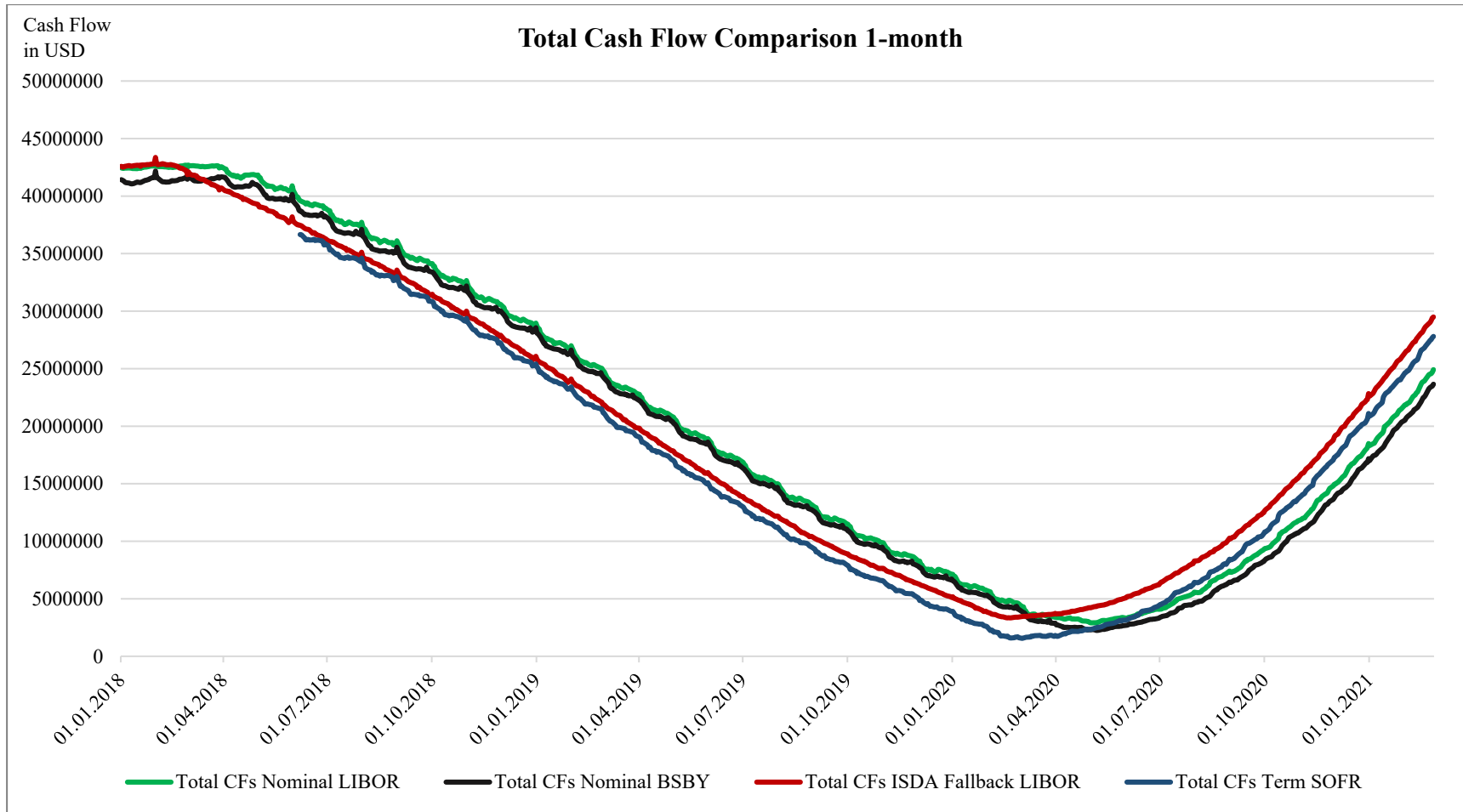


Figure 13 Total Cash Flow Comparison 1-month

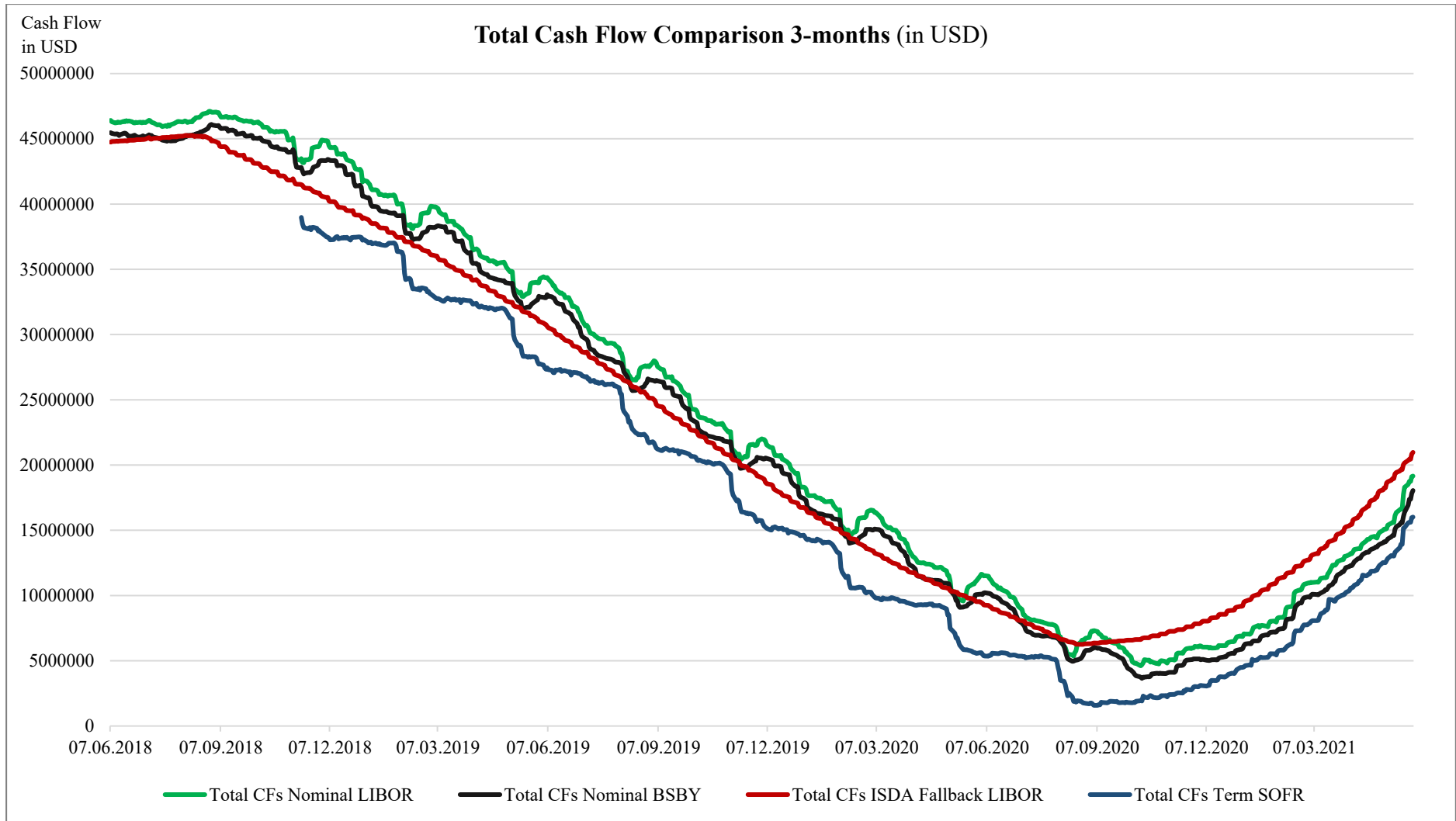


Figure 14 Total Cash Flow comparison 3-months

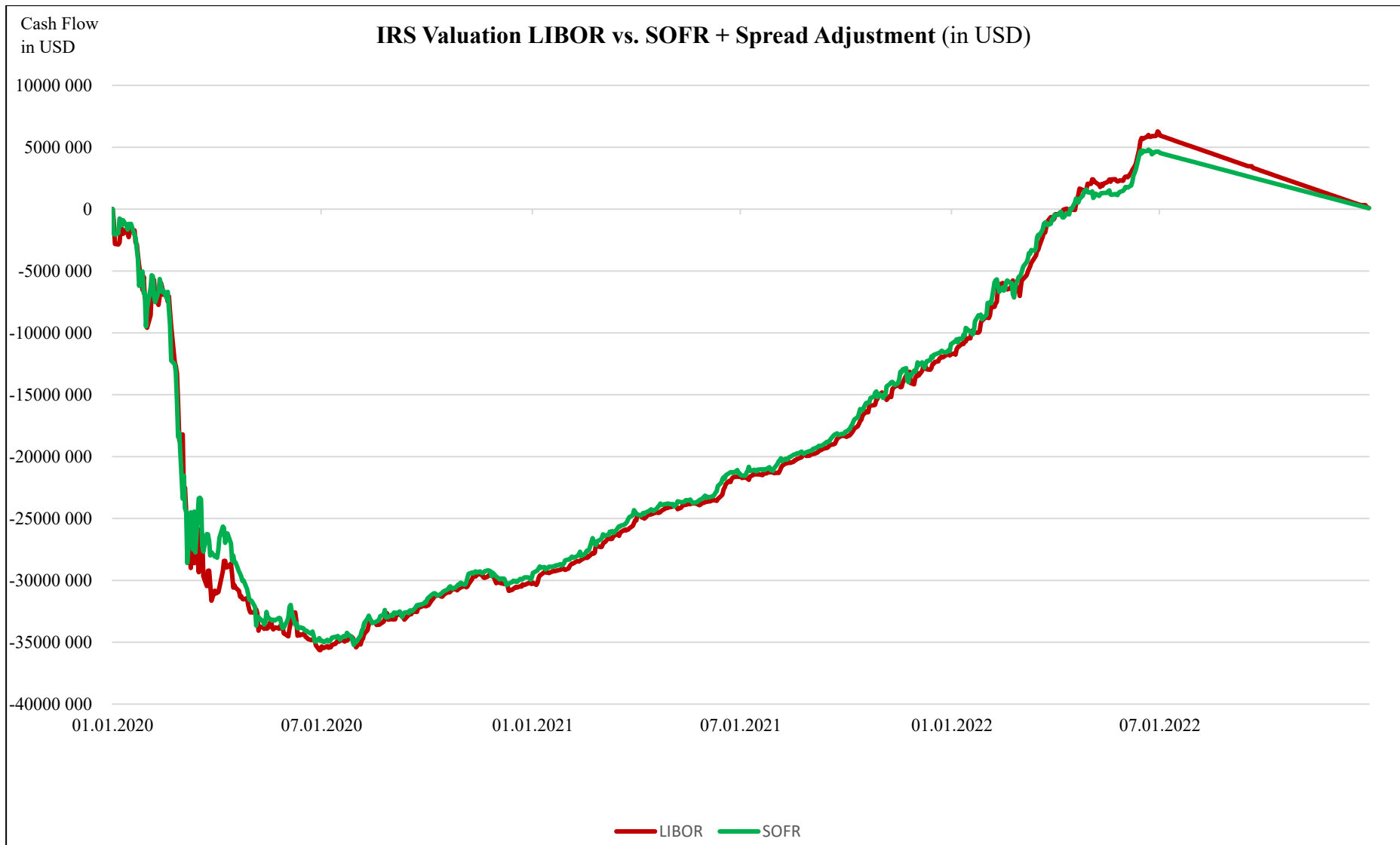


Figure 15 IRS valuation LIBOR vs. SOFR + Spread Adjustment

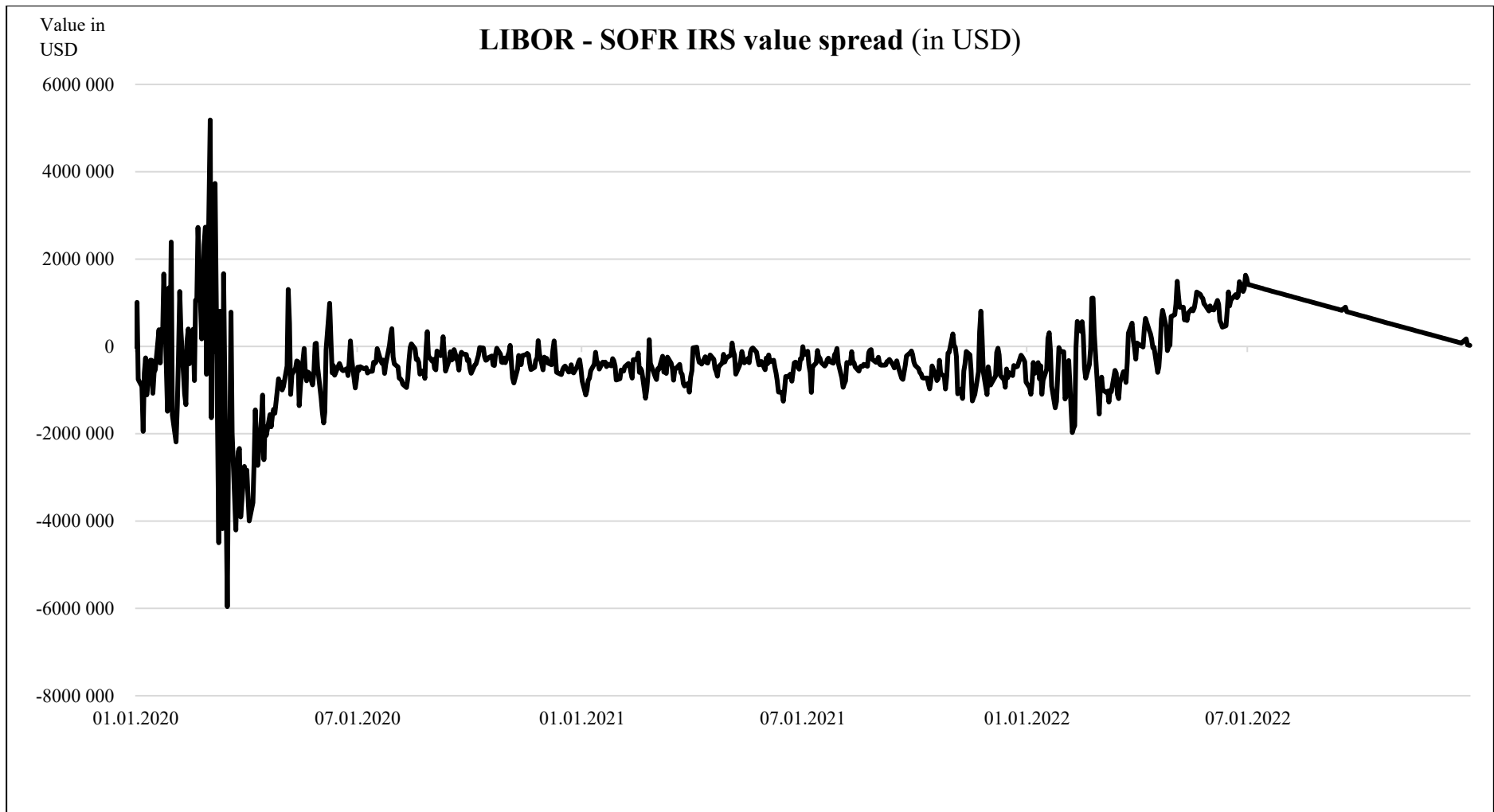


Figure 16 LIBOR – SOFR IRS value spread

## Bibliography

- Anbil, S., Anderson, A., & Senyuz, Z. (2020, February 27). *FEDS Notes*. Retrieved from Federal Reserve : <https://www.federalreserve.gov/econres/notes/feds-notes/what-happened-in-money-markets-in-september-2019-20200227.html>
- Andrew Bailey, C. E. (2017, July 27). *The future of LIBOR*. London, United Kingdom.
- ARRC. (2020). *ARRC Recommended Best Practices for Completing the Transition from LIBOR*. Alternative Reference Rate Committee.
- Bicksler, J., & Chen, A. H. (1986). An Economic Analysis of Interest Rate Swaps. *The Journal of Finance Vol XLI, No. 3*, 645-655.
- Bloomberg L.P. (2020). *Introducing the Bloomberg Short-Term Bank Yield Index (BSBY)*. Bloomberg L.P.
- Bloomberg L.P. (2023, January 31). *IBOR Fallback Fact Sheet*. Retrieved from Bloomberg Resources for LIBOR Transition: <https://www.bloomberg.com/professional/solution/libor-resource-center/>
- Bloomberg L.P. (2023, January 31). *IBOR Fallback Rate Adjustments Rule Book*. Retrieved from Bloomberg Resources for LIBOR Transition: <https://www.bloomberg.com/professional/solution/libor-resource-center/>
- Bloomberg Professional Services. (2023, May). *Bloomberg Short-Term Bank Yield Index*. Retrieved from Bloomberg Professional Services: <https://www.bloomberg.com/professional/product/indices/bsby/>
- Campbell, M. (2018, December). *LIBOR - A Brief History*. Retrieved from Clifford Chance: <https://www.cliffordchance.com/content/dam/cliffordchance/briefings/2018/10/libor-a-brief-history.pdf>
- Deutsche Bank. (n.d.). *Deutsche Bank IBOR transition: Resources*. Retrieved May 2023, from Deutsche Bank: <https://www.db.com/legal-resources/ibor-transition/ibor-transition-resources>
- FED. (2023, May 30). *SOFR Averages and Index Data*. Retrieved from Federal Reserve Bank of New York: <https://www.newyorkfed.org/markets/reference-rates/sofr-averages-and-index>
- Financial Conduct Authority. (2021, March 05). FCA announcement on future cessation and loss of representativeness of the LIBOR benchmarks .
- Guénette, J. D., Kose, M. A., & Sugawara, N. (2022). *Is a global Recession Imminent?* World Bank Group.
- Guggenheim, B., & Schrimpf, A. (2020). At the crossroads in the transition away from LIBOR: from overnight to term rates. *BIS Working Papers No. 891*, 1-23.
- Heitfeld, E., & Park, Y.-H. (2019). Inferring Term Rates from SOFR Futures Prices. *Finance and Economics Discussion Series 2019-014*, 1-24.

- ICE Benchmark Administration. (n.d.). *USD LIBOR Methodology*. Retrieved from ICE Benchmark Administration: <https://www.theice.com/iba/libor>
- IFRS Foundation. (2011, May). *IFRS 13 Fair Value Measurement*. Retrieved from IFRS: [https://www.ifrs.org/issued-standards/list-of-standards/ifrs-13-fair-value-measurement/#:~:text=IFRS%2013%20defines%20fair%20value%20as%20the%20price%20that%20would,date%20\(an%20exit%20price\)](https://www.ifrs.org/issued-standards/list-of-standards/ifrs-13-fair-value-measurement/#:~:text=IFRS%2013%20defines%20fair%20value%20as%20the%20price%20that%20would,date%20(an%20exit%20price)).
- IFRS Foundation. (2020, June). *IFRS 9 Financial Instruments*. Retrieved from IFRS: <https://www.ifrs.org/issued-standards/list-of-standards/ifrs-9-financial-instruments/#standard>
- Ikeda, Y., Kerry, W., Lewrick, U., & Schmieder, C. (2021). Covid-19 and bank resilience: where do we stand? *BIS Bulletin No. 44*, 1-5.
- ISDA. (2021). *Future Cessation and Non-Representativeness Guidance*. International Swap and Derivative Association.
- J.P. Morgan. (2022, March 30). *SOFR Takes Over*. Retrieved from J.P. Morgan: <https://www.jpmorgan.com/solutions/cib/markets/libor-sofr-transition>
- Jermann, U. (2021). INTEREST RECEIVED BY BANKS DURING THE FINANCIAL CRISIS: LIBOR VS HYPOTHETICAL SOFR LOANS. *NBER WORKING PAPER SERIES*, 1-17.
- Johannes, M., & Sundaresan, S. (2007). The Impact of Collateralization on Swap Rates. *The Journal of Finance*, 383-410.
- Marquit, M., & Curry, B. (2023, February 16). *What Is Libor And Why Is It Being Abandoned?* Retrieved from Forbes Advisor: <https://www.forbes.com/advisor/investing/what-is-libor/#:~:text=Libor%20transmitted%20the%20crisis%20far,rushed%20to%20slash%20interest%20rates>.
- Slaughter and May. (2020). *A PRACTICAL GUIDE TO LIBOR TRANSITION*. Slaughter and May.
- Smith, D. J. (2013). Valuing Interest Rate Swaps Using Overnight Indexed Swap (OIS) Discounting. *The Journal of Derivatives*, 49-59.
- Smith, D. J. (2017). *Interest Rate Swap Valuation Since the Financial Crisis: Theory and Practice*.
- The Alternative Reference Rates Committee. (2021, March 31). *Progress Report: The Transition from U.S. Dollar LIBOR*.
- The Alternative Reference Rates Committee. (2021, February). *An Updated User's Guide to SOFR*. Retrieved from New York Fed: <https://www.newyorkfed.org/medialibrary/Microsites/arrc/files/2021/users-guide-to-sofr2021-update.pdf>