



INTEREST RATES

# What is SOFR?

MARCH 2018

This note offers an introduction to the Secured Overnight Financing Rate (SOFR) and Chicago Mercantile Exchange (CME) One-Month and Three-Month SOFR futures. It compares the underlying interest rate exposures for SOFR futures versus those for other short-term interest rate futures, both to indicate normal spread relationships and to highlight characteristics that futures users should bear in mind when hedging or spreading.

## Enter SOFR

The Federal Reserve convened the Alternative Reference Rates Committee (ARRC) in November 2014. The ARRC's objectives were to identify alternative reference interest rates that are firmly based on transactions from a robust underlying market and that comply with the International Organization of Securities Commissions (IOSCO) Principles for Financial Benchmarks and to formulate a plan to facilitate acceptance and use of the chosen alternative.

On 22 June 2017, the ARRC named SOFR as its preferred alternative reference rate. The SOFR value for any U.S. government securities market business day (business day) will be published by the Federal Reserve Bank of New York (FRBNY) at approximately 8:00 a.m. New York time on the next business day. Regular publication is slated to begin Tuesday, 3 April 2018, based on trade data for Monday, 2 April 2018.<sup>1</sup>

SOFR comprises a broad universe of overnight Treasury repo trade activity, making it a benchmark for all seasons, impervious to future structural shifts in market preferences between bilateral repo versus tri-party repo. It is based firmly on transaction data drawn from multiple and diverse sources:<sup>2</sup>

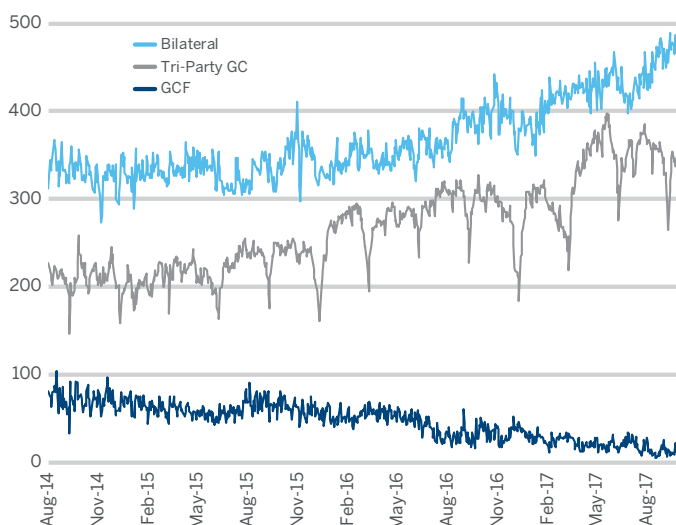
- Tri-party Treasury general collateral (GC) repo transactions cleared and settled by Bank of New York Mellon (BNYM), excluding repo transactions made through the Fixed Income Clearing Corporation (FICC) General Collateral Financing (GCF) repo market, and excluding transactions in which the Federal Reserve is a counterparty.

- Tri-party Treasury GC repo transactions made through the FICC GCF repo market, for which FICC acts as central counterparty.
- Bilateral Treasury repo transactions cleared through the FICC Delivery-versus-Payment (DVP) service.

The scale of SOFR's underlying transaction pool is massive. In 2017 Q3, for instance, average daily trading volumes ran \$351 bln in BNYM tri-party Treasury GC repo, \$18 bln in FICC GCF Treasury repo, and \$439 bln in FICC DVP bilateral Treasury repo, making a total average traffic flow of \$808 bln per day. Exhibit 1 depicts these daily transaction volumes from 22 August 2014 through 17 October 2017.

### Exhibit 1

#### Trade Activity (\$ Billions per Day) in SOFR Data Sources, 22 Aug 2014 through 17 Oct 2017



Source: FRBNY

<sup>1</sup> FRBNY, *Statement Regarding the Initial Publication of Treasury Repo Reference Rates, Statements and Operating Policies*, 28 February 2018, which is available at: [https://www.newyorkfed.org/markets/opolicy/operating\\_policy\\_180228](https://www.newyorkfed.org/markets/opolicy/operating_policy_180228).

<sup>2</sup> See *Federal Reserve System, Request for Information Relating to Production of Rates*, 82 FR 41259, 30 August 2017, which includes a detailed overview of the Treasury repo market, and which is available at: <https://www.federalregister.gov/documents/2017/08/30/2017-18402/request-for-information-relating-to-production-of-rates>.

Various filters, trims, and inclusion rules are applied to these data sources to isolate overnight Treasury GC repo transactions from other repo market activity, and to ensure that SOFR adheres to the IOSCO Principles<sup>3</sup>:

### BNYM Tri-party GC Repo

- Transactions with the Federal Reserve are removed.
- “Open” trades that are economically similar to overnight trades are included.
- Transactions between affiliated entities that are not conducted at arm’s length are removed.

### FICC GCF

- Any pair of duplicate trades with FICC as central counterparty is treated as a single trade.
- Transactions between affiliated entities are included, because they are blind-brokered.

### FICC DVP Bilateral Repo Data

- Transactions between affiliated entities are included, because counterparty names are not identified in the data supplied to FRBNY.
- For any given day, FRBNY ranks all FICC DVP bilateral repo trades by their transaction rates, from lowest to highest, and then removes 25 percent of trading volume corresponding to the lowest transaction rates. The goal of this data filtering is to remove repo transactions in which Treasury collateral is likeliest to be trading “special,” so as to achieve a residual set of bilateral repo data that largely (if not purely) reflects GC transactions.

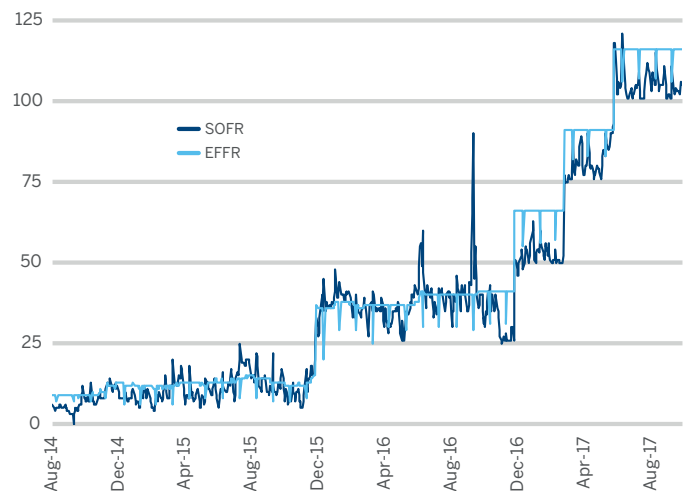
After editing each of the three sets of source data, FRBNY pools them, then ranks the aggregate of repo trading volumes by their transaction rates, from lowest to highest, then computes the transaction-weighted median repo rate, ie, the repo rate for which half of the day’s trading volume is transacted at rates that are equal to it or less than it, and for which the other half of the day’s trading volume is made at

rates that are equal to it or greater than it. The transaction-weighted median repo rate becomes the day’s SOFR benchmark value.

The trade-volume-weighted median methodology brings at least three advantages. It is a more robust statistic than alternatives such as, eg, the trade-volume-weighted average. Almost always, the value it produces is an interest rate level that actually has been observed, at which business actually has been conducted. And it aligns with the calculation method for daily EFFR and for the daily overnight bank funding rate (OBFR), which was adopted by the Federal Reserve in March 2016.<sup>4</sup>

### Exhibit 2

#### Daily EFFR and Estimated SOFR Values (Basis Points per Annum), 22 Aug 2014 through 17 Oct 2017



Source: FRBNY

### How do SOFR and EFFR compare?

Exhibit 2 displays daily SOFR and EFFR values over the same interval as in Exhibit 1. Their paths are broadly similar in the sense that the general level of each moves in concert with the target level that the Federal Open Market Committee sets for EFFR. But there are important differences in detail:

<sup>3</sup> See Frost, Joshua, *Presentation at the Alternative Reference Rates Committee Roundtable, FRBNY, New York, 8 November 2017, which is available at: <https://www.newyorkfed.org/newsevents/speeches/2017/fro171108>*; and Lorie K Logan, *The Role of the New York Fed as Administrator and Producer of Reference Rates, Remarks at the Annual Primary Dealer Meeting, FRBNY, New York, January 9, 2018, which is available at: <https://www.newyorkfed.org/newsevents/speeches/2018/log180109>*.

<sup>4</sup> See FRBNY, *Statement Regarding the Calculation Methodology for the Effective Federal Funds Rate and Overnight Bank Funding Rate, Operating Policy Statement, 8 July 2015, which is available at: [https://www.newyorkfed.org/markets/opolicy/operating\\_policy\\_150708](https://www.newyorkfed.org/markets/opolicy/operating_policy_150708)*.

- On average, daily SOFR runs 3.9 basis points per annum lower than daily EFFR.
- Unlike EFFR, SOFR exhibits no systematic tendency to drop on the last business day of each month.
- SOFR is more volatile from day to day than EFFR. This includes occasional bouts of quarter-end volatility arising in part from banks' balance sheet adjustments in connection with their reporting of Basel III leverage ratio components.<sup>5</sup>

during the contract delivery month. The contract will be sized at \$41.67 per basis point of contract interest. Both design features are essentially identical to the terms of 30-Day Federal Funds futures.

As detailed next, in each case the interest rate that enters into determination of an expiring contract's final settlement price is calculated in a way that blunts the impact of day-to-day volatility in the SOFR benchmark.

## CME SOFR Futures

On 7 May 2018 CME will launch One-Month SOFR futures and Three-Month SOFR futures.<sup>6</sup> The Appendix summarizes specifications for both products.

They will complement one another by facilitating price discovery along different segments of the term structure of money market interest rates. And they will enable intermarket spreading opportunities against the exchange's flagship short-term interest rate futures products, Three-Month Eurodollar (ED) futures and 30-Day Federal Funds (FF) futures, both of which are supported by long-established, deep, and resilient liquidity pools.

As with ED or FF futures, SOFR futures prices will be quoted in index terms, as "100 minus contract interest rate":

- Each Three-Month SOFR futures contract will expire by cash settlement, by reference to the three-month term interest rate implied by compounded daily SOFR interest between the third Wednesday (IMM Wednesday) of the contract month and IMM Wednesday of the contract delivery month. (See the nearby "Contract Critical Dates...") Thus, the Three-Month SOFR contract's critical dates will align with the IMM calendar familiar to ED futures users. And, like ED futures, Three-Month SOFR futures will be sized at \$25 per basis point per annum of contract interest.
- Each One-Month SOFR futures contract will expire by cash settlement, by reference to a final settlement price equal to 100 minus the average of daily SOFR values

### Contract Critical Dates for Three-Month SOFR Futures and Three-Month Eurodollar Futures

The "contract month" convention for naming Three-Month SOFR futures will mirror the established convention for Three-Month Eurodollar futures.

To see how, consider two contracts:

A Three-Month SOFR future (SR3) that comes to final settlement on the third Wednesday of December, for which the Reference Quarter – the interval of interest rate exposure that informs the contract final settlement price – starts on the third Wednesday of the preceding September.

A ED future that comes to final settlement on Monday before the third Wednesday of the preceding September, for which the final settlement price is based on the USD three-month ICE LIBOR<sup>®</sup> that corresponds to a three-month unsecured bank funding transaction that settles on the third Wednesday of September and that matures three months later.

Both will be referenced as "September" contracts. The interval of interest rate exposure for one is essentially the same as for the other. Importantly, the settlement date corresponding to the three-month term bank funding rate that corresponds to the September ED contract matches the start date of the contract Reference Quarter, the period over which daily SOFR interest is compounded, for the September SR3 contract.

<sup>5</sup> See, eg, James Egelhof, Antoine Martin, and Noah Zinsmeister, *Regulatory Incentives and Quarter-End Dynamics in the Repo Market*, Federal Reserve Bank of New York Liberty Street Economics (blog), 7 August 2017, which is available at: <http://libertystreeteconomics.newyorkfed.org/2017/08/regulatory-incentives-and-quarter-end-dynamics-in-the-repo-market.html>.

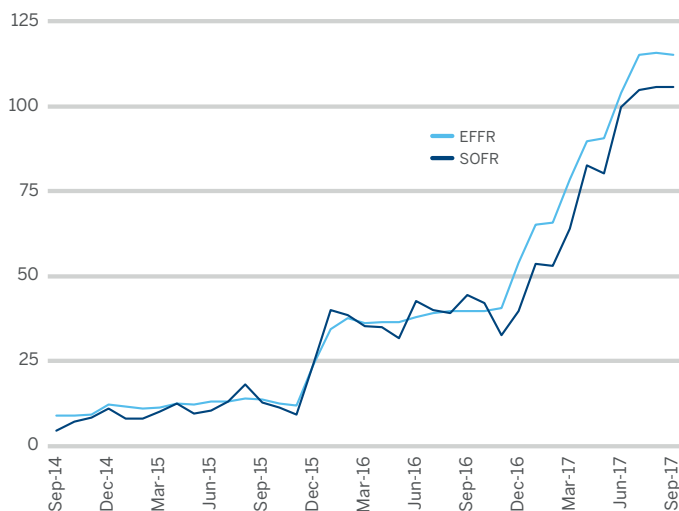
<sup>6</sup> Pending completion of all regulatory certification and review periods. See CME Group, *SOFR Futures Contract Specifications*, 14 February 2018, which is available at: <http://www.cmegroup.com/education/sofr-futures-contract-specifications.html>.

## One-Month SOFR and One-Month EFFR

For an expiring 30-Day Federal Funds futures contract, the final settlement price is set as 100 minus the arithmetic average of daily EFFR during the contract delivery month. The light blue line in Exhibit 3 traces these average interest rate levels for each of the 37 months between September 2014 and September 2017, inclusive. The dark blue line in Exhibit 3 is the outcome, if the same calculation is applied to obtain the arithmetic average of estimated historical daily SOFR values for each of the same 37 months.<sup>7</sup>

### Exhibit 3

#### Calendar-Month Averages of Daily Interest Rates (Basis Points per Annum) for EFFR and SOFR, September 2014 through September 2017



Source: FRBNY

Although month-averaging smooths over much of SOFR's comparatively lively day-to-day volatility, at least some residual effect persists. In Exhibit 3, the median absolute change from one month-average to the next is 0.8 basis points for EFFR. By contrast, it is 2.8 basis points for SOFR, over three times more volatile.

Other comparative features warrant mention:

- Over the entire span, monthly SOFR levels normally run 3.3 basis points below monthly EFFR.
- Although the sample is far too small to be conclusive, it suggests that the SOFR-EFFR spread varies in relation to monetary policy. From September 2014 through November 2015 – prior to the Federal Open Market Committee's initial decision to raise its EFFR target in December 2015 – monthly SOFR averaged a mere 1.4 basis points less than monthly EFFR. By contrast, between November 2016 and September 2017 – during which time the FOMC hiked its EFFR target thrice, for a cumulative increase of 75 basis points – the spread expanded to 10.3 basis points.
- On occasion, anomalies in daily SOFR volatility may be large enough to exert impact on month-average SOFR. This is exemplified by two episodes in which Treasury GC repo rates spiked during the final weeks of June and September 2016. In each case, the usually positive SOFR-EFFR spread was temporarily flipped, with month-average SOFR exceeding the corresponding month-average EFFR by 4.9 basis points.

<sup>7</sup> Historical daily values of the SOFR are as estimated and published by FRBNY. See Joshua Frost, *Presentation at the Alternative Reference Rates Committee Roundtable*, FRBNY, New York, November 8, 2017, which is available at: <https://www.newyorkfed.org/medialibrary/media/newsevents/speeches//2017/Frostpresentation-data.xlsx> and Kathryn Bayeux, Alyssa Cambron, Marco Cipriani, Adam Copeland, Scott Sherman, and Brett Solimine, *Introducing the Revised Broad Treasuries Financing Rate*, Federal Reserve Bank of New York Liberty Street Economics, FRBNY, New York, June 19, 2017, revised January 30, 2018, which is available at: [http://www.newyorkfed.org/medialibrary/media/research/blog/2017/LSE\\_2017\\_Cipriani\\_broadfinancing\\_data.xlsx](http://www.newyorkfed.org/medialibrary/media/research/blog/2017/LSE_2017_Cipriani_broadfinancing_data.xlsx).

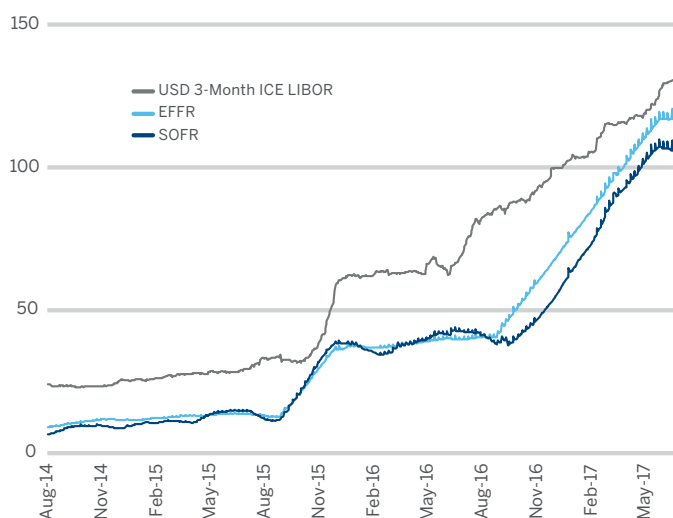
## Three-Month SOFR, Three-Month EFFR, and Three-Month ICE LIBOR®

The exchange will apply compounding of daily SOFR values between quarterly IMM dates (the third Wednesday of every March, June, September, and December) to determine final settlement prices of expiring Three-Month SOFR futures. The compounding conventions will be consistent with and familiar to users of standard US dollar overnight index swaps, for which a swap's floating-rate leg is based on the business-day-compounded EFFR.

As with the averaging process for One-Month SOFR futures, the compounding process for Three-Month SOFR futures is anticipated to dampen the impact of day-to-day volatility in SOFR. This is evidenced in Exhibit 4, which compares the paths of three-month compounded daily SOFR, three-month compounded daily EFFR, and USD 3-month ICE LIBOR® from 22 August 2014 through 17 July 2017.

### Exhibit 4

#### 3-Month Compounded Daily SOFR, 3-Month Compounded Daily EFFR, and USD 3-Month ICE LIBOR®, 22 August 2014 through 17 July 2017



Sources: FRBNY, ICE Benchmark Administration Ltd

For 3-month EFFR and 3-month SOFR, each date denotes the start of the corresponding three-month interval over which daily SOFR or daily EFFR is compounded and then transformed into a 3-month term interest rate per annum. For example, on 22 August 2014 the 3-month SOFR and 3-month EFFR values denote the term interest rates per annum that

result from daily compounding of SOFR values and EFFR values, respectively, during the interval from 22 August 2014 to 24 November 2014.

Similarly, on 22 August 2014 the USD 3-month ICE LIBOR® value is for settlement on that date. I.e., it is the value that would have been determined by ICE Benchmark Administration Ltd two London bank business days earlier, on 20 August 2014, for standard t+2 settlement.

A distinction worth note is that, on any given date, the 3-month EFFR and 3-month SOFR estimates are hypothetical “perfect foresight” rates, determined on the basis of the daily values of EFFR and SOFR that materialized in fact over the ensuing three months. By contrast, the corresponding 3-month ICE LIBOR® value for the same date is a bona fide market rate, reflecting market expectation (rather than full knowledge) of the course of market rates over the ensuing three months.

Despite these differences, the comparisons make a useful check:

- For the entire interval, 3-month daily compounded SOFR rates average 3.2 basis points per annum below corresponding 3-month daily compounded EFFR rates, comparable to the average spread of 3.3 basis points per annum between month-average levels of EFFR and SOFR for the same period.
- The 3-month compounding interval effectively squelches the differences in volatility between daily EFFR and daily SOFR. For the interval in Exhibit 4, the median absolute day-to-day change in 3-month daily compounded rates is nearly identical for EFFR and SOFR, 0.2 basis points. (Likewise, the mean absolute day-to-day change is essentially equal for both – in each case, slightly more than 0.4 basis points.)
- On average, the spread between 3-month daily compounded SOFR and 3-month ICE LIBOR® is 23.7 basis points.
- As before, the spread appears to vary with the tone of US monetary policy. The average for the interval from 22 August 2014 through year-end 2015 is roughly 15.2 basis points. For the spell from start of 2016 through 17 July 2017, it doubles to around 31.1 basis points.

## Appendix – Contract Specifications for CME Three-Month SOFR Futures and CME One-Month SOFR Futures

Three-Month SOFR futures and One-Month SOFR futures shall trade on and according to the rules of Chicago Mercantile Exchange (“CME”), pending certification of contract terms with the CFTC and completion of all regulatory review periods.

	CME Three-Month SOFR Futures	CME One-Month SOFR Futures
<b>Trading Unit</b>	Compounded daily Secured Overnight Financing Rate (“SOFR”) interest during contract Reference Quarter, such that each basis point per annum of interest = \$25 per contract. <b>Reference Quarter:</b> For a given contract, interval from (and including) 3rd Wed of 3rd month preceding Delivery Month, to (and not including) 3rd Wed of Delivery Month.	Average daily Secured Overnight Financing Rate (“SOFR”) interest during futures contract Delivery Month, such that each basis point per annum of interest is worth \$41.67 per futures contract.
<b>Price Basis</b>	Contract-grade IMM Index: <b>100 minus R</b> . <b>R</b> = compounded daily SOFR interest during contract Reference Quarter. <b>Example:</b> Contract price of 97.2950 IMM Index points signifies <b>R</b> = 2.705 percent per annum.	Contract-grade IMM Index: <b>100 minus R</b> . <b>R</b> = average daily SOFR interest during contract Delivery Month.
<b>Contract Size</b>	\$25 per basis point per annum	\$41.67 per basis point per annum
<b>Minimum Price Increment (MPI)</b>	<b>Contracts with Four Months or Less Until Termination of Trading:</b> 0.0025 IMM Index points (¼ basis point per annum) equal to \$6.25 per contract <b>All Other Contracts:</b> 0.005 IMM Index points (½ basis point per annum) equal to \$12.50 per contract	0.005 IMM Index points (½ basis point per annum) equal to \$20.835 per contract, <b>provided that:</b> <ul style="list-style-type: none"> <li>• If first day of contract Delivery Month is Sat, Sun, or Mon, then MPI is 0.0025 Index points, equal to \$10.4175 per contract, as of first trading day of contract Delivery Month.</li> <li>• If first day of contract Delivery Month is Tue, Wed, Thurs, or Fri, then MPI is 0.0025 Index points, equal to \$10.4175 per contract, as of last Sunday of month preceding contract Delivery Month.</li> </ul>
<b>Termination of Trading</b>	<b>Last Day of Trading:</b> Exchange Business Day first preceding 3rd Wed of Delivery Month. <b>Termination of Trading:</b> Close of CME Globex trading on Last Day of Trading.	<b>Last Day of Trading:</b> Last Exchange Business Day of contract Delivery Month.
<b>Delivery</b>	Cash settlement, by reference to Final Settlement Price, on first US government securities market business day following Last Day of Trading. <b>Final Settlement Price:</b> Contract-grade IMM Index evaluated on the basis of realized SOFR values during contract Reference Quarter: $R = [ \prod_i \{1+(d_i/360)*(r_i/100)\} - 1 ] \times (360/D) \times 100$ $n = \text{Number of US government securities market business days in the Reference Quarter}$ $i \sim \text{Running variable indexing US government securities market business days during Reference Quarter}$ $\prod_i \text{ denotes the product of values indexed by the running variable, } i = 1, 2, \dots, n.$ $r_i = \text{SOFR value for } i^{\text{th}} \text{ US government securities market business day}$ $d_i = \text{Number of calendar days to which } r_i \text{ applies}$ $D = \sum_i d_i \text{ (ie, number of calendar days in Reference Quarter)}$	<b>Final Settlement Price:</b> Contract-grade IMM Index evaluated at <b>R</b> = arithmetic average of daily SOFR during Delivery Month.

	CME Three-Month SOFR Futures	CME One-Month SOFR Futures
<b>Delivery Months</b>	Nearest 20 March Quarterly months (Mar, Jun, Sep, Dec). For each contract, <b>Contract Month</b> is the month in which Reference Quarter begins. <i>Example:</i> For a “Sep” contract, Reference Quarter starts on IMM Wed of Sep and ends with Termination of Trading on the first US government securities market business day before IMM Wed of Dec, the contract Delivery Month.	Nearest 7 calendar months
<b>Trading Venues and Hours</b>	CME Globex and CME ClearPort: 5 p.m. to 4 p.m. Sun-Fri.	
<b>CME Globex Algorithm</b>	Allocation (A Algorithm, with Top Order Allocation = 100% and Pro Rata Allocation = 100%)	Split FIFO and Pro-Rata (K Algorithm, with Top Order Allocation = 100% and Pro Rata Allocation = 100%)
<b>Block Trade Minimum Size</b>	ATH 250 contracts ETH 500 RTH 1,000  ATH – Asian Trading Hours (4pm–12am, Mon-Fri on regular business days and at all weekend times) ETH – European Trading Hours (12am– 7am, Mon-Fri on regular business days) RTH – Regular Trading Hours (7am–4pm, Mon-Fri on regular business days)	ATH 125 contracts ETH 250 RTH 500
<b>Product Code</b>	CME: SR3 Bloomberg: SFR Cmdty <GO>	CME: SR1 Bloomberg: SER Cmdty <GO>

Please refer to [www.cmegroup.com/sofr](http://www.cmegroup.com/sofr) for the complete One-Month and Three-Month SOFR futures contract specifications, press release, and forthcoming SOFR educational resources.

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