

A User's Guide to SOFR

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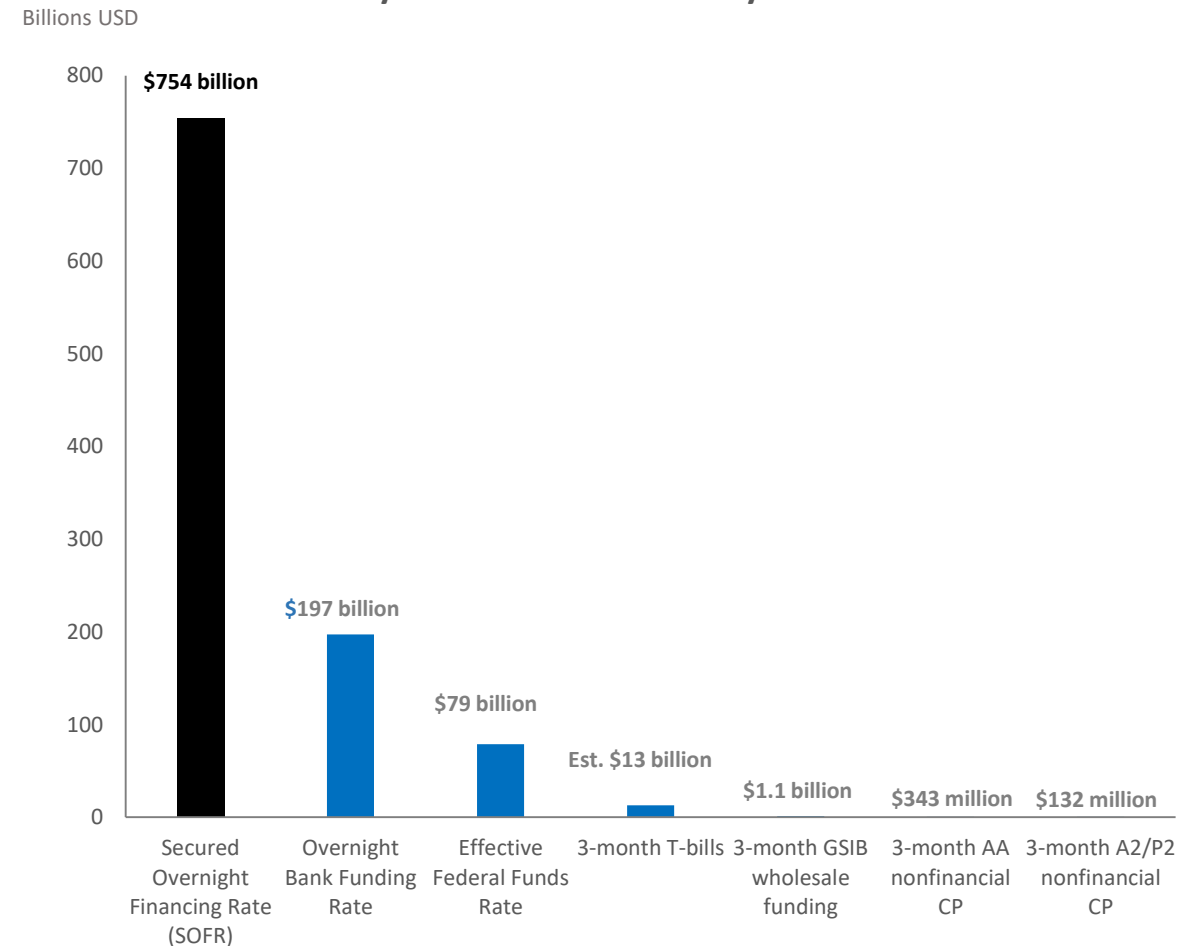
The Secured Overnight Financing Rate (SOFR)

SOFR has a number of characteristics that LIBOR and other similar rates like LIBOR that are based on wholesale term unsecured funding markets do not:

- It is a rate produced by the Federal Reserve Bank of New York (FRBNY) for the public good;
- It is derived from an active and well-defined market with sufficient depth to make it extraordinarily difficult to ever manipulate or influence;
- It is produced in a transparent, direct manner and is based on observable transactions, rather than being dependent on estimates, like LIBOR, or derived through models; and
- It is derived from a market that was able to weather the global financial crisis and that the ARRC credibly believes will remain active enough in order that it can reliably be produced in a wide range of market conditions.

However, SOFR is also new, and many are unfamiliar with how to use it.

Daily Volumes in U.S. Money Markets



Source: ARRC Second Report

SOFR Publication

SOFR is published on the Federal Reserve Bank of New York’s website every U.S business day at approximately 8am EST.

(<https://apps.newyorkfed.org/markets/autorates/sofr>)

The rate published each day represents the rates on overnight repo transactions that were entered in to the previous business day and that are to be repaid on the current business day. So, for example, on April 16, the rate for transactions entered in to on April 15 would be published.

This is similar to how the effective federal funds rate (EFFR) and risk-free rates (RFRs) in other jurisdictions are published.

Table 3: The Publication Timing of the RFRs

SOFR	Published around 8am the next business day
SONIA	Published at 9am the next business day
TONA	Published at 10am the next business day
ESTER	Will be published at 9am the next business day
SARON	Published at 6pm the same business day

Secured Overnight Financing Rate Data

The Secured Overnight Financing Rate (SOFR) is a broad measure of the cost of borrowing cash overnight collateralized by Treasury securities. The SOFR includes all trades in the [Broad General Collateral Rate](#) plus bilateral Treasury repurchase agreement (repo) transactions cleared through the Delivery-versus-Payment (DVP) service offered by the Fixed Income Clearing Corporation (FICC), which is filtered to remove a portion of transactions considered "specials".³

The SOFR is calculated as a volume-weighted median of transaction-level tri-party repo data collected from the Bank of New York Mellon as well as GCF Repo transaction data and data on bilateral Treasury repo transactions cleared through FICC's DVP service, which are obtained from DTCC Solutions LLC, an affiliate of the Depository Trust & Clearing Corporation. Each business day, the New York Fed publishes the SOFR on the New York Fed website at approximately 8:00 a.m.³

For more information on the production of the SOFR, please see [Additional Information about the TGCR, BGCR and SOFR](#).

To access historical data, please see: [Repo Rates Data Historical Search](#)

[Download daily historical indicative SOFR and accompanying volumes from August 2014 – March 2018](#) [EXCEL](#)

Use of the Secured Overnight Financing Rate is subject to important disclaimers, limitations and indemnification obligations. See the [Terms of Use](#). The New York Fed has no liability for publication of the rate on this webpage or in any other sources.

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SECURED OVERNIGHT FINANCING RATE DATA

Statistics on the Secured Overnight Financing Rates
See [Secured Overnight Financing Rates Chart](#)

Export to: [Excel](#) | [XML](#) | [Volume](#) | [Rates](#)

DATE	RATE (PERCENT)	PERCENTILES				VOLUME (U.S. \$ BILLIONS)
		1ST (PERCENT)	25TH (PERCENT)	75TH (PERCENT)	99TH (PERCENT)	
04/15	2.47	2.40	2.43	2.52	2.60	968
04/12	2.44	2.39	2.40	2.49	2.55	955
04/11	2.44	2.39	2.40	2.49	2.55	974

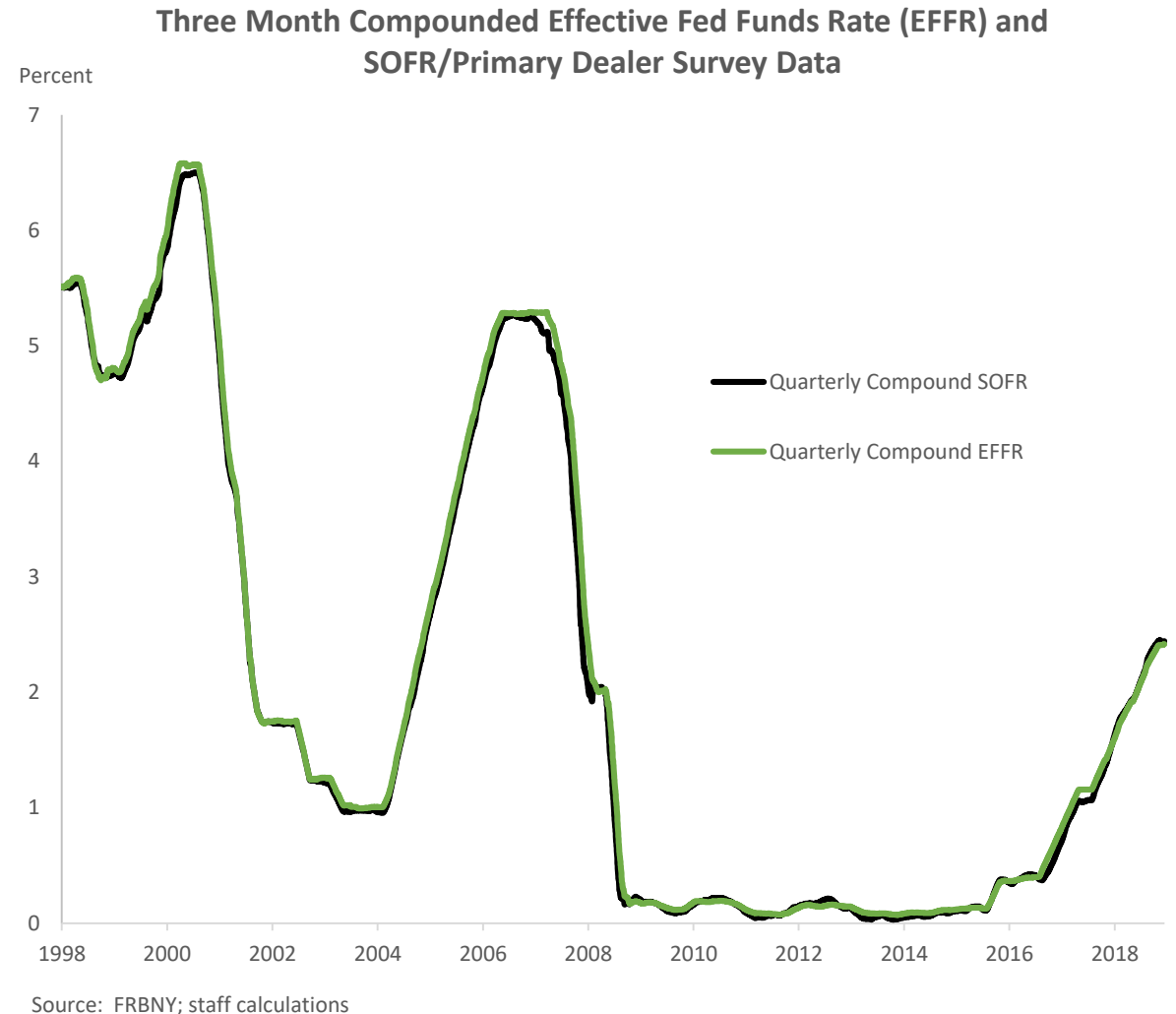
4/16/2019

SOFR is published on every U.S. business day at approximately 8:00am EST. Because the Fed has the ability to correct and republish this rate until 2:30pm New York City Time each day, users may wish to reference the rate after this time (e.g. 3:00pm)

The SOFR rate published on any day represents the rate on repo transactions entered into on the previous business day and the date associated with each rate reflects the date of the underlying transactions rather than the date of publication.

SOFR Data

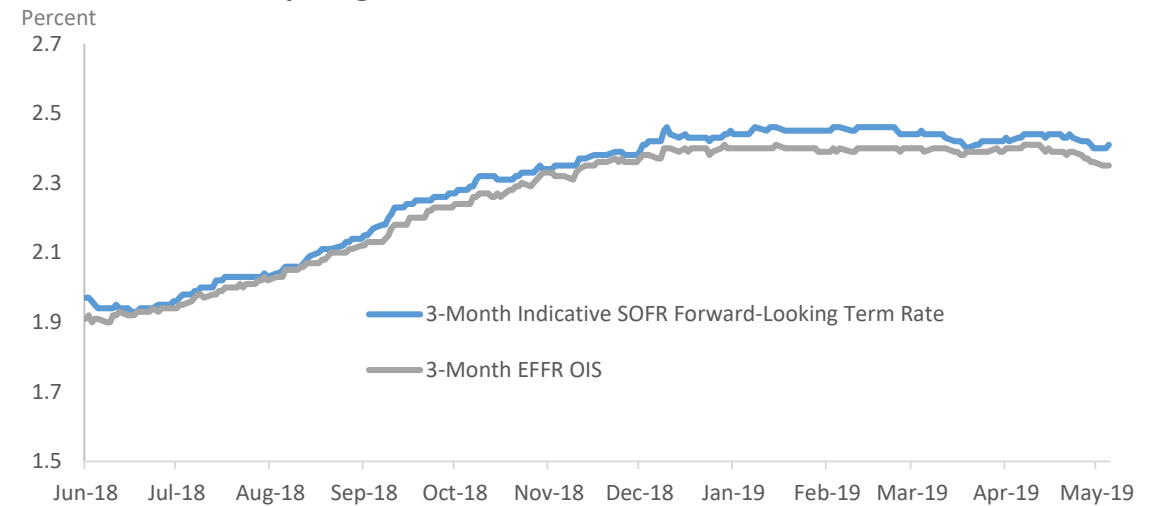
- FRBNY, in cooperation with the Office of Financial Research, began publishing SOFR on April 3, 2018.
- Prior to the start of official publication, FRBNY released data from August 2014 to March 2018 representing modeled, pre-production estimates of SOFR that are based on the same basic underlying transaction data and methodology that now underlie the official publication.
(https://www.newyorkfed.org/newsevents/speeches/2017/fr_o171108)
- FRBNY has also separately released a much longer historical data series based on primary dealers' overnight Treasury repo borrowing activity. (https://www.newyorkfed.org/markets/opolicy/operating_policy_180309)
- A forthcoming note I have written argues that the historical survey data is an adequate proxy for SOFR for risk modelling or other purposes



The Different Potential Versions of SOFR-Based Rates

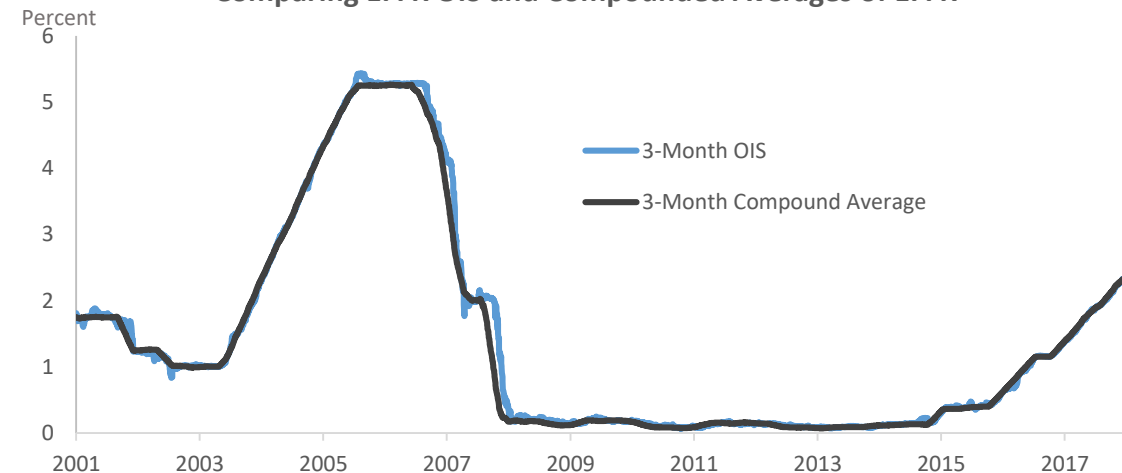
- The Federal Reserve Bank of New York has indicated that it plans to publish averages of SOFR in the first half of next year. Market participants are already using averages of SOFR in floating rate debt and derivatives markets.
- The ARRC has also set a goal of seeing forward-looking term rates based on SOFR derivatives produced as the last step of its Paced Transition Plan, but these rates may not come until 2021.
- Federal Reserve staff members have produced “indicative” forward-looking term rates that are not meant to be used in contracts and are not IOSCO compliant, but may help provide a sense as to how the term rates will behave (a link to this data is on the ARRC’s website).
- The forward-looking term rates that the ARRC envisions will effectively be segments of the SOFR OIS curve, and as such should behave much like EFRR OIS rates do today.
- The forward-looking term rates should also be tightly linked to compound averages of SOFR, just as EFRR OIS rates are tightly linked to compound averages of EFRR.

Comparing an Indicative SOFR Term Rate to EFRR OIS



Source: Federal Reserve Bank of New York, CME, Bloomberg, and Federal Reserve staff calculations

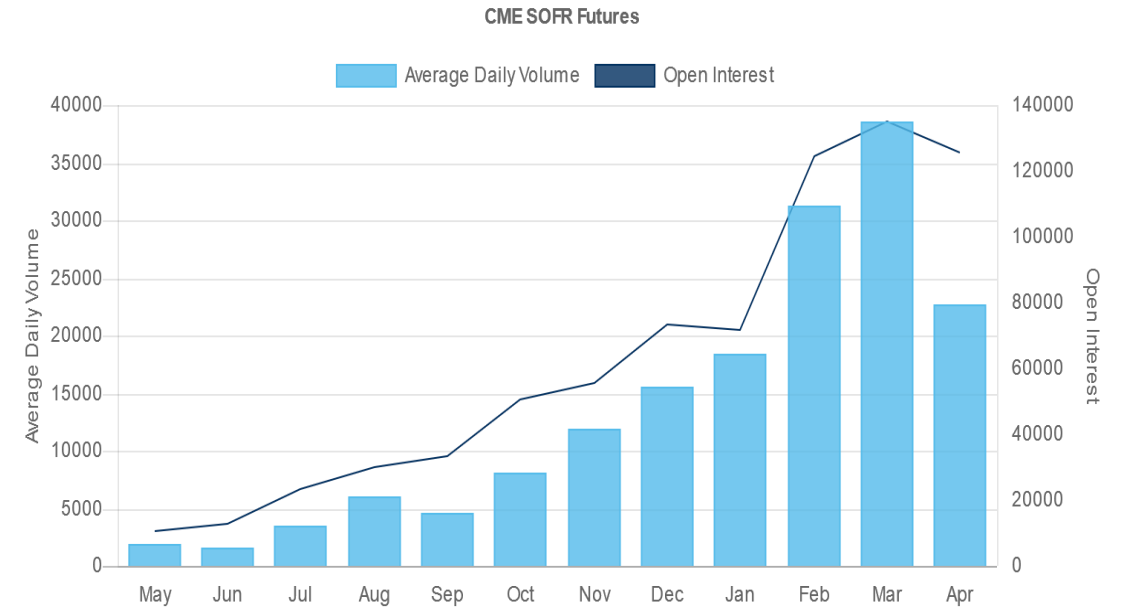
Comparing EFRR OIS and Compounded Averages of EFRR



Source: Federal Reserve Bank of New York, Bloomberg; Federal Reserve Board staff calculations

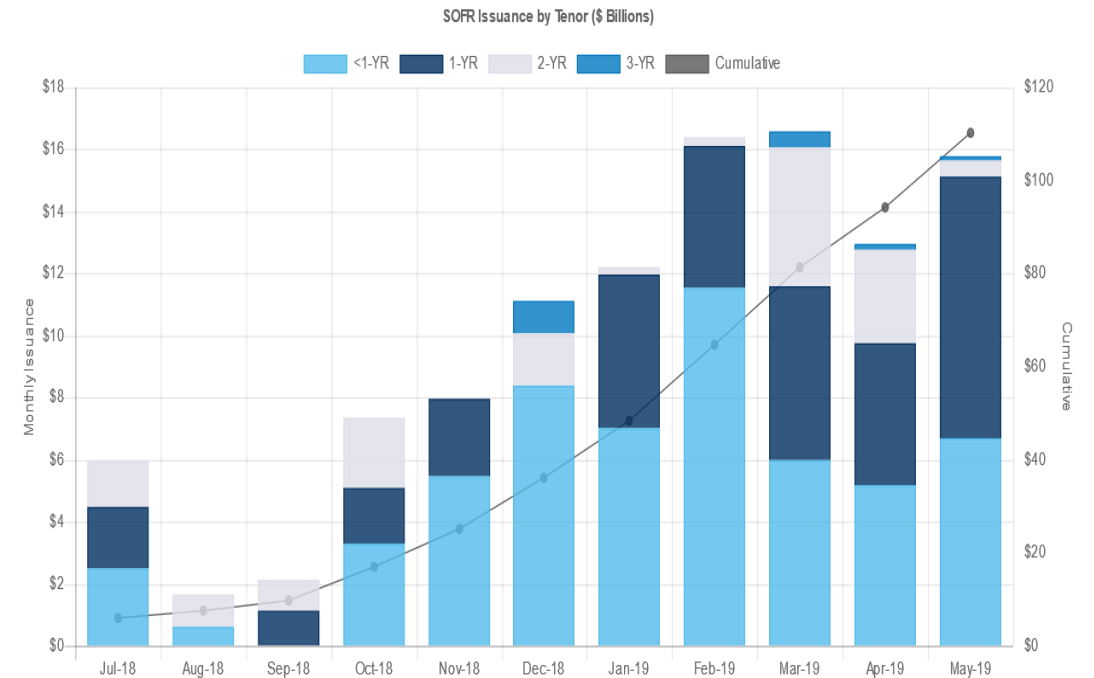
Reasons Not to Simply Wait for the Term Rates

- The forward-looking term rates will be based on SOFR derivatives markets. SOFR futures *are* growing at a rapid rate – SOFR futures are off to the third fastest start in CME’s product history – and SOFR derivatives are expected to become highly liquid...
- However, at the same time, SOFR futures are currently only have a small fraction of the depth of fed funds futures or Eurodollar futures. At the current level of market development, it is not possible to build robust, IOSCO compliant forward-looking term rates, and it is not likely to be possible for some time while the end of 2021 is not far away.
- The forward-looking term rates and the financial system can only be truly robust if most cash products reference SOFR itself. The ARRC envisions that term rates would be primarily used for some loans and as a fallback for cash products.



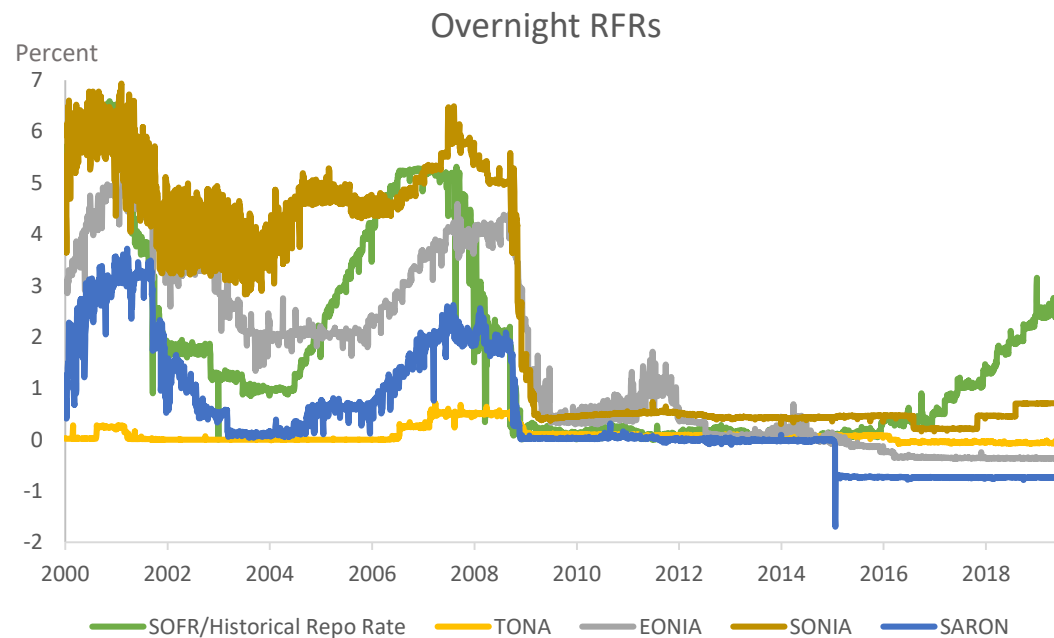
Reasons Not to Simply Wait for the Term Rates Continued

- A number of cash product issuances are demonstrating that it is possible to use averages of SOFR itself rather than waiting for the term rate.
- If people are seeking to hedge their positions in derivatives market, using averages of SOFR will likely be easier and cheaper than using the term rates.
- Averages of SOFR can actually provide a better hedge against interest rate risk. The term rate will reflect market *expectations* about what will happen to rates while a compound average will reflect what *actually happens* to rates.
- There are structures, such as loans based on overnight LIBOR, that can be readily adapted to use SOFR, and some clients may like having that choice and may appreciate the chance to transition away from LIBOR at an earlier stage.

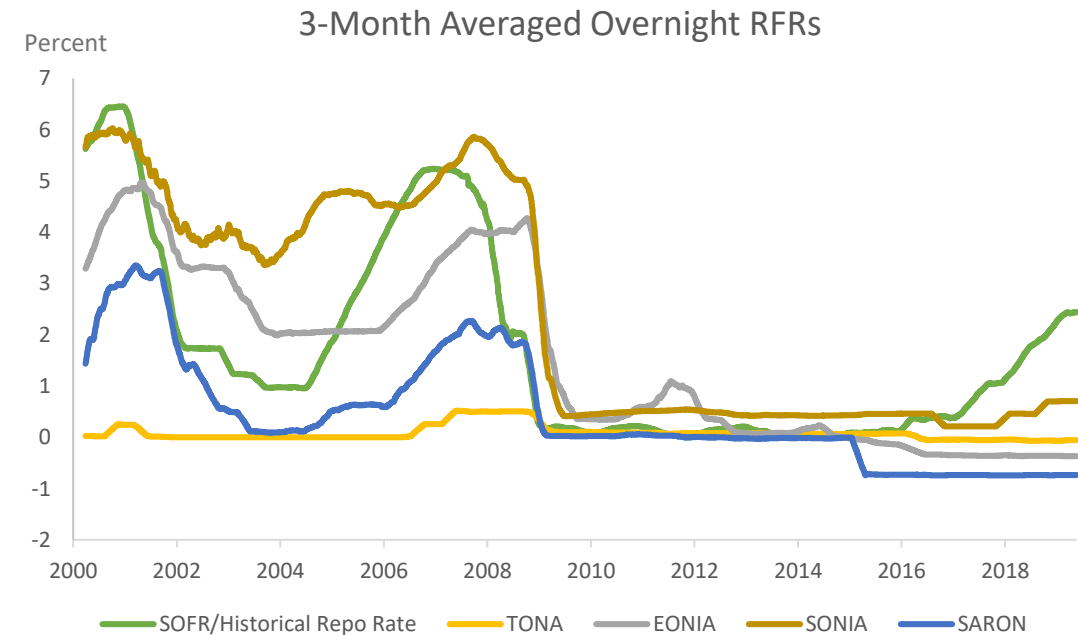


How to Use SOFR Lesson #1 -- Averaging

The financial contracts using overnight RFRs have referenced an average (1-month or 3-month) of the overnight RFR for floating rate payments, not typically one-day's reading of the rate. An average of daily overnight rates will accurately reflect movements in interest rates over a given period of time. Those averages tend to be very smooth and appropriate for use in financial contracts.



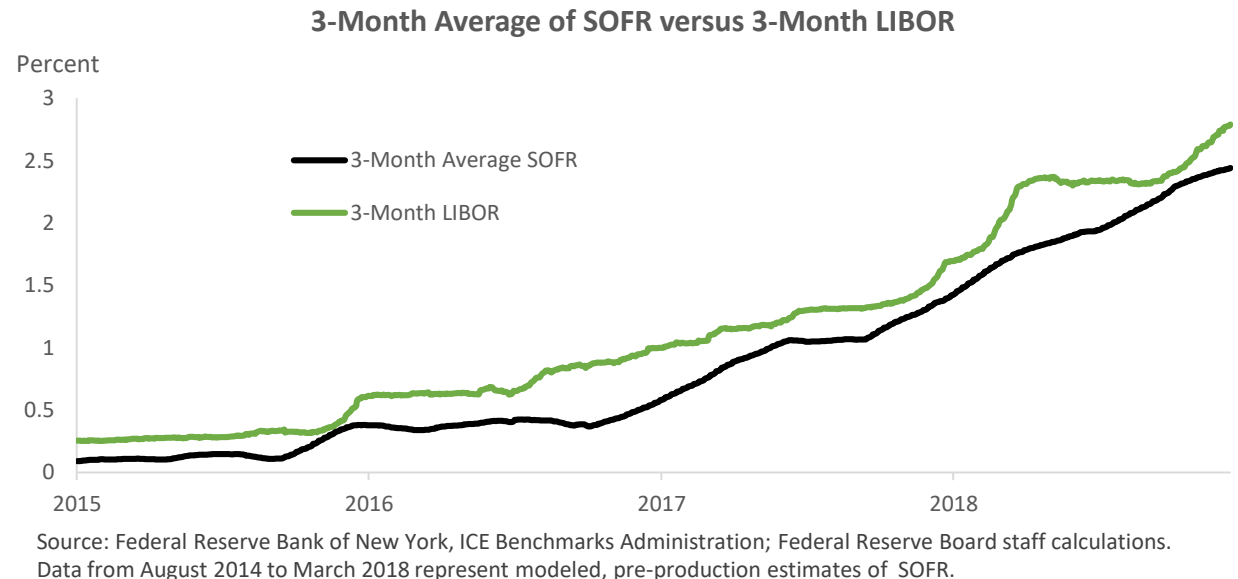
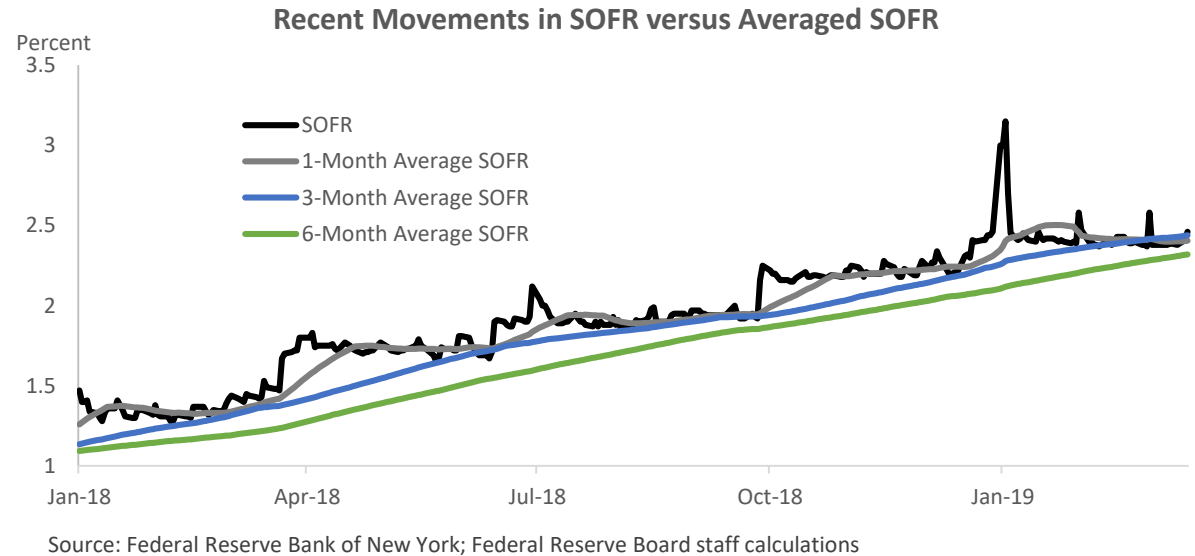
Sources: Federal Reserve Bank of New York; Bank of Japan; Bank of England; SIX (Swiss Infrastructure and Exchange); European Money Market Institute.



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Averaging and Year/Quarter Ends

- SOFR can temporarily move up at year or quarter ends, and it moved up appreciably at the end of last year.
- However, this isn't a new or unexpected phenomenon and year/quarter ends affect many market rates, not just SOFR.
- Averages of SOFR show very little or no impact of these kinds of temporary movements.
- A 3-month average of SOFR is less volatile than 3-month LIBOR, even over the last year end.
- FRBNY's expected publication of averages of SOFR should help to make this more clear.



Compound versus Simple Averaging

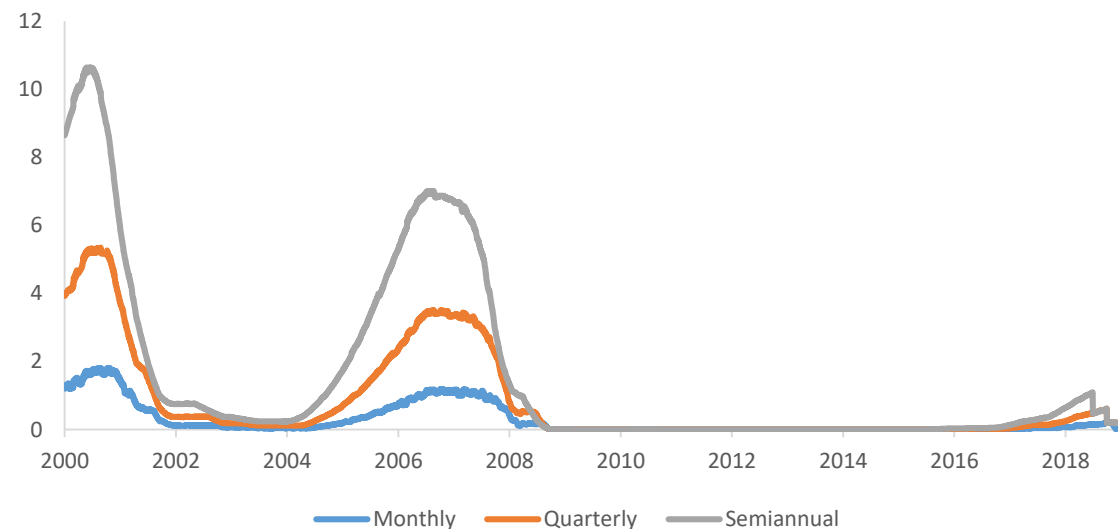
Compounding interest reflects the time value of money – for example, a money market account pays compound interest – and is used in OIS swaps and some futures. However, other contracts use simple averaging, largely because of historical precedent. There is some basis between the two types of averaging, but it is generally small and any difference can be adjusted for so that borrowers do not pay more or less under either convention.

Some products mix the two conventions in different ways – for example, 1-month SOFR futures at CME use simple averaging and 3-month futures use compounding. Some ARRC working groups are gravitating toward conventions that compound the rate but use a simple average of the margin.

Table: Basis between Compound and Simple Interest (bp)

Loan Rate:	1 percent	5 percent	10 percent
Loan Maturity:			
1-month	0.0	0.9	3.8
3-month	0.1	3.0	12.2
6-month	0.2	6.2	25.0

Historical Basis Between Compound and Simple SOFR (bp)



How to Use SOFR Lesson #2 – Notice of Payment

In addition to choosing between a compound or simple average, using SOFR will also require a decision on the timing of notice of payment:

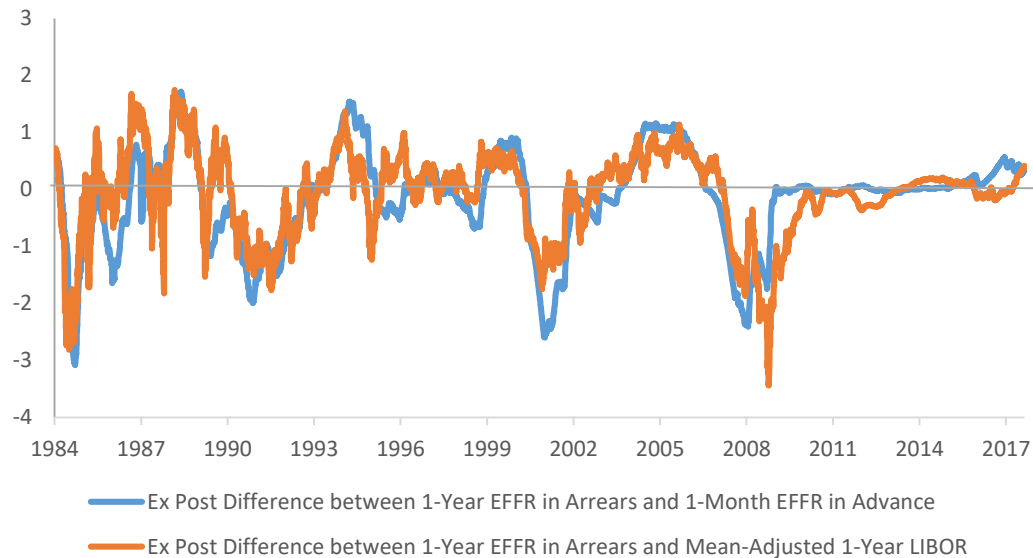
- Most of the contracts that reference LIBOR set the floating rate based on the value of LIBOR at the *beginning of the interest period*. This convention is termed *in advance* because the floating-rate payment due is set in advance of the start of the interest period. But not all LIBOR contracts take this form; some LIBOR swaps reference the value of LIBOR at the *end of the interest period*. This convention is termed *in arrears*.
- These conventions are used with overnight rates also. An *in advance* payment structure based on an overnight rate would reference an average of the overnight rates observed before the current interest period began, while an *in arrears* structure would reference an average of the rate over current the interest period. As noted above, an average overnight rate *in arrears* will reflect what *actually happens* to interest rates over the period and will therefore fully hedge interest rate risk in a way that LIBOR or a SOFR-based forward-looking term rate will not.

In Advance versus In Arrears

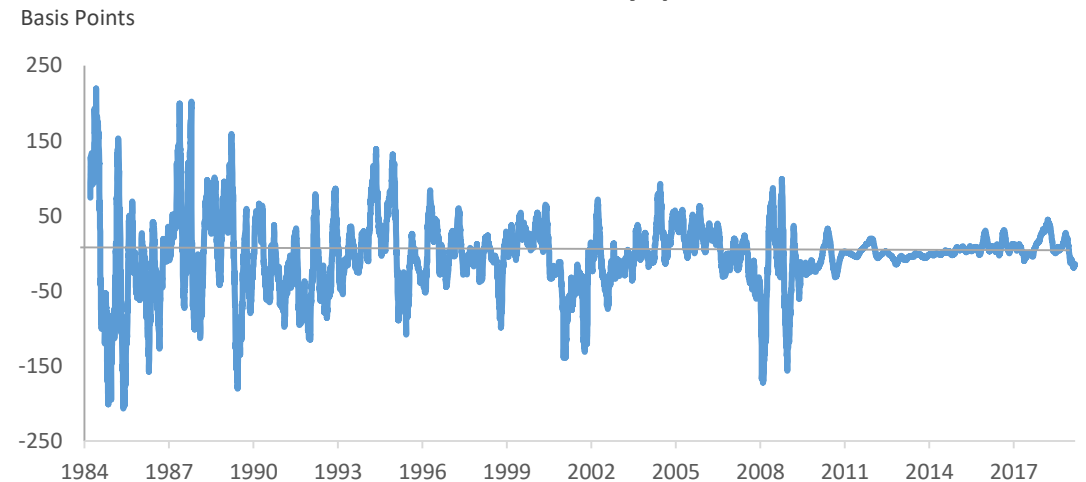
The tension between In Arrears and In Advance is that borrowers will reasonably prefer to know their payments ahead of time – well ahead of time for a consumer product – and so prefer In Advance, while investors will reasonably prefer returns based on rates over the interest period (In Arrears) and view rates set In Advance as “out of date.” For that reason, many assume that it is better to use a forward-looking term rate if rates are set in Advance.

But forward-looking term rates can also become out of date and create the same kinds of basis, so this isn't an entirely new problem: One-Year LIBOR can often quickly become out of date by about the same magnitude that a compound overnight rate (here EFFR) has become out of date and does not predict future rates much better than a simple average of EFFR, so while these issues will rightly be an area of focus, this is already an issue in the current market although it does not receive much focus.

Comparing Ex Post Predictive Power for Future Interest Rates



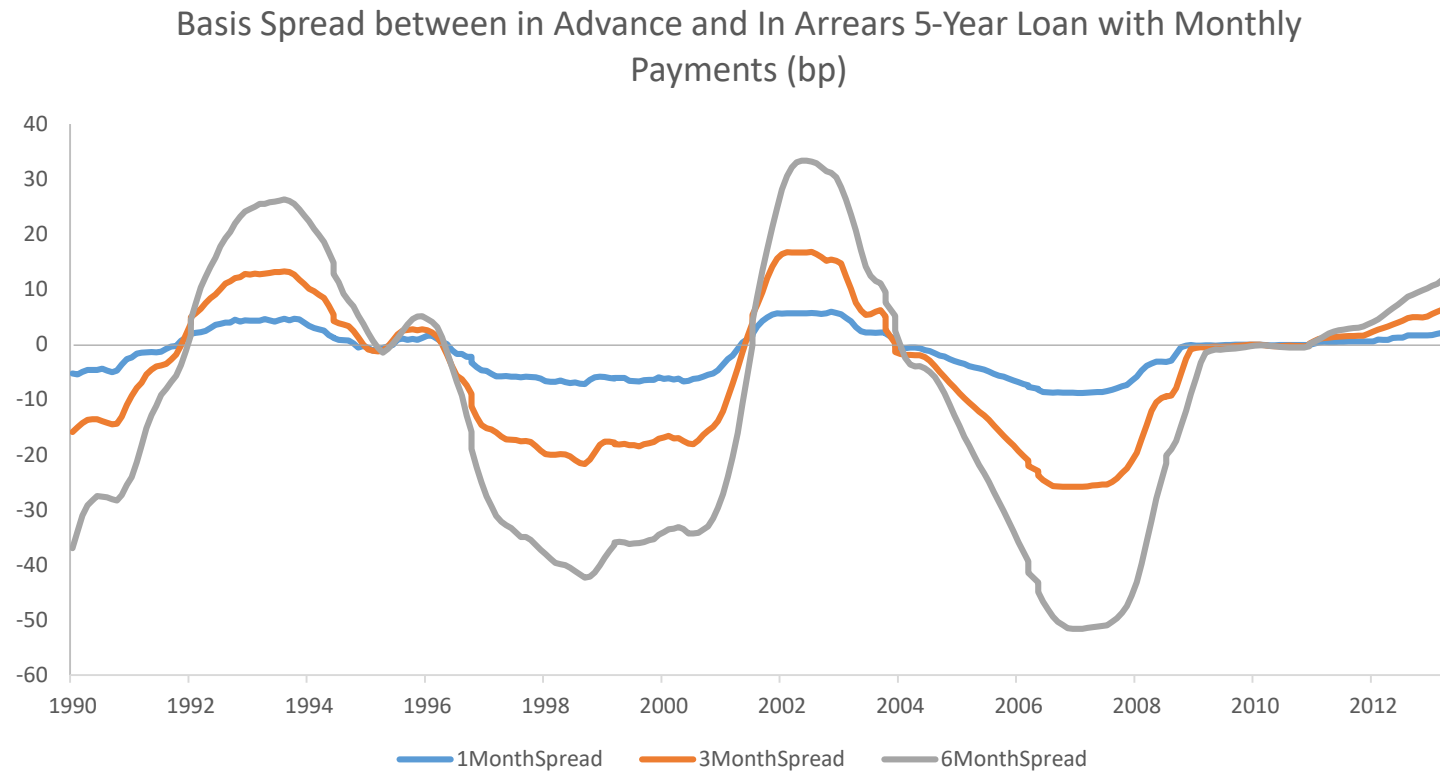
Difference between 1-Year LIBOR and the 1-month Average of 1-Year LIBOR 45 days prior



Source: ICE Benchmarks Administration; Federal Reserve Board staff calculations

In Arrears/In Advance (continued)

The amount of basis between In Advance and In Arrears depends on the frequency of interest periods. With a one-month reset, the basis is comparable to the amount of basis between simple and compound averaging. Even at 3- or 6-month resets the basis is limited and averages out to zero over longer periods of time.



Models for Using RFRs

The FSB and National Working Groups are looking at several models for using overnight risk-free rates in cash products. There are several different variants of both in Arrears and in Advance conventions, as well as potential hybrid conventions that attempt to bridge the difference between the two by allowing for advance notice while also allowing for complete or almost complete hedging of contemporaneous rate movements.

- **In Arrears**

- *Plain*: Used averaged rate over current interest period, paid on last day of the period (day T)
- *Payment Delay*: Use averaged rate over current interest period, paid k days after day T (Note: ISDA's conventions for SOFR swaps use a 1-day payment delay)
- *Lookback*: Use averaged rate over current interest period lagged k days (a 3-5 day lookback has been used in SONIA FRNs)
- *Lockout*: Use averaged rate over current period with last k rates set at the rate for day $T-k$ (a 3-5 day lockout has been used in most SOFR FRNs).

- **In Advance**

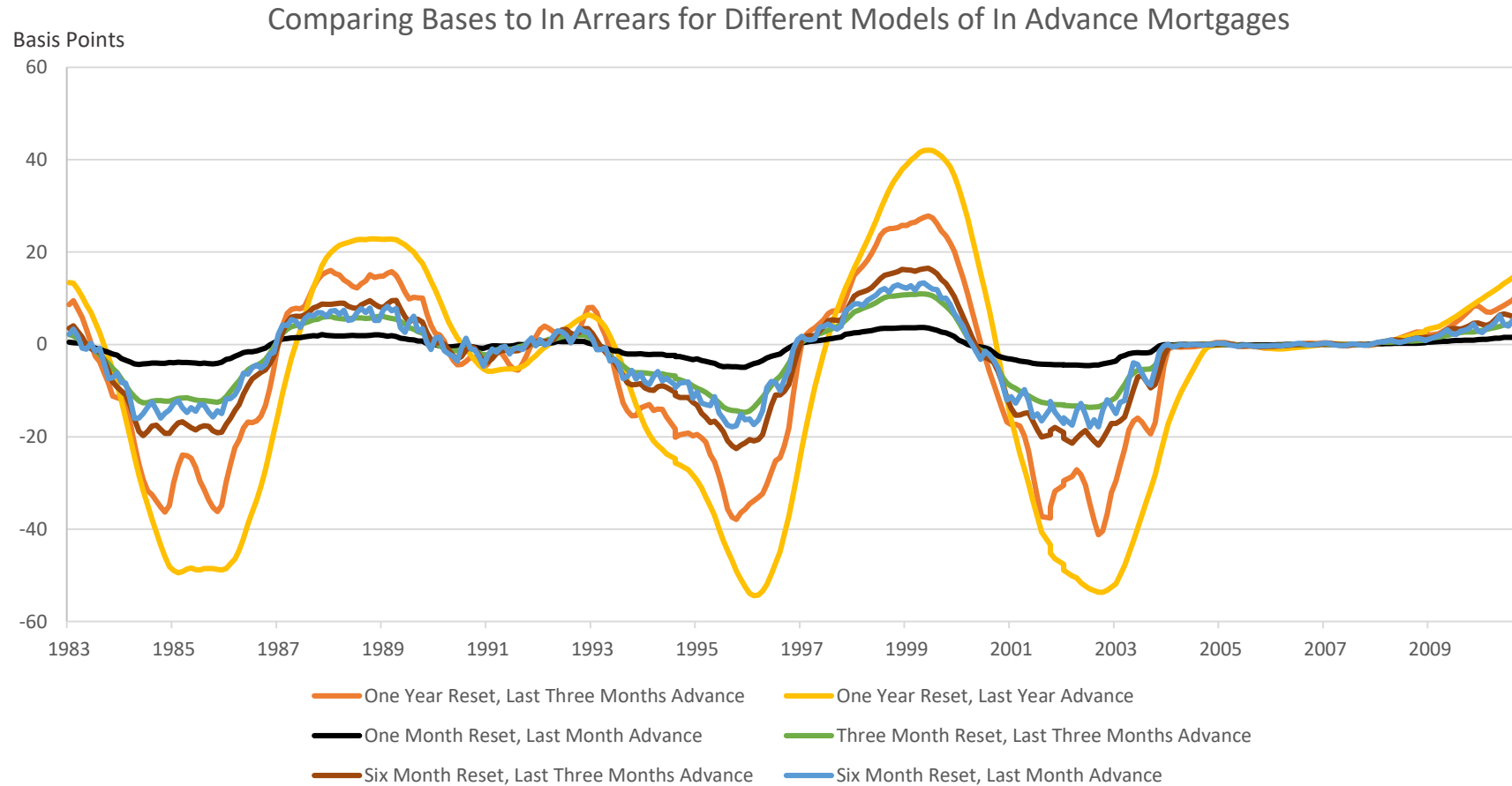
- *Last Reset*: Use averaged RFR from the last interest reset period as rate for current reset period
- *Last Recent*: Use averaged RFR from a shorter recent period as rate for current reset period

- **Hybrid Models**

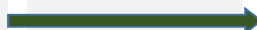
- *Principal Accrual*: Payments set *In Advance*, principal and interest accrue *In Arrears*
- *Interest Rollover*: Payments set *In Advance*, any missed interest relative to *In Arrears* is rolled over into the next payment period.

Models of In Advance

Using “Last Reset” with a shorter reset period and/or Using “Last Recent” can substantially cut the basis to relative to In Arrears



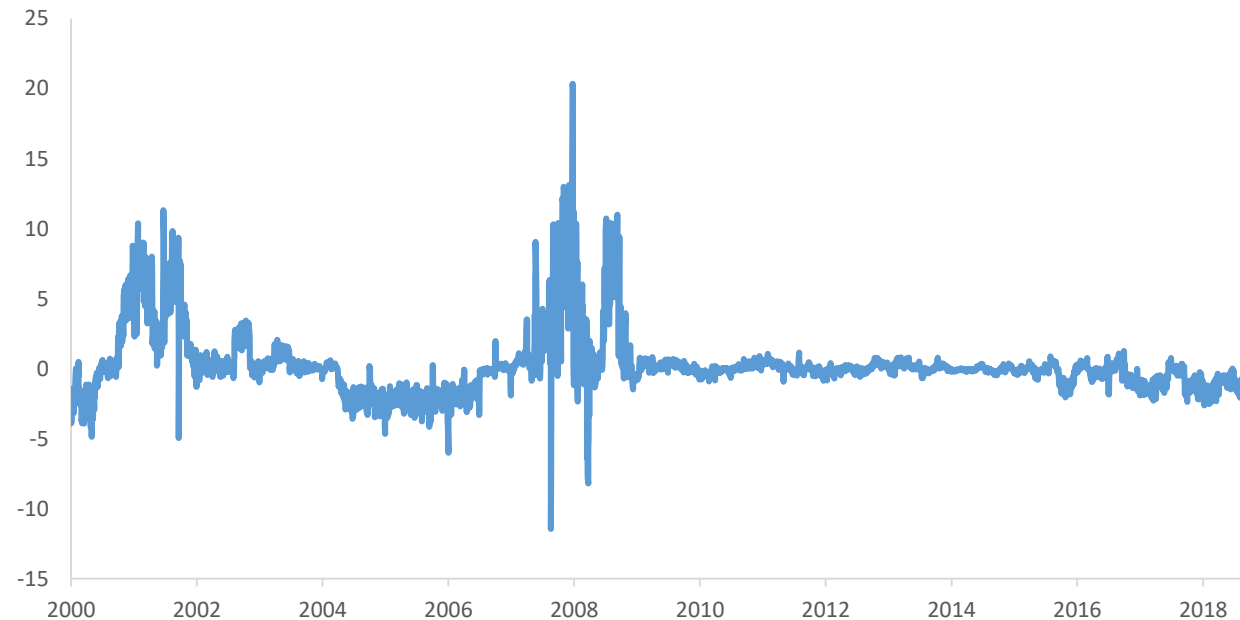
Models for Using SOFR in Arrears

	Day 1 (First Day of Interest Period)	Day 2	...	Day T-2	Day T-1	Day T (Last Day of Interest Period)	Day T+1 (First Day of Next Period)	Day T+2
		SOFR for Day 1 Published		SOFR for Day T-3 Published	SOFR for Day T-2 Published	SOFR for Day T-1 Published	SOFR for Date T Published	
Plain Arrears	Use SOFR for Day 1	Use SOFR for Day 2	...	Use SOFR for Day T-2	Use SOFR for Day T-1	Use SOFR for Day T	Payment Due	
Arrears with <u>Payment Delay</u>	Use SOFR for Day 1	Use SOFR for Day 2	...	Use SOFR for Day T-2	Use SOFR for Day T-1	Use SOFR for Day T	 OIS generally settle at T+2	Payment Due
Arrears with <u>1-Day Lockout</u>	Use SOFR for Day 1	Use SOFR for Day 2	...	Use SOFR for Day T-2	Use SOFR for Day T-1	Use SOFR for Day T-1	Payment Due	
Arrears with <u>1-Day Lookback</u>	Use SOFR for Day 0	Use SOFR for Day 1	...	Use SOFR for Day T-3	Use SOFR for Day T-2	Use SOFR for Day T-1	Payment Due	

In Arrears: Lockout Versus Lookback - Pros and Cons

Payment Delays or Lookbacks are consistent with ISDA compounding definitions and more easily hedged and does not skip any interest days. A lockout does skip some days and has some basis to the In Arrears model used in OIS swaps (below), On the other hand, for most of the interest period, the daily interest rate will correspond to the most recent published value of the RFR, which may be important to certain investors who do not have hedging needs.

Basis between Quarterly Compounded 3-day Lockout vs Pure Arrears (bp)



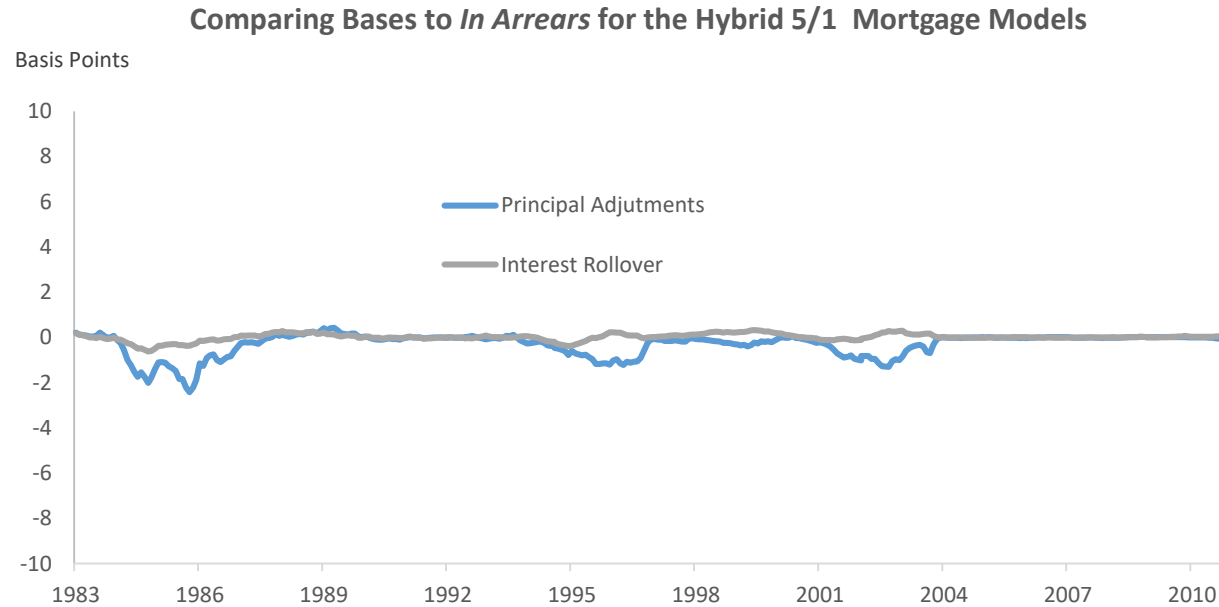
Models of In Arrears (Continued)

Most cash product issuances have used in Arrears frameworks, but there have been a wide array of choices between lookbacks, payment delays, and lockouts as well as compounding versus simple averaging.

Comparing Typical Conventions on SOFR and SONIA Floating Rate Notes and OIS			
	SOFR FRNs	SONIA FRNs	SOFR and SONIA OIS
In Arrears/In Advance	In Arrears	In Arrears	In Arrears
Averaging	Generally simple average, but some issuances have used compound averages	Compound Average	Compound Average
Payment Delay	None (Payment due next business day after Accrual Period ends)	None (Payment due next business day after Accrual Period ends)	One business day (Payment due two business days after accrual period ends)
Lookback	One business day	5 business days	None
Lockout/Suspension Period	Generally 2 business days	None	None

Hybrid Models

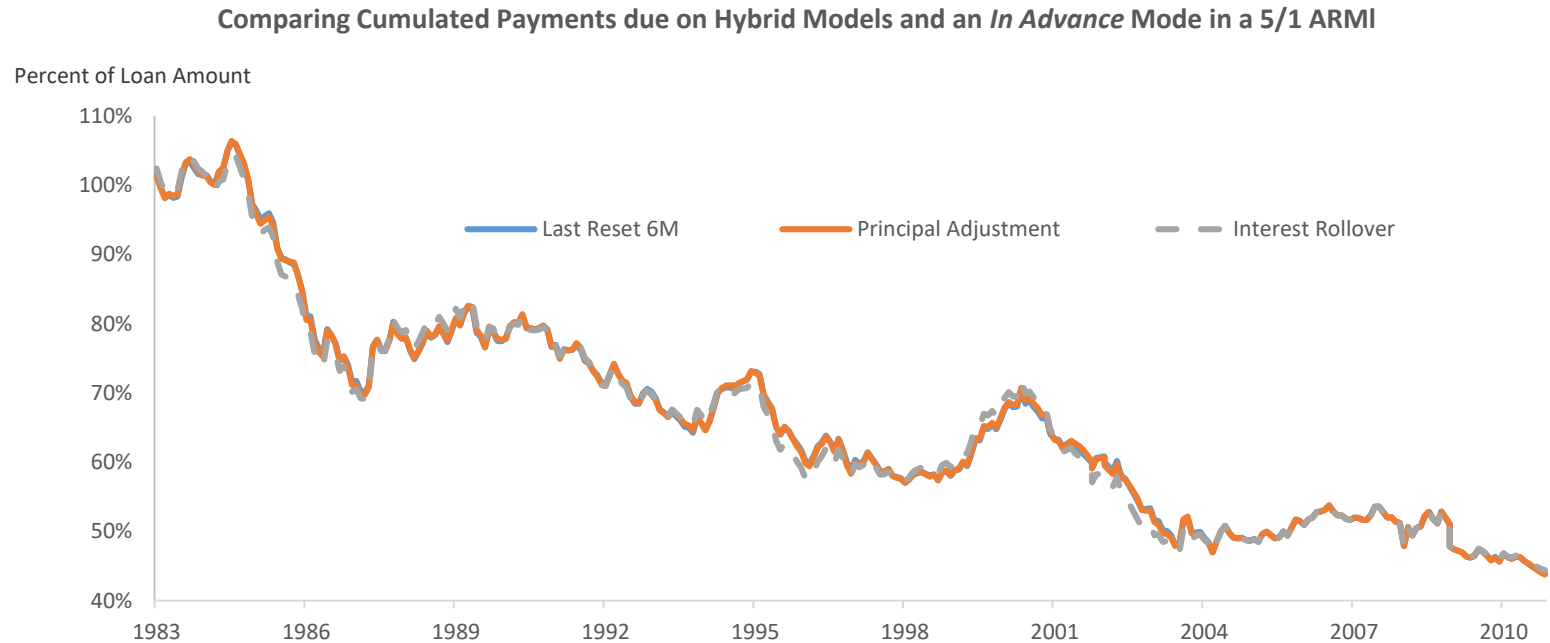
Either of the Hybrid Models can substantially further cut the basis relative to a pure In Arrears baseline, even for a product with a less frequent reset such as 5/1 ARM, while still allowing borrowers to know their payments at the start of the interest period. The Principal Accrual method can avoid negative amortization through a rate cap that guarantees that principle owed never rises at the cost of a small increase in the basis.



Source: Federal Reserve Bank of New York, Haver; Federal Reserve Board staff calculations

Hybrid Models (cont'd)

These models don't materially alter the cumulated payments that a borrower would make relative to a basic Last Reset In Advance Product. While they would be a new form of product and may not be practical for a consumer product such as ARMs, they could be fairly easy to incorporate in to some business loans.



Source: Federal Reserve Bank of New York, Haver; Federal Reserve Board staff calculations