The Clock is Ticking: A Multi-Maturity Clock Auction Design for LIBOR Transition

MIT MANAGEMENT SLOAN SCHOOL

Haoxiang Zhu

Associate Professor of Finance, MIT Sloan

Faculty Research Fellow, NBER

Securities and Exchange Commission, August 2019

Unsustainable LIBOR

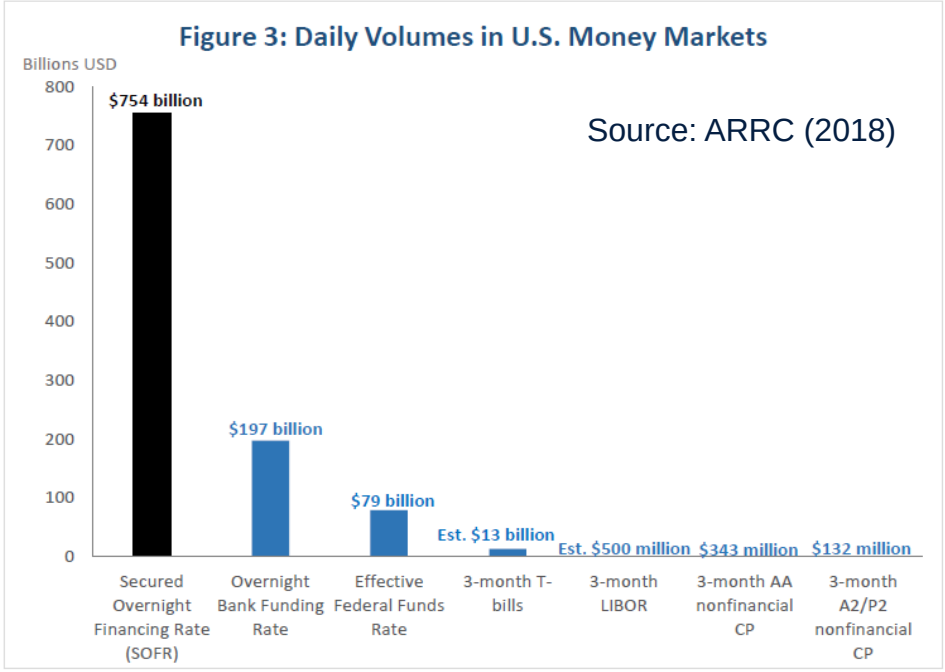
- LIBOR is a survey-based interest rate benchmark.
- $Billions of fines for LIBOR manipulation
- LIBOR is no longer viable for the scarcity of underlying transactions, but exposures to it is large, in $trillions.
- After 2021, LIBOR could be discontinued.

Source: ARRC (2018)

		Volume (Trillions USD)	Share Maturing By: End 2021	End 2025	After 2030	After 2040
Over-the-Counter Derivatives	Interest rate swaps	81	66%	88%	7%	5%
	Forward rate agreements	34	100%	100%	0%	0%
	Interest rate options	12	65%	68%	5%	5%
	Cross currency swaps	18	88%	93%	2%	0%
Exchange Traded Derivatives	Interest rate options	34	99%	100%	0%	0%
	Interest rate futures	11	99%	100%	0%	0%
Business Loans[2]	Syndicated loans	1.5	83%	100%	0%	0%
	Nonsyndicated business loans	0.8	86%	97%	1%	0%
	Nonsyndicated CRE/Commercial mortgages	1.1	83%	94%	4%	2%
Consumer Loans	Retail mortgages[3]	1.2	57%	82%	7%	1%
	Other Consumer loans	0.1	---	---	---	---
Bonds	Floating/Variable Rate Notes	1.8	84%	93%	6%	3%
Securitizations	Mortgage -backed Securites (incl. CMOs)	1.0	57%	81%	7%	1%
	Collateralized loan obligations	0.4	26%	72%	5%	0%
	Asset-backed securities	0.2	55%	78%	10%	2%
	Collateralized debt obligations	0.2	48%	73%	10%	2%
Total USD LIBOR Exposure:		**199**	**82%**	**92%**	**4%**	**2%**

The new US risk-free rate (RFR) is SOFR

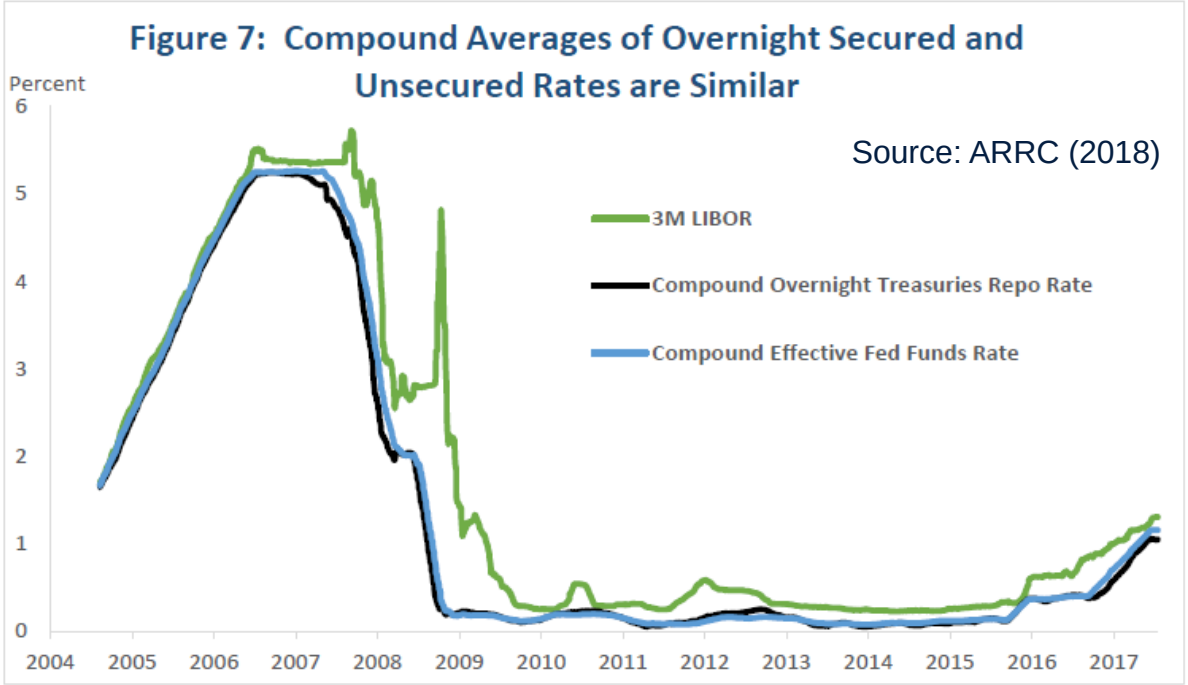
- SOFR is based on Treasury repo transactions, as a trimmed median.
- >$700 billion daily underlying volume
- 3-month LIBOR volume is < 1/1000th of SOFR volume



Average volumes over 2017H1, with the exception of 3-month T-bills, which are preliminary estimates from available FINRA Trade Reporting and Compliance Engine (TRACE) data over August and September 2017. 3-month volumes are based on all transactions with remaining maturities between 80 and 100 calendar days or 41-80 business days. Source: Federal Reserve Bank of New York; Financial Industry Regulatory Authority; DTCC Solutions LLC, an affiliate of the Depository Trust & Clearing Corporation; and the Board of Governors of the Federal Reserve System.

USD LIBOR vs repo rate

- LIBOR involves credit risk; SOFR does not.
- LIBOR is forward looking term rate; SOFR is an overnight rate known next day.



Forward Compounded Repo and Fed Funds Effective Rates are compound geometric averages of daily rates over the subsequent quarter. Repo rate data: Aug 2014-2017 from the Federal Reserve Bank of New York (link to data), prior data from ICAP/NEX (source: Bloomberg series IREPUSOP Index); Effective Fed Funds Rate: Federal Reserve Bank of New York; LIBOR: ICE Benchmark Administration.

LIBOR transition at the global scale

[2] Developments regarding Interest Rate Benchmarks across Jurisdictions (five LIBOR currencies)

	US dollar	Sterling	Swiss Franc	Euro	Japanese Yen
IBOR	LIBOR (Possible discontinuance after end-2021)	LIBOR (Possible discontinuance after end-2021)	LIBOR (Possible discontinuance after end-2021)	LIBOR (Possible discontinuance after end-2021) EURIBOR (To be reformed by 2019 Q4)	LIBOR (Possible discontinuance after end-2021) TIBOR (Reform completed in July 2017)
RFR	Secured Overnight Financing Rate (SOFR)	Sterling Overnight Index Average (SONIA)	Swiss Average Rate Overnight (SARON)	Public consultation completed (Note 1)	Tokyo Overnight Average Rate (TONA)
Deliberating Body (Secretariat)	Alternative Reference Rates Committee (FRB&NY Fed)	Working Group on Sterling Risk-Free Reference Rates (BOE&FCA)	National Working Group on Swiss Franc Reference Rates (SNB)	Working Group on Euro Risk-Free Rates (ECB)	Cross-Industry Committee on Japanese Yen Interest Rate Benchmarks (Bank of Japan)

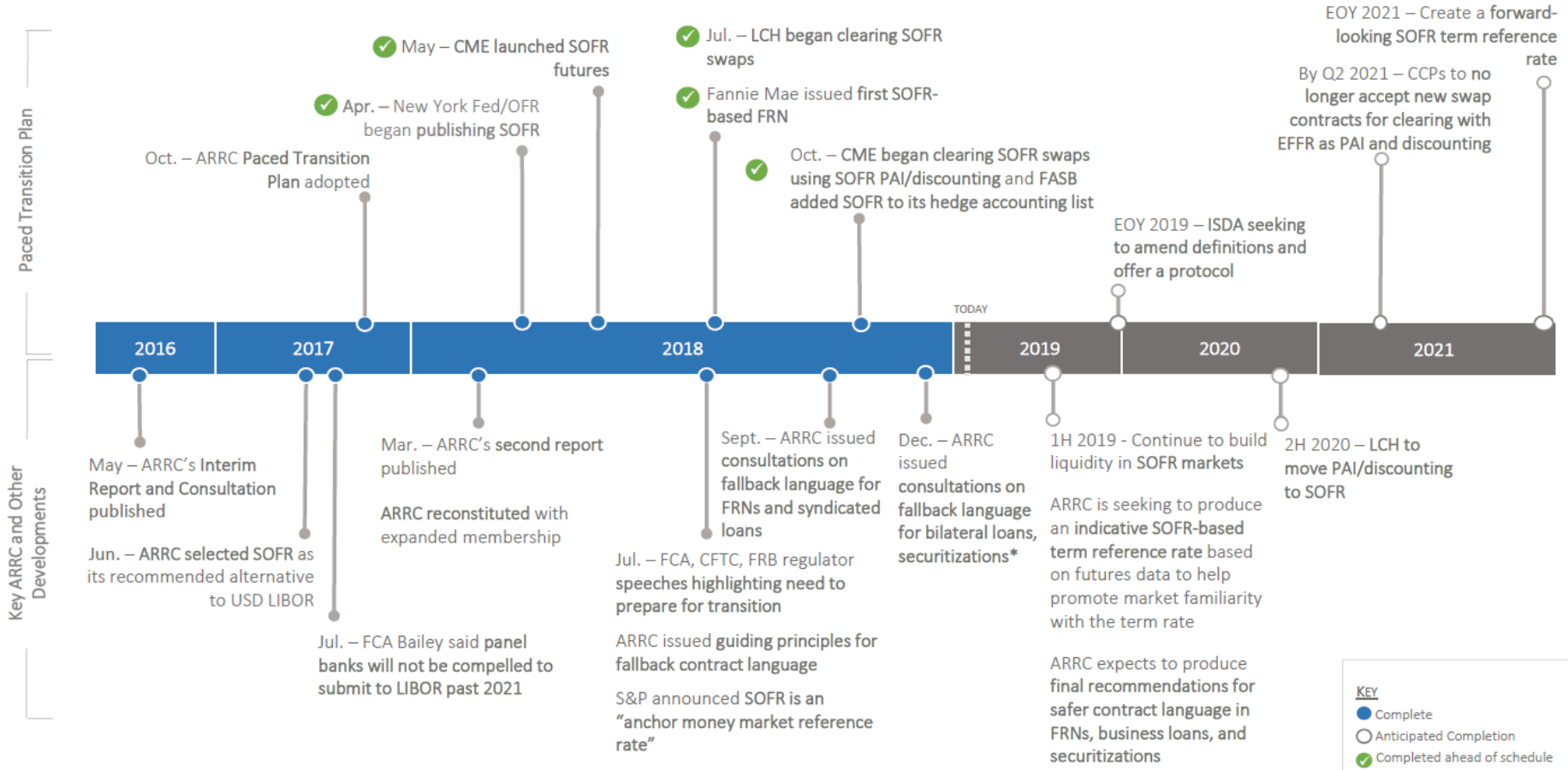
Source: Bank of Japan

Legal + economic solutions

- Legal & operational:
  - LIBOR fallback language and new SOFR contract language
  - Getting the plumbing ready for new RFR contracts, e.g. clearing
- Economic:
  - Creating liquidity for new RFR (e.g. swaps and bonds + loans)
  - Moving legacy LIBOR contracts to new RFR

Transition from U.S. Dollar LIBOR – Timeline

The Alternative Reference Rates Committee (ARRC) was originally convened in November 2014. Significant progress has been made to date.



**ARRC expects to consult on fallback language for other cash products*

Source: ARRC (2019)

As of 1/30/19

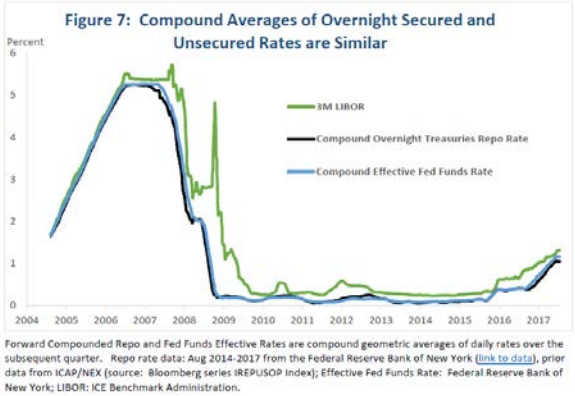
Does LIBOR fallback solve the problem of legacy contracts?

- Some have argued that new legal languages for fallback solve the legacy contract problems.
  - If LIBOR is discontinued, the legacy LIBOR contracts become SOFR contracts by fallback.
- But this view overlooks/underestimates economic problems:
  - Fallback will *define* LIBOR – tail wags the dog
  - LIBOR loses its ability to capture current market conditions
  - Value transfer upon fallback trigger

Why LIBOR fallback is insufficient

A hypothetical example

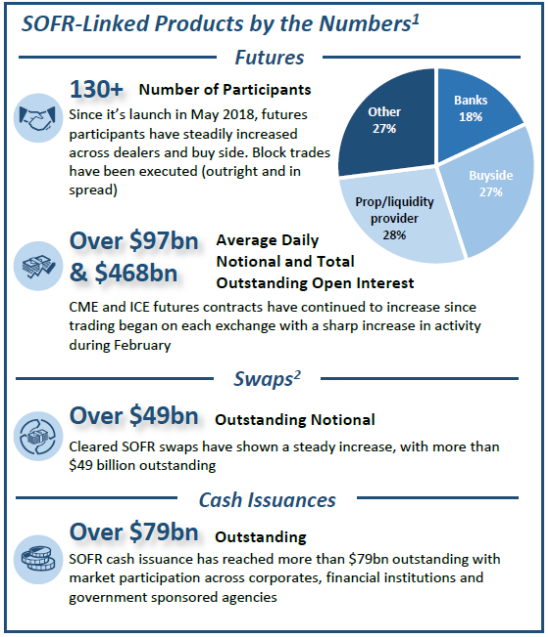
- In late 2021, the market agrees that LIBOR will discontinue shortly.
- LIBOR fallback plan dictates that upon cessation, “LIBOR” will be replaced by SOFR plus 10-year history average of LIBOR-SOFR spread (e.g. 20 bps).
- The market experiences a severe funding squeeze that would normally lead to a 100 bps LIBOR-SOFR spread.
- What is the market LIBOR? Despite the funding squeeze, LIBOR will trade at SOFR + 20 bps, the fallback/historical rate, by no arbitrage.
- LIBOR loses its information content about credit risk.
- LIBOR receivers will lose value of ~80 bps.



Forward Compounded Repo and Fed Funds Effective Rates are compound geometric averages of daily rates over the subsequent quarter. Repo rate data: Aug 2014-2017 from the Federal Reserve Bank of New York (link to data), prior data from ICAP/NEX (source: Bloomberg series IREPUSOP Index); Effective Fed Funds Rate: Federal Reserve Bank of New York; LIBOR: ICE Benchmark Administration.

We still need an economic solution

- The economic solution to LIBOR legacy contracts is to replace them by SOFR contracts.
- This requires a liquid underlying SOFR markets, but SOFR liquidity is not yet sufficient.
  - SOFR futures have liquidity up to ~2 years.
  - SOFR swaps have low volume.
  - SOFR FRNs have short maturities up to 3 years.
  - SOFR-linked preferred stocks start to be issued.



Source: ARRC (2019)

Outline

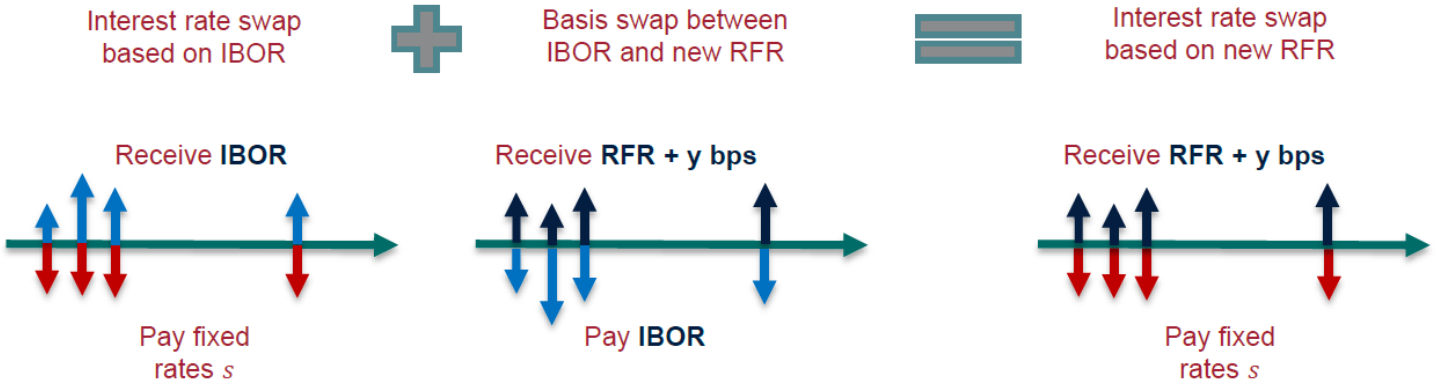
- I propose a clock auction design to replace legacy LIBOR contracts and help build liquidity for new RFR.
- I also discuss the role of the official sector in LIBOR transition.

A Clock Auction Design for LIBOR Transition

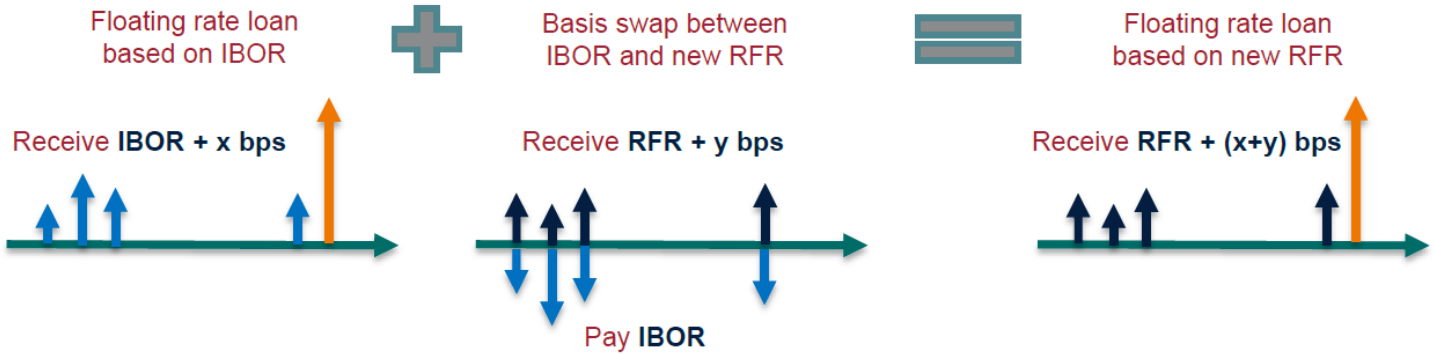
(using SOFR as example)

Multi-maturity clock auction

- This auction finds the spread adjustments to replace LIBOR cash flows to SOFR cash flows at various maturities.
- Adding the basis swap and clearing/compressing it together with the original swap ⇔ replacing IBOR in old contract by RFR + spread



- Cash product is similar, but loans/bonds and basis swaps are not cleared together. The auction does not eliminate LIBOR cash flows. It is more of a tool for hedging LIBOR exposure.



Multi-maturity clock auction
(1) Start

Maturity	2y	5y	7y	10y
Spread (bps)	0	0	0	0

- Various maturities open simultaneously.
- Example of a maturity grid: {0.25y, 0.5y, 0.75y, 1y, …, 30y}
  - Multiple maturities encourage arbitrage across maturities.
  - The grid could be made as dense or sparse as desired—driven by demand.
  - If a participant's favorite maturity is not there, pick the nearest one.
  - For simplicity of illustration, I only show a sparse grid of {2y, 5y, 7y, 10y}.
- LIBOR-SOFR spread on each maturity starts at zero. All spreads are displayed to all bidders—as if on digital clocks.
  - Transparency attracts liquidity providers.

Multi-maturity clock auction
(2) Bidding

Maturity	2y	5y	7y	10y
Spread (bps)	0	0	0	0
Demand ($b)	0	0	0	0
Supply ($b)	100	200	200	250

- If the current spread on maturity j is s_j, each participant submits a quantity q_j.
- $q_j > 0$ means demand: pay LIBOR, receive SOFR $+s_j$.
- $q_j < 0$ means supply: pay SOFR + s_j, receive LIBOR.
- The process allows limit orders and market orders—they are automatically translated into bids at each step.

Multi-maturity clock auction
(3) Price discovery

Maturity	2y	5y	7y	10y
Spread (bps)	20	20	20	20
Demand ($b)	0	0	0	0
Supply ($b)	100	200	200	250
Demand ($b)	75	120	150	150
Supply ($b)	80	180	180	200

- As long as Total Supply > Total Demand on a maturity, the auctioneer* raises the spread by a pre-defined increment.
- The new spreads will refresh the supply and demand.
- This iteration repeats.
- Since LIBOR > SOFR in the long run, s_j should come out positive.

Multi-maturity clock auction
(4) Closing

Maturity	2y	5y	7y	10y
Spread (bps)	25	30	32	35

Demand ($b)	77	160	169	178
Supply ($b)	78	158	170	180

- Once Demand and Supply are sufficiently balanced on all maturities (say within 5% of each other), the auction closes on all maturities simultaneously.
  - Spreads across maturities are linked by arbitrage relations.
- Heavy side is rationed (e.g. pro-rata or time priority).

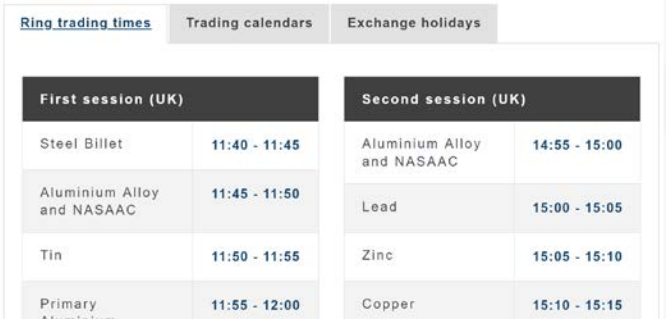
Multi-maturity clock auction
(5) Post auction

Maturity	2y	5y	7y	10y
Spread (bps)	25	30	32	35

- Compression
  - Legacy LIBOR cash flows and LIBOR-SOFR basis swap are compressed together, to eliminate the misalignment of cash flow dates.
  - Liquidity providers could end up with nonzero LIBOR-SOFR basis swap.
  - Compression services needs to be fairly priced (or subsidized).
- Voluntary conversion at the final auction spreads
  - After the auction, if two counterparties not in the auction both find the price acceptable, they can convert their legacy LIBOR contracts into SOFR ones at the market clearing price.

Core properties of the auction

- No arbitrage
  - Mispricing is corrected by liquidity providers due to transparency and simultaneity of auctions across maturities.
- Simplicity of strategies
  - Submit demand/supply at a given price, instead of coming up with prices.
- Coordination and flexibility
  - Start with short maturities, then extend to longer maturities



Successful clock auctions in practice

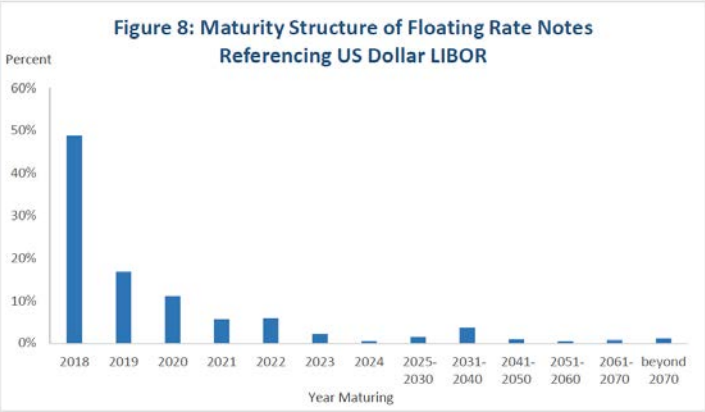
- Spectrum auctions since early 1990s
  - Bidders bid on multiple licenses that are substitutes or complements.
  - All prices are displayed and all licenses close simultaneously.
- Open and close auctions in equity markets are close to “multi-stock clock auctions”.
  - Before settlement prices are determined, indicative prices are shown to the market.
  - Market participants submit buy and sell orders in each stock into the respective auctions, given the indicative prices on all stocks. Then auctions closes at 4pm, simultaneously.
  - Closing auctions are now attracting more volume in equity markets.

Compression auction vs clock auction

- The key feature in both designs is about sourcing liquidity across maturities.
- Duffie (2017/18) compression auction uses the existing compression algorithms to search for matching maturities, subject to tolerances.
  - Party A wants 9 year maturity, Party B wants 11 year → Algo suggests 10 year.
- Zhu (2018) clock auction relies on transparent prices to attract liquidity providers who meet supply-demand imbalances across maturities.
  - Party A puts the order at 9 year, Party B puts the order at 11 year
    → Liquidity provider meets both and takes the basis risk

Design variables

- **What maturities?**
  - Perhaps use a dense enough maturity grid to cover popular maturities.
  - Example of FRN from ARRC (2018):



Design variables

- **Should supply-demand imbalance be displayed or hidden?**
  - My instinct is to have them displayed, maybe with some range but not the exact numbers.
  - Open auctions and close auctions on stock exchanges disseminate order imbalances before prices are finally determined.
- **How large are the spread increments?**
  - Increments should be large at the beginning of the auction and small toward the end.
  - Use data on price impact to come up with rules of thumb.

Design variables

- **How long does each round last? And how long does the whole auction last?**
  - It should be fast enough before market moves dramatically.
  - Desirable to run auction in “normal” times
  - Auctions in US equity markets use little time to run.
- **How closely should supply and demand match before auction finishes?**
- **If rationing is needed, which method?**
  - Pro-rata, time priority, size priority

Design variables

- **Who would run these auctions?**
  - Exchanges or clearinghouses
  - Official sector (e.g. central banks) or industry groups (e.g. ISDA)
- **Should market participants be charged?**
  - A lower fee would generates more participation and less incentive to trade outside of the auction.
  - Post-trade compression and legal/operational costs should be kept low.

Encourage participation and bidding

- **How to attract participation?**
  - Auctions could start with dealers, then expand to buy-side and end users.
  - Allow “non-competitive” bids. Example: Pay LIBOR and receive SOFR + spread for $100M and 5-year, at the market clearing spread.
  - Allow “limit orders.” Example: A firm specifies “Bid to receive LIBOR and pay SOFR + spread for $200m as long as the spread is less than 30 bps and if maturity is between 4.5 years and 5.5 years”.
  - Non-competitive bids and limit orders can be easily translated into bidding strategies in clock auctions by an algorithm.

Encourage participation and bidding

- **What if participants withhold bidding until the very end?**
  - Time priority of allocation if rationing is required.
  - Explicit reward for early bids (rescinded if withdrawn)
  - Require that a bidder’s demand to pay (receive) the spread cannot go up (down) if spread goes up. This is similar to the “activity rule” in FCC spectrum auctions
  - In open and close auctions in US equity markets, certain types of orders cannot be entered close to the auction ending time.

Role of Official Sector for LIBOR Transition

Regulatory incentives

- Regulators could and have provided incentives:
  - Converting a legacy LIBOR contract to SOFR would not trigger Dodd-Frank-mandated margin rules, etc.
  - If a trading venue starts to offer LIBOR transition trades, it should be made easy to register this specific service as a SEF.
  - If part of a portfolio moves from LIBOR to SOFR, they become imperfect offset under Basel III rules. A temporary relief on LIBOR-SOFR offsets would ease the transition.
  - Hedge accounting recognition of SOFR
- Legal clarity related to LIBOR-SOFR conversion, especially on consumer products such as mortgages
  - LIBOR + 200 bps → SOFR + 220 bps: does that represent a rate increase?

Issue Treasury securities linked to new RFRs

- US Treasury started to issue 2-year FRNs (indexed to 13-week Treasury bill auction yield) in 2014.
- How about issuing SOFR-linked FRNs for longer maturities? 5-30 years.
- Auction variable is spread over (compounded) SOFR.
- Daily SOFR can be compounded to the coupon frequency, and coupons may be delayed by a few months to make payments perfectly predictable.
- An investor/intermediary holding SOFR-linked Treasury FRNs receives SOFR + spread and expects to pay SOFR for financing. This structure hedges out fluctuations in repo rates and could improve the pricing of Treasuries.
- To persuade CFOs to use SOFR-linked notes, Treasury Department needs to lead.

Using new RFRs in monetary policy

- Pay SOFR as interest on excessive reserves (IOER).
- Target SOFR in monetary policy.
- The Fed Fund rate is less informative now because of limited access.

Summary

- LIBOR cessation is a real risk.
- The legal/operational side of LIBOR transition is progressing steadily.
- But liquidity in LIBOR replacement is not yet sufficient, and legacy contracts remain a challenge (especially cash products).
- I propose an auction design to help liquidity creation in new RFR and help LIBOR transition—contributing a small piece to a giant puzzle.
- The official sector holds very good cards to help liquidity creation in new RFRs; it just needs to be willing to use them.