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Shedding Light on the Dynamics of the Secured Overnight Financing Rate (SOFR)

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ABSTRACT

Investigating the transition from LIBOR to SOFR and considering the documented volatility of SOFR, this study examines the dynamic nature and potential drivers of the SOFR by analyzing both the SOFR-EFFR and SOFR-IOER spreads. The results reveal noteworthy correlations between the SOFR and end-of-month anomalies and Federal Reserve market interventions in the repo market. These effects persist even after controlling for other variables, such as the amount of outstanding Treasury securities, Treasury General Account balance, and net repo transactions by primary dealers. Investors in SOFR-linked instruments should be mindful of the possible impact of these factors.

Keywords: Secured Overnight Financing Rate (SOFR), London Interbank Offered Rate (LIBOR), Repurchase agreement (repo), Effective Federal Funds Rate (EFFR), Interest on Excess Reserves (IOER).
JEL classification: G12

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1 Introduction

In light of the transition from LIBOR to the Secured Overnight Financing Rate (SOFR), which stands as one of the major financial reforms in the past decade, we undertake a study to explore the dynamics of SOFR. While SOFR is based on repo rates, a familiar metric to participants in the financial market, its calculation is relatively new and has only been officially published since 2018. Therefore, this paper adds to the limited body of research investigating the dynamics of SOFR. The significance of our work is further emphasized by the recent increase in the volatility of SOFR when compared to the Effective Federal Fund Rate (EFFR) or Interest on Excess Reserves (IOER).

Using time-series analysis with both daily and weekly data, we have uncovered two noteworthy observations. Firstly, we observe a spike in the SOFR-EFFR spread (and SOFR-IOER spread) at the end of each month. This phenomenon appears to correspond to periods of cash shortages and balance-sheet constraints, as discussed by Klingler and Syrstand (2021), and Anbil et al. (2021). Secondly, we find a significant association between SOFR and Federal Reserve interventions in the repo market. This relationship remains evident even after considering other variables studied in previous research, such as the total amount of outstanding Treasury securities, the Treasury General Account, and primary dealers' transactions in the repo market. It is important to note that our analysis primarily focuses on illustrating correlations between these factors and SOFR, and it does not establish direct causal relationships.

The remaining sections of the paper are structured as follows. Section 2 reviews the relevant literature. Section 3 provides detailed information about the data and presents descriptive statistics. Section 4 presents the empirical analysis. Section 5 discusses the findings and offers policy recommendations. Finally, Section 6 concludes the paper.

2 Literature Review

In mid-September 2019, SOFR surprisingly jumped by about 280 basis points, soaring from 2.43% to 5.25%, while the 90-day average increased by approximately 5 basis points on the same day. The impact of this 5-basis-point change in the interest rate on assets worth trillions of dollars was enormous. Additionally, due to the averaging method, the distortion had a counter-effect (a decrease of 5 basis points) on Day 91.

The reasons behind this unusual spike in SOFR in September 2019 were extensively investigated. Several studies suggest that the unexpected upturn resulted from a perfect storm caused by a liquidity crunch, where the supply of cash available for lending contracted while the demand for cash increased. This situation has been detailed in studies by Afonso et al. (2020), Anbil et al. (2020), Ihrig et al. (2020), and Correa et al. (2020).

The turmoil began on the supply side with a decrease in the Federal Reserve balance sheet during the Fed's balance-sheet normalization (Correa et al. 2020). It was further amplified by the reserve-draining intermediation activities of global banks (Avalos et al. 2019) and money-market mutual funds (Afonso et al. 2020; Anbil et al. 2020). The sharp reduction in global banks' lending activity caused the repo rate to spike, and the banks took advantage of the situation, reaping an enormous windfall. To defend themselves, they claimed that regulators' liquidity requirements restricted their lending possibilities. In an interview with Bloomberg in October 2019, Jamie Dimon, Chief Executive Officer of J.P. Morgan, stated that J.P. Morgan had both the cash and the willingness to lend in mid-September, but that regulations held them back.[3]

Several studies have highlighted the influence of calendar end dates on financial asset prices. Du et al. (2018) observe end-of-quarter effects on deviations from covered interest rate parity (CIP). Additionally, there is a substantial and growing body of literature that examines the limits of arbitrage between Treasury repo rates and the interest on excess reserves (IOER) rate. Han (2020) attributes the upward regime shift in spreads between IOER and the overnight funding rate to the segmentation of U.S. money markets in the repo market. Yang (2020) suggests that intraday payment delays cause repo rates to surge.

Correa et al. (2020) analyze how daily changes in repo-rate spreads respond to fluctuations in the Treasury's general-account balances and the Federal Reserve's holdings of Treasuries and Agencies in its System Open Market Account. Pozsar (2019) argues that Treasury issuances contribute to increased repo rates through the intraday payment timing channel. Duffie and Krishnamurthy (2016) point to frictions associated with imperfect competition and regulation. Copeland et al. (2021) demonstrate that the Federal Reserve's

[3] https://www.bloomberg.com/news/articles/2019-10-15/jpmorgan-felt-barred-from-calming-repo-market-by-regulations "We could not redeploy it into the repo market. We would have been happy to do it. It is up to the regulators to decide if they want to recalibrate the kind of liquidity, they expect us to keep in that account."

"balance-sheet normalization," which reduced aggregate reserves between 2017 and September 2019, amplified repo rate distortions, the severity of rate spikes, and intraday payment timing stress, culminating in a significant disruption in Treasury repo markets in mid-September 2019. They concluded that repo rates rose above efficient-market levels when the total reserve balances held at the Federal Reserve by the largest repo-active bank holding companies declined and that repo rate spikes are strongly associated with delayed intraday payments of reserves to these large bank holding companies.

Our explanatory variables are drawn from two studies exploring factors influencing repo rates. The first study by Correa et al. (2020) investigated how daily changes in repo-rate spreads responded to fluctuations in the Treasury General Account (TGA) balances and the Federal Reserve's holdings of Treasuries and Agencies in its System Open Market Account (SOMA). They identified three key drivers: quarter-ends, increases in Treasury General Account balances, and reductions in the Federal Reserve's System Open Market Account (SOMA) portfolio.

The second study by Klinger and Syrstad (2021) found that an increase in government debt led to a rise in SOFR due to a crowding-out effect, where investors preferred Treasury debt over lending money to banks. They also observed that SOFR was prone to upward spikes, particularly at quarter-ends and year-ends. According to Klinger and Syrstad (2021), the main driving factors were the amount of outstanding government debt and primary dealer net repo borrowing. An increase in Treasury debt corresponded to significant increases in SOFR, and higher primary dealer net repo borrowing elevated SOFR, reflecting heightened demand for repo funding from the financial sector.

Consistent with Correa et al. (2020), we included the Treasury General Account (TGA), the U.S. government's primary operational account held at the Federal Reserve Bank, as a driving factor for SOFR. As demonstrated in the literature, Treasury supply shocks, in terms of the net supply of Treasuries and changes in the TGA, could potentially impact repo rates. To examine whether Federal Reserve purchases (a source of Treasury demand) influenced SOFR, we used these explanatory variables to control for Treasury supply. Similarly, in line with Correa et al. (2020), who included the Federal Reserve's System Open Market Account (SOMA) portfolio, we also incorporated changes in the Federal Reserve's holdings of Treasury securities as a control variable.

Additionally, we incorporated PDREP (Change in USD billions in the net of repo and reverse-repo overnight transactions by primary dealers) as a control variable, following Klinger and Syrstad (2021). After considering these variables, we proceeded to examine the relationship between SOFR and the Federal Reserve's direct intervention in the Repo market. Furthermore, our study extended the examination period of the actual SOFR from its launch in April 2018 to June 2023, contributing to the existing literature by highlighting that spikes also occurred on month-ends, not solely restricted to quarter-ends.

3 Data and Descriptive Statistics

We utilized data from Bloomberg, the Federal Reserve Bank of New York, Federal Reserve Economic Data (FRED), and TreasuryDirect, covering the period from April 2018 to June 2023. Some explanatory variables were published daily, while others were available on a weekly basis. As a result, we conducted two sets of regressions: one using daily data and another using weekly data.

In the main regressions, we explain the spread between SOFR and EFFR, both representing overnight lending rates. SOFR is associated with lending rates backed by Treasuries as collateral, while EFFR represents uncollateralized overnight loans. Like LIBOR, neither SOFR nor EFFR are risk-free rates. To assess bank funding stress, analysts often examine the spread between LIBOR and the Overnight Index Swap (OIS) rate, considered a reliable indicator of the one-day risk-free rate. Market frictions and institutional factors may influence the EFFR itself. It consistently stays below the interest on excess reserves (IOER) rate because not all Fed fund participants earn the IOER. Consequently, the cash position of government-sponsored enterprises impacts the difference between EFFR and IOER. Additionally, an unusually low EFFR rate correlates with reverse repo borrowing by the Fed, as institutions like the Federal Home Loan Banks actively lend in both markets. Therefore, when the EFFR rate is low, it becomes more appealing to park funds in the Fed's reverse-repo facility. In this specification, we introduced the spread between IOER and EFFR as an independent variable.

As a robustness check, we considered a second dependent variable, namely the SOFR-IOER spread, which represents the difference between SOFR and IOER. Table 1 presents the definitions of the explanatory variables, their frequency, and the source of the data about them.

Independent variables	Definition	Frequency	Source
VSOFR	Volume in USD billions of SOFR transactions in the U.S. Treasury repo market	Daily	Federal Reserve Bank of New York
VIX	Implied volatility of the S&P 500 index using options over the next 30 days, calculated by the Chicago Board Options Exchange (CBOE).	Daily	Bloomberg
Treasury	Face value amount of Treasury securities outstanding	Daily	TreasuryDirect
FEDREP	Net overnight repo and reverse-repo agreements conducted by the Federal Reserve (USD billions)	Daily	Federal Reserve Economic Data (FRED)
PDREP	Net overnight repo and reverse-repo agreements conducted by the Primary Dealers on Treasury securities (USD millions)	Weekly	Federal Reserve Bank of New York
EMO	A dummy variable receiving the value of 1 at the end of each month and 0 otherwise	Daily	Authors' calculation
RRP	Reverse Repurchase Agreement rate	Daily	Federal Reserve Economic Data (FRED)
FEDTR	Change in USD billions in Federal Reserve holdings of U.S. Treasury securities[4]	Weekly	Federal Reserve Economic Data (FRED)
TGA	Change in Treasury General Account	Weekly	Bloomberg

Table 1. Independent variables. This table presents the definitions of the independent variables used in the empirical analysis, their frequency, and the data sources about them.

Figure 1 depicts the daily time series of the primary dependent variable (SOFR), EFFR, and the spread between them throughout the sample period. The figure shows that, on average,

[4] Purchases or sales of U.S. Treasury securities by the Federal Reserve Bank of New York (FRBNY) are executed in the secondary market or involve various official foreign and international organizations that hold accounts with the Federal Reserve. FRBNY's purchases or sales in the secondary market are exclusively carried out through primary dealers.

SOFR and EFFR are quite similar. However, notable increases in SOFR are evident on September 17, 2019, and at month-ends. Additionally, sharp spikes occurred in March 2020, coinciding with the onset of the pandemic. From March 2022, we observe a gradual increase in rates and negative spikes in the spread. Notably, the negative spikes do not coincide with month-ends.

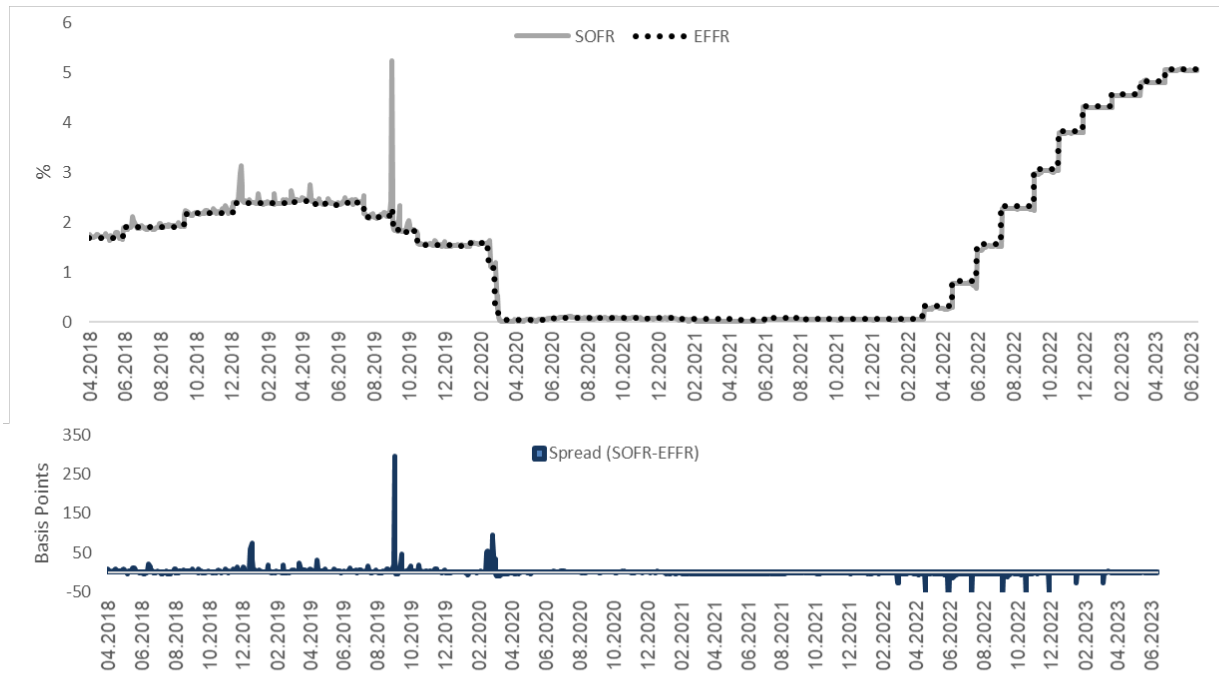

Figure 1. Daily SOFR and EFFR rates and their spread. This figure plots the time series of SOFR rates, EFFR rates, and the spread between the two. The sample period is April 2018–June 2023. Observations are daily. Source: Bloomberg and Federal Reserve Bank of New York.

Table 2 presents summary statistics for the levels of and changes in the independent variables. Our primary variable of interest is FEDREP. We notice that the mean change in this variable is relatively small, indicating stationarity. However, there is enough variation that allows us to investigate its relationship with the SOFR.

Level	Mean	S.D.	Min.	Max.	Obs. (N)
VSOFR (USD billions)	995	157	702	1,627	1,284
VIX	21.28	8.24	10.85	82.69	1,284
Treasury (USD billions)	19,635.17	3,279.84	14.759.0	24,503.0	1,284
FEDREP (USD billions)	-733.33	932.63	-2,553.72	99.38	1,284
IOEREFFR (%)	0.03	0.07	-0.68	0.85	1,284
RRP (%)	1.55	1.52	0.00	6.13	1,284
PDREP (USD millions)	387979.3	62390.38	261931	527103	272
FEDTR (USD billions)	4,066	1,472	2,081	5,771	272
TGA (USD billions)	622	476	48	1,792	272
Change					
VSOFR (USD billions)	-0.63	39.49	253	152	1,283
VIX	0.00	2.18	-24.86	17.64	1,283
Treasury (USD billions)	-7.55	26.61	-164	86	1,283
FEDREP (USD billions)	1.50	36.41	-365.45	245.39	1,283
IOEREFFR (%)	0.00	0.07	-0.85	1.00	1,283
RRP (%)	0.00	0.16	-3.56	3.13	1,283
PDREP (USD millions)	404.4502	29503.16	-110689	147481	271
FEDTR (USD billions)	10.08	40.05	-49.01	362.46	271
TGA (USD billions)	0.21	69.38	-220.77	363.99	271

Table 2. Summary statistics of the independent variables. This table presents the descriptive statistics of weekly levels and changes in the independent variables specified in Table 2. The variables included are as follows: VSOFR, which represents SOFR transactions; VIX, which denotes the VIX index; TREASURY, representing the amount of outstanding Treasury securities; FEDREP, indicating the net overnight repo and reverse-repo agreements conducted by the Federal Reserve; IOEREFFR, which represents the spread between IOER and EFFR; RRP, representing the reverse repo rate set on the reverse repo facility of the Federal Reserve; PDREP, indicating the net overnight repo and reverse-repo agreements conducted by primary dealers on Treasury securities; FEDRTR, representing the change in Federal Reserve holdings of Treasury securities; and TGA, indicating the change in Treasury General Account.

4 Empirical Analysis

4.1 Regressions with Daily Data

We conducted a time-series analysis employing the Dynamic Ordinary Least Squares (DOLS) method (Stock & Watson, 1993) to assess whether our chosen explanatory variables effectively explain the primary dependent variable, the SOFR-EFFR spread.[5] [6] To account for serial correlations in errors, we applied Newey and West's (1987) method. The estimated equation is as follows:

$$(1)\quad \mathrm{SOFREFFR}_t = \alpha_0 + \beta_o \mathrm{VSOFR}_t + \beta_1 \mathrm{VIX}_t + \beta_2 \mathrm{Treasury}_t + \beta_3 \mathrm{FEDREP}_t + \beta_4 \mathrm{IOEREFFR}_t + \beta_5 \mathrm{RRP}_t + \beta_6 \mathrm{EMO}_t + \sum_{j=-K}^{K} \varphi_{0j} \Delta \mathrm{VSOFR}_{t-j} + \sum_{j=-K}^{K} \varphi_{1j} \Delta \mathrm{VIX}_{t-j} + \sum_{j=-K}^{K} \varphi_{2j} \Delta \mathrm{Treasury}_{t-j} + \sum_{j=-K}^{K} \varphi_{3j} \Delta \mathrm{FEDREP}_{t-j} + + \sum_{j=-K}^{K} \varphi_{4j} \Delta \mathrm{IOEREFFR}_{t-j} + \sum_{j=-K}^{K} \varphi_{5j} \Delta \mathrm{RRP}_{t-j} + \varepsilon_t^i$$

where α_0 is the drift component and Δ is the first difference operator. K is the lag length. [7] SOFREFFR (SOFRIOER) is the spread between the SOFR rate and the EFFR (IOER) rate at time t. VSOFR is the volume of SOFR transactions. VIX is VIX index that reflects the volatility of the S&P500 index, and generally the level of uncertainty on capital markets. Treasury is the amount of outstanding Treasuries that we include in our regression in compliance with klinger and Syrstad (2021). FEDREP, our variable of interest is the net short-term repo and reverse-repo agreements conducted by the Federal Reserve. IOEREFFR is the spread between the IOER rate and the EFFR rate. We also include RRP, the Reverse Repurchase Agreement rate as an explanatory variable because it may reflect the Federal reserve policy to affect the repo rates on the repo and reverse repo facilities. EMO is a dummy variable that receives the value of 1 at the end of a month and 0 otherwise.

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[5] We conducted an Augmented Dickey-Fuller (ADF) test for a unit root in each regression residuals series. Based on this analysis, we rejected the null hypothesis of no cointegration relationship.

[6] We use a similar regression for the second dependent variable (SOFR-IOER spread) as well, omitting the explanatory variable ΔIOEREFFR.

[7] We used the Bartlett kernel with 31 lags, selected by the Newey-West method, for both regressions.

As shown in Table 3, the coefficient of FEDREP is statistically significant at the 1% level, suggesting a potential association between Federal Reserve market interventions and the SOFR rate spread over EFFR and IOER. Similarly, the coefficient of EMO is also statistically significant at the 1% level, indicating a positive relationship between month-end anomalies and the widening of the SOFR-EFFR spread in both models. However, it is important to note that our analysis does not establish a causal relationship between these factors and the SOFR rate spread.

Additionally, we have found that the coefficient of Treasury securities outstanding is statistically significant but negative. This finding contrasts with the study by Klinger and Syrstad (2021), which reported a positive association between this variable and SOFR. However, it should be noted that Klinger and Syrstad (2021) only found a positive effect of government debt when analyzing SOFR in the period from August 2014 to December 2019, and not for the equivalent rates for GBP (SONIA) and Euro (ESTR).

To verify the consistency of our results with previous literature, we conducted re-estimations of our models using early data on SOFR up to March 17, 2022 (before the EFFR started to increase). These regressions resulted in a positive and statistically significant coefficient for Treasury, which aligns with the findings of Klinger and Syrstad (2021). We believe that a regime change during our sample period may have contributed to this deviation from the results regarding Treasury observed in previous studies.

However, our comprehensive study of the two subperiods (before March 17, 2022, and afterward) concludes that all other coefficients maintain their sign and statistical significance in both subperiods. This suggests that the association between the Federal Reserve's interventions and the SOFR remains robust throughout our sample period, regardless of the changes in the coefficient of Treasury.[8]

[8] The regression results for the sub-periods are not displayed here due to brevity reasons but are available upon request.

Our analysis does not find any statistically significant association between the SOFR-EFFR spread and VIX or RRP. The results also hold robust for the secondary dependent variable, the SOFR-IOER spread.

	SOFR–EFFR spread	**SOFR–IOER spread**
VSOFR	**0.118***	0.132**
	(0.0452)	(0.0591)
VIX	-0.000183	-0.000468
	(0.000636)	(0.000774)
Treasury	**-8.49e-06***	**-9.07e-06***
	(2.96e-06)	(3.50e-06)
FEDREP	**3.35e-05***	**3.93e-05***
	(1.12e-05)	(1.07e-05)
IOEREFFR	**0.711***	//
	(0.189)	//
RRP	0.00711	0.00720
	(0.00435)	(0.00461)
EMO	**0.0422***	**0.0422***
	(0.0129)	(0.0132)
Constant	0.0334	0.0330
	(0.0477)	(0.0570)
N.	1,282	1,283
Adj. R-sq.	0.371	0.353

Table 3. Daily regressions. This table presents the regression results obtained through the Dynamic Ordinary Least Squares (DOLS) method. The primary dependent variable under consideration is the SOFR-EFFR spread. To ensure robustness, we also conducted a regression for the SOFR-IOER spread. The sample period covers April 2018 to June 2023. VSOFR is the of SOFR transactions, VIX is the VIX index, TREASURY is the amount of Treasury securities outstanding, FEDREP is the net overnight repo and reverse-repo agreements conducted by the Federal Reserve, IOEREFFR is the spread between IOER and EFFR, RRP is the reverse repo rate set on the reverse repo facility of the Federal Reserve, EMO is a dummy variable receiving value of 1 on month-ends and 0 otherwise.

Standard deviations are shown in brackets. *** indicates significance at the 1% level, ** at the 5% level.

4.2 Regressions with Weekly Data

We conducted a reexamination of the relationship between the SOFR-EFFR spread and the Federal Reserve's intervention in the open market. To achieve this, we utilized weekly data, enabling us to include additional variables available on a weekly basis. Prior research (Correa et al., 2020) has shown that Treasury supply shocks, represented by changes in the Treasury General Account (TGA), can have a significant impact on repo rates (i.e., SOFR). To thoroughly investigate the influence of Federal Reserve intervention in the repo market, it becomes essential to control for this type of Treasury supply, leading us to incorporate TGA as a control variable in our regressions.

Furthermore, in alignment with Klinger and Syrstad (2021), we also introduced control for the net repo-reverse-repo positions by primary dealers (PDREP). Given that the variable EOM is not applicable in weekly data, we excluded it from our analysis. Thus, based on these considerations, we estimated a weekly time-series regression using the Dynamic Ordinary Least Squares (DOLS) method (Stock & Watson, 1993): [9]

(2) $\mathrm{SOFREFFR}_{\,t} = \alpha_0 + \beta_0 \mathrm{VSOFR}_t + \beta_1 \mathrm{VIX}_t + \beta_2 \mathrm{Treasury}_t + \beta_3 \mathrm{FEDREP}_t + \beta_4 \mathrm{RRP}_t + \beta_5 \mathrm{PDREP}_t + \beta_6 \mathrm{FEDTR}_t + \beta_7 \mathrm{TGA}_t + \sum_{j=-K}^{K} \varphi_{0j} \Delta \mathrm{VSOFR}_{t-j} + \sum_{j=-K}^{K} \varphi_{1j} \Delta \mathrm{VIX}_{t-j} + \sum_{j=-K}^{K} \varphi_{2j} \Delta \mathrm{Treasury}_{t-j} + \sum_{j=-K}^{K} \varphi_{3j} \Delta \mathrm{FEDREP}_{t-j} + + \sum_{j=-K}^{K} \varphi_{4j} \Delta \mathrm{RRP}_{t-j} + \sum_{j=-K}^{K} \varphi_{5j} \Delta \mathrm{PDRERP}_{t-j} + \sum_{j=-K}^{K} \varphi_{6j} \Delta \mathrm{FEDTR}_{t-j} + \sum_{j=-K}^{K} \varphi_{7j} \Delta \mathrm{TGA}_{t-j} + \varepsilon_t^i$

In our analysis, we included two new explanatory variables, the Treasury General Account (TGA) and the Net overnight repo and reverse-repo agreements conducted by Primary Dealers on Treasury securities (PDREP). To ensure the reliability of our findings, we reestimated Equation (2) with the SOFR-IOER spread at time t as the dependent variable.

Table 4 shows that in both models, the coefficients of FEDREP are positive and statistically significant at the 1% and 5% levels, respectively, indicating a strong and positive association between the Federal Reserve's intervention in the repo market and the SOFR rate.

The TGA coefficient is statistically significant at the 5% and 10% levels only. We observed that in weekly observations, the volume of SOFR transactions (VSOFR) does not exhibit a significant association with the SOFR. However, the volume of net transactions of primary dealers (PDREP) is now positive and statistically significant, consistent with the findings of Klinger and Syrstad (2021).

Additionally, the coefficient of our control variable FEDTR (change in Federal Reserve holdings of Treasury securities) is statistically significant in both regressions but flips sign from positive (explaining SOFR-EFFR spread) to negative (explaining SOFR-IOER spread).

[9] We used the Bartlett kernel with 15 lags for the SOFR-EFFR spread regression and 18 lags for SOFR-IOER spread regression, both selected by the Newey-West method.

This result aligns with the findings of Correa et al. (2020) when also explaining the SOFR-IOER spread.

As for RRP, the coefficient is positive and statistically significant (at the 5% level) in explaining the SOFR-EFFR spread. This result may indicate the effectiveness of the Federal Reserve's interventions in the repo market. However, we do not find this relationship to be sufficiently robust.

	SOFR–EFFR spread	**SOFR–IOER spread**
VSOFR	0.0366	-0.0182
	(0.0602)	(0.0690)
VIX	0.00147	0.00359*
	(0.00244)	(0.00184)
Treasury	-1.61e-05	**2.59e-05*** **
	(1.40e-05)	(9.56e-06)
FEDREP	**0.000110*** **	**5.20e-05** **
	(3.75e-05)	(2.40e-05)
RRP	**0.0213** **	-0.00384
	(0.00865)	(0.00677)
PDREP	**4.03e-07** **	**3.60e-07*** **
	(1.69e-07)	(8.20e-08)
FEDTR	**6.81e-05** **	**-7.35e-05*** **
	(3.29e-05)	(2.55e-05)
TGA	**-8.95e-08** **	-4.77e-08*
	(3.61e-08)	(2.51e-08)
Constant	-0.105	**-0.363*** **
	(0.123)	(0.0861)
N.	271	271
Adj. R-sq.	0.264	0.640

Table 4. Weekly regressions. This table reports the means and standard deviations (in brackets). The main dependent variable is the SOFR–EFFR spread. For robustness, we also estimated the SOFR–IOER spread. VSOFR is the of SOFR transactions, VIX is the VIX index, TREASURY is the amount of Treasury securities outstanding, FEDREP is the net overnight repo and reverse-repo agreements conducted by the Federal Reserve, IOEREFFR is the spread between IOER and EFFR, RRP is the reverse repo rate set on the reverse repo facility of the Federal Reserve, PDREP is the net overnight repo and reverse-repo agreements conducted by primary dealers on Treasury securities, FEDRTR is the change in Federal Reserve holdings of Treasury securities, and TGA is the change in Treasury General Account. The sample period is April 2018-June 2023. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

5 Discussion

The transition from LIBOR to overnight rates presents significant challenges for the financial system, regulators, and market participants. A major concern lies in the high volatility of SOFR rates, similar to other overnight rates. This volatility was evident during the turmoil of mid-September 2019 and the Covid-19 shock in March 2020. On June 2, 2020, the ARRC Committee addressed this issue in its Frequently Asked Questions report. [10] To address the volatility of the new reference rate, the committee recommended utilizing 30-, 90-, and 180-day averages of the SOFR rate. It is evident that the 3-month SOFR rates are more volatile than the comparable LIBOR rates when calculated on a day-to-day basis. As shown in Figure 2A and Figure 2B, the 90-day average of the SOFR rate is even less volatile than the 3-month LIBOR rate.

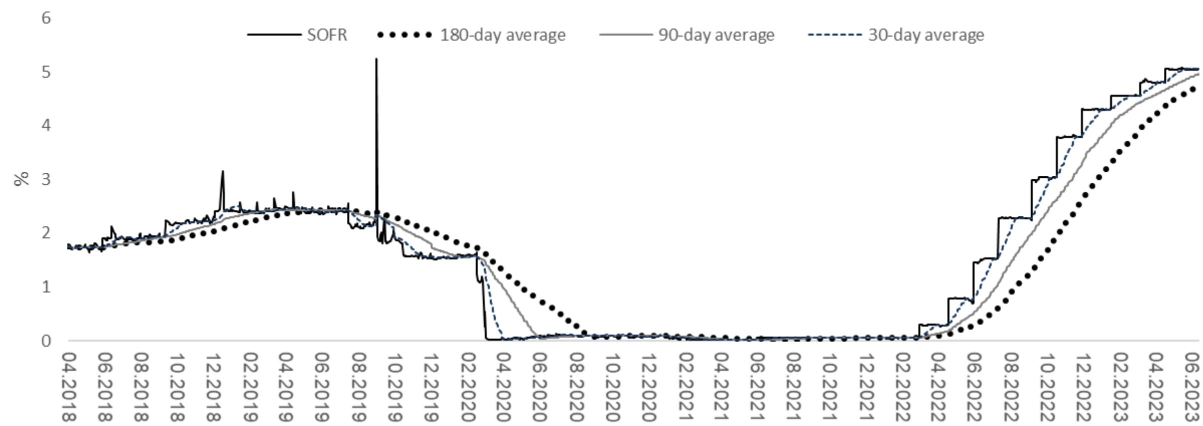

Figure 2A. SOFR and average SOFR. This figure plots the SOFR rate and the averages for 30, 90, and 180 days. Source: Bloomberg and Federal Reserve Bank of New York.

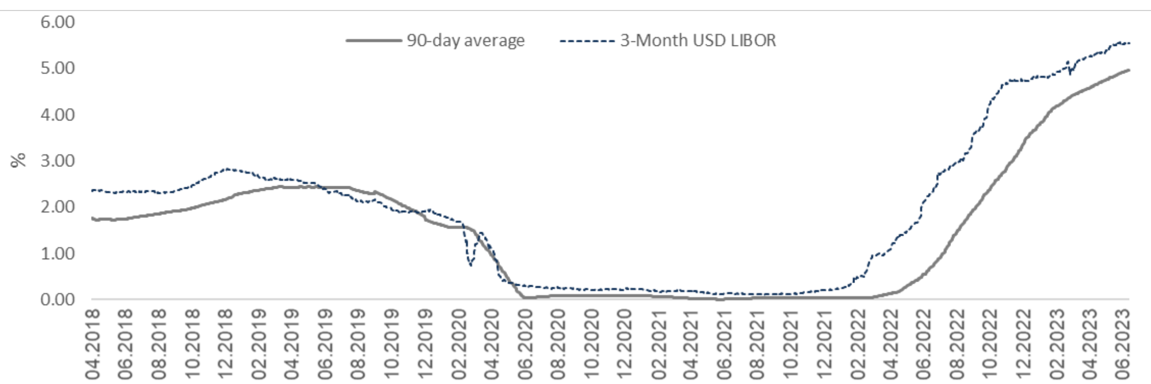

Figure 2B. 3-month LIBOR and 90-day SOFR average. This figure plots the 3-month LIBOR rate and the 90-day SOFR averages. Source: Bloomberg and Federal Reserve Bank of New York.

[10] See https://www.newyorkfed.org/medialibrary/Microsites/arrc/files/ARRC-faq.pdf

However, while it is true that the average SOFR rate is less volatile than the 3-month LIBOR rates, end-of-month friction has a significant influence on the 90-day average. Moreover, because of the averaging method, the distortion has a counter effect on Day 91 after every spike. To mitigate the distortion that the end-of month effect causes in the 90-day average calculation, it may be reasonable to exclude the end-of-month rates from the calculation.

In terms of the economic significance of our findings, our calculations indicate that a weekly change of one standard deviation in the amount of FED intervention corresponds to an approximate 10 basis point change in the SOFR. Comparatively, other factors associated with SOFR in the literature, such as FEDTR and TGA, lead to changes of 10 and less than 1 basis point in the SOFR, respectively. Additionally, we observe an average 4 basis point spike in SOFR during month-ends.

Considering that the SOFR remained below 2% for the vast majority of our sample period and, in some instances, was almost zero, our findings can be considered economically significant. This implies that investors with positions in SOFR-related instruments should take into account the expected changes in SOFR during month-ends and the correlation with the Fed's interventions.

6 Conclusions

For over half a century, LIBOR served as the primary reference rate for various financial instruments, including bonds, loans, mortgages, and derivatives. The transition from LIBOR to SOFR represents a significant and complex financial reform in recent times. However, the volatility experienced in the SOFR rate during September 2019 and March 2020 raises concerns about its stability. As this reference rate will play a crucial role in the near future, it becomes essential to identify the factors contributing to such volatility and explore potential measures to mitigate it.

Our paper reveals that end-of-month anomalies and the Federal Reserve's intervention in open-market operations are linked to changes in SOFR. This issue remains relevant, especially considering the Federal Reserve's ongoing unwinding of its quantitative-easing program. To reduce distortion, one potential approach could involve excluding the end-of-month rates when calculating the SOFR. Additionally, to prevent market dislocation during periods of stress when the supply of available cash for lending diminishes while demand increases, the Fed could incentivize banks to utilize the discount window by temporarily lowering the discount-window rate for a short and predetermined period.

References

Afonso, G., Cipriani, M., Copeland, A. M., Kovner, A., La Spada, G., & Martin, A. (2020). The market events of mid-September 2019. *FRB of New York Staff Report, (918).*

Afonso, G., & Lagos, R. (2015). Trade dynamics in the market for Federal funds. *Econometrica, 83(1), 263-313.*

Anbil, S., Anderson, A. G., & Senyuz, Z. (2020). What Happened in Money Markets in September 2019? *FEDS Notes, (2020-02), 27.*

Anbil, S., Anderson, A. G., & Senyuz, Z. (2021). Are Repo Markets Fragile? Evidence from September 2019. *Staff working papers in the Finance and Economics Discussion Series (FEDS)*

Avalos, F., Ehlers, T., & Eren, E. (2019). September stress in dollar repo markets: passing or structural? *BIS Quarterly Review.*

Copeland, A., Duffie, D., & Yang, Y. (2021). Reserves were not so ample after all (No. w29090). *National Bureau of Economic Research.*

Correa, R., Du, W., & Liao, G. Y. (2020). US banks and global liquidity (No. w27491). National Bureau of Economic Research.

Cunliffe, J. (2017). Repo Market Functioning. *Bank for International Settlements Report, CGFS No 59.*

Du, W., Tepper, A., & Verdelhan, A. (2018). Deviations from covered interest rate parity. *The Journal of Finance*, 73(3), 915-957.

Duffie, D., & Krishnamurthy, A. (2016). Passthrough efficiency in the fed's new monetary policy setting. In Designing Resilient Monetary Policy Frameworks for the Future. *Federal Reserve Bank of Kansas City, Jackson Hole Symposium (pp. 1815-1847).*

Federal Reserve Bank of New York (FRBNY) (2018). *Second report of the Alternative Reference Rates Committee.*

Han, Y. (2020). Money Market Segmentation and the Transmission of Post-crisis Monetary Policy. *Working Paper, New York University.*

Ihrig, J. E., Senyuz, Z., & Weinbach, G. C. (2020). The Fed's "Ample-reserves" approach to implementing monetary policy. *Staff working papers in the Finance and Economics Discussion Series (FEDS)*

Klingler, S., & Syrstad, O. (2021). Life after LIBOR. *Journal of Financial Economics.*

Newey, W. K., & West, K. D. (1987). Hypothesis testing with efficient method of moments estimation. *International Economic Review*, 777-787.

Pozsar, Zoltan. (2019) Collateral Supply and o/n Rates. *Global Money Notes 22, Credit Suisse.*

Schrimpf, A., & Sushko, V. (2019). Beyond LIBOR: a primer on the new benchmark rates. *BIS Quarterly Review, March.*

Stock, J. H., & Watson, M. W. (1993). A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica, 783-820.*

Yang, Y. D. (2020). Why Repo Spikes. Working paper. *Available at SSRN: https://ssrn.com/abstract=3721785 or http://dx.doi.org/10.2139/ssrn.3721785*