

How much central bank money does it now take to run the financial system?

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The Fed's "Balance sheet normalization"

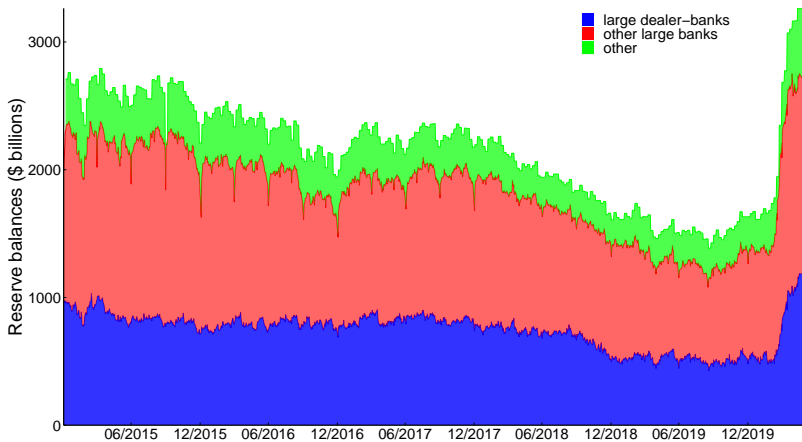


Figure: Data: Fedwire Funds Service, FRED.

Repo rates sometimes went far above their arbitrage level: IOR

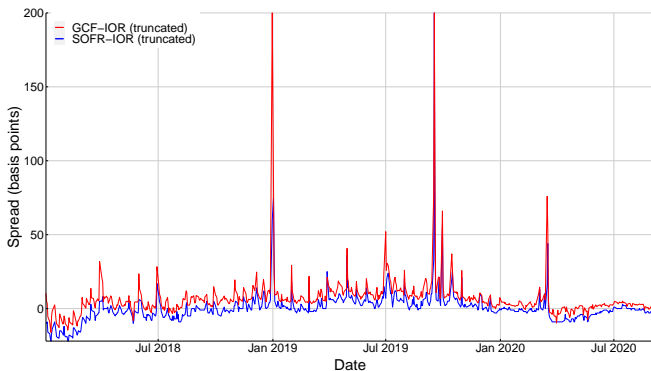


Figure: Spreads of SOFR over IOR and GCF over IOR, truncated at 200 basis points for better visualization of the spikes that are dominated by the large spike on September 17, 2019. Data: FRBNY and Tradition.

Dealer balances remained low until the Fed's Covid rescue

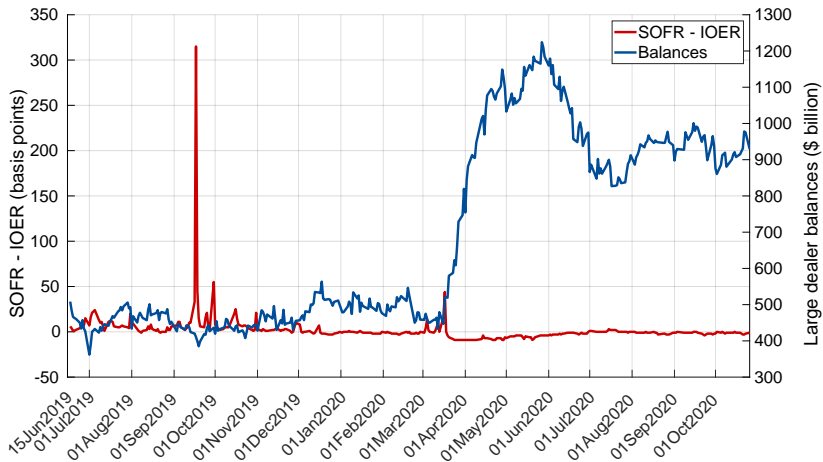


Figure: Data: Fedwire Funds Service, FRBNY.

Some empirical findings

1. Funding market liquidity depends a lot on the amplexness of reserve balances. [Already apparent from Correa, Du, and Liao (2020).]
2. The opening reserve balances of the ten largest repo-active dealer banks are especially highly associated with repo rate distortions.
3. Low opening balances for large non-dealer banks explains intraday payment timing stress on the major dealer banks, which in turn explains repo rate distortions even better than dealer opening balances.
4. Without super-abundant reserve balances, issuance of Treasuries adds stress to intraday balances and funding market liquidity.
5. Other key determinants of funding market liquidity: T-bill supply, quarter-end capital requirements.

What did Jamie Dimon say?

When asked on JP Morgan's Q3 2019 earnings call why the bank did not use its reserve balances to arbitrage repo rate spikes in September 2019, Jamie Dimon replied:

"... we have a checking account at the Fed with a certain amount of cash in it. Last year [2018] we had more cash than we needed for regulatory requirements. So when repo rates went up, we went from the checking account, which was paying IOER into repo. Obviously makes sense, you make more money. But now the cash in the account, which is still huge – it's \$120 billion in the morning and goes down to \$60 billion during the course of the day and back to \$120 billion at the end of the day – that cash, we believe, is required under resolution and recovery and liquidity stress testing."

Relevant intraday liquidity rules and supervision

1. **The Fed's Large Institution Supervision**, including CLAR tests. "In 2019, LISCC liquidity supervision is focusing on the adequacy of a firm's cash-flow forecasting capabilities, practices for establishing liquidity risk limits, and measurement of intraday liquidity risk."
2. **The Federal Reserve Board's Regulation YY, Enhanced Prudential Standards**, includes rules covering intraday liquidity exposures.
3. **Resolution Liquidity Adequacy and Positioning (RLAP)**. Banks must "ensure that liquidity is readily available to meet any deficits." ... "should take into account (A) the daily contractual mismatches between inflows and outflows; (B) the daily flows from movement of cash and collateral for all inter-affiliate transactions; and (C) the daily stressed liquidity flows and trapped liquidity as a result of actions taken by clients, counterparties, key FMUs."

Intraday interdealer volumes on Tradition

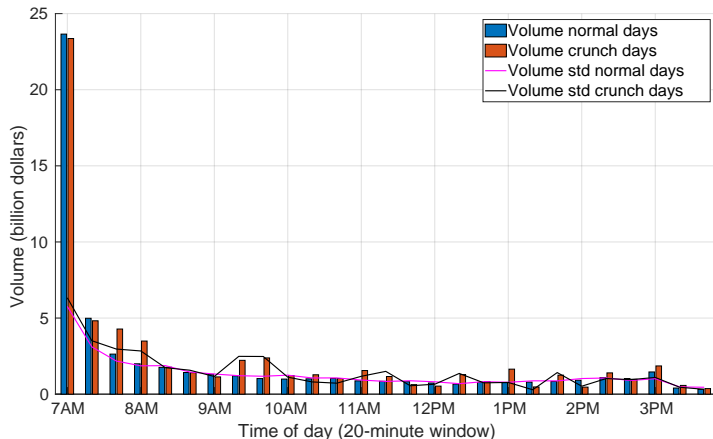


Figure: Average and standard deviation, across normal days and across crunch days, of Tradition O/N Treasury repo trading volume in each 20-minute time window. Data: Tradition.

Opening repo spreads are elevated on days when intraday payment timing are stressed

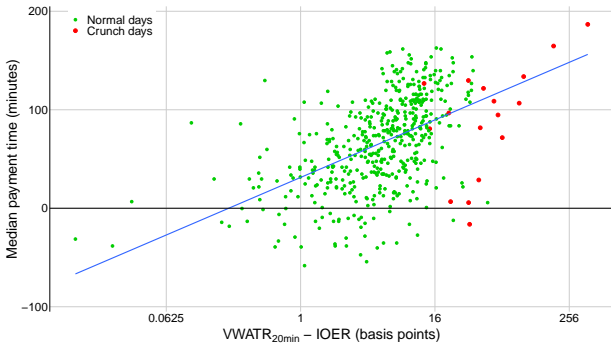


Figure: Horizontal axis: VWATR-IOER in the beginning 20 minutes, in basis points (log scale). VWATR is the volume-weighted average estimated mid-point repo rate executed on Tradition. Vertical axis: the time, net of sample mean, at which 50% of the day's total incoming value has been received over Fedwire by dealer banks. The regression line fits median payment time to $\log(\text{VWATR-IOER})$. Data sources: Fedwire and Tradition.

Opening balances of other large banks explains incoming payment timing to large dealer banks

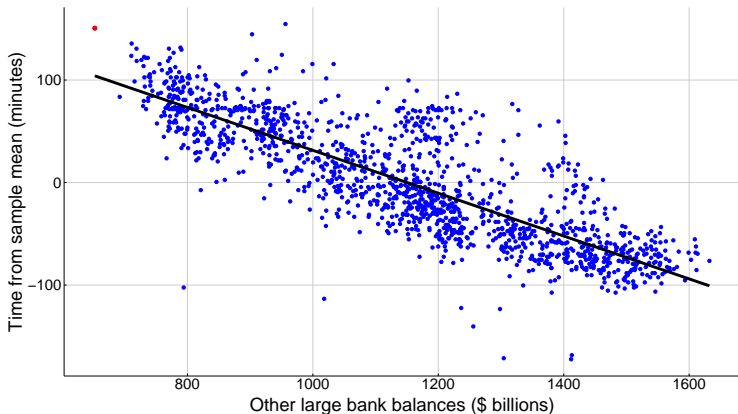


Figure: A scatter plot and regression fit of half-received time of payments to the ten dealer banks and opening balances of the remaining large banks in the 100-large-bank sample. The R^2 for the plotted linear relationship is 0.69. The red-dot date is September 17, 2019. Data sources: Federal Reserve.

What explains distortions in repo rates?

	Dependent variable: SOFR–IOR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dealer opening balances	-32.2*** (3.53)	-32.1*** (3.52)		-13.3*** (1.92)	-50.6*** (3.51)	-33.9*** (2.15)	-31.4*** (3.07)
median time of receives			0.141*** (0.0102)	0.128*** (0.00888)		0.0642*** (0.0156)	0.0612*** (0.0179)
quarter-end fixed effect		13.6*** (4.12)	13.3*** (4.09)	13.3*** (3.90)	13.9*** (3.96)	13.9*** (3.95)	9.85** (3.99)
Tbills outstanding					9.04*** (0.352)	5.50*** (0.645)	4.22*** (0.629)
net Treasuries inventory							13.2 (11.6)
Treasuries redemption							-32.1*** (11.1)
Bill issuance							38.0*** (11.4)
Coupon issuance							63.8*** (11.1)
Observations	1,452	1,452	1,454	1,451	1,450	1,449	1,436
R^2	0.122	0.136	0.360	0.378	0.392	0.414	0.424
Adjusted R^2	0.121	0.135	0.360	0.377	0.391	0.412	0.421
Residual Std. Error	12.9	12.8	11.0	10.9	10.8	10.6	10.5

Notes: Standard errors are adjusted for heteroskedasticity. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

A constant was included for each specification.

What explains the incidence of spikes in repo rates?

Table: Estimated probit likelihoods of a spike in SOFR—IOER when explanatory variables are at their sample means or at sample mean plus or minus one sample standard deviation.

spike probability	receive time (median, minutes)	opening balances (dealers, billions)	coupon issuance (billions)	quarter end
0.0096	0	686	10.2	0
0.020	57.6	686	10.2	0
0.037	57.6	536	10.2	0
0.038	0	686	91.1	0
0.11	57.6	536	91.1	0
0.37	0	686	10.2	1
0.48	0	536	10.2	1
0.49	57.6	686	10.2	1
0.60	0	686	91.1	1

Policy approaches that have been discussed

1. Maintain a balance sheet that achieves clearly abundant reserve balances.
 - Risks large interest expense for the Fed (Cavallo et al, 2019).
 - Impinges on bank capital requirements (Covas and Nelson, 2019).
 - Allows the Fed to conduct fiscal policy (Plosser, 2018).
2. Establish a standing repo facility (Andolfatto and Ihrigh 2019; Gagnon and Sack, 2020, FOMC 2021).
3. Relax post-crisis liquidity rules and supervision.
4. Add incentives for banks to use daylight overdrafts and the Discount Window.

Scratchpad

Scratchpad

Appendix exhibits

What explains the timing of payments to dealer banks?

	Dependent variable: Time by which half of daily payments to 10 repo-active banks has been received							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dealer opening balances	-144.0*** (11.3)		95.5*** (7.87)				98.3*** (6.02)	101.0*** (6.27)
other large bank balances		-209.0*** (3.05)	-248.0*** (4.0)				-216.0*** (3.70)	-216.0*** (3.70)
log (normalized SOFR-IOR)				62.7*** (2.82)		36.0*** (2.45)	28.2*** (1.66)	28.7*** (1.71)
balances of 100 large banks					-120.0*** (3.43)	-93.7*** (3.90)		
net Treasury issuance								-73.9* (41.5)
Constant	98.4*** (7.58)	240.0*** (3.57)	220.0*** (4.28)	-185.0*** (8.63)	221.0*** (5.85)	65.9*** (13.2)	98.2*** (8.17)	95.4*** (8.50)
Observations	1,464	1,464	1,464	1,454	1,464	1,451	1,451	1,450
R^2	0.14	0.691	0.728	0.381	0.515	0.632	0.808	0.809
Adjusted R^2	0.139	0.691	0.728	0.381	0.515	0.632	0.808	0.808
Residual Std. Error	53.8	32.2	30.2	45.0	40.4	34.7	25.1	25.0

Notes: Standard errors are adjusted for heteroskedasticity. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Peak overdrafts are related to opening balances

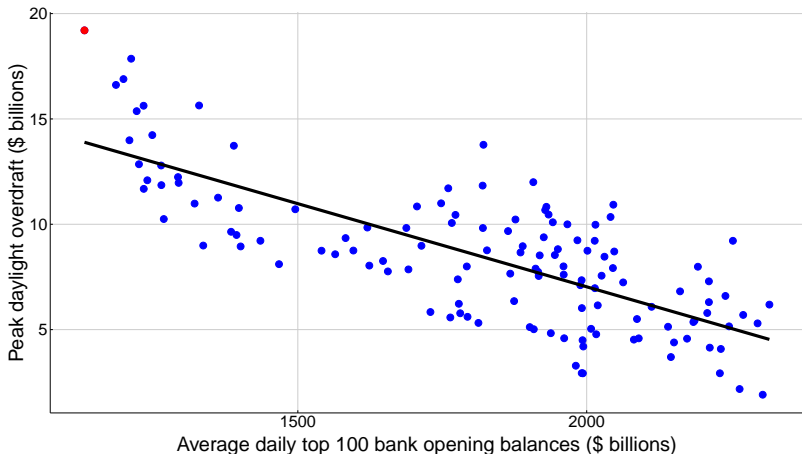


Figure: The R^2 for the linear relationship, plotted, is 0.57. The red dot corresponds to the observation for the 2-week maintenance period ending September 25, 2019. Data sources: Federal Reserve and Fedwire.

As reserves went down, their distribution across dealers flattened

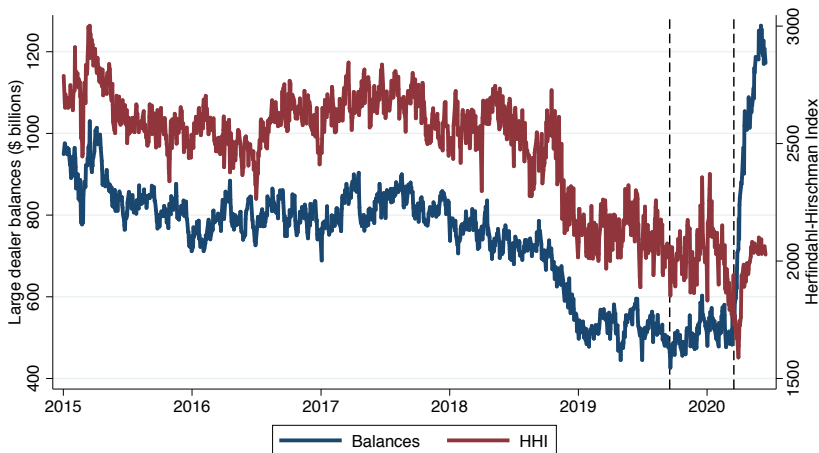


Figure: Repo rate spreads are significantly negatively correlated with HHI (concentration of reserves across the nine large dealers) after controlling for other covariates. Data: Fedwire Funds Service.

When reserves went up, intra-day payments were made earlier

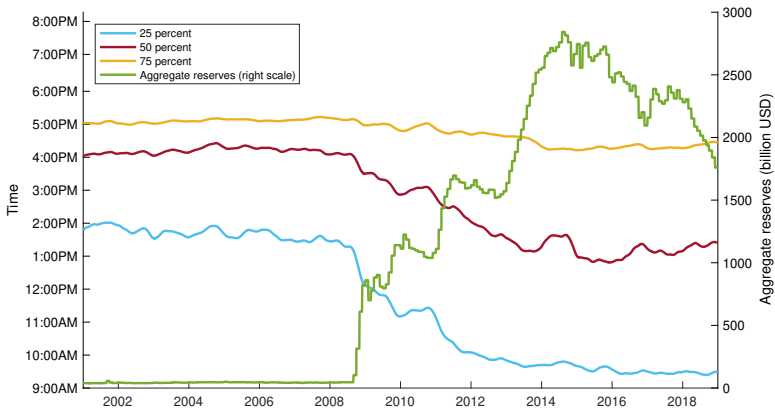


Figure: A variant of a figure from Copeland, Molloy, and Tarascina, Federal Reserve Bank of New York, February 25, 2019, based on data provided by the authors.

First IV stage: Prediction of dealer opening balances.

	Dependent variable: dealer opening balances
lag Q(0.25) receive time from other (non-dealer) banks	-0.0029*** (0.00023)
lag Q(0.5) receive time from other (non-dealer) banks	-0.00186*** (0.00014)
lag Q(0.75) receive time from other (non-dealer) banks	0.00181*** (0.00013)
corporate tax payments	-0.0375 (0.57)
Constant	0.686*** (0.00302)
Observations	1,461
R^2	0.439
Adjusted R^2	0.437
Residual Std. Error	0.112

Notes: Lagged variables are lagged by one day.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

What explains distortions in repo rates?

Table: Second stage of IV regression of SOFR–IOR (basis points). First stage predicts dealer opening balances from prior day payment timing ($R^2 = 0.44$).

	Dependent variable: SOFR - IOR					
	(1)	(2)	(3)	(4)	(5)	(6)
predicted dealer opening balances	-58.7*** (6.87)	-58.4*** (6.86)		-59.4*** (6.67)	-24.6*** (4.27)	-22.0*** (4.96)
median time of receives			0.141*** (0.0102)		0.102*** (0.0106)	0.0706*** (0.0159)
quarter-end fixed effect		13.2*** (4.25)	13.3*** (4.09)	13.9*** (4.47)	14.0*** (4.21)	9.77** (4.08)
Tbills outstanding				5.76*** (0.226)	1.80*** (0.387)	-0.533 (0.347)
net Treasuries inventory						47.0*** (10.2)
Treasuries redemption						-5.45 (11.4)
Bill issuance						10.2 (11.7)
Coupon issuance						49.2*** (11.2)
Observations	1,395	1,395	1,454	1,394	1,393	1,382
R^2	0.181	0.196	0.360	0.319	0.381	0.407

Probit model of probability of a repo rate spike

Table: Estimated probit models of the likelihood of a repo rate spike. These models are of the form $P(\text{Repo Spike} = 1 | X_1, X_2, \dots, X_k) = \Phi(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k)$, where Φ is the standard normal cumulative distribution function. Events of repo rate spikes are defined by criteria stated in the paper. The units of the explanatory variables are minutes and trillions of dollars.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
median time of receives	0.00569*** (0.00126)		0.00342** (0.00154)		0.00628*** (0.00144)	0.00372** (0.00173)	0.00499** (0.00199)
dealer opening balances		-2.52*** (0.545)	-1.47** (0.636)			-1.62** (0.673)	-1.78** (0.772)
Coupon issuance				10.1*** (1.37)	10.2*** (1.41)	10.6*** (1.44)	7.05*** (1.71)
quarter-end fixed effect							2.02*** (0.323)
Constant	-1.98*** (0.0782)	-0.289 (0.336)	-1.0** (0.419)	-2.13*** (0.0847)	-2.25*** (0.101)	-1.18*** (0.441)	-1.19** (0.506)
Observations	1,418	1,417	1,416	1,415	1,414	1,412	1,412
Log Likelihood	-178.0	-177.0	-174.0	-164.0	-153.0	-150.0	-129.0
Akaike Inf. Crit.	359.0	358.0	355.0	332.0	312.0	307.0	267.0

Note: *p<0.1; **p<0.05; ***p<0.01

Intraday interdealer repo rate spreads and volatility

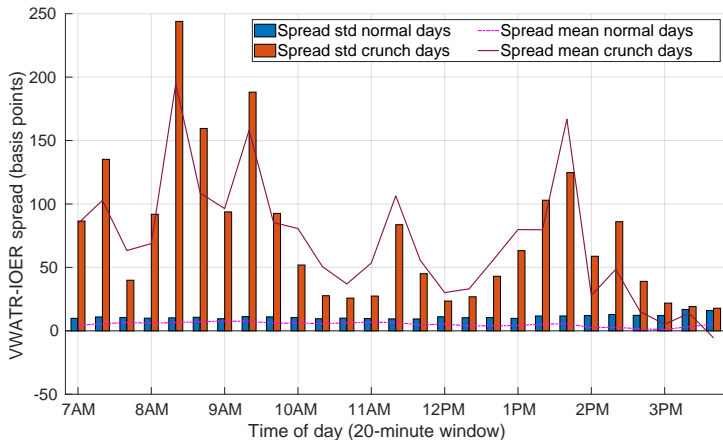


Figure: Data: Tradition.

SOFR was far from the fed funds target during the COVID19 crisis

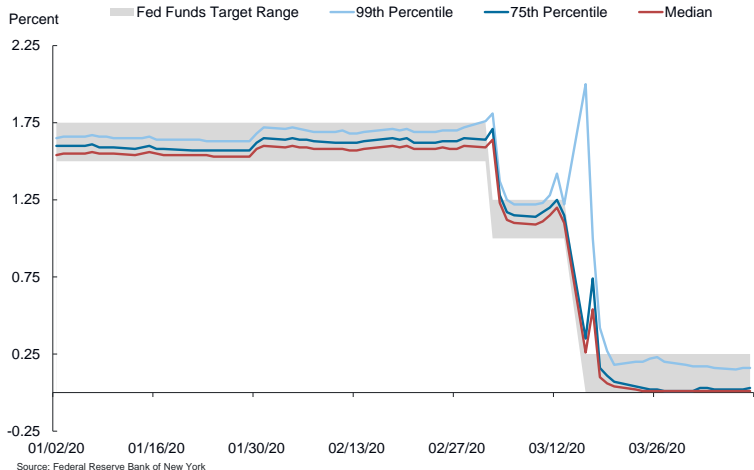


Figure: Federal Reserve Bank of New York, Lorie Logan speech, April 14, 2020.

Predicted rate distortions on non-spike days

Table: Basic regression models for market-wide (SOFR) Treasury repo spreads over IOR for the subsample without spike days

	Dependent variable: SOFR - IOR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dealer opening balances	-24.7*** (1.99)	-24.7*** (1.99)		-9.03*** (1.11)	-43.1*** (0.985)	-33.0*** (1.59)	-29.2*** (1.95)
median time of receives			0.123*** (0.00268)	0.114*** (0.00276)		0.0396*** (0.00482)	0.0349*** (0.00541)
quarter-end fixed effect		5.09 (3.66)	2.13 (2.97)	2.49 (2.83)	1.30 (3.14)	1.52 (3.02)	-3.12 (3.47)
Tbills outstanding					8.52*** (0.170)	6.34*** (0.306)	4.67*** (0.449)
net Treasuries inventory							20.2*** (5.43)
Treasuries redemption							-36.1*** (9.14)
Bill issuance							36.0*** (8.08)
Coupon issuance							61.8*** (9.51)
Observations	1,409	1,409	1,411	1,408	1,407	1,406	1,393
R ²	0.147	0.149	0.528	0.544	0.622	0.639	0.658
Adjusted R ²	0.146	0.148	0.527	0.543	0.621	0.638	0.656
Residual Std. Error	8.84	8.84	6.58	6.47	5.89	5.76	5.63

Notes: Standard errors are adjusted for heteroskedasticity. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
A constant was included for each specification.

What explains interdealer (GCF) repo spreads over IOER?

Dependent variable: GCF – IOER							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dealer opening balances	-0.041*** (0.004)	-0.040*** (0.004)		-0.015*** (0.003)	-0.046*** (0.004)	-0.027*** (0.005)	-0.024*** (0.004)
median time of receives			0.150*** (0.016)	0.123*** (0.016)		0.079*** (0.028)	0.078*** (0.030)
quarter-end fixed effect		30.833** (12.420)	28.829** (12.705)	29.081** (12.587)	32.519** (12.870)	31.383** (13.118)	25.734** (12.780)
Tbills outstanding					0.007*** (0.0004)	0.004*** (0.001)	0.002** (0.001)
net Treasuries inventory							0.011 (0.015)
Treasuries redemption							-0.030* (0.018)
Bill issuance							0.040** (0.019)
Coupon issuance							0.083*** (0.018)
Observations	1,419	1,419	1,418	1,418	1,417	1,416	1,413
R ²	0.133	0.179	0.258	0.269	0.266	0.283	0.295
Adjusted R ²	0.133	0.178	0.257	0.268	0.264	0.281	0.291
Residual Std. Error	16.205	15.777	15.007	14.895	14.934	14.767	14.669

Note: Standard errors are adjusted for heteroskedasticity. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
Constant included for each specification.

What explains tri-party (TGCR) repo spreads over IOER?

	Dependent variable: TGCR – IOER						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dealer opening balances	-0.037*** (0.003)	-0.037*** (0.003)		-0.010*** (0.002)	-0.048*** (0.003)	-0.034*** (0.003)	-0.033*** (0.003)
median time of receives			0.161*** (0.012)	0.145*** (0.012)		0.056*** (0.021)	0.055** (0.022)
quarter-end fixed effect		9.214** (3.917)	6.739* (3.940)	6.963* (3.812)	9.375*** (3.481)	8.664** (3.616)	5.867 (3.636)
Tbills outstanding					0.009*** (0.0003)	0.007*** (0.001)	0.006*** (0.001)
net Treasuries inventory							0.008 (0.010)
Treasuries redemption							-0.033*** (0.010)
Bill issuance							0.038*** (0.010)
Coupon issuance							0.051*** (0.010)
Constant	16.699*** (2.722)	16.536*** (2.707)	-13.271*** (0.191)	-5.775*** (1.281)	5.909*** (2.096)	-0.008 (1.069)	-0.842 (1.817)
Observations	1,444	1,444	1,440	1,440	1,442	1,438	1,434
R ²	0.178	0.184	0.389	0.397	0.447	0.461	0.466
Adjusted R ²	0.177	0.183	0.388	0.396	0.446	0.459	0.463
Residual Std. Error	12.575	12.528	10.853	10.783	10.321	10.209	10.178

Note: Standard errors are adjusted for heteroskedasticity. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.
Constant included for each specification.