Money Market Funds and the Pricing of Near-Money Assets

Sebastian Doerr
Bank for International Settlements

Egemen Eren
Bank for International Settlements

Semyon Malamud
Swiss Finance Institute, EPF Lausanne, and CEPR

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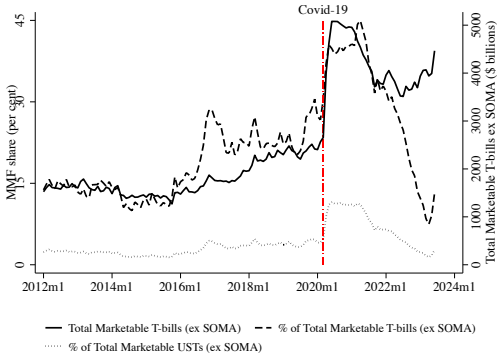
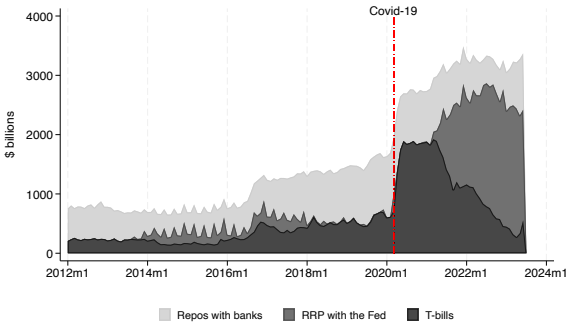
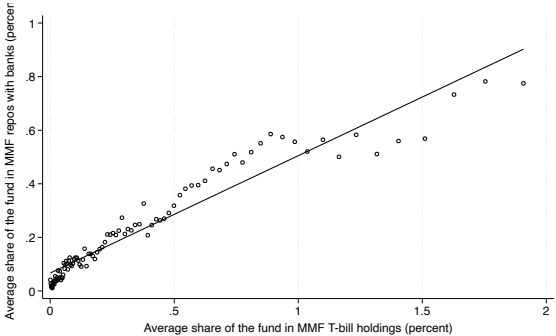
Money market funds are important investors of near-money assets

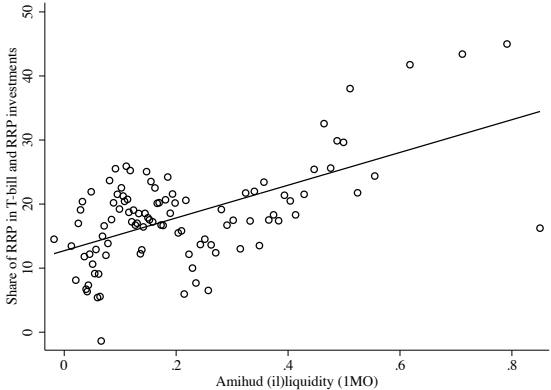
- MMFs' total assets under management (AUM) are close to $6 trillion
  - More than 20% of US GDP or total US commercial bank assets
- More than $3 trillion of MMFs' AUM are held in safe and liquid "near-money" assets
  - T-bills, repos with banks and the Fed' RRP facility
  - High correlation of holdings with bill supply - role as marginal investors





Two motivating observations: market concentration and liquidity





- Funds with a high share in the repo market also have a high share in the T-bill market, even conditional on AUM
- When the Tbill mkt is more illiquid, RRP holdings increase relative to T-bill holdings

This paper - Theory

- A model of strategic interactions of MMFs with each other and with banks.
- MMFs invest in repos with banks or T-bills or the RRP.
- MMFs set repo rates.
  - Probability of a deal depends (+) fund size and (-) on the repo rate.
  - Banks have downward-sloping demand for repos.
- T-bill rate is determined by market clearing. MMFs have price impact.
- RRP rate is set by the Fed.
  - Assume a non-monetary cost for RRP to match the interior shares in the data.
  - RRP alleviates, but does not eliminate the trade-offs.

This paper - Theory

- Key innovation:
  - If there is a large player with price impact in both markets and markets are connected through quantities (e.g. portfolio allocation), ...
  - ...then decisions/conditions in one market affect decisions/conditions in the other.
- Trade-off:
  - Market/bargaining power (price impact) in repo vs price impact in T-bills.

repo rate $\uparrow \rightarrow$ bank repo demand $\downarrow \rightarrow$ "residual cash" $\uparrow \rightarrow$ MMF T-bill demand $\uparrow \rightarrow$ T-bill rate $\downarrow$

This paper - Empirics

- MMFs have an economically large price impact in the T-bill market:
  - When MMFs bring more cash to the T-bill market $\rightarrow \downarrow$ T-bill rates.
  - We devise instrumental variables to show this effect is causal.
- Using a granular holding-level dataset, we show:
  - MMFs internalize their price impact in the T-bill market when they set repo rates.
    - and this effect gets stronger when Tbill market is less liquid.
  - When Treasury market liquidity is low, invest more in RRP compared to T-bills.
- Results help open up the black box of T-bill "convenience yields":
  - Measures of the T-bill liquidity premium do not entirely capture preference for liquidity
  - Part of it is driven by intermediation frictions and market illiquidity
- Policy implications:
  - Transmission of monetary policy/role of CB balance sheets
  - Regulation of the MMF sector
  - Government debt issuance/Treasury mkt liquidity

Testable predictions

- On aggregate, MMFs have an impact on the T-bill market:

$$\textit{residual cash share}_t \equiv \left(1 - \frac{\sum_f \textit{repo}_{f,t}}{\sum_f \textit{repo}_{f,t} + \textit{Tbill}_{f,t} + \textit{RRP}_{f,t}}\right) \times 100$$

  - **Prediction 1:** ↑ residual cash → ↓ T-bill rates

Micro data:

- Repo rates - MMFs charge repo mark-ups but internalize their T-bill price impact.
  - **Prediction 2:** ↑ repo market power → ↑ repo rates
  - **Prediction 3:** ↑ T-bill market share → ↓ repo rates (↓↓ if the Tbill mkt is illiquid)

- MMF portfolio allocations:
  - **Prediction 4:** ↑ residual cash & ↓ Treasury market liquidity → ↑ $\frac{RRP}{RRP+Tbills}$

MMFs aggregate impact on the T-bill market

- Sample period: February 2011 - June 2023.
- Micro data: Detailed month-end snapshots at portfolio holding level.
- Aggregate data: FRED, Bloomberg, NYFed, US Treasury

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
RRP(1M) - Tbill(1M)	143	-2	10.7	-44.71	44.25	-1
GC (1M) - Tbill (1M)	143	12.84	9.66	-4.74	43.5	10.93
residual cash share	143	39.26	21.63	7.31	86.23	35
%Δ EU repo (quarter-end)	48	-31.45	16.45	-75.94	.23	-29.6
HHI bank repo	143	260.37	72.9	160.12	384.69	278.59
FFR	143	.68	.88	.05	4.1	.14
log(bills to GDP)	143	-2.23	.28	-2.67	-1.43	-2.31
VIX	143	18.38	6.81	10.13	57.74	16.7

MMFs aggregate impact on the T-bill market

Instrumental variables approach

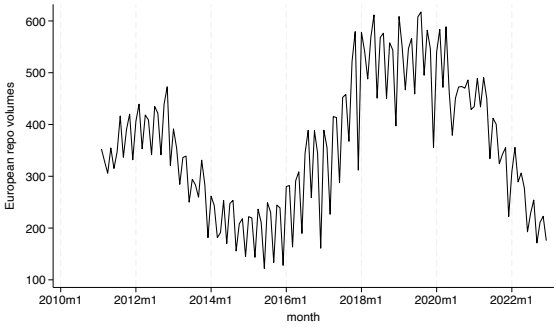
$$RRP\ (1M)_t - Tbill\ (1M) = \beta\ residual\ cash\ share_t + controls_t + \epsilon_t, \quad \beta < 0 \tag{1}$$

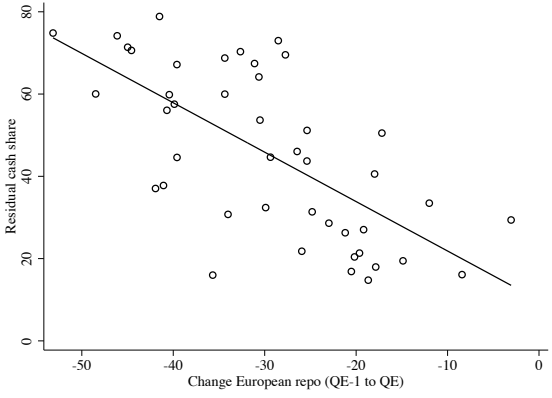
(2)

Use two distinct instruments for *residual cash share*:

1. At quarter-ends, European banks withdraw from repo markets (until 2023).
   - Instrument: **Change in European repos between QE-1 and QE (-)**.
   - Relevance: When European repo ↓, residual cash share ↑.
   - Exclusion: Decision based on global banking activities during the quarter - exo. to MMFs.
2. Our theory gives us another instrument: **repo market HHI**
   - ↑ Repo market HHI → ↑ repo markups (↓ repo demand) → ↑ residual cash share

Change of European repo volume at quarter-ends as an instrument





MMF price impact in the T-bill market is large

- Partial impact of 1sd ↑ RCS ≈ 6bps on RRP-Tbill (1 sd=10 bps), ↑ if Tbill mkt is illiquid
- This is beyond Tbill scarcity (after controlling for bill supply)

	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS
VARIABLES	RRP-Tbill	RRP-Tbill	RRP-Tbill	RRP-Tbill	RRP-Tbill
residual cash share	0.23**	0.37***	0.33***	0.32***	0.32***
	(0.09)	(0.10)	(0.04)	(0.12)	(0.05)
Amihud			-14.52***		-22.42***
			(2.53)		(4.65)
residual cash share × Amihud			0.35***		0.47***
			(0.05)		(0.10)
FFR		-1.32	-4.45***	2.39	-3.10*
		(2.27)	(1.01)	(4.06)	(1.77)
log(bills to GDP)		-19.29***	-9.28***	-12.57***	-5.38***
		(4.55)	(1.94)	(3.80)	(1.48)
VIX		0.01	-0.38**	-0.12	-0.41***
		(0.31)	(0.17)	(0.35)	(0.16)
Observations	143	143	143	48	48
R-squared	0.22	0.41	0.71		
Anderson-Rubin test (p-val)				0.01	0.05
F stat				18.78	3.32
IV Confidence set 1					[0.23,0.38]
IV Confidence set 2					[0.35,0.71]

MMF price impact in the T-bill market: Alternative IV

	(1) 2SLS	(2) 2SLS	(3) 2SLS HHI	(4) 2SLS HHI post	(5) 2SLS HHI post	(6) 2SLS EU+HHI
VARIABLES	RRP-Tbill	RRP-Tbill	RRP-Tbill	RRP-Tbill	RRP-Tbill	RRP-Tbill
residual cash share	0.33***	0.32***	0.25***	0.71***	0.54*	0.29***
	(0.12)	(0.05)	(0.08)	(0.08)	(0.32)	(0.10)
Amihud		-22.35***				
		(4.84)				
residual cash share × Amihud		0.47***				
		(0.11)				
%Δ foreign banks' treasury (quarter-end)	0.18	0.04				
	(0.15)	(0.11)				
share gov funds					0.90	
					(1.47)	
FFR	2.54	-3.14*	-0.88	1.30	3.08	2.52
	(4.01)	(1.88)	(2.91)	(1.19)	(3.91)	(4.23)
log(bills to GDP)	-12.59***	-5.19***	-15.20***	-19.02***	-12.90	-11.65***
	(3.81)	(1.49)	(4.13)	(6.71)	(14.07)	(3.38)
VIX	-0.10	-0.41**	0.03	-0.41**	-0.39*	-0.12
	(0.32)	(0.17)	(0.32)	(0.19)	(0.22)	(0.35)
Observations	48	48	143	75	75	48
Anderson-Rubin test (p-val)	0.00	0.05	0.01	0.00	0.32	0.02
F stat	16.60	3.29	9.62	47.12	4.19	4.35
IV Confidence set 1		[0.23; 0.52]				
IV Confidence set 2		[0.38; 1.25]				
Hansen J-stat (p)						0.29

Evidence for the repo 'pricing power' – T-bill 'price impact' trade-off

- ↑ MMF repo market share (or bargaining power) → ↑ repo rate.
- ↑ MMF T-bill market share → ↓ repo rate (↓ ↓ when T-bill mkt less liquid).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			FF		FF		FF
VARIABLES	rate	rate	rate	rate	rate	rate	rate
F MS bank repo	0.234***	0.239***					
	(0.073)	(0.073)					
FF MS bank repo			0.102**				
			(0.048)				
F bargaining power (repo)				0.037**		0.002	
				(0.017)		(0.013)	
FF bargaining power (repo)					0.066***		0.025**
					(0.019)		(0.010)
F MS treasury	-0.310***	-0.328***		-0.137**		-0.209***	
	(0.091)	(0.091)		(0.065)		(0.074)	
F MS treasury × Amihud		-0.164*		-0.150*		-0.169*	
		(0.091)		(0.091)		(0.091)	
FF MS treasury			-0.049		-0.013		-0.083**
			(0.055)		(0.036)		(0.038)
FF MS treasury × Amihud			-0.072***		-0.072***		-0.079***
			(0.015)		(0.015)		(0.014)
Observations	275,331	275,331	382,985	275,331	382,985	275,292	382,955
R-squared	0.752	0.752	0.739	0.751	0.739	0.764	0.761
collateral*time FE	✓	✓	✓	✓	✓	✓	✓
bank*fund type*time FE	✓	✓	✓	✓	✓	✓	✓
bank*FF FE	-	-	-	-	-	✓	✓
controls	✓	✓	✓	✓	✓	✓	✓

MMFs tilt portfolios toward RRP when Treasury market liquidity is low

$$\textit{RRP share}_{f,t} = \delta_1 \textit{ F residual cash share}_{f,t} + \delta_2 \textit{ F residual cash share}_{f,t} \times \textit{illiquidity}_t + \textit{controls}_{f,t} + \phi_f + \theta_t + \varepsilon_{f,t}.$$

- ↑ Residual cash AND ↑ market illiquidity → ↑ RRP share

VARIABLES	(1) RRP share	(2) RRP share	(3) RRP share	(4) RRP share	(5) Δ RRP share
F residual cash share	0.568***	0.562***	0.599***	0.509***	0.227***
	(0.027)	(0.027)	(0.027)	(0.031)	(0.022)
F residual cash share × illiquidity		0.051***	0.058***		
		(0.008)	(0.010)		
F residual cash share × debt ceiling				0.074**	
				(0.029)	
F residual cash share × Δ illiquidity					0.011*
					(0.007)
Observations	13,777	13,777	12,619	12,619	12,528
R-squared	0.703	0.705	0.751	0.747	0.269
time FE	✓	✓	-	-	-
fund FE	✓	✓	✓	✓	✓
fund type*time FE	-	-	✓	✓	✓
controls	-	-	✓	✓	✓

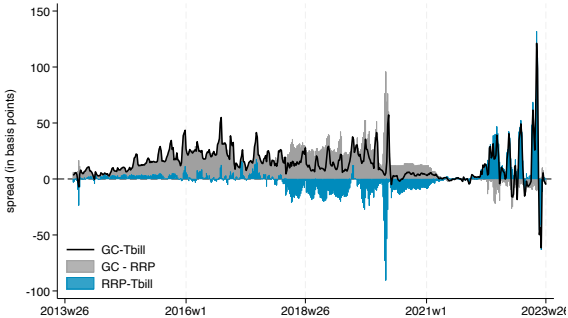
Implications for “the liquidity premium” of T-bills

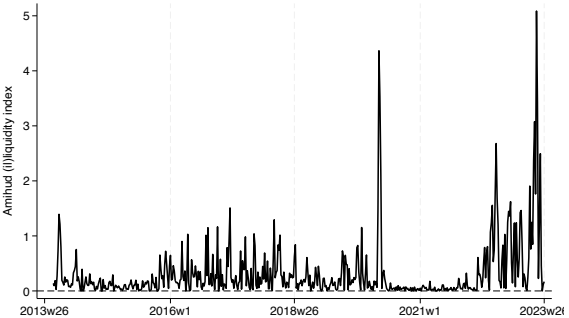
- 1m GC repo - Tbill rate is a commonly used measure of the liquidity premium of T-bills.
- Intended to be a measure of the preference for liquidity.

VARIABLES	(1) OLS GC-Tbill	(2) OLS GC-Tbill	(3) 2SLS GC-Tbill	(4) 2SLS RRP-Tbill	(5) 2SLS GC-RRP
residual cash share		0.10*	0.30***	0.32***	-0.02
		(0.06)	(0.09)	(0.12)	(0.14)
FFR	3.32***	2.94**	6.19***	2.39	3.80
	(1.09)	(1.32)	(1.47)	(4.06)	(4.42)
log(bills to GDP)	-18.76***	-22.37***	-31.88***	-12.57***	-19.31***
	(3.91)	(4.75)	(5.12)	(3.80)	(6.66)
VIX	0.23	0.21	0.33***	-0.12	0.45
	(0.16)	(0.14)	(0.12)	(0.35)	(0.44)
Observations	143	143	48	48	48
R-squared	0.31	0.34			
Anderson-Rubin test (p-val)			0.00	0.01	0.87
F stat			26.99	18.78	24.82

The measured liquidity premium is not entirely due to preferences

- RRP is safer and more liquid than T-bills.
- Since 2022, most of the measured liq. premium is driven by a positive RRP-Tbill spread
- Suggestive that intermediation frictions and market illiq. drive part of the measurement.





Policy implications

- Transmission of monetary policy (interest rates):
  - $\uparrow$ Fed funds rate $\rightarrow \uparrow$ inflows to MMFs.
  - T-bill price impact $\rightarrow \downarrow$ pressure on T-bill rates $\rightarrow$ weaker transmission mechanism.
- The size of the central bank balance sheet is important for the transmission:
  - A large central bank balance sheet and availability of RRP alleviates this concern.
  - A small central bank balance sheet and small RRP exacerbates the T-bill price impact.
- Treasury market liquidity is important for the transmission of monetary policy.
- The government leaves money on the table:
  - The government can adjust its short-term debt issuance to match demand by MMFs.
- Regulation of MMFs:
  - 2016 reform increased concentration.
  - Rising footprint of government MMFs - investment universe limited.
- MMFs have price impact in the most liquid market of the world. Global implications.

APPENDIX

Market power in the repo market vs price impact in the T-bill market

Fund repo HHI $\uparrow \rightarrow \uparrow$ repo rate $\rightarrow \downarrow$ repo demand $\rightarrow \uparrow$ "residual cash" $\rightarrow \uparrow$ T-bill demand $\rightarrow \downarrow$ T-bill rate

- Equilibrium Repo Rates without T-Bills:

$$r_f(b) = \underbrace{r_*(b)}_{\text{markup s.t. bank demand}} + \underbrace{F(\overbrace{H(W)}^{HHI})}_{\text{additional markup}} \quad \text{where } F'(H(W)) > 0 \tag{3}$$

- Residual Cash=Assets-repo lending:

$$\Delta_f = d_f - \underbrace{\sum_b (R_*/r_f(b))^{\xi} \frac{r_f(b)^{-b} w_f}{\Gamma_*(b)}}_{\text{repo lending given banks' demand curves}} \quad \text{where } \Delta_f'(r_f(b)) > 0 \tag{4}$$

- T-Bill rate pinned down by market clearing:

$$\hat{\rho} = \rho_* + \underbrace{\frac{S - a - \sum_f a_*(f)\Delta_f}{+\sum_{f*}(f)\Delta_f}}_{\text{demand}-\text{supply imbalance}} \quad \text{where } \hat{\rho}'(\Delta_f) < 0 \tag{5}$$

- When Treasury market liquidity is low, RRP is preferred to T-bills.

The Model I

- B banks, $b = 1, \cdots, B$; F funds, $f = 1, \cdots, F$.
- Probability of repo deal between b and f of size w_f and repo rate $r_f(b)$

$$\pi_f(r_f(b); b) \;=\; \frac{r_f(b)^{-\alpha_b} w_f}{\sum_{\phi=1}^{F} r_\phi(b)^{-\alpha_b} w_\phi}, \tag{6}$$

- banks' demand for liquidity

$$\ell(r_f(b)) \;=\; \underbrace{r_f^{-\xi} R_*^{\xi}}_{\textit{downward sloping demand for repos}} \tag{7}$$

The Model II

- **Equilibrium Repo Rates without T-Bills:**

$$r_f(b) \;=\; r_*(b) \;+\; \underbrace{F(H(W))}_{\textit{additional markup}} \quad . \tag{8}$$

with

$$r_*(b) \;=\; \rho \;+\; \underbrace{\rho \frac{1}{\xi + \alpha_b - 1}}_{\textit{markup}}, \tag{9}$$

where

$$H(W) \;=\; F^{-1} \sum_f (w_f)^2 \tag{10}$$

is the Herfindahl index of fund size distribution.

Equilibrium Rates with T-Bills I

- ρ is the T-Bill rate; ρ_*= outside option (RRP)
- Δ_f is the *residual cash share*:

$$\Delta_f \;=\; \textit{deposits} \;-\; \textit{repo lending} \tag{11}$$

- fund demand curves for T-Bills:

$$D_f^T(\rho) \;=\; (a_*(f) + \lambda_*(f)(\rho - \rho_*))\Delta_f \tag{12}$$

  with some fund-specific coefficients $a_*(f),\ \lambda_*(f) > 0$.
- T-Bill rate pinned down by market clearing:

$$\hat{\rho} \;=\; \rho_* \;+\; \underbrace{\frac{S - a - \sum_f a_*(f)\Delta_f}{\lambda + \sum_f \lambda_*(f)\Delta_f}}_{\textit{demand}-\textit{supply imbalance}}, \tag{13}$$

Equilibrium Rates with T-Bills II

Theorem

Suppose that fund f takes the repo rates charged by other funds, $r_\phi, \phi \neq f$, as given. Then, the equilibrium T-bill rate responds to changes in funds' repo rate, $r_f(b)$, for any b. The sensitivity, $\frac{\partial \hat{\rho}}{\partial r_f(b)}$, is negative and its absolute value is larger for funds with bigger w_f and d_f.

-

Theorem

The optimal repo rate set by fund f for bank b is monotone increasing in the fund market power, as captured by w_f^*, and is monotone decreasing in the fund's residual cash.

-

Equilibrium RRP choice I

- investing in RRP is associated with an implicit, non-monetary cost:

$$\xi_f(\theta_{ff}) \; + \; 0.5\beta_f(\theta_{ff})^2 \,, \tag{14}$$

- strategic trading by all funds, accounting for their impact:
  - endogenizes demand curves for T-Bills through strategic competition.

Theorem

The following is true.

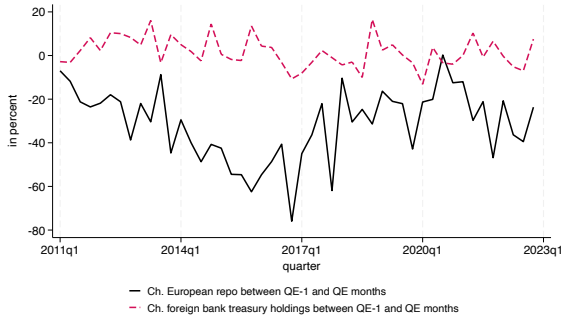
- *T-bill liquidity is negatively related to the residual cash $_f$.*
- *A drop in T-bill liquidity leads to an increase in the share of residual cash invested in the RRP.*
- *Funds with larger residual cash $_f$ invest more into RRP, and more so when markets are illiquid.*
- *The elasticity of funds' T-bill investments with respect to the T-bill rate is negatively related to T-bill illiquidity.*

Data description

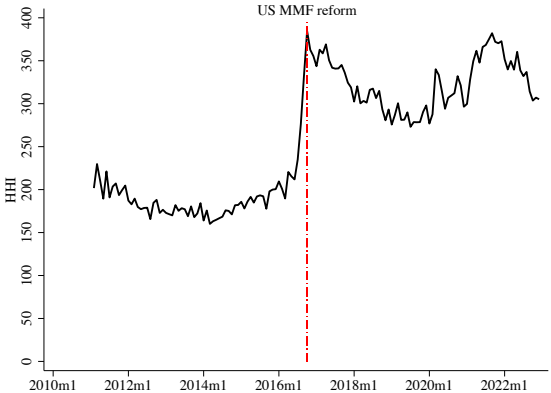
- Crane data:
  - Detailed holding level data from regulatory filings.
  - Between February 2011-November 2022. Month-end snapshots.
  - Focus only on repos, Tbills, RRP as these are the closest assets to money.

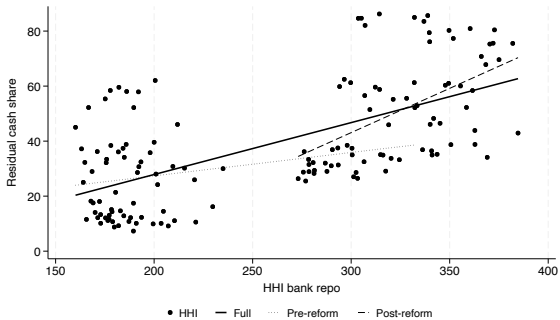
- Aggregate data:
  - FRED, US Treasury, Bloomberg, FRBNY

European banks' repo volume

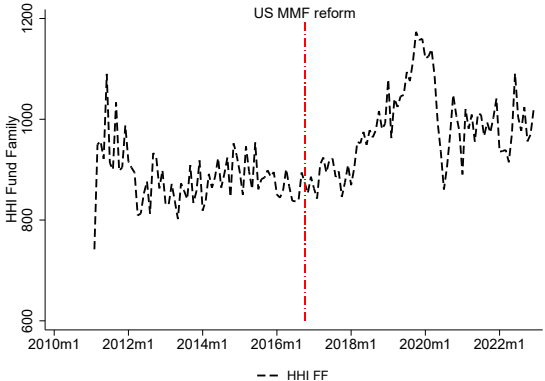


Repo market HHI as an instrument





HHI bank repo measured at fund family level



Treasury market liquidity and MMF portfolio allocation

$$\textit{RRP share}_{f,t} = \delta_1 \textit{ FMS treasury}_{f,t} + \delta_2 \textit{ liquidity tightness}_t \tag{15}$$

$$+ \delta_3 \textit{ FMS treasury}_{f,t} \times \textit{liquidity tightness}_t + \textit{controls}_{f,t} + \theta_t + \theta_f + \varepsilon_{f,t}. \tag{16}$$

Table: **Summary statistics (fund-time level)**

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
RRP share	12997	16.94	30.75	0	99.87	0
FMS treasury	12997	.44	.87	0	10.53	.09
liqu tight (BBG index)	12997	1.3	.48	.67	2.76	1.25