Corporate Bond Liquidity during the COVID-19 Crisis

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The views expressed here do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System

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Background & Motivation

- The corporate bond market in mid-Mar was “basically broken”
  - Credit spread, customer-to-dealer volume, fund outflows
- The Fed announced unprecedented actions in late March (MMLR)
  - PDCF, PMCCF & SMCCF
- **This paper:**
  - Study liquidity conditions & impact of Fed interventions
  - Consider both ***cost*** & ***quality*** (speed) of intermediation services
  - Simple model that guides of empirical work
  - Implications of demand surge for consumer surplus & dealer profits

Main findings

- Dealers reluctant to absorb bonds onto balance sheets
  - Price of fast (risky-principal) trades go up substantially
  - Customers respond: ***substitute*** towards slower (agency) trades
  - During worst of crisis, dealers were ***net sellers***
- Fed's interventions: significant improvement in liquidity conditions
  - Immediately after announcement: for eligible bonds only
  - Later after expansion: for a wide range of bonds
- Distinction between cost & quality matters for welfare
  - Consumer surplus still depressed (lower quality)
  - Dealer profits returned to pre-COVID levels (elevated volume)

Literature

- Post-GFC regulation and bond market liquidity
  - Bessembinder-Jacobsen-Maxwell-Venkataraman (18)
  - Bao-O'Hara-Zhou (18), Dick-Nielsen-Rossi (18), Choi-Huh (18)
- COVID-19 crisis in fixed income markets
  - Boyarchenko-Kovner-Shachar (20), Chen-Liu-Sarkar-Song (20), Duffie (20), Ebsim-Faria-e-Castro-Kozlowski (20), Falato-Goldstein-Hortaçsu (20), Fleming-Ruela (20), Foley-Fisher-Gorton-Verani (20), Haddad-Moreira-Muir (20), He-Nagel-Song (20), Ma-Xiao-Zeng (20), Mizrach-Neely (20), O'Hara-Zhou (20)

Two types of transaction services: both cost & quality matter

- **“Agency”** (“pre-arranged” or “riskless-principal”) trades
  - customers trade only after a suitable counterparty located
  - for a customer: low-quality transaction b/c customer has to wait
  - for a dealer: low-cost transaction b/c doesn’t use balance-sheet capacity (matchmaker)
- **“Risky-principal”** trades
  - customers trade immediately against dealer inventory
  - for a customer: high-quality transaction b/c provides immediacy
  - for a dealer: high-cost transaction b/c uses balance-sheet capacity

A simple model

Customers and dealers

- A measure N of customers, each has unit demand for transactions
- Demand low- and high-quality transaction services

$$\max_{(x_l, x_h)} \; u(x_l, x_h) - p_l x_l - p_h x_h \quad \text{s.t.} \quad x_l + x_h = 1$$

- A representative competitive dealer supplies transaction services

$$\max_{(X_l, X_h)} \; p_l X_l + p_h X_h - C(X_l, X_h)$$

- Market clearing: $N x_l = X_l$ and $N x_h = X_h$

COVID-19 as exogenous shock to transaction demand

- Suppose the **aggregate** demand for transaction services goes up
  - the measure of customers arriving to the market, N, goes up
  - assume no contemp. supply shock
- What happens to p_l, p_h?
- We find that, under natural conditions:
  - the cost of *all* transactions go up: both p_l and p_h increase
  - the cost of *high-quality* transaction goes up by more: $p_h - p_l$ increases
  - customers *substitute* towards low-quality transactions: x_h decreases

  ▸ Econ 101 plots
- If Fed intervention relaxes dealer balance sheet capacity (reducing C)
  - it should mitigate these changes

Empirical observations

Measuring the cost of *agency* (low-quality) trades

Measurement based on Feldhüter (12) “Implied Roundtrip Cost”

transaction cost = spread of roundtrip trades lasting < 15 min

- Dealers search for counterparties on behalf of customers
- So, when two CD trades happen in quick succession
  - likely an agency trade
  - as argued by Li-Schürhoff (19) and others

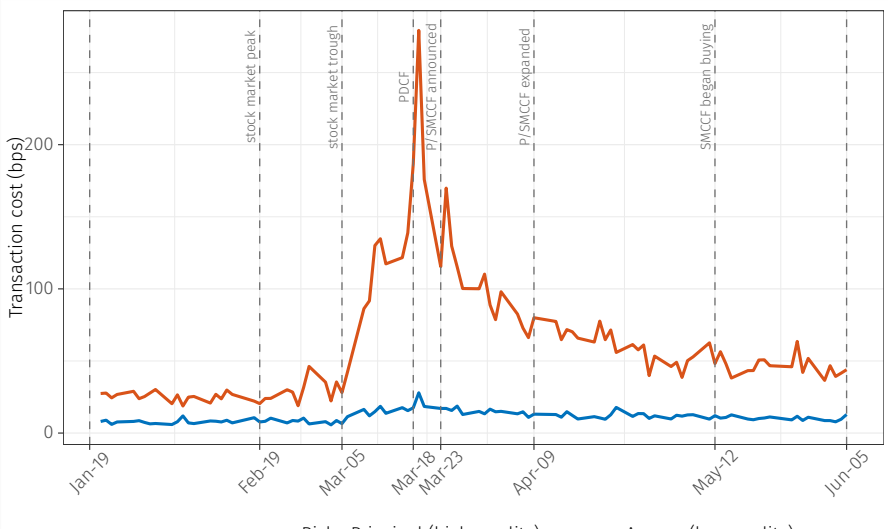
Measuring the cost of *risky-principal* (high-quality) trades

Measurement based on Choi-Huh (18)

$$\text{transaction cost} = 2Q \times \frac{\text{trade price} - \text{reference price}}{\text{reference price}}$$

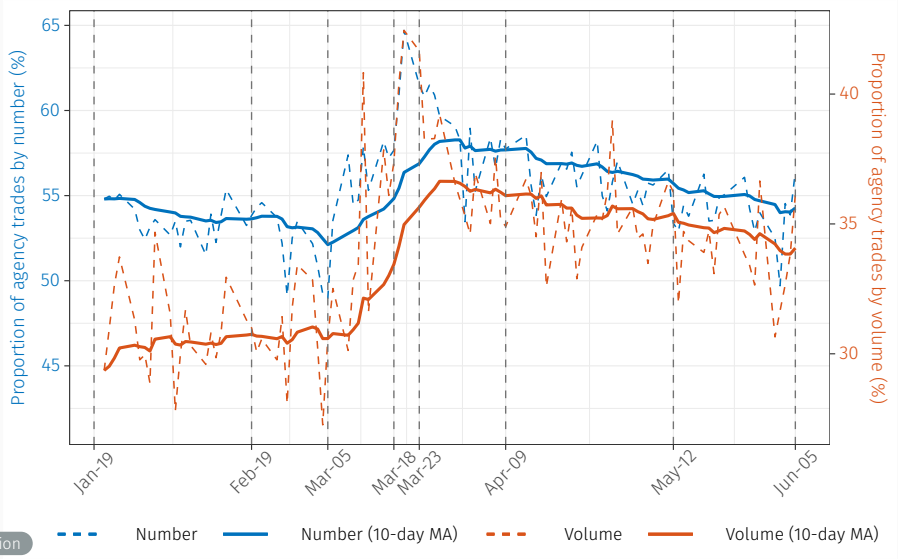
- $Q = +1$ for customer-buy and $Q = -1$ for customer-sell
  - excluding previously identified agency trades
- "reference price":
  - volume-weighted price of interdealer trades in same bond/day

Trading costs for high & low-quality: Jan-Jun



▸ diff ▸ time FEs ▸ regression

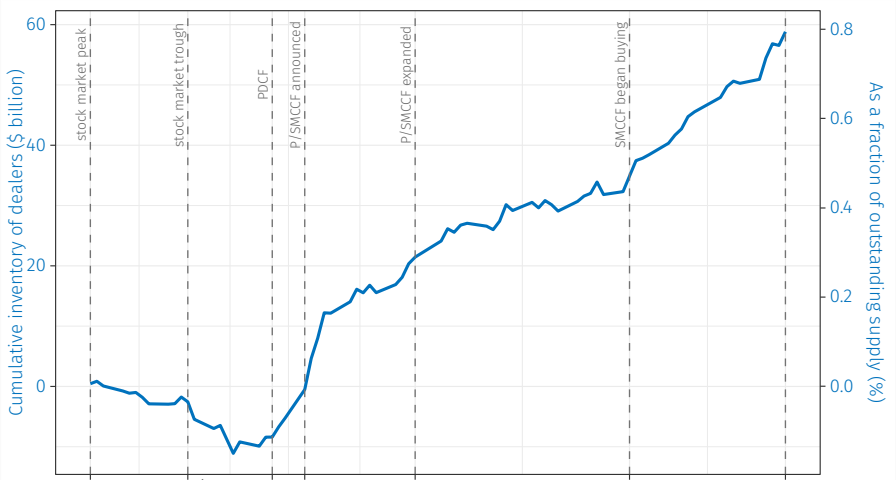
Substitution from high- to low-quality transactions



▸ regression

Who provided liquidity in mid-March?

Dealers did NOT “lean against the wind”! (until late March)



▸ plot details ▸ more recent series

Effect of the Fed’s intervention

Eligible vs. ineligible bonds for the SMCCF

- On 03/23, the Fed specified it would purchase U.S. bonds that have:
  - an IG rating (at least BBB−/Baa3)
  - a remaining maturity of ≤ 5 years
  - other criteria (not received CARES Act support, non-depository, . . .)
- **Question:**
  - Did the intervention improve eligible bond liquidity by more?
- **Empirical strategy:**
  - Diff-in-diff on U.S. bonds; before/after SMCCF announcement

Spillover effects?

$$y_{ijt} = \alpha_i + \alpha_s + \beta_1 \times \text{Crisis}_t + \beta_2 \times \text{SMCCF}_t + \beta_3 \times \text{SMCCF Expansion}_t + \varepsilon_{ijt}$$

- y_{ijt}: transaction cost (agency or risky-principal)
- α_i and α_s: bond and size category FEs
- Crisis_t: dummy for Mar 5–Mar 23
- SMCCF_t: dummy for Mar 23–Apr 9
- SMCCF Expansion_t: dummy for after Apr 9
- Eligible $=$ IG $\times$ (TTM $\leq$ 5 yr)

Spillovers of Fed facilities to ineligible bonds

	Dependent variable:					
	Risky-Principal			Agency		
	All	Eligible	Ineligible	All	Eligible	Ineligible
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis	105.64***	111.67***	102.16***	11.92***	16.32***	9.64***
	(14.96)	(15.62)	(15.65)	(2.16)	(3.52)	(1.80)
SMCCF	88.96***	62.14***	104.30***	14.35***	11.78***	15.98***
	(8.38)	(8.68)	(9.42)	(1.15)	(1.26)	(1.49)
SMCCF Expansion	31.15***	15.35***	40.16***	7.20***	4.56***	9.08***
	(3.14)	(3.08)	(4.28)	(1.01)	(0.98)	(1.44)
Bond FE	Yes	Yes	Yes	Yes	Yes	Yes
Trade size category FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	580,698	200,761	379,937	146,864	50,192	96,672
Adjusted R^2	0.18	0.19	0.18	0.27	0.21	0.27
Note:						*p<0.1; **p<0.05; ***p<0.01

The effect of Fed's interventions: Diff-in-diff

$$y_{ijt} = \alpha_s + \alpha_k + \beta_1 \times \text{SMCCF}_t \times \text{Eligible}_t + \beta_2 \times \text{SMCCF}_t + \beta_3 \times \text{Eligible}_t + \gamma \times X_{i,t} + \varepsilon_{ijt},$$

- y_{ijt}: transaction cost (agency or risky-principal)
- α_s and α_k: size category and industry FEs
- X_{it}: control for bond characteristics
- focus on bonds with no change in rating
- focus on trades before April 9 expansion to fallen angels

The effect of Fed's intervention: March 6–April 9

	Dependent variable:			
	Risky-Principal		Agency	
	(1)	(2)	(3)	(4)
SMCCF × Eligible	−57.67***	−47.33***	−10.30***	−9.58**
	(11.80)	(10.21)	(2.99)	(3.44)
SMCCF	−1.90	−14.20	6.36***	4.56**
	(14.59)	(14.68)	(2.00)	(1.98)
Eligible	2.44		0.48	
	(14.27)		(3.17)	
Bond controls	Yes	No	Yes	No
Bond FE	No	Yes	No	Yes
Trade size FE	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No
Observations	158,647	158,649	47,628	47,630
Adjusted R^2	0.04	0.20	0.08	0.25
Note:				*p<0.1; **p<0.05; ***p<0.01

▸ robustness

Welfare implications

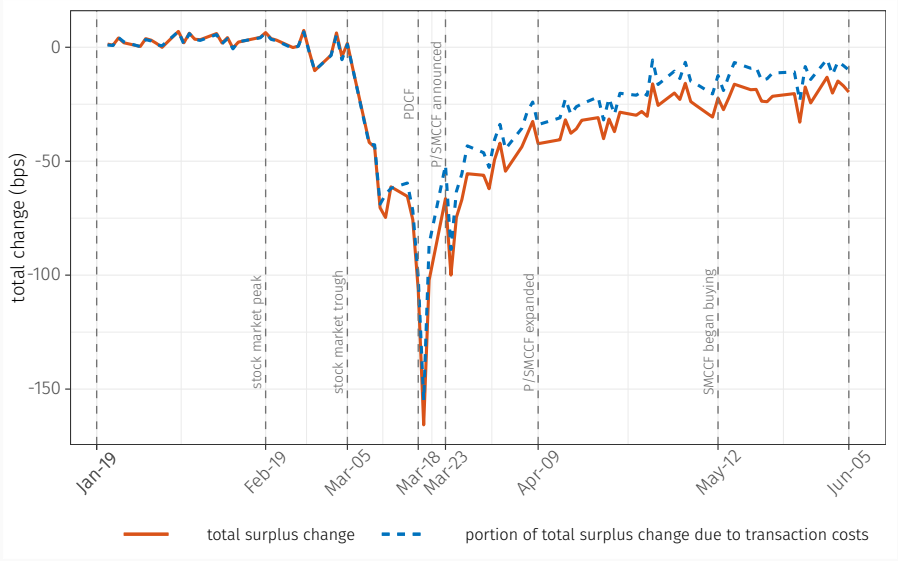
Change in consumer surplus

- Consumer surplus: $s_t = u(x_{lt}, x_{ht}) - p_{lt}x_{lt} - p_{ht}x_{ht}$
- Change in surplus

$$ds_t = \underbrace{-d(p_{lt}x_{lt} + p_{ht}x_{ht})}_{\Delta \text{ transaction cost}} + \underbrace{(p_{ht} - p_{lt})\, dx_{ht}}_{\Delta \text{ quality}}$$

- Increase in transaction costs alone, *underestimates* loss in surplus
  - ignores loss due to *substitution* towards lower-quality transactions

Change in consumer surplus: $s_t - s_0 = \int_0^t ds_u$ (per $ unit of transaction)



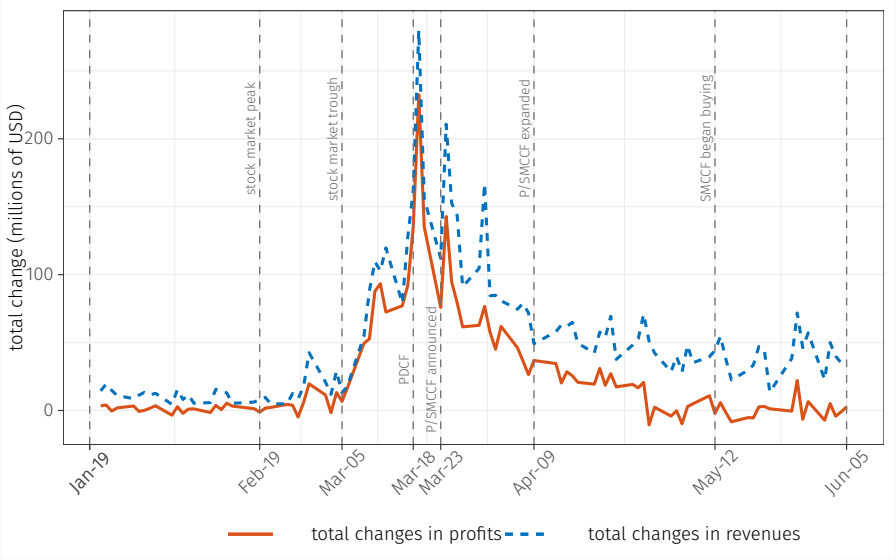
Dealer profits

- Dealer profits: $\Pi_t = N_t \left(p_{lt} x_{lt} + p_{ht} x_{ht}\right) - C(N x_{lt}, N x_{ht})$,
- Change in dealer profits: $d\Pi_t = -N_t ds_t$
- Dealer revenues: $R_t = N_t \left(p_{lt} x_{lt} + p_{ht} x_{ht}\right)$
- $d\Pi$ differs from dR due to

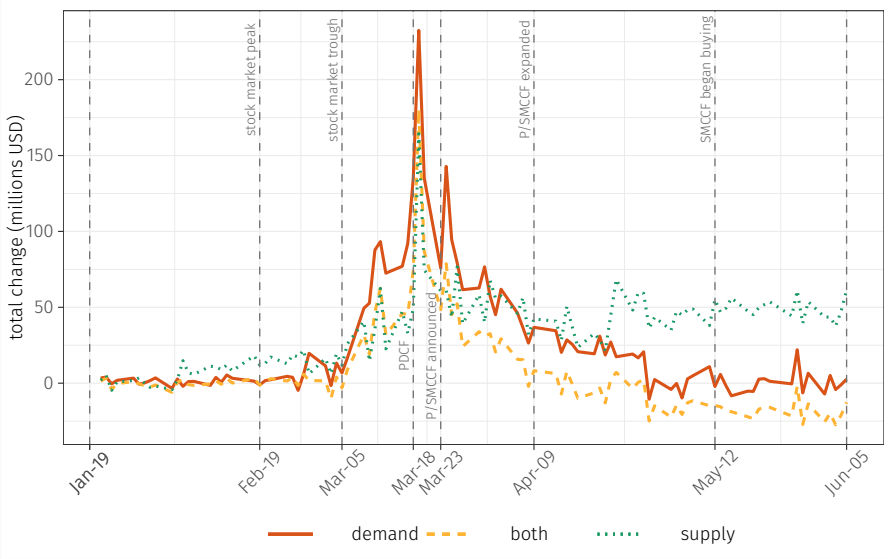
$$d\Pi_t = dR_t \quad \underbrace{-dN_t \left(p_{lt} x_{lt} + p_{ht} x_{ht}\right)}_{\text{volume effect } (<0)} \quad \underbrace{-N_t \left(p_{ht} - p_{lt}\right) dx_{ht}}_{\text{substitution effect } (>0)}$$

- The *negative* effect dominates post-Mar 23: volume remains elevated

Total change in daily dealer profits and revenues



Supply vs. demand shock?

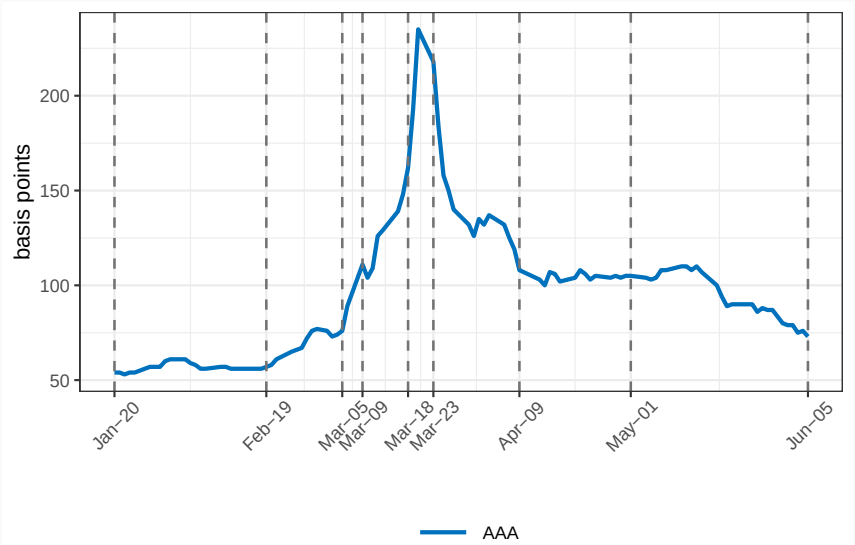


Conclusion

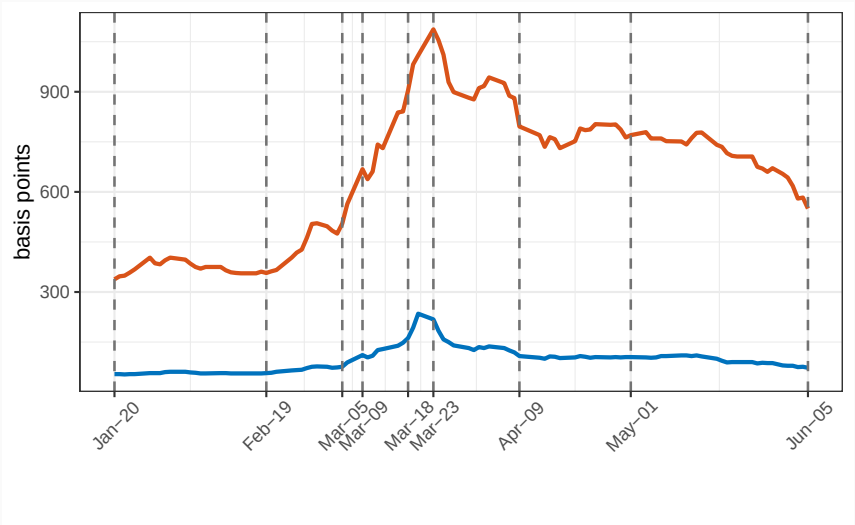
- Dealers absorbed *no* additional inventory in late March: net *sellers*
- The cost to investors of trading immediately with a dealer surged
- Substitution to slower, less costly agency trades
- Fed intervention have relaxed balance sheet constraints
  - liquidity immediately improved for eligible bonds; and for a wide range of bonds after expansion
  - dealer bond inventories surged
- A simple model to estimate the impact of shocks on consumer surplus and dealer profits

Backup Slides

Credit spread, AAA



Credit spread, AAA and HY



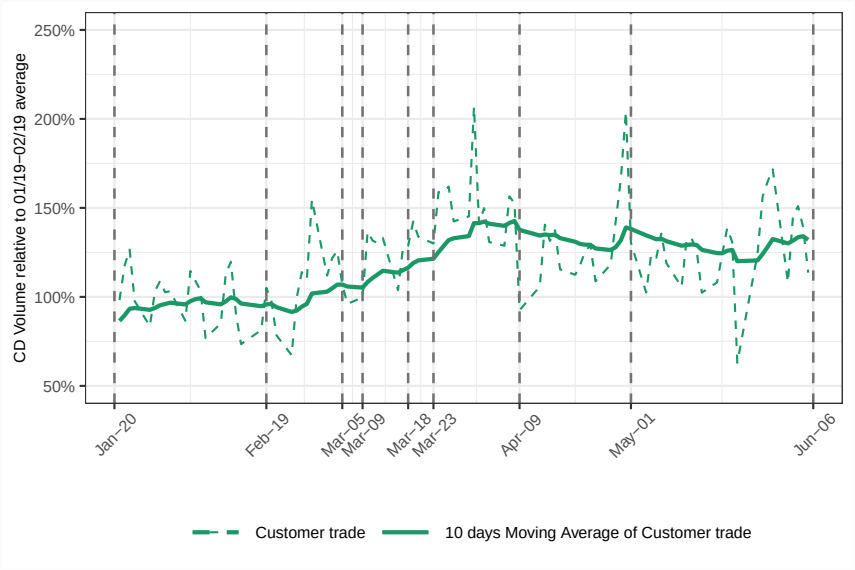
Wall Street Journal, May 20, 2020

"The Day Coronavirus Nearly Broke The Financial Markets"

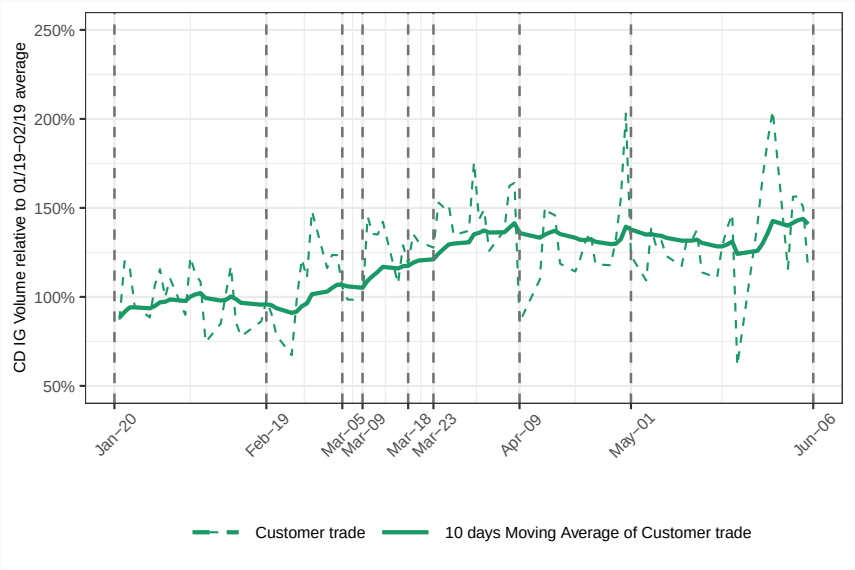
> *"So when Mr. Rao called senior executives for an explanation on why [broker-dealers] wouldn't trade, they had the same refrain: There was no room to buy bonds and other assets and still remain in compliance with tougher guidelines imposed by regulators after the previous financial crisis (. . .) One senior bank executive leveled with him: "**We can't bid on anything that adds to the balance sheet right now**."*

Back

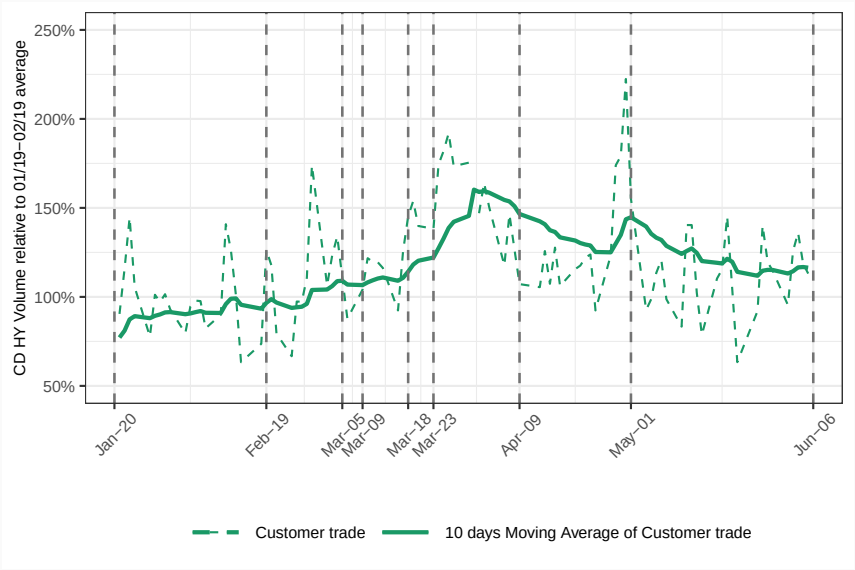
Customer-to-dealer volume, all bonds



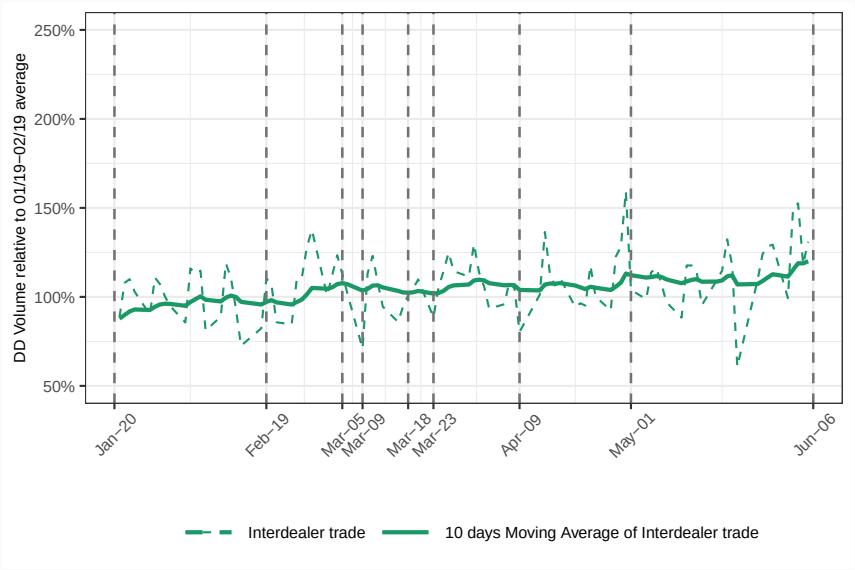
Customer-to-dealer volume, IG bonds



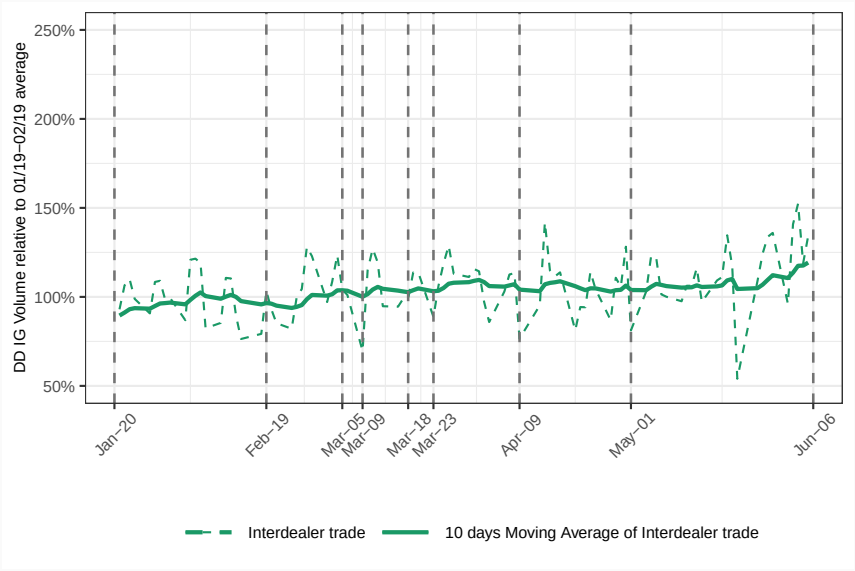
Customer-to-dealer volume, HY bonds



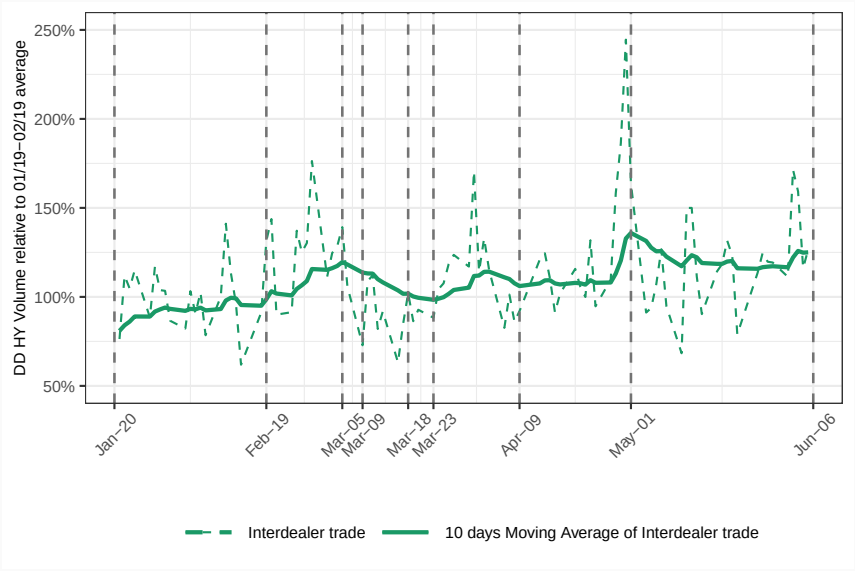
Inter-dealer volume, all bonds



Inter-dealer volume, IG bonds



inter-dealer volume, HY bonds



The natural conditions

- Customers' marginal value of high quality is larger:

$$u_h(x_l, x_h) - u_l(x_l, x_h) \geq 0$$

- Locally, the marginal cost of low-quality trades is increasing in N:

$$\text{holding } (x_l, x_h) \text{ fixed, } C_l(Nx_l, Nx_h) \text{ increases in } N$$

$$\text{i.e., } \frac{\partial C_l(Nx_l, Nx_h)}{\partial N} \geq 0$$

- Locally, the marginal cost of high-quality trades increases in N by more:

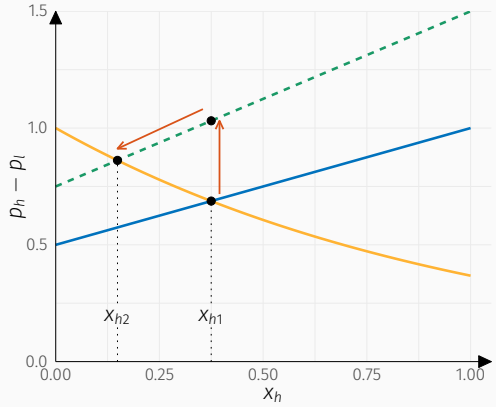
$$\text{holding } (x_l, x_h) \text{ fixed, } C_h(Nx_l, Nx_h) - C_l(Nx_l, Nx_h) \text{ increases in } N$$

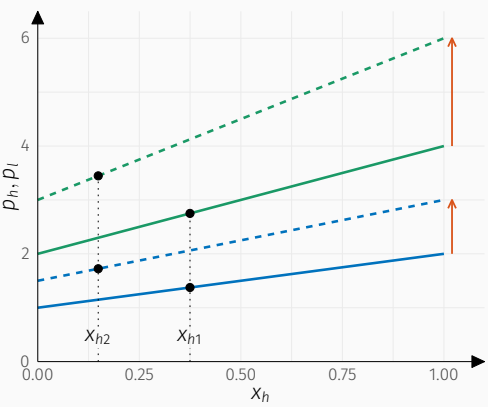
$$\text{i.e., } \frac{\partial C_h(Nx_l, Nx_h) - C_l(Nx_l, Nx_h)}{\partial N} \geq 0$$

Back

High- and low-quality: Equilibrium price and quantities

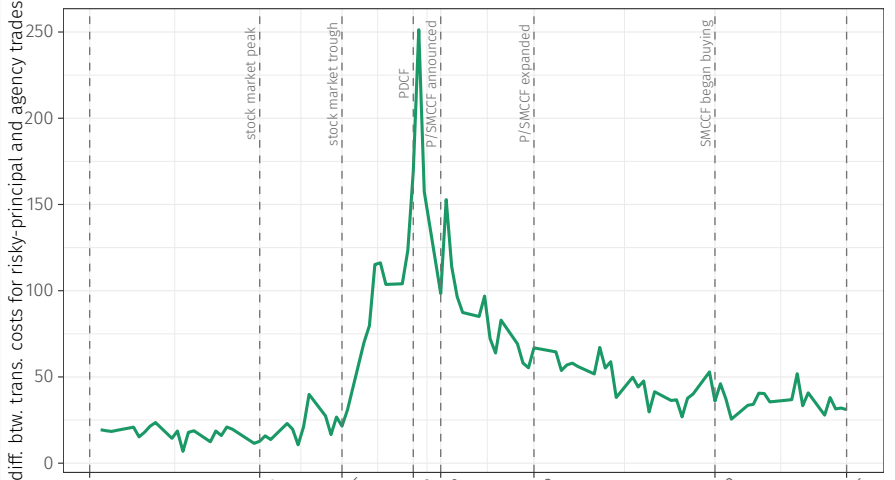
$$u_h(1-x_h, x_h) - u_l(1-x_h, x_h) = p_h - p_l = C_h(N(1-x_h), Nx_h) - C_l(N(1-x_h), Nx_h)$$





Back

Trading costs for high- & low-quality (difference): Jan-Jun



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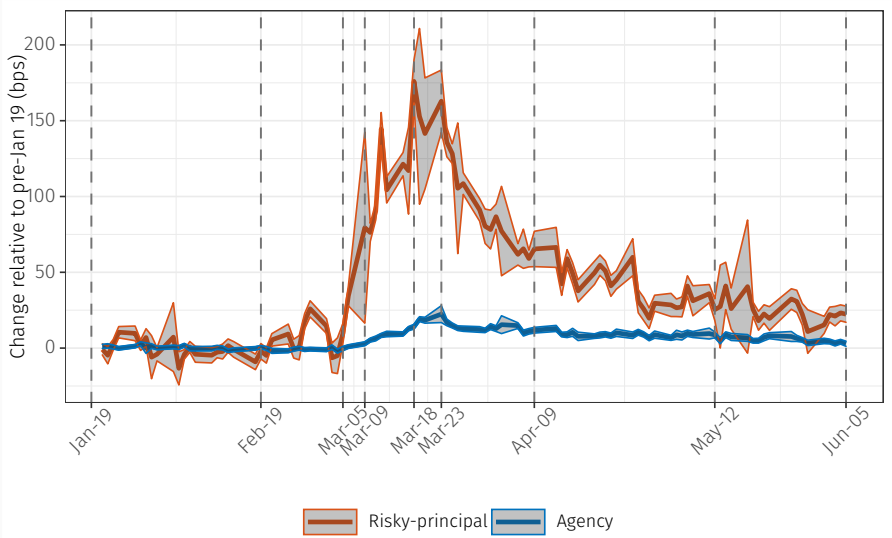
An entire set of time fixed effects



Back

Time-series evidence in regression

$$y_{ijt} = \alpha_i + \alpha_s + \beta_1 \times \text{Crisis}_t + \beta_2 \times \text{Intervention}_t + \varepsilon_{ijt}$$

- y_{ijt}: transaction cost, or trade type dummy (agency or risky-principal)
- Crisis_t: dummy for Mar 5–Mar 23
- Intervention_t: dummy for after Mar 23
- α_i and α_s: bond and size category FEs

Trading cost: Jan 3–Jun 5

	Dependent variable:			
	Risky-Principal		Agency	
	All bonds	US only	All bonds	US only
	(1)	(2)	(3)	(4)
Crisis	106.57***	105.64***	10.43***	12.04***
	(14.17)	(14.92)	(1.83)	(2.16)
Intervention	51.28***	52.07***	9.39***	10.16***
	(5.62)	(5.93)	(0.74)	(1.03)
Bond FE	Yes	Yes	Yes	Yes
Trade size category FE	Yes	Yes	Yes	Yes
Observations	769,809	580,698	245,670	146,864
Adjusted R^2	0.17	0.18	0.26	0.27
Note:				*p<0.1; **p<0.05; ***p<0.01

Substitution to agency trades

	Dependent variable:		
	Probability of agency trade		
	OLS	Logit	Probit
	(1)	(2)	(3)
Crisis	0.038***	0.037***	0.037***
	(0.010)	(0.010)	(0.009)
Intervention	0.031***	0.030***	0.030***
	(0.004)	(0.004)	(0.004)
Bond FE	Yes	Yes	Yes
Trade size category FE	Yes	Yes	Yes
Observations	7,052,589	7,052,589	7,052,589
Adjusted R^2	0.113		
Pseudo R^2		0.085	0.085
Note:			*p<0.1; **p<0.05; ***p<0.01

Back

Spillover effects?

$$y_{ijt} = \alpha_i + \alpha_s + \beta_1 \times \text{Crisis}_t + \beta_2 \times \text{SMCCF}_t + \beta_3 \times \text{SMCCF Expansion}_t + \varepsilon_{ijt}$$

- y_{ijt}: transaction cost, or trade type (agency or risky principal)
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- Crisis_t: dummy for Mar 5–Mar 23
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- SMCCF Expansion_t: dummy for after Apr 9
- Eligible $=$ IG $\times$ (TTM $\leq$ 5 yr)

Spillovers of Fed facilities to ineligible bonds

	Dependent variable:					
	Risky-Principal			Agency		
	All	Eligible	Ineligible	All	Eligible	Ineligible
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis	105.64***	111.67***	102.16***	11.92***	16.32***	9.64***
	(14.96)	(15.62)	(15.65)	(2.16)	(3.52)	(1.80)
SMCCF	88.96***	62.14***	104.30***	14.35***	11.78***	15.98***
	(8.38)	(8.68)	(9.42)	(1.15)	(1.26)	(1.49)
SMCCF Expansion	31.15***	15.35***	40.16***	7.20***	4.56***	9.08***
	(3.14)	(3.08)	(4.28)	(1.01)	(0.98)	(1.44)
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Note:						*p<0.1; **p<0.05; ***p<0.01

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DID: bonds just above/below TTM & rating threshold

	Dependent variable:							
	Risky-principal				Agency			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SMCCF × Eligible	−94.92**	−86.46**	−73.52**	−73.52**	−2.82	−5.38	−0.16	−0.16
	(45.73)	(43.93)	(30.56)	(30.56)	(3.58)	(3.80)	(3.90)	(3.90)
SMCCF	46.47	37.41	16.30	16.30	2.54	5.14**	2.41	2.41
	(29.20)	(24.24)	(17.65)	(17.65)	(1.89)	(2.04)	(2.34)	(2.34)
Eligible	63.68	46.64			−1.18	7.74		
	(46.38)	(52.37)			(4.19)	(7.49)		
Bond controls	Yes	Yes	No	No	Yes	Yes	No	No
Bond FE	No	No	Yes	Yes	No	No	Yes	Yes
Trade size FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	No	No	Yes	Yes	No	No
Credit rating FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	14,124	14,124	14,124	14,124	4,595	4,595	4,595	4,595
Adjusted R^2	0.04	0.05	0.16	0.16	0.12	0.13	0.28	0.28
Note:								*p<0.1; **p<0.05; ***p<0.01

▸ Back

Dealers inventory accumulation

- Complicated, since no info about dealers' initial position at issuance
- Moreover, in our data, trade size is top-coded
  - customer sell are larger than customer buy
  - underestimate total customer sell by more than customer buy
- We use Daily Market Sentiment data (FINRA)
  - report aggregate customer sell and customer buy (not top-coded)
- We calculate difference btw. customer sell and buy
  - we show cumulative series

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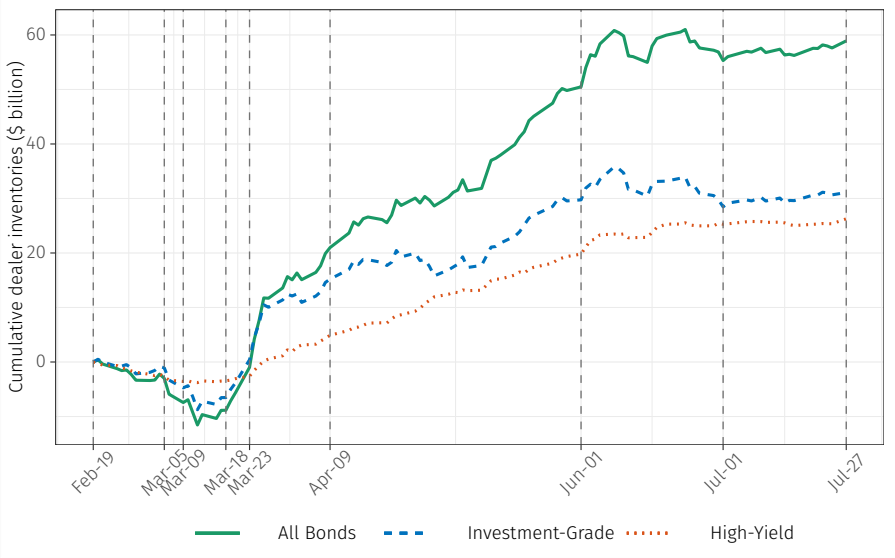
Cumulative dealer inventories across ratings (more recent)



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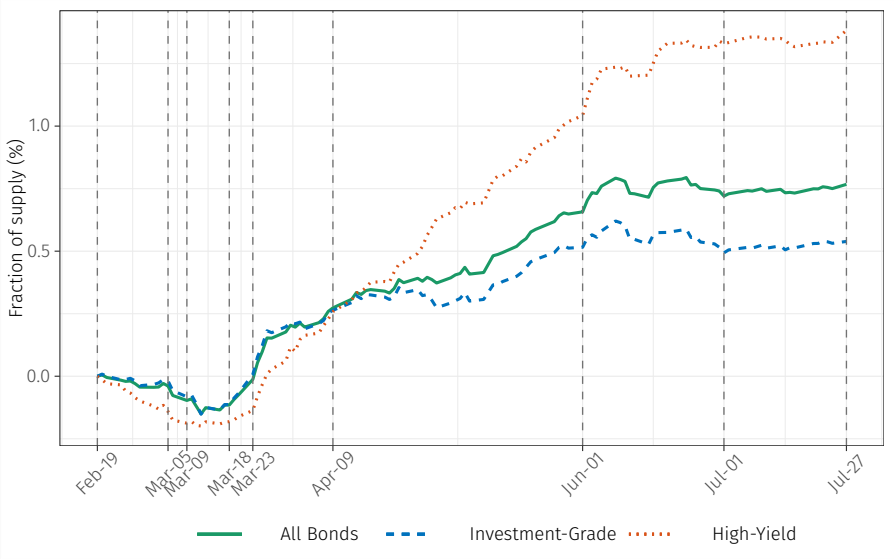
Cumulative dealer inventories across ratings (as % of supply)



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Supply vs. demand shock?

- So far, dealer cost function, $C(X)$ assumed to be constant.
- Surge in volume & price inconsistent with supply shock *only*
- Suppose instead, $C(X_l, X_h) = \Psi(X_l, \gamma X_h)$; $\gamma > 0$ is a cost-shifter for high-quality trades
- MRS btw. agency and risky-principal trades

$$\frac{C_h}{C_l} = \frac{p_h}{p_l} = \gamma \frac{\Psi_h}{\Psi_l}.$$

- MRS increased dramatically in mid-March. Two possibilities:
  - holding γ fixed: demand N could've increased
  - holding demand fixed: γ could've increased

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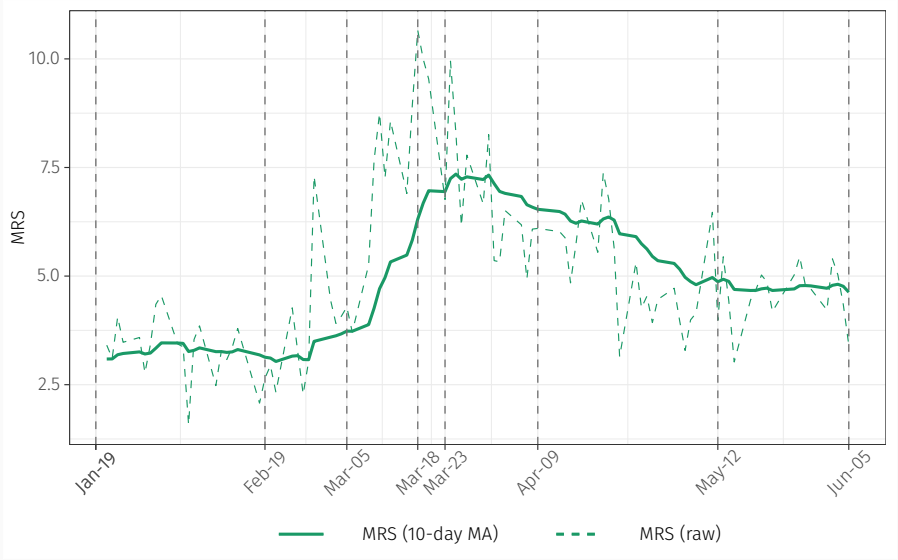
MRS between agency and risky-principal trades



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