Prime Broker Credit Supply and the Stock Market

Evidence on Hedge Fund Transmission

Daniel Barth [1] Nicholas Zarra [1]

[1]Fed Board

SFS Cavalcade
May 21, 2026

The views expressed are those of the authors and do not necessarily represent those of the Federal Reserve Board or its staff. All views are my own.

Motivation

1. Empirical intermediary asset pricing has been very successful.
   - Broker-dealer (B/D) factors explain returns across many asset classes (Adrian et al. [2014], He et al. [2017])
   - B/Ds direct ownership affect prices (Haddad and Muir [2021])

$$\textbf{B/D} \implies \textbf{Asset Markets}$$

Motivation

1. Empirical intermediary asset pricing has been very successful.
   - Broker-dealer (B/D) factors explain returns across many asset classes (Adrian et al. [2014], He et al. [2017])
   - B/Ds direct ownership affect prices (Haddad and Muir [2021])

$$\textbf{B/D} \implies \textbf{Asset Markets}$$

2. But B/Ds do not only participate through direct investing.

Motivation

1. Empirical intermediary asset pricing has been very successful.
   - Broker-dealer (B/D) factors explain returns across many asset classes (Adrian et al. [2014], He et al. [2017])
   - B/Ds direct ownership affect prices (Haddad and Muir [2021])

   $$\textbf{B/D} \implies \textbf{Asset Markets}$$

2. But B/Ds do not only participate through direct investing.
3. In stock markets, B/Ds mainly participate by lending to hedge funds (HFs) via their prime brokers (PBs).
   - As of 2024, total PB lending to HFs: \$2.8T
   - ...but directly hold little: \$0.3T

Motivation

1. Empirical intermediary asset pricing has been very successful.
   - Broker-dealer (B/D) factors explain returns across many asset classes (Adrian et al. [2014], He et al. [2017])
   - B/Ds direct ownership affect prices (Haddad and Muir [2021])

$$\textbf{B/D} \implies \textbf{Asset Markets}$$

2. But B/Ds do not only participate through direct investing.
3. In stock markets, B/Ds mainly participate by lending to hedge funds (HFs) via their prime brokers (PBs).
   - As of 2024, total PB lending to HFs: \$2.8T
   - ...but directly hold little: \$0.3T
4. We test if, and under what conditions:

$$\textbf{B/D} \implies \textbf{HF} \implies \textbf{Stock Market}$$

▸ Lending Aggregates ▸ Flow Chart

We Find a Conditional Transmission Mechanism

Credit supply shocks transmit to equity prices but only when HFs cannot fully substitute borrowing to healthier B/Ds.

We Find a Conditional Transmission Mechanism

Credit supply shocks transmit to equity prices but only when HFs cannot fully substitute borrowing to healthier B/Ds.

1. B/D financial health $\downarrow \implies$ B/D credit supply $\downarrow$

2. In widespread B/D distress, B/D credit supply $\downarrow \implies$ HF total borrowing and equity holding $\downarrow$
   - Why? HFs cannot fully substitute to healthier B/Ds

3. When HFs are forced to sell, stock prices $\downarrow$ before reverting
   - Sell-offs absorbed by non-levered investors
   - Large micro price impact multiplier

▸ Literature

Three complementary approaches to identify mechanism

Challenge: B/D credit quantities are endogenous to credit demand

1. **Two cross-sectional event studies** identify credit supply shocks
   - Euro Broker Distress (Systemic) and Archegos collapse (Idiosyncratic)
   - Observe differential transmission patterns

2. **Full panel regressions** test whether idiosyncratic B/D events are diversified by HF substitution behavior

3. **Time-series correlations and patterns** test whether aggregate patterns are consistent with the mechanism

▸ Literature

Three complementary approaches to identify mechanism

Challenge: B/D credit quantities are endogenous to credit demand

1. **Two cross-sectional event studies** identify credit supply shocks
   - Euro Broker Distress (Systemic) and Archegos collapse (Idiosyncratic)
   - Observe differential transmission patterns

2. **Full panel regressions** test whether idiosyncratic B/D events are diversified by HF substitution behavior

3. **Time-series correlations and patterns** test whether aggregate patterns are consistent with the mechanism

▸ Literature

Roadmap

Institutional Details and Data

Credit Supply in the Event Studies

Testing Credit Supply and Imperfect Substitution

Event Study Asset Pricing

Does aggregate credit supply transmit to prices?

Data and Institutional Context

Data Sources: More

- Form PF: Borrowing quantities information for HFs
  - Includes near universe of large hedge funds (including foreign)
- FactSet Ownership: Stock-level holdings by managers

Key Institutional Facts: More

- HFs are the main levered equity investors in U.S. markets, hold 8.3% of average stock
- Prime brokers (divisions of B/Ds) provide this leverage
- Concentrated market: Top 10 B/Ds HF lending share is 80%
- HFs diversify: Large funds use 4.3 PBs on average

Data and Institutional Context

Data Sources: More

- Form PF: Borrowing quantities information for HFs
  - Includes near universe of large hedge funds (including foreign)
- FactSet Ownership: Stock-level holdings by managers

Key Institutional Facts: More

- HFs are the main levered equity investors in U.S. markets, hold 8.3% of average stock
- Prime brokers (divisions of B/Ds) provide this leverage
- Concentrated market: Top 10 B/Ds HF lending share is 80%
- HFs diversify: Large funds use 4.3 PBs on average

PF analysis limited to aggregated sets of counter-parties!

Two Event Studies

Archegos (2021 Q2)

- Family office defaulted on derivatives $\implies$ \$10B losses
- **Grouping methodology:** B/Ds with realized losses
  - CS, NMR, UBS, MS, MUFG, MFG (Ex-Ante Lending: $\approx 33\%$)
  - Non-shocked B/D health: stable

Two Event Studies

Archegos (2021 Q2)

- Family office defaulted on derivatives $\implies$ \$10B losses
- **Grouping methodology:** B/Ds with realized losses
  - CS, NMR, UBS, MS, MUFG, MFG (Ex-Ante Lending: $\approx 33\%$)
  - Non-shocked B/D health: stable

Euro 5 (2016 Q1)

- Deutsche Bank and Credit Suisse write-downs+ DB default concerns $\implies$ Euro B/D weakness
- **Grouping methodology:** Top quintile of B/Ds by Δ CDS
  - CS, DB, ACA, NWG, BCS ($\approx 33\%$)
  - Non-shocked B/D health: declining

Two Event Studies

Archegos (2021 Q2)

- Family office defaulted on derivatives $\implies$ \$10B losses
- **Grouping methodology:** B/Ds with realized losses
  - CS, NMR, UBS, MS, MUFG, MFG (Ex-Ante Lending: $\approx 33\%$)
  - Non-shocked B/D health: stable

Euro 5 (2016 Q1)

- Deutsche Bank and Credit Suisse write-downs+ DB default concerns $\implies$ Euro B/D weakness
- **Grouping methodology:** Top quintile of B/Ds by Δ CDS
  - CS, DB, ACA, NWG, BCS ($\approx 33\%$)
  - Non-shocked B/D health: declining

In both events, treated B/Ds PB lending $\downarrow$ significantly

▸ Full Details & Navigation

Roadmap

Institutional Details and Data

Credit Supply in the Event Studies

- Testing Credit Supply and Imperfect Substitution

Event Study Asset Pricing

Does aggregate credit supply transmit to prices?

Did credit supply contract at distressed brokers?

To test for credit supply contraction, we regress:

$$\Delta \ln(PBL^{f,b}) = \alpha_f + \beta \cdot Treated^{f,b} + \epsilon^{f,b}$$

	Euro5 (2016Q1)			Archegos (2021Q2)		
	$\Delta \log(PBL^{f,b})$		$\frac{\Delta PBL^{f,b}}{NAV^f}$	$\Delta \log(PBL^{f,b})$		$\frac{\Delta PBL^{f,b}}{NAV^f}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Treated^{f,b}$	-0.158***	-0.155***	-0.024**	-0.079***	-0.085***	-0.024***
	(0.035)	(0.036)	(0.009)	(0.028)	(0.028)	(0.008)
R^2	0.64	0.59	0.49	0.52	0.51	0.42
N	1,086	962	962	1,169	1,043	1,043
Fund FE	X	X	X	X	X	X
Sample	All	Large Eq	Large Eq	All	Large Eq	Large Eq

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- Funds borrow 2.4 p.p. less in $\frac{PBL}{NAV}$ from each treated B/D
- **Yes, in both E5 and Archegos**

▸ E5: Full ▸ Arch: Full ▸ Methodology

Can funds perfectly substitute to other brokers?

To test fund substitution capacity, we regress:

$$\Delta \ln(PBL^f) = \alpha + \beta \cdot BorrowFromAnyTreated^f_{t-1} + \epsilon^f$$

	Euro 5 (2016 Q1)			**Archegos (2021 Q2)**		
	$\Delta \log(PBL^f_t)$		$\frac{\Delta PBL^f_t}{NAV^f}$	$\Delta \log(PBL^f_t)$		$\frac{\Delta PBL^f_t}{NAV^f}$
	(1)	(2)	(3)	(4)	(5)	(6)
$BorrowFromAnyTreated^f_{t-1}$	-0.186***	-0.146***	-0.067***	-0.005	-0.021	0.096***
	(0.041)	(0.035)	(0.025)	(0.034)	(0.032)	(0.030)
Intercept	0.074**	0.046*	0.038**	0.061**	0.073***	-0.024
	(0.031)	(0.027)	(0.019)	(0.028)	(0.027)	(0.024)
R^2	0.058	0.048	0.227	0.050	0.070	0.119
N	493	415	415	463	398	398
StratFE	X	X	X	X	X	X
MinEquity		X	X		X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- E5: Exposed funds borrow 6.7 p.p. less $\frac{PBL}{NAV}$ (Col 3)
- **Yes in Archegos, no in E5**

▸ Aggregate Substitution Tests ▸ E5: Full ▸ Arch: Full ▸ Uniqueness of Q1 2016 ▸ Methodology

Why E5 transmission? The role of other B/Ds' health

Non-shocked B/Ds health differed ▸ Details

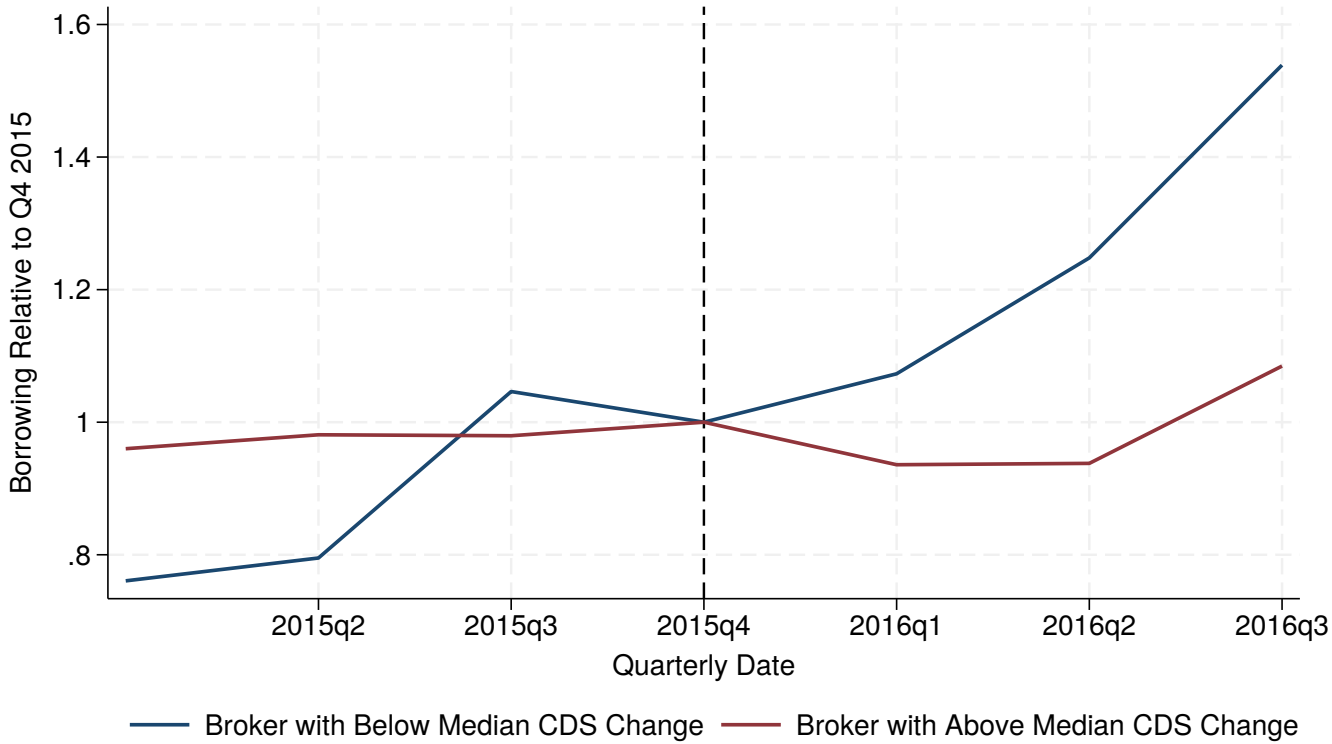
- Archegos: Median ΔCDS $\sim$0 bps (idiosyncratic)
- E5: Median ΔCDS $\sim$30 bps (agg. tightening)

Why E5 transmission? The role of other B/Ds' health

Non-shocked B/Ds health differed

▸ Details

- Archegos: Median ΔCDS ∼0 bps (idiosyncratic)
- E5: Median ΔCDS ∼30 bps (agg. tightening)



- Healthier broker-dealers too small ($19B total PBL) vs. funding lost ($35B)

▸ Consistent evidence in the cross-section

Roadmap

Institutional Details and Data

Credit Supply in the Event Studies

Testing Credit Supply and Imperfect Substitution

Event Study Asset Pricing

Does aggregate credit supply transmit to prices?

E5 HF Managers Sold Off Equities in Response to Shock

For each hedge fund (HF) manager m:

$$\Delta \ln(\text{EqHoldings}^{m}_{2016q1}) = \alpha + \beta \cdot \text{Treated}^{m} + \epsilon^{m}_{2016q1}$$

	$\Delta Log(PBL_{m,2016q1})$	$\Delta Log(Equity^{mkt}_{m,2016q1})$	$\Delta Log(Equity^{stale}_{m,2016q1})$	
	(1)	(2)	(3)	(4)
$Treated^{m}_{2015q4}$	-0.096*	-0.067**	-0.088***	-0.057*
	(0.052)	(0.034)	(0.034)	(0.032)
$\Delta ln(PBL^{m})$				0.100
				(0.089)
$Treated^{m}_{2015q4} \times \Delta ln(PBL^{m})$				0.243**
				(0.110)
Intercept	0.008	-0.083***	-0.025	-0.026
	(0.038)	(0.025)	(0.025)	(0.025)
R^2	0.017	0.020	0.034	0.195
N	196	196	196	196

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- $\text{StalePricePort}^{m}_{t} = \sum_{s} \text{Price}^{s}_{2015q4} \cdot \text{SharesHeld}^{m,s}_{t}$

▸ Similar evidence for fund-level exposure in PF

Documenting Stock-Level Effects

1. Ex-ante exposure:

$$\%\ \text{Held Euro5 HFs}^{s}_{2015q4} = \sum_{m \in M_{15q4}(s)} \text{MktShare}^{s,m}_{2015q4} \cdot \text{Treated}^{m}_{2015q4}$$

$$\text{where } \text{MktShare}^{s,m}_{2015q4} = \frac{\text{SharesHeld}^{s,m}_{2015q4}}{\text{SharesOutstanding}^{s}_{2015q4}}$$

Documenting Stock-Level Effects

1. Ex-ante exposure:

$$\%\ \text{Held Euro5 HFs}^{s}_{2015q4} = \sum_{m \in M_{15q4}(s)} \text{MktShare}^{s,m}_{2015q4} \cdot \text{Treated}^{m}_{2015q4}$$

$$\text{where MktShare}^{s,m}_{2015q4} = \frac{\text{SharesHeld}^{s,m}_{2015q4}}{\text{SharesOutstanding}^{s}_{2015q4}}$$

2. Exposure $\Longrightarrow$ Stock Sell-offs:

$$\Delta\%\ \text{Held Euro5 HFs}^{s}_{2016q1} = \alpha + \beta \cdot \%\ \text{Held Euro5 HFs}^{s}_{2015q4} + \epsilon^{s}$$

✓ ▸ Evidence

Documenting Stock-Level Effects

1. Ex-ante exposure:

$$\%\ \text{Held Euro5 HFs}^{s}_{2015q4} = \sum_{m \in M_{15q4}(s)} \text{MktShare}^{s,m}_{2015q4} \cdot \text{Treated}^{m}_{2015q4}$$

$$\text{where MktShare}^{s,m}_{2015q4} = \frac{\text{SharesHeld}^{s,m}_{2015q4}}{\text{SharesOutstanding}^{s}_{2015q4}}$$

2. Exposure $\Longrightarrow$ Stock Sell-offs:

$$\Delta\%\ \text{Held Euro5 HFs}^{s}_{2016q1} = \alpha + \beta \cdot \%\ \text{Held Euro5 HFs}^{s}_{2015q4} + \epsilon^{s}$$

✓ ▸ Evidence

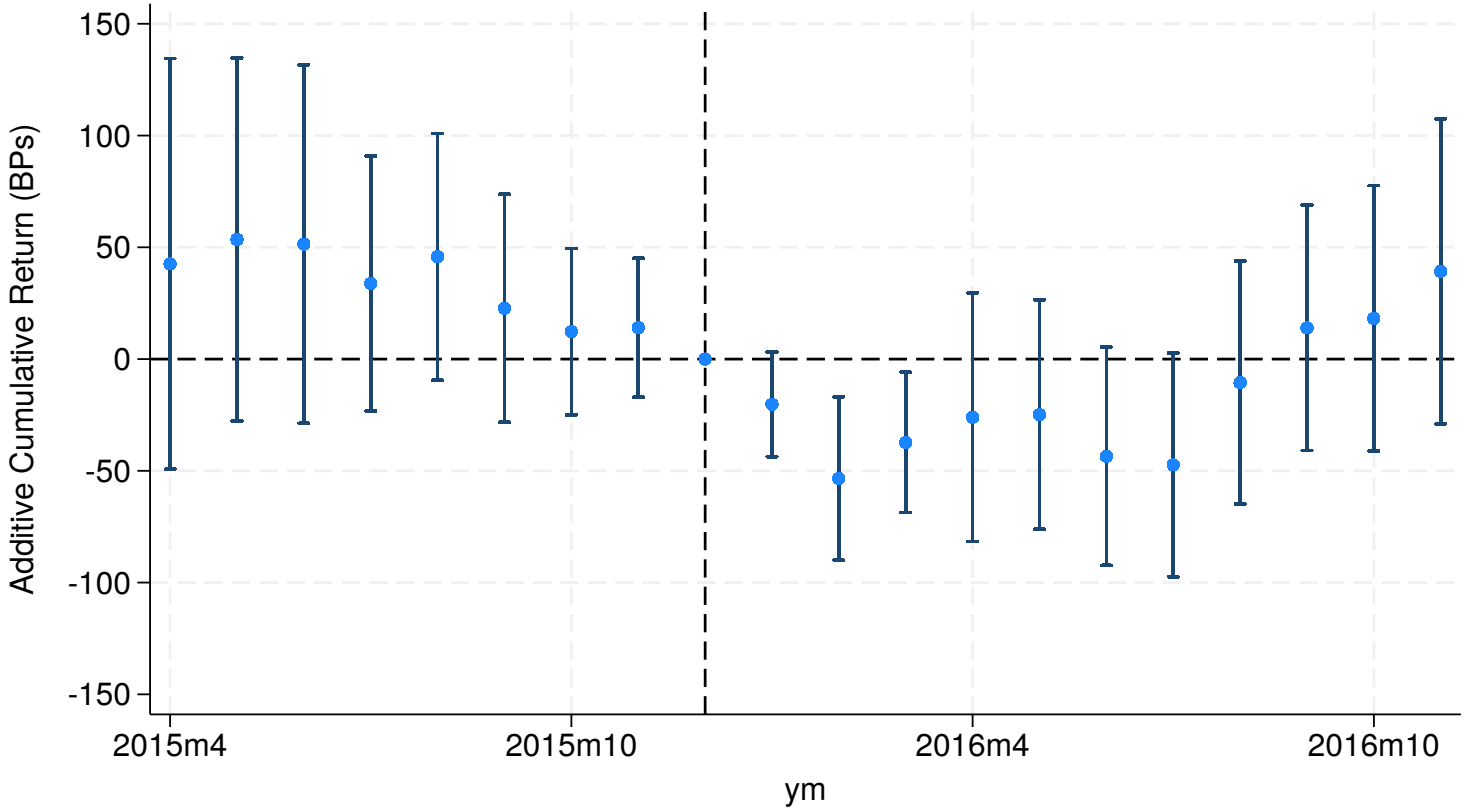
3. Exposure $\Longrightarrow$ Stock Returns:

$$\text{ret}^{s}_{2016q1} = \alpha + \beta \cdot \%\ \text{Held Euro5 HFs}^{s}_{2015q4} + \epsilon^{s}$$

where ret^{s}_{2016q1} denotes a realized return.

✓ ▸ Evidence

Temporary price impact



Additive cumulative returns

$$cumret^{s}_{2015m12+\tau} = \alpha + \beta\%\ \text{Held Euro5 HFs}^{s}_{2015q4} + \beta_2\%\ \text{Held nonEuro5 HFs}^{s}_{2015q4} + \epsilon^{s}_{2015m12+\tau}$$

Price impact is large

$$ret^s = \alpha + \beta \cdot \Delta\%\ \text{Held}^s + \varepsilon^s$$

	Realized Sell-offs $\Longrightarrow$ Returns			
	Ret_s	Ret_s	Ret_s	$\varepsilon_{FF4,s}$
	(1)	(2)	(3)	(4)
Δ % Held Euro5 HFs	1.022***	1.014***	2.629***	4.075***
	(0.347)	(0.357)	(0.603)	(0.717)
Δ % Held non-Euro5 HFs		-0.653	-0.204	-0.718
		(1.044)	(1.610)	(1.791)
Intercept	0.011	0.011	0.036**	0.044***
	(0.017)	(0.017)	(0.018)	(0.015)
R^2	0.01	0.01	0.02	0.05
N	1,537	1,537	828	828
IndustryFE				
E5SellOff			X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Large price impact multiplier (Gabaix and Koijen [2021])!

- Column (3): $\uparrow$ 1pp E5 sell-off $\Longrightarrow$ 2.63pp $\downarrow$ returns
- Implied multipliers: 2.9-4.72

▸ Exposure $\Longrightarrow$ Returns ▸ Sell-off $\Longrightarrow$ Returns ▸ Inst. and direct controls ▸ Liquidity

Non-levered and more inelastic investors absorb sell-off

We compute for each other investor class i

$$\%\ \text{Held}\ {}^{i}_{t} = \sum_{m \in M_t(s)} MktShare_t^{s,m} \cdot ManagerClass^{i}$$

We then estimate:

$$\Delta\%\ \text{Held}\ {}^{s,i}_{2016q1} = \alpha + \beta \Delta\%\ \text{Held Euro5 HFs}^{s}_{2016q1} + \epsilon^{s,i}_{2016q1}$$

	$\Delta\%HeldnonEuro5HFs$	$\Delta\%HeldOtherHFs$	$\Delta\%HeldBrokers$	$\Delta\%HeldHouseholds$	$\Delta\%HeldInvAdv$
	(1)	(2)	(3)	(4)	(5)
$\Delta\%HeldEuro5HFs$	-0.021	-0.024	0.006	-0.486***	-0.397***
	(0.036)	(0.058)	(0.022)	(0.101)	(0.110)
Intercept	-0.000	-0.001	-0.001***	-0.002*	0.003**
	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)
R^2	0.00	0.00	0.00	0.04	0.02
N	828	828	828	828	828

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- In line with theories where asset holders matter for risk premia!

Roadmap

Institutional Details and Data

Credit Supply in the Event Studies

Testing Credit Supply and Imperfect Substitution

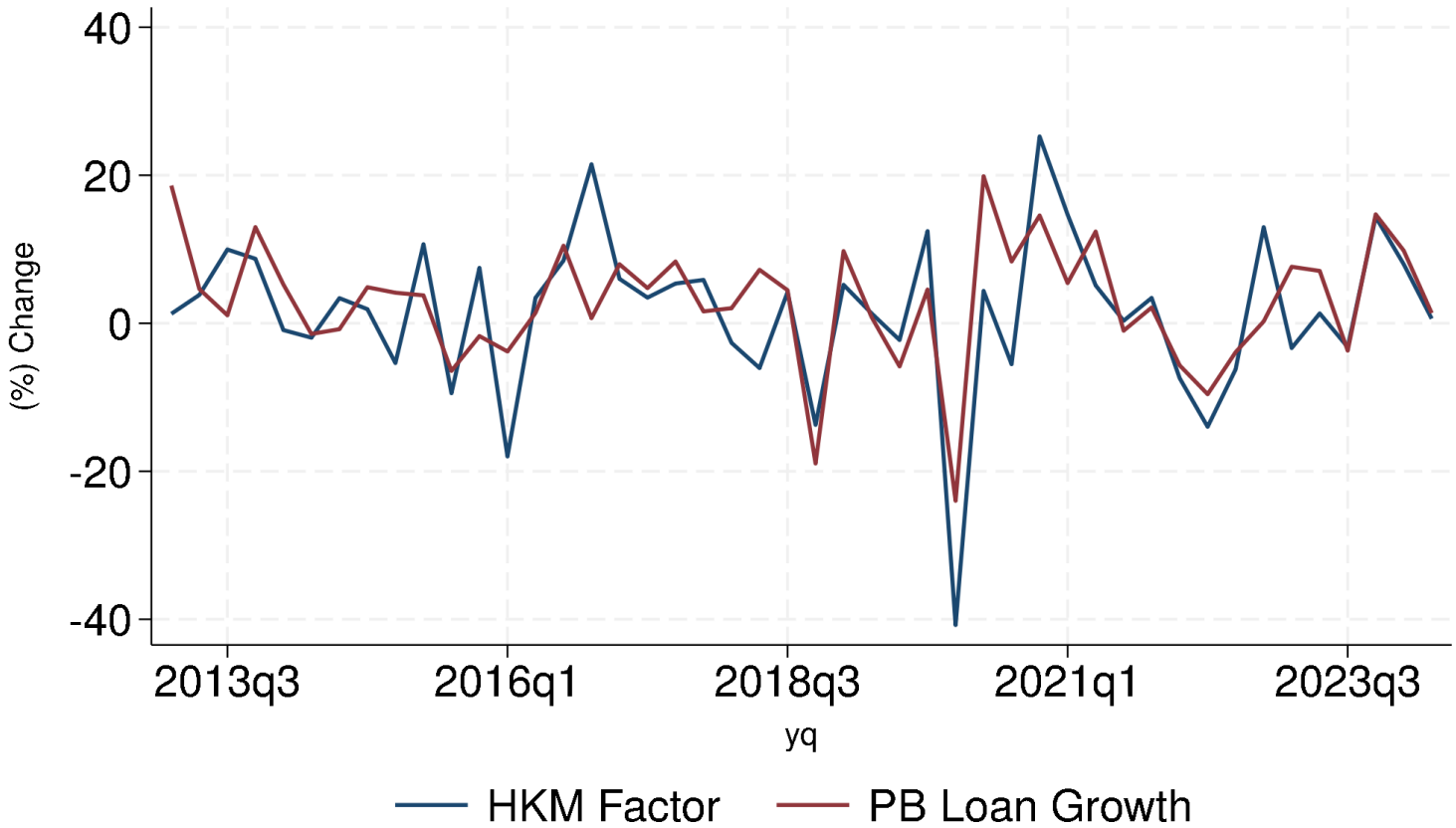
Event Study Asset Pricing

Does aggregate credit supply transmit to prices?

▸ Studying idiosyncratic shocks

PB Lending ↓ when Agg. B/D health ↓

Measure for aggregate B/D health: He et al. [2017] factor

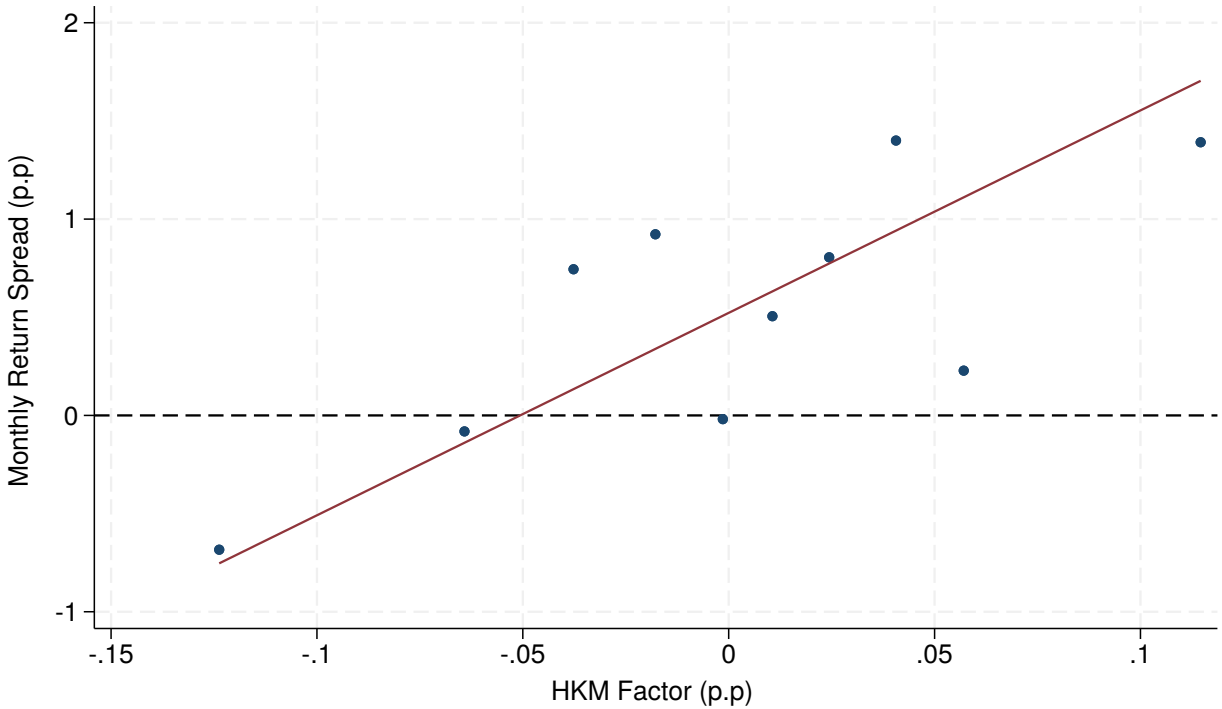


- Correlation: 67%

Returns on stocks more owned by HFs ↓ during B/D ↓

Return Spreads

(Portfolios sorted on HF ownership)



- Transmission mainly in bottom B/D health decile ▸ Asymmetric Regressions
- Effect amplifies when agg. substitution capacity is limited ▸ Details

Conclusions

Conclusion

A conditional transmission mechanism.

- Systemic distress $\Longrightarrow$ HF substitution breaks down
- Forced deleveraging $\Longrightarrow$ large price impact multiplier

Contribution:

- Intermediaries can affect prices via *indirect participation*
- Economic channel linking B/Ds to equity prices

Thank you!

References I

T. Adrian, E. Etula, and T. Muir. Financial intermediaries and the cross-section of asset returns. *The Journal of Finance*, 69(6): 2557–2596, 2014. doi: 10.1111/jofi.12189. URL `https://onlinelibrary.wiley.com/doi/abs/10.1111/jofi.12189`.

G. O. Aragon and P. E. Strahan. Hedge funds as liquidity providers: Evidence from the lehman bankruptcy. *Journal of Financial Economics*, 103(3):570–587, 2012. ISSN 0304-405X. doi: https://doi.org/10.1016/j.jfineco.2011.10.004. URL `https://www.sciencedirect.com/science/article/pii/S0304405X11002364`.

D. Barth, J. Joenvaara, M. Kauppila, and R. Wermers. The hedge fund industry is bigger (and has performed better) than you think. *SSRN*, 2021.

D. Barth, L. Hammon, and P. Monin. Leverage and risk in hedge funds. *SSRN*, 2022.

References II

M. K. Brunnermeier and L. H. Pedersen. Market liquidity and funding liquidity. *The Review of Financial Studies*, 22(6): 2201–2238, 11 2008. ISSN 0893-9454. doi: 10.1093/rfs/hhn098. URL https://doi.org/10.1093/rfs/hhn098.

M. K. Brunnermeier and Y. Sannikov. A macroeconomic model with a financial sector. *American Economic Review*, 104(2): 379–421, February 2014. doi: 10.1257/aer.104.2.379. URL https://www.aeaweb.org/articles?id=10.1257/aer.104.2.379.

M. Dahlqvist, V. Sokolovski, and E. Sverdrup. Hedge funds and financial intermediaries. *Working Paper*, 2021.

X. Gabaix and R. S. J. Koijen. In search of the origins of financial fluctuations: The inelastic markets hypothesis. Working Paper 28967, National Bureau of Economic Research, June 2021. URL http://www.nber.org/papers/w28967.

References III

V. Haddad and T. Muir. Do intermediaries matter for aggregate asset prices? *The Journal of Finance*, 76(6):2719–2761, 2021. doi: 10.1111/jofi.13086. URL `https://onlinelibrary.wiley.com/doi/abs/10.1111/jofi.13086`.

Z. He and A. Krishnamurthy. Intermediary asset pricing. *American Economic Review*, 103(2):732–70, April 2013. doi: 10.1257/aer.103.2.732. URL `https://www.aeaweb.org/articles?id=10.1257/aer.103.2.732`.

Z. He, B. Kelly, and A. Manela. Intermediary asset pricing: New evidence from many asset classes. *Journal of Financial Economics*, 126(1):1–35, 2017. doi: 10.1016/j.jfineco.2017.08.002. URL `https://www.sciencedirect.com/science/article/pii/S0304405X1730212X`.

References IV

R. Koijen, R. Richmond, and M. Yogo. Which investors matter for equity valuations and expected returns? *Review of Economic Studies*, 2023.

R. S. J. Koijen and M. Yogo. A demand system approach to asset pricing. *Journal of Political Economy*, 127(4):1475–1515, 2019. doi: 10.1086/701683. URL https://doi.org/10.1086/701683.

M. S. Kruttli, P. J. Monin, and S. W. Watugala. The life of the counterparty: Shock propagation in hedge fund-prime broker credit networks. *Journal of Financial Economics*, 2022. ISSN 0304-405X. doi: https://doi.org/10.1016/j.jfineco.2022.02.002. URL https://www.sciencedirect.com/science/article/pii/S0304405X2200054X.

S. Ma. Heterogeneous intermediaries and asset prices: A semiparametric approach? 2023.

References V

B. Seegmiller. Intermediation frictions in equity markets. *SSRN*, 2024.

E. N. Siriwardane. Limited investment capital and credit spreads. *The Journal of Finance*, 74(5):2303–2347, 2019. doi: https://doi.org/10.1111/jofi.12777. URL `https://onlinelibrary.wiley.com/doi/abs/10.1111/jofi.12777`.

Testing Aggregate Implications

E5: Substitution capacity to healthier B/Ds is central to transmission

- The experiment suggests that transmission depends on hedge funds' ability to reallocate toward healthier broker-dealers.
- This distinction naturally separates:
  - **Idiosyncratic shocks:** substitution feasible ▸ Results
  - **Common/systemic shocks:** substitution impaired
- This motivates two aggregate tests:
  1. Do periods of broad broker-dealer distress coincide with sell-offs and lower returns?
  2. Is transmission stronger when aggregate substitution capacity is lower?

Does substitution capacity amplify agg. relationship?

(1) Construct proxies from broker market equity:

$$AggHealth_t = \sum_b \Delta \ln(MarketEquity_t^b) \cdot LendingShr_{t-1}^b$$

$$ShareSpread_t = LendingShr_{t-1}^{\text{Top 25\% Healthy}} - LendingShr_{t-1}^{\text{Bottom 25\% Healthy}}$$

(2) Test specification:

$$\Delta Outcome_t = \alpha + \beta_1 AggHealth_t + \beta_2 ShareSpread_t + \underbrace{\beta_3}_{\text{Amplification}} (AggHealth_t \times ShareSpread_t) + \epsilon_t$$

$Outcome_t$: PB borrowing, equity exposure, HF-sorted returns.

▸ Details

Impaired substitution amplifies aggregate transmission

	$\Delta \ln(PBL_t)$	$\Delta \ln(Eq_t)$	$spread_t^{raw}$	$\varepsilon_{FF4,t}$
	(1)	(2)	(3)	(4)
$AggHealth_t$	0.112*	0.160**	0.176**	0.0138
	(1.73)	(2.40)	(2.65)	(0.38)
$ShareSpread_t$	0.0668	0.0533	0.0505	0.0456
	(1.54)	(1.35)	(1.04)	(1.17)
$AggHealth_t \times ShareSpread_t$	-1.050***	-1.080***	-0.786*	-0.562*
	(-3.45)	(-3.55)	(-1.72)	(-1.87)
Mktrf Ret	0.734***	0.833***		
	(7.60)	(8.43)		
R^2	0.835	0.879	0.380	0.124
N	39	39	39	39

t statistics in parentheses

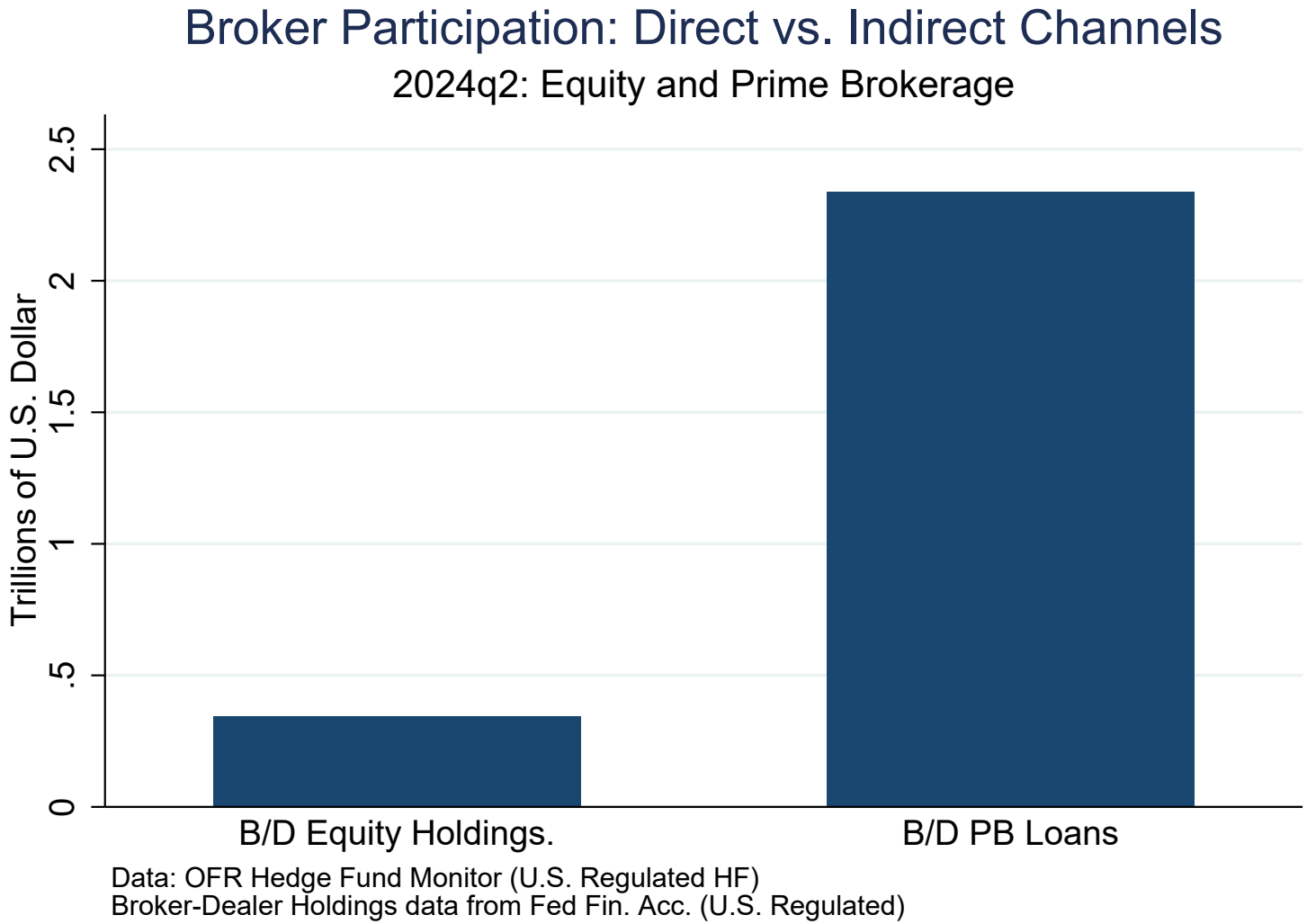
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(3): A 10% $\downarrow$ in AggHealth unconditionally has -1.8% $spread_t^{raw}$

- Easy substitution ($ShareSpread = +0.2$): -0.2%
- Hard substitution ($ShareSpread = -0.2$): -3.3%

▸ Results hold if we use HKM

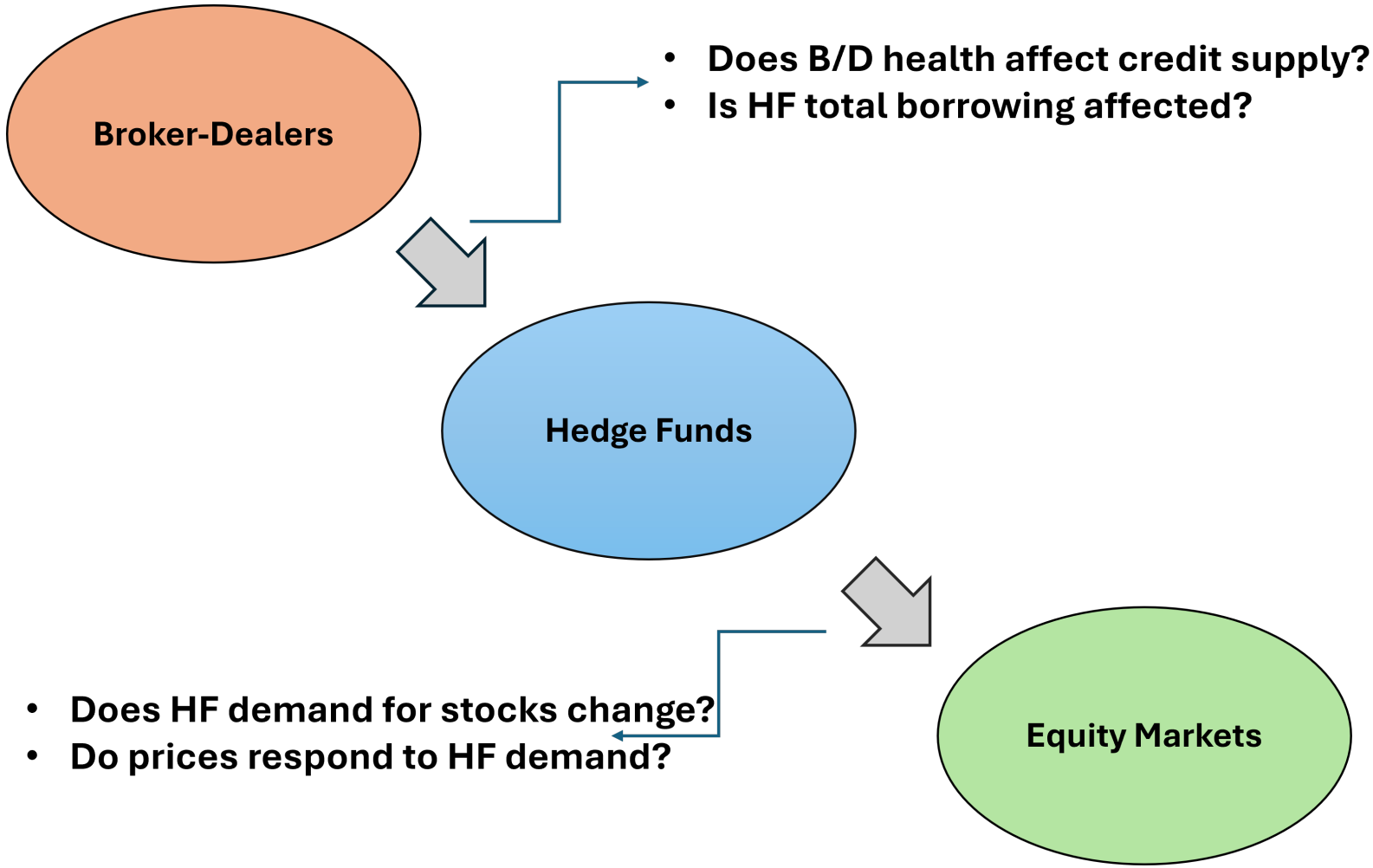
B/D Lending to HFs is Large



- Much larger than Commercial & Industrial Loans by G-SIBs ($1T)

▸ Return to Motivation

The Credit Supply Transmission Mechanism



Return

Related Literature and Contributions

1. **Intermediary Asset Pricing:**
   - 1.1 **Theory:** He and Krishnamurthy [2013], Brunnermeier and Sannikov [2014], Brunnermeier and Pedersen [2008]
   - 1.2 **Empirical:** Adrian et al. [2014],He et al. [2017], Ma [2023] , Siriwardane [2019], Haddad and Muir [2021], Seegmiller [2024]

   Contribution: We provide causal evidence for the credit supply transmission mechanism in equity markets.

2. **Hedge Funds, Leverage, and Brokers:**
   - 2.1 Aragon and Strahan [2012], Barth et al. [2022, 2021], Kruttli et al. [2022], Dahlqvist et al. [2021]

   Contribution 1: We document the full transmission channel, which
   Contribution 2: ...depends on HFs' capacity to substitute across B/Ds
   Contribution 3: ...which, in turn, depends on the health of other B/Ds.

3. **Inelastic Markets and Asset Prices**
   - 3.1 Koijen and Yogo [2019], Koijen et al. [2023], Gabaix and Koijen [2021]

   Contribution: We estimate the first price multiplier for a shock to arbitrage capital in a period of intermediary distress.

▸ Return

HFs borrow from multiple but not all B/Ds

	(1) At least $1B in PBL	(2) Any PBL
Mean Number of PB	4.30	3.09
SD Number of PB	3.24	2.87
10th Pctile Number of PB	2.00	1.00
25th Pctile Number of PB	2.00	1.00
50th Pctile Number of PB	3.00	2.00
75h Pctile Number of PB	5.00	4.00
90th Pctile Number of PB	7.00	6.00
Mean of Max Borr Shr	0.52	0.65
Mean of Dev Borr Shr	0.16	0.12
Number of Fund by Q obs in Sample	7529	20911

▸ Return ▸ Return to institutional details

Stocks are heterogeneously exposed to HFs

Statistic	Mean	SD	P50	P10	P25	P75	P90
HF Market Share	8.27	10.53	4.50	0.69	1.83	10.15	20.49
HF Inst. Share	12.23	14.83	6.77	1.38	2.96	14.84	30.56
HF Turnover Share (1)	17.66	14.00	14.09	4.09	7.89	23.37	35.59
HF Turnover Share (2)	19.08	15.70	15.49	2.12	6.47	28.15	41.13
Number of Managers	16.46	11.18	14.00	4.00	8.00	22.00	31.00

▸ Return to identification ▸ Return to institutional details

Regulatory Data: Form PF

- Dodd-Frank mandated enhanced regulatory reporting for private funds — primarily implemented through **Form PF**
- Advisers with $\geq$ \$150 million in regulatory private fund assets provide detailed data each year on the hedge funds they advise
- Advisers with $\geq$ \$1.5 billion of hedge fund assets ("large hedge fund advisers") report at a quarterly frequency, and provide additional details
  - These advisers provide even more details for their "qualifying hedge funds" ($\geq$ \$500 mm) $\rightarrow$ account for 86% of all HF assets
- Form PF data includes gross and net assets, gross- and net-of-fee returns, asset class exposures, types of borrowing, counterparty exposures and creditors, asset and investor liquidity, and much more
  - Key variable: fund-by-broker borrowing quantities (Q47)

Return

ES1: Archegos Default and Broker Losses

- In late March 2021, the large family office Archegos defaulted on its derivative positions with major broker-dealers.
- A disorderly liquidation process caused total losses exceeding $10 billion.
- Breakdown of broker losses:
  - Brokers with losses (% of net worth): Credit Suisse (17.6%), Nomura (16.4%), UBS (1.4%), Morgan Stanley (0.7%), MUFG (0.2%), Mizuho (0.28%)
  - Brokers with no losses: Goldman Sachs, Deutsche Bank, Wells Fargo.
- Exposure Group: B/Ds with realized losses ("Archegos" or "Arch")
  - Ex-ante lending share: about 33%

Back

ES2: European Broker-Distress in Q1 2016

- Near Default of **Deutsche Bank** (DB) shook markets
  - **2015 Q4:** EUR 6 billion write-downs in non-US retail banking. (15% of net worth)
  - **Jan 28, 2016:** Uncertainty emerged if DB could repay subordinated debt (CoCos) at DB Media Day

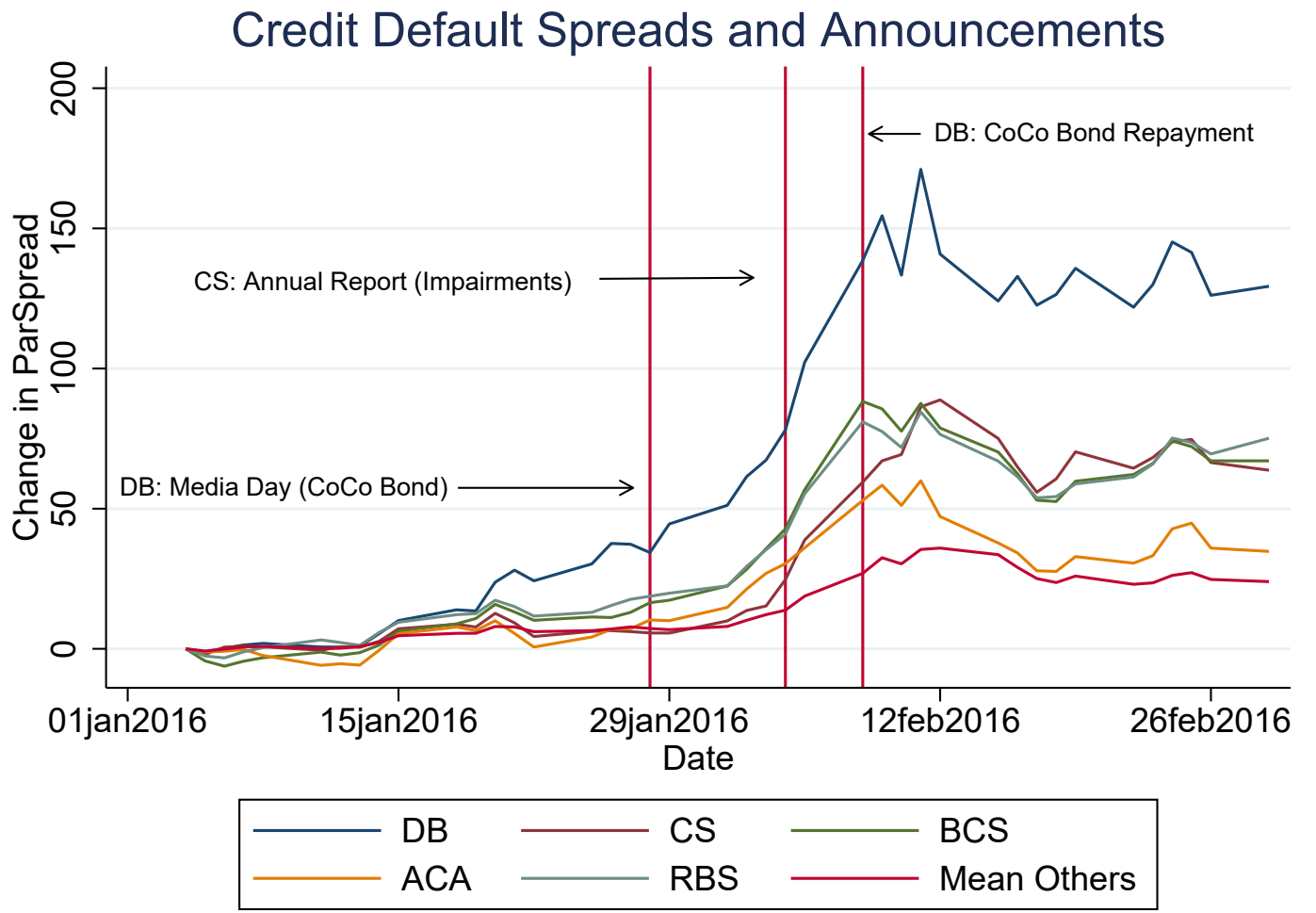
- Other European B/Ds suffered losses, namely **Credit Suisse**
  - **CS-Feb 4, 2016:** Good-will impairment (9% of net worth)

- Investors became worried about Euro B/Ds in general:

  "The worries about these bonds represent real fears that the European banking system may be weaker and more vulnerable...than a lot of people originally thought"–A major HF manager (02/08/16)

Return

CDS Spreads: Euro 5 Identification



- Top quintile of B/Ds of Δ CDS spread changes on announcement dates:
- Ex-ante lending share of E5: about 33% (like Archegos)

▸ E5: Ex-ante characteristics and ex-post outcomes ▸ E5 Announcements

▸ All brokers had major restrucuring losses in Q1 and Q2 2016

▸ Return

These spill-over brokers were ex-ante less profitable and showed higher reliance on lower tier capital

Ex-ante less-profitable as:

$$\frac{MarketCap_{2015q3}}{BookEquity_{2015q3}} = \alpha + \underbrace{\beta}_{-.5} Spillover + \epsilon \quad (1)$$

Ex-ante more reliant on lower tier capital by:

$$\frac{AT1_{2015q3} + Tier2Capital_{2015q3}}{TotalCapital_{2015q3}} = \alpha + \underbrace{\beta}_{12\%} Spillover + \epsilon \quad (2)$$

$$AT1_{2015q3} + Tier2Capital_{2015q3} = \alpha + \underbrace{\beta}_{3\%} Spillover + \epsilon \quad (3)$$

Moreover, two of three spillover brokers (BCS, RBS/NWG) announced billion dollar write-downs later in the quarter. ▸ Return

One-off charges by E5 broker-dealers

Name	Date Announced	Quarter	Losses	Type	Δ CDS
RBS/NWG	02/26/2016	2015 Q4	2.21bn pounds	Legal/restructuring	36.9
BCS	03/1/2016	2015 Q4	1.878bn pounds	Legal/restructuring	45.9
ACAEN	02/17/2016	2016 Q1	470 mn euros	Restructuring	26.1

- This is evidence that each of these banks experienced balance sheet disruption similar to DB/CS
- Caveat: Due to confidentiality, we cannot test bank-specific credit reductions due to these disruptions.

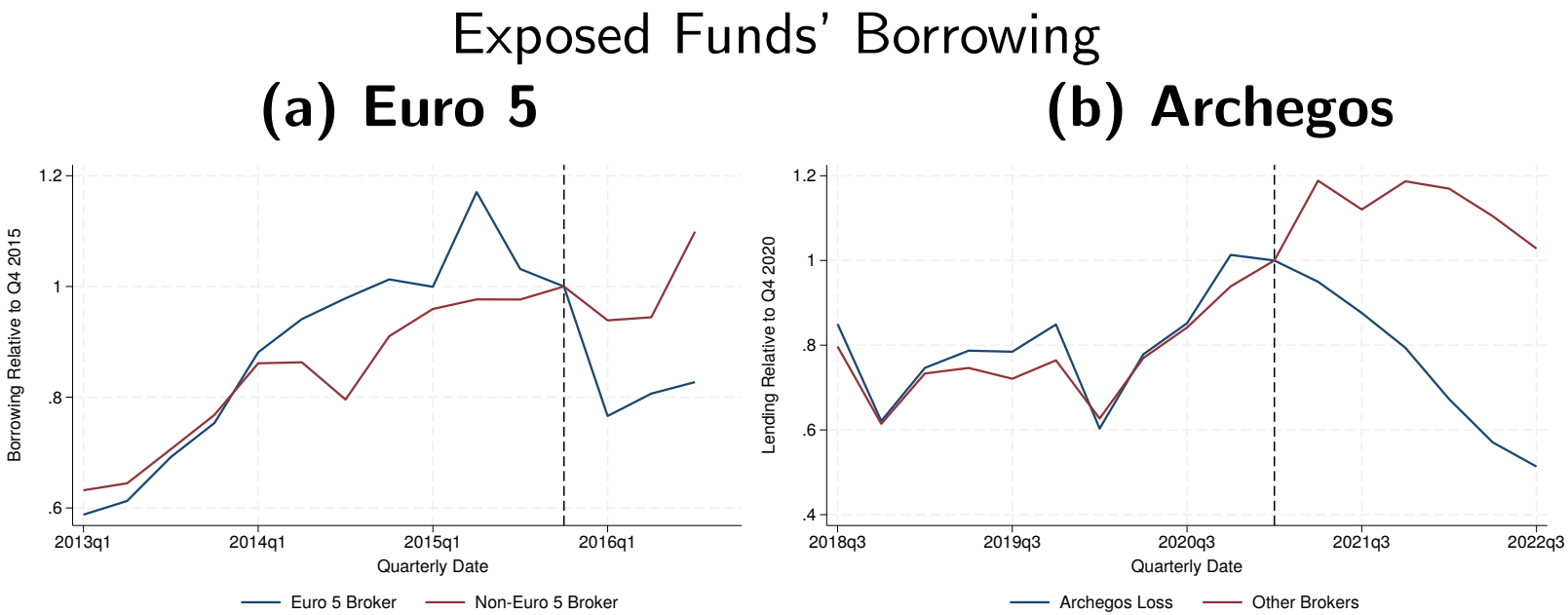
Additional narrative evidence of E5 shock

1. Fed: "The angst in global financial markets—reinforced by some unsettling news about the health of European banks—extended through mid-February" (March 2016 Tealbook A)
2. BIS: "The securities of European banks were hit particularly hard in the first weeks of 2016... Concerns about the sector's prospects, particularly with respect to earnings, seem to have been on investors' minds." (March 2016 BIS QR)
3. IMF: "Difficulties in business model transitions and legal costs have led to extraordinarily weak earnings results at several large European banks...One manifestation of this challenge is the sharp repricing in January and February in the market for subordinated and convertible debt-equity hybrid securities—on which some European banks have relied heavily." (April 2016 GFSR)

Return

Aggregate Substitution Tests

Plot: Total borrowing by group for funds ex-ante exposed to E5



- Identical results by testing substitution for average fund in x-section
  - KM estimator makes up about 60% of total lending

▸ Return

Credit Supply Contraction in Q1 2016

We estimate:

$$\Delta PBL^{f,b} = \alpha_f + \beta \cdot Treated^{f,b} + \epsilon^{f,b}$$

	$\Delta Log(PBL_t^{f,b})$							$\frac{\Delta PBL_t^{f,b}}{NAV_{t-1}^f}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Treated_{2015q4}^{f,b}$	-0.141***	-0.164***	-0.156***	-0.172***	-0.158***	-0.155***	-0.163***	-0.022**	-0.024**
	(0.037)	(0.037)	(0.038)	(0.037)	(0.035)	(0.036)	(0.035)	(0.008)	(0.009)
$OtherForeignBroker_{2015q4}^{f,b}$							-0.027		
							(0.054)		
R^2	0.01	0.07	0.04	0.10	0.64	0.59	0.64	0.01	0.49
N	1,103	1,103	1,103	1,103	1,086	962	1,086	974	962
Controls		X		X					
StratFE			X	X					
KMFE					X	X	X		X
Sample						Large Eq		Large Eq	Large Eq

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- Column (2): 16.4% decline in PBL at distressed brokers
- Column (9): 2.4pp decline in PBL/NAV ratio at distressed brokers

Return

Credit Supply Contraction in Q2 2021

We estimate:

$$\Delta PBL^{f,b} = \alpha_f + \beta \cdot Treated^{f,b} + \epsilon^{f,b}$$

	$\Delta Log(PBL_t^{f,b})$							$\frac{\Delta PBL_t^{f,b}}{NAV_{t-1}^f}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Treated_{2021q1}^{f,b}$	-0.074**	-0.073**	-0.083***	-0.083***	-0.079***	-0.085***	-0.082***	-0.024**	-0.024***
	(0.029)	(0.029)	(0.029)	(0.029)	(0.028)	(0.028)	(0.029)	(0.009)	(0.008)
$OtherForeignBroker_{2021q1}^{f,b}$							-0.015		
							(0.031)		
R^2	0.01	0.02	0.07	0.08	0.52	0.51	0.52	0.01	0.42
N	1,183	1,183	1,183	1,183	1,169	1,043	1,169	1,054	1,043
Controls		X		X					
StratFE			X	X					
KMFE					X	X	X		X
Sample						Large Eq		Large Eq	Large Eq

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Return

Fund Substitution in Q1 2016

We estimate:

$$\Delta PBL^f = \alpha + \beta \cdot \text{AnyDistressedBroker}^f + \epsilon^f$$

	$\Delta Log(PBL_t^f)$					$\frac{\Delta PBL_t^f}{NAV_{t-1}^f}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Treated_{2015q4}^f$	-0.186***	-0.146***	-0.139***	-0.207***	-0.140***	-0.067***
	(0.041)	(0.035)	(0.032)	(0.045)	(0.033)	(0.025)
EEA Holdings					0.028	
					(0.159)	
Intercept	0.074**	0.046*	0.079***	0.162***	0.075**	0.038**
	(0.031)	(0.027)	(0.025)	(0.042)	(0.032)	(0.019)
R^2	0.058	0.048	0.155	0.205	0.155	0.227
N	493	415	415	252	415	415
StratFE	X	X	X	X	X	X
Controls			X	X	X	X
MinEquity		X	X	X	X	X
Sample	All	All	All	Foreign	All	All

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- Column (1): 18.6% decline in aggregate PBL for exposed funds
- Column (6): 6.7pp decline in PBL/NAV ratio for exposed funds

Fund Substitution in Q2 2021

$$\Delta PBL^f = \alpha + \beta \cdot \text{AnyDistressedBroker}^f + \epsilon^f$$

	$\Delta Log(PBL_t^f)$				$\frac{\Delta PBL_t^f}{NAV_{t-1}^f}$
	(1)	(2)	(3)	(4)	(5)
$Treated_{2021q1}^f$	-0.005	-0.021	0.005	0.071	0.096***
	(0.034)	(0.032)	(0.031)	(0.071)	(0.030)
Intercept	0.061**	0.073***	0.026	-0.040	-0.024
	(0.028)	(0.027)	(0.029)	(0.068)	(0.024)
R^2	0.050	0.070	0.136	0.151	0.119
N	463	398	398	311	398
StratFE	X	X	X	X	X
Controls			X	X	X
MinEquity		X	X	X	X
Sample	All	All	All	Foreign	All

Standard errors in parentheses

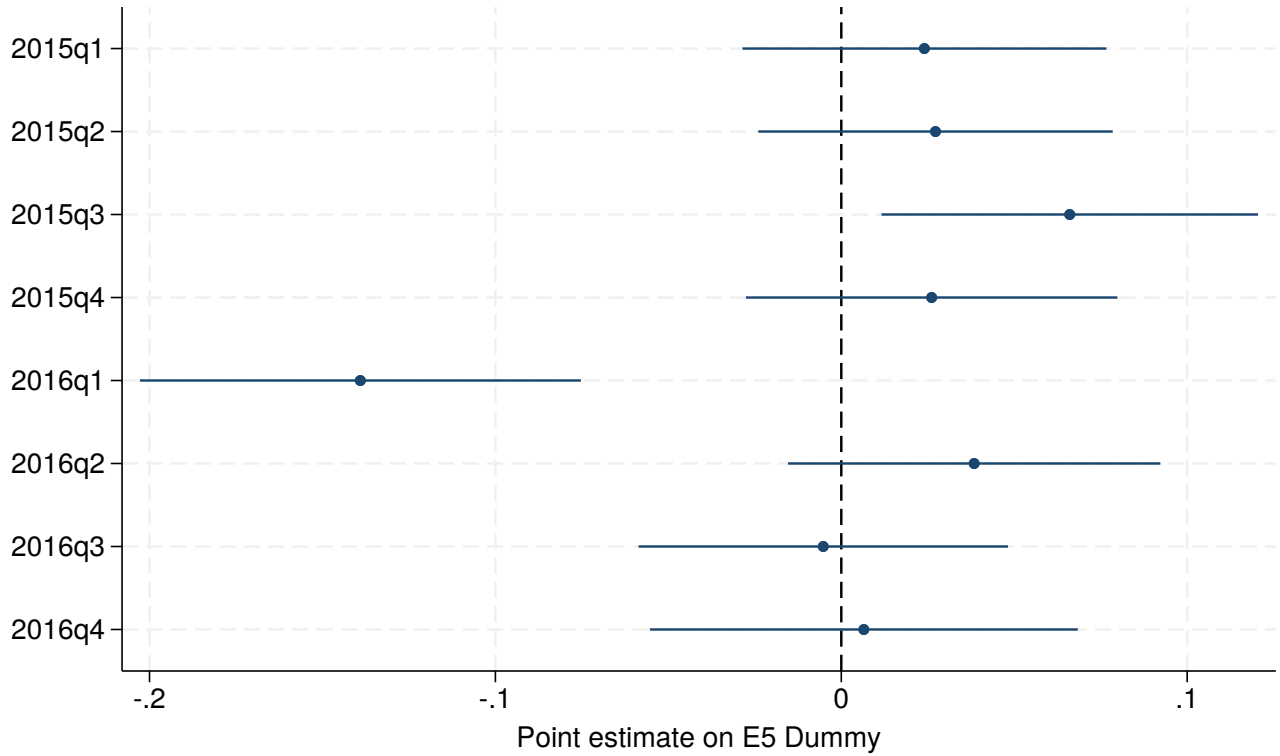
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Return

Imperfect substitution only observed in Q1 2016

We regression for $q \in \{2015q1, 2016q4\}$

$$\Delta PBL_q^f = \alpha + \beta\, Treated^f + \gamma X^f + \epsilon^f \tag{4}$$



Return

Fund by Broker Substitution in Q1 2016

We estimate:

$$\Delta \log(PBL^{f,b}_{2016q1}) = \alpha + \beta CumulativeEuroCDS^{b} + \epsilon_{2016q1} \quad (5)$$

$$(6)$$

where $CumulativeEuroCDS^{b}$ is the change in CDS spreads over E5 event s

	$\Delta Log(PB_{f,t,b})$			
	(1)	(2)	(3)	(4)
Cumulative Event CDS Spreads Chg	-1.069**			
	(0.458)			
Below Median CDS Chg		0.307***	0.392***	0.400***
		(0.116)	(0.117)	(0.101)
Above Median CDS Chg			0.084**	0.138***
			(0.038)	(0.033)
Intercept	0.155*	-0.073***	-0.157***	-0.186***
	(0.094)	(0.023)	(0.030)	(0.027)
R^2	0.01	0.02	0.02	0.59
N	498	498	756	751
Sample	non-Euro 5	non-Euro 5	All	All
KMFE				X
Outcome	Log	Log	Log	Log

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Return

PF equity exposures decrease

For a given asset class j, we estimate the following model:

$$\Delta Asset^{f}_{2016q1,j} = \alpha + \beta\, Treated^{f}_{2015q4} + \gamma X^{f} + \epsilon^{f}_{2016q1,j} \qquad (7)$$

	$\Delta Log(LongEq_{f,t})$			$\Delta Log(ShortEq_{f,t})$	$\Delta Log(Bonds_{f,t})$	$\Delta Log(FX_{f,t})$	$\Delta Log(RF_{f,t})$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Treated^{f}_{2015q4}$	-0.068***	-0.062***	-0.055***	-0.043	-0.119	0.195*	0.029
	(0.023)	(0.022)	(0.018)	(0.030)	(0.085)	(0.108)	(0.055)
Intercept	-0.050***	-0.054***	-0.019	0.037	0.217***	-0.077	0.071
	(0.015)	(0.016)	(0.013)	(0.023)	(0.064)	(0.085)	(0.046)
R^2	0.021	0.053	0.338	0.145	0.037	0.030	0.099
N	415	415	415	408	216	313	373
StratFE		X	X	X	X	X	X
Controls			X	X	X	X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

▸ Return

Stocks more sold-off by E5 mgrs have lower returns

	$Ret_{s,t}$						$\varepsilon_{CAPM,s,t}$	$\varepsilon_{FF4,s,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\%HeldEuro5HFs$	1.022***	2.633***	1.014***	2.629***	4.083***	4.058***	2.617***	4.075***
	(0.347)	(0.596)	(0.357)	(0.603)	(0.953)	(0.963)	(0.586)	(0.717)
$\Delta\%HeldnonEuro5HFs$			-0.653	-0.204		-1.242	-0.555	-0.718
			(1.044)	(1.610)		(1.779)	(1.632)	(1.791)
Intercept	0.011	0.036**	0.011	0.036**	0.075***	0.075***	0.029	0.044***
	(0.017)	(0.017)	(0.017)	(0.018)	(0.024)	(0.025)	(0.018)	(0.015)
R^2	0.01	0.02	0.01	0.02	0.04	0.05	0.02	0.05
N	1,537	828	1,537	828	414	414	828	828
E5SellOff		X		X	Above p50	Above p50	X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

▸ Return

Stocks more exposed to shock have lower realized returns

For each stock s, we estimate:

$$ret^{s}_{2016q1} = \alpha + \beta \%\text{ Held Euro5 HFs}^{s}_{2015q4} + \epsilon^{s}$$

	$Ret_{s,t}$					$\varepsilon_{CAPM,s,t}$	$\varepsilon_{FF4,s,t}$	$\varepsilon_{BAB,s,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Held Euro5 HFs	-0.687***	-0.501***	-0.439***	-0.359***	-0.359***	-0.380***	-0.552***	-0.357***
	(0.152)	(0.139)	(0.136)	(0.129)	(0.129)	(0.129)	(0.174)	(0.129)
% Held non-Euro5 HFs			-1.043***	-0.604***	-0.603***	-0.623***	-0.678***	-0.607***
			(0.243)	(0.136)	(0.135)	(0.140)	(0.189)	(0.136)
Foreign Sales Share					0.001			
					(0.009)			
Intercept	0.040**	0.032***	0.049***	0.037***	0.037***	0.032***	0.045***	0.041***
	(0.018)	(0.006)	(0.017)	(0.007)	(0.007)	(0.007)	(0.009)	(0.006)
R^2	0.02	0.20	0.04	0.21	0.21	0.22	0.20	0.21
N	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537
IndustryFE		X		X	X	X	X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- Robust to:
  - ▸ Amihud Illiquidity
  - ▸ Other institutional types and direct E5 exposure
  - ▸ Realized Sell-Offs

Results robust to other institutional investor controls

$$ret^{s}_{t\to t+1} = \alpha + \beta \Delta MktShareE5HFs^{s}_{t\to t+1} + \epsilon^{s}_{t\to t+1} \qquad (8)$$

	$Ret_{s,t}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Held Euro5 HFs	-0.447***	-0.455***	-0.444***	-0.559***	-0.458***	-0.474***	-0.501***	-0.499***
	(0.140)	(0.145)	(0.133)	(0.153)	(0.135)	(0.136)	(0.139)	(0.141)
% Held Other HF	-0.162							
	(0.109)							
% Held Brokers		-0.515						
		(0.756)						
% Held InvAdv			0.100***					
			(0.033)					
% Held Inst.				0.045				
				(0.030)				
% Held E5 B/D					-2.133*			
					(1.172)			
% Held E5 Affiliate						-1.428		
						(1.158)		
E5 Bank in Syndicate							-0.003	
							(0.036)	
E5 Bank Lead								-0.080**
								(0.036)
Intercept	0.048***	0.036***	-0.025	-0.003	0.037***	0.036***	0.032***	0.032***
	(0.013)	(0.010)	(0.018)	(0.022)	(0.007)	(0.008)	(0.006)	(0.006)
R^2	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20
N	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537
IndustryFE	X	X	X	X	X	X	X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Amihud Illiquidity results are consistent with HF managing liquidity

Define $AL = log(1 + AmihudIlliquidity)$

	$\Delta\%HeldEuro5HFs$		ΔAL		$Ret_{s,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)
% Held Euro5 HFs	-0.143***	-0.138***	1.762**	1.806**	-0.607***	-0.600***
	(0.015)	(0.013)	(0.749)	(0.820)	(0.172)	(0.174)
Lagged Illiq	0.002***	-0.001	0.560***	0.540***	-0.018**	-0.021**
	(0.000)	(0.000)	(0.065)	(0.082)	(0.007)	(0.010)
Interaction		0.055***		0.502		0.086
		(0.009)		(1.199)		(0.130)
Intercept	0.004***	0.004***	-0.066*	-0.067*	0.038***	0.038***
	(0.001)	(0.001)	(0.033)	(0.036)	(0.008)	(0.008)
R^2	0.17	0.18	0.28	0.28	0.22	0.22
N	1,352	1,352	1,352	1,352	1,352	1,352

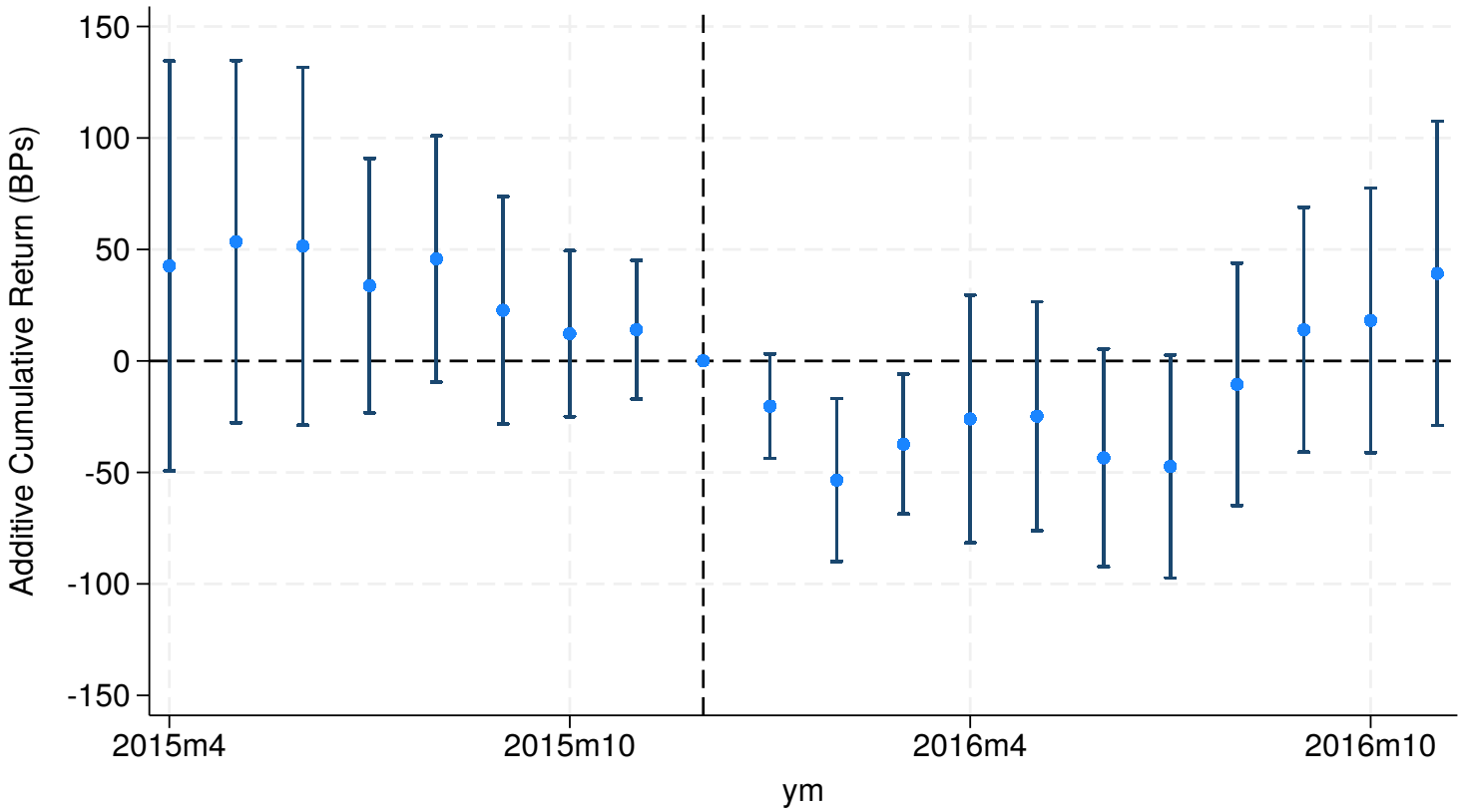
Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Return

Reversions with industry controls

▸ Return



Additive cumulative returns

Back-of-the-Envelope Calculations

Earlier, we estimated the following regressions:

$$\underbrace{\Delta\%\text{ Held Euro5 HFs}^{s}_{2016q1}}_{\frac{\Delta Q}{Q}} = \alpha + \beta_1 \cdot \%\text{ Held Euro5 HFs}^{s}_{2015q4} + \epsilon^{s} \tag{9}$$

$$\underbrace{\text{ret}^{s}_{2016q1}}_{\approx\frac{\Delta P}{P}} = \alpha + \beta_2 \cdot \%\text{ Held Euro5 HFs}^{s}_{2015q4} + \epsilon^{s} \tag{10}$$

Using these estimates, we compute the multiplier as:

$$M = \frac{\frac{\Delta P}{P}}{\frac{\Delta Q}{Q}} = \frac{\beta_2}{\beta_1}$$

Our results suggest:

- $M = 2.65 = \frac{-0.359}{-0.124}$ for all sell-offs.
- $M = 4.72 = \frac{-0.359}{-0.076}$ for abnormal sell-offs.

Return

Generally testing role of non-shocked B/D health

1. Our event studies show:
   - Idiosyncratic shocks (*Archegos*) $\Longrightarrow$ diversified away
   - Widespread shocks (*Euro 5*) $\Longrightarrow$ transmit

2. **Are idiosyncratic shocks generally substitutable?**
   - Proxy for shocks using large Δ CDS spreads
   - These cross-sectional shocks are idiosyncratic (except E5)
   - Strong evidence: broker health $\Rightarrow$ credit supply
   - We never document imperfect substitution outside E5

   Yes. ▸ Panel Results ▸ Covid and CS X-Section

▸ Return

Is the panel evidence consistent with the event studies?

- Construct from CDS spreads a panel measure of broker distress:

$$Distress_t^b = CDS_{t,max}^b - CDS_{t-1,eoq}^b$$
$$AbnormalDistress_t^b = Distress_t^b - \overline{Distress}_t$$

- Construct discrete treatment as:

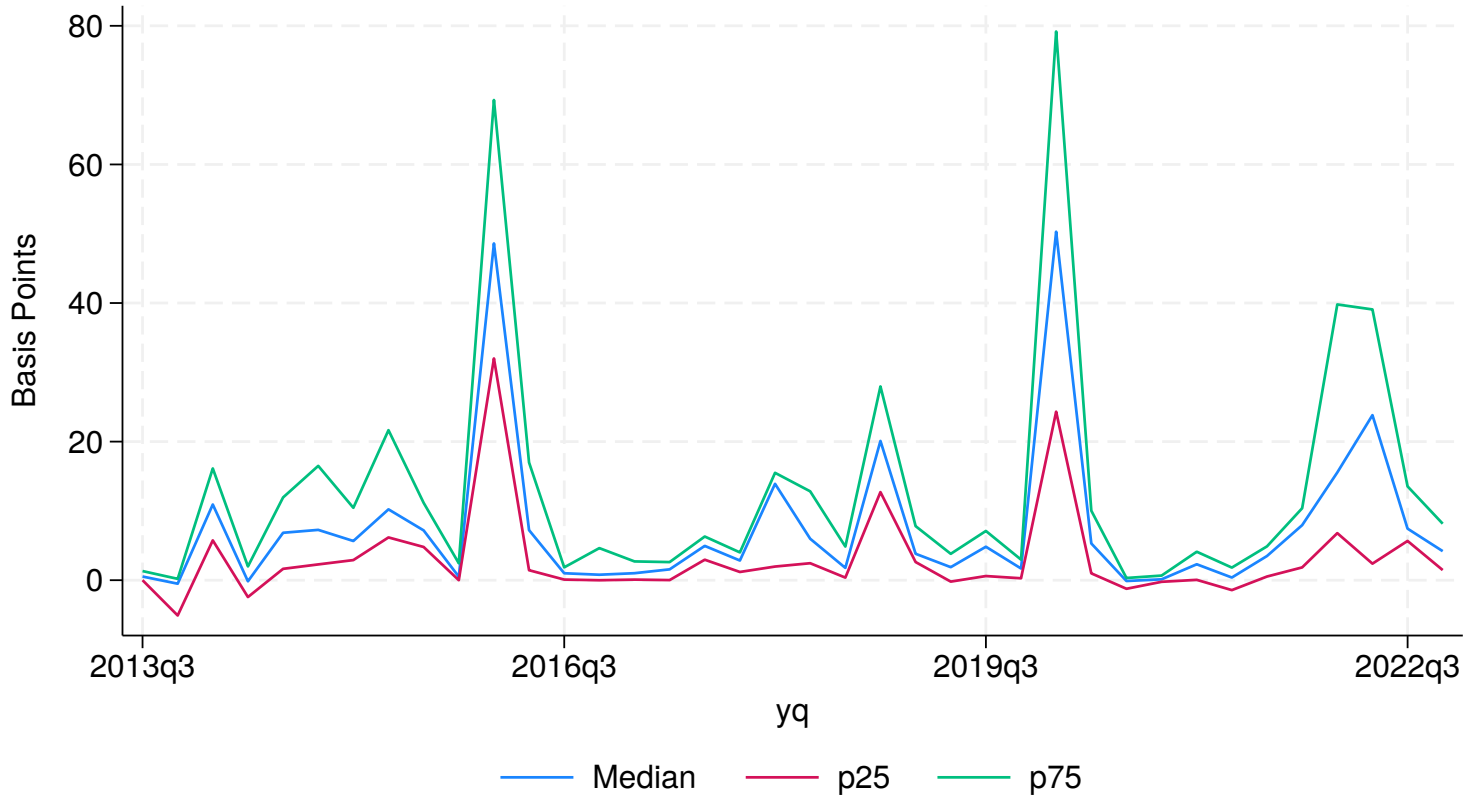
$$BigShock_t^b = \begin{cases} 1 & \text{if } AbnormalDistress_t^b \geq \mathrm{P}_\tau(AbnormalDistress), \\ 0 & \text{otherwise} \end{cases}$$

where τ is a percentile cut-off

- Test impact on broker-level lending and hedge fund equity holdings.

Return

Limited evidence of **widespread** distress outside Euro 5



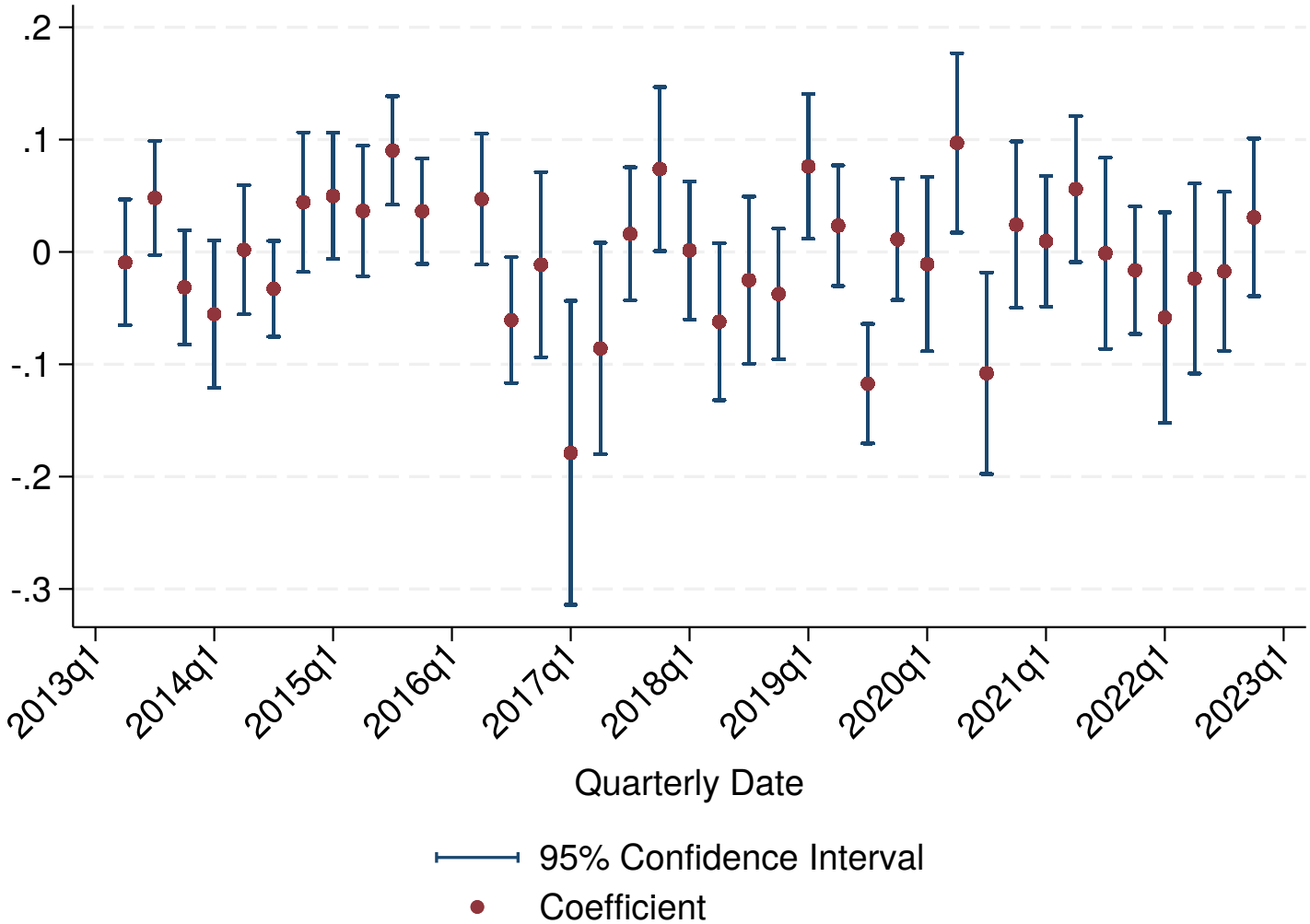
Set of all PF prime brokers ex Top 5 most distressed

- Covid-19: Limited Evidence of *Cross-Sectional* Credit Shock

▸ Evidence

▸ Return

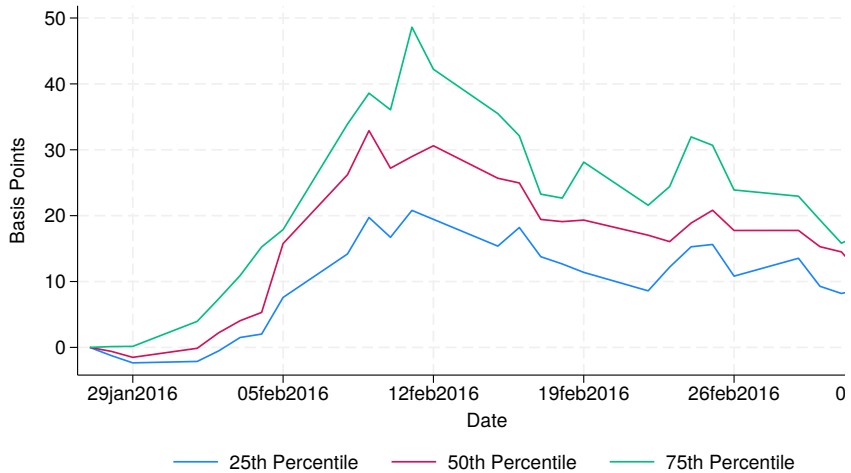
We find several periods where hedge funds substitute away from shocked brokers



Shocks differs on how widespread across non-treated B/Ds

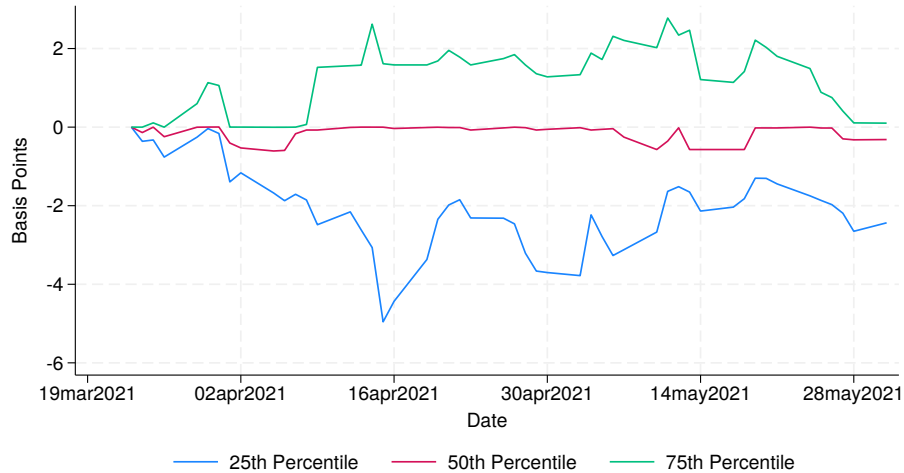
Cumulative CDS Spread Changes of Non-Shocked Brokers

(a) Euro 5



Cumulative Changes are measured from Jan 27 to February 29, 2016.
Brokers identified from Form PF, CDS spread from Markit

(b) Archegos



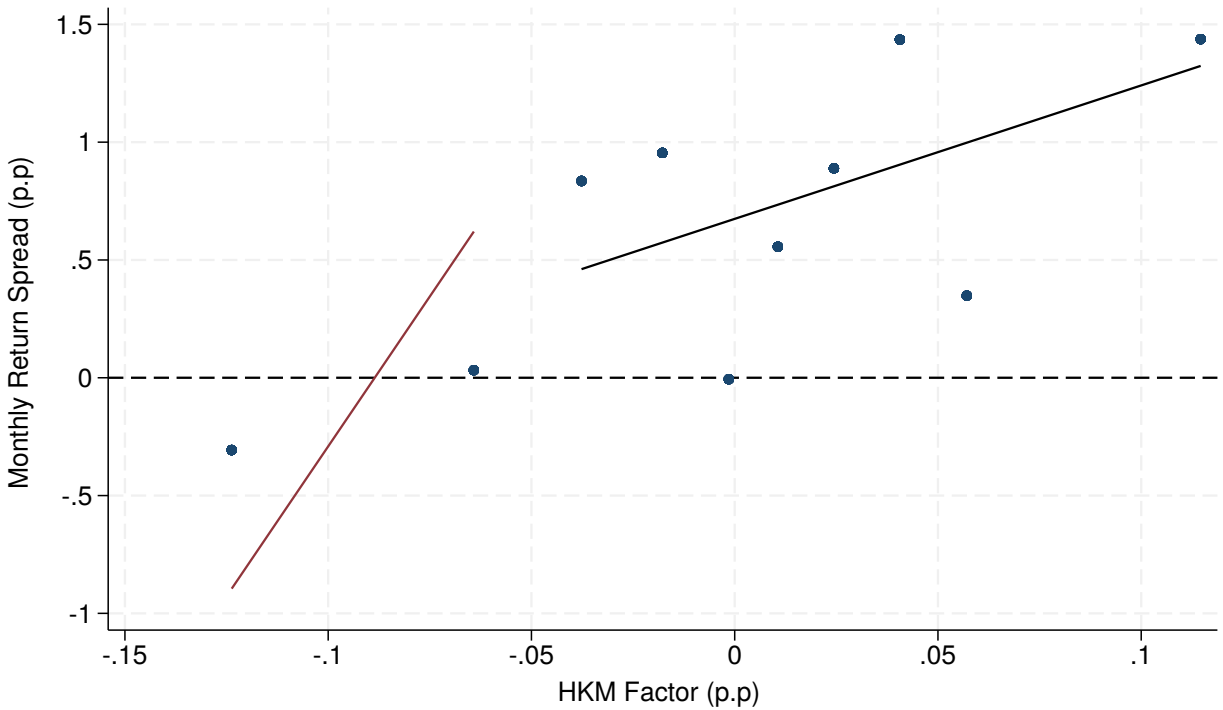
Cumulative Changes are measured from March 24th to May 31, 2021.
Brokers identified from Form PF, CDS spread from Markit

- Average broker-dealers' financial health deteriorated in E5, but not A5.
- ...also heterogeneity in which broker-dealers experienced pressures in E5.

▸ Return

...and the relationship is stronger in distress

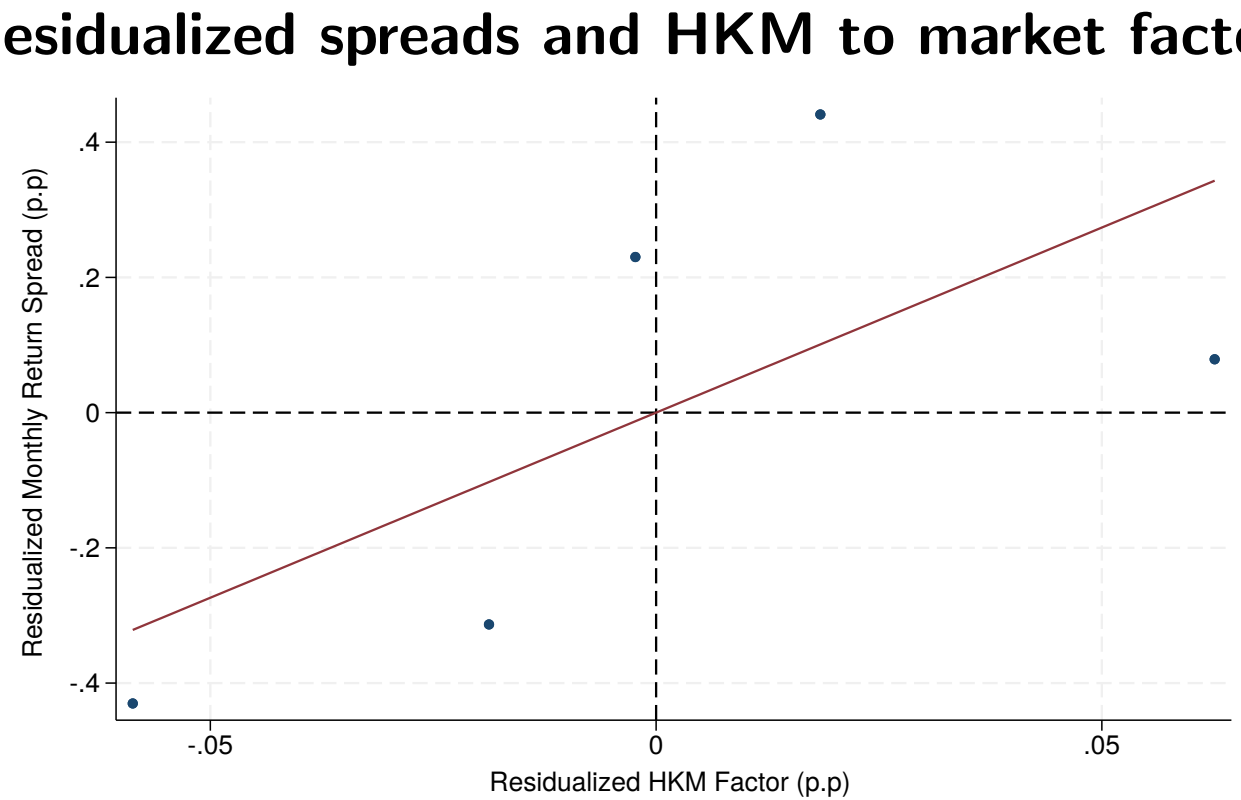
Compare bottom quintile HKM observations to others



- Consistent with our micro results emphasizing distress
- Can we test something more direct?

▸ Return ▸ Asymmetry holds controlling for market!

Strong negative relationship in distress holds controlling for market



▸ Return

Aggregate Substitution Measure

Hypotheses: If distressed banks make up more ex-ante lending, it will be more difficult for funds to substitute

1. Each quarter, we sort lendings into quartiles based on changes to log market equity.
2. For each quartile, we construct:

$$LendingShr_{t-1}^{quart} = \sum_{b \in B(quart)} LendingShr_{t-1}^{b} \qquad (11)$$

3. We construct:

$$Sub_t = LendingShr_{t-1}^{\text{Top 25\% Healthy}} - LendingShr_{t-1}^{\text{Bottom 25\% Healthy}}$$

▸ Return

Additional Results

	$\Delta \ln(PBL_t)$		$\Delta \ln(Eq_t)$		$spread_t^{raw}$	$\varepsilon_{FF4,t}$	Top 10 %	Top 25 %	$spread_t^{raw}$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$AggHealth_t$	0.460***	0.112*	0.555***	0.160**	0.176**	0.0138	-1.180***	-1.185**			
	(6.39)	(1.73)	(7.34)	(2.40)	(2.65)	(0.38)	(-5.34)	(-2.10)			
$ShareSpread_t$	0.0348	0.0668	0.0170	0.0533	0.0505	0.0456	-0.140	-0.703		0.0798*	0.0806*
	(0.68)	(1.54)	(0.33)	(1.35)	(1.04)	(1.17)	(-0.91)	(-1.46)		(1.74)	(1.73)
$AggHealth_t \times ShareSpread_t$	-1.310**	-1.050***	-1.376**	-1.080***	-0.786*	-0.562*	7.570***	10.51**			
	(-2.51)	(-3.45)	(-2.39)	(-3.55)	(-1.72)	(-1.87)	(4.38)	(2.52)			
Mktrf Ret		0.734***		0.833***							0.349***
		(7.60)		(8.43)							(2.76)
Lo Agg, Hi Sub									-0.00101		
									(-0.06)		
Hi Agg, Lo Sub									0.0197		
									(0.92)		
Lo Agg, Lo Sub									-0.0449**		
									(-2.09)		
HKM										0.166**	-0.0172
										(2.21)	(-0.18)
$HKM \times ShareSpread_t$										-1.036**	-0.836*
										(-2.04)	(-1.76)
Intercept	0.0280***	0.00535	0.0224**	-0.00338	0.0183**	0.00409	0.0154	0.181***	0.0247*	0.0159*	0.00692
	(2.79)	(0.66)	(2.25)	(-0.50)	(2.36)	(0.64)	(0.72)	(2.84)	(1.82)	(1.98)	(0.94)
R^2	0.669	0.835	0.712	0.879	0.380	0.124	0.684	0.448	0.227	0.322	0.454
N	39	39	39	39	39	39	39	39	39	39	39

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

▸ Return

Limited cross-sectional variation during pandemic

For different financial health measures in Q1 2020, we estimate:

$$\Delta lnPBL^{b,f}_{2020q1} = \alpha_f + \beta Health^{b}_{2020q1} + \epsilon^{b,f} \quad (12)$$

	$\Delta ln(PB_{f,b,t})$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta CDS^{b}_{eoq,t}$	-0.024				-0.021			
	(0.112)				(0.098)			
$\Delta MktNetWorth^{b}_{t}$		-0.141				-0.077		
		(0.168)				(0.140)		
$\Delta CDS^{b}_{max,t}$			-0.044				-0.038	
			(0.053)				(0.050)	
Top 5 Bank				-0.004				-0.011
				(0.043)				(0.039)
Intercept	-0.311***	-0.395***	-0.271***	-0.325***	-0.313***	-0.364***	-0.280***	-0.322***
	(0.077)	(0.084)	(0.071)	(0.031)	(0.065)	(0.070)	(0.063)	(0.024)
R^2	0.00	0.00	0.00	0.00	0.59	0.59	0.59	0.59
N	1,037	1,037	1,037	1,037 Ple	1,037	1,037	1,037	1,037
FE	None	None	None	None	KM	KM	KM	KM

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Return

Identification

- **E5 Identification Concern:** We group together five banks
  - What if some banks in Euro 5 aren't actually shocked?
  - Misclassification $\Longrightarrow$ including untreated banks in treatment group
- **Implication:** Misclassification causes *attenuation bias toward zero*
  - Our point estimates are **conservative/lower bounds** on true effects
  - Finding significant effects *strengthens* the evidence
- **Bottom line:** Misclassification affects *magnitude* (makes estimates smaller) but not *validity* of causal inference based on ex-ante exposures.

▸ Credit Supply Tests ▸ Asset Pricing Tests: Realized Sell-Off Tests are Robust ▸ Return

Identification: Credit Supply Tests

Our Specifications:

$$\Delta \text{PBL}^{f,b} = \alpha^f + \beta^1 \cdot \mathit{Treat}^b + \epsilon^{f,b} \qquad \text{(Khwaja-Mian)}$$

$$\Delta \text{PBL}^{f} = \alpha + \beta^2 \cdot \mathit{Treat}^f + \epsilon^{f} \qquad \text{(Imperfect Substitution)}$$

Effect of Misclassification:

- If only $N^{1'} \subset N^1$ are truly shocked (and $N^1 \setminus N^{1'}$ mistakenly included) and all treated banks contract credit γ
- Estimated effect: $\hat{\beta}^1 = \gamma \times \sum_{b \in N^{1'}} \frac{n^b}{n^{treat}} \cdot \mathit{Treat}^b$
- True effect: $\beta^{1,true} = \gamma \times \sum_{b \in N^{1'}} \frac{n^b}{n^{treat'}} \cdot \mathit{Treat}^b$
- Since $n^{treat} = \sum_{b \in N^1} n^b > n^{treat'} = \sum_{b \in N^{1'}} n^b$:

$$\boxed{\hat{\beta}^1 < \beta^{1,true} \quad \text{(Attenuation Bias)}}$$

Back

Identification: Asset Pricing Tests

Our Specifications:

$$ret_t^s = \alpha + \beta^1 \cdot Q_{t-1}^{s,E5} + \epsilon^s \qquad \text{(Ex-Ante Exposure)}$$

$$ret_t^s = \alpha + \beta^2 \cdot \Delta Q_t^{s,E5} + \epsilon^s \qquad \text{(Realized Sell-Offs)}$$

where $Q^{s,E5} = \sum_m Treat^m \times \frac{\text{Shares Held}^{s,m}}{\text{Shares Outstanding}^s}$

Effect of Misclassification:

- **Ex-ante exposure:** Classical measurement error $\Longrightarrow$ attenuation bias

$$\hat{\beta}^1 = \lambda \cdot \beta^{1,true} \quad \text{where } \lambda = \frac{\text{Var}(Q^{true})}{\text{Var}(Q^{measured})} < 1$$

- **Realized sell-offs:** *Robust* to bank misclassification
  - Actual changes in holdings reflect who truly sold
  - Key assumption: sell-offs driven by credit shocks, not fundamentals

Back

Asymmetric pass-through in regression form

	$spread_t^{hf}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HKM Factor	0.096***	0.042	0.093	0.077**	0.025	0.039	0.002
	(0.028)	(0.044)	(0.075)	(0.032)	(0.040)	(0.066)	(0.042)
Market Excess Return		0.001	-0.001		0.001	-0.001	0.002*
		(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Bottom Decile of HKM				0.030***	0.033***	0.047***	0.029***
				(0.011)	(0.011)	(0.018)	(0.010)
HKM $\times$ Bottom Decile				0.260***	0.264***	0.434***	0.414***
				(0.064)	(0.066)	(0.081)	(0.107)
Bottom Decile $\times$ Market							-0.004**
							(0.002)
Observations	252	252	117	252	252	117	252
R-squared	0.064	0.078	0.023	0.089	0.105	0.090	0.125

▸ Return

Higher exposure $\Longrightarrow$ Higher sell-off

To validate that this measure captures abnormal sell-offs:

$$\Delta\%\ \text{Held Euro5 HFs}_t^s = \alpha_t + \beta_1 \%\ \text{Held Euro5 HFs}_{t-1}^s + \beta_2 \%\ \text{Held Euro5 HFs}_{t-1}^s \times Q12016 + \epsilon_t^s$$

	$\Delta\%HeldEuro5HFs$				
	(1)	(2)	(3)	(4)	(5)
Lag % Held Euro5 HFs	-0.124***	-0.048***	-0.049***	-0.050***	-0.052***
	(0.016)	(0.005)	(0.005)	(0.006)	(0.006)
Lag % Held Euro5 HFs × I{Q12016}		-0.076***	-0.075***	-0.077***	-0.076***
		(0.005)	(0.005)	(0.005)	(0.005)
Intercept	0.004***	0.003***	0.003***	0.003***	0.004***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.10	0.02	0.03	0.03	0.03
N	1,537	19,548	19,548	19,548	19,548
Q12016	X				
QtrxYearFE			X		X
IndustryFE				X	X

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

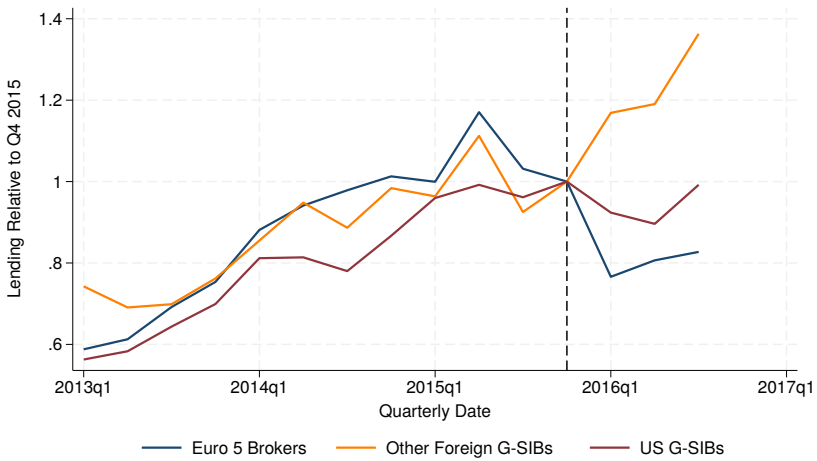
- Column (1): 1pp ↑ in E5 exposure $\Longrightarrow$ 12.4bps ↑ sell-off

▸ Full specifications

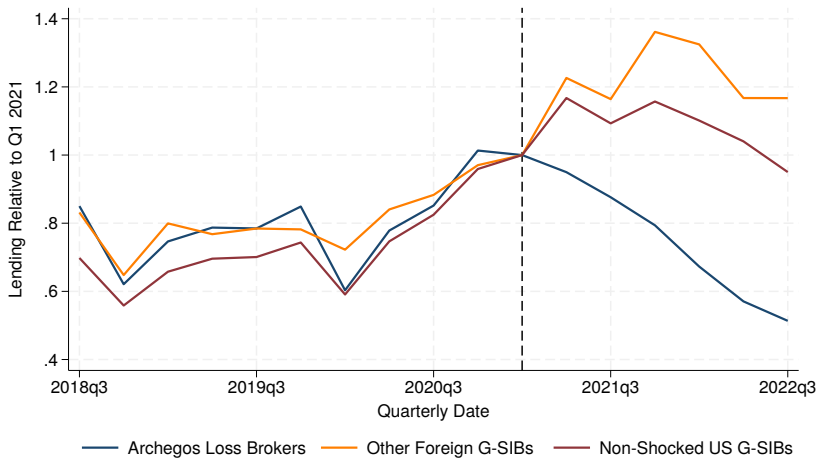
Does broker health affect lending to HFs?

To test if distressed brokers reduced lending, we plot aggregate PBL^b by group:

(a) Euro 5



(b) Archegos



- **Yes, in both E5 and Archegos**

Return

Notation and Quantities

Notation: PBL_t^i = Prime broker lending to hedge funds at time t

Treated Groups for Two Experiments:

- **2016 Q1:** Euro 5, $PBL^{E5} = \$278B$
- **2021 Q2:** Brokers with reported Archegos losses ($419B)

Control Groups:

- US G-SIBs ($554B in 2015, $710B in 2020)
- Other Foreign G-SIBs ($57B in 2015, $88B in 2020)

Different lending sizes $\Longrightarrow$ Normalize plots to pre-period levels

We estimate a *large* price impact multiplier

- Compute price multiplier:

$$M = \frac{\frac{\Delta P^s}{P^s}}{\frac{\Delta Q^{s,E5}}{Q^{s,E5}}}$$

  - OLS Sell-Off Estimate: 2.63-4.075 for sell-offs
  - From ex-ante measures: 2.9 (sell-off) or 4.72 (ab. sell-off)

- Is this big?
  - Gabaix and Koijen [2021] (Micro): Estimates from 0.7 to 2.5

- This is the first estimate of a direct shock to arbitrageur capital where:
  - Liquidity deteriorates
  - Uncertainty increases
  - and ...

▸ Uncertainty Quote

▸ Back-of-the-Envelope Calculations

Cross-Sectional Credit Supply Empirical Design

1. Do broker shocks associate with **lending quantities**?

$$\Delta PBL^{b} = \alpha + \beta \cdot Treated^{b} + \epsilon^{b}$$

2. If so, is there evidence of a **credit supply channel**?

$$\Delta PBL^{f,b} = \alpha_{f} + \beta \cdot Treated^{f,b} + \epsilon^{f,b}$$

3. Can funds substitute across brokers?

$$\Delta PBL^{f} = \alpha + \beta \cdot \text{AnyDistressedBroker}^{f} + \epsilon^{f}$$

4. Does imperfect substitution trigger stock sell-offs?

$$\Delta \text{EquityHoldings}^{f} = \alpha + \beta \cdot \text{AnyDistressedBroker}^{f} + \epsilon^{f}$$

▸ Return KM ▸ Return Sub

HF-PB Institutional Details

- HFs are active investors with broad mandates:
  - In U.S. equity markets, HFs are the main levered investors
  - Equity leverage is provided mainly from PBs
- Broker-Dealer Industrial Organization
  - Prime brokers are the divisions of B/Ds that lend to HFs
  - 90% of HF lending by B/Ds in G-SIBs
  - The top 10 B/Ds account for 80% of HF lending
- Hedge Fund Market Structure
  - Large HFs ($> \$1B$ in PB lending) have 4.3 PBs on average
  - \$3 trillion in long cash equity exposures
  - PF HFs hold 8.27% of mean stock and account for about 18% of the mean stock's turnover

▸ Additional stock-level exposures ▸ Prime brokerage concentration ▸ Return

Data

1. Dodd-Frank mandated enhanced regulatory reporting for hedge funds — primarily implemented through **Form PF**
   - Includes near universe of large hedge funds (include those domiciled internationally)
   - Covers hedge fund balance sheets, including **fund-level prime brokerage borrowing & total fund-by-broker borrowing**
   - We impute fund-by-broker prime brokerage quantities

2. We merge this data with stock-level quantities data from FactSet Ownership
   - Security-info: FactSet + standard CRSP-Compustat merge.
   - Merge on hedge fund adviser

3. PF analysis limited to aggregated sets of counter-parties!

▸ More details on PF ▸ Return

Two Event Studies: Additional Details

Archegos (2021 Q2):

- ▸ Event Details
- ▸ Lending Reductions

Euro 5 (2016 Q1):

- ▸ Event Details
- ▸ Identification Concerns
- ▸ CDS Grouping
- ▸ Ex-Ante Characteristics
- ▸ Policy Reports
- ▸ Charge Offs

Cross-Event Analysis:

- ▸ Non-Shocked B/D Health

▸ Back to Main