Does Broker-Dealer Health Affect Stock Prices?

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January 5, 2025

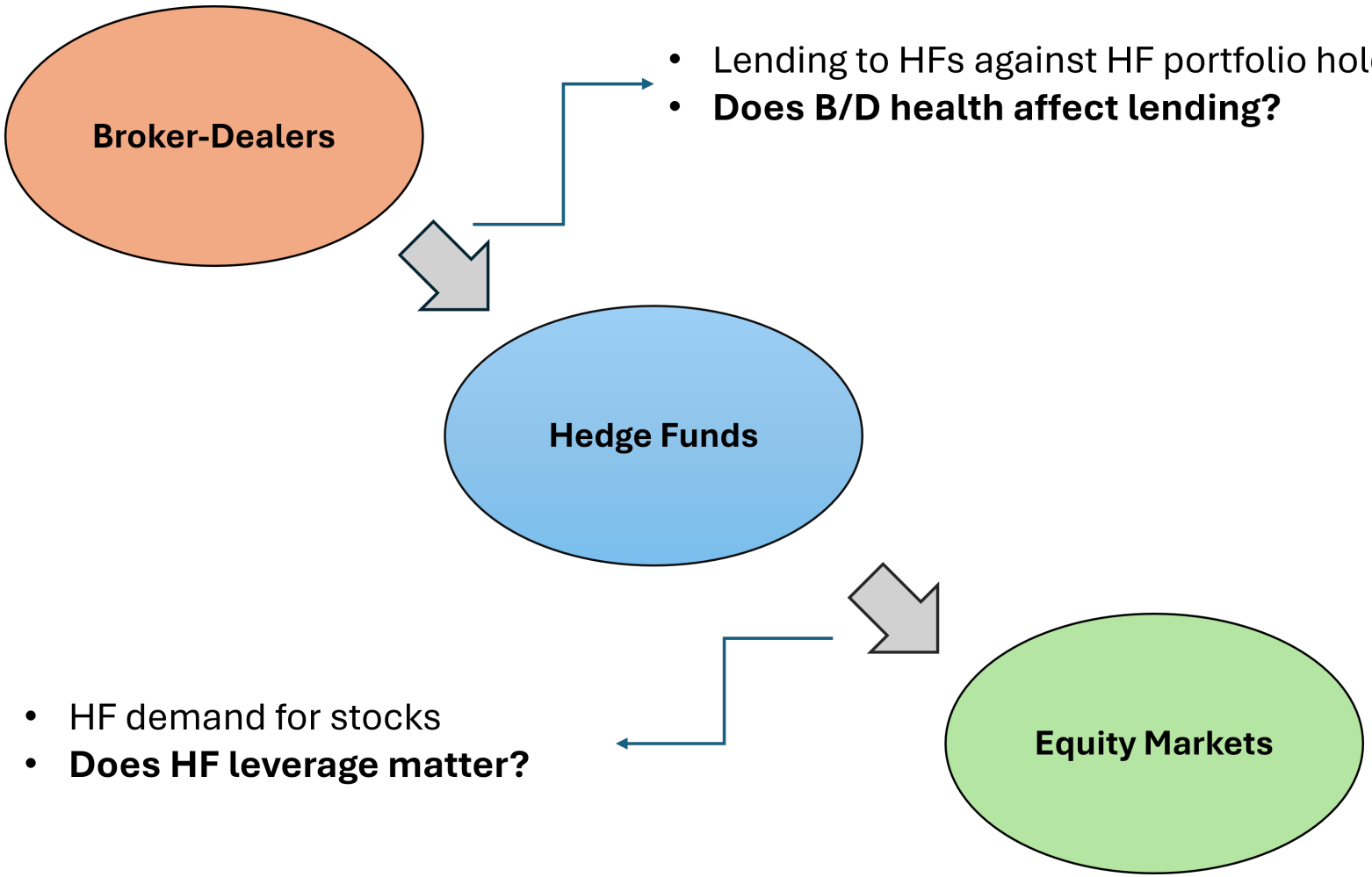
This Paper

1. Aggregate broker-dealer (B/D) financial health explains returns across many asset classes (Adrian et al. [2014], He et al. [2017])
   - Puzzle: Even in classes with low B/D ownership (e.g., stocks)

2. In stock markets, B/Ds mainly participate by lending to hedge funds (HFs) via their prime brokers (PBs).

3. We test if, and under what conditions, B/D health shocks transmit to equity markets via lending to HFs.

The Credit Supply Transmission Mechanism



Our Setting and Approach

- Challenge: B/D health is endogenous to loan demand.
- Identify via large cross-sectional shocks from event studies.
  1. Losses from **Archegos** in Q2 2021
  2. Widespread **European B/D distress** in Q1 2016
- Provide additional evidence from the panel and GFC.
- *Cross-sectional identification* rests on imperfect substitution across B/Ds, which ex-ante isn't obvious:
  1. **B/D Concentration:** Top 10 B/Ds account for 80% of loans.
  2. **HF Diversification:** Large HFs borrow from about 3.6 B/Ds.

Our Main Results

1. B/D health $\downarrow \implies$ PB lending $\downarrow$.

2. B/D health $\downarrow \implies$ HF equity holdings $\downarrow$, but *only in broad distress*.
   - Broad: direct B/D shock coincides with other B/Ds' health $\downarrow$.
   - Why? HFs cannot substitute between B/Ds.

3. When B/D shocks $\implies$ HF equity holdings, stock liquidity $\downarrow$, and stock prices $\downarrow$ that subsequently revert.
   - The price impact multiplier is 3!

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.

HF-PB Institutional Details

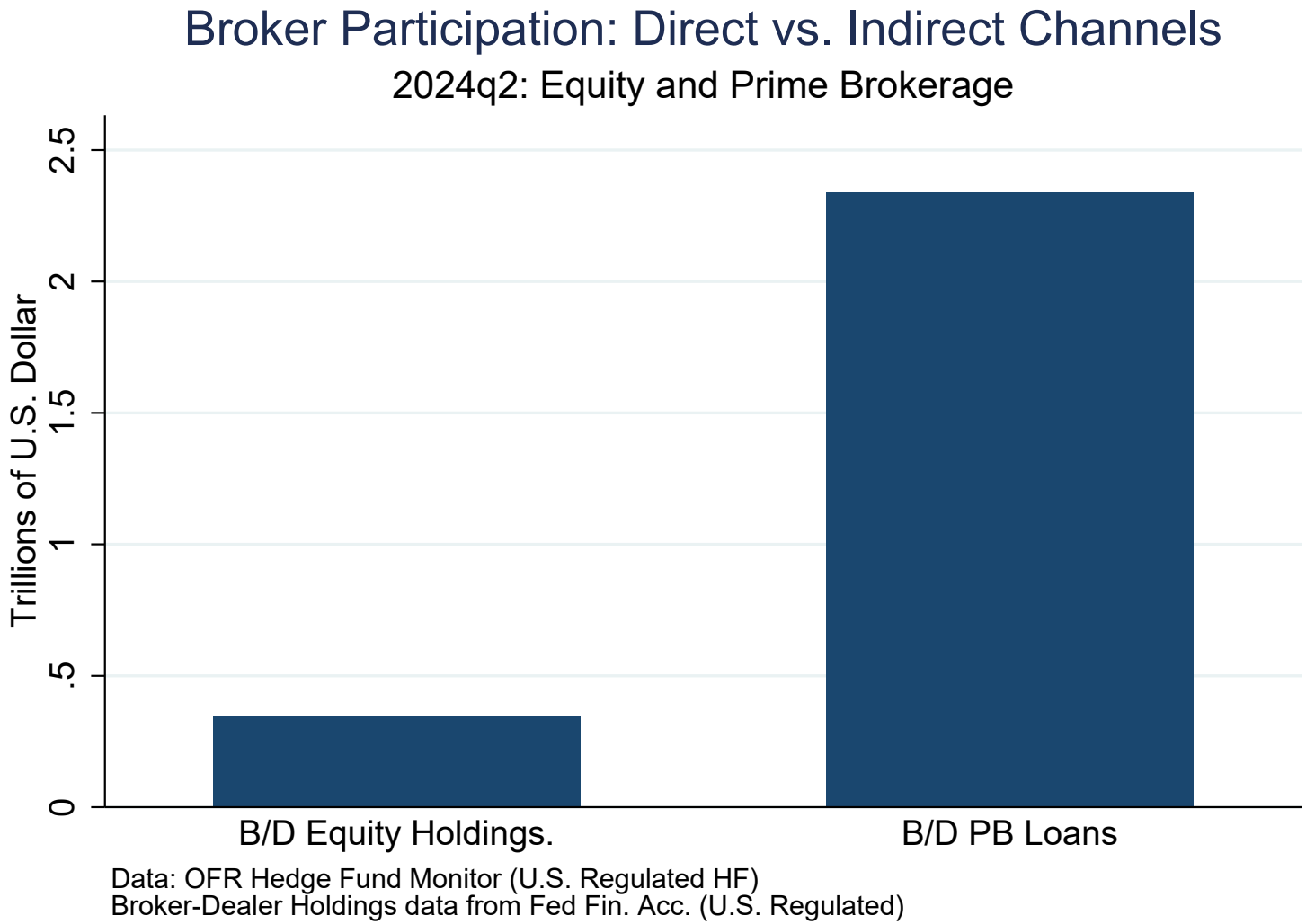
- In U.S. equity markets, HFs are the main levered investors
  - ... PBs are the main source of debt financing.
  - ... PB loans are collateralized.

- Broker-Dealer Industrial Organization
  - B/Ds affiliated with global systemically important banks (G-SIBs) provide 90% of HF loans.
  - The top 10 B/Ds account for 80% of HF lending.

- Hedge Fund Market Structure
  - HFs manage \$11 trillion in gross assets across 2,000 funds.
    - \$3 trillion in stocks
  - On average, equity hedge funds have a leverage ratio of 1.7.
  - Large HFs ($> \$1B$ in gross assets) have 3.6 PBs on average

Three Aggregate Novel Facts

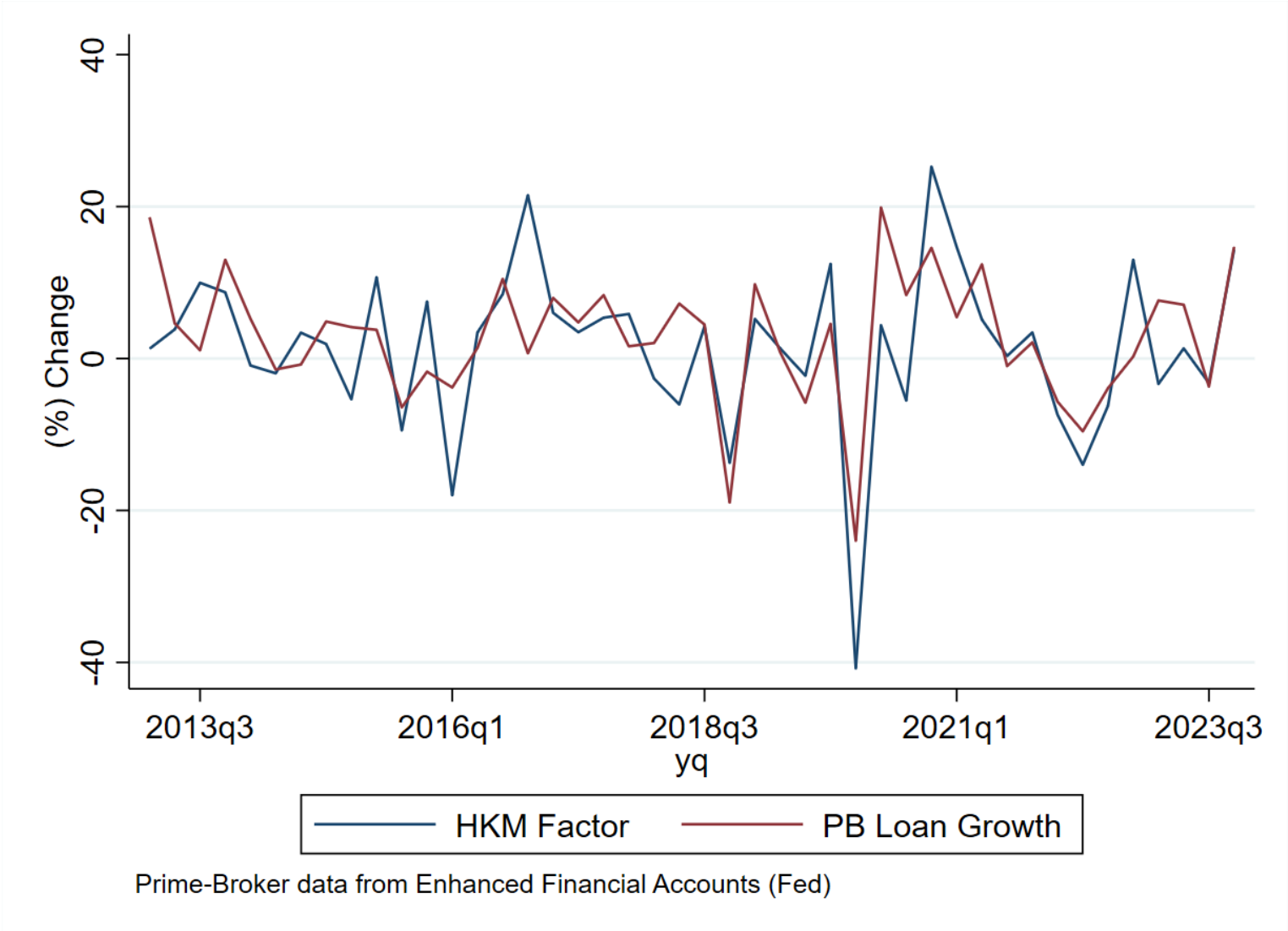
B/D Lending to HFs is Large



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

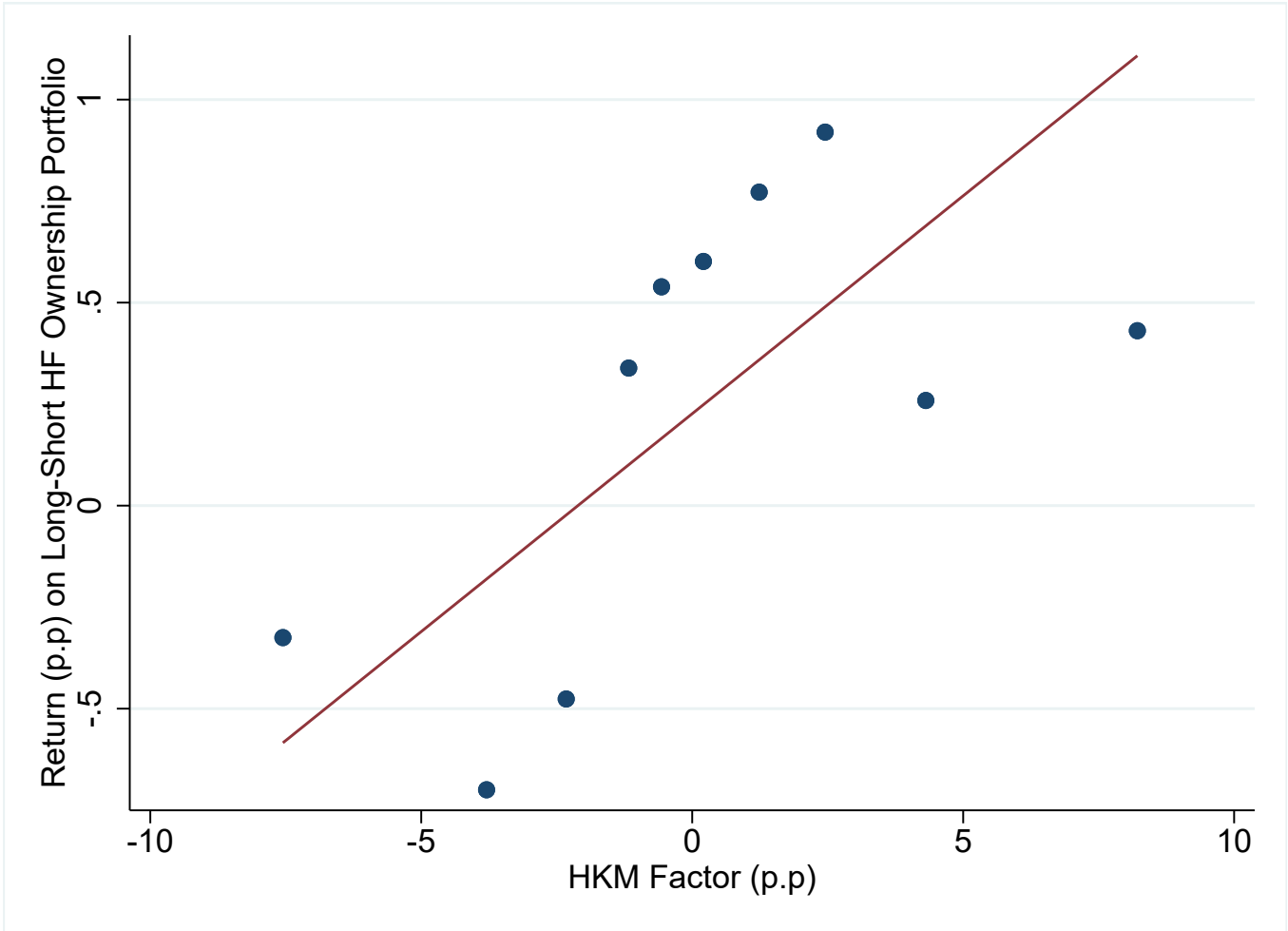
▸ Total Lending with Repo

Prime Brokerage Lending Tracks Aggregate B/D Health



- Prime broker lending growth and He et al. [2017] factor correlate 66%.

Stocks Held More by HFs ↓ When Agg. B/D Health ↓



▸ Time-Series ▸ Time-Series Controlling for MKT-RF

Roadmap

Empirical Methodology and Data

Event Studies

- Archegos
- European Broker-Distress
- Importance of Broad Shocks

Additional Evidence

Identifying Transmission Channel

- Previous slides provide novel suggestive evidence that:
  1. B/D health $\downarrow \Longrightarrow$ Loans $\downarrow$
  2. B/D health $\downarrow \Longrightarrow$ Stock Prices $\downarrow$
- But there are identification challenges, namely:
  - Some missing factor drives both B/D health and HF loan demand (e.g. Covid, GFC)

Identifying Transmission Channel

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  - Some missing factor drives both B/D health and HF loan demand (e.g. Covid, GFC)
- Our approach: exploit plausibly exogeneous shocks to B/D health and multiple cross-sections
  1. Cross-section of brokers:
     - Why? Allows us to assign treatment to certain brokers
  2. Cross-section of funds:
     - Why? Fund-level heterogeneity rule outs common HF shock
  3. Cross-section of stock holdings:
     - Why? Measure x-sectional price impact based on differential exposure

▸ BD Heterogeneity ▸ Fund Heterogeneity ▸ Stock Heterogeneity

Ideal Cross-Sectional Credit Supply Empirical Design

Let *PBL* denote PB loan quantities, *b* a broker, and *f* a fund:

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

$$\Delta PBL^{b} = \alpha + \beta \cdot \mathbf{1}\{b = \text{Distressed}\} + \epsilon^{b}$$

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

$$\Delta PBL^{f,b} = \alpha_f + \beta \cdot \mathbf{1}\{b = \text{Distressed}\} + \epsilon^{f,b}$$

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?

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

Today's empirical methodology

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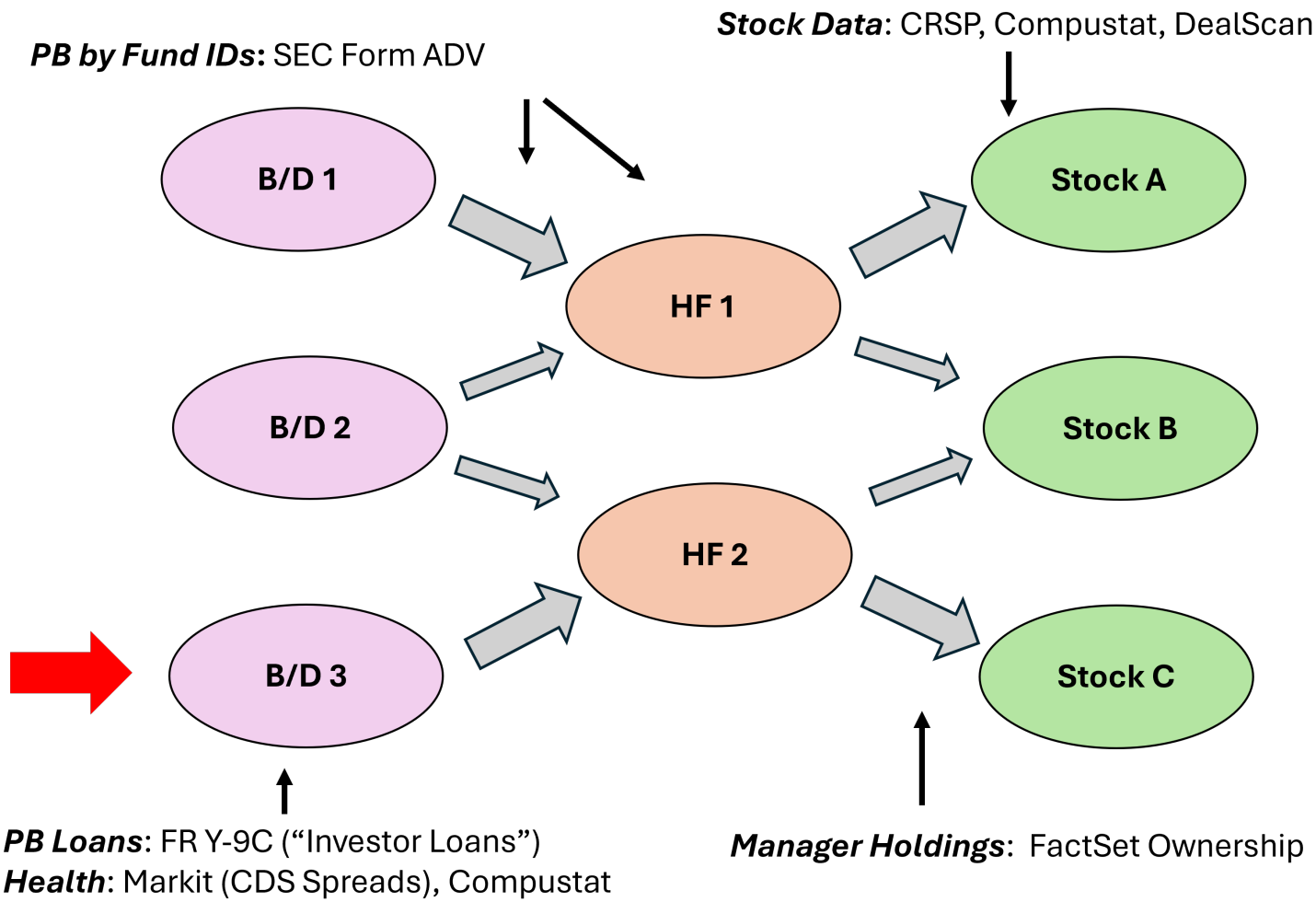
Today's Data


PB by Fund IDs: SEC Form ADV
Stock Data: CRSP, Compustat, DealScan
B/D 1
B/D 2
B/D 3
HF 1
HF 2
Stock A
Stock B
Stock C
PB Loans: FR Y-9C ("Investor Loans")
Health: Markit (CDS Spreads), Compustat
Manager Holdings: FactSet Ownership

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Additional Evidence

Two Event Studies

- We rely on two event studies to examine the conditions under which B/D health transmits to equity markets:
  1. Archegos in 2021
  2. European B/D Distress in Q1 2016
- These shocks are similar in terms of:
  - # of B/Ds shocked (6 vs. 5) and the concentration of PBs (33% vs. 25%)
  - Reported losses that initiate the shock ($10.5B vs. $11.5B)
- These shocks differ in the health of non-shocked B/Ds:
  - Archegos — Idiosyncratic shock
    - "Idiosyncratic"- non-treated B/D health remains healthy.
  - **European B/D — Broad shock**
    - "Broad shocks" occur when direct B/D shocks coincide with a deterioration in the health of other B/Ds.
- We find evidence that the capacity to substitute varies b/w the two events, related to the health of non-shocked B/Ds.

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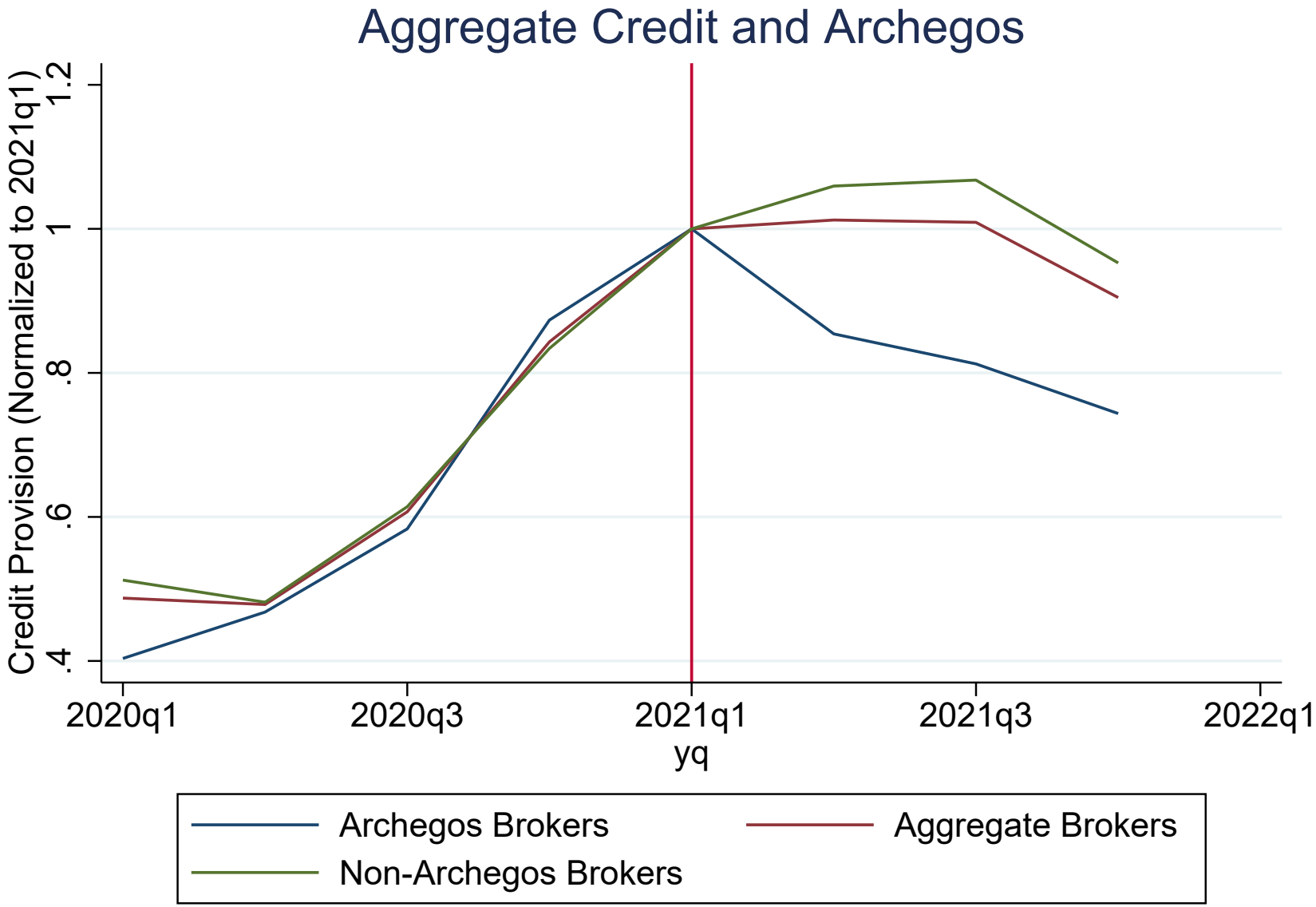
Archegos Default and Broker Losses

- 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")

Brokers with Archegos Losses ↓ Lending, Other B/D ↑



▸ Equity holdings show similar patterns

▸ Similar patterns in the cross-section

HF managers are able to substitute away from distress

To test fund substitution capacity, we regress:

$$\Delta \ln(\text{EqHoldings}^{m}_{2021q2}) = \alpha + \beta \cdot \text{BorrowedFromAnyArch}^{m}_{2021q1} + \epsilon^{m}_{2021q2}$$

	$\Delta(\ln \text{EqHoldings}^{m}_{2016q1})$					
	(1)	(2)	(3)	(4)	(5)	(6)
BorrowedFromAnyArchegos	0.009	0.022	0.028	-0.013	-0.014	-0.001
	(0.022)	(0.021)	(0.023)	(0.018)	(0.018)	(0.021)
Intercept	0.133***	0.111***	0.111***	-0.021***	-0.031***	-0.024**
	(0.009)	(0.010)	(0.012)	(0.007)	(0.009)	(0.011)
R-squared	0.001	0.004	0.007	0.001	0.002	0.000
N	562	320	222	562	320	222
Size	All	At Least 500M	At Least 1B	All	At Least 500M	At Least 1B
Port	Market	Market	Market	Stale	Stale	Stale

Standard errors in parentheses.

Robust standard errors.

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

- $\text{StalePricePort}^{m}_{t} = \sum_{s} \text{Price}^{s}_{2021q1} \cdot \text{SharesHeld}^{m,s}_{t}$
- Consistent with perfect substitution across broker-dealers!

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Financial Press in 2016 Q1

Charges to push Deutsche Bank to €6.7bn loss

Cryan calls result 'sobering' after multibillion-euro litigation and restructuring costs

THE WALL STREET JOURNAL

Credit Suisse swings to massive loss after write down

FT Trading Room Deutsche Bank AG + Add to myFT

Investors flock to CDS amid fear over banks' bonds

High trading volumes come as poor earnings at Deutsche add to concerns

European banks: left behind

The market increasingly belongs to better-capitalised US banks that were restructured years ago

Are Deutsche Bank's tanking shares the start of the next financial crisis?

Shares in Germany's biggest bank have plummeted to 30-year lows this week

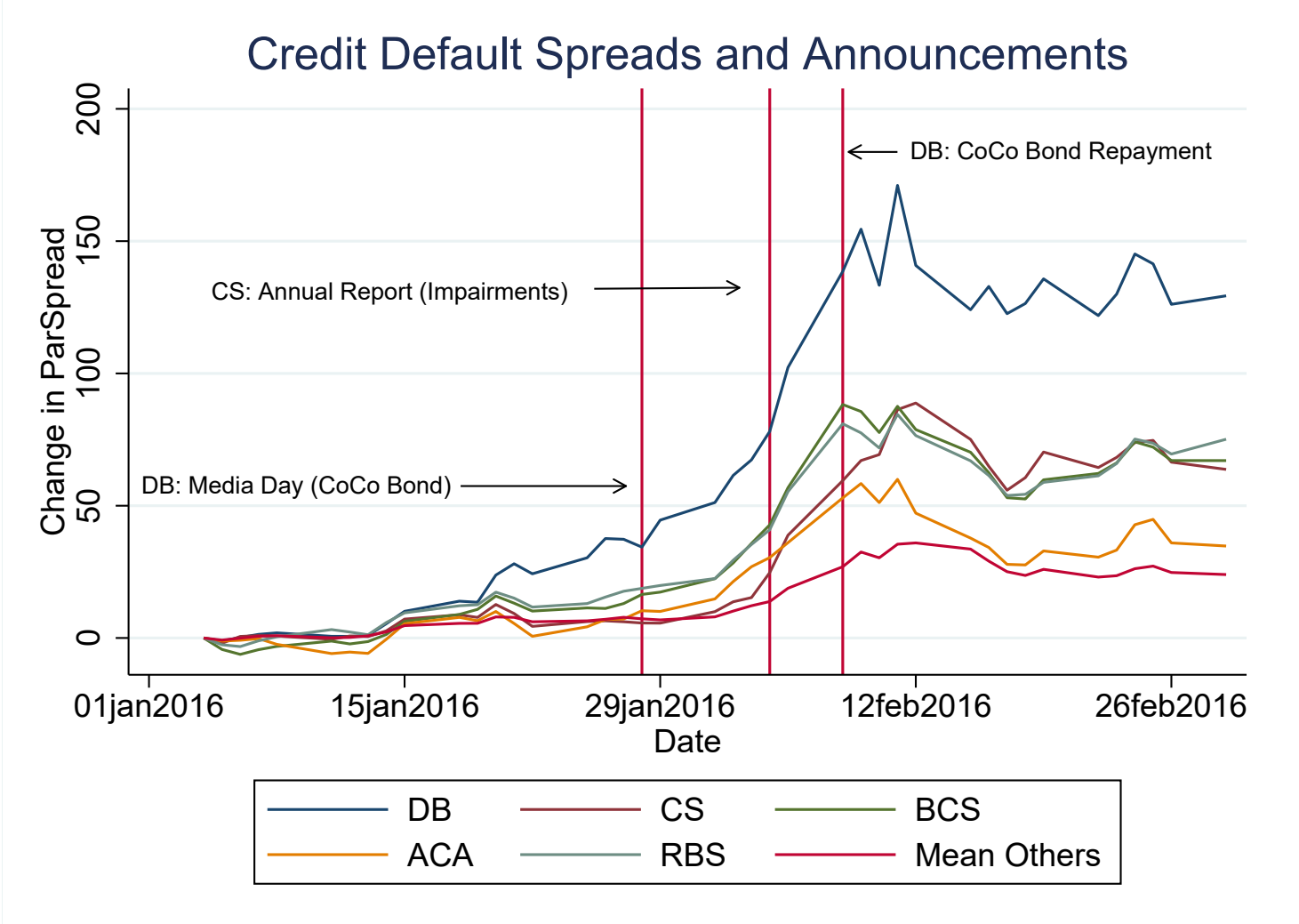
European Broker-Distress in Q1 2016

- Near Default of **Deutsche Bank** (DB) shook markets
  - **2015 Q4:** €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)*

We call the most distressed Euro brokers the "Euro 5" (E5)



- Top quintile of B/Ds of Δ CDS spread changes on announcement dates:
- Today: Test impact of E5 on fund equity holdings as no public loan data

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

E5 HF Managers Sold Off Equities in Response to Shock

For each hedge fund (HF) manager m:

$$\Delta \ln(\text{EqHoldings}^{m}_{2016q1}) = \alpha + \beta \cdot \text{BorrowedFromAnyE5}^{m} + \epsilon^{m}_{2016q1}$$

	$\Delta \ln(\text{EqHoldings}^{m}_{2016q1})$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{BorrowedFromAnyE5}^{m}$	-0.047*	-0.053*	-0.074**	-0.057**	-0.063**	-0.081***
	(0.025)	(0.028)	(0.029)	(0.025)	(0.028)	(0.028)
Intercept	-0.061***	-0.070***	-0.065***	-0.019*	-0.031**	-0.028*
	(0.011)	(0.014)	(0.016)	(0.011)	(0.014)	(0.015)
R-squared	0.008	0.015	0.037	0.012	0.022	0.047
N	454	232	170	454	232	170
Size	All	At Least 500M	At Least 1B	All	At Least 500M	At Least 1B
Port	Market	Market	Market	Stale	Stale	Stale

Robust standard errors.

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

- $\text{StalePricePort}^{m}_{t} = \sum_{s} \text{Price}^{s}_{2015q4} \cdot \text{SharesHeld}^{m,s}_{t}$
- This provides evidence towards imperfect substitution across broker-dealers!

▸ Aggregate Holdings ▸ Borrowing from DB and Other E5 Predicts Highest Sell-off
▸ Decomposing Market vs Stale Portfolios ▸ Less distressed US brokers increase lending more

From Hedge Fund Exposure to Stock Exposure

- Let's document stock-level effects.
- Construct a stock-level ex-ante exposure metric:

$$\text{E5Shr}^{s}_{2015q4} = \sum_{m \in M_{15q4}(s)} \text{MktShare}^{s,m}_{2015q4} \cdot \text{BorrowFromAnyE5}^{m}$$

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

- Validate that $\uparrow$ exposure implies $\uparrow$ stock-level sell-offs:

$$\Delta\text{E5Shr}^{s}_{2016q1} = \alpha + \beta \cdot \text{E5Shr}^{s}_{2015q4} + \epsilon^{s}$$

- Establish the impact on stock prices:

$$\text{ret}^{s}_{2016q1} = \alpha + \beta \cdot \text{E5Shr}^{s}_{2015q4} + \epsilon^{s}$$

where ret^{s}_{2016q1} denotes either raw or residualized stock returns.

▸ Distribution of Exposure Measure

Stocks more exposed to the shock have abnormal turnover

We test for abnormal sell-offs by:

$$\Delta E5Shr_t^s = \alpha_t + \beta_1 E5Shr_{t-1}^s + \beta_2 E5Shr_{t-1}^s \times Q12016 + \epsilon_t^s$$

	Δ % Held Euro5 HFs				
	(1)	(2)	(3)	(4)	(5)
$E5Shr_{t-1}$	-0.094***	-0.045***	-0.050***	-0.049***	-0.056***
	(0.009)	(0.003)	(0.004)	(0.004)	(0.004)
$E5Shr_{t-1} \times$ Q12016		-0.049***	-0.044***	-0.050***	-0.044***
		(0.009)	(0.009)	(0.009)	(0.009)
Intercept	-0.0025***	-0.0006***			
	(0.0004)	(0.0001)			
N	1835	21972	21972	21969	21969
Q12016	X				
Quarter FE			X		X
IndustryFE				X	X

Stocks more exposed to shock have lower realized returns

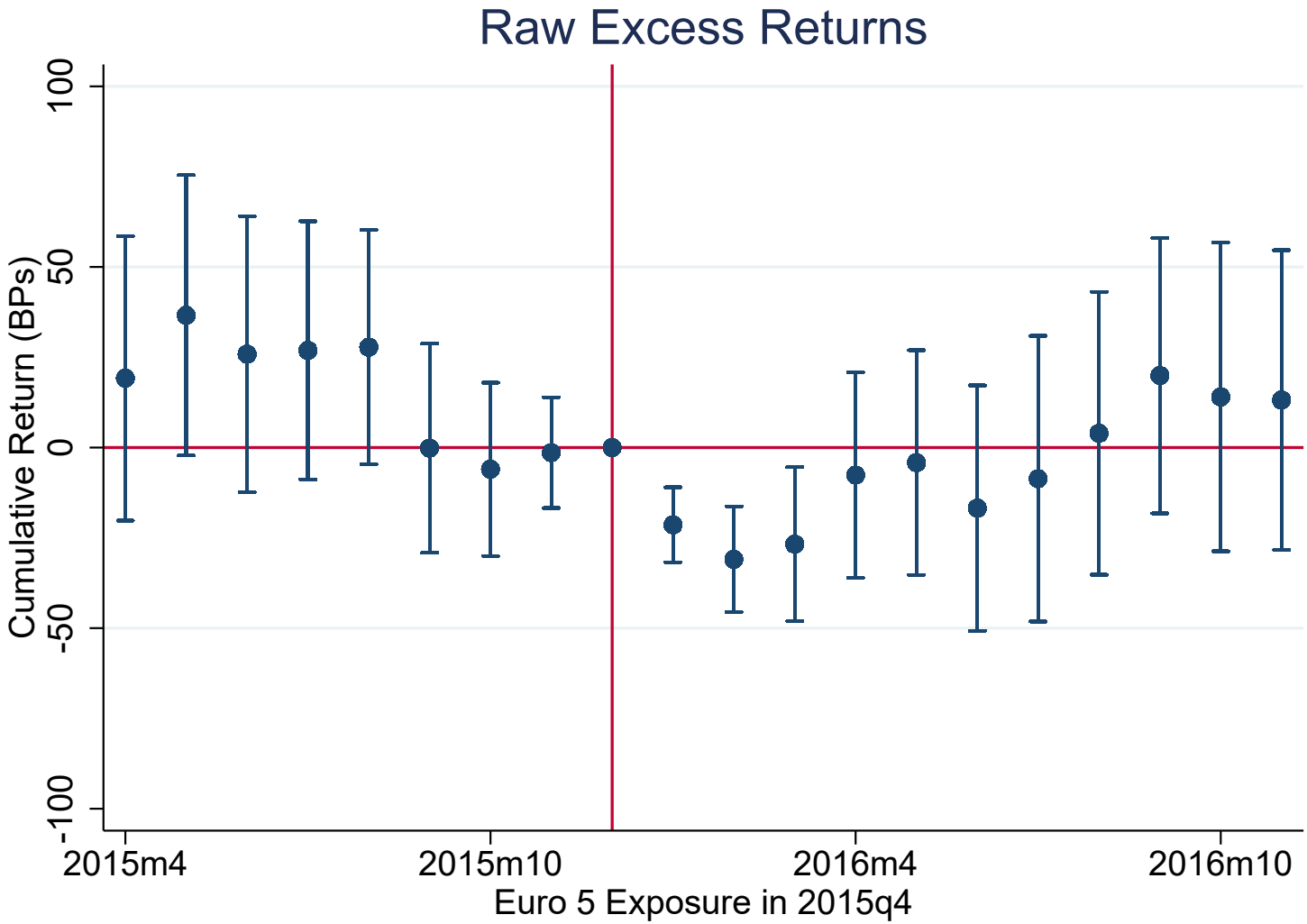
For each stock s, we estimate:

$$ret^{s}_{2016q1} = \alpha + \beta E5Shr^{s}_{2015q4} + \epsilon^{s}$$

	$Rets_{s,q}$			$\epsilon_{CAPM,s,q}$	$\epsilon_{FF4,s,q}$	ϵ^{s}_{BAB}
	(1)	(2)	(3)	(4)	(5)	(6)
$E5Shr^{s}_{2015q4}$	-0.507***	-0.409***	-0.315***	-0.310***	-0.347***	-0.302***
	(0.129)	(0.104)	(0.0935)	(0.0952)	(0.0876)	(0.0942)
$nonE5Shr^{s}_{2015q4}$		-0.237	-0.0647	-0.0803	-0.113	-0.0512
		(0.144)	(0.0842)	(0.0848)	(0.0721)	(0.0835)
Intercept	0.0351***	0.0433***	0.0284***	0.0233***	0.0366***	0.0392***
	(0.0119)	(0.00999)	(0.00608)	(0.00616)	(0.00530)	(0.00610)
R^2	0.018	0.024	0.283	0.288	0.239	0.278
Industry FE			X	X	X	X
N	1835	1835	1803	1802	1800	1803

- 1 $\sigma \uparrow$ in B/D exposure $\implies \approx -1.5$PP return in quarter
- Robust to: Other institutional types, Stock-Level E5 Controls, Realized Sell-Offs, Amihud Illiquidity

Effect reverses in four months



$$cumret^{s}_{2015m12+\tau} = \alpha + \beta Euro5MktShare^{s}_{2015q4} + \epsilon^{s}_{2015m12+\tau}$$

Identical results for residualized returns. ▸ Residualized Return Reversion

Sizing the Impact

- Compute price multiplier:

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

  - Back-of-envelope: 3.35 (sell-off) or 7.14 (ab. sell-off)
  - OLS Sell-Off Estimate: 2.97 for sell-offs, 0 for purchases

- 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 ▸ Uncertainty Quote
  - and ...

▸ Back-of-the-Envelope Calculations

Non-levered and more inelastic investors absorb sell-off

We compute for each other investor class i

$$MktShare_t^i = \sum_{m \in M_t(s)} MktShare_t^{s,m} \cdot ManagerClass^i$$

We then estimate:

$$\Delta MktShare_{2016q1}^{s,i} = \alpha + \beta Euro5SellOff_{2016q1}^{s} + \epsilon_{2016q1}^{s,i}$$

	(1) Δ % Held nonE5 HFs	(2) Δ % Brokers	(3) Δ % Households	(4) Δ % Inv Adv
% Sold-Off E5 HFs	0.106** (0.0469)	-0.0137 (0.0164)	0.609*** (0.107)	0.320*** (0.0900)
R-squared	0.009	0.002	0.079	0.022
N	934	933	934	934

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

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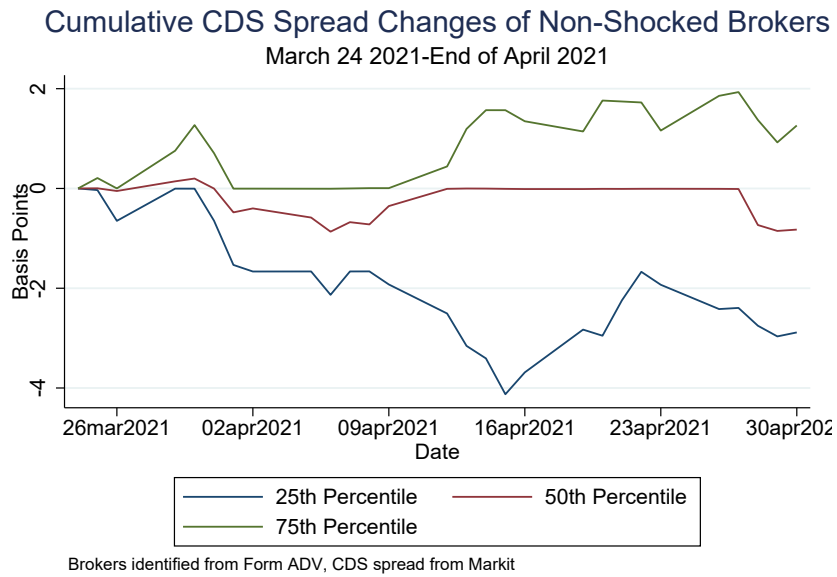
Additional Evidence

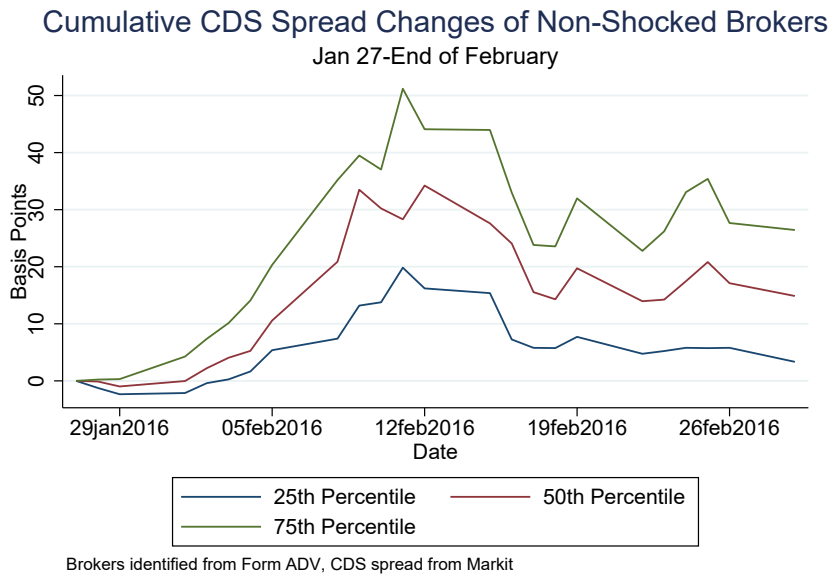
Shocks differ on the health of non-directly shocked B/Ds

This paper:

1. Archegos (Large, idiosyncratic shock)
2. European Broker Distress (Large, broad shock)

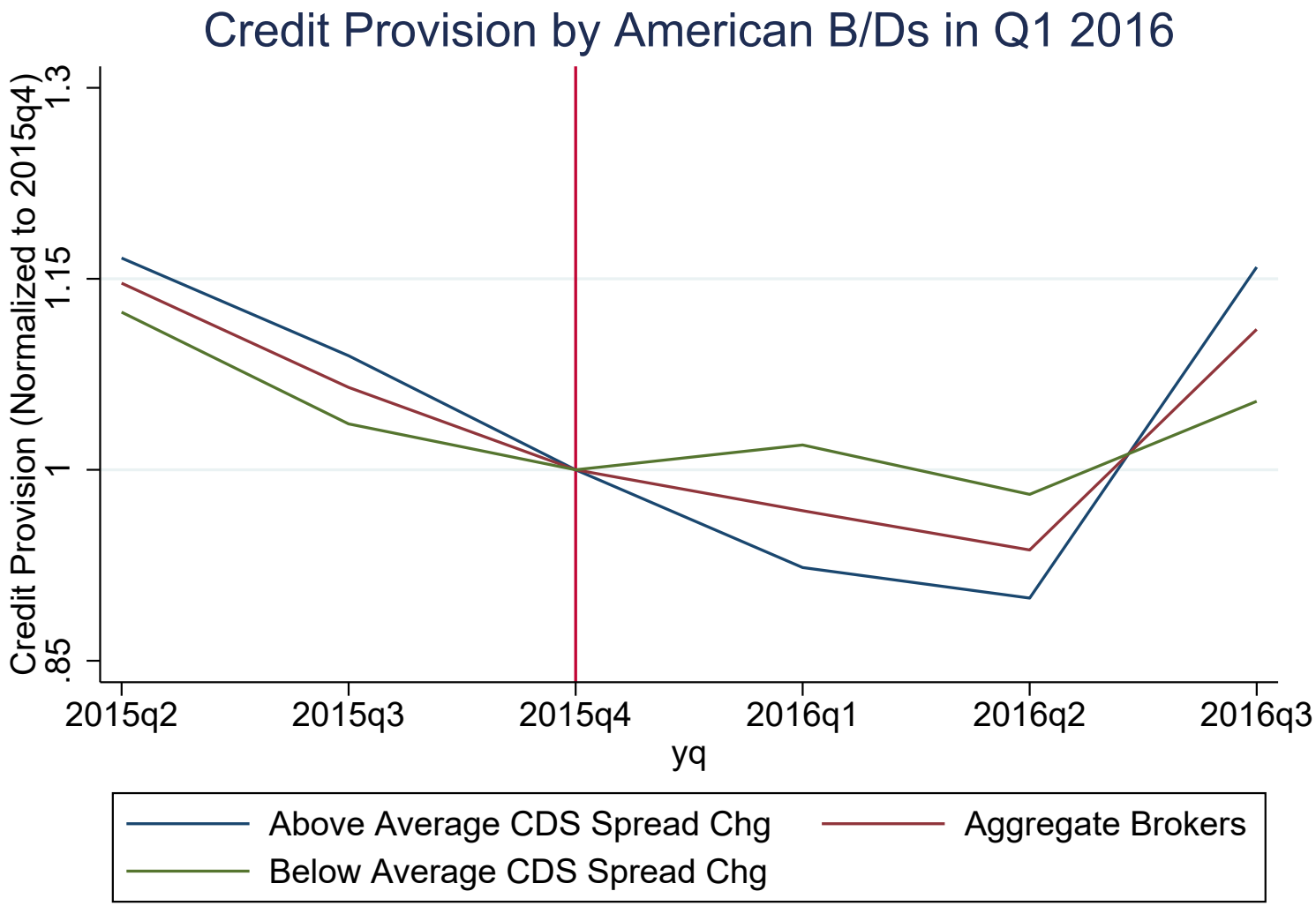


Archegos



European Broker Distress

Less distressed American B/Ds expanded credit in 2016 Q1



- Consistent with substitution to less distressed brokers! ▸ Regression Results
- Suggest time-varying substitution frictions vis-a-vis Archegos

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Additional Evidence

Broad Distress and Transmission

- **Panel Data:** Most shocks are idiosyncratic ▸ Results
  - Construct general distress shocks measures from CDS spreads
    - All shocks other than 2016 Q1 are idiosyncratic
  - High distress $\Longrightarrow$ broker lending $\downarrow$, no HF equity holding transmission.

- **Lehman Brothers:** Similarly broad to to 2016 Q1
  - Broad distress from funding market contagion. ▸ Results
  - HFs with higher exposure to distressed brokers $\Longrightarrow$ equity holdings $\downarrow$, equity prices $\downarrow$. ▸ Results

- **Conclusion:** Non-shocked B/D health crucial for equity market transmission!

▸ Covid and CS X-Section

Conclusions

Conclusion

- B/D health shocks do transmit to equity markets
  - ...but only when hedge fund managers cannot substitute away
  - ...which is determined by the health of non-shocked B/Ds
- In normal times, hedge funds are well-diversified against these shocks due to their private actions.
  - In such cases, broker-dealer credit supply is not a financial stability concern.
- In periods of broad distress, B/D shocks affect equity prices with a price multiplier of at least 3.

My agenda

- Intermediaries and Investors:
  1. Private Liquidity Backstops: Bank Credit Lines and Loan Mutual Funds (w/Schrimpf, Todorov and Wang)
  2. Intermediary Risk and Hedge Fund Crowding: A Narrative Approach (solo)
  3. Bank Holding Company Internal Capital Markets (w/ Friedrichs, Mann, and Schrimpf)

- Published:
  1. Partisanship and Fiscal Policy in Economic Unions: Evidence from US State (Carlino et al. 2023—AER)

- Policy Publications:
  1. Hedge Fund Exposure to the Carry Trade (Packer et al. [2024])

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

K. Gleason, S. Bright, F. Martinez, and C. Taylor. Europe's cocos provide a lesson on uncertainty. *OFR Working Paper*, 2017.

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

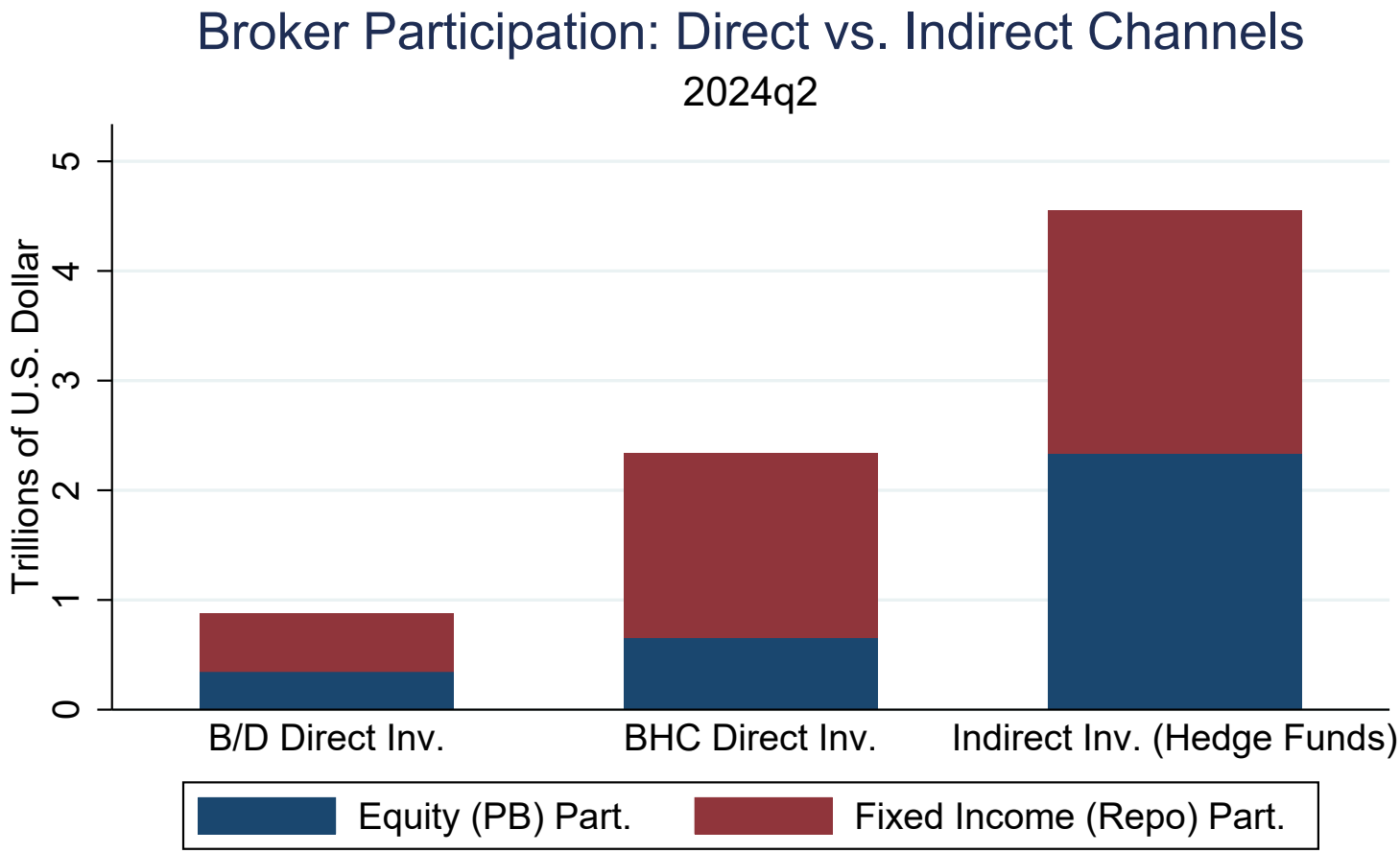
M. Mitchell and T. Pulvino. Arbitrage crashes and the speed of capital. *Journal of Financial Economics*, 104(3):469–490, 2012. ISSN 0304-405X. doi: https://doi.org/10.1016/j.jfineco.2011.09.002. URL https://www.sciencedirect.com/science/article/pii/S0304405X11001991. Market Institutions, Financial Market Risks and Financial Crisis.

F. Packer, A. Schrimpf, V. Sushko, and N. Zarra. Hedge fund exposure to the carry trade. *BIS Quarterly Review*, 2024.

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.

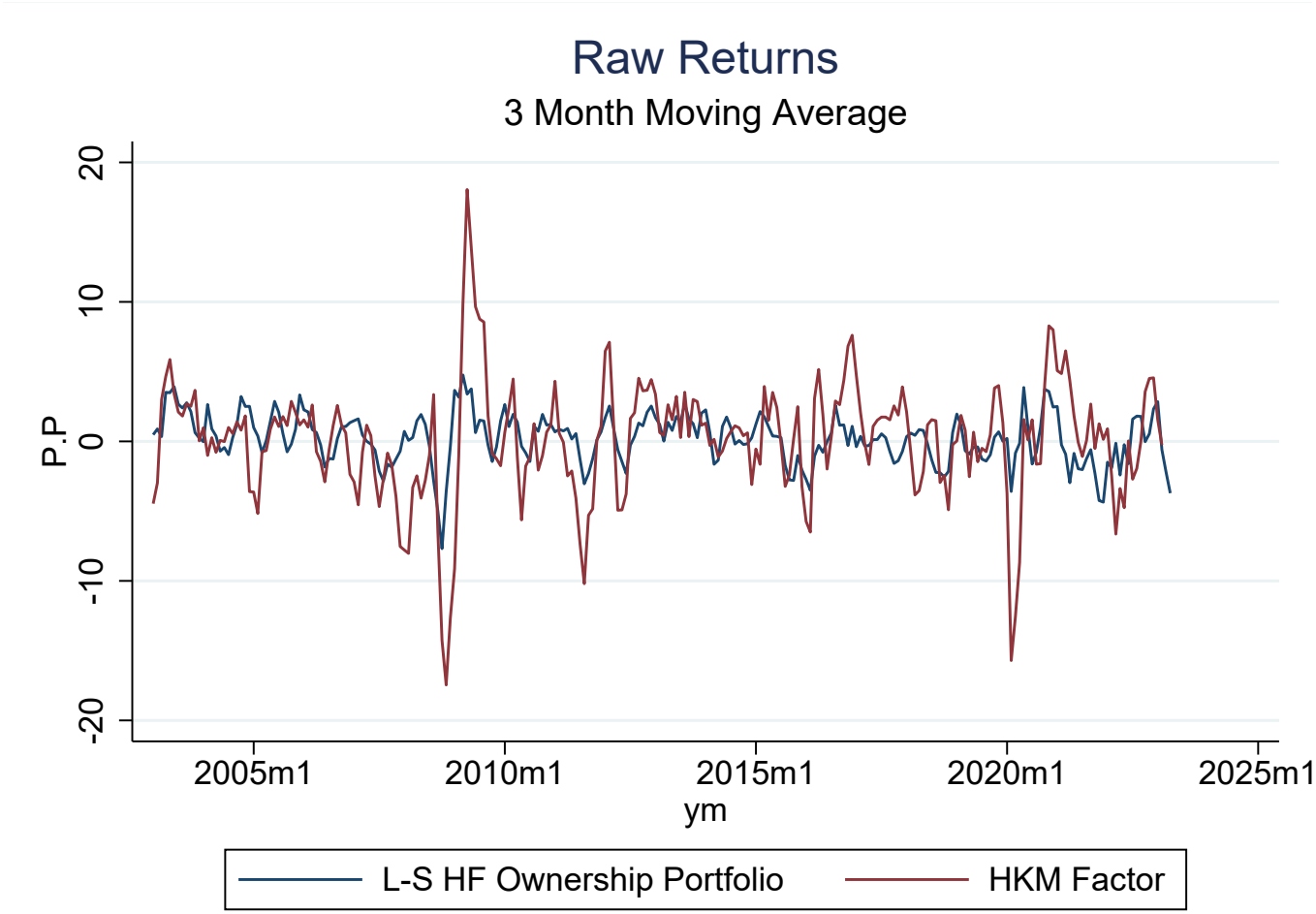
Indirect participation is much larger than direct participation (all types)



Data: OFR Hedge Fund Monitor (U.S. Regulated HF)
Broker-Dealer data from Fed Fin. Acc. (U.S. Regulated)
Bank Holding Company data from Y-9C (All U.S. Regulated BHC)
BHC Direct Bond Intermediation includes AFS Bond Securities

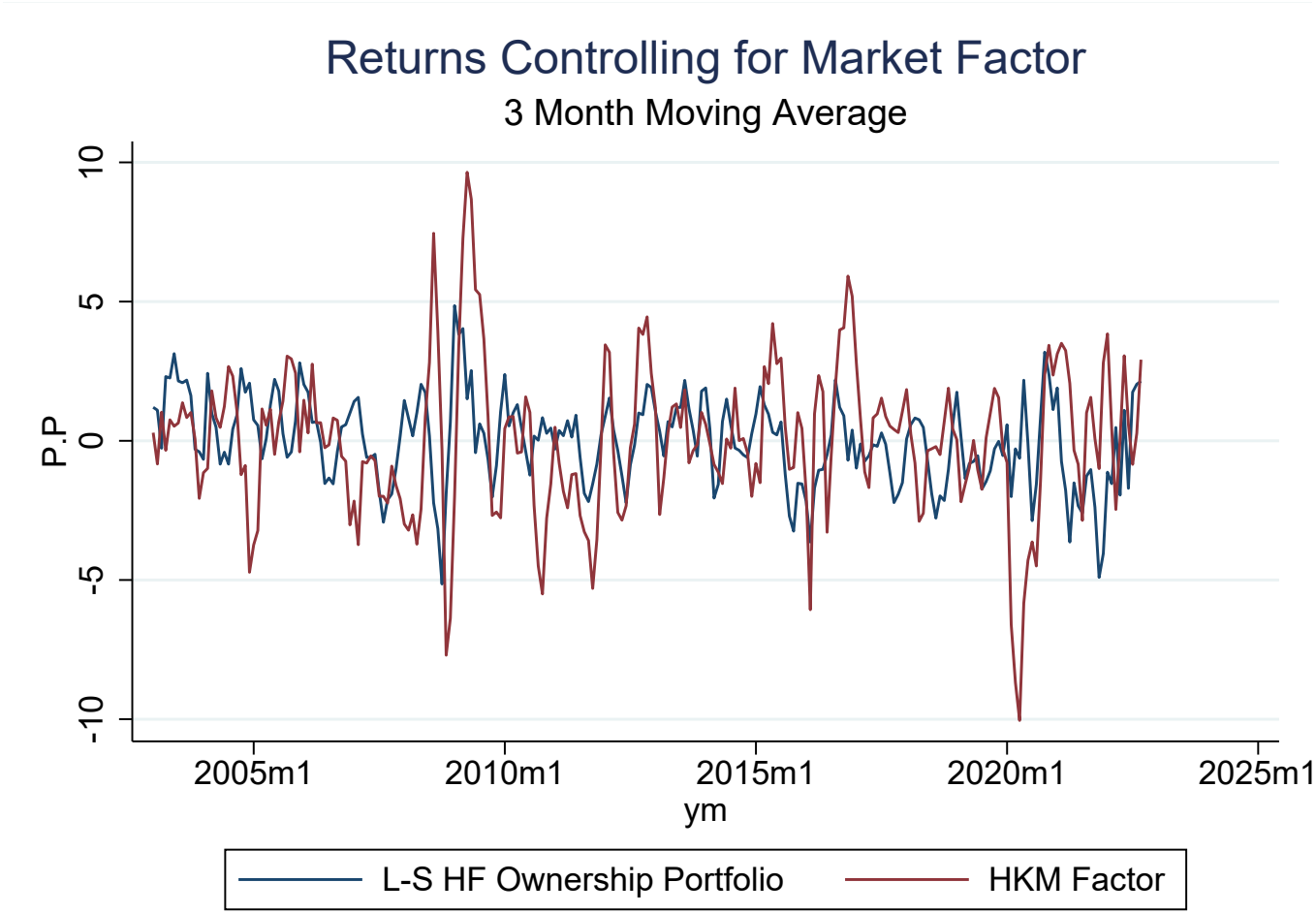
▸ Return

Stocks More Exposed to HFs ↓ When Agg. B/D Health ↓



▸ Return

Stocks More Exposed to HFs ↓ When Agg. B/D Health ↓



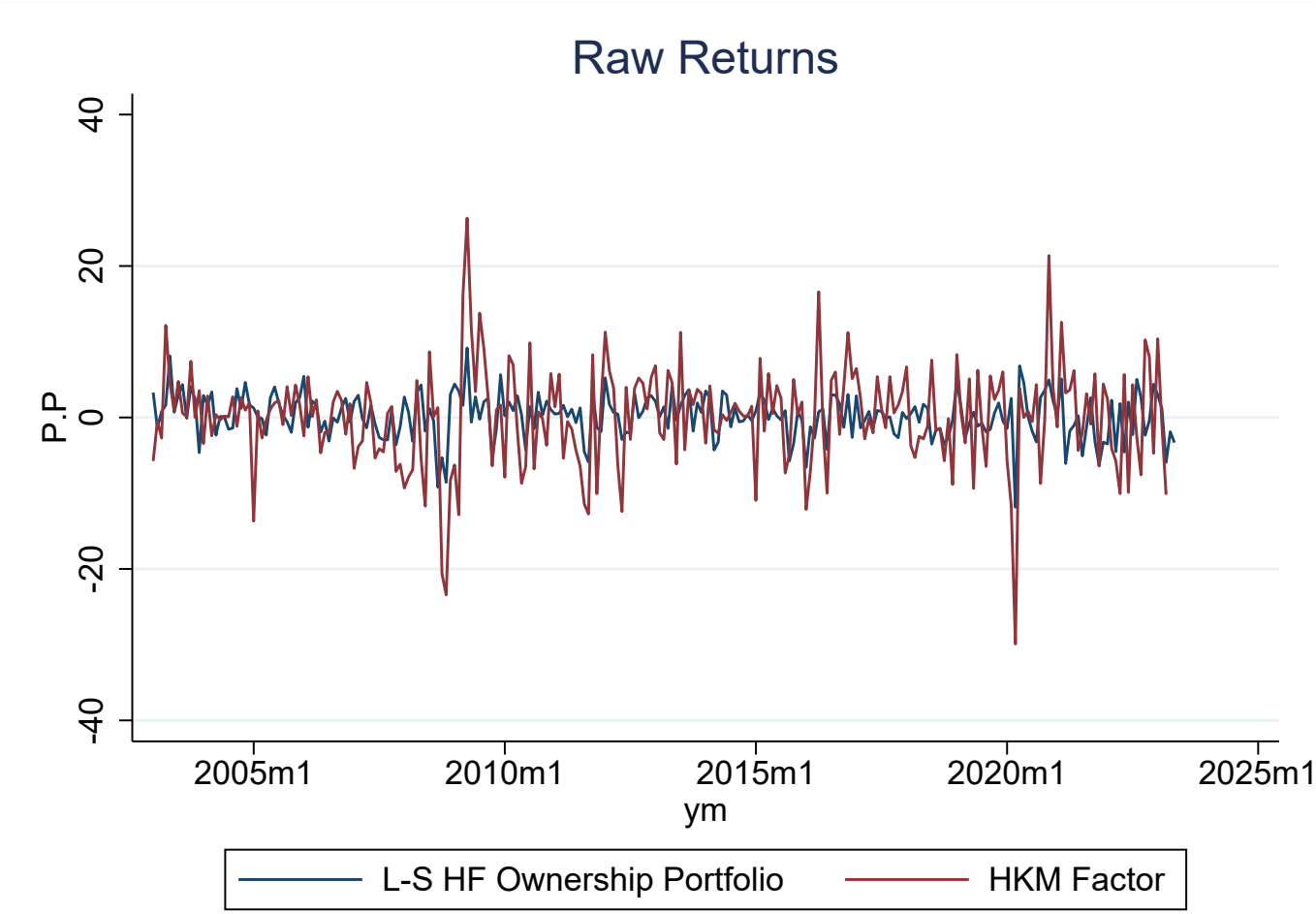
▸ Return

HFs borrow from multiple but not all B/Ds

	Number of Prime Brokers per Fund							
	mean	p50	p10	p25	p75	p90	Obs	Total Gross Assets ($ B)
HFs with at least 5B gross assets	5.1	4	1	2	8	10	105	1945
HFs with at least 1B gross assets	3.6	3	1	1	5	8	375	2505
All HFs	2.6	2	1	1	3	6	987	2790

▸ Return

Stocks More Exposed to HFs ↓ When Agg. B/D Health ↓



▸ Return

Lending Concentration: PB vs C&I

	(1) Hedge Fund Credit Concentration	(2) Y-9C Total Loan Concentration
1	14	12.3
2	27.9	22.3
3	40.3	30.7
4	48.2	36.9
5	55.7	40.3
6	63.1	43.2
7	69.8	46.1
8	75.4	48.9
9	77.8	51.3
10	80.2	53.7

▸ Return

Stocks are heterogeneously exposed to HFs

	mean	p50	p1	p5	p10	p25	p75	p90	p95	p99
HF Institutional Share	15.3	10.3	1.1	1.8	2.6	4.7	20.5	35.2	46.1	68.3
HF Market Share	10.9	7.3	0.3	1.1	1.7	3.4	14.4	25.7	33.8	53.0
HF Institutional Turnover Share	27.4	25.4	0.1	1.9	4.8	12.5	39.4	52.6	60.9	81.2
Number of Hedge Funds	41.4	36	2	8	13	23	55	74	90	124
Observations	2180									

▸ Return

Stocks are heterogeneously exposed to E5 and non E5 brokers

	mean	p50	p1	p5	p10	p25	p75	p90	p95	p99
E5 Market Share	5.4	3.8	0.1	0.4	0.8	1.9	7.5	12.5	17.2	20.5
Non-E5 Market Share	7.1	5.0	0.2	0.6	1.1	2.3	9.7	16.7	22.0	27.9
Observations	2166									

- Correlation b/w E5 and non-E5: about 30%

Return

Brokers with Archegos losses ↓ lending

In the broker, we test the following:

$$\Delta ln(PBL^{b}_{2021q1 \rightarrow 2021q2}) = \alpha + \beta \cdot ArchegosBroker^{b} + \epsilon$$

	$\Delta ln(PBL^{b}_{t})$					
	(1)	(2)	(3)	(4)	(5)	(6)
A5Broker	-0.293***	-0.177**	-0.299***	-0.290**	-0.111*	-0.311**
	-3.628	-2.507	-3.518	-2.477	-1.871	-2.269
Archegos Exposed/No Losses			-0.028			-0.050
			-0.297			-0.363
r2	0.422	0.270	0.425	0.434	0.333	0.445
N	20	19	20	10	9	10
Sample	All PB	All PB ex CS	All PB	Lg PB	Lg PB ex CS	Lg PB

▸ Return

Results robust to other institutional investor controls

	$Ret_{s,t}$	$\varepsilon_{FF4,s,t}$	$Ret_{s,t}$	$\varepsilon_{FF4,s,t}$	$Ret_{s,t}$	$\varepsilon_{FF4,s,t}$
% Held Euro5 HFs	-0.519***	-0.461***	-0.503***	-0.518***	-0.554***	-0.550***
	(0.129)	(0.103)	(0.126)	(0.102)	(0.120)	(0.0976)
% Held Brokers	-0.0137	-0.798				
	(0.583)	(0.531)				
% Held non-HF IA			0.0671***	0.0442**		
			(0.0250)	(0.0220)		
% Held non E5 Inst.					0.0546***	0.0342*
					(0.0184)	(0.0202)
Intercept	0.0364***	0.0451***	-0.00239	0.0149	-0.00955	0.0117
	(0.0115)	(0.00833)	(0.0185)	(0.0145)	(0.0126)	(0.0131)
R-squared	0.019	0.028	0.024	0.028	0.024	0.028
N	1823	1820	1835	1832	1835	1832

Standard errors are clustered at the three-digit SIC industry code level.

▸ Return

Results are robust to direct Euro 5 bank exposure controls

	$Ret_{s,q}$					
	(1)	(3)	(5)	(7)	(9)	(11)
% Held Euro5 HFs	-0.485***	-0.507***	-0.500***	-0.510***	-0.508***	-0.507***
	(0.120)	(0.120)	(0.125)	(0.129)	(0.128)	(0.129)
% Held E5 B/D	-1.147					
	(1.169)					
% Held E5 Affiliate		-0.183				
		(1.022)				
E5 Bank in Syndicate			0.0356**			
			(0.0144)			
SyndicatedLoansE5/FirmAssets				8.954		
				(7.006)		
E5 Bank Lead					-0.0196	
					(0.0315)	
SyndicatedLoansLeadE5/FirmAssets						-46.72
						(101.1)

Standard errors in parentheses

* p ¡ 0.10, ** p ¡ 0.05, *** p ¡ 0.01

▸ Return

Stocks more sold-off by E5 mgrs have lower returns

	$Rets_{s,q}$				$\epsilon_{CAPM,s,q}$	$\epsilon_{FF4,s,q}$	$BABRet_t^s$
	(1)	(2)	(3)	(4)	(6)	(8)	(10)
$\Delta MktShareE5HFs$	1.442***	2.852***	1.149**	2.970***	2.894***	3.104***	2.866***
	(0.517)	(0.786)	(0.470)	(0.741)	(0.772)	(0.757)	(0.729)
$\Delta MktSharenonE5HFs$			-0.323	-0.553	-0.630	-0.437	-0.553
			(0.366)	(0.492)	(0.494)	(0.406)	(0.492)
Intercept	0.0142	0.0321**	0.0128***	0.0320***	0.0254***	0.0321***	0.0444***
	(0.0171)	(0.0128)	(0.00102)	(0.00622)	(0.00648)	(0.00636)	(0.00612)
R-squared	0.008	0.026	0.304	0.328	0.333	0.303	0.325
N	1659	902	1621	846	845	844	846
selloff		X		X	X	X	X

▸ Return

What's the impact of a one σ higher E5 exposure?

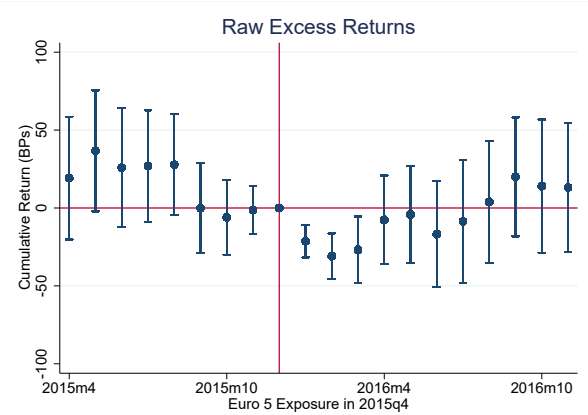
	Data			Estimates		
Measure	**Mean**	**SD**	**IQR**	β	**1 SD**	**IQR Impact**
Ex-Ante Exposure	5.2%	4.8%	5.5%	-0.315	1.5%	1.7%
Realized Sell-Off	0	1.1%	0.8%	1.149	1.4%	1.0%

1. Is this reasonable?
   - This is a realized very bad outcome
   - GFC: 10–15% time-series discount in September 2008 on HF arbitrage assets (Mitchell and Pulvino [2012])
   - Back of envelope Amihud Illiquidity estimates ranges from $[.2, 3]$
   - Later on: estimates from Lehman collapse is -4.8% (quarterly)

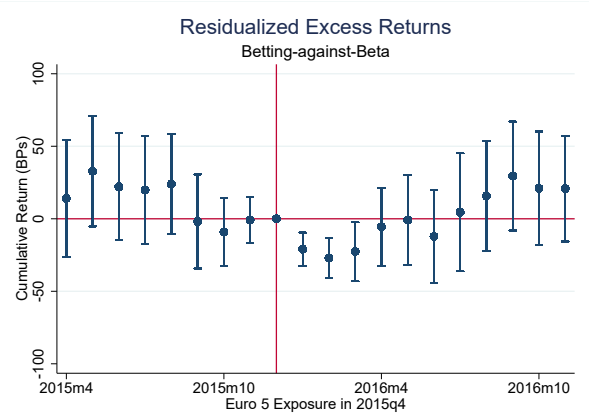
Return

Reversions

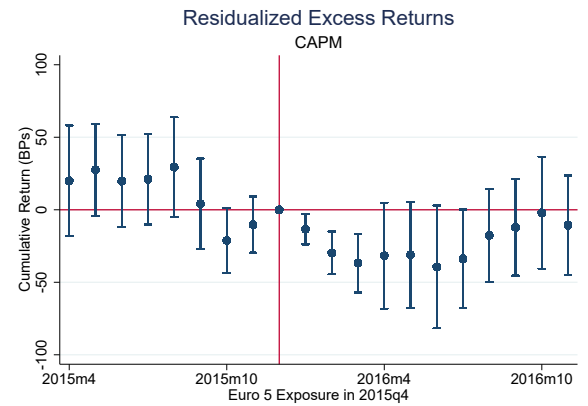
▸ Return



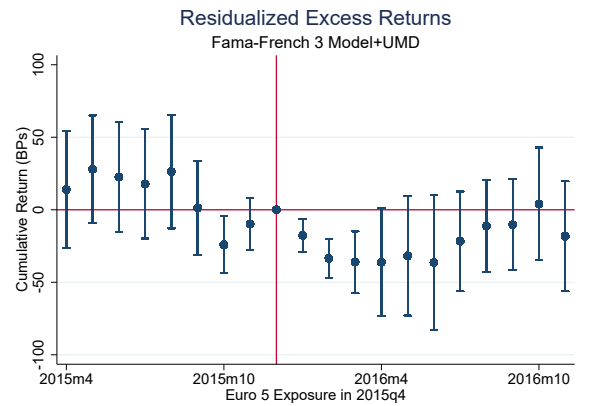
(a) Raw Realized Returns



(b) Betting-Against-Beta Residuals



(c) CAPM Residuals



(d) Fama-French 4 Res.

Amihud Illiquidity results are consistent with HF managing liquidity

Define $AL = log(1 + AmihudIlliquidity)$

	$\Delta E5$		ΔAL		ret_t^s	
	(1)	(2)	(3)	(4)	(5)	(6)
$E5Shr^s_{2015q4}$	-0.111***	-0.127***	0.283**	0.081	-0.514***	-0.508***
	(0.009)	(0.010)	(0.126)	(0.106)	(0.139)	(0.129)
AL^s_{2015q4}		-0.001***		0.000		-0.009
		(0.000)		(0.017)		(0.006)
$E5Shr^s_{2015q4} \times AL_{2015q4}$		0.051***		0.838**		-0.195
		(0.017)		(0.374)		(0.133)
R-squared	0.107	0.118	0.004	0.025	0.019	0.025
N	1751	1751	1751	1751	1751	1751

Standard errors in parentheses

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

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.

B/D-Panel: Higher distress associates with lower lending

For $\tau = 95\%$, we regression:

$$\Delta ln(PBL_t^b) = \alpha_t + \alpha_b + \beta H_t^b + \epsilon_t^b$$

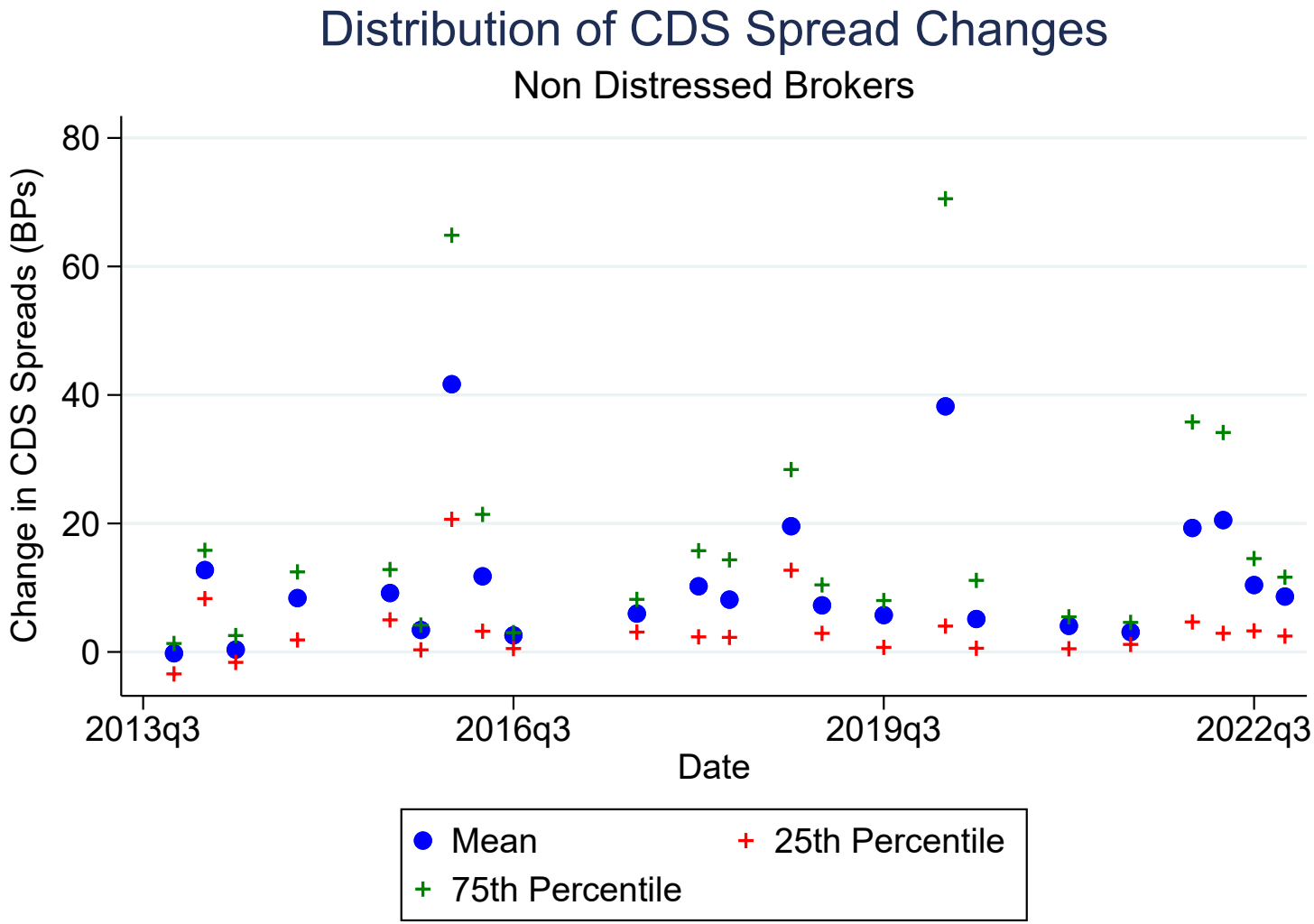
where $H_t^b = \in \{AbnormalDistress_t^b, BigShock_t^b\}$

	$\Delta ln(PBL_t^b)$			
	(1)	(2)	(3)	(4)
$AbnormalDistress_t^b$	-0.182***	-0.157***		
	(0.0524)	(0.0495)		
$BigShock_t^b$			-0.172***	-0.155***
			(0.0549)	(0.0444)
Intercept	0.0327***	0.0296***	0.0137**	0.0134***
	(0.00831)	(0.00501)	(0.00487)	(0.000541)
R-squared	0.163	0.233	0.148	0.224
N	669	669	669	669
FE	Q	Q and B	Q	Q and B

Standard errors in parentheses

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

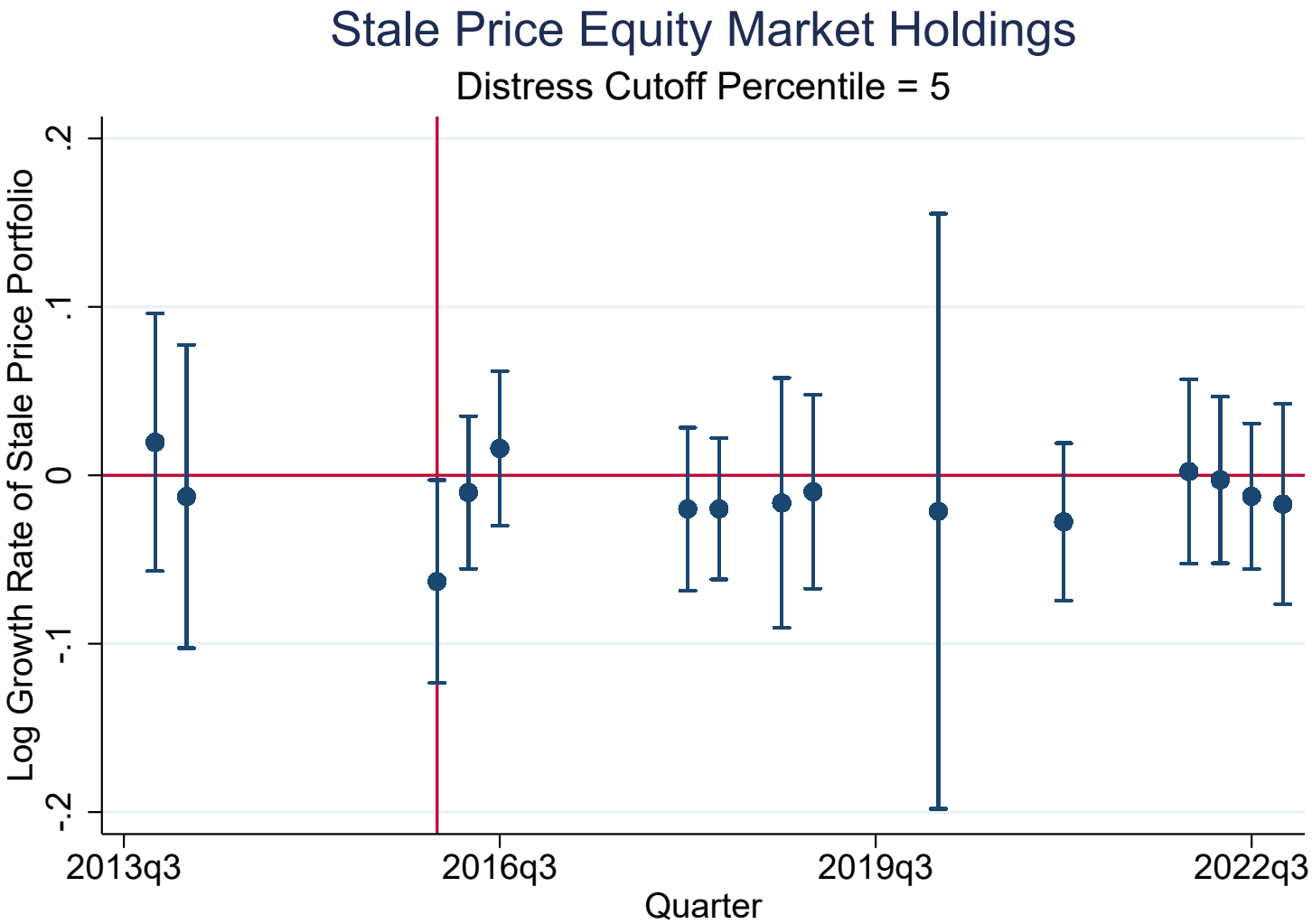
Limited evidence of **broad** distress outside Euro 5



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

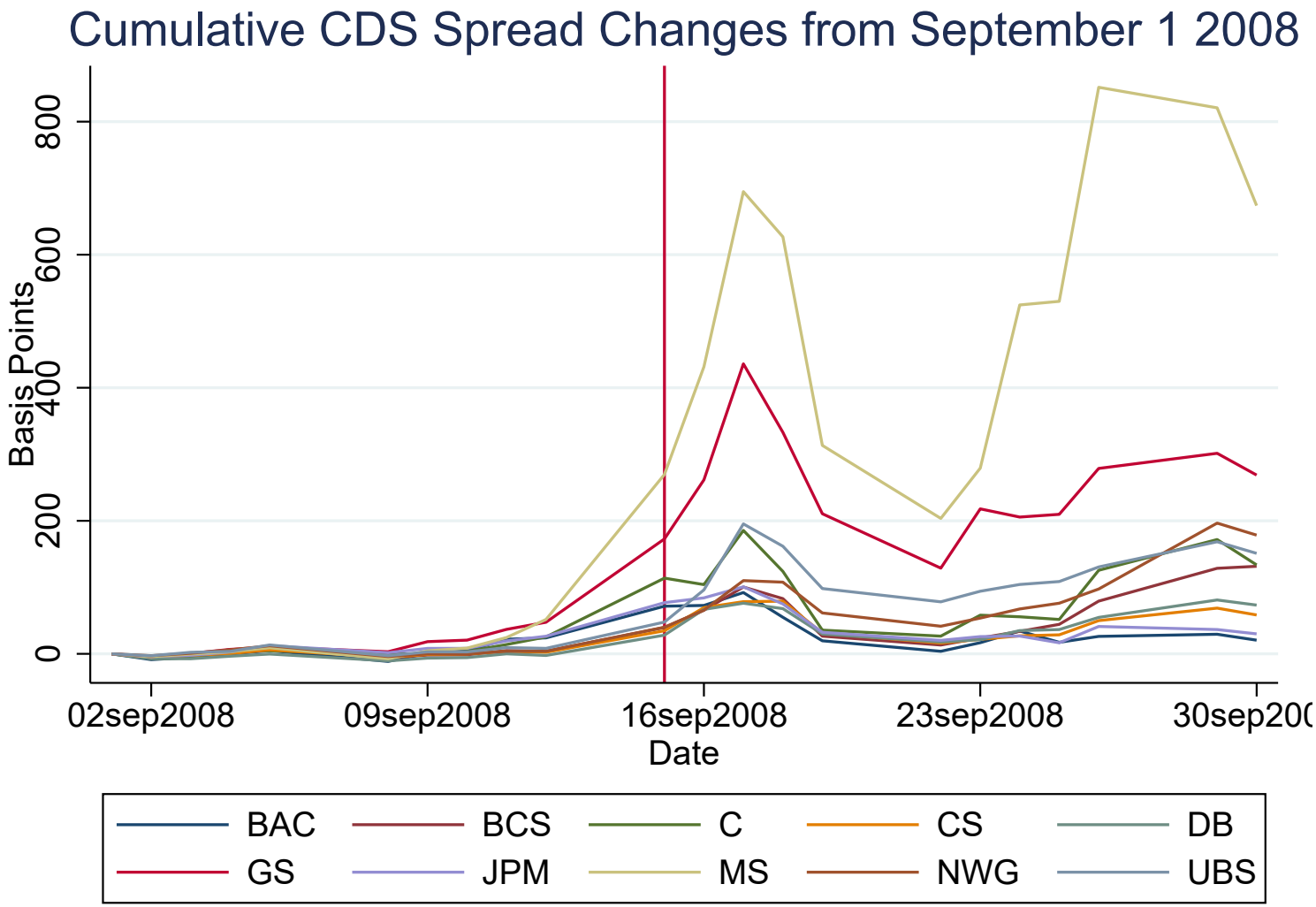
▸ Evidence

B/D health doesn't transmit to HF equity portfolios outside Q1 2016

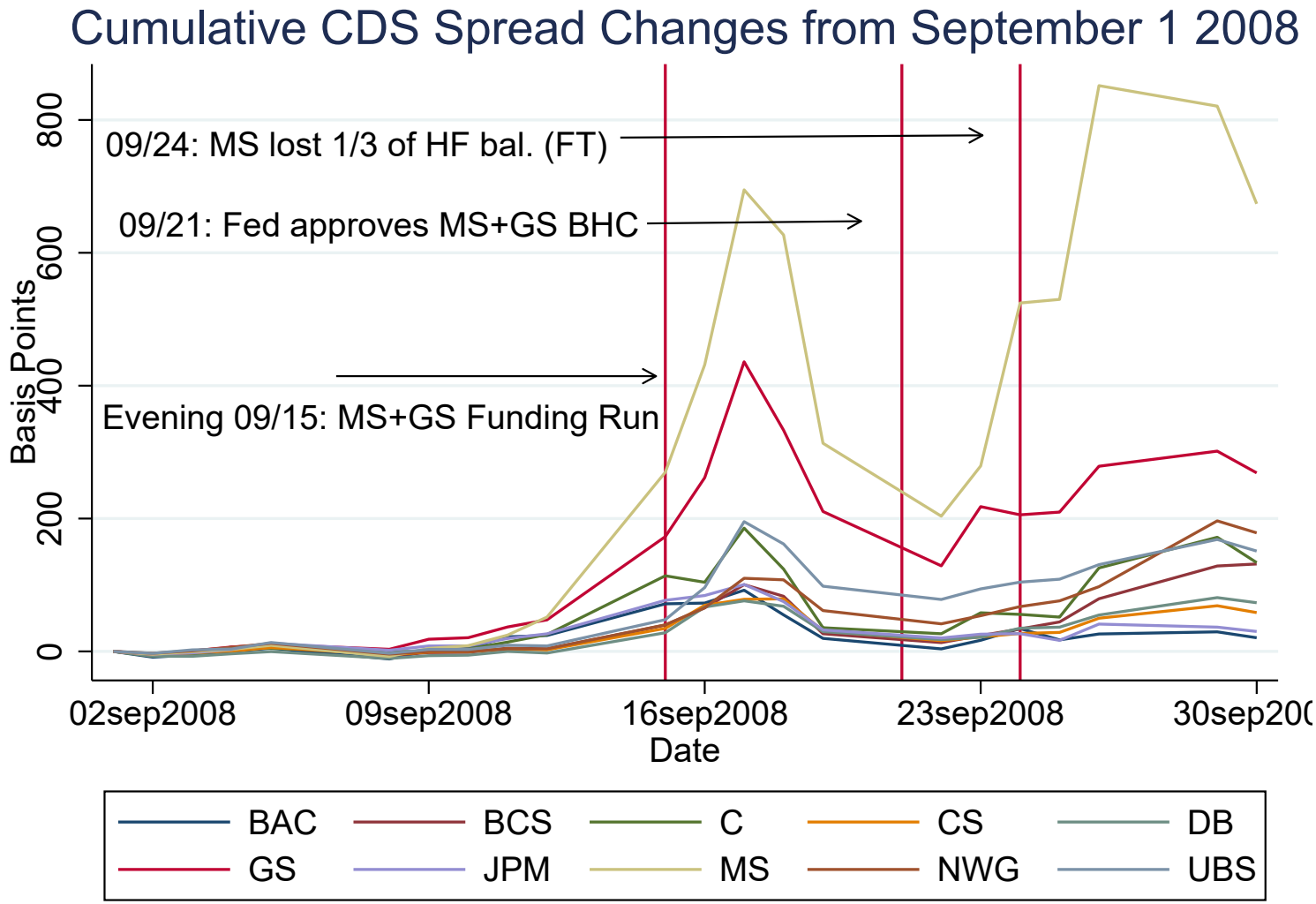


▸ Return ▸ Conclusion

CDS markets suggest "broad" distress after Lehman collapses



The funding run on MS's prime brokerage business



- MS (and GS) funded itself via "free credits"–the balances that HFs have in their brokerge accounts.

Sell-offs Sparked by Lehman + Other Broker-Dealers

- Construct partial HF to B/D x-walk using Lipper TASS.

- Evidence of abnormal sell-offs for **Lehman (LEH), Merrill Lynch (ML), and Morgan Stanley (MS):**
  1. Hedge fund manager sell-offs observed in the cross-section. ▸ HFM
  2. Stock-level turnover for a consolidated group of LEH, MER, and MS. ▸ Stock-Level

- Findings:
  - Contagion likely impacted Morgan Stanley's credit supply
  - Group all MS,MER, and LEH together as Lehman 3 (LEH3)
  - Group all MS+MER+LEH together

Stocks more exposed to LEH3 exhibit lower returns, even after accounting for LEH exposure

	(1) $ret_{s,t}$	(2) $\varepsilon_{FF4,s,t}$	(3) $ret_{s,t}$	(4) $\varepsilon_{FF4,s,t}$	(5) $ret_{s,t}$	(6) $\varepsilon_{FF4,s,t}$	(7) $ret_{s,t}$	(8) $\varepsilon_{FF4,s,t}$
LEH (t-1)	-0.833*	-0.779			-0.650	-0.585		
	(0.436)	(0.501)			(0.432)	(0.500)		
LEH3 (t-1)			-0.503***	-0.496**			-0.484**	-0.477**
			(0.185)	(0.221)			(0.187)	(0.223)
MS+MER (t-1)					-0.683***	-0.724**		
					(0.245)	(0.287)		
non LEH3 HF (t-1)							-0.193**	-0.181**
							(0.0795)	(0.0878)
R-squared	0.002	0.001	0.007	0.005	0.009	0.008	0.010	0.007
N	1889	1889	1889	1889	1885	1885	1885	1885

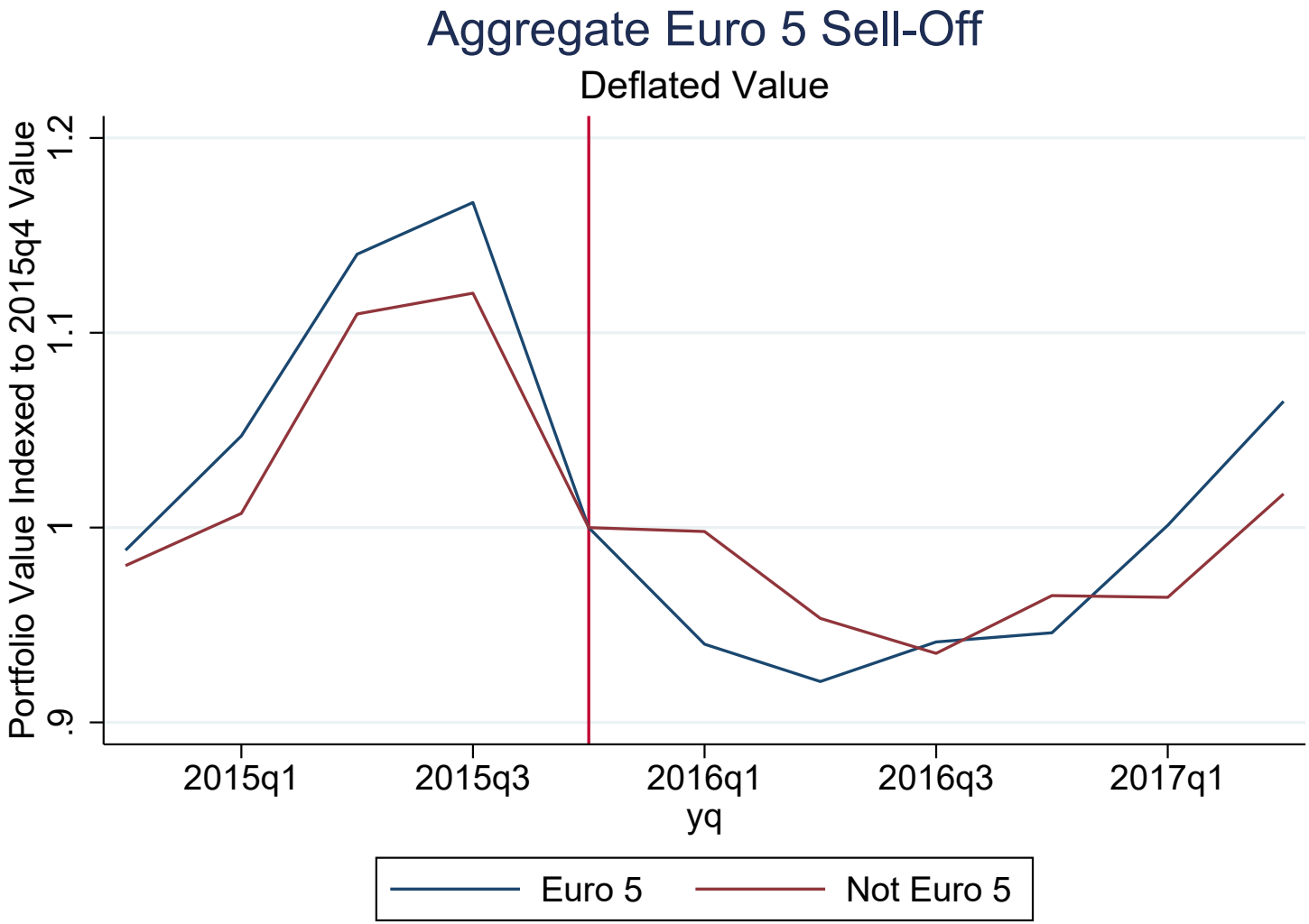
Standard errors in parentheses

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

- 1 $\sigma \uparrow$ in B/D exposure $\implies \approx$ 4.8PP return in quarter (0.8p.p from 09/15-09/20

▸ Conclusion

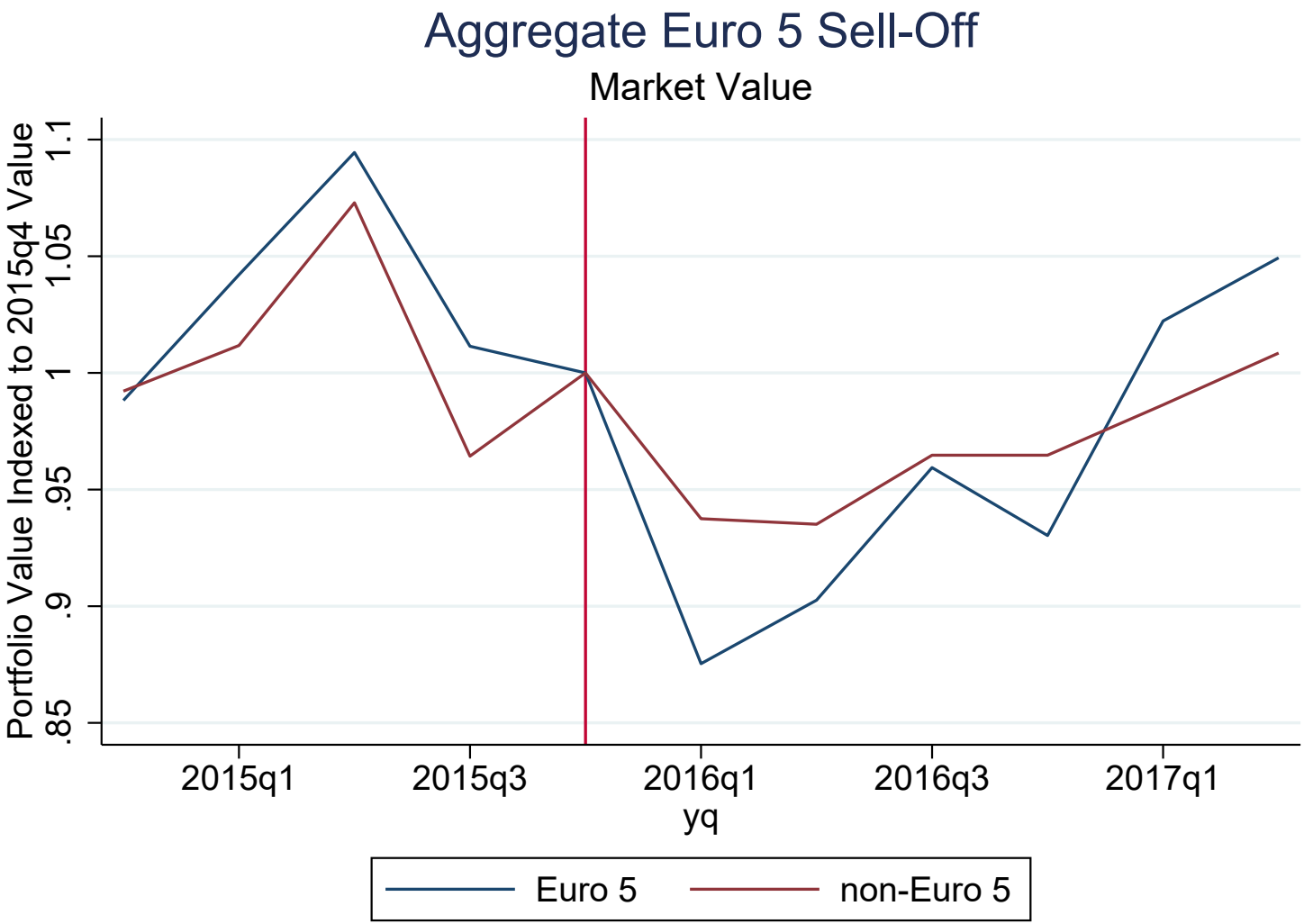
2016Q1: Aggregate Equity Sell-Off



- Deflate each series by value-weighted hedge fund return

Return

2016Q1: Aggregate Equity Sell-Off (Market Value)



Return

B/Ds with higher CDS spread Δ had ↓ lending growth

For American brokers that filed Y-9C,

$$\Delta ln(Loans^{b}_{2016q1}) = \alpha + \beta Distress^{b}_{2016q1} + \epsilon$$

where $Distress_{2016q1}$ is constructed from CDS Δ over E5 annc.

	$\Delta ln(Loans^{b}_{t})$		$\Delta Loans^{b}_{t} < 0$	
	(1)	(2)	(3)	(4)
CDS Chg.	-0.257*		0.901	
	-1.702		1.289	
Above Median CDS Chg.		-0.129**		0.429**
		-2.124		2.108
r2	0.106	0.285	0.107	0.257
N	13	13	13	13

- Consistent with substitution to non-distressed brokers! Return

Market vs Stale Price Portfolio Decomposition

Decompose difference b/w portfolios by:

$$\text{MktChange} - \text{StaleChange} = \underbrace{\Delta P \cdot Q_{2015q4}}_{\Lambda_1} + \underbrace{\Delta P \cdot \Delta Q}_{\Lambda_2}$$

	MktChange (1)	StaleChange (2)	Λ_1 (3)	Λ_2 (4)
Euro 5 Manager	-0.063**	-0.070**	0.000	0.008
	(0.028)	(0.028)	(0.011)	(0.006)
Intercept	-0.056***	-0.028*	-0.026***	-0.003
	(0.014)	(0.015)	(0.005)	(0.003)
R-squared	0.030	0.036	0.000	0.010
N	170	170	170	170

Standard errors in parentheses

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

- Difference is driven by sell-off term Λ_2!

Return

DB and ≥ 1 other E5 relationship predict greatest sell-off

	$\Delta \ln(\text{EqHoldings}^{m}_{2016q1})$		
	(1)	(2)	(3)
Non DB Euro 5 Relationship	-0.049*	-0.017	0.000
	(0.025)	(0.029)	(0.032)
only DB Relationship	-0.062*	-0.081*	-0.032
	(0.037)	(0.044)	(0.045)
DB+ at least one other Euro 5 Relationship	-0.073**	-0.063*	-0.116***
	(0.033)	(0.036)	(0.037)
Intercept	-0.008	-0.026	-0.028
	(0.012)	(0.017)	(0.019)
R-squared	0.020	0.024	0.064
N	445	225	163
Size	All	At Least 500m	At Least 1B
Port	Stale	Stale	Stale

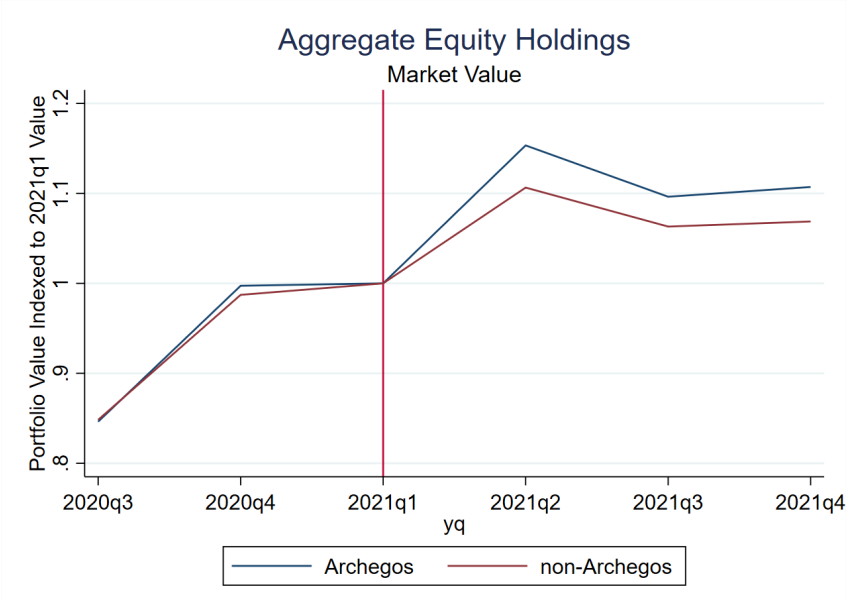
Robust standard errors.

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

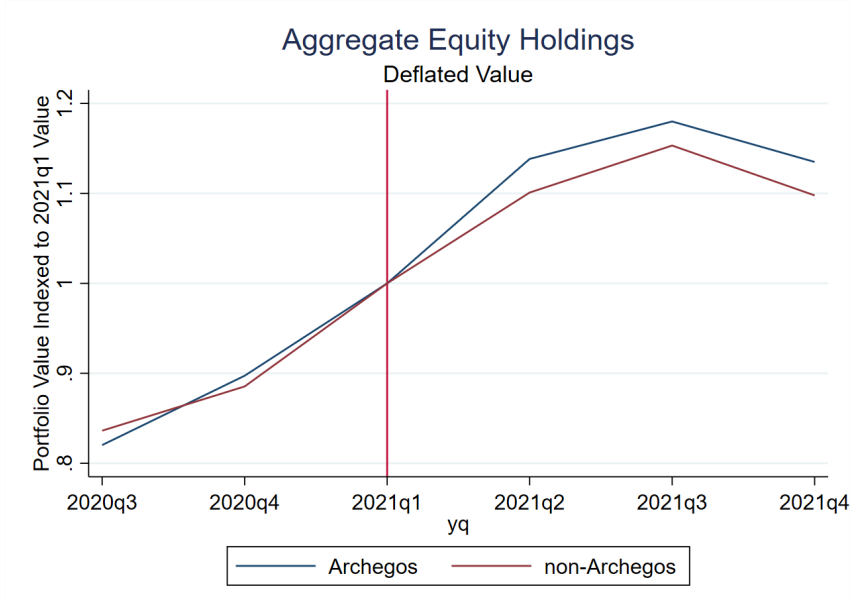
- Evidence towards credit contraction by E5 brokers ▸ Return

▸ Time Series Comparison

Aggregate Equity Holdings by Archegos Exposure



(a) Market Value

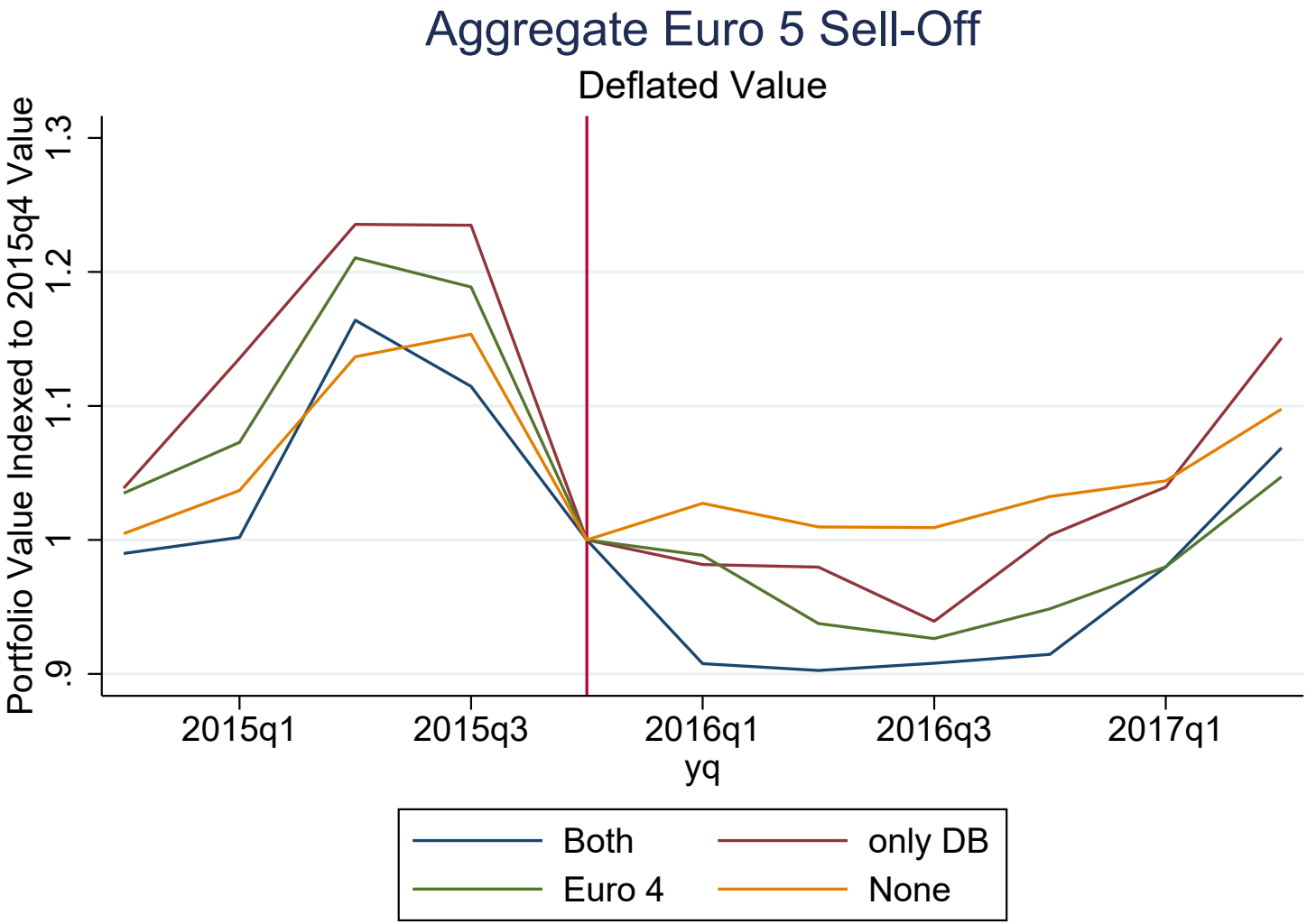


(b) Deflated Value

▸ Return

- Deflated value:= remove value-weighted return

2016Q1: Aggregate Equity Sell-Off



- Deflate each series by value-weighted hedge fund return

Return

Bloomberg Uncertainty Quote

"In a normal market this would be a great time to buy, but everyone is afraid to step in...Everyone is looking for the door at the same time."–Trader 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

Announcements

Table: **News Events Concerning European Broker Distress:** Here, we take the news events first discussed by Gleason et al. [2017] to understand how news about the health of two large European BHCs is released.

Institution	Date	Event Description
DB	28-Jan-16	DB annual media conference clarifying losses and implying possible non-payment of AT1 debt
CS	4-Feb-16	CS announces unexpectedly large losses, driven by impairment of legacy acquisition worth 4bn or 9% of net worth
DB	8-Feb-16	DB releases press lease outlining cash available for CoCo bond repayments in attempt to calm market
DB	23-Feb-16	DB releases press lease describing Euro-denominated bond repurchase

▸ Return

Limited cross-sectional variation during pandemic

	$\Delta ln(PBL_t^b)$			
	(1)	(2)	(3)	(4)
$AbnormalDistress_t^b$	-0.124*		0.0203	
	(0.0662)		(0.0562)	
$BigShock_t^b$		-0.181**		-0.0354
		(0.0759)		(0.0841)
R-squared	0.197	0.256	0.005	0.011
N	19	19	9	9
brokers	All ADV	All ADV	Top 50%	Top 50%

* $p < 0.10$, ** $p < 0.05$, ***, $p < 0.01$ *robust standard errors*

- Primary Dealer Credit Facility provided liquidity to distressed broker-dealer sector (03/17/20)

Return

B/Ds with lower CDS spread Δ had ↑ lending growth

For American brokers that filed Y-9C,

$$\Delta ln(Loans^{b}_{2016q1}) = \alpha + \beta Distress^{b}_{2016q1} + \epsilon$$

where $Distress_{2016q1}$ is constructed from CDS Δ over E5 annc.

	$\Delta ln(Loans^{b}_{t})$		$\Delta Loans^{b}_{t} > 0$	
	(1)	(2)	(3)	(4)
CDS Chg.	-0.257*		0.901	
	-1.702		1.289	
Below Median CDS Chg.		0.129**		0.429**
		2.124		2.108
r2	0.106	0.285	0.107	0.257
N	13	13	13	13

- Consistent with substitution to non-distressed brokers! ▸ Return
- Suggest time-varying substitution friction vis-a-vis Archegos

Back-of-the-Envelope Calculations

Earlier, we estimated the following regressions:

$$\underbrace{\Delta \text{E5Shr}^{s}_{2016q1}}_{\frac{\Delta Q}{Q}} = \alpha + \beta_1 \cdot \text{E5Shr}^{s}_{2015q4} + \epsilon^{s},$$

$$\underbrace{\text{ret}^{s}_{2016q1}}_{\approx \frac{\Delta P}{P}} = \alpha + \beta_2 \cdot \text{E5Shr}^{s}_{2015q4} + \epsilon^{s}.$$

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:

- $M = 3.35 = \frac{-0.315}{-0.094}$ for all sell-offs.
- $M = 7.14 = \frac{-0.315}{-0.044}$ for abnormal sell-offs.

Return