LEVERAGE INDUCED FIRE SALES AND STOCK PRICES

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LEVERAGE AND FIRE SALES

- EXCESSIVE LEVERAGE AND FIRE SALES ARE CONSIDERED TO BE THE UNDERLYING MECHANISMS OF MANY CRISES IN FINANCIAL MARKETS
  - 2007/08 financial and housing market crises
  - Chinese stock market crash in 2015
- YET, VERY LIMITED EMPIRICAL EVIDENCE ON FIRE-SALE, AND NOT IN THE CONTEXT OF LEVERAGE
  - Coval and Stafford (2007) and Edmans, Goldstein and Jiang (2012): fire-sale of mutual funds due to fund outflows
  - Ellul, Jotikasthira, and Lundblad (2011): fire-sale of downgraded corporate bonds due to regulatory constraint
  - Campbell, Giglio, and Pathak (2011): foreclosure housing price
- THIS PAPER: DIRECT EVIDENCE OF LEVERAGE-INDUCED FIRE SALES
  - Based on account level data in Chinese stock market in 2015
  - Bian et al (2017) using similar dataset but focuses on amplification in leverage network

CHINESE STOCK MARKET CRASH IN 2015

- CHINESE STOCK MARKET RISES QUICKLY IN THE FIRST HALF OF 2015 AND CRASHED THEREAFTER
  - Shanghai Composite Index: started around 3100 on Jan 2015, peaked 5166 on June 15th, 2015, then collapsed to 3663 at the end of July
- FORCED FIRE-SALE OF LEVERAGED ACCOUNTS IS ACCUSED AS THE LEADING CAUSE OF CHINA'S STOCK MARKET CRASH
  - May 22 2015, CSRC (China Securities Regulation Commission) announces to start investigating "illegal" shadow margin accounts
  - June 12 2015, release draft rules that cap **brokerage margin financing**; reiterate ban on **shadow margin financing**
  - Both are leveraged accounts; the latter is with higher leverage and much less regulation

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DATA DESCRIPTION

- DETAILED ACCOUNT LEVEL DAILY TRADING RECORDS DURING CRISIS (MAY-JULY 2015)
  - Brokerage margin financing (Brokerage later on) is from a leading brokerage in China, with a market share of ~10% in brokerage margin service
  - Shadow margin financing (Shadow later on) is from a leading web-based peer-to-peer lending platform
    - Hard to estimate its market share in shadow margin accounts; one reasonable estimate is about 11%
- EACH INDIVIDUAL ACCOUNT IN BOTH CATEGORIES:
  - Daily stock holdings and trading
  - Daily asset and debt data, hence leverage defined as asset/(asset-debt)
  - Account maximum allowable leverage (pingcang level, 平仓线)
- STOCK DAILY INFORMATION: PRICES, RETURNS, OUTSTANDING SHARES, ETC

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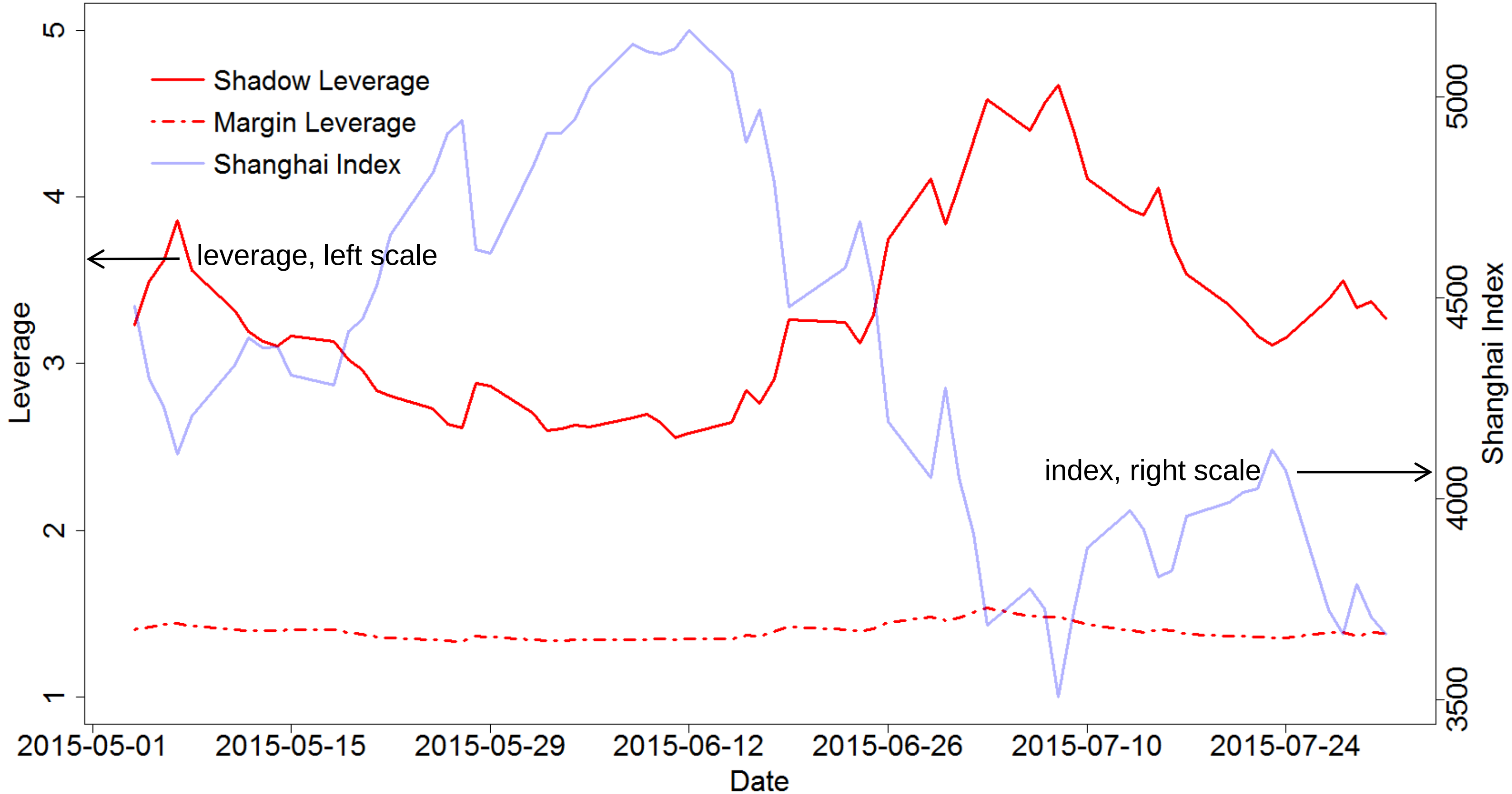
MEAN LEVERAGE FOR TWO ACCOUNTS AND MARKET INDEX

- Leverage: Asset/Equity. Unregulated shadow has higher leverage



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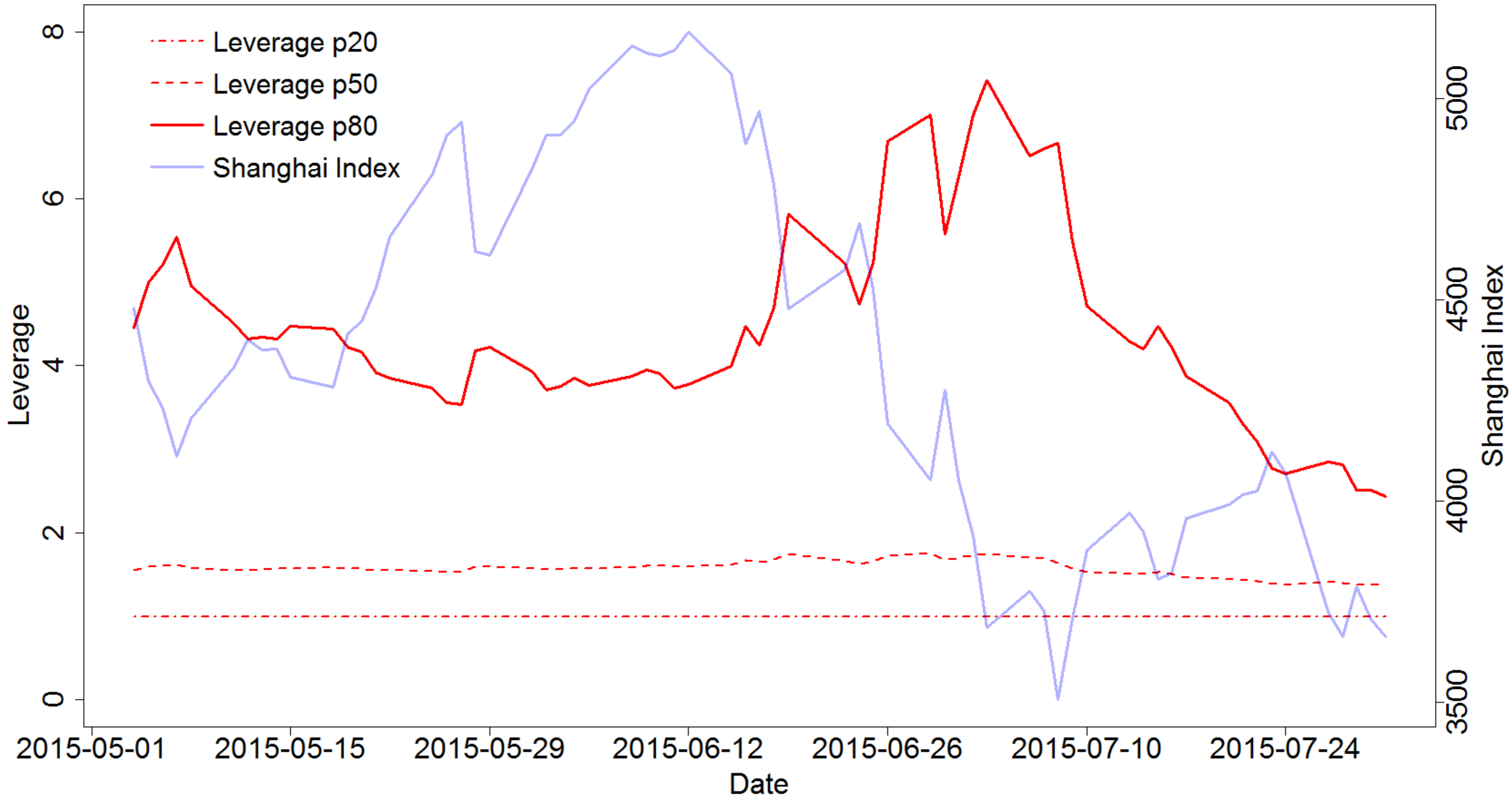
LEVERAGE DISPERSION AND FIRE-SALE PRESSURE



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LEVERAGE INDUCED FIRE-SALE: ACCOUNT LEVEL EVIDENCE (2)

- $\overline{lev}_j$: THE MAXIMUM ALLOWABLE LEVERAGE OF THIS ACCOUNT
  - So-called Pingcang level;
  - $lev_{j,t} > \overline{lev}_j$ possible,: cannot sell if hit -10% daily limit rule; lenders are unsophisticated investors as well
- DEFINE DISTANCE TO MAXIMUM ALLOWABLE LEVERAGE

$$d_{j,t} = \frac{lev_{j,t} - 1}{\overline{lev}_j - 1}$$

  - Sort accounts into equally-spaced bins by $d_{j,t}$
  - $I_{k,t}^{j} = 1 \text{ if } d_{j,t} \in \left[k/10, (k+1)/10\right)$

LEVERAGE INDUCED FIRE-SALE: ACCOUNT LEVEL EVIDENCE (1)

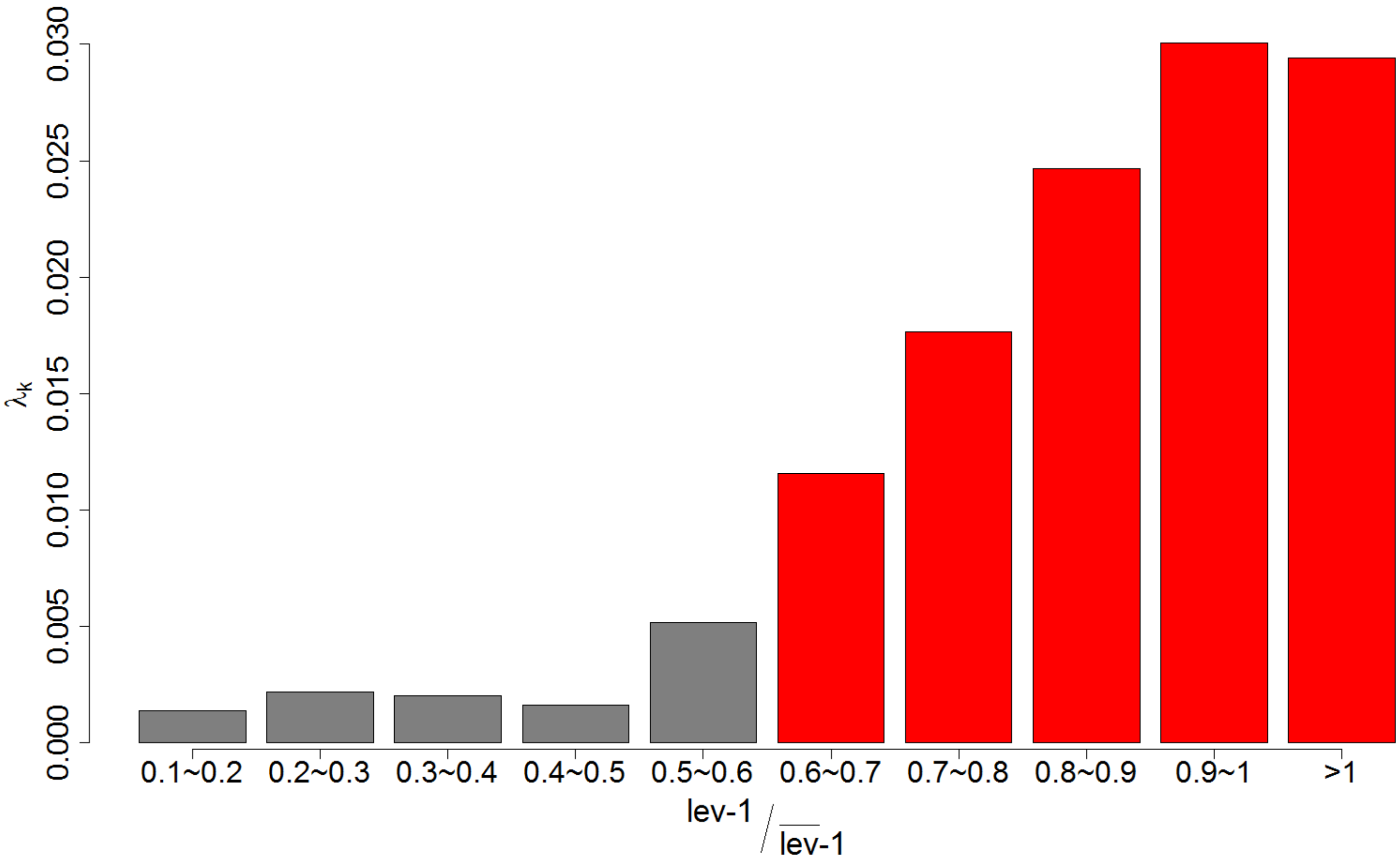
- ACCOUNT-STOCK-DATE LEVEL REGRESSION:

$$\delta_{i,t}^{j} = \sum_{k=1}^{10} \left(-\lambda_k\right) \cdot I_{k,t}^{j} + \alpha_{i,t} + \alpha_j + \varepsilon_{i,t}^{j}$$

  - $\delta_{i,t}^{j} = \dfrac{\text{Account } j\text{'s net buying of stock } i \text{ at date } t}{\text{Account } j\text{'s initial holding of stock } i \text{ at date } t}$
  - Stock-date fixed effect $\alpha_{i,t}$ and account fixed effect α_j
  - Identification comes from account j's time-varying $d_{j,t}$

- LEVERAGE INDUCED SELLING IMPLIES THAT λ_k INCREASES WITH k

LEVERAGE INDUCED FIRE-SALE: ACCOUNT LEVEL EVIDENCE (2)



- Benchmark: classify accounts with $k \geq 6$ as "fire-sale accounts," cut-off rule
- Robustness later: using these λ_k's as weights

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LEVERAGE INDUCED FIRE-SALE: STOCK LEVEL EVIDENCE (1)

- IF STOCK i IS HELD BY MORE FIRE-SALE ACCOUNTS, IT WILL BE SOLD MORE HEAVILY BY THESE ACCOUNTS
- RUN REGRESSION

$$\delta_{i,t} = \lambda \cdot FSP_{i,t} + \text{controls} + \varepsilon_{i,t}^{j}$$

- $$\delta_{i,t} = \frac{\text{Net buying of stock } i \text{ during date } t \text{ in fire-sale accounts}}{\text{Outstanding shares of stock } i \text{ at date } t}$$
- Fire-sale accounts: accounts with $d_{j,t} \geq 0.6$ at the beginning of t
- $FSP_{i,t}$ is stock i's fire-sale pressure, defined as

$$FSP_{i,t} = \frac{\text{Total shares of stock } i \text{ in fire-sale accounts at the beginning of date } t}{\text{Outstanding shares of stock } i \text{ at date } t}$$

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LEVERAGE INDUCED FIRE-SALE: STOCK LEVEL EVIDENCE (2)

	(1)	(2)	(3)	(4)
VARIABLES	**Net buy of fire-sale accounts**			
Fire Sale Pressure (FSP)	**-0.0908*****	**-0.0936*****	**-0.0935*****	**-0.102*****
	(0.0202)	**(0.0229)**	**(0.0230)**	**(0.0255)**
Return Volatility			X	X
Size (Market Cap)			X	X
Turnover			X	X
Past 10-day cum. return			X	X
Past 10-day daily return				X
Stock FE		X	X	X
Date FE		X	X	X
Observations	142,849	142,843	142,465	125,057
R-squared	0.124	0.165	0.166	0.186

STOCK RETURNS FOLLOWING FIRE-SALE

- KEY QUESTION: DO LEVERAGE-INDUCED FIRE SALES CAUSE SUBSEQUENT LOW STOCK RETURN?
- EMPIRICAL PREDICTIONS:
  - Stocks with high FSP underperform in the short-run but not in the long-run
- TWO METHODS
  - Double sort on past return and FSP; long-short strategy based on FSP
  - Regression of stock return on FSP with various controls

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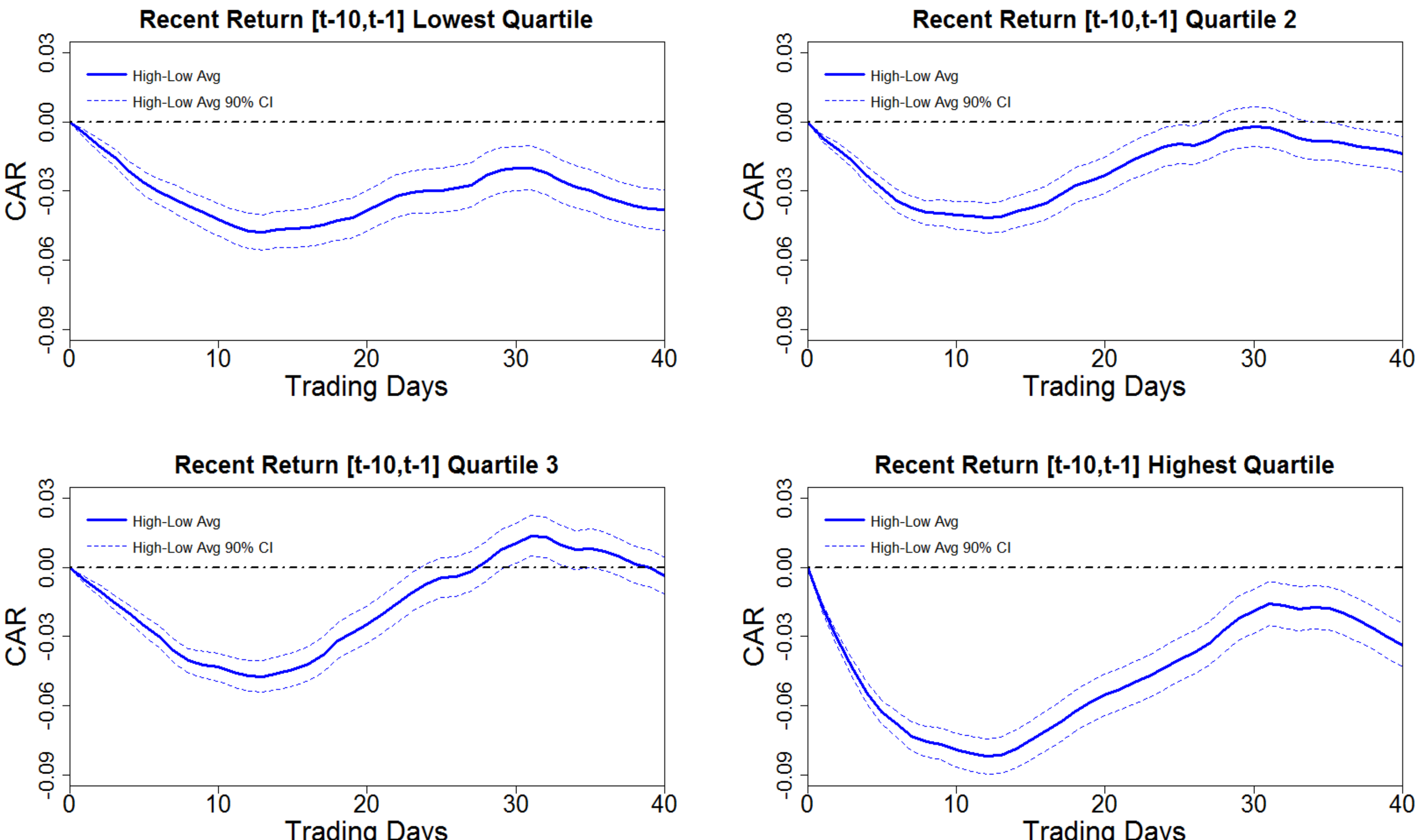
STOCK RETURNS FOLLOWING FIRE-SALE: NONPARAMETRIC

- DOUBLE SORT: EACH DAY, WE
  - First, sort stocks into quartiles by $R_{i,t} = (D_{i,t} + P_{i,t})/P_{i,t-1}$;
  - Second, sort each quintile into deciles by $FSP_{i,t+1}$ (recall this is measured at the beginning of date $t+1$)
- CUMULATIVE ABNORMAL RETURN OF LONG-TOP-SHORT-BOTTOM FSP DECILES
- LEVERAGE INDUCED FIRE-SALE STORY
  - Negative abnormal return of this long-short strategy, but disappears in long-run

STOCK RETURNS FOLLOWING FIRE-SALE: LONG-SHORT PORTFOLIO



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STOCK RETURNS FOLLOWING FIRE-SALE

- **REGRESSION**

$$CAR_{i,t+h} = \gamma_h \cdot FSP_{i,t} + \text{controls} + \varepsilon_{i,t+h}$$

  - Abnormal return is based on CAPM with stock beta calculated using 2014 data
  - $h = 1, 3, 5, 10, 20$, and 40
- **MODEL PREDICTION**
  - $\gamma_h < 0$ for small k but $\gamma_h \approx 0$ for large h

STOCK RETURNS FOLLOWING FIRE-SALE

CAR identified by FSP

	1 Day	3 Days	5 Days	10 Days	20 Days	40 Days
FSP	-1.356***	-3.346***	-4.898***	-5.829***	-2.629***	0.200
SE	(0.265)	(0.547)	(0.865)	(1.218)	(0.947)	(0.555)

- Robust standard errors in parentheses, clustered at date level
- Controls include return volatility; market cap; past 10-day daily returns; past 10-day cumulative return; turnover; stock fixed effect; date fixed effect

ROBUSTNESS: CONSTRUCTING *FSP* BASED ON WEIGHTS

- CONSTRUCTING STOCK LEVEL FIRE-SALE PRESSURE $FSP_{i,t}$ BASED ON λ_k

$$FSP_{i,t} = \frac{\sum_j x_{i,t}^j \cdot I_{k,t}^j \lambda_k}{\text{Outstanding shares of stock } i \text{ at date } t}$$

  - $x_{i,t}^j$: number of shares of stock i in account j
  - Numerator: weighted sum of shares of stock i in account j; if account j belongs to group k then the weight is λ_k
  - Again, leverage is measured at the beginning of date t
- ROBUST RESULTS AND CONCLUSIONS

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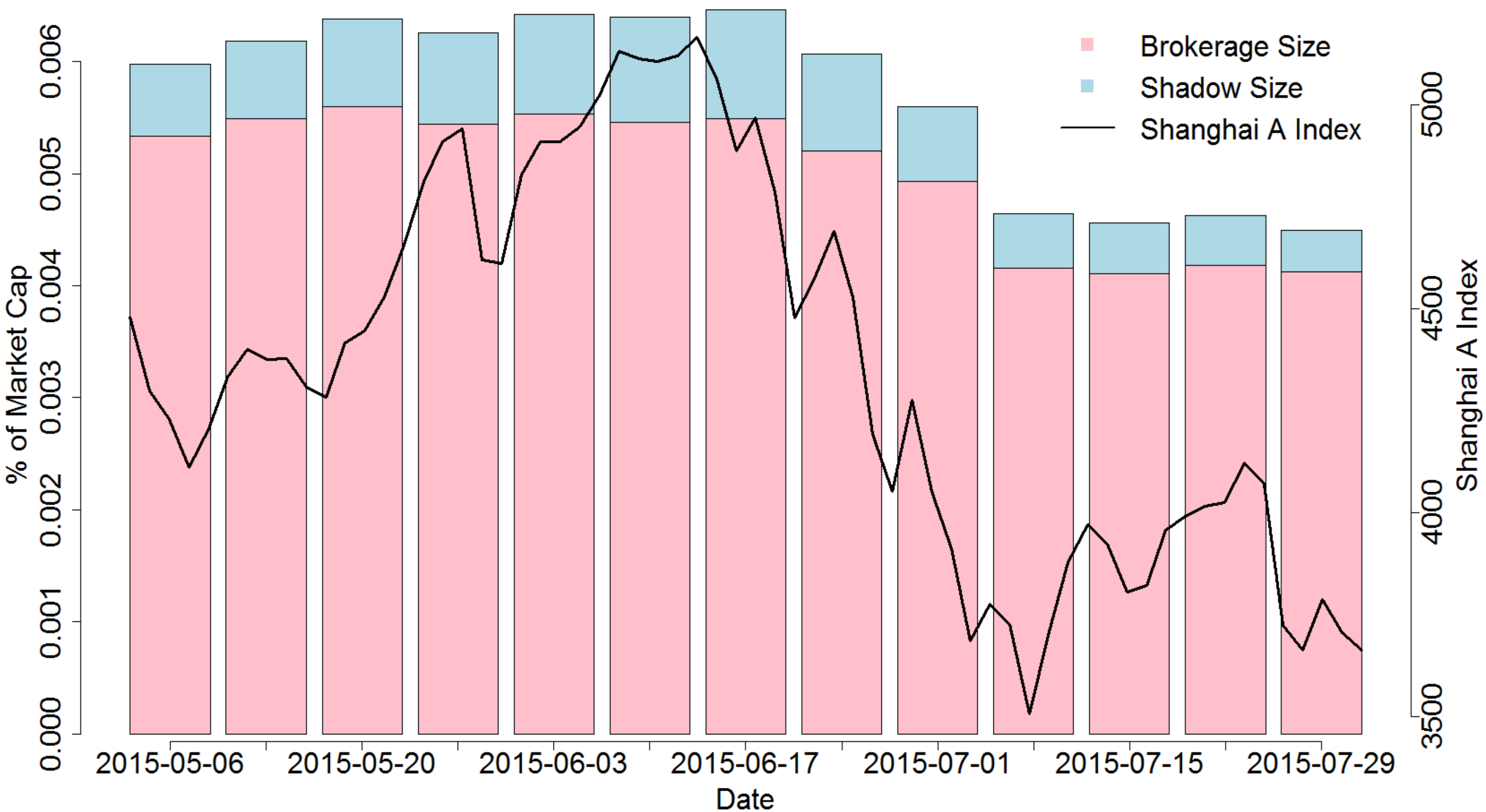
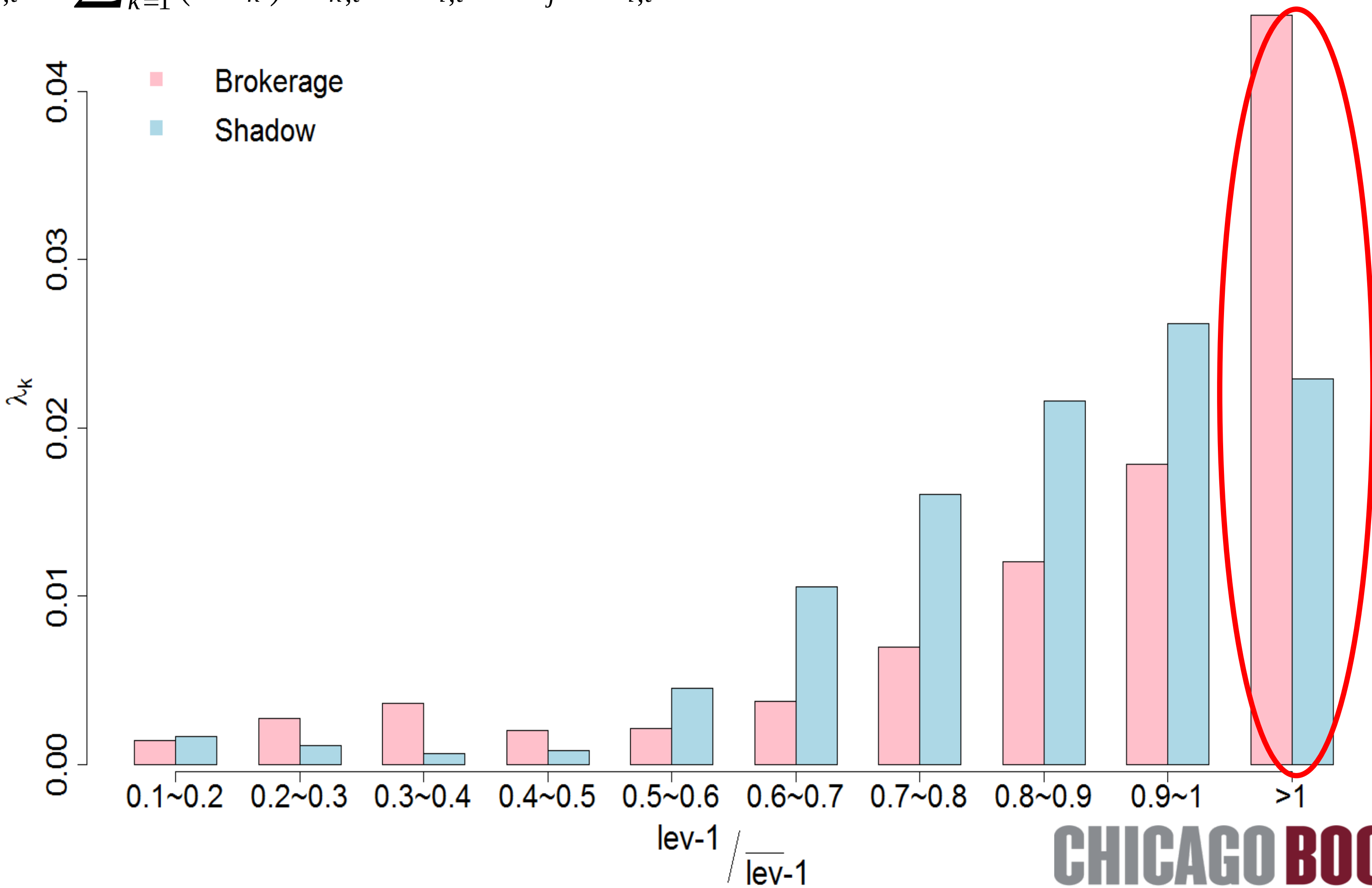
BROKERAGE & SHADOW ACCOUNTS



LEVERAGE-INDUCED SELLING ON BROKERAGE AND SHADOW

$\delta_{i,t}^{j} = \sum_{k=1}^{10} (-\lambda_k) \cdot I_{k,t}^{j} + \alpha_{i,t} + \alpha_j + \varepsilon_{i,t}^{j}$, now separately for Brokerage and Shadow



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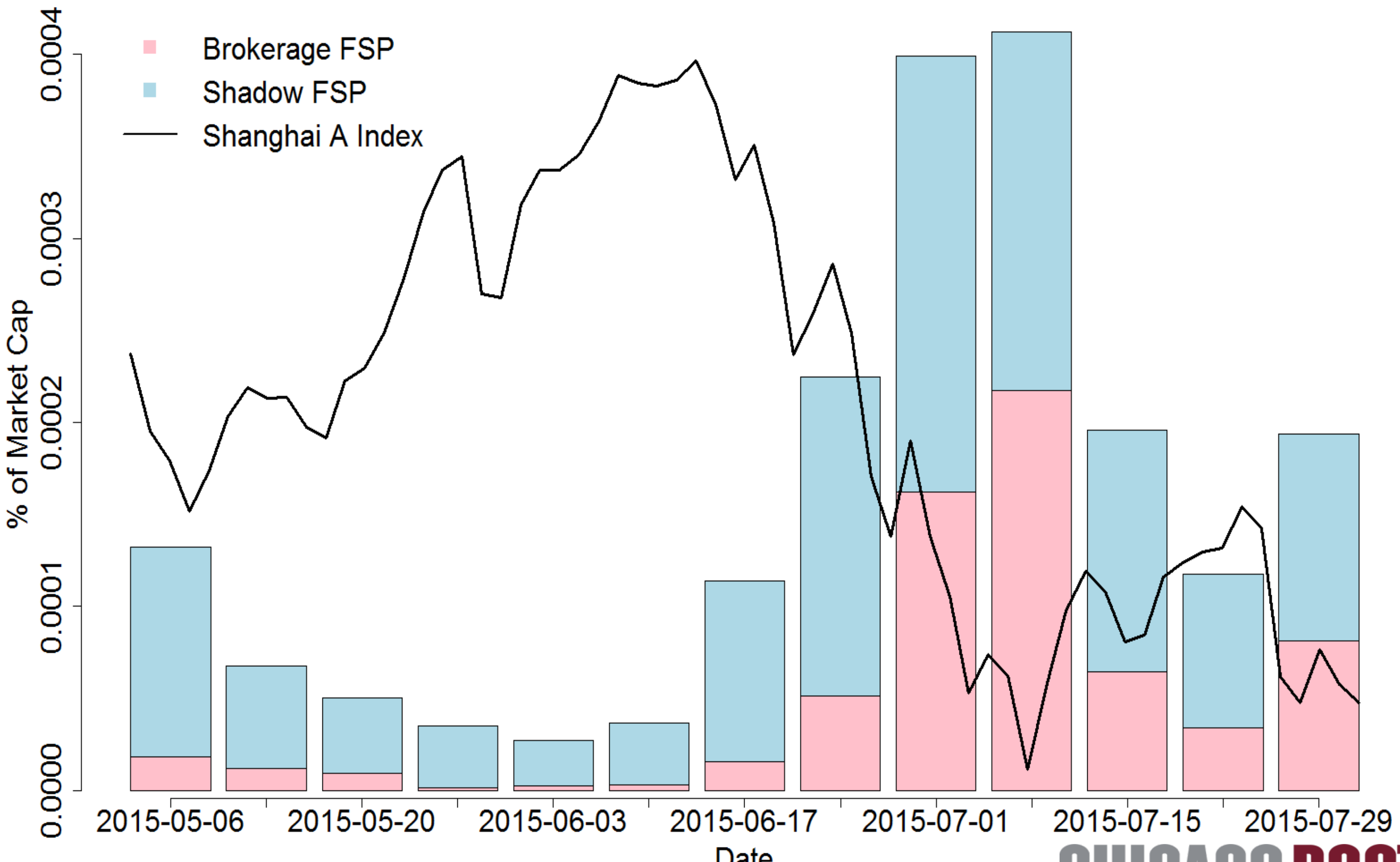
FSP: BROKERAGE VS SHADOW

- Benchmark cut-off $d = 0.6$



MARGIN OR SHADOW?

	1 Day	3 Days	5 Days	10 Days	20 Days	40 Days
FSP of shadow	-2.074***	-5.214***	-8.230***	-11.24***	-3.072	0.507
SE	(0.459)	(1.092)	(1.650)	(2.217)	(1.913)	(0.839)
FSP of brokerage	-0.574***	-1.452***	-1.663**	-0.856	-2.238***	-0.0573
SE	(0.205)	(0.450)	(0.696)	(0.791)	(0.467)	(0.649)

- Robust standard errors in parentheses, clustered at date level

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CONCLUDING REMARKS

- DIRECT EVIDENCE ON LEVERAGE-INDUCED FIRE SALES
  - The closer to the maximum allowable leverage, the more you sell (including both forced sale and preemptive sale)
  - The resulting selling downward price pressures cause negative abnormal return in the short-run
- REGULATED BROKERAGE VS UNREGULATED SHADOW MARGIN ACCOUNTS
  - Brokerage margin accounts are dominant in holdings, but relatively low fire-sale pressure
  - Shadow margin accounts are the major force of leverage-induced fire-sale in 2015 stock market crash
- BIAN ET AL (2017) STUDY THE AMPLIFICATION EFFECT THROUGH THE LENS OF A NETWORK FRAMEWORK
  - Full-blown amplification and propagation requires a structural model, work to be done in the future

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