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
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
MEAN LEVERAGE FOR TWO ACCOUNTS AND MARKET INDEX

- Leverage: Asset/Equity. Unregulated shadow has higher leverage.
LEVERAGE DISPERSION AND FIRE-SALE PRESSURE
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 \( d_{j,t} \)
- \( I_{k,t}^j = 1 \) if \( d_{j,t} \in \left[ k/10, (k + 1)/10 \right) \)
LEVERAGE INDUCED FIRE-SALE: ACCOUNT LEVEL EVIDENCE (1)

ACCOUNT-STOCK-DATE-LEVEL LEVEL

REGRESSION:

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

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

LEVERAGE INDUCED SELLING IMPLIES

THAT \( \lambda_k \) 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 $\lambda_k$'s as weights
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

\[ \delta_{i,t} = \lambda \cdot FSP_{i,t} + \text{controls} + \varepsilon_{i,t} \]

- \( \delta_{i,t} = \) Net buying of stock $i$ during date $t$ in fire-sale accounts
- \( \delta_{i,t} = \) Outstanding shares of stock $i$ 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

\[ FSP_{i,t} = \frac{\text{Total shares of stock } i \text{ in fire-sale accounts at the beginning of date } t}{\text{Outstanding shares of stock } i \text{ at date } t} \]
# Leverage Induced Fire-Sale: Stock Level Evidence (2)

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

Recent Return $[t-10,t-1]$ Lowest Quartile

Recent Return $[t-10,t-1]$ Quartile 2

Recent Return $[t-10,t-1]$ Quartile 3

Recent Return $[t-10,t-1]$ Highest Quartile
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

<table>
<thead>
<tr>
<th></th>
<th>1 Day</th>
<th>3 Days</th>
<th>5 Days</th>
<th>10 Days</th>
<th>20 Days</th>
<th>40 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FSP</strong></td>
<td>-1.356***</td>
<td>-3.346***</td>
<td>-4.898***</td>
<td>-5.829***</td>
<td>-2.629***</td>
<td>0.200</td>
</tr>
<tr>
<td><strong>SE</strong></td>
<td>(0.265)</td>
<td>(0.547)</td>
<td>(0.865)</td>
<td>(1.218)</td>
<td>(0.947)</td>
<td>(0.555)</td>
</tr>
</tbody>
</table>

- 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 \( \lambda_k \)

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

- \( x_{i,t}^j \): 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 \( \lambda_k \)
- Again, leverage is measured at the beginning of date \( t \)

- ROBUST RESULTS AND CONCLUSIONS
BROKERAGE & SHADOW ACCOUNTS

Date

% of Market Cap
0.00 0.002 0.004 0.006

Shanghai A Index
3500 4000 4500 5000

Brokerage Size
Shadow Size
Shanghai A Index
LEVERAGE-INDUCED SELLING ON BROKERAGE AND SHADOW

\[ \delta^{j}_{i,t} = \sum_{k=1}^{10} (-\lambda_k) \cdot I^{j}_{k,t} + \alpha_{i,t} + \alpha_j + \varepsilon^{j}_{i,t}, \]  

now separately for Brokerage and Shadow
FSP: BROKERAGE VS SHADOW

- Benchmark cut-off $d = 0.6$
## MARGIN OR SHADOW?

<table>
<thead>
<tr>
<th></th>
<th>1 Day</th>
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<th>10 Days</th>
<th>20 Days</th>
<th>40 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSP of shadow</td>
<td>-2.074***</td>
<td>-5.214***</td>
<td>-8.230***</td>
<td>-11.24***</td>
<td>-3.072</td>
<td>0.507</td>
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<tr>
<td>SE</td>
<td>(0.459)</td>
<td>(1.092)</td>
<td>(1.650)</td>
<td>(2.217)</td>
<td>(1.913)</td>
<td>(0.839)</td>
</tr>
<tr>
<td>FSP of brokerage</td>
<td>-0.574***</td>
<td>-1.452***</td>
<td>-1.663**</td>
<td>-0.856</td>
<td>-2.238***</td>
<td>-0.0573</td>
</tr>
<tr>
<td>SE</td>
<td>(0.205)</td>
<td>(0.450)</td>
<td>(0.696)</td>
<td>(0.791)</td>
<td>(0.467)</td>
<td>(0.649)</td>
</tr>
</tbody>
</table>

- Robust standard errors in parentheses, clustered at date level
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