Self-Fulfilling Runs:
Evidence from the U.S. Life Insurance Industry

Nathan Foley-Fisher    Borghan Narajabad    Stéphane Verani
Federal Reserve Board

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The views expressed in this paper do not necessarily reflect the views of the Board of Governors of the Federal Reserve System, or its staff
Question

- Is shadow banking vulnerable to self-fulfilling runs?
  - Empirical challenge is to tease out the self-fulfilling component
  - May affect *different links* in the financial intermediation chain
  - Could *originate* or *amplify* shocks
Financial Intermediation and Runs

- Traditional banking:
  
  ![Traditional banking diagram]

- Shadow banking (example):
  
  ![Shadow banking diagram]
This paper

- Studies a run by *institutional investors* on U.S. life insurers
- Exploits the contractual structure of their short-term securities
- Finds evidence of a self-fulfilling component to the run
- Coincident to runs on ABCP and repo by the same investors
How are insurers part of shadow banking?

- Funding agreements are insurance obligations
- The U.S. FABS market peaked at over $160 billion in 2007
- FABS can be issued under various terms, and with put options
Extendible FABS are put-able FABS designed for MMFs.

From 2007Q3, institutional investors refused to extend XFABS.
Contractual terms

Prospectus for an $800 million note issued by MetLife

Maturity Date:

— Initial Maturity Date: July 6, 2012, or, if such day is not a Business Day, the immediately preceding Business Day, except for those Extendible Notes the maturity of which is extended on the initial Election Date in accordance with the procedures described under “Extendible Notes” below.

— Extended Maturity Dates: If a holder of any Extendible Notes does not make an election to extend the maturity of all or any portion of the principal amount of such holder’s Extendible Notes during the notice period for any Election Date, the principal amount of the Extendible Notes for which such holder has failed to make such an election will become due and payable on any later date to which the maturity of such holder’s Extendible Notes has been extended as of the immediately preceding Election Date, or if such later date is not a Business Day, the immediately preceding Business Day.

— Final Maturity Date: July 6, 2017, or, if such day is not a Business Day, the immediately preceding Business Day.

Election Dates: The 6th calendar day of each month, from July 6, 2011, through, and including, June 6, 2016, whether or not any such day is a Business Day.
Investor decisions

\[ S_{it+1} \in [0, RE_{it+1}] \]

\[ D_{lit} \quad D_{lit+1} \quad \ldots \quad t_i + m_i \quad t_i + m_i + 1 \]

\[ \begin{align*}
Q_{it} &= \{ Q_{it}, Q_{it}^{FABS} \} \\
S_{it+1} &
\end{align*} \]

\[ Q_{it+1} \]

\begin{align*}
D_{lit} & \quad \text{Withdrawal decision} \\
S_{it+1} & \quad \text{Fraction of XFABS converted} \in [t_i, t_i + 1] \\
Q_{it} & \quad \text{XFABS maturing} \in [t_i, t_i + m] \\
RE_{it+1} & \quad \text{Maximum fraction of XFABS up for election} \in [t_i, t_i + 1] \\
Q_{it}^{FABS} & \quad \text{Predetermined maturing FABS}
\end{align*}
When could there be a self-fulfilling run?

- If investors’ withdrawals affect the expected future liquidity of the insurer
  
  - if an investor expects other investors to withdraw $\mathbb{E}_t S_{it+1}$ in the future, she may worry about the insurer’s future liquidity
  
  - Concerns about insurer’s future liquidity leads to withdrawal $D_{it}$ today, adding to the queue of claims on the insurer
  
  - Withdrawals affect the expected insurer liquidity, inducing other investors to withdraw $S_{it+1}$, confirming the original expectation
Identification problem

- Alternatively: worsening fundamentals could imply that $D_{it}$ and $S_{it+1}$ are positively correlated during the run.

- The identification problem arises because:
  - We are interested in estimating the effect of $E_t S_{it+1}$ on $D_{it}$.
  - Withdrawal decisions $D_{it}$ and $S_{it+1}$, and $Q_t$ are observable.
  - Expectations $E_t S_{it+1}$, and fundamentals are not (directly).
Econometric specification

- Unit of observation: election $t$ of XFABS $i$ from insurer $j$
- Regression specification:

$$D_{ijt} = \gamma_0 + \gamma_1 S_{ijt+1} + \gamma_2 Q_{ijt} + x_{ijt}' \beta + \epsilon_{ijt}$$

- $D_{ijt}$: fraction of XFABS $i$ from insurer $j$ withdrawn on $t$
- $S_{ijt+1}$: fraction of XFABS withdrawn between $t$ and $t + 1$
- $Q_{ijt}$: fraction of XFABS withdrawn prior to $t$
- $x_{ijt}$: insurer, aggregate and time controls
Constructing an IV from XFABS contracts (1/3)

**Assumption:** $\mathbb{E}_t S_{ijt+1} \nRightarrow S_{ijt+1}$

$S_{ijt+1} \in [0, R_{Eijt+1}]$

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$D_{ijt}$ Withdrawal decision

$S_{ijt+1}$ Fraction of XFABS converted $\in [t_{ij}, t_{ij} + 1]$

$Q_{ijt}$ XFABS maturing $\in [t_{ij}, t_{ij} + m]$

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$t_{ij} + m_{ij}$ $D_{ijt}$ spinoff maturity date

$R_{Eijt+1}$ Maximum fraction of XFABS up for election $\in [t_{ij}, t_{ij} + 1]$

$Q_{ijt}^{FABS}$ Predetermined maturing FABS
Constructing an IV from XFABS contracts (2/3)

- $D_{ijt}$: Fraction of XFABS $i$ withdrawn at election date $t$
- $S_{ijt+1}$: Fraction of XFABS withdrawn between $t$ and $t+1$
- $RE_{ex3mijt+1}$: Fraction of XFABS that are up for election between $t$ and $t+1$, excluding developments in the 3 months leading up to $t$
Constructing an IV from XFABS contracts (3/3)

Heterogeneity across and within FABS programs allows using fine insurer and time controls.
Data

- Universe of U.S. FABS at a daily frequency
- Extendible FABS:
  - 13 life insurers; 65 XFABS; 117 Spinoffs
  - CUSIP, issue date, initial and final maturity, election dates
  - Amount withdrawn (spinoffs) at every election dates
  - Every spinoff matched to its parent XFABS
- Statutory filings, Ratings, CDS, VIX, ABCP, etc.
- Sample: January 1, 2005 to December 31, 2010

→ 1,316 insurer-security-election date observations
### Instrumental variable results

<table>
<thead>
<tr>
<th>Dependent variable: $D_{ijt}$</th>
<th>Baseline 1st stage</th>
<th>Baseline 2nd stage</th>
<th>Weekly FE 1st stage</th>
<th>Weekly FE 2nd stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{ijt+1}$</td>
<td></td>
<td>2.142*** (0.472)</td>
<td></td>
<td>2.207** (0.686)</td>
</tr>
<tr>
<td>$RE_{ex3m_{ijt+1}}$</td>
<td>0.0946*** (0.0136)</td>
<td></td>
<td>0.0739*** (0.0190)</td>
<td></td>
</tr>
<tr>
<td>$Q_{ijt}$</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Insurer FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Weekly FE</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Observations</td>
<td>921</td>
<td>921</td>
<td>921</td>
<td>921</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses. *** $p < 1\%$, ** $p < 5\%$
How much of the run was self-fulfilling?

Between 62% and 84% of the $18 billion withdrawal during 2007Q3-2008Q4 can be attributed to the self-fulfilling component.
### Robustness (1/3)

<table>
<thead>
<tr>
<th>Dependent variable: $D_{ijt}$</th>
<th>Fragile by design?</th>
<th>Lagged IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1^{st}$ stage</td>
<td>$2^{nd}$ stage</td>
</tr>
<tr>
<td>$S_{ijt+1}$</td>
<td>0.279</td>
<td>0.685</td>
</tr>
<tr>
<td></td>
<td>(2.873)</td>
<td>(0.923)</td>
</tr>
<tr>
<td>$RE@l_{ijt+1}$</td>
<td>0.0102</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0138)</td>
<td></td>
</tr>
<tr>
<td>$RE_{ijt}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Q_{ijt}$</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Insurer FE</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Observations</td>
<td>921</td>
<td>921</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses. *** $p < 1\%$, ** $p < 5\%$
### Robustness (2/3)

<table>
<thead>
<tr>
<th>Dependent variable: $D_{ijt}$</th>
<th>Idiosyncratic shocks</th>
<th>Placebo using $Q_{jt+1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1^{st}$ stage</td>
<td>$2^{nd}$ stage</td>
</tr>
<tr>
<td></td>
<td>$1^{st}$ stage</td>
<td>$2^{nd}$ stage</td>
</tr>
<tr>
<td>$S_{ijt+1}$</td>
<td>$0.0691^{***}$</td>
<td>$0.0946^{***}$</td>
</tr>
<tr>
<td></td>
<td>$(0.0242)$</td>
<td>$(0.0136)$</td>
</tr>
<tr>
<td>$REex3m_{ijt+1}$</td>
<td>$3.513^{***}$</td>
<td>$-0.158$</td>
</tr>
<tr>
<td></td>
<td>$(0.612)$</td>
<td>$(1.310)$</td>
</tr>
<tr>
<td>$Q_{ijt}$</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Insurer FE</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Insurer x Month FE</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Observations</td>
<td>921</td>
<td>921</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses. $$$p < 1\%$$, $$**p < 5\%$$
Robustness (3/3)

- Chari and Jagannathan (1988 JF): *uninformed* investors could be acting on the actions of *informed* investors.

- Regardless of heterogeneity in investors’ information about fundamentals, a run on XFABS could be self-fulfilling iff there is a withdrawal externality:
  - Informed investors’ expectations are not self-fulfilling unless there is a withdrawal externality.
  - Uninformed investors can act on *past* changes in the queue.
  - But do not form self-fulfilling expectations if there is no withdrawal externality.
Conclusion

• Evidence of a sizeable self-fulfilling component to the run

• The same institutional investors were active in ABCP and repo

• Identifying this effect in ABCP and repo is not possible

• Methods of dealing with bank depositor runs are either infeasible or ineffective to cope with institutional investor runs
### Reduced form results

<table>
<thead>
<tr>
<th>Dependent variable: $D_{ijt}$</th>
<th>No controls</th>
<th>Fixed effects</th>
<th>Kitchen sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{ijt+1}$</td>
<td>0.884***</td>
<td>0.339***</td>
<td>0.476**</td>
</tr>
<tr>
<td></td>
<td>(0.129)</td>
<td>(0.158)</td>
<td>(0.241)</td>
</tr>
<tr>
<td>$Q_{ijt}$</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>$Q_{FABS}$</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Insurer FE</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Quarterly FE</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>VIX, ABCP, CDS, EDF, Stk Pr.</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Observations</td>
<td>921</td>
<td>921</td>
<td>383</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.172</td>
<td>0.300</td>
<td>0.365</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses. *** $p < 1\%$, ** $p < 5\%$
FABS as a share of Assets
Appendix

FHLB Advances to FABS Issuers

[Graph showing FHLB advances to FABS issuers, with vertical bars indicating amounts in US$ billion over time. Each bar is color-coded to represent different issuers.]
## Data summary statistics

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Median</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of XFABS</td>
<td>57</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Number of spinoffs</td>
<td>110</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>XFABS election dates</td>
<td>1316</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Days b/t election dates</td>
<td>1260</td>
<td>31.0</td>
<td>45.4</td>
<td>36.1</td>
<td>28</td>
<td>366</td>
</tr>
<tr>
<td>XFABS issue amt (USDm)</td>
<td>56</td>
<td>400.0</td>
<td>497.8</td>
<td>349.9</td>
<td>100</td>
<td>2000</td>
</tr>
<tr>
<td>Spinoff issue amt (USDm)</td>
<td>110</td>
<td>134.5</td>
<td>193.7</td>
<td>198.2</td>
<td>.2</td>
<td>1338.5</td>
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<tr>
<td>Spinoff maturity (days)</td>
<td>56</td>
<td>367.0</td>
<td>497.4</td>
<td>211.3</td>
<td>302</td>
<td>1006</td>
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<tr>
<td>Dependent var ($D_{ijt}$)</td>
<td>942</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Endogenous var ($S_{ijt+1}$)</td>
<td>1098</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Instrument ($REex3m_{ijt+1}$)</td>
<td>1098</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Maturing FABS ($Q_{ijt}^{FABS}$)</td>
<td>1260</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
## Correlations

<table>
<thead>
<tr>
<th></th>
<th>$S_{jt+1}$</th>
<th>$RE_{ex3m_{jt+1}}$</th>
<th>$RE_{jt+1}$</th>
<th>$RE_{jt}$</th>
<th>$RE_{@l_{jt+1}}$</th>
<th>$\Delta_{3m}VIX_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{jt+1}$</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>$RE_{ex3m_{jt+1}}$</td>
<td>0.36</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{jt+1}$</td>
<td>0.33</td>
<td>0.95</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$RE_{jt}$</td>
<td>0.24</td>
<td>0.82</td>
<td>0.85</td>
<td>1</td>
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<tr>
<td>$RE_{@l_{jt+1}}$</td>
<td>0.01</td>
<td>0.35</td>
<td>0.34</td>
<td>0.36</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$\Delta_{3m}VIX_t$</td>
<td>0.07</td>
<td>0.02</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.00</td>
<td>1</td>
</tr>
</tbody>
</table>
$RE_{jt+1}$ is not necessarily a sunspot

- $g^{A/B}(S_{jt+1})$ is the distribution of beliefs, $\mathbb{E}^A_t S_{jt+1} = 0$
- Shocks (real or sunspot) switch the distribution from $A$ to $B$
- Identification requires $\mathbb{E}_t S_{jt+1} \not\perp RE_{jt+1}$ during the run
Appendix

Estimated distribution of $RE_{t+1}$

Kernel density estimate

$RE_{ex3m_{jt+1}}$: Max value of $S_{jt+1}$

kernel = epanechnikov, bandwidth = 0.0789

2006 2007 2008
Appendix

Scatter plots of $S_{jt+1}$ with $RE_{jt+1}$

$S_{jt+1}$: Fraction of XFABS liquidated

$RE_{ex3m_{jt+1}}$: Max value of $S_{jt+1}$

- Allstate
- Genworth
- Hartford
- ING USA
- Jackson
- MassMutual
- Metropolitan Life
- Monumental
- Nationwide
- New York Life
- Pacific Life
- Principal Financial
- Prudential
- Security Life of Denver

After 2006

2006 and before