Financial Panics &
Liquidity Interventions

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The views expressed are our own and do not necessarily reflect the views of the Bank of England or its staff.
Motivation

- Rise of non-bank financial intermediation (NBFI)
  
  [(i) funding cost advantages, (ii) search-for-yield, (iii) macroprudential regulation on banks]

Figure 1: Growth of alternative debt sources for non-financial business in the U.S.

Ordoñez (2018)

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Motivation

• Rise of non-bank financial intermediation (NBFI) [(i) funding cost advantages, (ii) search-for-yield, (iii) macroprudential regulation on banks]

• Rise of NBFI typically associated with
  ▶ deepening of capital markets & expansion of credit [(i) specialization, (ii) technological innovation, (iii) lower financing cost, (iv) alternative funding sources]
  ▶ run susceptibility & recurrent crisis interventions [Sept-2008, Mar-2020, Sept-2022; (i) maturity/liquidity mismatch, (ii) reliance on short-term wholesale funding, (iii) high leverage]

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European Central Bank

ECB raises alarm over growing risks to financial system

Vice-president Luis de Guindos urges investment funds to hold more liquid assets to cope with turmoil

Martin Arnold in Frankfurt YESTERDAY

The ECB called on global regulators — co-ordinated by the Financial Stability Board — to accelerate work to address the non-bank financial sector’s vulnerability to liquidity squeezes, similar to one that hit money market funds after the coronavirus pandemic struck in March 2020.

De Guindos said the ECB's priority was for investment funds exposed to the risk of rapid and large-scale withdrawals in times of market stress to be forced to hold a certain proportion of liquid assets.
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Trade-off: efficiency gains vs financial stability concerns
This paper

[1] Build a tractable structural model of financial panics with efficient but run-prone non-bank financial intermediaries

[2] Simulate the model with recurrent belief-driven booms and busts building on Gertler, Kiyotaki & Prestipino (2020a,b)
This paper

[1] Build a **tractable structural model** of financial panics with efficient but run-prone non-bank financial intermediaries

[2] Simulate the model with recurrent **belief-driven booms and busts** building on Gertler, Kiyotaki & Prestipino (2020a,b)

[3] Analyze the **implications of different policies:**
   - today: central bank interventions (*emergency liquidity provision*)
     [future work: macroprudential (*capital requirements, redemption fees*)]
   - trade-off: ex-ante **anticipation effects** (moral hazard) & ex-post **crisis mitigation**
Literature

- Rise of non-bank financial intermediation

- Macroeconomic models w/ financial panics
Literature

- Rise of non-bank financial intermediation

- Macroeconomic models w/ financial panics

→ our contribution: assess central bank liquidity interventions explicitly trading off anticipation effects (moral hazard) & crisis mitigation
I. Motivation

II. Model

III. First Results

IV. Next steps
The model in a nutshell

Endowment economy w/ fixed capital stock intermediated by two classes of agents

  ▶ workers receive a fixed endowment and consume
  ▶ bankers invest holding (i) capital [s.t. capital management cost], (ii) NBFI debt, and (iii) NBFI equity [s.t. equity injection cost]

[2] Non-bank financial intermediaries (NBFI)
  ▶ raise funds [s.t. limited liability + endog run risk] to invest in capital
  ▶ susceptible to over-optimistic beliefs about the state of the economy

[3] Central bank
  ▶ implements emergency liquidity interventions (& macroprudential policy)

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In more detail: Runs on non-bank financial intermediaries

- Aggregate exogenous state: shock to the return on capital $Z_t$
- NBFI run susceptibility: state-contingent assets vs non-state-contingent debt

\[
R_t^{K,F} = \frac{Q_t + Z_t}{Q_{t-1}} \quad \text{vs} \quad R_t^D = \overline{R}_{t-1}^D \quad \& \quad N_t \geq 0
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- **A run on NBFI.** Household decides to not roll over NBFI debt
  - NBFI wiped out $\rightarrow N_t^* = 0$ and $\xi_t^* = 0$
  - all intermediation done by household and government
    $\rightarrow K_t^{F*} = 0$, $K_t^{H*} + K_t^{G*} = 1$, and fire sale asset price $Q_t^* < Q_t$
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$$R^K,F_t = \frac{Q_t + Z_t}{Q_{t-1}} \quad \text{vs} \quad R^D_t = \bar{R}^D_{t-1} \quad \& \quad N_t \geq 0$$

- **When can a run happen?** Run equilibrium exists if $N^*_t \leq 0$

  $\iff$ recovery rate on debt $x_t = \frac{(Q^*_t+Z_t)K^F_{t-1}}{R^D_tD_{t-1}} \leq 1$  
  $\quad \iff \quad R^D^*_t = x_t\bar{R}^D_{t-1}$
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- When can a run happen? Run equilibrium exists if $N_t^* \leq 0$

\[ \iff \quad \text{recovery rate on debt } x_t = \frac{(Q_t^* + Z_t)K_{t-1}^F}{R_{t,D} D_{t-1}} \leq 1 \quad \rightarrow \quad R_{t,D}^* = x_t \bar{R}_{t-1} \]

- When does a run happen? Existence of run equilibrium + sun spot

  - run probability is a function of the probability of $Z_t$ being below the threshold value $Z_t^R$ at which $x_t = 1$:

\[ P_t^R = \chi \times \text{Prob} \left( Z_{t+1} < Z_{t+1}^R \right) \]
In more detail: Belief-driven booms & busts + CB policy

• Notion of **belief-driven booms and busts** via news shocks on future $Z_t$
  ▶ news materialize (i) w/ probability $\bar{P}$ over (ii) distribution of possible dates
  ▶ households don’t believe the news, NBFI are over-optimistic, $\bar{P}_0 > \bar{P}$
  ▶ $\Phi_t \uparrow$ (via Bayesian updating of probability news will occur & $\xi_t \downarrow$) $\rightarrow P_t^R \uparrow$
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• Policy intervention (today): central bank credit policy in crisis
  - CB intermediates capital subject to inefficiency & capital management cost
  - assume CB intervenes if expected to break even
    $\rightarrow$ limits size & frequency of policy (not all runs avoided; alt: stochastic)
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- Calibration, global solution & simulation for 100 000 periods [Calibration]

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I. Motivation

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Median crisis window w/o policy intervention

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Distribution w/o policy intervention
Distribution w/ credit policy

- Output
- Assets (HH)
- Assets (NBFI)
- Assets (Govt)
- Asset Price
- Leverage
- Run Probability
- Dividend Shock

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I. Motivation

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Today

- Motivation [rise of NBFI, trade-off: efficiency vs financial stability concerns]
- Model [w/ two types of financial intermediation & endogenous run probabilities]
- Preliminary results [on crisis simulations & implications of emergency liquidity provision]
Today

- Motivation [rise of NBFI, trade-off: efficiency vs financial stability concerns]
- Model [w/ two types of financial intermediation & endogenous run probabilities]
- Preliminary results [on crisis simulations & implications of emergency liquidity provision]

Future work

- Investigate sensitivity of results (belief-driven vs fundamental; anticipated/non-anticipated; implementation of liquidity intervention ...)
- Contrast with macroprudential policy (capital requirements, redemption fees)
Extra slides
Motivation: further evidence on the rise of NBFI
Motivation: further evidence on the rise of NBFI II

Financial Stability Board (2020)
Motivation: further evidence on the rise of NBFI III

Gertler, Kiyotaki, and Prestipino (2016)

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Motivation: overview on non-bank financial intermediation

• Non-Bank Financial Intermediaries (NBFI) are financial institutions that
  ▶ perform bank-like services (maturity/risk/liquidity transformation), but
  ▶ are outside the regulatory perimeter of standard macroprudential policy

• Growth of NBFI provides benefits (specialization, technological innovation, market deepening, lower financing cost) but might give rise to systemic risk

• Many NBFIIs are characterised by
  [1] maturity/liquidity mismatch,

• Features [1]-[3] + lack of deposit insurance/ LoLR make NBFIIs susceptible to financial panics & roll-over crises (Sept-2008, Mar-2020, Sept-2022)
Motivation: institutions in non-bank financial intermediation I

- FSB ‘narrow measure’ of NBFI (grouped by economic function ’EF’):
  - ‘involved in credit intermediation + increased potential for risks to fin stability’
  - 15% of total fin assets in US (5% in UK); ann growth rate of 8% in recent years
  - EF1 key driver of post-financial crisis growth

[EF1] Collective investment vehicles (inv funds & - to some degree - MMFs)
[EF2] Finance companies (incl leasing/ factoring & consumer credit)
[EF3] Broker dealers
[EF5] Structured finance & securitization vehicles (incl asset backed securities)

- Macroprudential regulation on banks after 07/08 has increased bank resilience
  but pushed intermediation towards unregulated NBFI (leakage)
Motivation: institutions in non-bank financial intermediation II

Size of monitoring aggregates and composition of the narrow measure

At end-2018

Exhibit 0-1

Narrowing down¹

<table>
<thead>
<tr>
<th>Total Financial Assets</th>
<th>$379 trn</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUNFI $184 trn</td>
<td></td>
</tr>
<tr>
<td>OFIs $114 trn</td>
<td></td>
</tr>
<tr>
<td>Narrow measure $51 trn</td>
<td></td>
</tr>
</tbody>
</table>

Composition of the narrow measure²

<table>
<thead>
<tr>
<th>Economic Functions</th>
<th>Size (USD trillion)</th>
<th>Share (%)</th>
<th>Change in 2018 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF1 (collective investment vehicles with features that make them susceptible to runs)</td>
<td>36.6</td>
<td>72.0</td>
<td>0.4</td>
</tr>
<tr>
<td>EF2 (lending dependent on short-term funding)</td>
<td>3.6</td>
<td>7.0</td>
<td>6.9</td>
</tr>
<tr>
<td>EF3 (market intermediation dependent on short-term funding)</td>
<td>4.5</td>
<td>8.8</td>
<td>8.7</td>
</tr>
<tr>
<td>EF4 (facilitation of credit intermediation)</td>
<td>0.3</td>
<td>0.6</td>
<td>5.0</td>
</tr>
<tr>
<td>EF5 (securitisation-based credit intermediation)</td>
<td>4.7</td>
<td>9.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Unallocated</td>
<td>1.1</td>
<td>2.3</td>
<td>9.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50.9</strong></td>
<td><strong>100</strong></td>
<td><strong>1.7</strong></td>
</tr>
</tbody>
</table>

¹ Total financial assets, MUNFI and OFIs are based on 21+EA Group; Narrow measure is based on the 29-Group. ² Net of prudential consolidation into banking groups. For additional details on these categories, see Section 4.

Source: Jurisdictions’ 2019 submissions (national sector balance sheet and other data); FSB calculations.
Model: households I

- Consume and invest holding (i) capital, (ii) NBFI debt, & (iii) NBFI equity

\[
\max_{\{C_t, D_t, K_t^H, \xi_t, N_t\}} U_t \equiv E_t \sum_{i=0}^{\infty} \beta^i \log (C_{t+i})
\]

subject to the budget constraint,

\[
C_t + Q_t K_t^H + D_t + \xi_t + f(K_t^H) + g(\xi_t) = \bar{W} + (Q_t + Z_t) K_{t-1}^H + R_t^D D_{t-1} + (1 - \sigma) N_{t-1} R_t^N
\]

and the law of motion for NBFI equity,

\[
N_t = \sigma N_{t-1} R_t^N + \xi_t
\]
Model: households II

- Consume and invest holding (i) capital, (ii) NBFI debt, & (iii) NBFI equity

\[
(D_t) \quad \mathbb{E}_t [\Lambda_{t,t+1} R_{t+1}^D] = 1
\]

\[
(K_t^H) \quad \mathbb{E}_t \left[ \Lambda_{t,t+1} \frac{Q_{t+1} + Z_{t+1}}{Q_t + f'(K_t^H)} \right] = 1
\]

\[
(\xi_t) \quad \psi_t^H = 1 + g'(\xi_t)
\]

\[
(N_t) \quad \psi_t^H = \mathbb{E}_t \left[ \Lambda_{t,t+1} \left( 1 - \sigma + \sigma \psi_{t+1}^H \right) R_{t+1}^N \right]
\]
Model: non-bank financial intermediaries I

- Raise funds [s.t. aff + endog run risk] to invest in capital

\[
\max_{\{D_t, K_t^F, \tilde{N}_{t+1}\}} \nabla_t \equiv E_t \left\{ \Lambda_{t,t+1} \left[ (1 - \sigma) \tilde{N}_{t+1} + \sigma \nabla_{t+1} \right] \right\}
\]

subject to

(Balance sheet) \quad Q_t K_t^F = \tilde{N}_t + D_t

(Incentive constraint) \quad \nabla_t \geq \theta Q_t K_t^F

(Evolution of net worth) \quad \tilde{N}_t = (Q_t + Z_t) K_{t-1}^F - R_t^D D_{t-1}

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Model: non-bank financial intermediaries

- Raise funds [s.t. a ff + endog run risk] to invest in capital

\[
(K_t^F) \quad \psi_t^F \geq \theta \Phi_t \\
(\tilde{N}_{t+1}) \quad \psi_t^F = \mathbb{E}_t [\Lambda_{t,t+1} (1 - \sigma + \sigma \psi_{t+1}^F) R_{t+1}^N]
\]

(Leverage) \quad \Phi_t \equiv \frac{Q_t K_t^F}{N_t}

(Return on net worth) \quad R_t^N \equiv \frac{\tilde{N}_t}{\tilde{N}_{t-1}} = \left( R_t^{K,F} - R_t^D \right) \Phi_{t-1} + R_t^D

(Return on capital) \quad R_t^{K,F} \equiv \frac{Q_t + Z_t}{Q_{t-1}} \quad \& \quad R_t^{K,H} \equiv \frac{Q_t + Z_t}{Q_{t-1} + f'(K_{t-1}^H)}

(Market clearing) \quad 1 = K_t^H + K_t^F + K_t^G

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In more detail: Belief-driven booms & busts + CB policy

- Notion of **belief-driven booms and busts** via news shocks on future $Z_t$
  - News materialize (i) with probability $\bar{P}$ over (ii) distribution of possible dates
  - Households don’t believe the news, NBFI are over-optimistic, $\bar{P}_0^F > \bar{P}$
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- Policy intervention (today): **central bank credit policy in crisis**
  - CB intermediates capital subject to inefficiency & capital management cost
    
    $R_t^{K,G} \equiv \varphi \frac{Z_t + Q_t}{Q_{t-1} + h'(K_{t-1}^G)}$
    
    - Assume CB intervenes if expected to break even $\rightarrow K_t^G = f(\mathbb{E} R_{t+1}^{K,G} - R_t^D)$
    - Limits size & frequency of policy (not all runs avoided; alt: stochastic)

- Calibration, global solution & simulation for 100 000 periods

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Model: calibration I

Calibration of baseline parameters.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
<th>Value</th>
<th>Target</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ</td>
<td>Share of Divertible Assets</td>
<td>0.23</td>
<td>Capital Ratios = 10 pct</td>
<td>(E(\kappa) = 10) pct</td>
</tr>
<tr>
<td>(\sigma)</td>
<td>Banker Survival Rate</td>
<td>0.935</td>
<td>Quarterly Spread = 50 bpts</td>
<td>(E(R^b - R) = 48) bpts</td>
</tr>
<tr>
<td>(\bar{\xi})</td>
<td>Startup Equity</td>
<td>1 pct of (N^{SS})</td>
<td>HH Share of Intermediation = .5</td>
<td>(K^h = 0.49)</td>
</tr>
<tr>
<td>(\alpha_{\xi})</td>
<td>Equity Injections Costs</td>
<td>0.001</td>
<td>Average Issuance rate = 1 pct</td>
<td>(E_{\xi_{N^{SS}}}^N = 1.1) pct</td>
</tr>
<tr>
<td>(\alpha)</td>
<td>HH Intermediation Costs</td>
<td>0.00625</td>
<td>Output Drop During Run = 6 pct</td>
<td>(\frac{y_t - y_{SS}}{y_{SS}} = 6.4) pct</td>
</tr>
<tr>
<td>(\chi^s)</td>
<td>Sunspot Probability</td>
<td>0.125</td>
<td>Avg Yearly Frequency of Runs = 3.7 pct</td>
<td>(4 \cdot Ep^R = 3.6) pct</td>
</tr>
<tr>
<td>(\sigma(e^z))</td>
<td>Std Dev of Z Innovation</td>
<td>0.01</td>
<td>Std Dev of U.S. Output = 1.9 pct</td>
<td>(\sigma(Y) = 1.9) pct</td>
</tr>
<tr>
<td>Fixed Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\beta)</td>
<td>Impatience</td>
<td>0.99</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(\rho^z)</td>
<td>Serial Correlation of Z</td>
<td>0.95</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(W)</td>
<td>HH Endowment</td>
<td>2 \cdot Z</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Model: calibration II

Calibration of news shocks.

<table>
<thead>
<tr>
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<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu(t^B)$</td>
<td>Expected time of Z boom</td>
<td>10.5 Quarters ahead</td>
</tr>
<tr>
<td>$\sigma(t^B)$</td>
<td>Standard Deviation of Prior</td>
<td>2 Quarters</td>
</tr>
<tr>
<td>$T$</td>
<td>News Horizon</td>
<td>21 Quarters</td>
</tr>
<tr>
<td>$B$</td>
<td>Size of Productivity Boom</td>
<td>$2 \cdot \sigma(e^Z)$</td>
</tr>
<tr>
<td>$\overline{P}_0^{B}$</td>
<td>Banker Prob. that Boom will happen</td>
<td>0.999</td>
</tr>
<tr>
<td>$\overline{P}_0^{TRUE}$</td>
<td>True Prob. that Boom will happen</td>
<td>0.5</td>
</tr>
<tr>
<td>$\chi^n$</td>
<td>Prob. of Receiving News</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Median crisis window w/ credit policy

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(Ext) Median crisis window - ‘fundamental’ vs news-driven

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