Financial Panics & Liquidity Interventions

Alexander Haas
University of Oxford

Derrick Kanngiesser
Bank of England

November 2023 | Oxford

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) ▸ NBFI definition ▸ NBFI institutions
  [(i) funding cost advantages, (ii) search-for-yield, (iii) macroprudential regulation on banks]

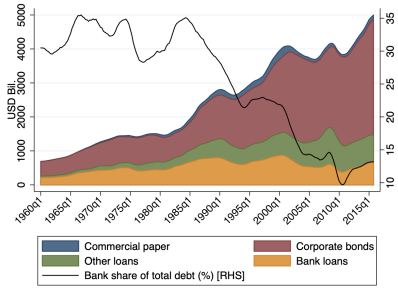
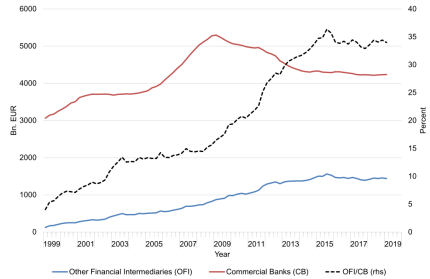


Figure 1: **Growth of alternative debt sources for non-financial business in the U.S.**

Ordoñez (2018)

Figure 1: Commercial and Shadow Bank Loans to Non-Financial Corporates



Note: Outstanding amount of loans of commercial and shadow banks (OFI) to non-financial coprorates (billions of euro). Source: Euro Area Accounts and Monetary Statistics (ECB).

Gebauer and Mazelis (2020) ▸ Further evidence

Motivation

- Rise of non-bank financial intermediation (NBFI) ▸ NBFI definition ▸ NBFI institutions
  [(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]

Motivation

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

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.

Motivation

- Rise of non-bank financial intermediation (NBFI) ▸ NBFI definition ▸ NBFI institutions
  [(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]

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)

[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
  Ordoñez (2018), Gebauer & Mazelis (2020), Dempsey (2020),
  Farhi & Tirole (2020), Xiao (2020), Begenau & Landvoigt (2022) ...

- Macroeconomic models w/ financial panics
  Gertler, Kiyotaki & Prestipino (2016, 2020a,b), Faria-e Castro (2020),
  Poeschl (2020), Rottner (2021), Amador & Bianchi (2022) ...

  $\longrightarrow$ our contribution: asses 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

[1] Households: workers & bankers
- 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)

The model in a nutshell

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

[1] Households: workers & bankers
- 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)

Households

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

$$\max_{\{C_t,\, D_t,\, K_t^H,\, \xi_t,\, N_t\}} \mathbb{U}_t \equiv \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \log\left(C_{t+i}\right)$$

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,

$$N_t = \sigma N_{t-1} R_t^N + \xi_t$$

▸ First order conditions

Non-bank financial intermediaries

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

$$\max_{\{D_t, K_t^F, \tilde{N}_{t+1}\}} \mathbb{V}_t \equiv \mathbb{E}_t \left\{ \Lambda_{t,t+1} \left[(1-\sigma)\, \tilde{N}_{t+1} + \sigma \mathbb{V}_{t+1} \right] \right\}$$

subject to

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

$$\text{(Incentive constraint)} \qquad \mathbb{V}_t \geq \theta\, Q_t K_t^F$$

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

▸ First order conditions

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

$$R_t^{K,F} = \frac{Q_t + Z_t}{Q_{t-1}} \text{ vs } R_t^D = \bar{R}_{t-1}^D \quad \& \quad N_t \geq 0$$

- **A run on NBFI.** Household decides to not roll over NBFI debt
  - NBFI wiped out $\longrightarrow N_t^* = 0$ and $\xi_t^* = 0$
  - all intermediation done by household and government $\longrightarrow K_t^{F*} = 0,\ K_t^{H*} + K_t^{G*} = 1,$ and fire sale asset price $Q_t^* < Q_t$

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

$$R_t^{K,F} = \frac{Q_t + Z_t}{Q_{t-1}} \text{ vs } R_t^D = \bar{R}_{t-1}^D \quad \& \quad N_t \geq 0$$

- **When *can* a run happen?** Run equilibrium exists if $N_t^* \leq 0$
  $\iff$ recovery rate on debt $x_t = \frac{(Q_t^* + Z_t)K_{t-1}^F}{R_t^D D_{t-1}} \leq 1 \ (\longrightarrow R_t^{D*} = x_t \bar{R}_{t-1}^D)$
- **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 $x_t = 1$: $P_t^R = \chi * \text{Prob}\left(Z_{t+1} < Z_{t+1}^R\right)$

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, $\bar{P}_0^F > \bar{P}$
  - $\Phi_t \uparrow$ (via Bayesian updating of probability news will occur & $\xi_t \downarrow$) $\longrightarrow P_t^R \uparrow$

- 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 $\longrightarrow K_t^G = f(\mathbb{E}R_{t+1}^{K,G} - R_t^D)$ $\longrightarrow$ limits size & frequency of policy (not all runs avoided; alt: stochastic)

- Calibration, global solution & simulation for 100 000 periods ▸ Calibration

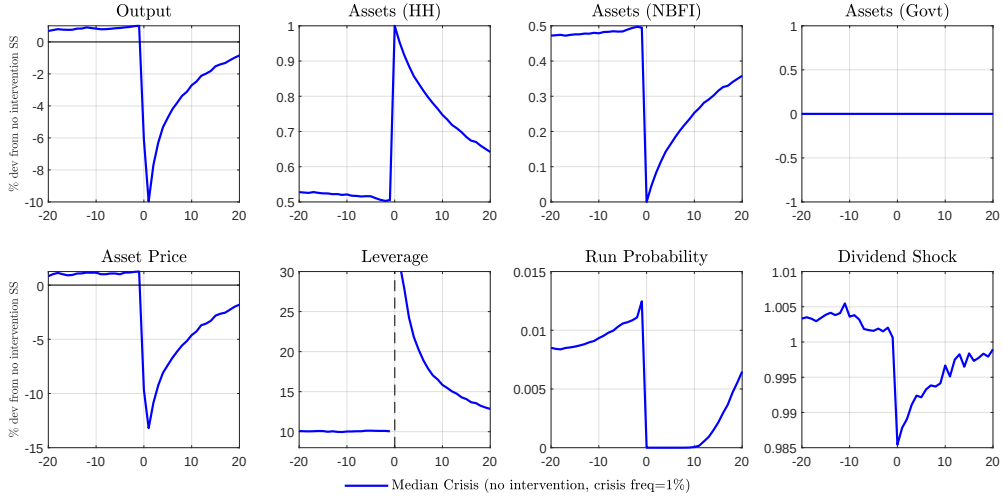
I. Motivation

II. Model

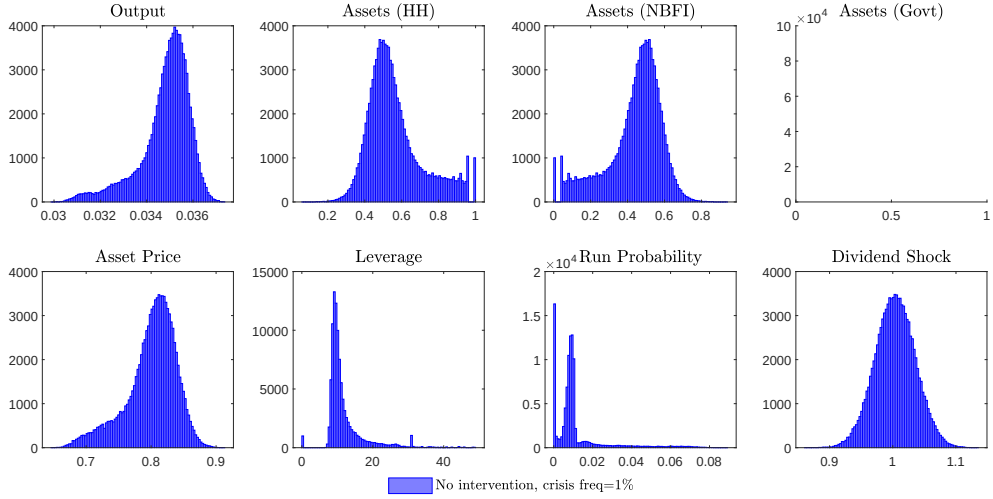
III. First Results

IV. Next steps

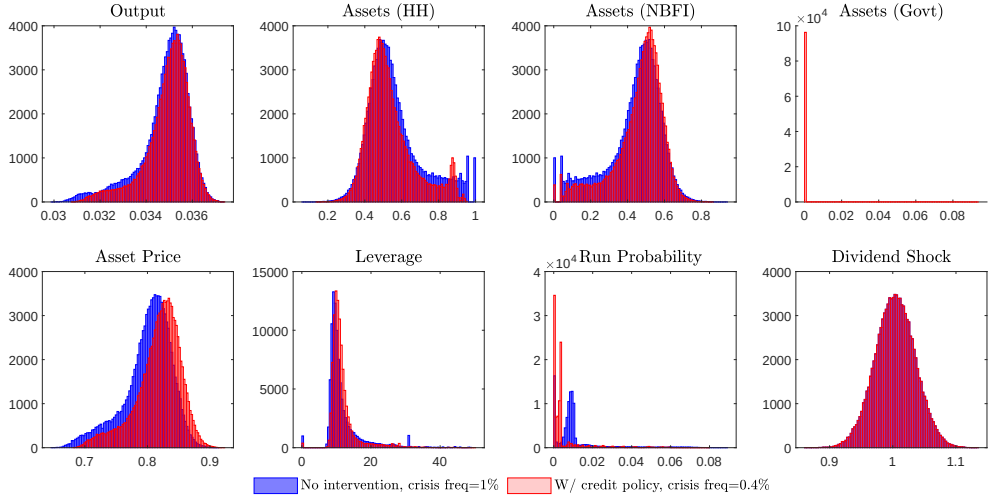
Median crisis window w/o policy intervention



Distribution w/o policy intervention



Distribution w/ credit policy



I. Motivation

II. Model

III. First Results

IV. Next steps

Today

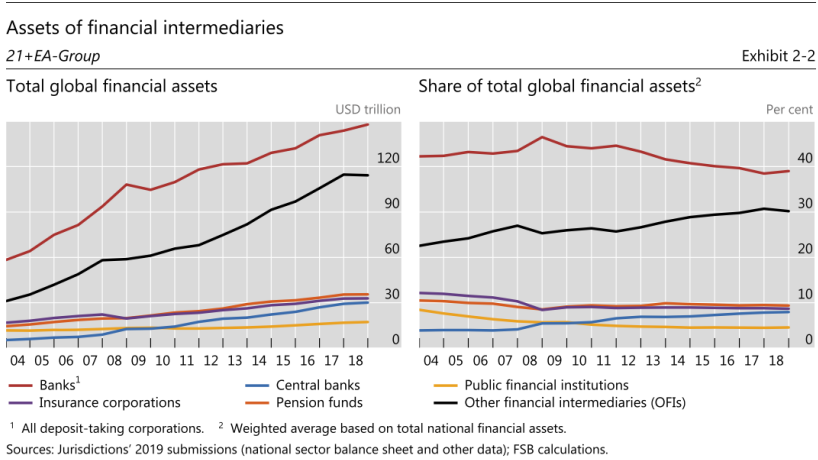
- Motivation [rise of NBFI, trade-off: efficiency vs financial stability concerns]
- Model [w/ two types of financial intermediation & endogenous run probabilities]
- Preliminary results [on crisis simulations & implications of emergency liquidity provision]

Next steps

- Sensitivity/ Robustness (belief-driven vs fundamental; anticipated/non-anticipated; implementation of liquidity intervention ...)
- Macroprudential policy (capital requirements, redemption fees)

Extra slides

Motivation: further evidence on the rise of NBFI I



Financial Stability Board (2020)

◂ Main part

Motivation: further evidence on the rise of NBFI II

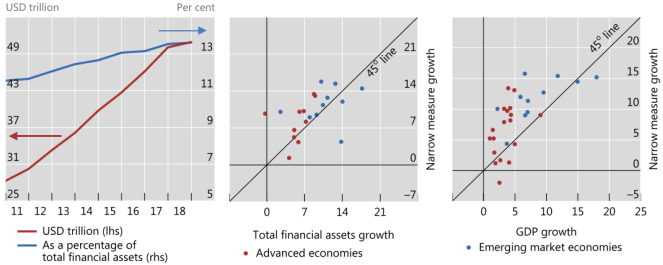
Narrow measure, total financial assets and GDP[1]

29-Group Exhibit 4-4

Narrow measure in USD trillion and relative to total financial assets

Total financial assets and narrow measure growth 2012-18

GDP growth and narrow measure growth 2012-18



[1] Changes in aggregated data may also reflect improvements in the availability of data over time at a jurisdictional level. Due to data gaps, China's growth rate is based on data from 2013-18; Russia's and Argentina's growth rates are based on data from 2014-18.

Sources: Jurisdictions' 2019 submissions (national sector balance sheet and other data); FSB calculations.

Financial Stability Board (2020)

◂ Main part

Motivation: further evidence on the rise of NBFI III

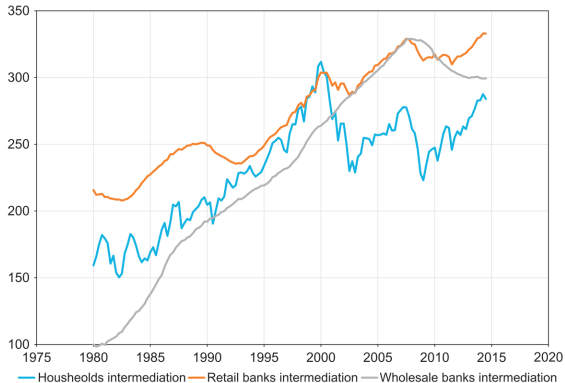


Fig. 3 Intermediation by sector. The graph shows the evolution of credit intermediated by the three different sectors. Nominal data from the Flow of Funds are deflated using the CPI and normalized so that the log of the normalized value of real wholesale intermediation in 1980 is equal to 1. The resulting time series are then multiplied by 100.

Gertler, Kiyotaki, and Prestipino (2016)

◂ Main part

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 NBFIs are characterised by
  [1] maturity/liquidity mismatch,
  [2] high reliance on short-term wholesale funding, [3] high leverage
- Features [1]-[3] + lack of deposit insurance/ LoLR make NBFIs susceptible to financial panics & roll-over crises (Sept-2008, Mar-2020, Sept-2022) ◂ Main part

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) **-72%-**
[EF2] Finance companies (incl leasing/ factoring & consumer credit) **-7%-**
[EF3] Broker dealers **-9%-**
[EF5] Structured finance & securitization vehicles (incl asset backed securities) **-9%-**

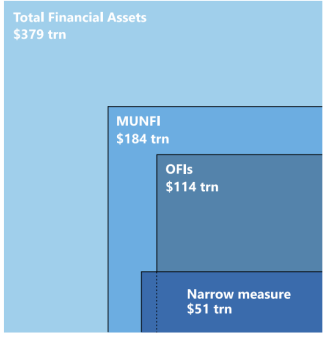
- Macroprudential regulation on banks after 07/08 has increased bank resilience but pushed intermediation towards unregulated NBFI (leakage) ◂ Main part

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 down[1]



Composition of the narrow measure[2]

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

[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.

◂ Main part

Model: households

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

$$\max_{\{C_t, D_t, K_t^H, \xi_t, N_t\}} \mathbb{U}_t \equiv \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \log\left(C_{t+i}\right)$$

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: household, FOCs

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

$$(D_t) \qquad \mathbb{E}_t \left[\Lambda_{t,t+1} \, R^D_{t+1} \right] = 1$$

$$(K^H_t) \qquad \mathbb{E}_t \left[\Lambda_{t,t+1} \, \frac{Q_{t+1} + Z_{t+1}}{Q_t + f'(K^H_t)} \right] = 1$$

$$(\xi_t) \qquad \psi^H_t = 1 + g'(\xi_t)$$

$$(N_t) \qquad \psi^H_t = \mathbb{E}_t \left[\Lambda_{t,t+1} \, \left(1 - \sigma + \sigma \psi^H_{t+1} \right) R^N_{t+1} \right]$$

◂ Main part

Model: non-bank financial intermediaries

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

$$\max_{\{D_t,\, K_t^F,\, \tilde{N}_{t+1}\}} \mathbb{V}_t \equiv \mathbb{E}_t \left\{ \Lambda_{t,t+1} \left[(1-\sigma)\, \tilde{N}_{t+1} + \sigma \mathbb{V}_{t+1} \right] \right\}$$

subject to

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

$$\text{(Incentive constraint)} \qquad \mathbb{V}_t \geq \theta\, Q_t K_t^F$$

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

Model: non-bank financial intermediaries, FOCs

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

$$(K_t^F) \qquad \psi_t^F \geq \theta \Phi_t$$

$$(\tilde{N}_{t+1}) \qquad \psi_t^F = \mathbb{E}_t \left[\Lambda_{t,t+1} \left(1 - \sigma + \sigma \psi_{t+1}^F \right) R_{t+1}^N \right]$$

$$\text{(Leverage)} \qquad \Phi_t \equiv \frac{Q_t K_t^F}{N_t}$$

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

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

$$\text{(Market clearing)} \qquad 1 = K_t^H + K_t^F + K_t^G$$

◂ Main part

Model: 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, $\bar{P}_0^F > \bar{P}$
  - $\Phi_t \uparrow$ (via Bayesian updating of probability news will occur & $\xi_t \downarrow$) $\longrightarrow P_t^R \uparrow$

- 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 $\longrightarrow K_t^G = f(\mathbb{E}R_{t+1}^{K,G} - R_t^D)$
    $\longrightarrow$ limits size & frequency of policy (not all runs avoided; alt: stochastic)

- Calibration, global solution & simulation for 100 000 periods

Model: calibration I

Calibration of baseline parameters.

Parameters	Description	Value	Target	Model
Calibrated Parameters				
θ	Share of Divertible Assets	0.23	Capital Ratios = 10 pct	$E(\kappa) = 10$ pct
σ	Banker Survival Rate	0.935	Quarterly Spread = 50 bpts	$E(R^b - R) = 48$ bpts
$\overline{\xi}$	Startup Equity	1 pct of N^{SS}	HH Share of Intermediation = .5	$K^h = 0.49$
α_ξ	Equity Injections Costs	0.001	Average Issuance rate = 1 pct	$E\frac{\xi^N}{N^{SS}} = 1.1$ pct
α	HH Intermediation Costs	0.00625	Output Drop During Run = 6 pct	$\frac{Y_{t^*} - Y^{SS}}{Y^{SS}} = 6.4$ pct
χ^s	Sunspot Probability	0.125	Avg Yearly Frequency of Runs = 3.7 pct	$4 \cdot Ep^R = 3.6$ pct
$\sigma(\epsilon^Z)$	Std Dev of Z Innovation	0.01	Std Dev of U.S. Output = 1.9 pct	$\sigma(Y) = 1.9$ pct
Fixed Parameters				
β	Impatience	0.99	-	-
ρ^Z	Serial Correlation of Z	0.95	-	-
W	HH Endowment	$2 \cdot Z$	-	-

main part

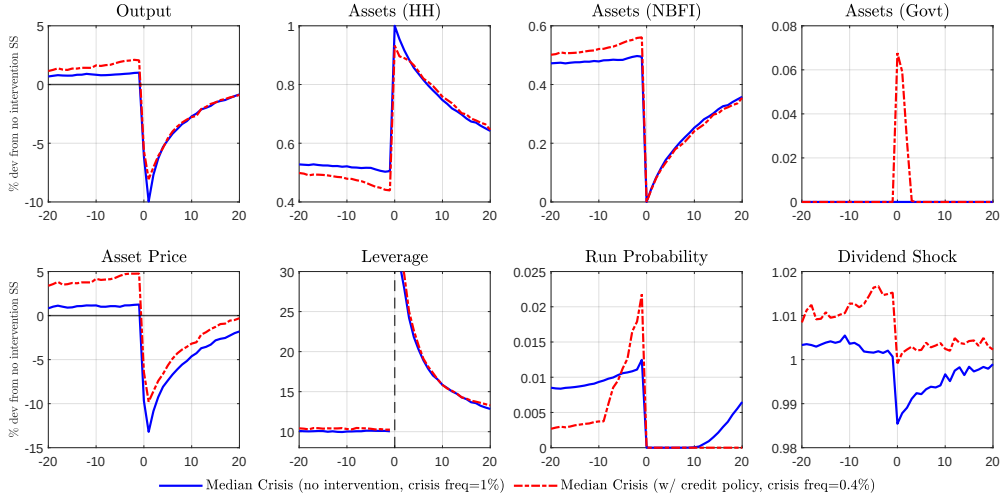
Model: calibration II

Calibration of news shocks.

Parameters	Description	Value
$\mu(t^B)$	Expected time of Z boom	10.5 Quarters ahead
$\sigma(t^B)$	Standard Deviation of Prior	2 Quarters
T	News Horizon	21 Quarters
B	Size of Productivity Boom	$2 \cdot \sigma(\epsilon^Z)$
$\overline{P}_0^B$	Banker Prob. that Boom will happen	0.999
$\overline{P}_0^{TRUE}$	True Prob. that Boom will happen	0.5
χ^n	Prob. of Receiving News	0.02

◂ main part

Results: median crisis window w/ credit policy



Results: median crisis window - 'fundamental' vs news-driven