Bank Runs, Fragility, and Credit Easing

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Motivation

- Financial crises typically involve bank runs
- Short-term debt can make a bank vulnerable to a self-fulfilling run
- Empirically, runs more likely with weak aggregate fundamentals
    - General equilibrium feedbacks potentially important

★ Macroeconomic model essential to understand feedbacks

Q: What are the implications for government policy?

A Macroeconomic Model of Bank Runs

- Dynamic portfolio and equity decisions for banks
  - Depend on asset prices, determined in equilibrium
- Limited commitment and endogenous strategic default
  - Defaults triggered by fundamentals or runs
- Fragility linked to fundamentals, as in Gertler-Kiyotaki, but key differences:
  - Runs on individual banks
  - Maturity critical for fragility $\Rightarrow$ role for lender of last resort

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    - Runs on individual banks
    - Maturity critical for fragility $\Rightarrow$ role for lender of last resort
- Normative analysis

Preview of Main Normative Results

- Desirability of **credit easing** depends on source of the crisis

    - Welfare *reducing* if driven by fundamentals, but welfare *improving* if driven by runs

- **Key distinction:** Repaying banks are *net buyers* when crises are driven by fundamentals but *net sellers* when driven by runs

    - Increase in asset prices have opposite effects on the fraction of defaulting banks

Outline of the Talk

1. Environment without runs

2. Model with bank runs

3. Policy analysis

Environment

- Discrete time, infinite horizon, no aggregate risk
- Continuum of banks, preferences $\sum_{t=0}^{\infty} \beta^t \log(c_t)$.
- Creditors have linear utility, discount rate R
- Technology
    - Production of consumption good: $y = zk$
    - Capital in fixed supply $\overline{K}$
- Competitive market for assets and deposits
- No commitment to repay deposits

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Banks' Budget Constraints

All banks start at $t = 0$ with portfolio $(b_0, \overline{K})$

- If repay at time t:

$$c = (\bar{z} + p_t)k - Rb + q_t(b', k')b' - p_t k'.$$

  - q_t price schedule of deposits
  - p_t price of capital

- Deposits are one-period non-state contingent claims
  - Without loss for now, but will matter with runs
- Capital is liquid
  - Price determined in equilibrium

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- If default at time t:

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  - Permanent financial exclusion $b' = 0$
    - Restriction on saving w/o loss
  - Productivity loss $y = \underline{z}k$
    - Evidence on losses of firms exposed to defaulting banks

Banks' Optimization: Values of Repayment and Default

$$
\begin{aligned}
V_t^R(b,k) &= \max_{k',b',c} \log(c) + \beta V_{t+1}(b',k') \\
& \quad \text{s.t.} \quad c = (\bar{z} + p_t)k - Rb + q_t(b',k')b' - p_t k' \\
& \qquad\quad\;\; \text{No-Ponzi} \\
V_t^D(k) &= \max_{k',c} \log(c) + \beta V_{t+1}^D(k') \\
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Repayment decision:

- If $V_t^R(b,k) = V_t^D(k)$: indifferent
  - Repay for $t > 0$
  - **Default with probability** ϕ

Equilibrium Consistent Borrowing Limit

- Equilibrium default only at $t = 0$
- Guess and verify that bank pays at $t + 1$ if

$$b_{t+1} \leq \gamma_t p_{t+1} k_{t+1}$$

where

$$\frac{\bar{z} + p_{t+1}(1 - \gamma_t R)}{\underline{z} + p_{t+1}} = \left(1 - \gamma_{t+1} \frac{p_{t+2}}{p_{t+1}}\right)^{\beta}$$

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- Potentially many solutions, but only one consistent with No-Ponzi

Solving for γ_t for Constant Price

$$\gamma_{t+1} = 1 - \left(\frac{R^k(p)/R - \gamma_t}{R^D(p)/R} \right)^{\frac{1}{\beta}} \equiv H(\gamma_t)$$

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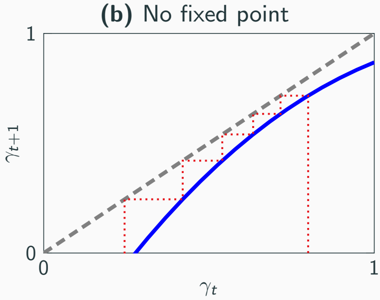
- Partial eqm. does not exist if return on capital is too high
  - No borrowing limit



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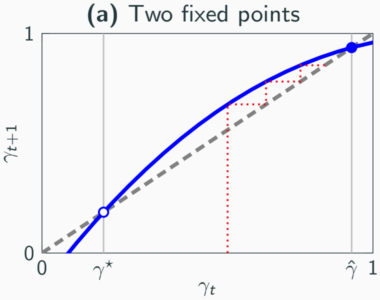
- If eqm $\exists$, two fixed points but only smallest satisfies No-Ponzi
  - First fixed point unstable $\Rightarrow \gamma_t = \gamma^\star$
  - $\gamma^\star$ is increasing in $(\beta, \bar{z})$ and decreasing in $(R, \underline{z}, p)$



Outline of the Talk

1. Environment without runs
   - Bank problem in partial equilibrium
   - General equilibrium
2. Model with bank runs
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General Equilibrium

- Market clearing for capital

$$\phi K_t^D + (1 - \phi) K_t^R = \overline{K}$$

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- Recall a bank is indifferent at $t=0$ if $b_0 = \gamma_{-1} p_0 k_0$

where

$$\frac{\bar{z} + p_0(1-\gamma_{-1}R)}{\underline{z} + p_0} = \left(1 - \gamma_0 \frac{p_1}{p_0}\right)^{\beta}$$

- Therefore,

$$\phi = \begin{cases} 1 & \text{if } B_0 > \gamma_{-1} p_0 \overline{K}, \\ 0 & \text{if } B_0 < \gamma_{-1} p_0 \overline{K}, \\ \in [0,1] & \text{if } B_0 = \gamma_{-1} p_0 \overline{K} \end{cases}$$

General Equilibrium

Type of equilibrium depends on B_0

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Repayment eqm. | Mixed eqm. | Default eqm

$\gamma^R p^R \overline{K}$ $\quad$ $\gamma^D p^D \overline{K}$ $\quad \rightarrow B_0$

Type of equilibrium depends on B_0

Mixing within thresholds: Fraction ϕ defaults and $1 - \phi$ repays.

- Generalize Kehoe-Levine, by allowing initial defaults

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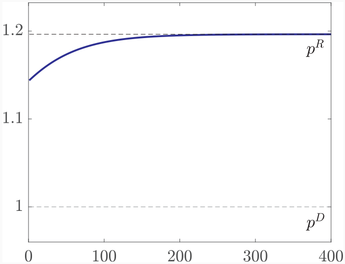
In the paper:

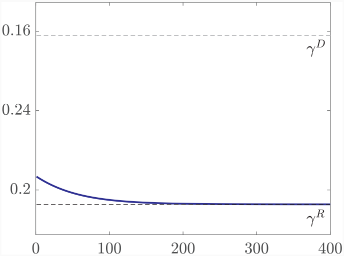
- Analytical characterization of thresholds
- Unique stationary eqm. and unique transition results
- Repaying banks are net buyers of k in the mixed eqm.

Mixed Equilibrium Simulations

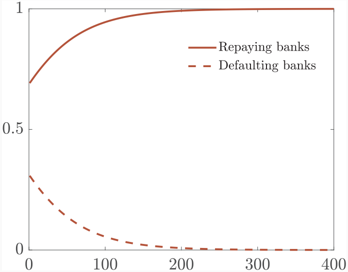
Price of Capital p_t



Leverage Threshold γ_t



Capital Holdings



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Self-Fulfilling Bank Runs

Coordination problem between creditors a la Cole-Kehoe

- Creditors may refuse to rollover $\Rightarrow$ repayment more costly
- If optimal to default during a run, a bank is "vulnerable"

Multiplicity of Equilibria

Bank facing a run needs to de-lever:

$$\hat{V}_t^{Run}(n) = \max_{k' \geq 0, c} \log(c) + V_{t+1}\left((\bar{z} + p_{t+1})k'\right)$$

$$s.t \quad c = n + \cancelto{0}{b'} - p_t k'$$

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Safe bank faces tighter constraint:

$$\hat{V}_t^{Safe}(n) = \max_{b', k' \geq 0, c} \log(c) + \beta \hat{V}_{t+1}^{Safe}((\bar{z} + p_{t+1})k' - Rb')$$

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$$\hat{V}_{t+1}^{Run}(n') \geq V_{t+1}^{D}(k')$$

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- Multiplicity: $\hat{V}_t^{Safe}(n) > \hat{V}_t^{D}(k) > \hat{V}_t^{Run}(n)$

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- Multiplicity: $\hat{V}_t^{Safe}(n) > \hat{V}_t^{D}(k) > \hat{V}_t^{Run}(n)$
  - Assume that if a bank is vulnerable for $t > 0$, a run happens

The Effects of Bank Runs

- Financial fragility, default region expands $\downarrow \gamma^D$
  - Repayment region contracts $\gamma^R \downarrow$ if and only if $\beta R < 1$

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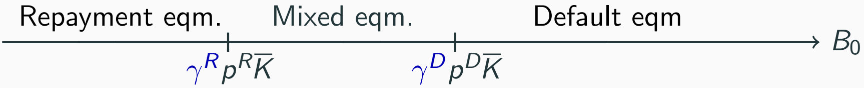

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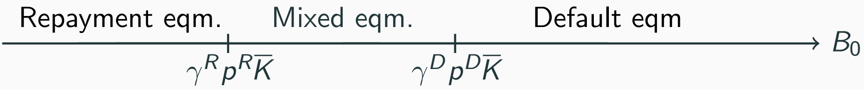

- Lower price of capital
  - Lower γ, implies lower demand by repaying banks
  - More defaulting banks, which have lower demand for capital

Outline of the Talk

1. Basic environment without bank runs
    - Bank problem in partial equilibrium
    - General equilibrium
2. Introduce bank runs
3. Policy analysis

Credit Easing

Introduce government purchases of assets K^g at $t = 0$

Assume that government makes losses:

- Productivity $z^g < \underline{z}$ and return $(z^g + p_1)/p_0 < R$

$\Rightarrow$ Investors they do not purchase k if same productivity as govt.

Q: How does credit easing affect ϕ and welfare?

Welfare $\Downarrow$ if defaults due to fundamentals

$$\frac{dW}{dK_g} = \left[\phi \frac{dV^D}{dK_g} - (1-\phi)\frac{dV^R}{dK_g}\right] - \left(V^R - V^D\right)\frac{d\phi}{dK_g}$$

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Without runs:

- $V^R = V^D \;\Rightarrow\; d\phi$ irrelevant

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With runs:

- $V^R = V^{Safe} > V^{Run} = V^D$

$\Rightarrow$ If $d\phi < 0$, possibility that $\Uparrow W$

A repaying banks facing a run is a net seller of assets

$\Rightarrow$ benefits from intervention that $\Uparrow p_0 \Rightarrow d\phi < 0$

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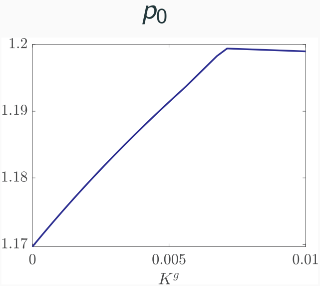
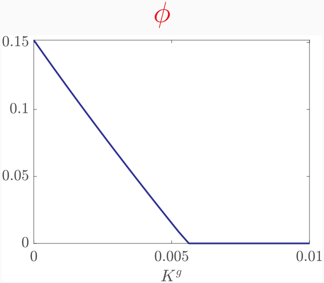
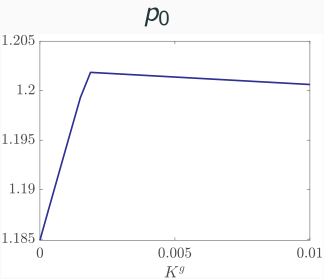
Credit Easing: Self-Fulfilling vs. Fundamentals

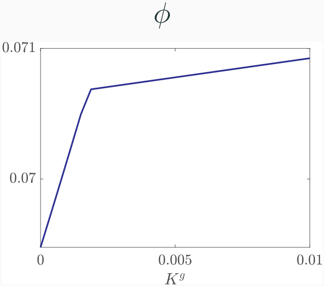
Self-Fulfilling Runs





Fundamentals





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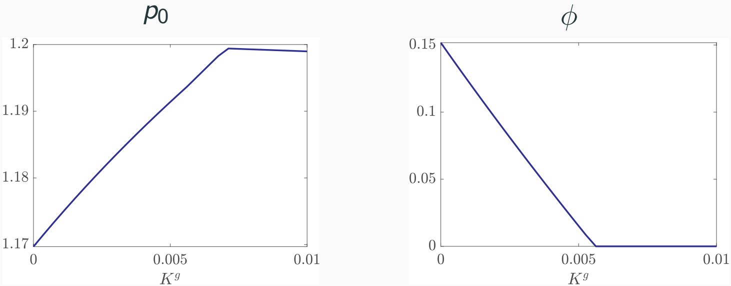

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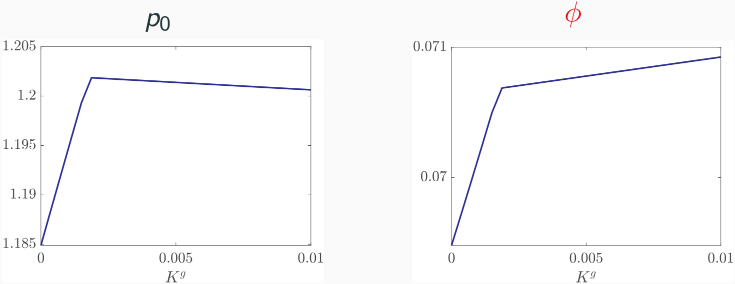

Other Policies

- Controlling default decisions: ▸ Details
  - Higher ϕ w/o runs and lower ϕ w/runs
- Tax on purchases of capital at $t = 0$ rebated lump sum
  - Irrelevant: after-tax price remains constant and has no effects
- Deposit insurance: deters runs, but requires borrowing limits
- Lender of last resort: must cover *all* banks to be effective

Conclusions

- A dynamic macroeconomic model of self-fulfilling bank runs
- General equilibrium effects crucial to assess govt. policies
- Desirability of credit easing depends on whether a crisis is diriven by fundamentals or self-fulfilling runs
- Agenda:
  - Anticipation effects of credit easing
  - Use framework for other policies, such as macroprudential

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Banks' welfare

$$W = (1 - \phi)V^R + \phi V^D$$

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- *Assume only p_0 changes in response to policy:*

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$$\left.\frac{dV^R(p_0)}{dp_0}\right|_{\phi=\phi^E} = u'(c^R)(\overline{K} - k^R(p_0^E)), \quad \left.\frac{dV^D(p_0)}{dp_0}\right|_{\phi=\phi^E} = u'(c^D)(\overline{K} - k^D(p_0^E)).$$

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$$W = (1-\phi)V^R + \phi V^D$$

- *Assume only p_0 changes in response to policy:*

$$\left.\frac{dW}{d\phi}\right|_{\phi=\phi^E} = \cancelto{0}{[V^D(p_0^E) - V^R(p_0^E)]}$$

$$- \ (1-\phi)[\overbrace{u'(c^R(p_0^E)) - u'(c^D(p_0^E))}^{>0}]\overbrace{(k^R(p_0^E) - \bar{K})}^{>0}\overbrace{\frac{dp_0}{d\phi}}^{<0}$$

$\uparrow \phi$ reduces p_0 and helps repaying banks that have high u'

Government picks ϕ at $t = 0$

Banks' welfare

$$W = (1 - \phi)V^R + \phi V^D$$

- *Assume only p_0 changes in response to policy:*

$$\left.\frac{dW}{d\phi}\right|_{\phi=\phi^E} = \cancelto{0}{[V^D(p_0^E) - V^R(p_0^E)]}$$
$$- \ (1-\phi)\overbrace{[u'(c^R(p_0^E)) - u'(c^D(p_0^E))]}^{>0}\overbrace{(k^R(p_0^E) - \bar{K})}^{>0}\overbrace{\frac{dp_0}{d\phi}}^{<0}$$

$\uparrow \phi$ reduces p_0 and helps repaying banks that have high u'

- Without runs: optimal to have more banks defaulting

Government picks ϕ at $t = 0$

Banks' welfare

$$W = (1-\phi)V^R + \phi V^D$$

- *Assume only p_0 changes in response to policy:*

$$\left.\frac{dW}{d\phi}\right|_{\phi=\phi^E} = [V^D(p_0^E) - V^R(p_0^E)]$$

$$- \ (1-\phi)[\overbrace{u'(c^R(p_0^E)) - u'(c^D(p_0^E))}^{>0}]\overbrace{(k^R(p_0^E) - \bar{K})}^{>0}\overbrace{\frac{dp_0}{d\phi}}^{<0}$$

$\uparrow \phi$ reduces p_0 and helps repaying banks that have high u'

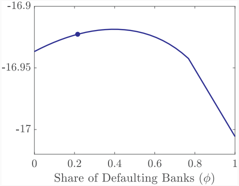
- Without runs: optimal to have more banks defaulting
- With runs: may be optimal to reduce defaults back

Simulations: Socially Optimal Default

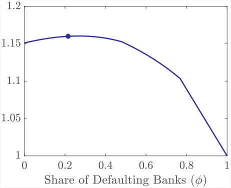
Back

Fundamentals

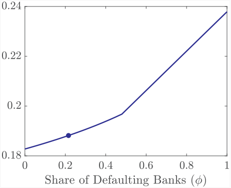
(a) Welfare



(b) p_0

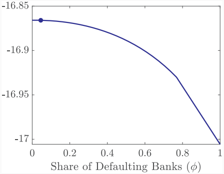


(c) $\gamma_0 p_1$

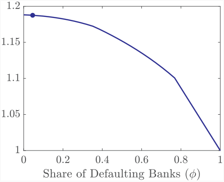


Self-Fulfilling Runs

(d) Welfare



(e) p_0



(f) $\gamma_0 p_1$