CREDIT POLICY IN TIMES OF FINANCIAL DISTRESS

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1. THE ISSUES & THE RECORD

- Forestalling financial panics
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- Developed nations 1870-1933 (Bordo, 1986)
  - 16 banks crises (runs, failures)
  - 30 financial crises (runs, failures, panics, stock market crashes)
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- Averting bank runs
- Managing credit supply
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- Developed nations 1870-1933 (Bordo, 1986)
  - 16 banks crises (runs, failures)
  - 30 financial crises (runs, failures, panics, stock market crashes)
- Crises defused by central bank action
  - Bank of England: 1878, 1890, 1914
  - Bank of France: 1882, 1889, 1930
  - Federal Reserve: 2008-2010(?)
2. TOOLS & LITERATURE

- Manipulating capital reserves
  - Recipies from Thornton (1802), Bagehot (1873), Rochet & Vives (2004)
  - Champ, Smith & Williamson (1996)
  - Deposit insurance
    - Diamond & Dybvig (1983)
    - Ennis & Keister (2010)
    - Martin (2006)
  - Role of private information
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- Evaluate two policies: capital reserves, LLR
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  \langle Kehoe & Levin(1993), Alvarez & Jermann(2000) \rangle 
- No private information or equilibrium default
- Ignore \{ deposit insurance, bailouts
  \\{ moral hazard, liquidity, default
3. GOALS OF THIS ESSAY

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  - deposit insurance, bailouts
  - moral hazard, liquidity, default
- Default successfully averted by debt limits on borrowers
4. FINANCIAL CRISES: CAUSES AND CURES

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- Dynamic complementarity: expected future credit conditions → value of borrower’s reputation → current credit conditions
- Bank panics triggered by adverse shocks to expectations of future credit supply
- Central Bank goal: offset adverse shocks to expected future debt limits
5. BASELINE MODEL

(a) Benchmark Economy

- Discrete time $t = 0, 1, ...$
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- Two groups of households $i = 1, 2$
  - equal mass
  - common preferences: $v^i_t = \sum_{s=0}^{\infty} \beta^s u(c^i_{t+s})$
  - alternating endowments with constant aggregate income
    $$(\omega^1_t, \omega^2_t) = \begin{cases} 
    (1+\alpha, 1-\alpha) & \text{if } t = 0, 2, \ldots \\
    (1-\alpha, 1+\alpha) & \text{if } t = 1, 3, \ldots 
    \end{cases}$$
  - with $0 < \alpha < 1$
5. BASELINE MODEL

- Budget and debt constraints

\[ c_t^i + b_{t+1}^i = \omega_t^i + R_t b_t^i \quad (1) \]

\[ b_t^i + L_t^i \geq 0 \quad (2) \]

\[
\left\{ 
\begin{array}{l}
  b_t^i = \text{claims of household } i \text{ on other households payable at time } t \\
  R_t = 1 + r_t = \text{yield on debt payable at time } t \\
  L_t^i = \text{debt limit for households } i \text{ at } t
\end{array}
\right.
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- Default
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  \[ c_t^i + b_{t+1}^i = \omega_t^i + R_t b_t^i \]  
  
  \[ b_t^i + L_t^i \geq 0 \]  

  - \( b_t^i \) = claims of household \( i \) on other households payable at time \( t \)
  
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  - \( L_t^i \) = debt limit for households \( i \) at \( t \)

- **Default**
  
  - implies perpetual financial autarky, i.e. exclusion from all future asset trades
  
  - value of default at \( t \)

  \[ v_{t,A}^{i,t} = \sum_{s=0}^{\infty} \beta^s u (\omega_{t+s}^i) \]
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  - consumers maximize $v_i^t$ s.t. (1) and (2)
  - market clears: $\sum_i b_t^i = 0, \forall t$
  - debt limits ($L_t^i$) are the largest values consistent with participation constraints

$$v_t^i \geq v_t^{i,A} \forall t, i$$

(3)
5. BASELINE MODEL

(b) Laissez-Faire Equilibrium w/o Financial Frictions

- Ignore participation constraint

\[ (c_i, R_t) = (1, 1/\beta) \quad \forall t, \quad i_t = \pm \alpha \beta^{1+\beta} \]

This equilibrium satisfies the constraint

\[ i_t \geq \alpha \beta / (1 + \beta) \quad \forall t, \quad i_t \]

equivalently the payoff from solvency exceeds that of default

\[ u(1) - \beta \geq u(1 + \alpha) + \beta u(1 - \alpha) \]
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- Ignore participation constraint
- Perfect consumption smoothing at symmetric (and optimal) equilibrium [cf. point E, Figure 1]

\[(c_t^i, R_t) = (1, 1/\beta) \ \forall t, i\]

\[b_t^i = \pm \frac{\alpha \beta}{1 + \beta}\]
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\[(c_t^i, R_t) = (1, 1/\beta) \quad \forall t, i\]

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- This equilibrium satisfies the constraint (3) iff

\[L_t^i \geq \alpha \beta / (1 + \beta) \quad \forall t, i\]
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- This equilibrium satisfies the constraint (3) iff

\[L^i_t \geq \alpha \beta / (1 + \beta) \ \forall t, i\]

- equivalently iff the payoff from solvency exceeds that of default

\[\frac{u(1)}{1 - \beta} \geq \frac{u(1 + \alpha) + \beta u(1 - \alpha)}{1 - \beta^2} \quad (4)\]
5. BASELINE MODEL

Steady states: $c_t^H = \begin{cases} 1 + \alpha & \text{suboptimal & robust} \\ \hat{x} & \text{optimal & fragile} \end{cases}$

FIGURE 1: FINANCIAL FRAGILITY UNDER LAISSEZ-FAIRE
5. BASELINE MODEL

(c) Equilibrium with Financial Frictions

Assume \( \{ \text{Arrow – Debreu allocation violates (4)} \} \)

\[ (1 + \beta) u(1) > u_A := u(1 + \alpha) + \beta u(1 - \alpha) \]  \hspace{1cm} (5)

\[ \bar{R} := \frac{u'(1 + \alpha)}{\beta u'(1 - \alpha)} < 1 \]  \hspace{1cm} (6)
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▶ Assume \( \{ \text{Arrow – Debreu allocation violates (4)} \} \) \( \Rightarrow \)

\[
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▶ Figure 1 illustrates; also shows golden rule allocation (GR)
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- Figure 1 illustrates; also shows golden rule allocation (GR)
- The allocation \((\hat{x}, 2 - \hat{x})\) at C is the constrained optimum
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(c) Equilibrium with Financial Frictions

Assume \( \{ \text{Arrow – Debreu allocation violates (4)}, \text{Autarky is a suboptimal allocation} \} \implies \)

\[
(1 + \beta) u(1) > u_A := u(1 + \alpha) + \beta u(1 - \alpha)
\]  (5)

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- Figure 1 illustrates; also shows golden rule allocation (GR)
- The allocation \((\hat{x}, 2 - \hat{x})\) at C is the constrained optimum
- CO maximizes SWF, the equal-treatment social welfare function \(u(x) + u(2 - x)\), s.t. resource & participation constraints
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- $\hat{x} \in [1, 1 + \alpha]$ is the smallest solution to

$$u(x) + \beta u(2 - x) = u_A \quad (7)$$
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\[ u(x) + \beta u(2 - x) = u_A \] (7)

- If $\hat{R} := \frac{u'(\hat{x})}{\beta u'(2 - \hat{x})}$, then the CO is also a stationary equilibrium at a loan yield $\hat{R}$, with

\[
(c_t^i, b_t^i) = \begin{cases} 
(\hat{x}, -\frac{1 + \alpha - \hat{x}}{1 + \hat{R}}) & \text{if } \omega_t^i = 1 + \alpha \\
(2 - \hat{x}, \frac{1 + \alpha - \hat{x}}{1 + \hat{R}}) & \text{if } \omega_t^i = 1 - \alpha
\end{cases}
\]
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\left(2 - \hat{x}, \frac{1 + \alpha - \hat{x}}{1 + \hat{R}}\right) & \text{if } \omega_t^i = 1 - \alpha
\end{cases}$$

- Autarky is also an equilibrium corresponding to

$$(R_t, c_t^i, b_t^i) = (\bar{R}, \omega_t^i, 0) \quad \forall t, i$$
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- Autarky is asymptotically stable: robust
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- CO equilibrium is fragile: requires that debt limits never fall below \( \frac{1 + \alpha - \hat{x}}{1 + \hat{R}} \)
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- Autarky is asymptotically stable: robust
- CO equilibrium is fragile: requires that debt limits never fall below $\frac{1 + \alpha - \hat{x}}{1 + \hat{R}}$
- Laissez-Faire dynamics in Figure 2 and eq.

$$u_A = u(x_t) + \beta u(2 - x_{t+1})$$  \hspace{1cm} (8)

$$x_t \in [1, 1 + \alpha]$$  \hspace{1cm} (9)
5. BASELINE MODEL

Steady states:

\[
\begin{align*}
\mathbf{c}^H_t &= \hat{x} \quad \longleftrightarrow \text{optimal & locally robust} \\
\mathbf{c}^H_t &= \bar{x} > \hat{x} \quad \longleftrightarrow \text{suboptimal & locally robust}
\end{align*}
\]
5. BASELINE MODEL

- Solving eq. (8) [cf. Fig. 2]

\[ x_{t+1} = f (x_t) \]  \hspace{2cm} (10)
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- Solving eq. (8) [cf. Fig. 2]

\[ x_{t+1} = f(x_t) \quad (10) \]

- with \( f \): increasing concave;
  \[ f(\hat{x}) = \hat{x}, \quad f(1 + \alpha) = 1 + \alpha \]
  \[ f'(\hat{x}) = \hat{R} \in (1, 1/\beta) \]
  \[ f'(1 + \alpha) = \overline{R} \in (0, 1) \]
6. ACTIVIST CREDIT POLICIES

(a) Central Bank as Intermediary

- Similarities with private FI’s
  - excludes defaulters from future asset trades

- Advantages over private FI’s
  - commitment to repay loans (cares about SWF)
  - power to extract and collateralize (small) reserves from lenders

- Disadvantages
  - reserves invested in inferior storage technology with low yield
  \[ R < 1 \]
  - LLR wastes exogenous fraction \( \delta \in (0, 1) \) of all CB deposits; converts \( 1 - \delta \) into CB loans
  - CB informational disadvantage:
    - higher cost of state verification
    - cannot exclude defaulters from future lending
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  - power to extract and collateralize (small) reserves from lenders
- Disadvantages
  - reserves invested in inferior “storage” technology with low yield \( \bar{R} < 1 \)
  - LLR “wastes” exogenous fraction \( \delta \in (0, 1) \) of all CB deposits; converts \( 1 - \delta \) into CB loans
  - CB informational disadvantage:
    \[
    \begin{align*}
    \{ & \text{higher cost of state verification;} \\
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    \} 
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    \]
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(b) Reserve Policies

- In equilibrium:
  aggregate consumption = endowment - investment in storage + returns from past storage
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- Equivalently,

\[ c_t^H + c_t^L = 2 - k_{t+1} + \bar{R}k_t \]
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- Capital reserves are small: \( 0 \leq k_t \leq \bar{k}, \quad \bar{k} \ll 1 \)
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- Countercyclical credit policy: \( k_{t+1} = \phi(x_{t+1}, k_t) \), mapping the 
  current state \( (x_{t+1}, k_t) \in [1, 1+\alpha] \times [0, \overline{k}] \) 
  of the economy into today’s reserve requirement.
(b) Reserve Policies

- In equilibrium:
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- Equivalently,
  \[ c_t^H + c_t^L = 2 - k_{t+1} + \bar{R}k_t \]
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- Countercyclical credit policy: \( k_{t+1} = \phi(x_{t+1}, k_t) \), mapping the current state \( (x_{t+1}, k_t) \in [1, 1 + \alpha] \times [0, \bar{k}] \) of the economy into today’s reserve requirement.
  - If autarky and the constrained optimum outcome are both steady states, then

\[ \phi(\hat{x}, 0) = \phi(1 + \alpha, 0) = 0 \quad (11) \]
6. ACTIVIST CREDIT POLICIES

- Desirable policy rules

\[ u(x_t) + \beta u(2 - x_t + 1 - k_t + 1 + R k_t) = u_A(12) \]

Solution to \((12)\) shown in Fig. 2 for \(k_t = k_t + 1 = k\)
6. ACTIVIST CREDIT POLICIES

- Desirable policy rules
  - remove fragility of optimal state

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- Solution to (12) shown in Fig. 2 for \( k_t = k_t + 1 = k \)
6. ACTIVIST CREDIT POLICIES

- Desirable policy rules
  - remove fragility of optimal state
  - reverse stability of no-lending state

\[ u(x_t) + \beta u(2 - x_t + 1 - k + R_k) = u_A(12) \]

\[ x_t + 1 = f(x_t) - k + 1 + R_k(13) \]

shown in Fig. 2 for \[ k_t = k_t + 1 = k \]
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  - guide economy to optimal state as quickly as possible
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- Rationing equilibria
  satisfy policy rule and analog of eq. (8), i.e.

\[ u(x_t) + \beta u(2 - x_{t+1} - k_{t+1} + Rk_t) = u_A \] (12)
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  satisfy policy rule and analog of eq. (8), i.e.

\[
u(x_t) + \beta u(2 - x_{t+1} - k_{t+1} + \bar{R}k_t) = u_A \quad (12)\]

- Sol’n to (12)

\[
x_{t+1} = f(x_t) - k_{t+1} + \bar{R}k_t \quad (13)\]

shown in Fig.2 for \(k_t = k_{t+1} = \bar{k}\)
7. CAPITAL RESERVES

(a) When loans have dried up
- CB rewards “good” behavior by lowering capital requirements; punishes “bad” behavior by raising them

(b) Policy near constrained optimum
7. CAPITAL RESERVES

(a) When loans have dried up
   ▶ CB rewards “good” behavior by lowering capital requirements; punishes “bad” behavior by raising them
   ▶ Economy guided away from autarky if capital requirements are maximal when $x \to 1 + \alpha$

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   - CB rewards “good” behavior by lowering capital requirements; punishes “bad” behavior by raising them
   - Economy guided away from autarky if capital requirements are maximal when \( x \to 1 + \alpha \)
   - Then \( \phi(x_{t+1}, k_t) = \bar{k} \) if \( 1 + \alpha - x_{t+1} \) small

(b) Policy near constrained optimum
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- Economy guided away from autarky if capital requirements are maximal when \( x \to 1 + \alpha \)
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(b) Policy near constrained optimum
- Achieving \( x_{t+1} = \hat{x} \) for any \( x_t \) near \( \hat{x} \)
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- CB rewards “good” behavior by lowering capital requirements; punishes “bad” behavior by raising them
- Economy guided away from autarky if capital requirements are maximal when $x \to 1 + \alpha$
- Then $\phi(x_{t+1}, k_t) = \bar{k}$ if $1 + \alpha - x_{t+1}$ small

(b) Policy near constrained optimum

- Achieving $x_{t+1} = \hat{x}$ for any $x_t$ near $\hat{x}$
- Eqs. (12) and (13) suggest

$$x_{t+1} = \hat{x} + \bar{R} k_t - k_{t+1} \quad (\Rightarrow)$$

$$k_{t+1} = \phi(x_{t+1}, k_t) = \bar{R} k_t + f(x_{t+1}) - \hat{x} \quad (14)$$
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- CB rewards “good” behavior by lowering capital requirements; 
  punishes “bad” behavior by raising them
- Economy guided away from autarky if capital requirements are maximal when \( x \to 1 + \alpha \)
- Then \( \phi(x_{t+1}, k_t) = k \) if \( 1 + \alpha - x_{t+1} \) small

(b) Policy near constrained optimum

- Achieving \( x_{t+1} = \hat{x} \) for any \( x_t \) near \( \hat{x} \)
- Eqs. (12) and (13) suggest

\[
x_{t+1} = \hat{x} + \bar{R}k_t - k_{t+1} \quad (\Rightarrow)
\]

\[
k_{t+1} = \phi(x_{t+1}, k_t) = \bar{R}k_t + f(x_{t+1}) - \hat{x} \quad (14)
\]
- \( \therefore \) Capital requirements overreact to deviations of equilibrium from the optimal state

\[
\left( \frac{\partial k_{t+1}}{\partial x_{t+1}} \right)_{x_{t+1} = \hat{x}} = \hat{R} \in \left( 1, \frac{1}{\beta} \right)
\]
7. CAPITAL RESERVES

(c) Policy far from Laissez-Faire states

▶ What if state of economy is far from the extremes of optimality and autarky?
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- Fig. 2 shows one of them: points near autarky may be stable
- CB response to large credit shocks fraught with peril if conducted through capital reserves
8. LENDING OF LAST RESORT

(a) CB as inefficient FI
   ▶ Wastes fraction $\delta$ of all household deposits

(b) Rationing equilibria
8. LENDING OF LAST RESORT

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   ▶ Wastes fraction $\delta$ of all household deposits
   ▶ Zero profit condition
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     \begin{aligned}
     \text{yield on deposits} &= R \\
     \text{yield on loans} &= R / (1 - \delta)
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  \delta \cdot (\text{Central Bank deposits}) = \frac{\delta}{1 - \delta} \cdot (\text{Central Bank loans})
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(b) Rationing equilibria

- Market clearing condition
  \[
  c_t^H + c_t^L = 2 - \frac{\delta}{1 - \delta} L_{t+1}
  \]  \hspace{1cm} (15)

  where \( L_{t+1} = \text{loans made by CB at } t \text{ and maturing at } t + 1 \)
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- Participation constraint
  \[
  u \left( c_t^H \right) + \beta u \left( c_{t+1}^L \right) = u_A
  \]  \hspace{1cm} (16)

  (assuming central bank excludes defaulters from both sides of credit market)
8. LENDING OF LAST RESORT

- Policy rule

\[ L_{t+1} = L \left( c_t^H \right) \]  \hspace{1cm} (17)
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- **Policy rule**

\[
L_{t+1} = L \left( c_t^H \right) \tag{17}
\]

- Setting \( c_t^H = x_t \in [1, 1+\alpha] \), we reduce (15), (16) and (17) to

\[
u( x_t ) + \beta u \left( 2 - x_{t+1} - \frac{\delta}{1-\delta} L(x_t) \right) = u_A \tag{18}
\]

Solving for \( x_{t+1} \):

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x_{t+1} = f(x_t) - \delta - \delta L(x_t)
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8. LENDING OF LAST RESORT

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The optimal policy rule

\[ L(x_t) = \frac{1 - \delta}{\delta} [f(x_t) - \hat{x}] \]  

(20)

rules out all equilibria except the optimal one. It implies that \( x_{t+1} = \hat{x} \) for any \( x_t \in [1, 1 + \alpha] \).
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Fig. 3 diagrams this rule and Fig. 4 compares laissez-faire equilibria with what occurs under an optimal policy.
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▶ Fig.3 diagrams this rule and Fig.4 compares laissez-faire equilibria with what occurs under an optimal policy.

▶ To achieve this outcome, the CB must react vigorously to any diminution of private credit below the optimal amount.
8. LENDING OF LAST RESORT

\[ L_{t+1} \quad \text{(Current CB loans)} \]

\[ \frac{1 - \delta}{\delta} [f(x_t) - f(x)] \]

Slope: \( \frac{1 - \delta}{\delta} \hat{R} \)

\( (\bar{x}, \hat{x}) \)

1 + \( \alpha \)

\( x_t \)

FIGURE 3: OPTIMAL LLR POLICY
8. LENDING OF LAST RESORT

**FIGURE 4: LOAN DYNAMICS UNDER OPTIMAL LLR POLICY**
8. LENDING OF LAST RESORT

CB in effect guarantees that total available credit will always be at its optimal value by standing ready to lend generously to solvent borrowers at a yield somewhat about the optimal, i.e.

$$R^L = \frac{\hat{R}}{1 - \delta}$$
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- The best a weak CB can do is guide economy to GR(cf. Fig. 4)
9. CONCLUSIONS AND EXTENSIONS

(a) Conclusions

- Manipulating capital reserves useful against small deviations from steady states; problematic for large shocks
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(a) **Conclusions**

- Manipulating capital reserves useful against small deviations from steady states; problematic for large shocks
- Last resort lending by informed CB an effective guarantee against panics in economies with complete markets / no private information
- Last resort lending by relative uninformed CB averts panics at the cost of never achieving the constrained optimum reached by laissez-faire in good times
(b) Extensions

- Separating FI’s from households
  - FI’s highly levered, prone to default: regulation needed
  - FI’s informational and scale advantages: do not over-regulate
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  - borrower’s private information [Rochet & Vives(2004), Martin(2006)]
  - bankruptcy and costly state verification (CSV) (Gale & Hellwig, 1985)
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- CB efficiency. CSV for FI’s and CB’s: Who is better at collecting information on borrowers?