Bank Runs, Fragility, and Regulation

Manuel Amador Javier Bianchi

July 2024

NBER Summer Institute

The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.

Motivation

Banking regulation proposals:

- Higher equity buffers to make banks less vulnerable to runs

Motivation

Banking regulation proposals:

- Higher equity buffers to make banks less vulnerable to runs

• Why banks choose *not* to hold more equity and make themselves less vulnerable?

Motivation

Banking regulation proposals:

- Higher equity buffers to make banks less vulnerable to runs

> • Why banks choose *not* to hold more equity and make themselves less vulnerable?

- Popular rationale: moral hazard due to bailouts

Motivation

Banking regulation proposals:

- Higher equity buffers to make banks less vulnerable to runs

> • Why banks choose *not* to hold more equity and make themselves less vulnerable?

- Popular rationale: moral hazard due to bailouts

Today: risk of bank runs induce banks to over-leverage even absent bailouts

A Theory of Banking Regulation

- General equilibrium model of banks runs (Amador-Bianchi 2024)
  - Analyze efficiency of ex-ante leverage decisions

A Theory of Banking Regulation

- General equilibrium model of banks runs (Amador-Bianchi 2024)
  - Analyze efficiency of ex-ante leverage decisions

A Theory of Banking Regulation

- General equilibrium model of banks runs (Amador-Bianchi 2024)
  - Analyze efficiency of ex-ante leverage decisions

In the absence of runs:

- Competitive equilibrium is constrained efficient

A Theory of Banking Regulation

- General equilibrium model of banks runs (Amador-Bianchi 2024)
  - Analyze efficiency of ex-ante leverage decisions

In the absence of runs:

- Competitive equilibrium is constrained efficient

With self-fulfilling runs:

- Competitive equilibrium exhibits excessive leverage

A Theory of Banking Regulation

- General equilibrium model of banks runs (Amador-Bianchi 2024)
  - Analyze efficiency of ex-ante leverage decisions

In the absence of runs:

- Competitive equilibrium is constrained efficient

With self-fulfilling runs:

- Competitive equilibrium exhibits excessive leverage

Mechanism:

- Higher equity buffers induce higher asset prices

  $\Rightarrow$ banks more "liquid" $\Rightarrow$ less prone to (inefficient) runs

Environment

- Three periods $t = 0, 1, 2$
  - Idiosyncratic risk only – realized at $t = 1$
- Technology
  - Production linear in capital
  - Capital in fixed supply K

Environment

- Three periods $t = 0, 1, 2$
  - Idiosyncratic risk only – realized at $t = 1$
- Technology
  - Production linear in capital
  - Capital in fixed supply K
- Continuum of banks with concave utility
  - Identical initial deposits and capital $b_0 = B_0, k_0 = K$
  - Constant productivity z under repayment
  - Can default at $t = 1, 2$ – outside option shock at $t = 1$
- Creditors: linear utility and discount rate R

Individual Bank Problem

Preferences and budget constraints

- Preferences

$$u(c_0) + \beta \mathbb{E} u(c_1) + \beta^2 \mathbb{E} u(c_2),$$

  where $u = \log$

Preferences and budget constraints

- Preferences

$$u(c_0) + \beta \mathbb{E} u(c_1) + \beta^2 \mathbb{E} u(c_2),$$

  where $u = \log$

- Budget constraints under **repayment**

$$c_0 = (z + p_0)k_0 - Rb_0 + q_0(b_1, k_1)b_1 - p_0 k_1,$$

$$c_1 = (z + p_1)k_1 - Rb_1 + q_1(b_2, k_2)b_2 - p_1 k_2,$$

$$c_2 = zk_2 - Rb_2.$$

where q_t is the bond price schedule and p_t the price of capital

Preferences and budget constraints

- Preferences

$$u(c_0) + \beta \mathbb{E} u(c_1) + \beta^2 \mathbb{E} u(c_2),$$

  where $u = \log$

- Budget constraints under **repayment**

$$c_0 = \overbrace{(z + p_0)k_0 - Rb_0}^{n_0} + q_0(b_1, k_1)b_1 - p_0 k_1,$$

$$c_1 = (z + p_1)k_1 - Rb_1 + q_1(b_2, k_2)b_2 - p_1 k_2,$$

$$c_2 = zk_2 - Rb_2.$$

where q_t is the bond price schedule and p_t the price of capital

Banks Outside Options: Default Values

Banks Outside Options: Default Values

- Default triggers
  - Loss in productivity or capital
  - Exclusion from borrowing and capital markets

Banks Outside Options: Default Values

- Period 2 value

$$V_2^D(k_2, z_2^D) = u(z_2^D k_2)$$

  - z_2^D is predetermined and common across banks.

- Period 1 value

$$V_1^D(k_1, z_1^D) = u(z_1^D k_1) + \beta u(z_2^D k_1)$$

  - z_1^D i.i.d. across banks – F is the CDF

Banks Outside Options: Default Values

- Period 2 value

$$V_2^D(k_2, z_2^D) = u(z_2^D k_2)$$

  - z_2^D is predetermined and common across banks.

- Period 1 value

$$V_1^D(k_1, z_1^D) = u(z_1^D k_1) + \beta u(z_2^D k_1)$$

  - z_1^D i.i.d. across banks – F is the CDF

V^D independent of prices (and increasing in k)

- Generates a standard endogenous borrowing limit

Period 2: Bank Problem

$$V_2(b_2, k_2) = \max_{d_2 \in \{0,1\}} \left\{ (1 - d_2) u(z k_2 - R b_2) + d_2 u(z_2^D k_2) \right\}$$

Default choice:

$$d_2(b_2, k_2) = \begin{cases} 1 & \text{if } R b_2 > \phi k_2, \text{where } \phi \equiv z - z_2^D \\ 0 & \text{otherwise,} \end{cases}$$

Period 1: Repayment Values

Period 1: Repayment Values

$$V_1^R(n_1) = \sup_{c_1, k_2 \geq 0, b_2} \left\{ u(c_1) + \beta u(zk_2 - Rb_2) \right\} \qquad \text{Without a run}$$

$$\text{s.t.} \quad c_1 = n_1 + b_2 - p_1 k_2$$

$$Rb_2 \leq \phi k_2$$

Period 1: Repayment Values

$$V_1^R(n_1) = \sup_{c_1, k_2 \geq 0, b_2} \left\{ u(c_1) + \beta u(zk_2 - Rb_2) \right\} \qquad \text{Without a run}$$

$$\text{s.t.} \quad c_1 = n_1 + b_2 - p_1 k_2$$

$$Rb_2 \leq \phi k_2$$

$$V_1^{Run}(n_1) = \sup_{c_1, k_2 \geq 0, b_2} \left\{ u(c_1) + \beta u(zk_2 - Rb_2) \right\} \qquad \text{With a run}$$

$$\text{s.t.} \quad c_1 = n_1 + b_2 - p_1 k_2$$

$$b_2 \leq 0 \qquad \text{can save but not borrow}$$

Period 1: Repayment Values

$$V_1^R(n_1) = \sup_{c_1, k_2 \geq 0, b_2} \left\{ u(c_1) + \beta u(z k_2 - R b_2) \right\} \qquad \text{Without a run}$$

$$\text{s.t.} \quad c_1 = n_1 + b_2 - p_1 k_2$$

$$R b_2 \leq \phi k_2$$

$$V_1^{Run}(n_1) = \sup_{c_1, k_2 \geq 0, b_2} \left\{ u(c_1) + \beta u(z k_2 - R b_2) \right\} \qquad \text{With a run}$$

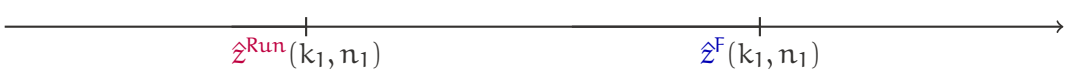
$$\text{s.t.} \quad c_1 = n_1 + b_2 - p_1 k_2$$

$$b_2 \leq 0 \qquad \text{can save but not borrow}$$

Vulnerable to self-fulfilling runs when $V_1^{Run}(n_1) < V_1^D(k_1, z_1^D) \leq V_1^R(n_1)$

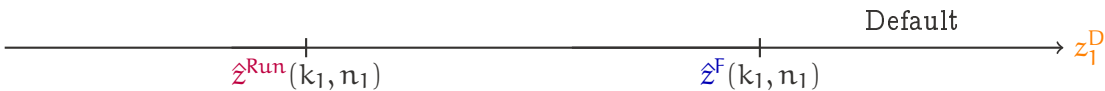
Period 1: Multiplicity of Equilibria

- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds



Period 1: Multiplicity of Equilibria

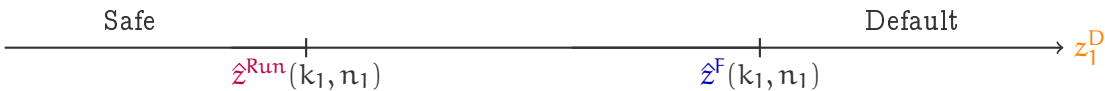
- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds



$$V_1^D(k_1, z_1^D) > V_1^R(n_1)$$

Period 1: Multiplicity of Equilibria

- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds

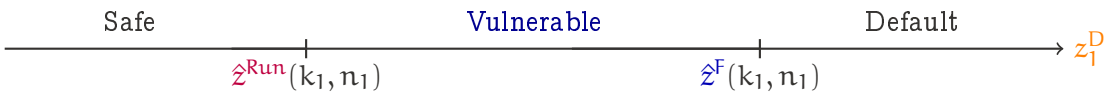


$V_1^{Run}(n_1) \geq V_1^D(k_1, z_1^D)$ $\qquad$ $V_1^D(k_1, z_1^D) > V_1^R(n_1)$

[Run & repay is off-equilibrium event]

Period 1: Multiplicity of Equilibria

- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds

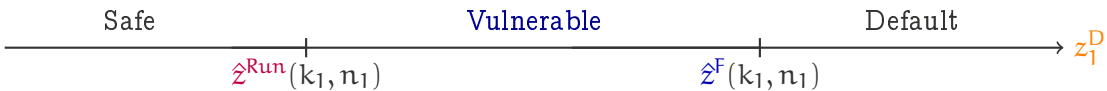


$V_1^{Run}(n_1) \geq V_1^D(k_1, z_1^D)$ $\quad V_1^{Run}(n_1) < V_1^D(k_1, z_1^D) \leq V_1^R(n_1)$ $\quad V_1^D(k_1, z_1^D) > V_1^R(n_1)$

[Run & repay is off-equilibrium event]

Period 1: Multiplicity of Equilibria

- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds

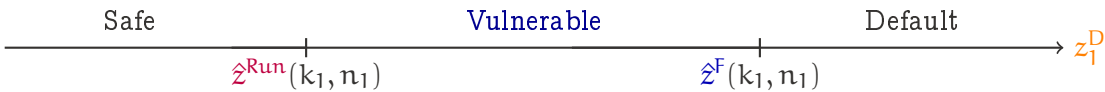


Runs occur despite assets being liquid (Amador-Bianchi 2024)

- When $R^K > R$, leverage raises expected profits
  - A run prevents bank from leveraging $\Rightarrow$ reduces profits and value of repayment $\Rightarrow$ run may become self-fulfilling, $\hat{z}^{Run} < \hat{z}^{F}$

Period 1: Multiplicity of Equilibria

- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds

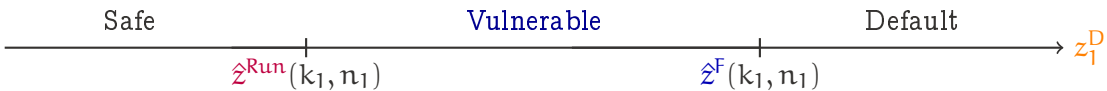


Runs occur despite assets being liquid (Amador-Bianchi 2024)

- When $R^K > R$, leverage raises expected profits
  - A run prevents bank from leveraging $\Rightarrow$ reduces profits and value of repayment $\Rightarrow$ run may become self-fulfilling, $\hat{z}^{Run} < \hat{z}^F$
- Instead, if $R^K = R$, defaults only occur due to fundamentals $\hat{z}^{Run} = \hat{z}^F$.

Period 1: Multiplicity of Equilibria

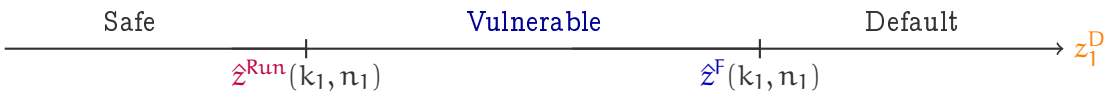
- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds



- Sunspot: If vulnerable, we assume a bank faces run with probability λ.

Period 1: Multiplicity of Equilibria

- Given portfolio (k_1, n_1) and p_1
  - Two default thresholds



- Sunspot: If vulnerable, we assume a bank faces run with probability λ.

$\Rightarrow$ Default probability for individual bank

$$d_1(n_1, k_1, z_1^D) = \begin{cases} 0 & \text{if } z_1^D \leq \hat{z}^{Run}(n_1, k_1) \\ \lambda & \text{if } \hat{z}^{Run}(n_1, k_1) < z_1^D \leq \hat{z}^F(n_1, k_1) \\ 1 & \text{if } z_1^D > \hat{z}^F(n_1, k_1) \end{cases}$$

Period 0: Value and Leverage Choice

$$V_0(n_0) = \max_{c_0 \geq 0, k_1 \geq 0, b_1} u(c_0)$$

$$+ \beta \int_{\underline{z}}^{\bar{z}} \left[d_1(n_1, k_1, \tilde{z}) V_1^D(k_1, \tilde{z}) + (1 - d_1(n_1, k_1, \tilde{z})) V_1^R(n_1) \right] dF(\tilde{z})$$

subject to

$$c_0 = n_0 + q_0(n_1, k_1) b_1 - p_0 k_1,$$
$$n_1 = (z + p_1) k_1 - R b_1.$$

where the bond price is given by

$$q_0(n_1, k_1) = (1 - \lambda) F(\hat{z}^F(n_1, k_1)) + \lambda F(\hat{z}^{Run}(n_1, k_1))$$

Period 0: Value and Leverage Choice

$$V_0(n_0) = \max_{c_0 \geq 0, k_1 \geq 0, b_1} u(c_0)$$

$$+ \beta \int_{\underline{z}}^{\bar{z}} \left[d_1(n_1, k_1, \tilde{z}) V_1^D(k_1, \tilde{z}) + (1 - d_1(n_1, k_1, \tilde{z})) V_1^R(n_1) \right] dF(\tilde{z})$$

subject to

$$c_0 = n_0 + q_0(n_1, k_1) b_1 - p_0 k_1,$$
$$n_1 = (z + p_1) k_1 - R b_1.$$

where the bond price is given by

$$q_0(n_1, k_1) = (1 - \lambda) F(\hat{z}^F(n_1, k_1)) + \lambda F(\hat{z}^{Run}(n_1, k_1))$$

Deposits allow for higher portfolio returns and c_0, but raises exposure to default

Competitive Equilibrium

Definition

Given B_0, and a run probability, λ, a *symmetric competitive equilibrium* consists of $\{p_0, p_1, q_0, \hat{z}^F, \hat{z}^{Run}, d_1, d_2, V_1^R, V_1^D, b_1, k_1, b_2, k_2\}$ such that:

(a) Banks optimize

(b) Investors break even

$$q_0(n_1, k_1) = (1-\lambda)F(\hat{z}^F(n_1, k_1)) + \lambda F(\hat{z}^{Run}(n_1, k_1))$$

(d) The market for capital clears

- Aggregate demand for capital equals K at $t = 0, 1$.

Equilibrium at $t = 1$

- Characterization in terms of **leverage** $l_1 = b_1/k_1$
  - Redefine thresholds as $\hat{z}^F(l_1|p_1)$, $\hat{z}^{Run}(l_1|p_1)$
  - In the aggregate $L_1 = b_1/K$

- Share of banks defaulting is increasing in L_1:

$$\underbrace{\left[1 - F(\hat{z}^F(L_1|p_1)\right]}_{\text{Fundamentals}} + \underbrace{\lambda\left[F(\hat{z}^F(L_1|p_1) - F(\hat{z}^{Run}(L_1|p_1)\right]}_{\text{Runs}}$$

- Price for capital p_1 decreasing in L_1 when banks are constrained

$$\mathcal{P}_1(L_1) \equiv \begin{cases} \frac{z}{R} & \text{if } L_1 \leq \hat{L}, \\ \beta z + (1+\beta)\frac{\phi}{R} - \beta R L_1 & \text{if } L_1 \in (\hat{L}, \bar{L}). \end{cases}$$

Roadmap for Normative Analysis

- Constrained-efficient planner problem
- Evaluate competitive equilibrium vs. constrained-efficient
  - Without runs $\lambda = 0$
  - With runs $\lambda > 0$

Constrained-Efficient Leverage

- Planner chooses L_1 and banks retain all other decisions
  - Market for capital clears competitively in period 1
  - Banks choose default decisions at $t = 1, 2$

Constrained-Efficient Leverage

- Planner chooses L_1 and banks retain all other decisions
  - Market for capital clears competitively in period 1
  - Banks choose default decisions at $t = 1, 2$

$$\max_{c_0, L_1} \left\{ u(c_0) + \beta \int_{\underline{z}}^{\overline{z}} \left[d_1(L_1, \tilde{z}|p_1) V_1^D(K, \tilde{z}) + (1 - d_1(L_1, \tilde{z}|p_1)) V_1^R(n_1|p_1) \right] dF(\tilde{z}) \right\},$$

subject to:

$$c_0 = zK - RB_0 + q_0(L_1|p_1)L_1K,$$

and where:

$$n_1 = (z + p_1)K - RL_1K, \quad p_1 = \mathcal{P}_1(L_1), \text{and } d_1 \text{ as defined above}$$

Constrained-Efficient Leverage

- Planner chooses L_1 and banks retain all other decisions
  - Market for capital clears competitively in period 1
  - Banks choose default decisions at $t = 1, 2$

$$\max_{c_0, L_1} \left\{ u(c_0) + \beta \int_{\underline{z}}^{\overline{z}} \left[d_1(L_1, \tilde{z}|p_1) V_1^D(K, \tilde{z}) + (1 - d_1(L_1, \tilde{z}|p_1)) V_1^R(n_1|p_1) \right] dF(\tilde{z}) \right\},$$

subject to:

$$c_0 = zK - RB_0 + q_0(L_1|p_1)L_1K,$$

and where:

$$n_1 = (z + p_1)K - RL_1K, \;\; p_1 = \mathcal{P}_1(L_1), \text{and } d_1 \text{ as defined above}$$

Creditors remain indifferent

Analysis without Runs

Proposition (Constrained-efficiency)

Suppose $\lambda = 0$. Any competitive equilibrium is constrained efficient.

Prelude for the Proof

Lemma: Consider any aggregate leverage L_1 and its associated price $p_1 = \mathcal{P}_1(L_1)$

(i) $V_1^R((z+)K - RKL_1|p_1) \leq V_1^R((z+\hat{p}_1)K - RKL_1|\hat{p}_1)$;

(ii) $q_0(L_1|p_1) \leq q_0(L_1|\hat{p}_1)$,

with the first inequality is strict if $\hat{p}_1 \neq p_1$.

Key idea:

- In equilibrium, banks are neither net buyers nor net sellers
  - If price deviates from eqm. one, value of repayment goes up (for same leverage).

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

- In the competitive eqm., banks prefer (L^E, K) rather than (L^P, K) when facing p_1^E:

$$u\big(zK - RB_0 + q_0(L^E|p_1^E)L^E K\big) + \beta \mathbb{E} V_1(L^E, K|p_1^E)$$

$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^E)L^P K\big) + \beta \mathbb{E} V_1(L^P, K|p_1^E).$$

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

- In the competitive eqm., banks prefer (L^E, K) rather than (L^P, K) when facing p_1^E:

$$u\big(zK - RB_0 + q_0(L^E|p_1^E)L^E K\big) + \beta \mathbb{E}V_1(L^E, K|p_1^E)$$

$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^E)L^P K\big) + \beta \mathbb{E}V_1(L^P, K|p_1^E).$$

$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^P)L^P K\big) + \beta \mathbb{E}V_1(L^P, K|p_1^P)$$

By prev. lemma: $\mathbb{E}V_1(L^P, K|p_1^E) \geq \mathbb{E}V_1(L^P, K|p_1^P)$

and $q_0(L^P|p_1^E) \geq q_0(L^P|p_1^P)$

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

- In the competitive eqm., banks prefer (L^E, K) rather than (L^P, K) when facing p_1^E:

$$u\big(zK - RB_0 + q_0(L^E|p_1^E)L^E K\big) + \beta \mathbb{E} V_1(L^E, K|p_1^E)$$

$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^P)L^P K\big) + \beta \mathbb{E} V_1(L^P, K|p_1^P)$$

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

- In the competitive eqm., banks prefer (L^E, K) rather than (L^P, K) when facing p_1^E:

$$u\big(zK - RB_0 + q_0(L^E|p_1^E)L^E K\big) + \beta \mathbb{E} V_1(L^E, K|p_1^E)$$
$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^P)L^P K\big) + \beta \mathbb{E} V_1(L^P, K|p_1^P)$$

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

- In the competitive eqm., banks prefer (L^E, K) rather than (L^P, K) when facing p_1^E:

$$u\big(zK - RB_0 + q_0(L^E|p_1^E)L^E K\big) + \beta \mathbb{E} V_1(L^E, K|p_1^E)$$
$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^P)L^P K\big) + \beta \mathbb{E} V_1(L^P, K|p_1^P)$$

$\Rightarrow$ Banks can achieve weakly higher utility than planner.

Proof of Constrained-Efficiency with $\lambda = 0$

Let L^E and L^P be the competitive eqm. and planner's leverage

Associated prices: $p_1^E = \mathcal{P}(L^E)$ and $p_1^P = \mathcal{P}(L^P)$

- In the competitive eqm., banks prefer (L^E, K) rather than (L^P, K) when facing p_1^E:

$$u\big(zK - RB_0 + q_0(L^E|p_1^E)L^E K\big) + \beta \mathbb{E} V_1(L^E, K|p_1^E)$$
$$\geq u\big(zK - RB_0 + q_0(L^P|p_1^P)L^P K\big) + \beta \mathbb{E} V_1(L^P, K|p_1^P)$$

$\Rightarrow$ Banks can achieve weakly higher utility than planner.

But planner can also choose L^E.

$\Rightarrow$ L^E must solve the planner's problem

Uniqueness and Existence

Proposition (Uniqueness)

Suppose that: (i) there is a unique solution to the planner problem, or (ii) there exists a competitive equilibrium with leverage $L_1 = B_1/K > \hat{L}$.

Then, there is at most one (symmetric pure-strategy) competitive equilibrium.

Proposition (Existence)

Suppose that Assumption 2 holds and

i) f *is continuous and such that* $f(\underline{z}) = f(\overline{z}) = 0$.

ii) $\left[\frac{1-F(z)}{1+\beta} + \frac{f(z)}{F(z)}z\right]$ *is decreasing in* z *for any* $z \in [\underline{z}, \overline{z}]$.

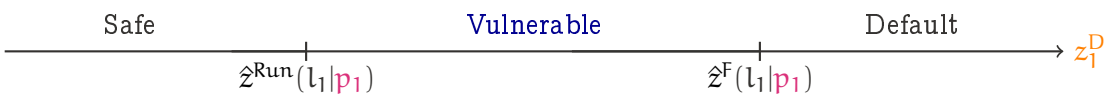
Then, there $\exists$ a competitive equilibrium.

Available theorems with default risk only in *partial equilibrium*

Economy with runs $\lambda > 0$

Preview: Thresholds as a Function of Aggregate Leverage

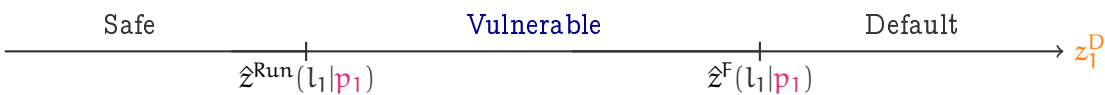
Start from $l_1 = L_1$ and consider a reduction in L_1



Preview: Thresholds as a Function of Aggregate Leverage

Start from $l_1 = L_1$ and consider a reduction in L_1 $\Rightarrow$ raises p_1

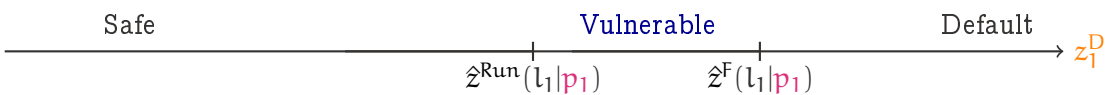
- Zero *first-order* effects on $\hat{z}^F$ (neither net buyer nor net seller)



Preview: Thresholds as a Function of Aggregate Leverage

Start from $l_1 = L_1$ and consider a reduction in L_1 $\Rightarrow$ raises p_1

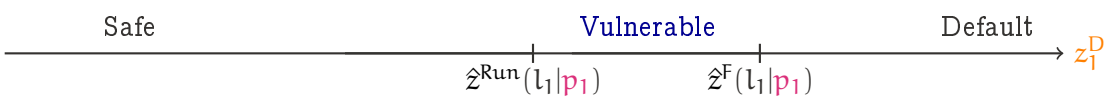
- Zero *first-order* effects on $\hat{z}^F$ (neither net buyer nor net seller)
- But $\uparrow \hat{z}^{Run}$ because banks are net sellers in a run



Preview: Thresholds as a Function of Aggregate Leverage

Start from $l_1 = L_1$ and consider a reduction in L_1 $\Rightarrow$ raises p_1

- Zero *first-order* effects on $\hat{z}^F$ (neither net buyer nor net seller)
- But $\uparrow \hat{z}^{Run}$ because banks are net sellers in a run
  - Not internalized by individual banks



Over-leverage with $\lambda > 0$

$$\frac{1}{c_0} - \frac{\beta R}{c_1} = -\frac{(1-\lambda) f(\hat{z}^F) \frac{\partial \hat{z}^F}{\partial L_1} + \lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{L_1}{c_0}$$

$$- \frac{\lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{\beta}{K} \left[V_1^R(n_1|p_1) - V_1^D(K, \hat{z}^{Run}) \right]$$

$$- \frac{\lambda f(\hat{z}^{Run})}{q_0} \underbrace{\frac{\partial \hat{z}^{Run}(L_1|p_1)}{\partial p_1} \mathcal{P}_1'(L_1)}_{\text{G.E.}} \left[\frac{L_1}{c_0} + \frac{\beta}{K} \left[V_1^R(n_1|p_1) - V_1^D(K, \hat{z}^{Run}) \right] \right]$$

Over-leverage with $\lambda > 0$

$$\frac{1}{c_0} - \frac{\beta R}{c_1} =$$

Over-leverage with $\lambda > 0$

$$\frac{1}{c_0} - \frac{\beta R}{c_1} = -\frac{(1-\lambda) f(\hat{z}^F) \frac{\partial \hat{z}^F}{\partial L_1} + \lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{L_1}{c_0}$$

Higher L_1 reduces q_0

Over-leverage with $\lambda > 0$

$$\frac{1}{c_0} - \frac{\beta R}{c_1} = -\frac{(1-\lambda) f(\hat{z}^F) \frac{\partial \hat{z}^F}{\partial L_1} + \lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{L_1}{c_0}$$

Higher L_1 reduces q_0

$$-\frac{\lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{\beta}{K} \left[V_1^R(n_1|p_1) - V_1^D(K, \hat{z}^{Run}) \right]$$

Higher L_1 raises run prob

Over-leverage with $\lambda > 0$

$$\frac{1}{c_0} - \frac{\beta R}{c_1} = -\frac{(1-\lambda) f(\hat{z}^F) \frac{\partial \hat{z}^F}{\partial L_1} + \lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{L_1}{c_0}$$

Higher L_1 reduces q_0

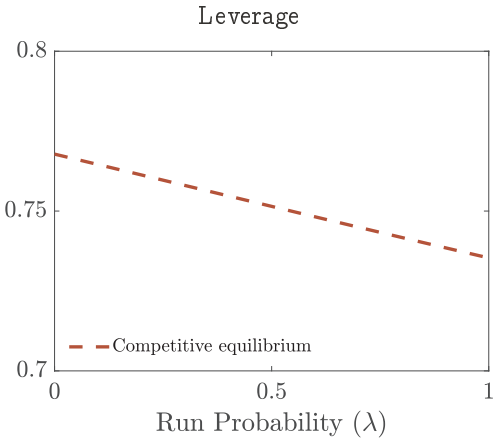
$$-\frac{\lambda f(\hat{z}^{Run}) \frac{\partial \hat{z}^{Run}}{\partial L_1}}{q_0} \frac{\beta}{K} \left[V_1^R(n_1|p_1) - V_1^D(K, \hat{z}^{Run}) \right]$$

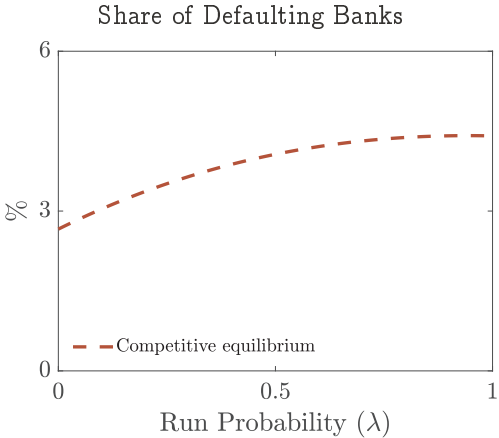
Higher L_1 raises run prob

$$-\frac{\lambda f(\hat{z}^{Run})}{q_0} \underbrace{\frac{\partial \hat{z}^{Run}(L_1|p_1)}{\partial p_1} \mathcal{P}_1'(L_1)}_{\text{G.E.}} \left[\frac{L_1}{c_0} + \frac{\beta}{K} \left[V_1^R(n_1|p_1) - V_1^D(K, \hat{z}^{Run}) \right] \right]$$

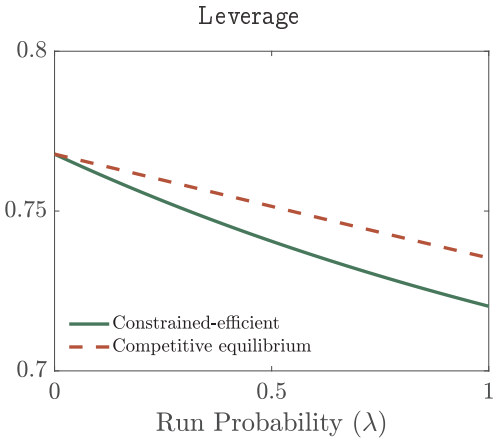
- An increase in p_1 helps $\uparrow V^{Run}$ because banks facing a run are net sellers $k_1^{Run} < K \Rightarrow$ fewer banks vulnerable
- Planner internalizes that $\downarrow L_1$ leads to $\uparrow p_1$ and fewer runs

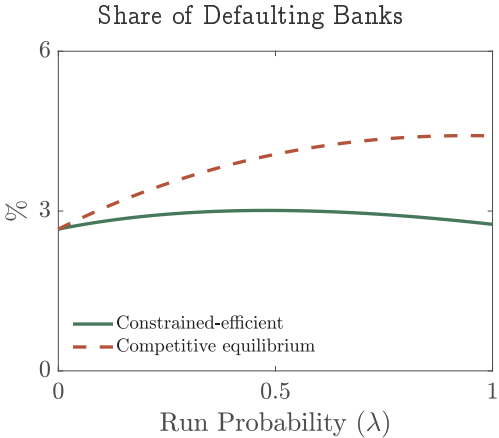
Competitive Eqm. vs. Constrained Efficient





Competitive Eqm. vs. Constrained Efficient

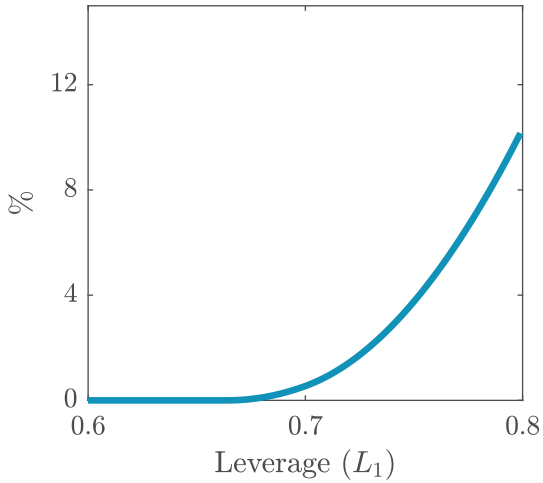




Conclusions

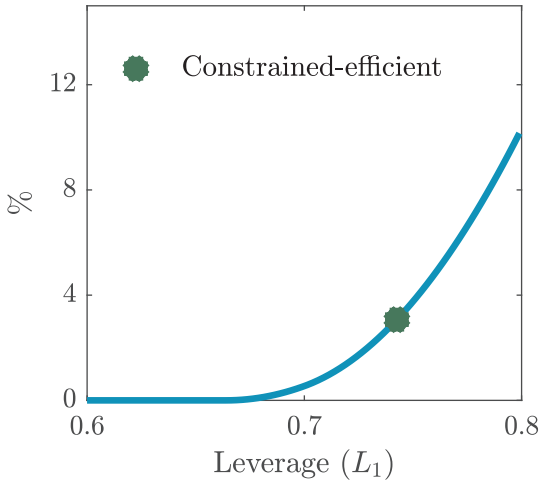
- A macroprudential theory of banking regulation under self-fulfilling runs
- Banks do not internalize that by raising leverage
  - they contribute to lower asset prices
  - making other banks more vulnerable to runs
- Higher capital requirements can implement the constrained-efficient allocation

Share of Defaulting Banks



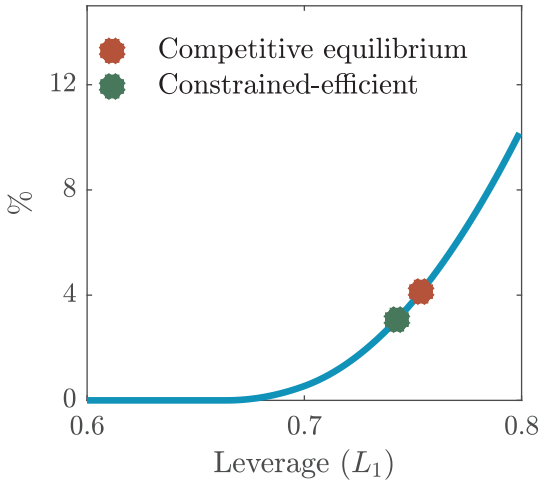
Back

Share of Defaulting Banks



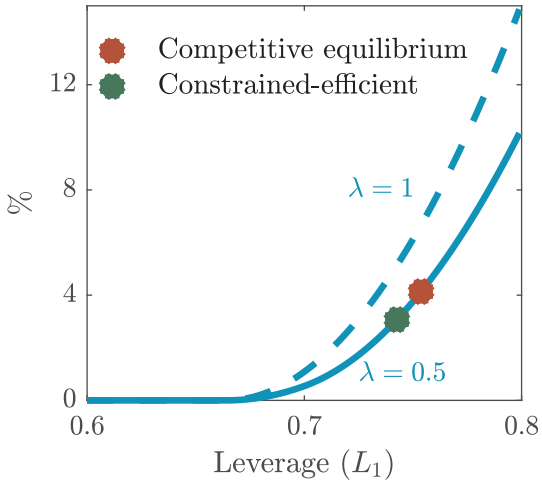
Back

Share of Defaulting Banks



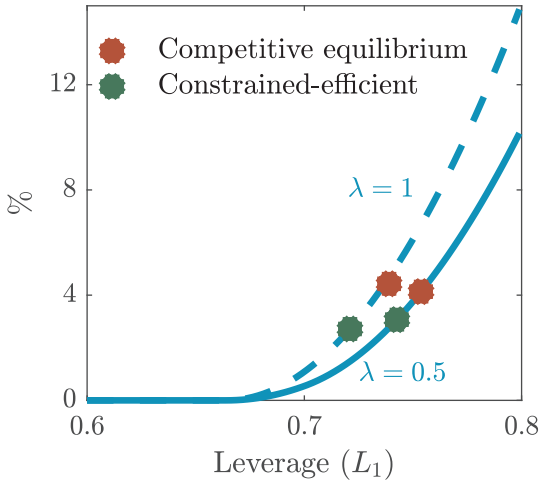
Back

Share of Defaulting Banks



Back

Share of Defaulting Banks



Back