Bank Fragility and Liquidity in Business-Cycle Analysis[a]

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[a]This paper represents our own views, not necessarily those of the European Central Bank or Eurosystem.

Introduction

Model of endogenous runs on financial intermediaries

- within standard macro framework.

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Macroeconomic effects of supply of liquid assets (e.g., treasuries)?

– It reduces run risk $\implies$ supports lending.

Literature

Macro-banking: Gertler and Kiyotaki (2010), Gertler and Karadi (2011), Brunnermeier and Sannikov (2014), Gertler, Kiyotaki, and Prestipino (2020), Karadi and Nakov (2021).

$\rightarrow$ different friction.

Banking theory: Diamond and Dybvig (1983), Goldstein and Pauzner (2005).

$\rightarrow$ in general equilibrium.

Demand for reserves/liquid assets: Poole (1968), Bianchi and Bigio (2022).

$\rightarrow$ different micro-foundation.

Roadmap

1. Coordination game among bank creditors.

   $\implies$ no-run condition.

2. Macro model
   - Four agents: firms, households, banks and a government.
   - General equilibrium and shocks.

3. Quantitative exercise.

4. Empirical evidence.

Bank fragility

• $m = \frac{M}{K+M}$, • $n = \frac{N}{K+M}$, • $\lambda \in [0,1]$ liquidation value of capital.

At beginning of period, each bank $b \in [0,1]$

- offers debt D to households at interest rate j, and
- makes portfolio allocation decision s.t. $K + M = D + N$.

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- Leverage and liquidity choices determine fragility.

Coordination game

• $H = \int_0^1 H_h \,\mathrm{d}h$, • ρ HH discount rate, • j interest on debt,
• θ loss given default.

Each household $h \in [0,1]$ decides $H_h \in \{0,1\}$, i.e. whether to hold a bank's debt.

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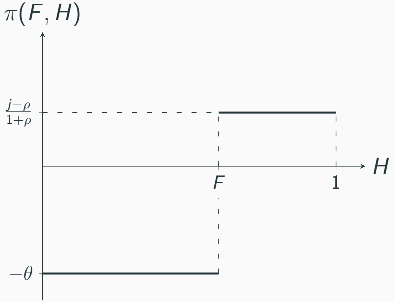
A household's net payoff from holding bank debt:

$$\pi(F, H) = -1 + \frac{1 + j}{1 + \rho} \mathbb{1}_{H \geq F} + (1 - \theta) \left(1 - \mathbb{1}_{H \geq F}\right)$$



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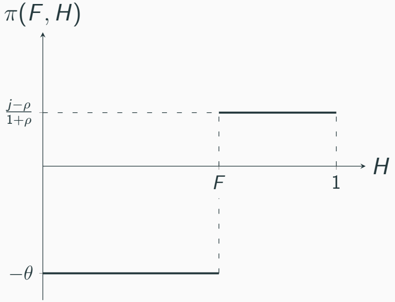

Information structure: • (F,H) unobservable, • arbitrarily precise idiosyncratic signal $\hat{F}_h$.

→ Standard global game.

No-run constraint

• $m = \frac{M}{K+M}$, • $n = \frac{N}{K+M}$, • $\lambda \in [0,1]$ liquidation value of capital.

Standard global game $\implies$ households behave as if $\hat{F}_h = F$ and $H \sim \text{U}[0,1]$.

Lemma

Unique equilibrium strategy implies $H_h = 1$ only if $\hat{F}_h \leq F^*(j,\rho)$ with

$$\frac{j-\rho}{1+\rho} = \frac{F^*}{1-F^*}\theta. \tag{1}$$

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Proposition

In equilibrium, the bank avoids failure only if $F(m,n) \leq F^*(j,\rho)$.
The resulting no-run condition is

$$m + \frac{1}{1-\lambda} \cdot n + \frac{\lambda + (1-\lambda)m}{\theta(1-\lambda)} \cdot \frac{j-\rho}{1+\rho} \geq 1. \tag{2}$$

Bank's optimality conditions ▸ Bank problem

• r_t expected return on physical capital, • i_t interest on liquid assets.

Bank maximizes PDV(dividends) s.t. BCs, no-run condition and minimum dividend payout.

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Given $\{r_s\}_{s=t}^{+\infty}$ with $\frac{r_t-\rho_t}{1+\rho_t} \in \left(0, \theta\frac{1-\lambda}{\lambda}\right)$, **FOCs imply:**

- binding no-run condition

$$K_t = \frac{1}{1-\frac{\lambda}{\theta}\left(\frac{j_t-\rho_t}{1+\rho_t}+\theta\right)}\left(N_t + \frac{1}{\theta}\frac{j_t-\rho_t}{1+\rho_t}M_t\right), \qquad (3)$$

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- optimal bank leverage pinned down by

$$\frac{j_t-\rho_t}{1+\rho_t} = \max\left\{0, \frac{\theta}{\lambda}\left[1-\lambda-\sqrt{1-\frac{\lambda}{\theta}\left(\frac{r_t-\rho_t}{1+\rho_t}+\theta\right)}\right]\right\}, \tag{4}$$

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- demand for liquid assets

$$\frac{\rho_t-i_t}{1+\rho_t} = \frac{1}{\theta}\left(\frac{j_t-\rho_t}{1+\rho_t}\right)^2. \tag{5}$$

Calibration: targets and parameters

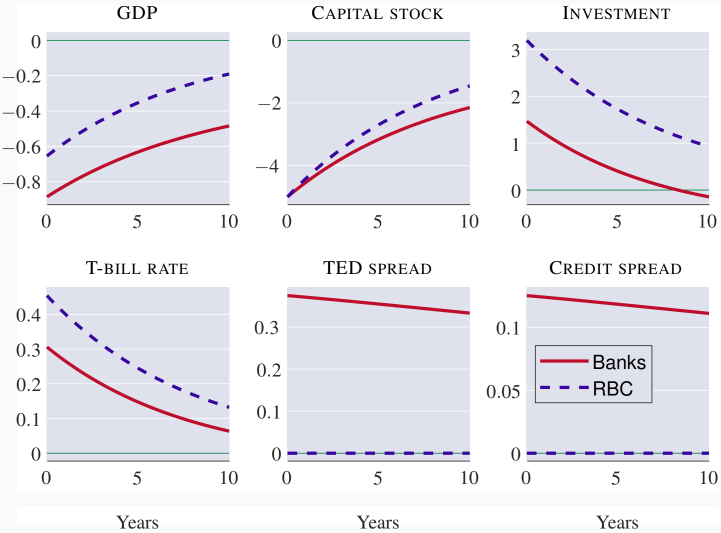
- A model period is one month.
- Data 1986–2006.

Description	Notation	Value
Real Treasury Bill rate	i	1.4%
TED spread	$j - i$	0.63%
Real return on bank equity	q	10.8%
Bank capital ratio	n	7.9%
Liquidity ratio	m	20.8%

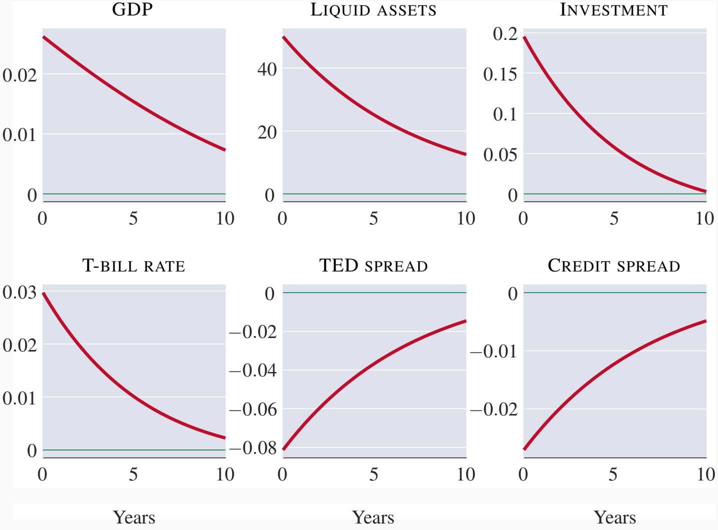
Description	Notation	Value
Bank-asset liquidity relative to T-bills	λ	0.822
Loss given bank default	θ	0.0068
Minimum dividend distribution	γ	0.0090
Subjective discount factor	β	0.9988
Elasticity of intertemporal substitution	σ	0.5
Frisch elasticity of labour supply	ψ	1
Capital elasticity of output	α	1/3
Depreciation	δ	0.0063

One-off 5% capital destruction shock

▸ Additional variables



Increase in supply of liquid assets



Empirics: does liquidity reduce spreads?

OLS regressions with **daily** data of TED spread, LIBOR, and T-bill rate on supply of treasuries

- 2005-2022.
- Controls: day, month, year dummies, FOMC dates, NBER recessions, lags of TED spread, LIBOR, T-bill rate, 10-year treasury yield, corporate bond yield, S&P500, S&P financials index
- Identification: supply of treasuries does not respond to endogenous variables *within a day*.

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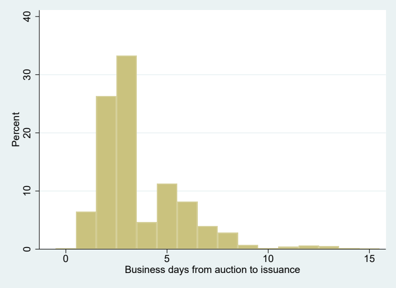
- Identification: supply of treasuries does not respond to endogenous variables *within a day*.
- Issuance of treasuries predetermined at auctions



Empirics: effects of Treasury issuance

	(1)	(2)	(3)
	TED spread	LIBOR	T-bill rate
Treasuries	-0.028***	-0.007*	0.021***
	(0.2%)	(6.5%)	(0.8%)

p-values in parentheses. * $p < 10\%$, ** $p < 5\%$, *** $p < 1\%$.
Treasuries are log-transformed and multiplied by 100.
Standard errors are bootstrapped with 1000 draws.

Conclusion

RBC model + bank fragility.

Coordination game among bank creditors:

1. Fragility is costly because funding costs $\uparrow$.
2. Leverage $\downarrow$ and liquidity $\uparrow \implies$ fragility $\downarrow$.

Macro model:

1. Demand for liquid assets.
2. Amplification and propagation of shocks via spreads.
3. Liquidity supports bank lending and activity.

Quantitative exercise: After capital-destruction shock, GDP falls 40% more and more persistently.

Empirical evidence implies liquidity supply reduces spreads.

Bank's problem ▸ Back

Given prices $\{i_t, r_t, \rho_t\}_{t=0}^{+\infty}$ and init. cond. N_0, bank sets $\{D_t, K_t, M_t, j_t, N_{t+1}, \Pi_{t+1},\}_{t=0}^{+\infty}$ to maximize

$$\sum_{t=0}^{+\infty} \beta^t \frac{u'(C_t)}{u'(C_0)} \cdot \Pi_t \tag{6}$$

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subject to:

$$D_t + N_t = K_t + M_t, \tag{7}$$

$$N_{t+1} = (1 + r_t)K_t + (1 + i_t)M_t - (1 + j_t)D_t - \Pi_{t+1}, \tag{8}$$

$$j_t \geq \rho_t, \tag{9}$$

$$K_t \leq \frac{1}{1 - \frac{\lambda}{\theta}\left(\frac{j_t - \rho_t}{1+\rho_t} + \theta\right)} \left(N_t + \frac{1}{\theta}\frac{j_t - \rho_t}{1 + \rho_t} M_t\right), \tag{10}$$

$$\Pi_t \geq \gamma N_t. \tag{11}$$

One-off 5% capital destruction shock - additional

Back