Banking Competition and Stability: The Role of Leverage

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- Motivations
- Contributions
- Linkages

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Endogenous Leverage

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Contradicting Theories

- Charter value theories, Keeley (1990):
  - banks choosing risk
  - competition erodes ‘charter value’, incentivizing risk-taking
- Risk-shifting hypothesis, Boyd and De Nicolo (2005):
  - banks inheriting risk from firms
  - high loan rate reduces entrepreneurs’ skin in the game
- Buffer effects of profits, Martinez-Miera and Repullo (2010):
  - monopolistic profit of banks is a capital buffer
  - non-monotonic relationship between competition and stability
- All focusing on insolvency risk.

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Does banking *competition* lead to *instability*?

Paper	Risk	Competition	Results	Data Source
Keeley (1990)	Interest Cost	Tobin's q	Yes	US
Demsetz, Saidenberg, and Strahan (1996)	Stock Volatility	Market-Book Value	Yes	US
Brewer and Saidenberg (1996)	Stock Volatility	Market-Book Value	Yes	US S&L banks
Jayaratne and Strahan (1996, 1998)	NPLs	Deregulation	No	US
Salas and Saurina (2003)	Loan Loss	Tobin's q	Yes	Spain
De Nicolo and Loukoianova (2005)	Z-Score	HHI	No	Non-industrialized
Beck, Demirgüç-Kunt, and Levine (2006)	Crisis Dummy	Concentration	Yes	Cross-Country
Beck, Demirgüç-Kunt, and Levine (2006)	Crisis Dummy	Contestability	No	Cross-Country
Dick (2006)	Loan Loss	Deregulation	Yes	US
Yeyati and Micco (2007)	Z-Score & NPLs	P-R H-Stat.	Yes	Latin America
Schaeck and Cihák (2010a)	Capitalization	P-R H-Stat.	No	Developed Countries
Dell'Ariccia, Igan, and Laeven (2008)	Lending standard	Number of banks	Yes	US
Boyd and Jalal (2009)	Loan Loss	HHI	No	US/Cross-Country
Boyd and Jalal (2009)	Z-Score	HHI	No	US/Cross-Country
Boyd, De Nicolo, and Loukoianova (2009)	Crisis Dummy	HHI/C3	No	Cross-Country
Berger, Klapper, and Turk-Ariss (2009)	NPLs	Lerner Index/HHI	No	Developed Countries
Berger, Klapper, and Turk-Ariss (2009)	Z-Score	Lerner Index/HHI	Yes	Developed Countries
Schaeck, Cihák, and Wolfe (2009)	Crisis Dummy	P-R H-Stat.	No	Cross-Country
Schaeck, Cihák, and Wolfe (2009)	Duration until crisis	P-R H-Stat.	No	Cross-Country
Schaeck and Cihák (2010b)	Z-Score	Boone's Indicator	No	US/EU
Jiménez, Lopez, and Salas (2013)	NPLs	Lerner Index	Yes	Spain
Jiménez, Lopez, and Salas (2013)	NPLs	HHI/C5	No	Spain
Beck, Jonghe, and Schepens (2011)	Z-Score	Lerner Index	Yes	Cross-Country
De Nicolo and Ariss (2010)	Z-Score	Deposit market rent	Yes	Europe
De Nicolo and Ariss (2010)	Z-Score	Loan market rent	No	Europe
Dick and Lehnert (2010)	Personal bankruptcy	Deregulation	Yes	US
Dick and Lehnert (2010)	NPLs/risk management	Deregulation	No	US
Anginer, Demirgüç-Kunt, and Zhu (2012)	D-to-D Correlation	Lerner Index	No	Cross-Country

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Contribution: Multi-tier Risk & Endogenous Leverage

- The concept of financial stability should be refined.
- The banking system faces more than insolvency risk:
  - loan default risk – borrow risk-shifting
  - portfolio risk – imperfectly correlated loan defaults
  - solvency risk – adjusted by endogenous leverage
  - funding liquidity risk – coordination failure
  - systemic risk – contagion due to distressed market condition
- **Competition affects different types of risk differently**
- Endogenous leverage
  - responding to: portfolio risk
  - affecting solvency, liquidity and systemic risk
- **Competition-risk v.s. competition-leverage-risk**

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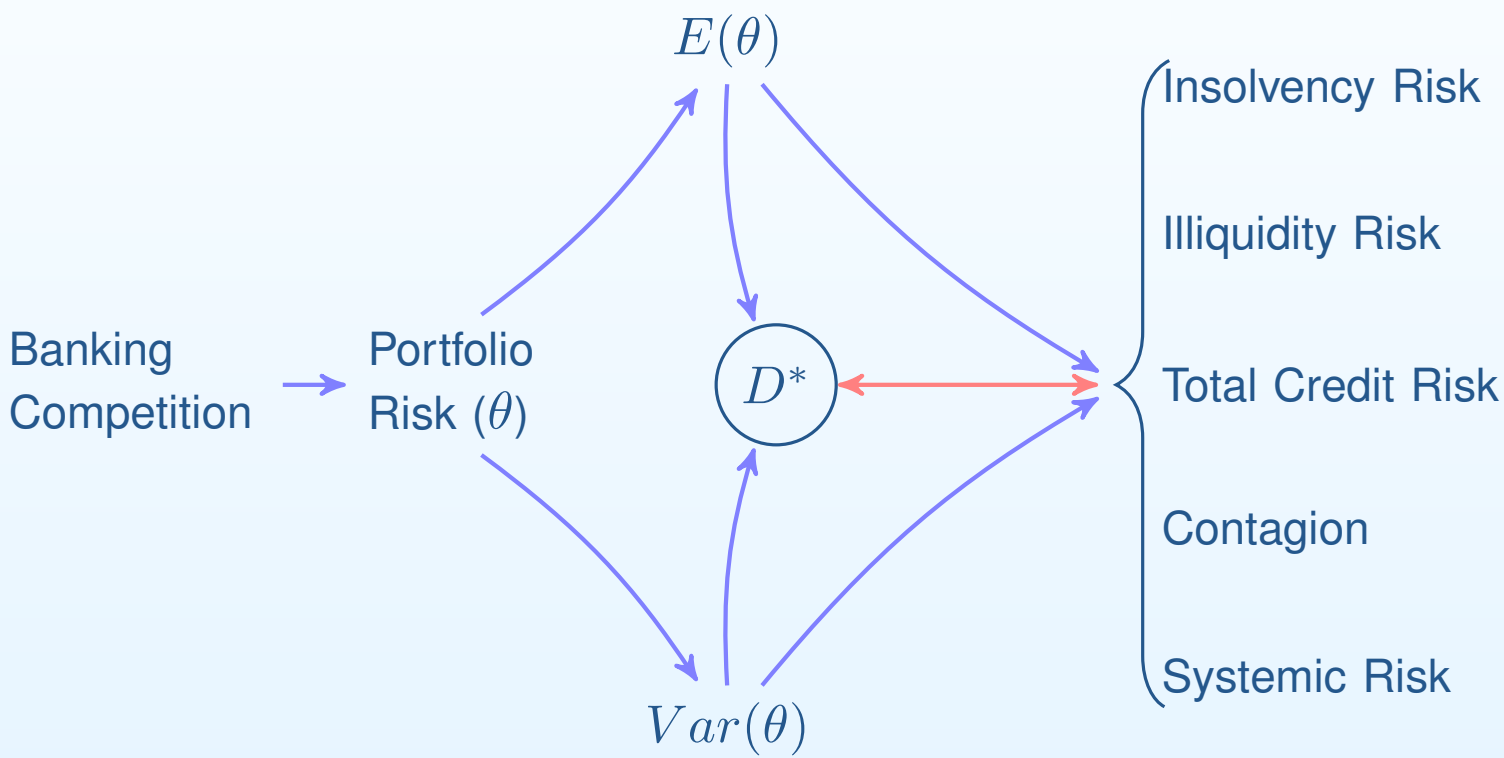
Banking Competition, Leverage and Various Risk



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Entrepreneurs: Loan Default Risk

- Projects of entrepreneurs'
  - costs 1, gross return x if succeeds, 0 if fails
  - repays loan r if succeeds
- Entrepreneur moral hazard: choosing probability of success P

$$U_E = P(x - r) - \frac{1}{2b}P^2.$$

$b \sim U(0, B)$ representing entrepreneur types (full market coverage)

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Aggregate Risk: Portfolio Risk

- Loan defaults also affected by a common risk $z \sim N(0,1)$
- Default represented by a random variable y.

$$y = -\Phi^{-1}(1-P) + z$$

When $y < 0$, the project fails.

$$\begin{aligned} Prob(y \leq 0) &= Prob(z \leq \Phi^{-1}(1-P)) \\ &= \Phi(\Phi^{-1}(1-P)) \\ &= 1-P \end{aligned}$$

- Common risk for correlated defaults
- Heterogenous types b for imperfect correlation
- Portfolio generating cash flow θ

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Banks: Insolvency Risk

- Financing the loan portfolio with a mixture of equity and debt
  - asset: cash flow θ
  - insured and uninsured debts:
    - retail deposits in fixed supply F: subsidized & insured
    - wholesale short-term debts D: risky & uninsured
  - equity: $max\{0, \theta - F - D\}$
- Capital structure maximizes existing shareholders' value
- Trade-off between
  - saving the cost of capital
  - avoiding bankruptcy cost

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Wholesale Financiers: Runs & Liquidity Risk

- A continuum of wholesale financiers of mass 1
  - demandable debt
  - at maturity paying D
  - early withdrawal qD
- Secondary market liquidation incurs fire-sale discount

$$P_1 = \theta/(1+\lambda_1)$$

  (due to adverse selection or cash-in-the-market pricing)
- Refinement by global games
- Unique equilibrium that features “solvent but illiquid” banks
- Extra buffer in need to avoid runs, which crucially depends on
  - leverage
  - profitability

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Firesale Prices: Contagion and Systemic Risk

- Two banks, ex ante identical
- The same bank-run game for both
- A second run pushing down bank asset price further
  - informational contagion
  - cash-in-the-market pricing
- $P_2 = \theta/(1+\lambda_2)$, with $\lambda_2 > \lambda_1$
- Contagion defined as a bank to be
  - solvent and liquid if *the other bank faces no run*
  - solvent but illiquid if *the other bank faces a run*
- Systemic risk defined as both bank failing

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Timeline of the Model

t = 0	t = 1	t = 3
1. Banks choose capital structure (D). 2. Entrepreneurs choose P for a given r.	1. Wholesale creditors decide to run or not after observing private signals. 2. Banks that face runs sell their assets at a discount. 3. Banks fail or survive.	1. Returns realize for surviving banks. 2. Wholesale creditors who have not run get paid provided that their bank does not fail.

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Risk-Shifting

- Optimal choice of entrepreneurs' (some with corner solutions)

$$P_B^*(r) = \begin{cases} 1 & \text{if } b \in [1/(x-r), B] \\ B(x-r) & \text{if } b \in [0, 1/(x-r)) \end{cases}$$

- Lower loan rate, higher stake for firms: inducing more effort
- Risky and risk-free pools
  - risk-free fraction α, $\alpha \equiv 1 - 1/[B(x-r)]$
- Competition reduces portfolio risk: $\partial\alpha/\partial r < 0$
- Define loan loss γ as the fraction of default in the risky pool
  - $\gamma \sim U(0,1)$, $E(\gamma) = 1/2$, risk reflected in α
- **Competition reduces loan default and portfolio risk, BUT**
  - Portfolio risk $\neq$ bank risk

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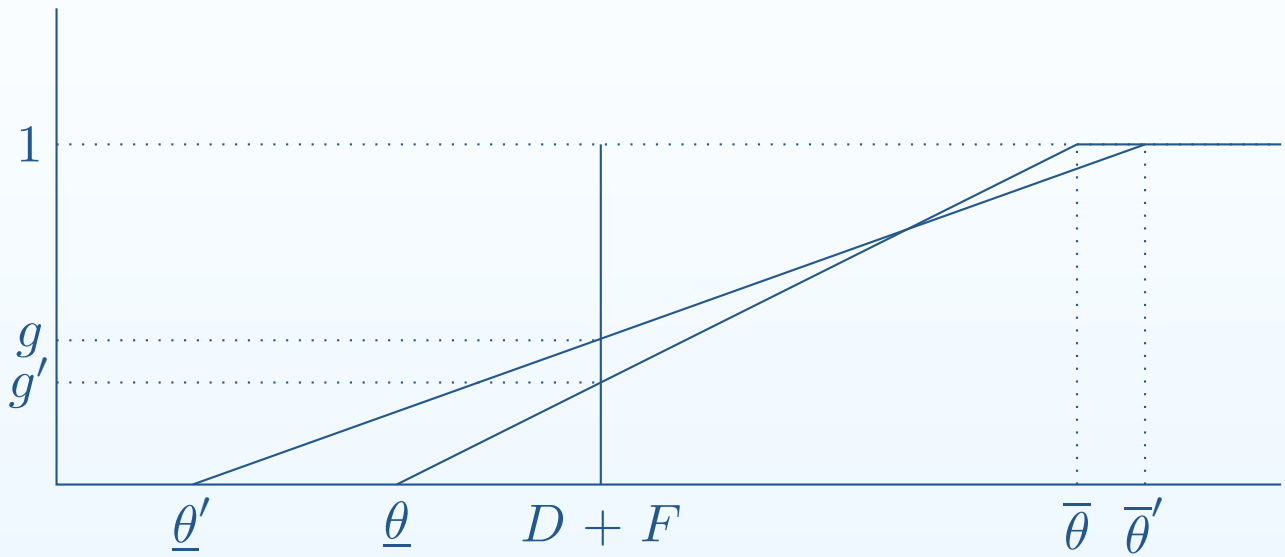
Insolvency



- Solvent if $\theta = \alpha r + (1-\alpha) r (1-\gamma) \geq D$
- Portfolio cash flow $\theta \sim U(\alpha r, r)$
- Critical loan loss $g \equiv 1 - \frac{D - \alpha r}{(1-\alpha) r}$: solvency probability $S = g$
- **Competition reduces insolvency risk iff** $r^2 > x(F + D)$
  - risk shifting vs. margin effect

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Coordination Failure and Run

- Equilibrium selected by the global games
- Fire-sale loss: surviving banks having to be more than merely solvent
- $\hat{\theta}_1 = F + \mu_1 D$, $\mu_1 = 1 - q[1 - (1 + \lambda_1)q] > 1$
- A bank with $\theta \in [D, \hat{\theta}_1]$: solvent but illiquid
  - being able to sustain in the absence of bank runs
  - but going bankrupt if a run happens
- **Competition increases pure liquidity risk.**
  - Thinner buffers to absorb fire-sale losses
- Total credit = Insolvency Risk + Pure Liquidity Risk
- **Competition reduces total credit risk iff** $r^2 > x(F + \mu_1 D)$
  - $\theta \in [x(F + D), x(F + \mu_1 D)]$
  - reducing insolvency risk, yet increasing total credit risk

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Contagion through Price

- $\hat{\theta}_2 = F + \mu_2 D > \hat{\theta}_2$
- $\mu_2 = 1 - q[1 - (1 + \lambda_2)q] > \mu_1$
- A bank of $\theta \in [\hat{\theta}_1, \hat{\theta}_2]$ subject to contagion
  - liquid if the other one is
  - failing in runs if the other is not
- Exposure to contagion defined as $Prob\{\theta \in [\hat{\theta}_1, \hat{\theta}_2]\}$
- **The chance of contagion increases with competition.**
- Systemic risk: two banks failing at the same time.
- **Competition reduces systemic crisis iff** $r^2 > x(F + \mu_2 D)$

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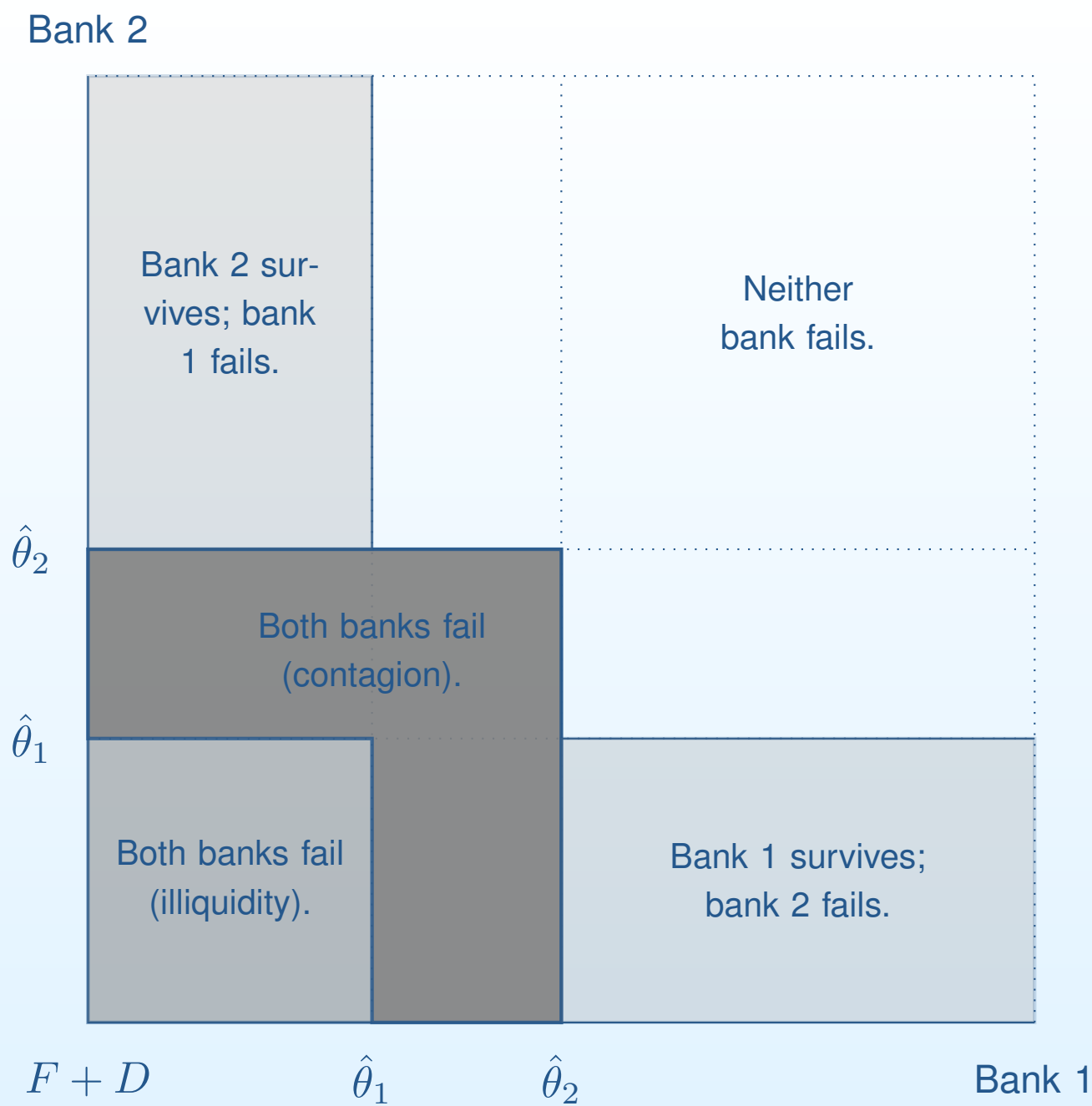

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Endogenous Leverage

- Maximizing existing shareholders' value:

$$\max_{\alpha,D}\left\{(1-\alpha)\int_{F+\mu_1 D}^{\overline{\theta}}[\theta-F-D]h(\theta,r)d\theta\right\}$$

$$s.t. \qquad \alpha\int_{F+\mu_1 D}^{\overline{\theta}}[\theta-D-F]h(\theta,r)d\theta=(1+k)V_S$$

$$\int_{F+\mu_1 D}^{\overline{\theta}}Dh(\theta,r)d\theta=V_D$$

$$F=V_F$$

$$V_S+V_D+V_F=1$$

- Optimal debts: $D^*=\frac{r-F}{\mu_1^2/k+2\mu_1}$; Optimal leverage: $D^*/E(\theta-F)$
- Leverage not monotonic in r
  - risk effects vs. margin effects

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Risk under Endogenous Leverage

- Competition continues reducing individual loan and portfolio risk
- **Other types of risk all depending on if $r^2 > xF$,**
- if the inequality holds, competition
  - **decreases** pure insolvency risk.
  - **increases** pure liquidity risk (always opposite to insolvency)
  - **decreases** total credit risk (insolvency dominating illiquidity)
  - **increases** exposure to contagion
  - **decreases** systemic risk (provided $\mu_2 c < 1$)
- Interpreting r/x as firm leverage
  - $r^2 > xF$ is about relative leverage ratio in financial and real sector

Endogenous vs Exogenous Leverage

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- Competition & Risk under *Exogenous Leverage*

	$r^2 < x(F+D)$	$r^2 \in [x(F+D), x\hat{\theta}_1)$	$r^2 \in [x\hat{\theta}_1, x\hat{\theta}_2)$	$r^2 > \hat{\theta}_2$
Pure insolvency risk	+	-	-	-
Pure liquidity risk	+	+	+	+
Total credit risk	+	+	-	-
Exposure to contagion	+	+	+	+
Systemic risk	+	+	+	-

- Competition & Risk under *Endogenous Leverage*

	$r^2 < xF$	$r^2 > xF$
Pure insolvency risk	+	-
Pure liquidity risk	-	+
Total credit risk	+	-
Exposure to contagion	-	+
Systemic risk	+	-

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Implications for Empirical Literature

- Explaining the diverse empirical results
  - Charter value as a prior
- Proper measurement of risk (open question)
  - non-performing loans for loan/portfolio
  - z-scores for insolvency risk
  - liquidity ratio as a predictor of potential funding liquidity risk
  - systemic crisis dummy
- Taking care of endogenous leverage
  - e.g., interaction with the ease of borrowing

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Take-home Messages

- Banking sector faces multiple tiers of risk
- Leverage responses to and affects different risks
- Endogenous vs Exogenous Leverage: dramatic differences
- Empirical implications
  - rationalizing the diverse results
  - clarifying risk definitions
  - taking care of leverage