A macroeconomic model of banks' systemic risk taking

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4th CEMLA/Dallas Fed Financial Stability Workshop
San Antonio (TX), November 2025

Motivation

- Ben Bernanke defined systemic risk as "*developments or events that threaten the stability of the financial system as a whole and consequently the broader economy, not just that of one or two institutions.*"

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- We develop a model where:
  - Systemic risk stems from banks' exposure to a common source of risk
  - These exposures result from endogenous (unobservable) risk-taking decisions by banks

    [distorted by high leverage, shaped by capital requirements]

- We examine:
  - Determination of systemic risk taking in dynamic general equilibrium
  - Impact on aggregate outcomes
  - Effectiveness & optimal design of capital requirements

This paper

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- Banking theory: Banks make unobservable decisions regarding their exposure to rare but devastating, common shocks

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→ Novel implication: Systemic risk taking is determined not just by static risk-shifting gains but also *scarce-bank-equity-presevation incentives*

- Only some banks decide to be "systemic"
- Systemic risk taking is maximal after long periods of calm

Policy analysis — Preview of the results

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   - Capital requirements still useful in its absence
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3. Cyclical adjustments
   - Lowering requirements ex post increases risk taking incentives ex ante

Fit in the literature

- Net worth channel and aggregate fluctuations: Kiyotaki-Moore (97), Carlstrom-Fuerst (97), Bernanke-Gertler-Gilchrist (99)
- Financial intermediaries' net worth channel: Meh-Moran (10), Gertler-Karadi (11), He-Krishnamurthy (12), Brunnermeier-Sannikov (14), Nuño-Thomas (17)
- Bank capital requirements in macro: Van den Heuvel (08), Collard et al. (17), Malherbe (20), Begenau (20), Corbae-D'Erasmo (21), Elenev et al. (21), Begenau-Landvoigt (22), Mendicino et al. (24)

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- Risk shifting: Jensen-Meckling (76), Stiglitz-Weiss (81)
- Moral hazard in banking: Karekeen-Wallace (78), Keeley (1990), Holmstrom-Tirole (97), Hellmann et al. (2001), Repullo (2004)

  → Role of dynamic general equilibrium considerations and quantitative results

Outline

- Introduction
- The model
- Calibration
- Main results
- Concluding remarks

The model

- Infinite horizon, discrete time t; single consumption good
  - Representative household: delegates bank equity investment to bankers
  - Two types of physical capital:
    - Bank dependent
    - Non bank dependent
  - Bankers allocate equity across a continuum of banks which choose between non-systemic & systemic investment mode
  - Final good producers
  - Government: runs deposit guarantee scheme (DGS) & sets capital requirements

Production environment

- Banks finance firms' investment in physical capital: a_{st} units of investment at t yield $\Delta_{t+1}(s_{jt})a_{st}$ units of capital at $t+1$ with gross returns R^b_{t+1}

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$$\Delta_{t+1}(s_{jt}) = \begin{cases} 1 + \mu s_{jt} & \text{if} \quad \xi_{t+1} = 0, \\ 1 - \lambda s_{jt} & \text{if} \quad \xi_{t+1} = 1, \end{cases}$$

with $\mu > 0$, $\lambda \in (0, 1]$, and $\text{Prob}(\xi_{t+1} = 1) = \pi \in (0, 1)$

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- Systemic investment is inefficient: $(1-\pi)(1+\mu) + \pi(1-\lambda) < 1$

  ...but may be attractive to shareholders of levered banks

Bankers

- Bankers manage HH investment in bank equity deciding on
  - Costly equity issuance ($m_{it} > 0$) or costless discretionary dividends ($m_{it} < 0$)
  - Fraction x_{it} of net worth to invest in equity of systemic banks

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- Key state variable is net worth resulting from previous period of operation:

$$n^b_{it+1} = \psi \left[(1 - x_{it}) R^e_{0t+1} + x_{it} R^e_{1t+1} \right] (n^b_{it} + m_{it})$$

R^e_{st+1}: gross equity returns under each mode s

ψ: exogenous equity retention ratio

Banks

- Balance sheet at t under investment mode s:

$$\text{Investment } (a_{st}) = \text{Deposits } (d_{st}) + \text{Equity } (e_{st})$$

subject to capital requirement $e_{st} \geq \gamma a_{st}$

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- Deposits pay:

$$\tilde{R}^d_{st+1} d_{st} = \eta R^d_{st} d_{st} + (1-\eta) \min\{R^d_{st} d_{st}, R^b_{t+1} \Delta_{t+1}(s) a_{st}\},$$

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- Equity pays:

$$R^e_{st+1} e_{st} = \max\{R^b_{t+1} \Delta_{t+1}(s) a_{st} - R^d_{st} d_{st}, 0\}$$

[limited liability: equity enjoys upside risk $\rightarrow$ risk-taking incentives]

Equilibrium – Bankers' systemic risk-taking decision

- Bankers consider properly discounted equity returns under each investment mode
  → Marginal value of wealth under bankers' management satisfies

$$v_t = \mathbb{E}_t \max\{\Lambda_{t+1}(1-\psi+\psi v_{t+1})R^e_{0t+1}, \Lambda_{t+1}(1-\psi+\psi v_{t+1})R^e_{1t+1}, 1\}$$

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- Indifference between $s = 0$ and $s = 1$ equires

$$\mathbb{E}_t\left[\Lambda_{t+1}(1-\psi+\psi v_{t+1})R^e_{0t+1}\right] = \mathbb{E}_t\left[\Lambda_{t+1}(1-\psi+\psi v_{t+1})R^e_{1t+1}\right]$$

[→ any $x_t \in [0,1]$ is compatible with optimization;
but only one is eventually compatible with equilibrium!]

Equilibrium – Regimes with and without full deposit insurance

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- We solve numerically for the equilibrium of the calibrated model using a global method

Calibration strategy

- Annual frequency
- Based on US economy in the years around the Global Financial Crisis
- Two steps / sets of parameters:
  - Pre-set parameters: (i) conventional values in the literature, or (ii) directly observable empirical counterparts
  - Calibrated parameters: simultaneous matching of key moments
- Importantly,
  - we use moments concerning the magnitude of banking crises
  - we follow the banking crises empirical literature in setting 4-year crisis event windows

Calibration

Parameter		Value	Source/Target
Subjective discount rate	β	0.98	Standard
Output share of physical capital composite	α	0.3	Standard
Depreciation rate of physical capital	δ_h, δ_b	0.10	Standard
Probability of systemic event	π	0.04	Schularick&Taylor (2012)
Risk-taking losses	λ	0.615	BCBS (2004), Bennet&Unal (2015)
Capital requirement	γ	0.08	BCBS (2004)
Deposit insurance coverage	η	1	Full deposit insurance

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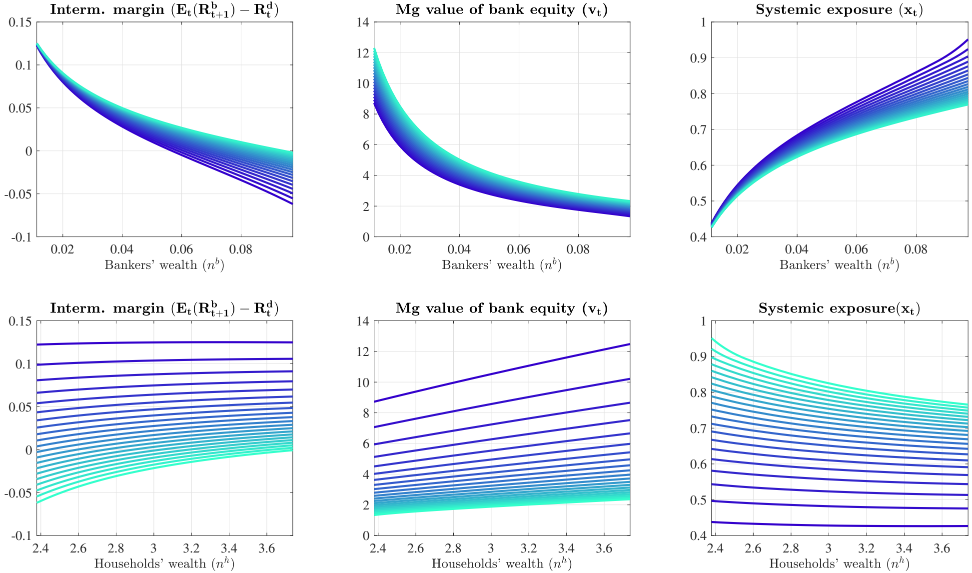
Capital requirement	γ	0.08	BCBS (2004)
Deposit insurance coverage	η	1	Full deposit insurance
Risk-taking gains	μ	0.012	Crisis fall in credit/GDP ratio
Retained wealth-under-management	ψ	0.85	Return on bank equity
Non-bank-dependent share in capital	ϕ	0.53	Bank/non-bank ratio
Substitution parameter capital composite	σ	0.65	Crisis fall in bank/non-bank ratio
Equity issuance cost, scale parameter	κ_0	125	Bank equity issuance
Equity issuance cost, elasticity parameter	κ_1	10	Crisis bank equity issuance

Calibration — Targeted moments

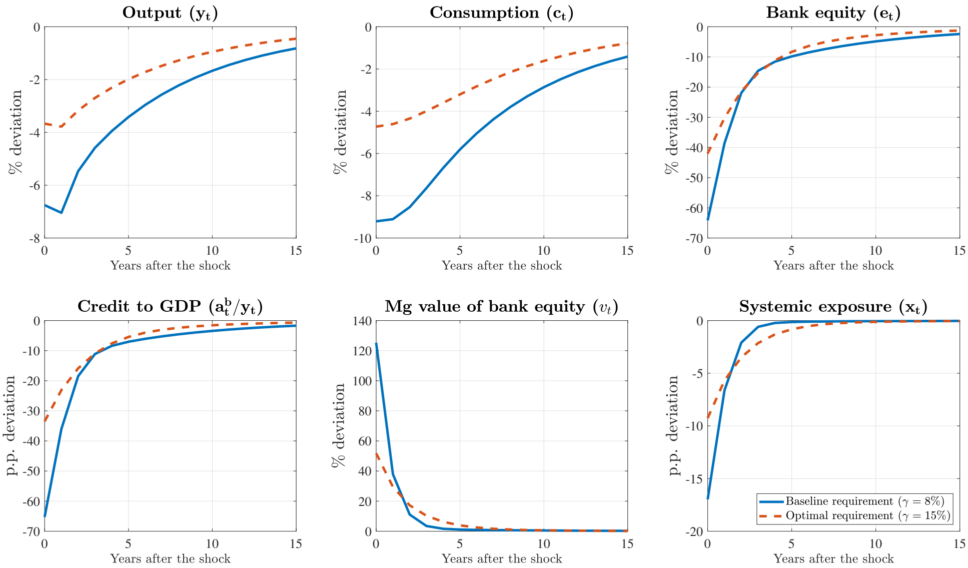
Variable	Data	Model
Crisis fall in credit/GDP ratio (4-year average, % of SSS value)	30.3	30.9
Return on bank equity	12.44	12.97
Bank/non-bank ratio	69.9	69.9
Crisis fall in bank/non-bank ratio (4-year average, % of SSS value)	35.4	31.3
Bank equity issuance (% of pre-issuance equity)	4.61	4.14
Crisis bank equity issuance (4-year average, % of pre-issuance equity)	7.61	8.03

Stochastic steady state (SSS) values, in % (unless indicated). In model terms, moments with the label "crisis" are defined as the mean of the corresponding variable (or fall in a variable) in the four years following the realization of a systemic shock (relative to its SSS value).

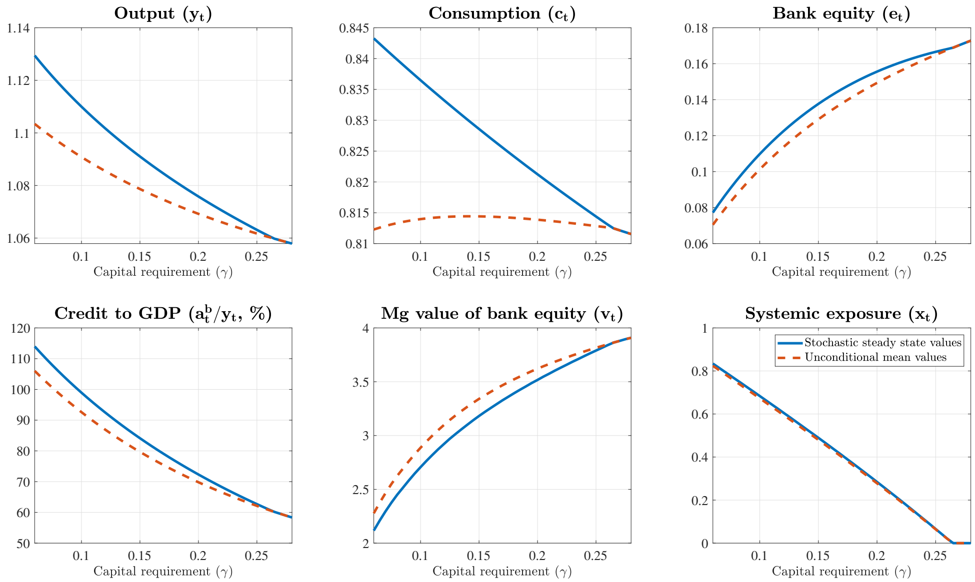
Equilibrium systemic risk taking



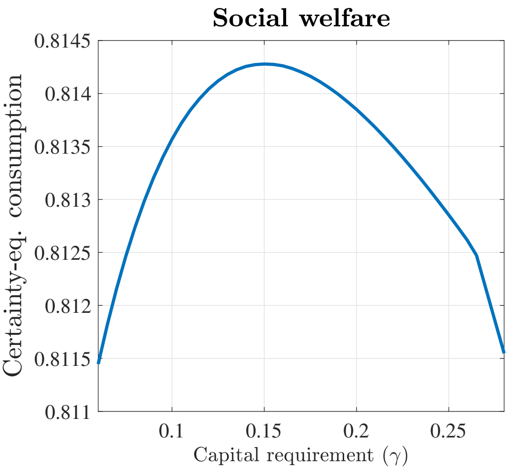
Endogenous responses to a systemic shock



Effects of capital requirements — selected endogenous variables



Effects of capital requirements — social welfare



The role of deposit insurance

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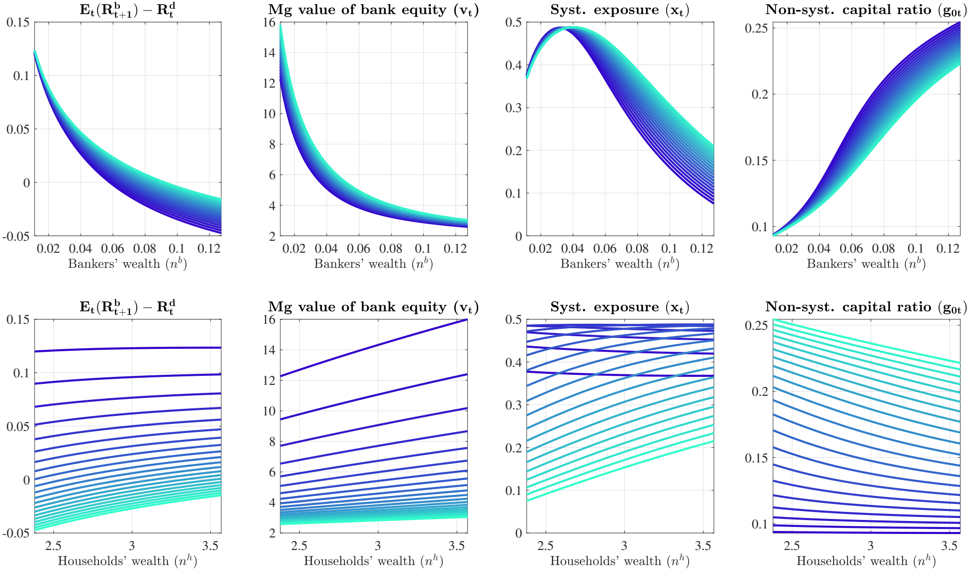
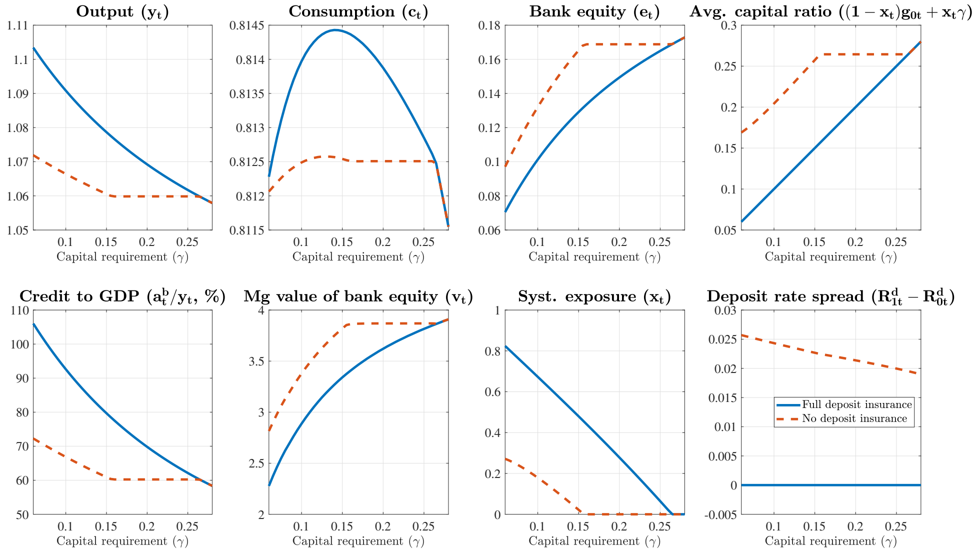
- In the separating equilibrium:
  - Non-systemic banks commit to safe strategy by operating a voluntary capital buffer above the regulatory minimum and pay lower deposit rates
  - Systemic banks stick to the regulatory minimum and need to promise higher deposit rates

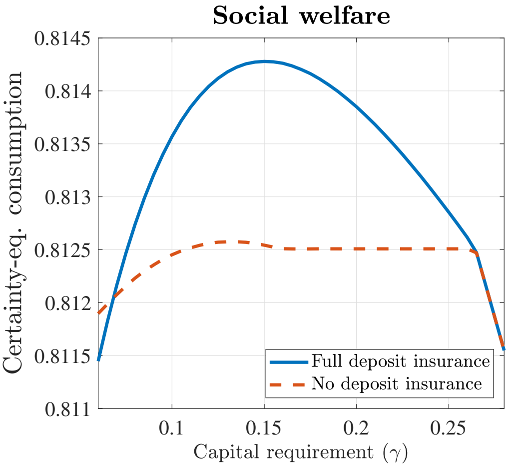
Systemic risk taking without deposit insurance



Effects of capital requirements with & without deposit insurance



Social welfare with & without deposit insurance



Concluding remarks

- We develop a model to understand the drivers of systemic risk taking at the macro level
- Combines elements in traditional banking and quantitative macro literature
  - Main ingredient: unobservable risk taking decisions
  - Static risk-shifting incentives vs. dynamic equity-preservation motives
  - Non-trivial welfare trade-offs: higher requirements reduce systemic risk but also activity

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  - Static risk-shifting incentives vs. dynamic equity-preservation motives
  - Non-trivial welfare trade-offs: higher requirements reduce systemic risk but also activity
- Capital requirements also beneficial in the absence of deposit insurance
- Extensions (in the paper):
  - Counter-cyclical requirements carry modest welfare gains and can backfire
  - Starting point and speed of transition matters when introducing higher requirements