Lending Relationships and Optimal Monetary Policy

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Motivation and Evidence

Two major sources of finances for firms: **cash** and **bank credit**

Lending relationships: long-term matches between firms and banks

- benefits to firms: stable funding, insurance (Petersen & Rajan, 1994)
- during banking crises, lending relationships are severed with a slow recovery of lending (Chen, Hanson, Stein, 2017; McCord and Prescott, 2014)

Question: what is the optimal monetary policy response following a destruction of lending relationships?

What We Do

Develop a search model of **corporate finance** and **long-term lending relationships**

- Internal finance: retained earnings held in liquid wealth
- External finance: lines of credit through banking relationships
- Banked and unbanked firms, frictional creation of banking relations
- Monetary policy determines return to liquid wealth

Calibrate model using data on small business finances

- banked firms hold 20% less cash relative to unbanked firms
- banked firms less responsive to changes in user cost of cash
- user cost positively affects measure of bank's profit margin

Optimal Monetary Policy

Study optimal policy following a destruction of lending relationships:

Key policy tradeoff: decrease cost of liquidity

- Promotes self-insurance through internal finance
- Discourages bank entry and creation of lending relationships by reducing banks' profit margin

With commitment: optimal to lower interest rate initially (quantitative easing) with a promise of high future rates (forward guidance)

- optimal path of rates are hump-shaped, overshooting long-run value

Without commitment: optimal to raise rates initially to promote recovery in banking relationships, followed by a gradual reduction

- optimal path of rates lower than under commitment, except for the initial periods
- recovery slower than under commitment

Literature

Relationship Lending Sharpe (1990), Elyasiani and Goldberg (2004)

- Insurance role: Berger and Udell (1992), Corbae and Ritter (2004)
- Monitoring: Diamond (1984), Holmstrom and Tirole (1997)
- Screening with hidden types: Agarwal and Hauswald (2010)
- Dynamic learning: Rajan (1992), Hachem (2011), Bolton et al. (2016)

New Monetarist approach to money, credit, and banking

- Sanches and Williamson (2010), Gu et al. (2014), Rocheteau et al. (2018)

Optimal policy approaches

- Chang (1998), Aruoba and Chugh (2010), Klein, Krusell, and Rios-Rull (2008), Martin (2011, 2013)

Environment

Environment

- Discrete time, infinite horizon
- Production economy: productive capital, k, numeraire c, labor h
- Agents:
  1. Entrepreneurs (e) produce output using capital
  2. Suppliers (s) produce capital using labor
  3. Banks (b) finance acquisition of capital
- Entrepreneurs and Banks form long-term bilateral relationships
- Each period has 3 stages:
  1. Bank entry, competitive market for capital
  2. Formation of lending relationships, bilateral bank loans
  3. Production, competitive market for output, settlement, destruction of lending relationships

Preferences and Technologies

- All agents are risk-neutral with discount factor, $\beta = 1/(1+\rho)$

$$U(c, h) = c - h$$

- Supplier's technology (stage 1)

$$k = h$$

- Entrepreneur's technology (stage 2)

$$y = \epsilon f(k)$$

  where $\epsilon = \{0, 1\}$ with probability (i.i.d.) λ

- Social efficiency: $y'(k^*) = 1$

Internal Finance

- Risk-free assets with real return r_{t+1} (policy)
  - Perfectly storable
  - Partial liquidity ($\rightarrow$ imperfect self-insurance)

- Acceptability of liquid assets, $\nu \in [0, 1]$.
  - ν probability (i.i.d.) assets are accepted in a period
  - $1 - \nu$ probability assets are not accepted

- Partial liquidity captures limitations to internal finance:
  - assets are subject to theft or fraud
    e.g. Sanches and Williamson (2010) or Li, Rocheteau, and Weill (2012)
  - banks generate additional investment opportunities
    e.g. Hachem (2011) or Bolton et al. (2016)
  - takes time to accumulate internal funds
    e.g. Aiyagari (1994) or Rocheteau et al. (2018)

External Finance

- Rule out direct external finance (no trade credit):
  - Entrepreneurs lack commitment, private trading histories
  - Suppliers have no enforcement power

- Banks possess commitment power and can enforce debt repayment
  1. Supply loans (capital) L to entrepreneurs
  2. Issue short-term liabilities to suppliers to purchase capital
  3. Operating costs $\psi(\text{L})$
     - $\psi'(\text{L}) > 0$, $\psi''(\text{L}) > 0$, $\psi(0) = \psi'(0) = 0$

Long-term Lending Relationships

Frictional formation of relationships

- Bank entry at cost $\zeta > 0$
- Random matching:
  - Ratio of (unmatched) banks to entrepreneurs θ_t
  - Entrepreneur's matching probability $\alpha(\theta_t)$
  - Bank matching probability $\alpha^b = \alpha(\theta_t)/\theta_t$
  - $\alpha(0) = 0, \alpha'(0) = 1, \alpha(\infty) = 1, \alpha'(\infty) = 0$
- Exogenous destruction rate $\delta > 0$

Measure of entrepreneurs in a banking relationships, ℓ_t

$$\ell_{t+1} = (1-\delta)\ell_t + \alpha(\theta_t)(1-\ell_t)$$

Equilibrium

Suppliers

- Produce capital in stage 1, redeem IOUs and consume in stage 3
    - no incentive to accumulate assets

- Production decision, given price of capital q_t

$$\max_{k \geq 0} \quad -k + q_t k$$

- Capital market is active iff $q_t = 1$.

Unbanked Entrepreneurs

Stage 1: current holdings of liquid assets m_t

$$U_t^e(m_t) = \mathbb{E}[V_t^e(\omega_t)]$$
$$s.t.\ \ \omega_t = m_t + \chi_t \max_{k_t \leq m_t}[y(k_t) - k_t]$$

$\chi_t = 1$ with probability $\lambda\nu$

Stage 2: current wealth ω

$$V_t^e(\omega) = (1-\alpha)W_t^e(\omega) + \alpha_t X_t^e(\omega)$$

Stage 3: current wealth ω

$$W_t^e(\omega) = \max_{m_{t+1} \geq 0} \omega - \frac{m_{t+1}}{1 + r_{t+1}} + \beta U_{t+1}^e(m_{t+1})$$

Unbanked Entrepreneurs, cont.

Substitute: expected profits of unbanked entrepreneur π_t^u

$$\pi_t^u(s_t) \equiv \max_{m_t \geq 0} \left\{ -s_t m_t + \lambda\nu \max_{k_t \leq m_t} [y(k_t) - k_t] \right\}$$

where $s_t = \frac{\rho - r_t}{1 + r_t}$ is spread between liquid and illiquid assets

Unbanked liquidity demand:

$$s_t = \lambda\nu[y'(m_t^u) - 1]$$

Take-away: $\uparrow r_t$, $\downarrow s_t$, improves ability to self-insure

- as $r_t \to \rho$, liquidity is costless $m_t^u - \to k^*$
- still limited by acceptability friction

Banked Entrepreneurs

Lending contract (stage 2): list $\langle \Phi_t, \{\mathrm{L}_{t+\tau}\}_{\tau=0}^{\infty} \rangle$

- Φ_t discounted sum of payments to bank over the relationship
- $\mathrm{L}_{t+\tau}$ contingent intra-period loans

Many payoff-equivalent ways to implement Φ_t

- $\phi_{t+\tau}$ non-contingent payments every period
- loan $\mathrm{L}_{t+\tau} = k^b_{t+\tau} - d_{t+\tau}$ with access to liquidity
- loan $\mathrm{L}_{t+\tau} = \hat{k}$ with no access to liquidity

Choice of liquid wealth (stage 3):

$$\max_{m^b_t \geq 0} \left\{ -s_t m^b_t - \beta\phi_t + \beta\lambda\nu \left[y(k^b_t) - k^b_t \right] + \beta\lambda(1-\nu) \left[y(\hat{k}) - \hat{k} \right] \right\}$$

Lending Contract

Determine $\{\phi_{t+\tau}, k^b_{t+\tau}, m^b_{t+\tau}, d_{t+\tau}\}_{t=0}^{\infty}$ using Nash bargaining

- η banks' bargaining power

Entrepreneur's Suprlus:

$$\mathcal{S}^e_t = \underbrace{-\phi_t + s_t \left[m^u_t - m^b_t\right]}_{\text{net savings}} + \underbrace{\lambda\nu \left\{\left[y(k^b_t) - k^b_t\right] - \left[y(k^u_t) - k^u_t\right]\right\}}_{\text{expected gain, w/ access to internal finance}}$$
$$+ \underbrace{\lambda(1-\nu)\left[y(\hat{k}^b_t) - \hat{k}^b_t\right]}_{\text{expected gain, w/o access}} - \left[V^e_t(0) - W^e_t(0)\right] + (1-\delta)\beta\mathcal{S}^e_{t+1}$$

Bank's Suprlus:

$$\mathcal{S}^b_t = \phi_t - \underbrace{\lambda\nu\psi(k^b_t - d_t) - \lambda(1-\nu)\psi(\hat{k})}_{\text{expected cost of issuing loans}} + \beta(1-\delta)\mathcal{S}^b_{t+1}$$

Optimal Lending Contract

Optimal Lending Contract: $\max\ [\mathcal{S}_t^b]^\eta [\mathcal{S}_t^e]^{1-\eta}$

$$\psi'\left(k_t^b - m_t^b\right) = y'(k_t^b) - 1 \leq \frac{s_t}{\lambda\nu}$$

$$\psi'(\hat{k}) = y'(\hat{k}) - 1$$

$$\phi_t = \lambda(1-\nu)\psi(\hat{k}) + \lambda\nu\psi(k_t^b - m_t^b) + \eta\left[\pi^b(s_t) - \pi^u(s_t)\right] - (1-\eta)\zeta\theta_t$$

Pecking-order of financing means: conditional on m^b

- if $m^b \geq k^*$, then $k^b = k^*$ and $\mathrm{L} = 0$
- if $m^b < k^*$, then $k^b = m^b + \mathrm{L}$ where $\psi'(\mathrm{L}) = y'(\mathrm{L} + m^b) - 1$

Additional profits from lending relationship increase with spread

- $\partial[\pi^b(s_t) - \pi^u(s_t)]/\partial s_t = m_t^u - m_t^b \geq 0$
- pass-through to bank's intermediation fees

Bank Entry and Equilibrium

Free-entry: $\zeta = \beta \frac{\alpha(\theta_t)}{\theta_t} \mathcal{S}^b_{t+1}$

Combine with $\mathcal{S}^b_t$ and ϕ_t

$$\frac{\theta_t}{\alpha(\theta_t)} = \frac{\beta\eta[\pi^b(s_{t+1}) - \pi^u(s_{t+1})]}{\zeta} - \beta(1-\eta)\theta_{t+1} + \beta(1-\delta)\frac{\theta_{t+1}}{\alpha(\theta_{t+1})}$$

Equilibrium: list $\{\theta_t, \ell_t, m^u_t, m^b_t, k^b_t, \phi_t\}_{t=0}^{\infty}$ such that:

1. k^b_t, m^b_t, ϕ_t solve optimal lending contract
2. k^u_t solve unbanked entrepreneur's problem
3. given ℓ_0, ℓ_{t+1} satisfies

$$\ell_{t+1} = (1-\delta)\ell_t + \alpha(\theta_t)(1-\ell_t)$$

Monetary Policy Transmission

Higher spreads incentivize bank entry: if $(\rho+\delta)\zeta < \eta[\pi^b(s) - \pi^u(s)]$

$$\frac{\partial\theta}{\partial s} = \eta\frac{(m^u - m^b)}{\zeta}\left[\frac{(\rho+\delta)[1-\epsilon(\theta)]}{\alpha(\theta)} + 1 - \eta\right]^{-1} > 0$$

But discourages investment: if $s_t \leq \lambda\nu\psi'(\hat{k})$

$$\frac{\partial k_t^u}{\partial s_t} = \frac{\partial k_t^b}{\partial s_t} = \lambda\nu y''(k_t^u) < 0$$

Unbanked hold more liquid wealth: if $s_t \leq \lambda\nu\psi'(\hat{k})$

$$m_t^u - m_t^b = \psi'^{-1}(s_t/\lambda\nu)$$

Liquidity demand less elastic for unbanked than banked:

$$\frac{\partial(m_t^u - m_t^b)/(m_t^u - m_t^b)}{\partial s_t/s_t} = \frac{\psi'(m_t^u - m_t^b)}{(m_t^u - m_t^b)\psi''(m_t^u - m_t^b)}$$

Optimal Monetary Response to a Destruction in Lending Relationships

Overview

Data: 2003 National Survey of Small Business Finances (SSBF)

Target moments important in transmission mechanism:

- share of banked firms, average length of banking relationships
- difference in liquid wealth between banked and unbanked firms
- elasticity of liquid wealth wrt to liquidity spread
    - banked vs unbanked
- bank profitability from small business loans

Unanticipated destruction shock $\ell_0 = (1 - z)\ell^*$

- consider different values of $z = 10\%, 35\%, 60\%$
- corresponding to moments on decline in number of commercial banks (10%), small business loan originations (35%), and U.S. corporate loans (60%)

Time period and functional forms

Time period a month, $(1+\rho)^{12} = 1.04$

Functional forms:

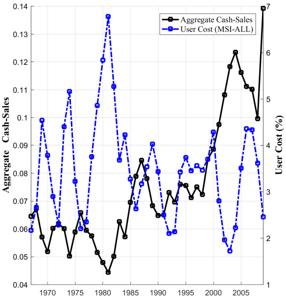
- matching function: $\alpha(\theta) = \bar{\alpha}\frac{\theta}{1+\theta}$
- production function: $y(k) = Ay^{a}$, $a = 1/3$, set A such that $k^{*} = 1$
- cost of monitoring loans: $\psi(\text{L}) = B\text{L}^{1+\xi}/(1+\xi)$

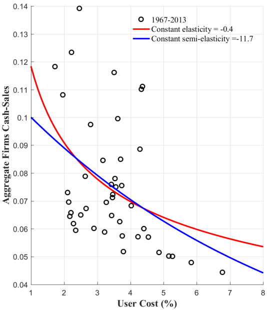
Parameters to calibrate: $\bar{\alpha}, \delta, \lambda, s, \nu, B, \xi, \eta, \zeta$

Firm's demand for liquid assets

Liquidity cost, investment, and acceptability: s, λ, ν

- cash-to-sales ratio to proxy for liquid wealth (Mulligan, 1997; Adao and Silva, 2016)
- cash includes demand deposits, money orders, checks, bank drafts, and CDs.
- spread as user cost of MSI-ALL (average 2%)
- high acceptability $\nu = 0.985$



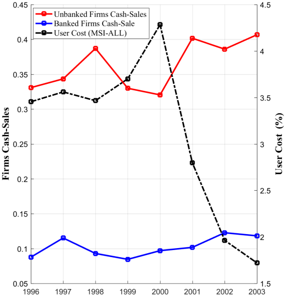


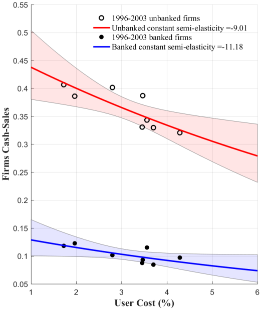
Liquidity demand depends on credit access

Cost of monitoring loans: B, ξ

- average difference in cash between banked and unbanked = 20%
- elasticity of $(m^u - m^b)$ to s

$$log(m_{i,t}) = \beta_b D_{i,t} + e_u(1 - D_{i,t})s_t + e_b D_{i,t} s_t + X_{i,t} + y_t + \epsilon_{i,t}$$





Banks' profitability and the cost of liquid assets

Matching and destruction: $\bar{\alpha}, \delta$

- average length of credit relationship $=$ 8.25 years
- share of banked firms $=$ 68%

Bargaining power: η

- match bank's average Net Interest Margin (NIM) on small business loans $=$ 3% from Call Reports

$$NIM_t = \frac{\phi_t}{\lambda \left[\nu (k_t^b - m_t^b) + (1 - \nu) \hat{k} \right]}$$

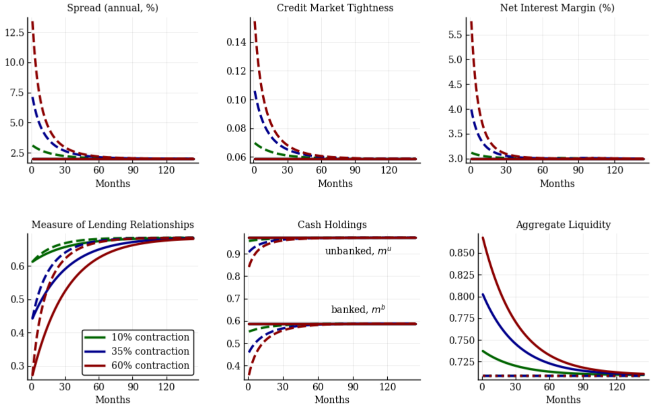
Parameters

Parameter	Value	Moment	Data	Model
Matching efficiency, $\bar{\alpha}$	0.395	Share of banked firms	0.68	0.68
Destruction, δ	0.01	Length of credit rel.	8.25	8.25
Productivity shock, λ	0.086	Semi-elasticity of m^u to s	-17.1	-17.1
External finance, B	43.93	$(m^u - m^b)/m^u$	0.39	0.39
External finance, ξ	8.00	elas. of $(m^u - m^b)$ to s	0.13	0.13
Bargaining power, η	0.52	Average NIM (%)	3.00	3.00
Bank entry cost, ζ	0.024	Optimal spread	0.20	0.20
Acceptability, ν	0.985	exog. set		

Exogenous targeting rules

Suppose policy targets constant interest rate or supply of liquid assets:

- Constant spread, s_t
- Constant supply of liquidity, $M_t = \ell_t m^b(s_t) + (1 - \ell_t) m^u(s_t)$



Policy trade-off: between promoting self insurance and recovering lending relationships

Constrained Efficiency

Social Welfare: $\mathbb{W}(\ell_0) = \sum_{t=0}^{\infty} \beta^t \mathcal{W}_t$

$$\mathcal{W}_t = -\underbrace{\zeta\theta_t(1-\ell_t)}_{\text{entry costs}} + \beta \underbrace{(1-\ell_{t+1})\lambda\nu\left[y(k^u_{t+1}) - k^u_{t+1}\right]}_{\text{unbanked profits}}$$

$$+\beta \underbrace{\ell_{t+1}\lambda\nu\left[y(k^b_{t+1}) - k^b_{t+1} - \psi(\mathrm{L}_{t+1})\right]}_{\text{banked profits w/ internal \& external funds}}$$

$$+\beta \underbrace{\ell_{t+1}\lambda(1-\nu)\left[y(\hat{k}^b_{t+1}) - \hat{k}^b_{t+1} - \psi(k^b_{t+1})\right]}_{\text{banked profits w/ external funds}}$$

Implementation: equilibrium achieves constrained-efficiency if and only if

- Friedman rule: $s_t = 0$
- Hosios condition: $\epsilon(\theta_t) = \eta$

Optimal Policy under Commitment

Ramsey problem: policymaker chooses $\{s_t\}_{t=1}^{\infty}$ to maximize $\mathbb{W}(\ell_0)$, subject to:

$$\theta_t = \frac{\bar{\alpha}\beta\eta}{\zeta}[\pi^b(s_{t+1}) - \pi^u(s_{t+1})] + \beta[1-\delta-\bar{\alpha}(1-\eta)]\theta_{t+1} + \beta(1-\delta) - 1$$

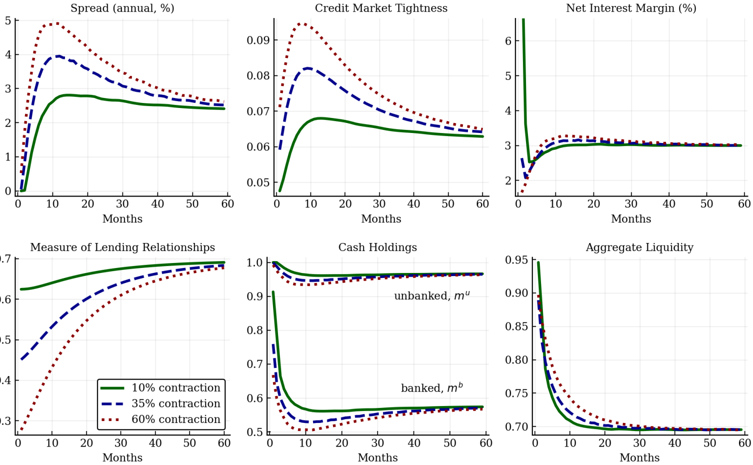
Result #1: It is optimal to deviate from the Friedman rule if

$$\frac{\epsilon(\underline{\theta}) - \eta}{1 - \epsilon(\underline{\theta})} > \left[\frac{(1-\delta)\ell_0}{\alpha(\underline{\theta})(1-\ell_0)} + 1\right]\frac{1}{\xi}$$

where $\underline{\theta}$ steady-state tightness at $s_t \equiv 0$.

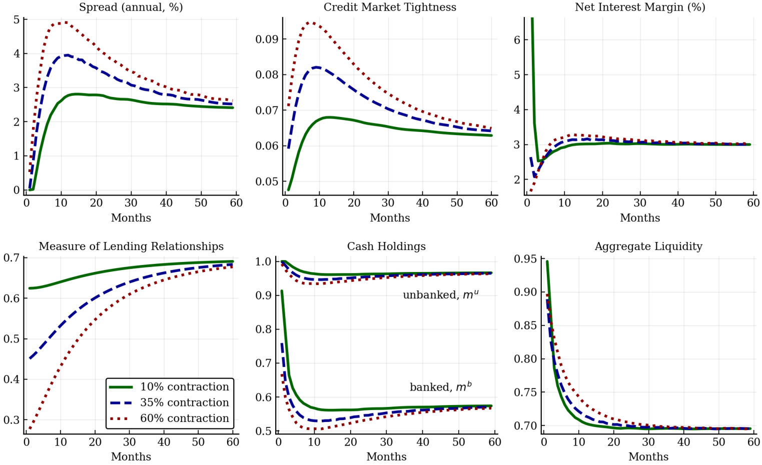
- if $\eta < \epsilon(\underline{\theta})$, bank entry is inefficiently low at $s = 0$

Optimal Policy under Commitment



Result #2 (forward guidance): policymaker lowers spread close to zero at the onset of the crisis then increases it quickly above the long-run steady state.

Optimal Policy under Commitment



Result #3: optimal policy with commitment is consistent with quantitative easing followed by quantitative tightening.

Optimal Policy without Commitment

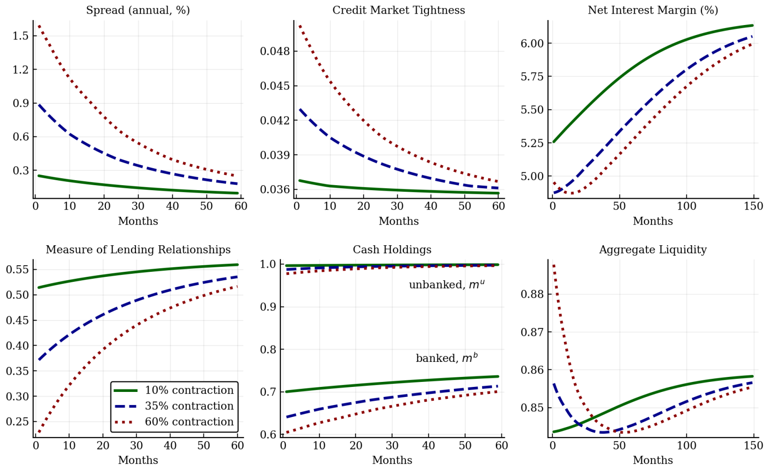
Markov problem: Timing

- policymaker sets s_{t+1} in period t at beginning of stage 2
- private sector choses θ_{t+1}, m^u_{t+1}, and m^b_{t+1}
- Markov perfect equilibria

Strategies:

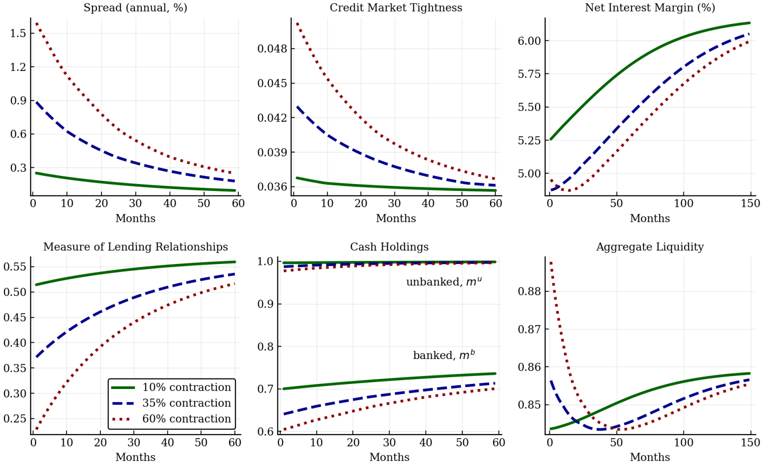
- Policymaker: $m^u_{t+1} = \mathcal{K}(\ell_t)$
- Bank entry: $\theta_t = \Theta(\ell_t, m^u_{t+1})$

Optimal Policy without Commitment



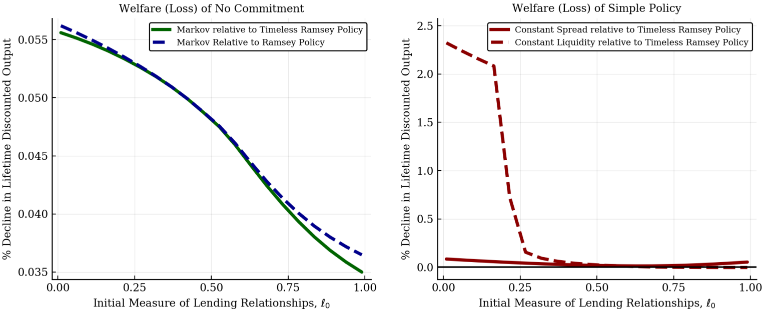
Result #4: Without commitment, optimal policy consists of raising spread at onset of crisis, then reducing it gradually.

Optimal Policy without Commitment



Result #5: The aggregate supply of liquidity increases initially (for large enough shocks), then overshoots steady-state value.

Welfare Gains from Commitment



Results:

- lack of commitment slows down the recovery with a gain to unbanked entrepreneurs
- welfare gain of commitment ranges from 0.036% to 0.057%
- for large enough shocks, large welfare cost of maintaining constant supply of liquidity

Conclusion

- Lending relationships are a critical source of funds for firms
- Monetary policy impacts the profitability and formation of these relationships
- Presents a trade-off for the policymaker
  - Promote self-insurance through retained earnings held in liquid wealth
  - Promote bank profits and the creation (recovery) of relationships
- Commitment power matters in response to a destruction of relationships
  - Under commitment, lower rates initially but promise high future rates
  - Policy is not time-consistent
  - Without commitment, increase rates initially then gradually decrease them