Dynamic Coordination with Flexible Security Design

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Motivation

- How does liquidity creation in a dynamic environment affect financial fragility when there are
    - limited commitment: without collateral borrowers cannot commit to paying back.
    - adverse selection on (dividend paying) collateral asset
- New financial fragility source via dynamic price feedback loop.
- Security design has implications on fragility of financial system.

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Key Takeaways

- Two frictions: Limited commitment and adverse selection
- Dynamic (mis)coordination without security design
  - Collateral asset resale price ameliorates adverse selection
  - An asset that is a good (lousy) collateral has high (low) resale price, but high (low) resale price makes an asset a good (lousy) collateral.
  - Leads to multiplicity and volatility in asset price and real output.
- Flexible security design facilitates dynamic coordination
  - Optimal security (short-term, asset-backed liquid debt) eliminates fragility
  - Haircut $\Leftarrow$ adverse selection+heterogenous valuation (between borrower and lender)
  - Interest rate $\Leftarrow$ default risk + demand for liquidity
  - Slow security run and multiple equilibria $\Leftarrow$ rigidity of security design

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Related Literature

- Financial intermediaries and liquidity creation: Gorton and Pennacchi (90)
- Adverse selection: Akerlof (70), Myers and Majluf (84)
- Security design: De Marzo and Duffie (99), Biais and Mariotti (05)
- Role of collateral: Kiyotaki and Moore (97), Fostel and Geanakoplos (12), Simsek (13)
- Financial frictions and boom-bust cycles: Gorton and Ordonez (14), Kurlat (13)
- Dynamic price feedback: Asriyan, Fuchs and Green (19)

Agents

- Two Agents
  - Agent B (banker/borrower);
    Agent I (intermediate goods supplier)
  - Both: a basic technology produces consumption goods 1-to-1 from labor at period end
  - Utility in period t is $U_t(x,l) = x - l$
    - x: consumption; l: labor
    - Discount rate between periods $\beta \in (0,1)$
- Agent B has a CRS z-technology which produces $z > 1$ units of consumption good from one intermediate good
- Agent I produces intermediate good 1-to-1 from labor
- Gains from trade:
  - Agent B would like to borrow unlimited amount of intermediate goods from agent I.
  - because returns to scale of z-technology is $z > 1$
- ... but agent B's promise to pay back is not enforceable

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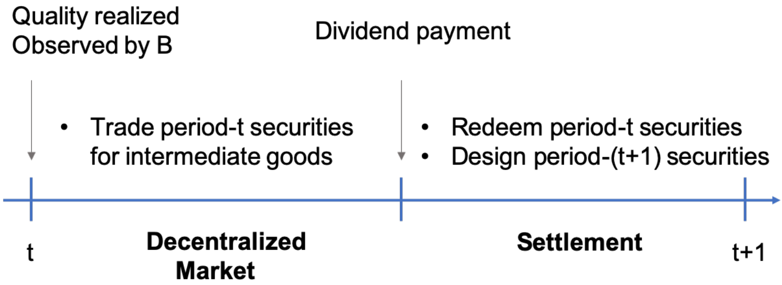
Assets and securities

- Risky assets
  - Low distribution $F_L(s)$ w.p. λ
  - High distribution $F_H(s)$ w.p. $1-\lambda$
  - Agent B observes asset quality
  - Quality iid over time
- Securities backed by assets

$$\sum_j y^j(s) \leq s + \phi_t, \forall s \in [s_L, s_H],$$

$$y^j(s) \text{nonnegative and increasing in } s$$

Timeline

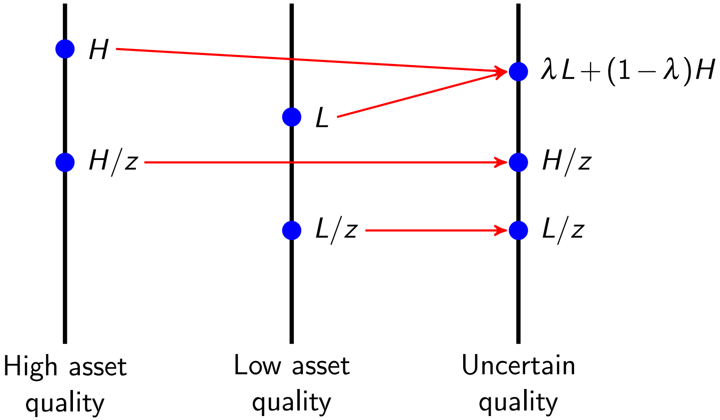

Quality realized
Observed by B
Dividend payment
• Trade period-t securities for intermediate goods
• Redeem period-t securities
• Design period-(t+1) securities
t
Decentralized Market
Settlement
t+1

Market for Each Security

- A secondary market for each private IOU
- Multiple buyers matched to each bank
- Buyers make simultaneous price offers
  Bank chooses how much to sell at the best offer
  Bertrand competition $\Rightarrow$ price $=$ reservation value of the bank
- No communication across markets

Pooling: Liquid Security

Reservation price of agent B and agent Is



Separating: Illiquid Security

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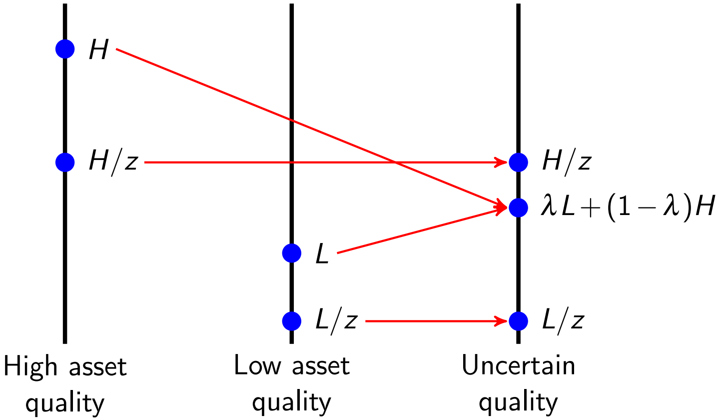

Equilibrium in Security j's Market

- Index of info. insensitivity: higher R_t^j, lower adverse selection

$$R_t^j \equiv \frac{E_L y_t^j}{E_H y_t^j}$$

- If $R_t^j > \zeta \equiv 1 - (z-1)/\lambda z$, pooling eq. in market j
    - both high and low B types sell
    - $q_t^j = \lambda E_L y_t^j + (1-\lambda) E_H y_t^j$
- If $R_t^j < \zeta$, separating eq. in market j
    - only low type sells
    - $q_t^j = E_L y_t^j$

How does security design affect financial fragility?

- Benchmark
  - only equity backed by the collateral
- Flexible Security Design
  - monotone securities
  - update security design each period
- Rigid Security Design
  - monotone securities
  - update security design with some probability

Benchmark: Dynamic Lemons Market – Pooling

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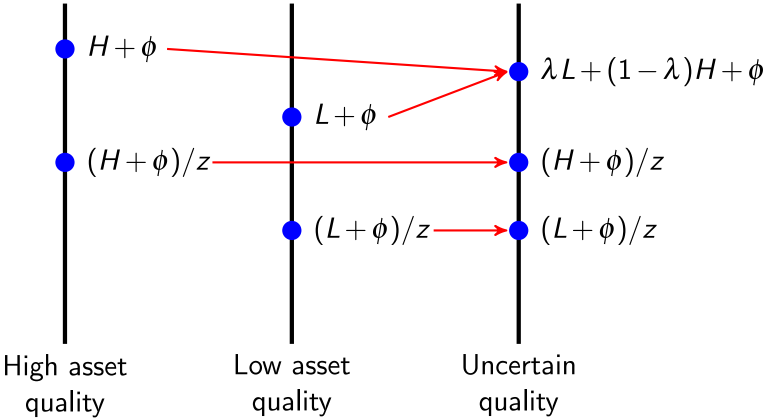

Benchmark: Dynamic Lemons Market – Separating

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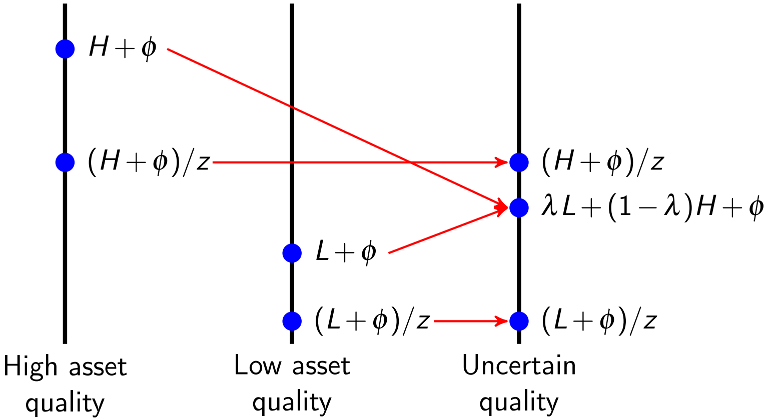
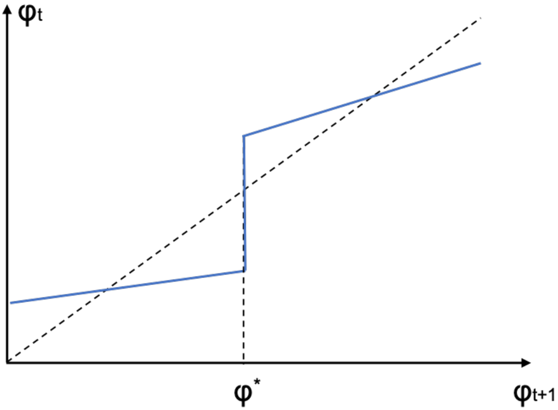


Fragility of the Dynamic Lemons Market



$$\phi_t = \begin{cases} \beta\left[\lambda z(E_L s + \phi_{t+1}) + (1-\lambda)(E_H s + \phi_{t+1})\right] & \text{if } \phi_{t+1} \le \phi^* \\ \beta\left[\lambda z(E_L s + \phi_{t+1}) + (1-\lambda) z(E_H s + \phi_{t+1})\right] & \text{if } \phi_{t+1} > \phi^* \end{cases}$$

$$\phi^* : (E_L s + \phi^*)/(E_H s + \phi^*) = \zeta$$

Fragility of Dynamic Lemons Market

- There can be multiple equilibria in a dynamic lemons market.
- Asset prices are self-fulfilling.
- Occurs when $\frac{E_L s+\phi^S}{E_H s+\phi^S} < \zeta \leq \frac{E_L s+\phi^P}{E_H s+\phi^P}$.
- Plugging for ϕ_S and ϕ_P we obtain the condition for multiplicity as $(0 < \kappa_P < \kappa_S < 1)$

$$\kappa_P < \frac{E_L s}{E_H s} < \kappa_S,$$

For intermediate values of $E_L s / E_H s$ both equilibria exist.

- Liquidity price premium $\phi^P > \phi^S > PV = \frac{\beta[\lambda E_L s+(1-\lambda)E_H s]}{1-\beta}$

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Optimality of Repo

Proposition

Assume that $\frac{f_L(s)}{f_H(s)}$ *is decreasing in* s. *The optimal securities are unique and include a liquid repo contract* y_D *and an illiquid equity contract such that*

$$y_D(s) = \phi + \min(s, \delta),$$
$$y_E(s) = \max(s - \delta, 0),$$

for some $\delta \in (s_L, s_H)$.

With more than N quality levels, N tranches in equilibrium.

Optimal Security Design: δ

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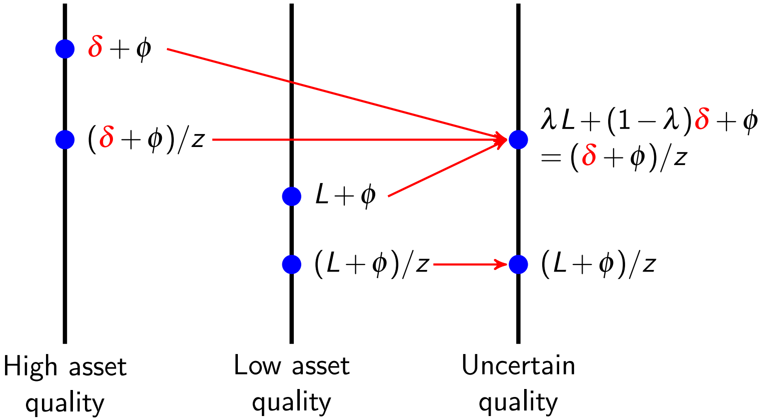
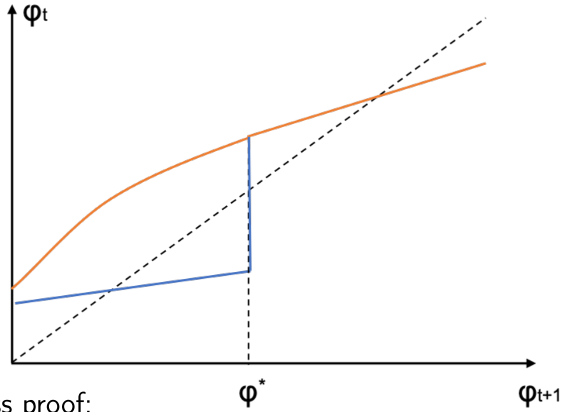


Uniqueness with security design



Uniqueness proof:
$\phi_t - \phi_{t+1}$ is quasiconcave in ϕ_{t+1}
(Intuition: ϕ_{t+1} is always in the liquid tranche)
$\phi_t > 0$ when $\phi_{t+1} = 0$.

Feedback Loop $\phi(\delta)$

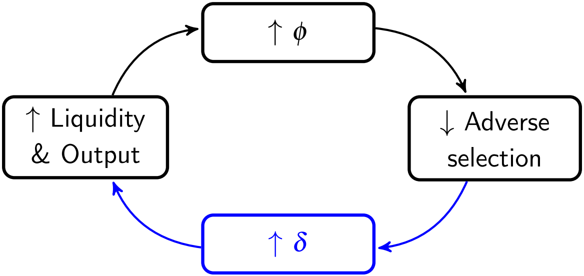


Figure: Asset Price ϕ and Liquid Debt Face Value $\phi + \delta$

Discussions on Fragility and Robustness

- Unravelling results when flexible security design option is introduced.
  - Suppose low asset price,
  - tranche a small senior liquid debt, asset price $\uparrow$, which allows more liquid tranching $\delta \uparrow$, which leads to asset price $\uparrow$, ... converges to the unique optimal.
- Unique equilibrium
  - improve the unique separating equilibrium by allowing tranching out liquid debt.
  - select the optimal pooling equilibrium in the multiple equilibria region.

Rigidity in Security Design

- Suppose agent B can only update design with some probability
- Security design is rigid $\Rightarrow$ securities are long-lived
- Dynamic lemons problem $\Rightarrow$ fragility of the securities market

Dynamics of Repo Runs

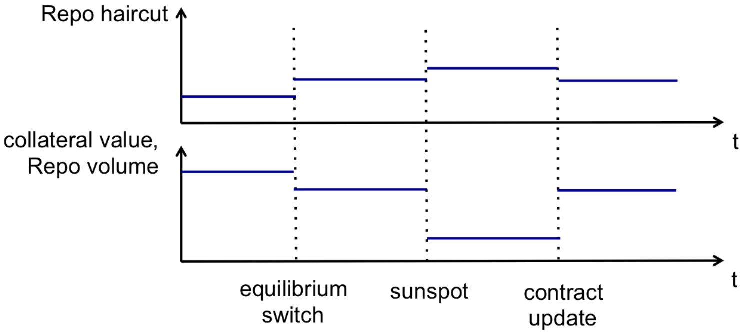


Figure: Dynamics of Repo Run.

Implementation as Short-Term Repo

- Repo terms (two point distributions for $F_L$and F_H for closed form solutions)
  - haircut
  - interest rate
- Persistent (asset quality or productivity) fundamentals
  - quanitify the effect of shocks to fundamentals to prices/output

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Example: Two-point Distribution

- High quality asset pays 1 w.p. π_H and 0 otherwise.
- Low quality asset pays 1 w.p. π_L and 0 otherwise.
- $0 < \pi_L < \pi_H < 1$.
- Debt contract: pays ϕ if 0 dividend and $\phi + \delta$ if 1 dividend.
- Closed form solutions and can show:
  - $\frac{d\delta}{d\lambda} < 0$ and $\frac{d\phi}{d\lambda} < 0$
  - $\frac{d\delta}{dz} > 0$ and $\frac{d\phi}{dz} > 0$

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Repo terms

- Repo rate:

$$R = \underbrace{\frac{\phi+\delta}{\phi+\pi_H\delta}}_{\text{Cashflow Riskiness}} \underbrace{z}_{\text{Technology Multiplier}} -1 = \left[\frac{1-\pi_H}{\lambda(\pi_H-\pi_L)}+1\right](z-1)$$

  - impact of adverse selection diminishes when $\pi_H \to 1$

- Repo haircut

$$h \simeq \underbrace{(z-1)}_{\text{Technology Multiplier}} \left[1-\underbrace{\frac{\pi_H}{\lambda\left(\pi_H-\pi_L\right)}}_{\text{Information Friction}}\right] + 1-\beta$$

  - Incorporates two views of haircut:
  - Fostel & Geanakoplos; Simsek: heterogeneous valuation/difference of opinion
  - Dang & Gorton & Holmstrom & Ordonez: information sensitivity.

Conclusion

Optimal security design in a dynamic lemons market

- When the design is updated frequently,
  - Unique equilibrium with liquid repo contract
  - Eliminates fragility and Pareto improves welfare
- When the design is rigid, repo run may emerge
- Amplification of shocks to asset quality and productivity
- Haircut more information sensitive than interest rate