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. $\lambda$
  - High distribution $F_H(s)$ w.p. $1 - \lambda$
  - Agent $B$ observes asset quality
  - Quality iid over time

- **Securities backed by assets**

\[
\sum_{j} y^j(s) \leq s + \phi_t, \forall s \in [s_L, s_H],
\]

$y^j(s)$ 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

Decentralized Market

Settlement

\(t\)

\(t+1\)
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 $I$ is

\[ \frac{H}{z} \rightarrow \lambda L + (1 - \lambda)H \]

High asset quality \hspace{2cm} Low asset quality \hspace{2cm} Uncertain quality

\[ \frac{H}{z} \]
\[ \frac{L}{z} \]
Separating: Illiquid Security

Reservation price of agent $B$ and agent $I$ is

\[ H \]

\[ \frac{H}{z} \]

\[ L \]

\[ \frac{L}{z} \]

High asset quality

Low asset quality

Uncertain quality

\[ \frac{\lambda L + (1 - \lambda)H}{z} \]
Equilibrium in Security $j$’s Market

- Index of info. insensitivity: higher $R^j_t$, lower adverse selection
  \[ R^j_t \equiv \frac{E_L y^j_t}{E_H y^j_t} \]

- If $R^j_t > \zeta \equiv 1 - (z - 1)/\lambda z$, pooling eq. in market $j$
  - both high and low $B$ types sell
  - $q^j_t = \lambda E_L y^j_t + (1 - \lambda) E_H y^j_t$

- If $R^j_t < \zeta$, separating eq. in market $j$
  - only low type sells
  - $q^j_t = E_L y^j_t$
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

Reservation price of agent $B$ and agent $I$s

\[
\frac{H + \phi}{z} \leftrightarrow \frac{L + \phi}{z} \leftrightarrow \frac{\lambda L + (1 - \lambda) H + \phi}{z}
\]

High asset quality
Low asset quality
Uncertain quality
Benchmark: Dynamic Lemons Market – Separating

Reservation price of agent $B$ and agent $I$s

$$H + \phi$$

$$\frac{(H + \phi)}{z}$$

$$L + \phi$$

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High asset quality

Low asset quality

Uncertain quality

$$\lambda L + (1 - \lambda)H + \phi$$

$$\frac{(H + \phi)}{z}$$

$$\frac{(L + \phi)}{z}$$
Fragility of the Dynamic Lemons Market

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

\[ \phi^* : (E_L s + \phi^*)/(E_H s + \phi^*) = \zeta \]
Fragility of Dynamic Lemons Market

- There can be multiple equilibria in a dynamic lemons market.
- Asset prices are self-fulfilling.

- Occurs when
  \[
  \frac{E_{LS} + \phi^S}{E_{HS} + \phi^S} < \zeta \leq \frac{E_{LS} + \phi^P}{E_{HS} + \phi^P}.
  \]

- Plugging for \( \phi_S \) and \( \phi_P \) we obtain the condition for multiplicity as \((0 < \kappa_P < \kappa_S < 1)\)
  \[
  \kappa_P < \frac{E_{LS}}{E_{HS}} < \kappa_S,
  \]

  For intermediate values of \( E_{LS}/E_{HS} \) both equilibria exist.

- Liquidity price premium \( \phi^P > \phi^S > PV = \frac{\beta[\lambda E_{LS} + (1-\lambda)E_{HS}]}{1-\beta} \)
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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: $\delta$

Reservation price of agent $B$ and agent $I$s

- **High asset quality**: $\delta + \phi$
- **Low asset quality**: $L + \phi$
- **Uncertain quality**: $\frac{(L + \phi)}{z}$

\[
\frac{\delta + \phi + \phi}{z} = \frac{\lambda L + (1 - \lambda)\delta + \phi}{z} = \frac{(\delta + \phi)}{z}
\]
Uniqueness proof:
\( \phi_t - \phi_{t+1} \) is quasiconcave in \( \phi_{t+1} \)

(Intuition: \( \phi_{t+1} \) is always in the liquid tranche)

\( \phi_t > 0 \) when \( \phi_{t+1} = 0 \).
Feedback Loop $\phi(\delta)$

Figure: Asset Price $\phi$ 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
  - quantify the effect of shocks to fundamentals to prices/output
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Example: Two-point Distribution

- High quality asset pays 1 w.p. $\pi_H$ and 0 otherwise.
- Low quality asset pays 1 w.p. $\pi_L$ and 0 otherwise.
- $0 < \pi_L < \pi_H < 1$.
- Debt contract: pays $\phi$ 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:**
  
  $$R = \frac{\phi + \delta}{\phi + \pi_H \delta} \left(z \right)$$
  
  **Cashflow Riskiness**
  
  **Technology Multiplier**

- **Impact of adverse selection diminishes when** $\pi_H \to 1$

- **Repo haircut**
  
  $$h \approx \left( z - 1 \right)$$
  
  **Technology Multiplier**

  $$1 - \frac{\pi_H}{\lambda \left( \pi_H - \pi_L \right)}$$

  **Information Friction**

  $$1 - \beta$$

- 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