Financial Intermediaries, Asset Transformation, and Liquidity

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September 2012
Road map of the talk

- **Motivations:**
  - assets’ liquidity and their characteristics
  - the role for financial intermediaries

- **The environment:**
  - markets; assets; banks
  - private information

- **Types of equilibria**
  - banks’ portfolios
  - asset liquidity and prices
  - welfare implications for banks
Motivations

Imperfect recognizability of an asset’s authenticity or true value weakens its usefulness as a payment instrument or collateral.

- During 2007-2008, asset-backed securities became hard to serve as collateral, due to the complexity in these assets that hinders investors to verify their true value.
- Some banknotes ceased to circulate since they were threatened by counterfeits by the 1850s in the U.S.
Motivations

• Akerlof (1970):
  goods with lemons problem $\rightarrow$ market failure
  • there is a role for middlemen to facilitate trades

• This paper:
  assets with imperfect recognizability $\rightarrow$ market failure
  $\rightarrow$ liquidity $\rightarrow$ output

*Can financial intermediaries improve aggregate liquidity and welfare in an economy with private information?*
Objectives

- frictions: the quality of real assets is private information.
- liquidity: the role of assets in payments.

(Lagos (2010), Rocheteau (2011), Li and Rocheteau (2010))

To provide a theory of asset liquidity and explore implications for

1. the relationship between assets’ characteristics, liquidity, and asset prices;
2. the effects of banks on liquidity and welfare.
Features of banks

- Asset transformation

- banks’ portfolios are public information;
- deposits and bank equity: recognizable means of payment.
- Banks have no informational advantages over individuals
- price-quantity schedules in the asset market: screening assets’ quality.
Can banks’ screening eliminate the private information problem?

- yes
  real assets are free from private information
  highest welfare among multiple equilibria

- no
  to signal, good assets may be held but not spent
  good assets are subject to an endogenous liquidity constraint
  lower aggregate liquidity
Related literature

- Liquidity constraints:

- The recognizability of assets:

- Bank liabilities serve as payments:
The environment

- Each period contains a DM and a CM
  - DM: decentralized market
  - CM: competitive market
- Two types of agents: *Buyers* and *Sellers*

![Diagram showing DM and CM periods](image)
Trades

DM: buyers and sellers meet bilaterally and randomly

- the buyer makes a take-it-or-leave-it offer
  - output: $x_1$
  - assets transferred from buyer: $(y_a, y_d, y_e)$
- buyers: utility $u_1(x_1)$; sellers: disutility $c_1(x_1)$
Trades

CM: all agents consume and produce
- each buyer is endowed with $A^E$ units of real assets
  - one-period-lived assets
  - the private signal about the quality of $A^E$
- production technology: $x_2 = h$
- banks open
  - portfolio choices: deposits and bank equity
- an asset market opens in late CM

In DM, buyers use assets to make payments
  - deposits and bank equity
  - real assets may be subject to private information problem
  - private information regarding means of payment
Time sequence

- Endowment $A_t^E$
- Dividends of $A_{t-1}^E$ realize: $k$, $k_e$;
  $k$ and $k_e$ are delivered

Banks open:
- issue deposits and equities
- invest in real assets

- Private signals: the quality of $A_t^E$
- An asset market opens

Let $x_1$ and $x_2$ be the perishable consumption goods produced in the DM and the CM, respectively. Buyers enjoy utility $u_1(x_1,t)$ from consuming $x_1$, and sellers suffer a disutility of working $c_1(x_1,t)$ in the DM. All agents get utility $u_2(x_2,t)$ from consuming $x_2$, and incur the disutility of working, where the disutility of working hours $h_n$ is linear, $c_2(h_n) = h_n, n = s, b$. Producing one unit of consumption goods demands one working hour that creates one unit of disutility.
The quality of real assets:

- The expected value of bad assets is lower than that of good assets.
Agents’ problem in the CM

The value function of a buyer is

$$W^b(a, d, e; k_j) = \max_{x_2, h, a', d', e'} \{x_2 - h + \beta V^b_{j,+1}(a', d', e')\}$$

s.t.  $x_2 + d' + q_e e' = h + k_j a + (1 + i) d + k_e e + q_{a,j,+1}^i (A^E - a')$

- $k_j$: dividends of asset $j$, $j \in \{h, \ell\}$;
  $k_e$: dividends of bank equity; $q_e$: the price of bank equity;
- $i$: deposit interest rate; $q_{a,j,+1}^i$: price of asset $j$, $+1$.
- $V^b_{j,+1}(a', d', e')$: buyer’s value function in the DM of period $t + 1$. 
Value function in the DM

\((x_1, y_a, y_d, y_e)\): the quantity of outputs and transfers of assets.

- The buyer’s value function is,

\[
V_j^b(a', d', e') = S_j(a', d', e') + k_j a + (1 + i) d + k_e e + W^b(0, 0, 0)
\]

- \(S_j(a', d', e')\): buyer’s surplus from trade in the DM
- \(S_j(a', d', e') \equiv u_1[x_1(y_a, y_d, y_e)] - k_j y_a(a', d', e') - (1 + i) y_d(a', d', e') - k_e y_e(a', d', e')\)
• All buyers choose the same $d$ and $e$;

$$\frac{1 - (1 + i)^\beta}{\beta} \geq \xi S_{h,2}(a, d, e) + (1 - \xi)\left\{\eta[S_{h,2}(a, d, e) + (1 - \eta)S_{\ell,2}(a, d, e)]\right\},$$

“ = ” if $d > 0$.

$$\frac{q_{e} - k_{e}\beta}{\beta} \geq \xi S_{h,3}(a, d, e) + (1 - \xi)\left\{\eta[S_{h,3}(a, d, e) + (1 - \eta)S_{\ell,3}(a, d, e)]\right\},$$

“ = ” if $e > 0$.

• $q_{j}^i$: determined by banks’ problem in the asset trade.

$$\frac{q_{a}^h - k_{h}\beta}{\beta} \geq S_{h,1}(a, d, e) \quad " = " \quad if \quad a_{h} > 0.$$  

$$\frac{q_{a}^\ell - k_{\ell}\beta}{\beta} \geq S_{\ell,1}(a, d, e) \quad " = " \quad if \quad a_{\ell} > 0.$$
Banks’ flow of funds

- Source of funds: deposits, equity, and dividends from bank assets
- Use of funds: investments, dividend and interest payments
- Flow of funds in period $t$ is

$$k_e E + (1 + i) D + q_h^h \Omega_h' + q_\ell^\ell \Omega_\ell' = D' + q_e E' + (k_h \Omega_h + k_\ell \Omega_\ell).$$

- $\Omega_j$: the quantity of asset $j$ banks hold in period $t$. 
Banks’ problem in the asset market

Banks want to buy $\omega_j$ units of asset $j$, at the price $q^j_a$, $j = h, \ell$

$$\max_{q^h_a, q^\ell_a, \omega_h, \omega_\ell} \xi[-q^h_a\omega_h + \beta k_h \omega_h] + (1 - \xi)[-q^\ell_a\omega_\ell + \beta k_\ell \omega_\ell]$$

s.t.  

$$q^h_a\omega_h + \beta V^b_h(a_h, d, e; k_h) \geq \beta V^b_h(A^E, d, e; k_h), \quad (1)$$

$$q^\ell_a\omega_\ell + \beta V^b_\ell(a_\ell, d, e; k_\ell) \geq \beta V^b_\ell(A^E, d, e; k_\ell); \quad (2)$$

$$q^h_a\omega_h + \beta V^b_h(a_h, d, e; k_h) \geq q^\ell_a\omega_\ell + \beta V^b_h(a_\ell, d, e; k_h), \quad (3)$$

$$q^\ell_a\omega_\ell + \beta V^b_\ell(a_\ell, d, e; k_\ell) \geq q^h_a\omega_h + \beta V^b_\ell(a_h, d, e; k_h); \quad (4)$$

$$q^h_a, q^\ell_a \geq 0, \omega_h \leq A^E, \omega_\ell \leq A^E. \quad (5)$$

- Condition (1)-(2): participation constraints.
- Condition (3)-(4): incentive compatibility constraints.
Algorithm to find an equilibrium

Strategy to pin down equilibrium:

1. conjecture a possible portfolio
2. check if the portfolio optimizes agents’ and banks’ problems in the CM
3. agents’ and banks’ portfolio choices; market clearing conditions \( \rightarrow a_h, a_\ell, d, e, q_a^h, q_a^\ell, q_e, i, k_e \)
4. bargaining in the DM \( \rightarrow \) terms of trade: \((x_1, y_a, y_d, y_e)\)
Types of equilibria

- Banks solve the private information problem:
  1. banks buy all of good assets and zero or some bad assets
  2. banks buy all of bad assets and zero or some good assets

- Banks do not solve the private information problem:
  3. banks buy more good assets than bad ones
  4. banks buy more bad assets than good ones
  5. banks buy the same quantity of good and bad assets

$\Rightarrow$ real assets which serve as payments in the DM are threatened by private information problem
Buyers’ offer without private information

Any offer made by a buyer who does not sell all of real assets to banks is,

$$\max_{x_1', y_a', y_d', y_e'} \left[ u_1(x_1) - k_j y_a - (1 + i) y_d - k_e y_e \right]$$

subject to,

$$- c_1(x_1) + k_j y_a + (1 + i) y_d + k_e y_e \geq 0,$$

$$y_a \leq a_j, \quad y_d \leq d, \quad y_e \leq e,$$

Any offer made by a buyer who sells all of his real assets to banks is,

$$\max_{x_1^-, y_d^-, y_e^-} \left[ u_1(x_1) - (1 + i) y_d - k_e y_e \right]$$

subject to,

$$- c_1(x_1) + (1 + i) y_d + k_e y_e \geq 0,$$

$$y_d \leq d, \quad y_e \leq e.$$
Proposition 1 (Asset prices)

When banks buy all one type of assets, deposits, bank equity and real assets have the same liquidity, and $\frac{k_e}{q_e} = 1 + i$.

1. If banks buy all good assets, then $q_h^a > q_\ell^a$.
2. If banks buy all bad assets and $\frac{\sigma_\ell k_\ell}{\sigma_h k_h} > 1$, then

$$q_\ell^a > q_h^a - \beta(k_h - k_\ell),$$

where $\sigma_j \equiv \frac{u'_1(x_1^j)}{c'_1(x_1^j)} - 1$. Moreover, when $k_h$ is large enough such that $\frac{\sigma_\ell k_\ell}{\sigma_h k_h} < 1$, then banks buy good assets at a higher price, i.e., $q_h^a > q_\ell^a$. 
Buyers’ offer under private information

Any offer made by a buyer with good assets is such that

\[
\max_{x_1^h, y_a^h, y_d^h, y_e^h} \left[ u_1(x_1) - k_h y_a - (1 + i) y_d - k_e y_e \right]
\]

\[(6)\]

subject to

\[-c_1(x_1) + k_h y_a + (1 + i) y_d + k_e y_e \geq 0,\]

\[(7)\]

\[u_1(x_1) - k_\ell y_a - (1 + i) y_d - k_e y_e \leq u_1(x_1^\ell) - c_1(x_1^\ell),\]

\[(8)\]

\[y_a \leq a_h, y_d \leq d, y_e \leq e.\]

\[(9)\]

- In eqm, condition (7) holds with equality because buyers make take-it-or-leave-it offers;
- condition (8) holds with equality to prevent imitating.
Proposition 2 (The pecking-order payment arrangement)

The buyer $h$’s offer, $(x^h_1, y^h_a, y^h_d, y^h_e)$, has the following properties:

- If $(1 + i)d + k_e e < c_1(x^*_1)$, then
  
  $$
y^h_d = d,$$
  $$y^h_e = e.$$

And $(x^h_1, y^h_a)$ satisfies

$$k_h y^h_a = c_1(x^h_1) - (1 + i)d - k_e e,$$

$$u_1(x^\ell_1) - c_1(x^\ell_1) = u_1(x^h_1) - c_1(x^h_1)$$

$$+ (1 - \frac{k_{\ell}}{k_h})[c_1(x^h_1) - (1 + i)d - k_e e],$$

where $x^\ell_1 = \min\{x^*_1, c_1^{-1}[k_{\ell} a_\ell + (1 + i)d_\ell + k_e e_\ell]\}$.

Moreover, if $a_h > 0$, then $x^h_1 < x^\ell_1$ and $y^h_a < a_h$. 


Proposition 2 (con’t)

• If \((1 + i)d + k_e e > c_1(x_1^*)\), then

\[
\begin{align*}
x_1^h &= x_1^* \\
k_h y_a^h + (1 + i)y_d^h + k_e y_e^h &= c_1(x_1^*) \\
y_a^h &= 0.
\end{align*}
\]
Proposition 3 (The liquidity-price relationship)

When banks do not remove private information problems, good assets are subject to liquidity constraints, and the asset prices are such that \( q^h_a < q^\ell_a + \beta(k_h - k_\ell) \).
Figure 3.3: Welfare

We set up utility function $u_1(x_1) = x_1^{0.8}$, cost function $c_1(x_1) = 0.7x_1$; the parameter value for the benchmark are $A = 4.5$, $\bar{k}_\ell = 0.5$, $\eta = 0.4$, and $\xi = 0.5$.∗∗ The number of equilibrium is specified by banks' portfolios comprised of good assets and bad assets. eqli.1: all good assets and no bad ones; eqli.2: all bad assets and no good ones; eqli.3: a fraction of real assets, and more bad assets than good ones.

Our numerical examples show that when banks buy all of one type of assets, the economy enjoys higher welfare than otherwise (eqli.1 and eqli.2 in Figure 3). The reason is that, banks not only provide recognizable and safe assets to facilitate trades, but also eliminate the private information problem regarding the means of payment. When the quality difference of real assets becomes smaller, there also exists an equilibrium where the means of payment in the DM is subject to private information (eqli.3 in Figure 3). In this type of equilibrium, buyers need to retain a fraction of good assets as a signaling device, which reduces the aggregate liquidity and, therefore, welfare. The equilibrium (see eqli.1 in Figure 3) in which banks buy all of good assets entails the highest welfare. The reason is that, 

$$
\mathbb{W} = \sum_{t \geq 0} \beta^t \int_{j \in h, \ell} [u_1(x_1^j) - c_1(x_1^j)] dj + \sum_{t \geq 0} \beta^t \int_{j \in h, \ell} [u_2(x_2^j) - h^j] dj.
$$

eqli.1: banks buy all of good assets, and no bad ones;
eqli.2: banks buy all of bad assets, and no good ones;
eqli.3: banks buy some of good and bad assets.
Conclusion

- Prices of risky real assets are affected by assets’ contributions to trades.
- Good assets face an endogenous liquidity constraint under private information.
  - bank liabilities are preferred means of payment
  - to signal, good real assets may be held but not spent.
- Banks can improve aggregate liquidity and welfare by providing recognizable assets, even if they are not able to verify assets’ quality.
- When bank liabilities are backed with high quality real assets, the economy achieves the highest welfare.