Fire sales, inefficient banking and liquidity ratios

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Fire sales: an old phenomenon

► Financial fire sales are periods during which financial institutions are forced to engage in distressed sale of assets to meet their obligations.

► Fire sales defined theoretically as *forced sales at a dislocated price* (Schleifer and Vishny 1992).

► Modern financial markets have not invented fire sales (1866 crisis on the money market of Lombard Street).

► During those episodes, liquidity demand by distressed banks cannot be satisfied by sufficient supply of liquidity to buy back assets: collapse of price.
Welfare and fire sales

- Are fire sales harmful?
  - mere innocuous redistribution effect between sellers and buyers with no impact on welfare in absence of imperfections (Greenwald Stiglitz 1986)

- However, market failures could generate a pecuniary externality: need a good model of banking
Literature

1. Banking model

2. Fire Sales
   - Seminal work by Schleifer Vishny (1992)
   - Fire sales: credit constraint: Kiyotaki Moore (1997)
   - Stein (2012): fire sales induce a negative externality in a model where banks are money creators and there is a binding collateral constraint: excessive creation of private money

3. Externalities
This paper

- Introduction of a financial intermediary offering illiquid contracts: similar to contractual savings (pension funds, insurance companies)

- **General equilibrium analysis of fire sales**: understand how both the demand for and the supply of liquidity are determined

- Fire sales are a transfer of money within the financial sector that is not neutral with incomplete markets: redistribution between different ex post type of households = **insurance problem**
Paper at a glance

- Banking model a la Diamond and Dybvig: a shock makes a stochastic proportions of households impatient before assets have matured

- Households can choose between:
  - liquid contract of banks (can withdraw if impatient)
  - illiquid offered by funds (cannot withdraw early but higher return - riskier)

- Financial sectors composed of banks and funds which interact on market of assets: banks sell assets to funds

- Welfare loss arises that goes through the price, no deadweight loss of asset sales
Contribution- 1

- Uncover an externality of fire sales new in the literature by building a model of supply and demand of liquidity - Takes 2 forms:
  1. Banks invest too much in assets (Banks’ choice)
  2. Inefficient size of banking sector (HH choice)

- Crucially, no mixed equilibrium (Allen Gale 2004):
  - Sales of assets between different sectors
  - In my setting, mixed equilibrium not necessary to have an equilibrim

- Motivate a pecuniary externality in a setting with:
  1. No collateral constraint (different from Stein 2010)
  2. Ex ante identical households (different from Allen Gale 2004)
Intuition behind welfare loss of fire sales

- Fire sales are a redistribution between the two sectors offering contracts of different liquidity (banks and funds).

- In fine, transfer through price effect of price sales implies a transfer of wealth between households needing liquidity and households who can postpone withdrawals.

- Externality arises because agents do not take into account their impact on fire sale prices and hence on the transfer operated by fire sales.

- Cost of fire sales = inefficient insurance of risk of becoming impatient i.e. against idiosyncratic liquidity risk.
Contribution- 2

- Provide an assessment of liquidity ratios in general equilibrium setting
- Reduce inefficiency in bank’s choice
- But can worsen inefficiency in HH’s choice
- Tax on deposits and subsidy of illiquid contracts of funds
Take-away results

1. Banks take on too much risk

2. Banking sector is too big relative to funds: **illiquid contracts are valuable**

3. Liquidity ratios help for the first inefficiency (banks) but can worsen the second one (households)
Content

1. Model

2. Inefficiencies

3. Policy: liquidity ratios and tax on deposits
Environment

- 3-period banking model: 0, 1 and 2

- *Ex ante*, 3 agents: banks, funds, *ex ante* identical households,
  - after shock: patient / impatient households

- Households invest in contracts of financial intermediaries
  which invest for them in assets

- Assets mature in period 2, two types of assets:
  - early assets (done in period 0) - return $R^E$
  - late assets (done in period 1) - return $R^L$
Liquidity shock

- Liquidity shock hits consumers’ preferences in period 1 before asset maturation

- Idiosyncratic: households do not know their type \textit{ex ante}
  - Impatient only care about middle period consumption, cannot postpone consumption until asset maturation
  - Patient wait for asset maturation in last period to consume: lucky outcome

- Aggregate: size of the shock (number of impatient) is stochastic
Model ingredients

- Before liquidity shock, households allocate wealth between banks and funds

- **Liquid** contracts of banks: can withdraw if hit by liquidity shock

- **Illiquid** contracts of funds: cannot withdraw if hit by liquidity shock: riskier investment for HH

- If liquidity shock too high, banks can sell assets to funds who have cash

- Fire sales when price of assets sold by banks to funds falls below fundamental value
Timing

1. **Period 0**
   1.1 Households allocate $D$ to liquid contracts of banks and $K$ to illiquid contracts of funds
   1.2 Banks and funds invest in reserves ($L^B, L^F$) and in early assets ($S^B, S^F$) and banks decide fixed rate to pay impatient households $\bar{c}$

2. **Period 1**
   2.1 Shock realized: proportion $\theta$ of households impatient withdraw from banks $\theta \bar{c} D$
   2.2 Banks can sell assets to funds if needed - remaining cash of banks and funds invested in early assets
   2.3 Banks default if ICC not respected

3. **Period 2**: early and late assets mature, funds’ profits (and banks’ if no default before) realized and shared between $1 - \theta$ patient (patient no longer care about consumption)
Micro imperfections

1. **Incomplete markets**: generates the externality
   - Missing markets: no Arrow securities allowing banks to insure against aggregate liquidity shock
   - Funds and banks cannot raise new cash in period 1

2. **Asymmetry of information** between bank and depositors: imperfections innocuous
   - Depositor type (patient/impatient) is private information
   - Contract cannot be made contingent upon the type
   - Bank run possible: need incentive compatible contract
Probability of default

- Bank defaults when incentive compatibility constraint no longer verified:

\[ \theta \bar{c}D + (1 - \theta) \bar{c}D \frac{P(\theta)}{RE} \leq L^B + S^B P(\theta) \]

- Gives the default threshold: \( \bar{\theta} \)

- \( (1 - \bar{\theta}) \) is the probability of default
Fundamental price

- Price that makes funds indifferent between holding early assets sold by banks or investing in new late assets

\[ P^F = \frac{R^E}{R^L} \]

- Ratio btw marginal return of buying back early assets and marginal return on investing in new assets projects
Fire sales

Theorem

For high liquidity shock and $R^E$ sufficiently high compared to $R^L$, price falls to cash in the market price when banks default.

- Market clearing: demand of liquidity by banks = supply by funds

$$P^* = \frac{L^F}{S^B}$$

- Discontinuity in the price at bankruptcy price $P^*$
- $P^*$ decreases with $S^B$ and with $D$ ($L^F = E - D - S^F$)
Externality takes two forms

1. In banks’ choice

2. In households’ choice
Externality lies in choice of $S^B$

- The 2 f.o.c. wrt to $\bar{c}$ and $L^B$ are identical in both economies, only the f.o.c. wrt to $S^B$ differs

- Bank does not internalize the effect on its choice of $S^B$ on bankruptcy price $P^* = L^F / S^B$

- Choosing more $S^B$ in period 0 implies a lower bankruptcy price, and has an impact on:

1. Probability of default
2. Payment banks can make to depositors in case of default
Impact of choice of $S$ on probability of default

- Decentralized bank does not internalize the impact of its choice of $S^B$ on bankruptcy price

$$\frac{\partial \theta^*}{\partial S^B_{dec}} = \frac{R^E P^*_{dec}}{c^c_{dec} D_{dec}(R^E - P^*_{dec})}$$

- Social planner understands that partial derivative is:

$$\frac{\partial \theta^*}{\partial S^B_{soc}} = \frac{R^E P^*_{soc}}{c^c_{soc} D_{soc}(R^E - P^*_{soc})} \frac{c^c_{soc} D_{soc} - L^B_{soc} - K_{soc}}{R^E S^B_{soc} - K_{soc}}$$
Over investment in $S^B$ by decentralized bank

Theorem

**Banks invest too much in assets, i.e. take on too much risk**

- The value of the partial derivative of the Lagrangian with respect to $S^B$ is greater in the decentralized economy than in the constrained efficient economy for a given value of $S^B$, $S^B = \overline{S}$.

\[
\frac{\partial L_{dec}}{\partial S^B} (S^B = \overline{S}^B) > \frac{\partial L_{soc}}{\partial S^B} (S^B = \overline{S}^B)
\]

- For decentralized bank, increasing $S^B$ marginally increases the utility more than in constrained social planner problem because neglect impact on price.
Inefficiency on households’ side

Theorem

**Households can over invest in banks: banks are too big compared to funds**

- Households do not internalize the effect of their choice on the bankruptcy price
- Fail to realize that bankruptcy price $P^*$ depends on $D$ and $K$
  - Neglect the impact on probability of default by banks and on payments by banks in case of default
  - Neglect impact on expected payments by banks
Liquidity ratios

- Liquidity ratios constraint whose Lagrange multiplier is $\mu_2$:

\[ S^B \leq \alpha D \text{ with } \alpha \leq 1 \]

- $\mu_2$ enters banks and households’ program
Effect of liquidity ratios - Banks choice

Theorem

Binding liquidity ratios alleviate the inefficiency lying in bank’s choice

- In the decentralized economy with ratio:
  \[
  \frac{\partial L_{dec}}{\partial S^B} = \frac{\partial L_{dec}}{\partial S^B} - \mu_1 - \mu_2
  \]

- In the efficient constraint economy:
  \[
  \frac{\partial L_{soc}}{\partial S^B} = \frac{\partial L_{soc}}{\partial S^B} - \mu_1
  \]

\( \Rightarrow \mu_2 > 0 \) allows to get the decentralized allocation closer to the constrained efficient allocation
Effect of liquidity ratios - HH choice

$$\max_{D,K,\tau,L^B,S^B} + \lambda[E - D - K] = \max_{D,K} U + \mu_1[D - S^B - L^B] + \mu_2[\alpha D - S^B]$$

$$\frac{\partial L^B_{ratio}}{\partial D} = \frac{\partial L^B_{dec}}{\partial D} + \alpha \mu_2$$

**Theorem**

Imposing $\mu_2 > 0$ in order to alleviate the inefficiency lying in the bank’s choice can worsen the inefficiency lying in the households choice.
Non contingent tax

- Households withdrawing in period 1 now receive \( c_1 = \overline{c}D(1 - t) \) when the bank is solvent and the patient receive a subsidy equal to \( \frac{\theta \overline{c}Dt}{1-\theta} \)

- Equivalent to a redistribution between types
- Does not require to observe the type

**Theorem**

*Any tax \( t \geq 0 \) allows to get the choice of households closer to the efficiency and increases welfare.*

\[
\frac{\partial L_{\text{dec}}}{\partial D^i} \leq 0
\]

\[
\frac{\partial L_{\text{dec}}}{\partial K^i} \geq 0
\]
Conclusion

- Pecuniary externality is an inefficient insurance due to transfer btw patient and impatient by price effect of fire sales

- Arises both in banks and HH choice:
  1. Banks invest too much in assets and cannot insure depositors optimally against risk of being impatient
  2. Banking sector is too big relatively to financial sector because households invest too much in deposits

- Policy needs to take care of two inefficient choices: liquidity ratios can worsen inefficiency in households’ choice

- Complementary policy to ratio: redistributive tax to restore optimal insurance