"Fire Sales in a Model of Complexity" Macro Reading Group

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Motivation

- Financial assets provide liquidity and return to their holders
- In times of crises, asset prices plummet, so that liquidity cannot be provided, precisely at the moment at which it is needed most.
- Credit Crunch and Fire Sales of Assets occur simultaneously when distressed institutions go to secondary markets to sell their assets. These assets are complex and difficult to price ex-ante, so demand is low. This reduces the value of the portfolios of the institutions, and further amplifies their liquidity needs.
    - Amplification Mechanism of crises
- This paper looks for a microfoundation for this behavior in order to study policies that may solve it

How can this happen?

- During normal times banks only need to know the financial health of those banks with whom they trade more often.
- However, if further away in the financial network, an institution becomes distressed (falls), the bank lacks information about its portfolio and cannot respond perfectly to the shock
- Banks are aware of this fact, and this uncertainty makes them behave conservatively and retrench their assets
- Hence, when shocks are big, both distressed and healthy banks sell their assets in the secondary market, making asset prices to plummet and further reducing credit. Fire sales may occur.

Related Literature

- Fire Sales:
  - Brunnermeier and Pedersen (2008) - rational and unconstrained traders do not arbitrage fire sales to get higher profits in the future
  - Shleifer and Vishny (1992) - fire sales occur because all banks are distressed
- Contagion in Financial Markets:
  - Allen and Gale (2000) and follow-ups - Mechanisms of Contagion through a network of linked institutions.
  - Passive Role of banks.

Environment

- Three dates $t = 0, 1, 2$
- A single good (a dollar) can be kept in liquid reserves or loaned to production firms.
- Loans yield $R > 1$ at date 2 but are partially iliquid at date 1
- There are n (continuums of) banks b^j

Balance Sheet of Bank i

Liabilities		Assets	
legacy loans	$1 - y$	core capital	1
reserves	y	claim by bank $\sigma^{-1}(i)$	z
claim in bank $\sigma(i)$	z		

Financial Network

$$\mathbf{b}(\sigma) = \left(b^{\sigma(1)} \rightarrow b^{\sigma(2)} \rightarrow b^{\sigma(3)} \rightarrow \ldots \rightarrow b^{\sigma(n)} \rightarrow b^{\sigma(1)}\right)$$

- Debt is senior to equity, so that in case of distress (liquidity needs exceed liquidity holdings), the bank is liquidated and z is repaid.
- The bank has two execute two payments (one at each date)
    1. q_1^j is the repayment of the claim to bank $\sigma^{-1}(i)$. If the bank is financially sound, $q_1^j = z$, otherwise it is liquidated and $q_1^j < z$
    2. q_2^j is the equity at the end of the economy. If the bank is liquidated $q_2^j = 0$, otherwise $q_2^j > 0$
- Additionally, a rare event occurs and bank i_θ has to pay $\theta > 0$ to an outsider
- Finally, banks us legacy loans and reserves to buy or sell in a secondary market. Banks can take full long or short positions in this market, depending on the price. Let this decision be $A_0^j \in \{S, B\}$
    - $A_0^j = S$, the bank hoards all y as liquidity and (potentially) sells $1 - y$ in the secondary market at price p
    - $A_0^j = B$, the bank retains $1 - y$ for date 2 and uses y in the most profitable use (either loans or secondary market)

Preferences of the Bank

- The Bank faces Knightian uncertainty and is unable to name a probability distribution governing the rare event
- Max-Min Preferences - Maximizes against the worst case!!

$$\max_{A \in \in \{S,B\}} \min_{b \in \mathcal{B}} \omega q_1^j(b) + (1-\omega) q_2^j(b)$$

where $\mathcal{B}$ is the set of admisible permutations. That is, $b \in \mathcal{B}$ implies that the bank puts positive probability on $b \in \mathcal{B}$, given its information.

Secondary Market

- The secondary market opens at date 1 and banks trade their loans and reserves
- M_s is the mass of sellers (those who choose $A_0^j = S$) and M_b is the mass of buyers. Market clearing requires that

$$(1-y)M_s + \frac{y}{p}M_b = \begin{cases} \geq 0 & p = p_{scrap} \\ = 0 & p \in (p_{scrap}, 1) \\ \leq 0 & p = 1 \end{cases}$$

where $p_{scrap} > 0$ is a floor in the price of the assets and $p = 1$ is the face-value price of the asset.

Equilibrium

- An Equilibrium for this economy is a tuple of decisions $\left[\left\{A_0^j\right\}_j\right]_b$ and of payments $\left[\left\{(q_t^j)_t\right\}_j\right]_b$ and a price in the secondary market p^* such that:
  - given the realization of b and the rare event, each bank chooses its actions in order to maximize its min-max payoff
  - p^* clears the secondary market

The payoff relevant uncertainty of the bank is simply the distance to the rare event. Let k be that distance. Formally, k is defined as

$$j = \sigma\left(i_\theta - k\right)$$

Benchmark Case: No Complexity (uncertainty)

- They solve the economy letting $\mathcal{B} = \{b\}$ a singleton. In this case we have a "cascade equilibrium". We first fix p and solve for the decisions, then solve for p
- There exists some $K(p)$ such that if $k \leq K(p) - 1$, the bank becomes a seller and hoards liquidity in order to withstand the shock and if $k \geq K(p)$, the bank becomes a buyer.
- Let ϕ_j be the liquidity need of bank j

$$\phi_j = z - q_1^{\sigma(i_\theta - k + 1)} + \vartheta \mathbf{1}_{k=0}$$

If $\phi_j > 0$ the bank is distressed and takes action $A_0^j = S$. It recovers $l(p) = y + (1-y)p$ units of liquidity and uses them to pay to its creditor before liquidating. If $\phi_j = 0$, $A_0^j = B$ and the bank acquires $\frac{y}{p}$ units of liquidity in the secondary market.

- Under this conjecture
  - i_θ gets $q_1^{\sigma(i_\theta+1)} = z$ and repays $q_1^{\sigma(i_\theta)} = z + l(p) - \theta$. If $q_1^{\sigma(i_\theta)} > 0$, the cascade ends. If $q_1^{\sigma(i_\theta)} < 0$, the bank is liquidated
  - $i_\theta - 1$ gets $q_1^{\sigma(i_\theta)} = z + l(p) - \theta$ and repays $q_1^{\sigma(i_\theta-1)} = z + l(p) - \theta + l(p)$
  - $i_\theta - 2$ gets $q_1^{\sigma(i_\theta-1)} = z + 2l(p) - \theta$ and repays $q_1^{\sigma(i_\theta-2)} = z + 2l(p) - \theta + l(p)$
- Repayment increases linearly in distance. If n is large enough, eventually $z + ml(p) - \theta > z$ and the cascade ends. Let $m = K(p)$
- All banks with $k \geq K(p)$ are solvent and buy liquidity. Hence

$$K(p) = \left\lceil \frac{\theta}{l(p)} \right\rceil - 1 = \left\lceil \frac{\theta}{y + (1-y)p} \right\rceil - 1$$

so that the size of the cascade decreases in the price of the asset.

- Clearing Market implies that

$$(K(p)+1)(1-y)-(n-(K(p)-1))y=\begin{cases} \geq 0 \ p=p_{scrap} \\ =0 \ p\in(p_{scrap},1) \\ \leq 0 \ p=1 \end{cases}$$

  If n is large enough (deep market), the only equilibrium price is $p^*=1$, so that $K(p)=\lceil\theta\rceil-1$ and aggregate loans $\mathcal{Y}=ny-\lceil\theta\rceil$
- The cascade is as big as the shock and does not get amplified in this case

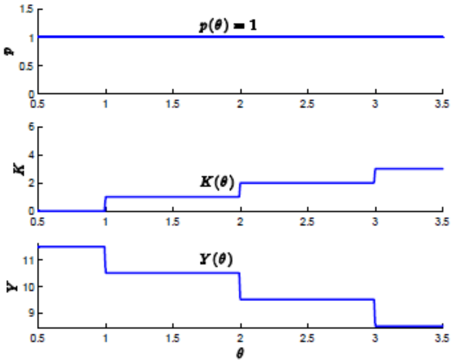

Figure: Benchmark Economy

Complexity

- Now, we let $\mathcal{B}$ contain all permutations that cannot be ruled out by a bank who knows only the financial health of other banks with whom he trades. In this case, he knows whether he has received the shock or whether one of his neighbors has received it. However, he does not know whether one of the neighbors of his neighbors has received it.
- Since the bank puts itself in the worst-case scenario, it will assume that indeed $\tilde{k} = 2$ if $k \geq 2$

Equilibrium

- Each bank $k \in \{0, 1\}$ chooses the same action as in the benchmark case
- Each bank $k \notin \{0, 1\}$ chooses the same action as bank $k = 2$ chose before.
- Hence, if $K(p_{scrap}) \leq 1, A_0^j = S$ for every bank and the equilibrium price is p_{scrap}. Fire Sales
- If $K(1) \geq 2, A_0^j = B$ for all banks with $k \geq 2$ and the equilibrium is the same as before.
- If $K(1) \leq 1 < 2 \leq K(p_{scrap})$ there is multiiplicity of equilibria.

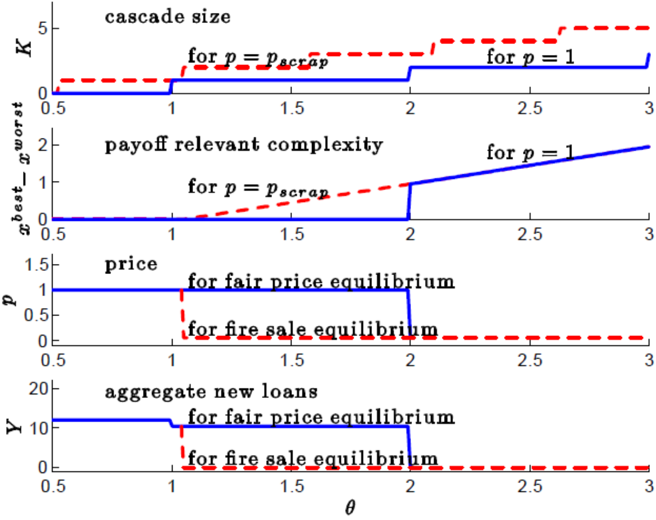

Figure: Complex Economy

Externalities

In this model a handful of externalities are present

- Complexity Externality: When an additional firm decides to sell, the price goes down, decreasing the price of assets and increasing the size of the cascade
- Fire Sale Externality: Since sellers are financially constrained and buyers are unconstrained, a decrease in the price has a first order effect on welfare

Policy

- Government intervation may be useful
  - Shorten the cascade: Bail-outs, Support-loans, Liquidity providers
  - Give more information: Stress Tests
  - Reduce linkeages: Substitute OTC trading for exchanges

Discussion

- Very simple model of financial linkeages.
- Crucial and unjustified assumptions: No contingent contracting, max-min utility function
- Very simple policy recommendations
- Not a single insight beyond common sense.