
Where should liquidity be injected during a financial crisis?

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1. Motivation

Some actions of the Fed in the last year and a half:

- TAF – credit auction to banks for 28, 84 days
- TSLF (28d) and PDCF (overnight) – primary dealers
- TALF – lend against collateral provided by ABSs on student, auto, credit card, and SBE loans.
- AMLF and MMIFF – Credit to money market funds.
- CPFF – Credit to firms directly by buying commercial paper as a backstop provider

Liquidity everywhere...

Effect on the Fed's balance sheet

Fed's assets January 07

Assets	
Securities held outright	
U.S. Treasury bills	277.2
U.S. Treasury notes and bonds	501.7
Agency Debt	0
Repurchase Agreements	39.8
Direct Loans	1.3
Gold	11.0
Foreign reserves	20.5
Other Assets	27.0
<i>Total Assets</i>	<i>878.5</i>

Fed's assets August 09

Assets	
Securities held outright	
U.S. Treasury bills	18.4
U.S. Treasury notes and bonds	717.7
Agency debt	111.8
Repurchase Agreements	0
Direct Loans	106.3
Gold	11.0
Foreign reserves and other assets	76.7
New asset categories	
Term Auction Facility (TAF)	221.1
Commercial Paper FF	53.7
Maiden Lane	61.7
Mortgage-backed securities	609.5
Central Bank liquidity swaps	69.1
<i>Total Assets</i>	<i>2063.8</i>

Contributions

Question: where are liquidity injections more effective?

Three desired features of a model:

- Financial market with many players.
- Borrowing markets interacting with securitization. ABSs taking central stage in financing.
- Mark to marketing and leveraging.

What I won't do:

- Focus is not on whether there is sufficient liquidity.
 - Financial system as re-allocating funds, no risk management or maturity transformation
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Literature review

Pervasive imperfection: pledgeability constraints

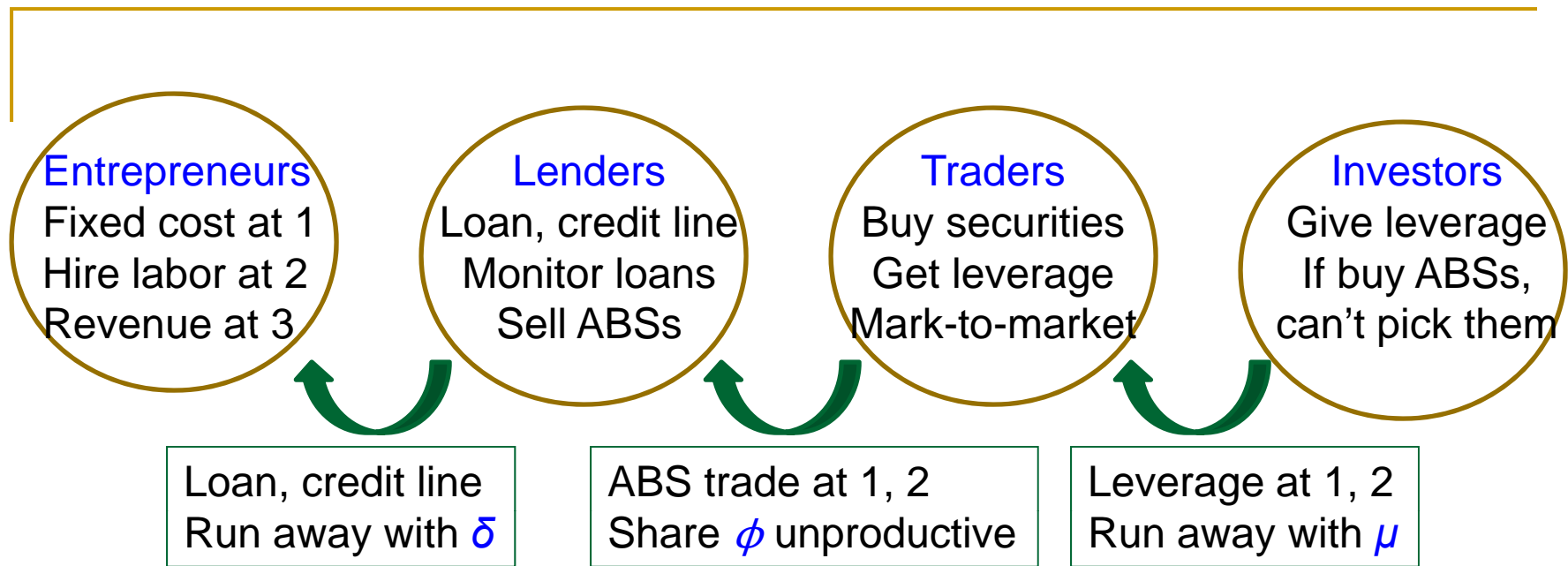
- ❑ Holmstrom Tirole (1996, 1998, 2008)
- ❑ Kiyotaki Moore (1997)
- ❑ Matsuyama (2007), Krishnamurthy (2009)

Mark-to-market of trading activities

- ❑ Shleifer Vishny (2009)
- ❑ He Krishnamurthy (2008)

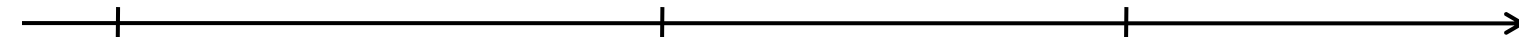
Monetary policy in response to credit problems

- ❑ Farhi Tirole (2009)
 - ❑ Diamond Rajan (2009)
 - ❑ Kocherlakota (2009)
-



Second period flow of funds:

- Lenders -> Entrepreneurs (credit lines)
- Traders -> Lenders (securities market)
- Investors -> Traders (leverage over capital gains)
- Investors -> Lenders (if $Q' = 1 - \phi$)



First period flow of funds:

- Lenders -> Entrepreneurs (loan for set-up costs)
- Traders -> Lenders (securities market)
- Investors -> Traders (leverage)

Third period flow of funds:

- Entrepreneurs -> Lenders (loans repaid)
- Lenders -> Traders (securities mature)
- Lenders -> Investors (securities mature)
- Traders -> Investors (leverage repaid)
- All agents -> representative household

2. Model

Three periods, no discounting, no aggregate uncertainty.

Representative consumer-worker:

$$U = \ln(C) - (L^S + L^{S'} + L^{S''})$$

$$C = \left(\int_0^N Y_i^{1/m} di \right)^m, m \in [1, 2]$$

$$\int_0^N P_i C_i di + H = W(L^S + L^{S'} + L^{S''}) + \text{Payoff}$$

Capital: H

Claims issued by government, redeemable for consumption in final period, redeemable by lump-sum taxes.

Could also think of as capital good.

Entrepreneurs

Only ones with access to production technology

Total entrepreneurial capital K

Continuum in $[0,1]$, monopolist of variety of good

Set-up cost WF

Production technology for each variety

$$Y_i'' = A_i' \min \left\{ \frac{L_i'}{\nu}, \frac{L_i''}{1-\nu} \right\}$$

$A_i' = a$ with prob. $1-\phi$, 0 otherwise

I projects started period 1, $N = (1-\phi)I$ continued period 2.

Lenders

Only ones with access to monitoring technology of entrepreneurial behavior

Continuum of them, but total capital D and D' .

If use monitoring technology, entrepreneur can only abscond with δ share of funds. Assume that $(1-\delta)m > 0$ so all projects profitable.

Credit: initial loan for set-up cost $WF-K$, credit line for WL' .

Financing: Issue securities S and S' , sell for Q , Q' , pay 1.

Traders

Besides entrepreneurs and lenders, only ones that can verify quality of securities (whether positive productivity)

Capital E and E' , other financing from investors

Can abscond with μ share of assets, so for assets S , pledgeability constraint is $Inv \leq (1-\mu)S$

First period: equity E , $Inv=(1-\mu)S$, and $S=E/\mu$

Second period entering equity $E + \left(\frac{(1-\phi)Q'}{Q} - 1 \right) S$

Second period new purchases $E' + \left(\frac{1-\mu}{\mu} \right) \left(\frac{(1-\phi)Q'}{Q} - 1 \right) \left(\frac{E}{\mu} \right)$

Investors

Capital M , (so that $H = K + D + D' + E + E' + M$)

H (or M) is large enough to finance all projects and to implement efficient production.

Can keep as capital earning zero return or:

- Lend to entrepreneurs – they abscond with it
- Buy lenders' securities – never at 1, but extreme lemons problem. At 2, per \$1 spent, only $1 - \phi$ back next period, so only do so if $Q' \leq 1 - \phi$.
- Invest in traders up to pledgeability constraints. Behave competitively so return of 1.

Key ingredients in this set-up

Many agents

- Banks became a mix of lenders and traders recently.
- Separated capital + holding of same securities.

Mark-to-marketing and leveraging

- Important among traders, discouraged for banks
- Leveraging of traders (I-banks) above lenders (C-banks)

Securities

- Investors go through securities market via traders.
 - Crucial source of financing.
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3. Solution of the model

Optimal behavior of the representative agent

-- demand for each variety

$$Y_i^\alpha = C^\alpha P_i^{m/(1-m)}$$

-- static cost-of-living price index

$$\left(\int_0^N P_i^{\alpha/(1-m)} di \right)^{1-m} = 1$$

-- consumption-labor trade-off

$$C^\alpha = W$$

Entrepreneur/bank problem

Joint problem of bank and entrepreneur

$$\max_{P_i'', Y_i'', L_i', L_i''} \{ P_i'' Y_i'' - W L_i'' - W L_i' / Q' \}$$

$$Y_i'' = A_i' \min \left\{ \frac{L_i'}{\nu}, \frac{L_i''}{1-\nu} \right\},$$

$$Y_i'' = C'' P_i^{m/(1-m)}$$

Optimality conditions:

$$N = (1 - \phi)I$$

$$L' = \nu(L' + L'')$$

$$P_i'' = m \left(1 - \nu + \frac{\nu}{Q'} \right) \frac{W}{a}$$

In symmetric equilibrium

Combining the optimality conditions, symmetric equilibrium:

$$C = N^m Y$$

$$L' + L'' = \frac{1}{m(1-v + v/Q')(1-\phi)I}$$

$$W = \frac{a[(1-\phi)I]^{m-1}}{m(1-v + v/Q')}$$

$$\begin{aligned} \pi_i(Q', I) &\equiv (1-\delta)P_i Y_i - WL_i' / Q' - WL_i'' \\ &= \frac{[(1-\delta)m-1]a}{m^2(1-v + v/Q')[(1-\phi)I]^{2-m}} \end{aligned}$$

Financial decisions

Entrepreneurs maximize H_E'' subject to

$$WFI + H_E = K + Loan,$$

$$WL'N + H_E' = Loan' + H_E, \quad \Rightarrow H_E = H_E' = 0$$

$$WL''N + H_E'' = \delta P'' Y'' N + H_E'.$$

Lenders maximize H_L'' subject to

$$Loan + H_L = D + S,$$

$$Loan' + H_L' = D' + S' + Sec' + H_L,$$

$$(1 - \phi)S / Q + S' / Q' + (1 - \phi)Sec' / Q' + H_L'' = (1 - \delta)NP'' Y'' + H_L'.$$

$$\Rightarrow Q \leq (1 - \phi)Q' \text{ and } Q' \leq 1 \quad \Rightarrow H_L = H_L' = 0 \text{ if strict inequalities}$$

Financial decisions

Traders maximize H_T'' subject to

$$S + H_T = E + Inv,$$

$$S' + H_T' = E' + Inv',$$

$$Inv + Inv' + H_T'' = (1 - \phi)S / Q + S' / Q'.$$

$$Inv \leq (1 - \mu)S,$$

$$Inv' \leq (1 - \mu) \left\{ S' + \left[(1 - \phi)Q' - Q \right] S / Q \right\}.$$

$$\Rightarrow H_T = H_T' = 0,$$

if $Q < (1 - \phi)Q'$ and $Q' < 1$

\Rightarrow pledgeability binds

Investors maximize H_I'' subject to

$$Inv + H_I = M,$$

$$Inv' + H_I' + Sec' = H_I,$$

$$H_I'' = H_I' + Inv + Inv' + (1 - \phi)Sec' / Q'.$$

Solution of the model in first period

Bank's choice of issuing ABSs in first period

- If $Q < (1 - \phi)Q'$ then $S = WFI - K - D$
- If $Q = (1 - \phi)Q'$ then $S \geq WFI - K - D$

Traders' demand for ABSs in first period

- If $Q < (1 - \phi)Q'$ then $S = E/\mu$
- If $Q = (1 - \phi)Q'$ then $S \leq E/\mu$

Supply = demand using equilibrium wage (if <):

$$E / \mu = IFW(Q', I) - K - D \Leftrightarrow$$

$$I^m = \left(K + D + \frac{E}{\mu} \right) \left[\frac{m}{a(1-\phi)^{m-1} F} \right] \left(1 - \nu + \frac{\nu}{Q'} \right)$$

Solution of the model in first period

Bank's free entry condition

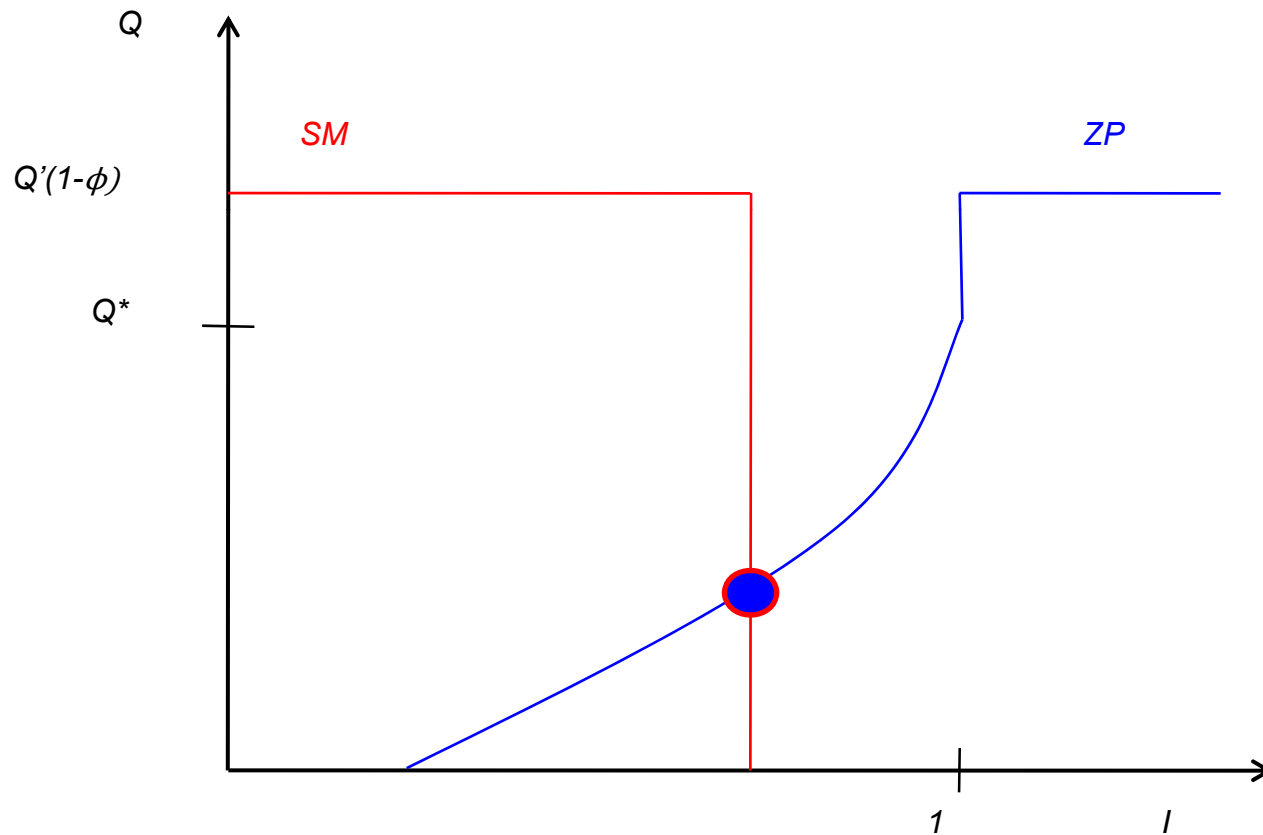
$$Q(1-\phi)I\pi(Q', I, \delta) - WFI + K \geq 0$$

If $Q > Q^*$, then $I = 1$, positive profits. Otherwise zero profits:

$$a(1-\phi)^{m-1} I^m \left\{ F - \frac{Q[(1-\delta)m-1]}{mI} \right\} = Km \left(1 - \nu + \frac{\nu}{Q'} \right)$$

Partial equilibrium in the first period

Solve for I and Q , taking S' and Q' as given.



Second-period equilibrium

Supply of securities by banks

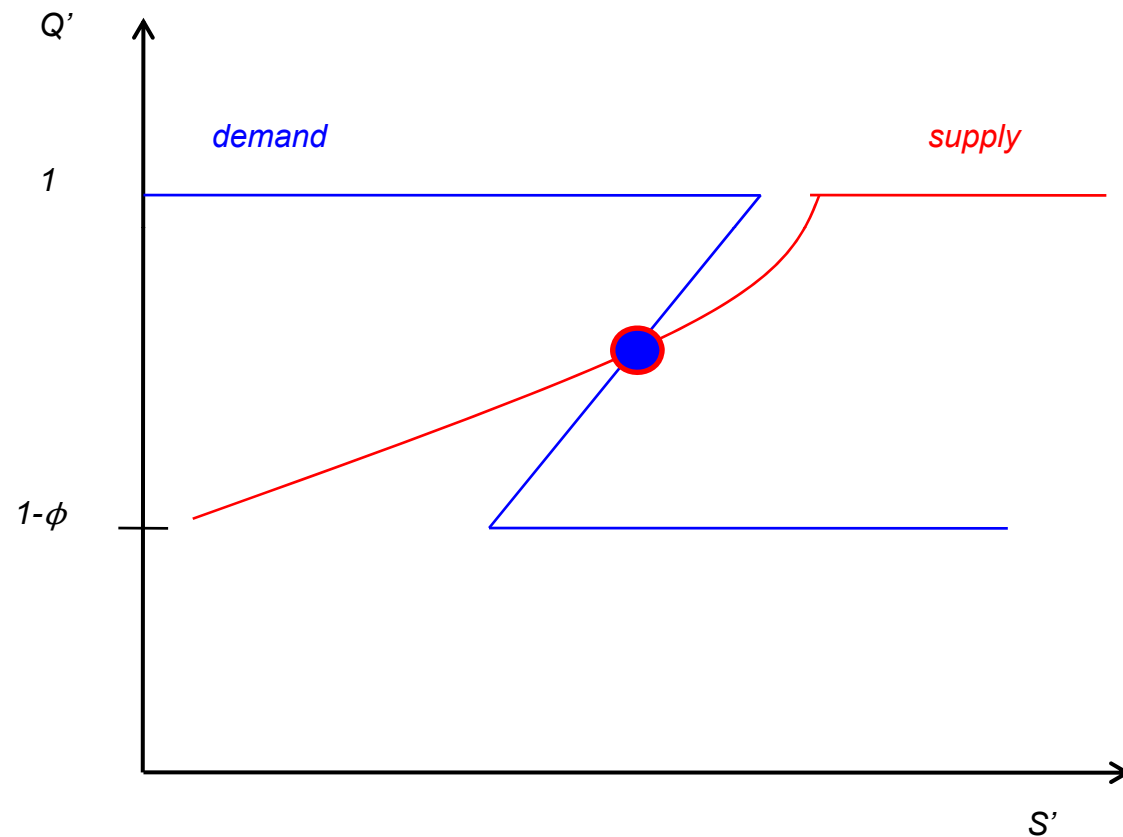
$$S' \geq (1 - \phi)IWL' - D' \Leftrightarrow$$
$$S' \geq \frac{va(1 - \phi)^{m-1} I^{m-1}}{m^2(1 - v + v/Q')} - D'$$

Demand of securities, by traders only if $Q' > 1 - \phi$:

$$S' = \frac{E'}{\mu} + \left(\frac{1 - \mu}{\mu} \right) \left(\frac{(1 - \phi)Q'}{Q} - 1 \right) \left(\frac{E}{\mu} \right)$$

Partial equilibrium, second period

Solve for S' and Q' , taking I and Q as given.



4. Equilibria

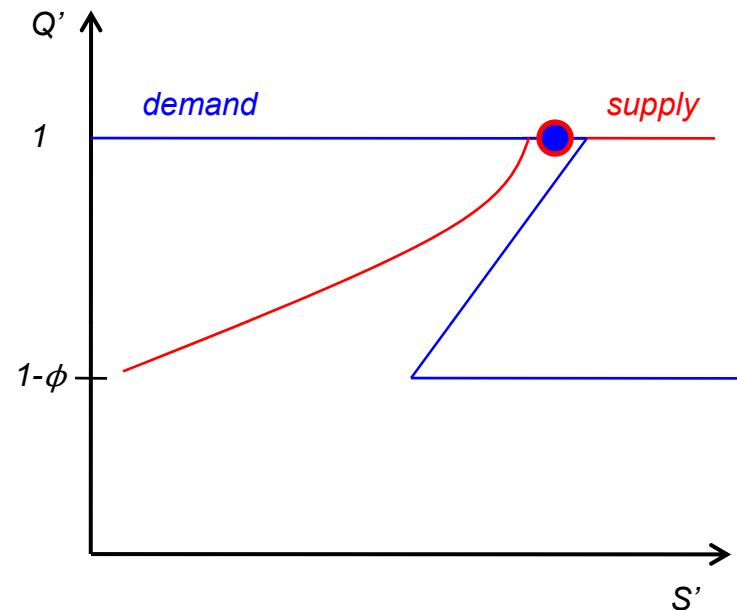
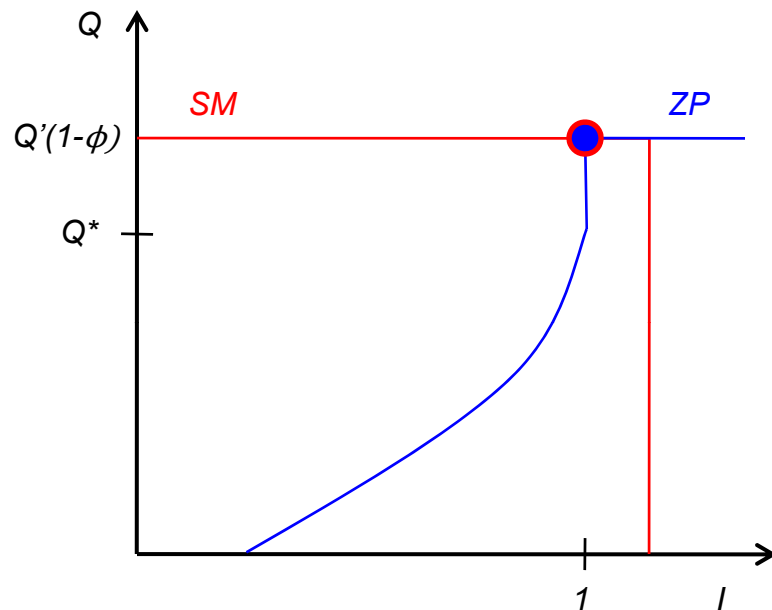
Three credit frictions:

- δ – pledgeability/leverage constraint on entrepreneurs
- μ – pledgeability/leverage constraint on traders
- ϕ – bad securities/lemons in market

Depending on how high they are, there are three possible cases for equilibrium:

- Efficient equilibrium
- Constrained equilibrium
- Catastrophe equilibrium

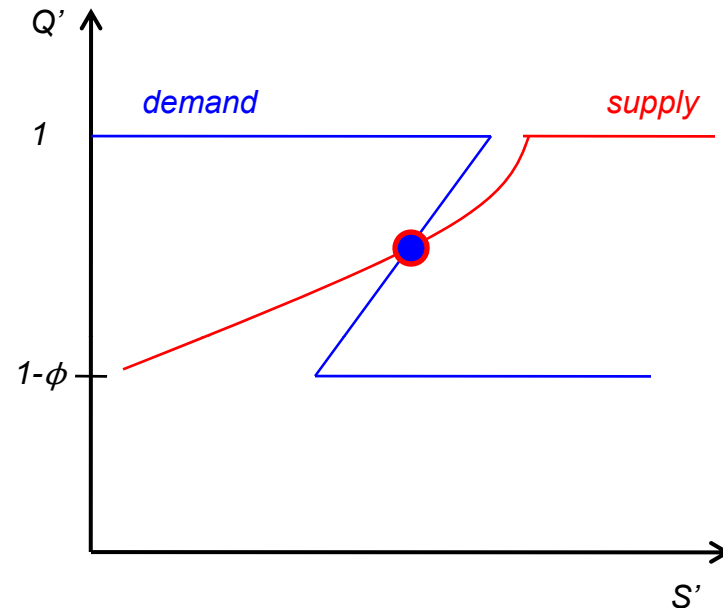
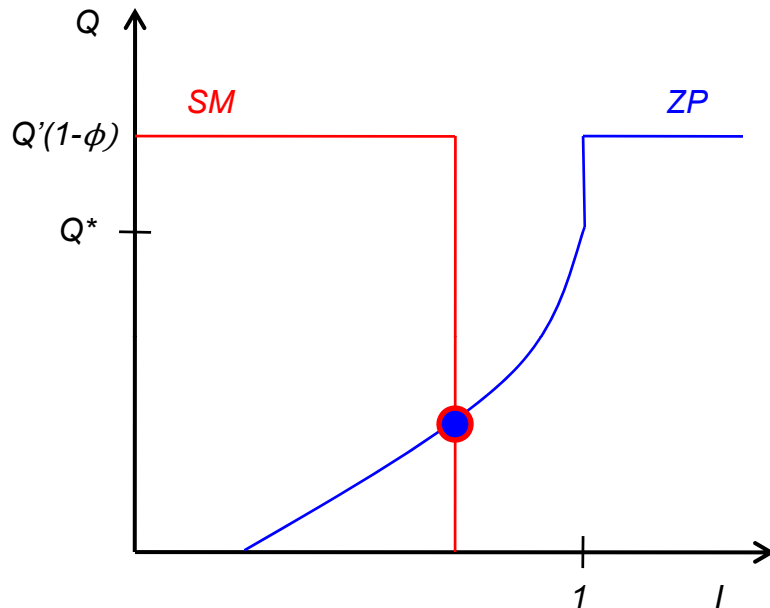
Efficient equilibrium graphically



Efficient extensive margin $I = 1$ and intensive $L = [m(1-\phi)]^{-1}$

Holds if δ, μ, ϕ are all small enough.

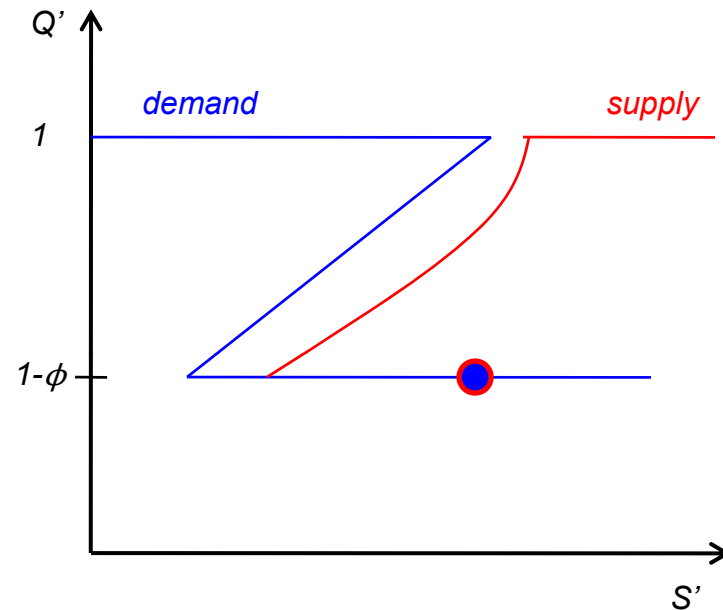
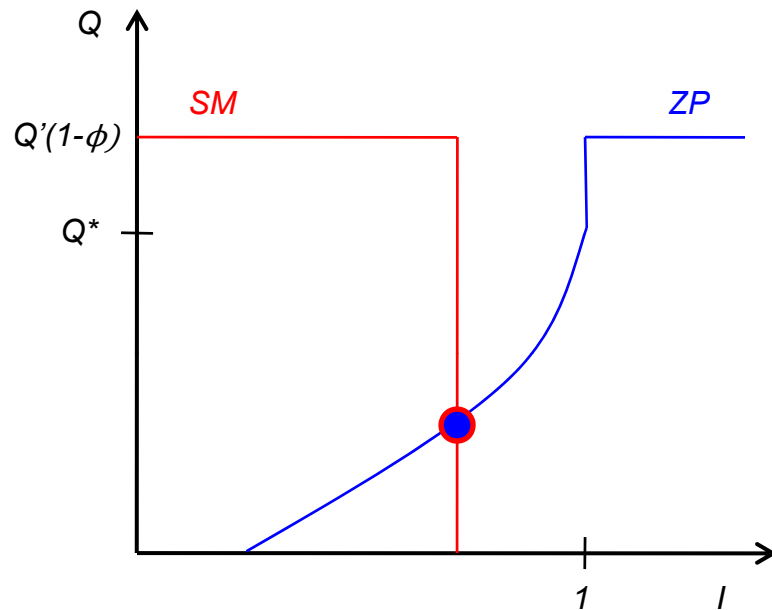
Constrained equilibrium graphically



Two inefficiencies:

- too few projects, $I < 1$
- operated at too small scale, $L' + L''$ small

Catastrophic equilibrium



Third inefficiency:

- mispricing as good projects pooled with bad
- resources wasted as bad projects run away with funds.

The role of frictions

If all projects are productive ($\phi=0$):

- Then no lemons problem in period 2. Investors buy securities directly, trades unnecessary, $Q'=1$.

If traders cannot run away with capital ($\mu=0$):

- They can get all necessary funding from investors, demand for securities satiates supply, $Q'=1$, $Q=(1-\phi)Q'$.

If entrepreneurs cannot run away with capital ($\delta=0$):

- Higher operating profits, more lenders enter, but if not enough capital, then pushes Q down, leading to higher capital gains in second period.

5. Injecting liquidity during a crisis

Goal: assessing effectiveness of liquidity injections if in constrained or catastrophic equilibrium. Focus on constrained equilibrium for simplicity.

An interpretation (not an explanation) of the crisis:

- Learn that many more of the securities were of low quality. Can see as ϕ rising.
- Mistrust soundness and trustworthiness of the financial system, withdraw money. Can see as μ rising.
- Securities market scales down + drag of legacy assets on traders' marked-to-market balance sheets.

Policy interventions

Technology: ability to transfer capital across agents (either by creating it or not, not important)

Effectiveness, depends on what powers you think the policymaker has. Two extreme cases:

Case 1) Policymaker is just another investor

- No impact at all.

Case 2) Policymaker can monitor entrepreneurs

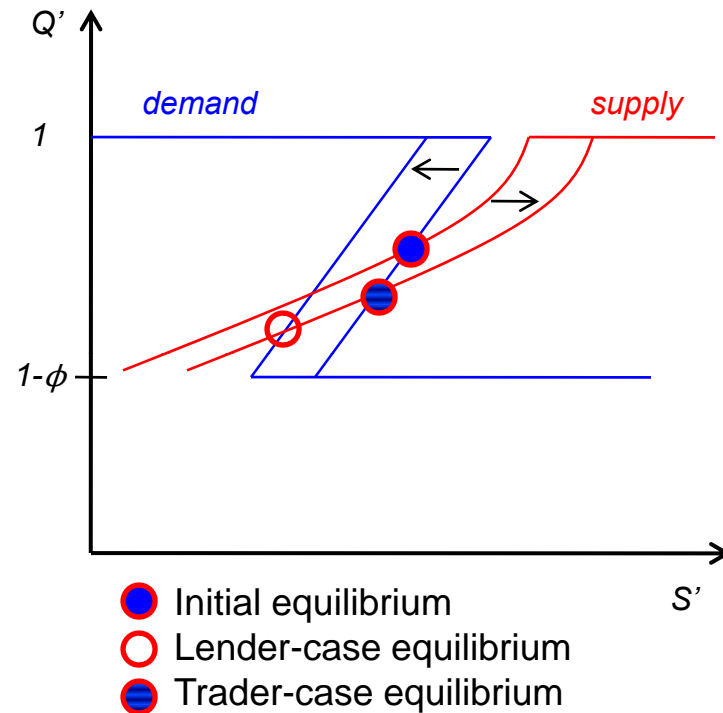
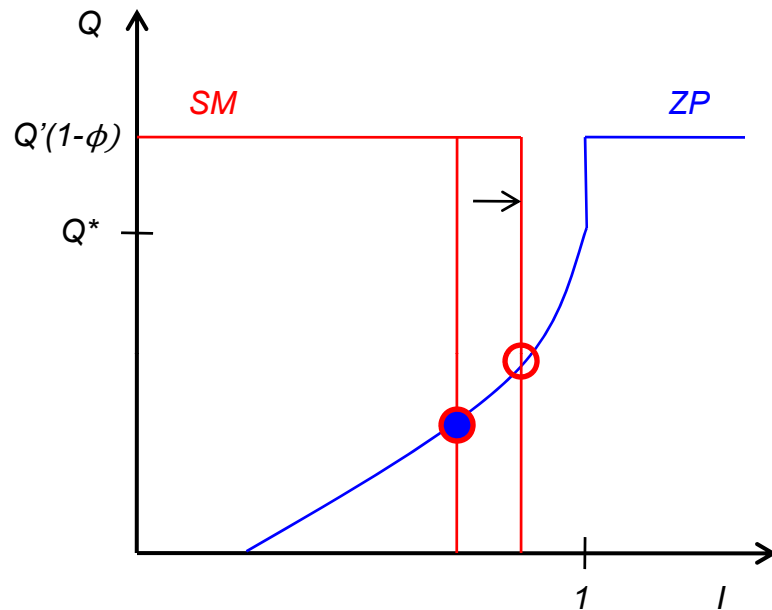
- Why do we have a financial system in the first place?

What policy can do

Case 3) Policymaker can make senior secured loans

- Can distinguish good projects and that gets paid first.
- Senior to other debts. Can ensure get repaid.
 - Because can use regulatory power
 - Because intervene only in exceptional circumstances
- At favorable terms, price 1. If at price Q , then no effect.
- Question: To lenders or to traders?

Senior loans to lenders or traders



- Initial equilibrium
- Lender-case equilibrium
- ○ Trader-case equilibrium

Both have same first-round effect in first period.

Both increase supply and lower demand in second period.

But traders make profits on new capital that can use to get investors' capital in the second period.

What policy can do

If instead in period 2:

- Then no difference whether to traders or lenders.
- Difference comes from ability to offset legacy losses, and ensure expected capital gains draw funds from investors.

Case 4) policymaker buying good securities directly

- Just like the senior loans in period 2

Objections:

- Less effective, does not draw funds from investors
- More demanding information.

What policy can do

Case 5) Policymaker can make equity injections

- Without any change in traders' incentives.

- Effect in model:
 - Clearly better policy.
 - Same effect as before but now leveraged up by $1/\mu$.

- In reality:
 - How to prevent absconding with funds, shirking, picking bad projects?
 - How to prevent interference with profit objectives?

6. Conclusion

Model of financial frictions and credit constraints with:

- Many players in the financial market.
- Securities as source of funds to make loans.
- Interaction of legacy assets, mark-to-market.

Policy lesson: providing funds to traders, injecting liquidity in securities market, is the most effective

Work in progress:

- Endogenize initial allocation of capital.
 - Dynamic propagation of interventions.
 - Aggregate uncertainty.
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