Self fulfilling Liquidity dry-ups

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Motivation

- Traditional framework used to explain liquidity dry-ups is "the cash-in-the-market pricing theory".
- It explain endogenous market breakdown and underpricing like recent financial crisis with assumption of limit of arbitrage.
- But the assumption seems to contradict the recent facts.

Observation

While excess reserve never exceeded 10% of required level between Jan-07 and Aug-08, then it skyrocketed to more than 1000%.

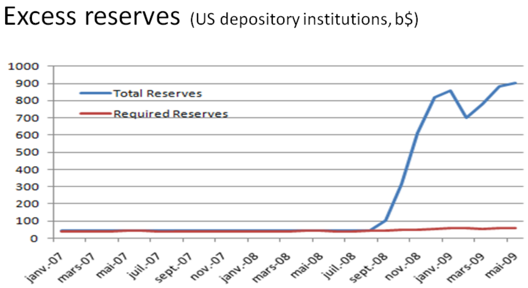


Figure: Excess reserves

Observation Cont.

Despite the surge in supply, there are still enough buyers of such assets for the yield to stay low, i.e. close to the Fed Funds target rate, without the Monetary Policy.

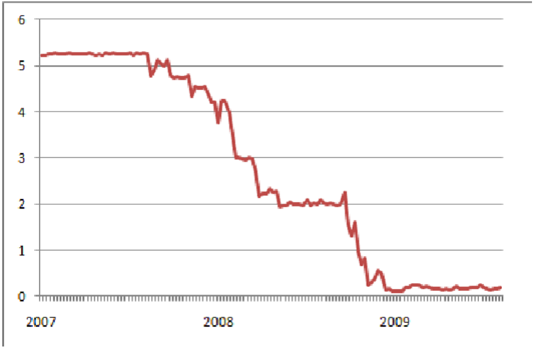


Figure: Yield on short-term Treasury Bills

Main Contribution

Using adverse selection in the market, the paper explain...

- endogenous liquidity dry-ups even with assumption of no limit of arbitrage in the markets.
- the fear of a market breakdown due to adverse selection might induce agents to adopt behaviors that would actually cause such a breakdown ("Self fulfilling dry-ups").
- liquidity dry-ups can endogenously arise for the very reason that investors self-insure against it (high possession of reserve for self-insurance against some shock would create negative externalities in future market).
- the promise of a market bailout implements the second-best.

Outline

Trade-off technology

- There are three dates $(t = 0, 1, 2)$
- short-term technology:
  - one-period storage
  - risk-free
  - yields an exogenous rate of return r
  - access at dates 0 and 1
- long-term technology:
  - only pay off at date 2
  - success with probability q, yield R_H
  - fail with probability $1 - q$, yield R_L
  - access only at dates 0
  - assume $qR_H + (1-q)R_L > 1 + r$ and $R_L < 1 + r$

Issuing claims

- Moral hazard concerns consequently restrict ex-ante risk-sharing (not as Diamond-Dibvig model!)
- Projects cannot be physically liquidated at date 1
- No other way to borrow against future income than to issue claims to ongoing projects in a competitive and anonymous secondary market
  - agents have access to secondary market at date 1
  - the output of the underlying project will be verifiable at date 2 (no moral hazard problem about claims)

Information

At the beginning of date 1, investors observe their project's quality

- it is private information
- quality is common to all the projects of a given investor
- ex-ante probabilities are common knowledge
- no aggregate uncertainty in the fundamentals

Investors

There is a measure one of exante identical investors

- they can be understood as bank or SIV(Structured investment vehicle)
- they maximize the expected utility from consumption at date 1 and date 2
- the period utility function $u(\cdot)$ is increasing, concave, and twice continuously differentiable
- at date 0, they are endowed with one unit of the consumption good and allocate between the long-term risky investment and short-term storage

The time line

At date 0, investors:

- form anticipations about date-1 secondary market price
- choose the share of endowment they invest in the long-term technology, the remaining being stored

At date 1, they:

- learn their true type: project return
- choose how much claims to issue and how much to consume at date 1 and store until date 2
- take P, the price at which they may issue claims on their projects (liquidate them) as given

At date 2:

- projects pay off and output is distributed to claimants.
- agents consume their remaining resources and die.

Demand for claims and market price

- "Deep-pocket" agents work as arbitrager to clear the competitive secondary market at that price (no limit of arbitrage)
- The price is determined by average quality of claims in market as

$$P(\eta) = \frac{R_L + \eta(R_H - R_L)}{1 + r} \tag{1}$$

- η denotes the proportion of good quality claims in the secondary market

Equilibrium definition

Definition

A triple $\gamma \equiv (P^*, \lambda^*, \eta^*)$ is an equilibrium for this economy if and only if

$$\begin{cases} P^* = P(\eta^*) \\ \lambda^* \in \lambda(P^*) \\ \eta^* = \eta(P^*, \lambda^*) \end{cases} \tag{2}$$

- P^* is the price implied by η^*
- λ^* is an optimal investment decision given P^*
- η^* is the proportion of high-return claims in the market at P^* and λ^*

Assumption 1 (simplicity)

- Return to storage is normalized: $r = 0$
- Project succeed and fail with equal probabilities: $q = 0.5$
- Period utility is logarithmic: $u(C_t) = lnC_t$

Notation

- C_{tj}:consumption for type-j (j=H,L) agent at date t
- λ: investment to long-term project
- S_j: storage from date 1 to date 2
- L_j: issued claim (liquidation level of long-term project)
- P: claim price in secondary market

Equilibrium with positive prediction

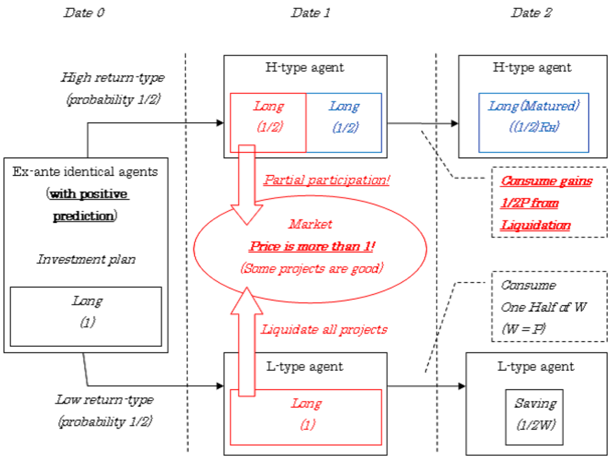


Figure: With positive prediction

Equilibrium with negative prediction

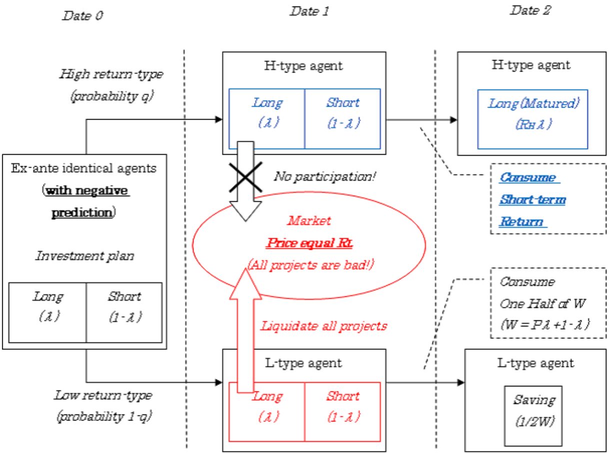


Figure: With negative prediction

The Problem

Consider two representative agents H and L.

$$\begin{aligned}\max_{\lambda, L_j, S_j} U_0 &= E_0[ln(C_1) + ln(C_2)] \\ &= (1/2)[ln(C_{1H}) + ln(C_{2H})] \\ &+ (1/2)[ln(C_{1L}) + ln(C_{2L})]\end{aligned} \tag{3}$$

$$s.t. \begin{cases} C_{1j} + S_j = 1 - \lambda + L_j P \ \ \forall j \\ C_{2j} = (\lambda - L_j) R_j + S_j \ \ \forall j \\ 0 \leq L_j \leq \lambda \leq 1 \ \ \forall j \\ 0 \leq S_j \ \ \forall j \end{cases}$$

Solve the model

Using backward induction

- First, derive the optimal policy $L_j(P, \lambda), S_j(P, \lambda)$, given λ and P at date 1 for each j.
- Second, derive optimal $\lambda(P)$ at date 0 given the decision rule at date 1, given P.
- Third, find the consistent price with the policy.

Date-1 optimal policy for L

- Agent L should sell off all project as soon as $P > R_L$
- Remember that $P \in [R_L, R_H]$
- Assume he also sells off all when $P = R_L$
- Thus, his optimal policy is

$$\begin{cases} L_L(P, \lambda) = \lambda \\ S_L(P, \lambda) = (1 - \lambda + \lambda P)/2 \end{cases} \tag{4}$$

Date-1 optimal policy for H

- From the FOC, we derive optimal policy as follows;

$$L_H(P,\lambda) = max\{0, \frac{P\lambda - 1 + \lambda}{2P}\}$$
$$S_H(P,\lambda) = max\{0, \frac{1 - \lambda - \lambda R_H}{2}\}$$

- L_H is weakly increasing P and λ
  - If P and λ are high enough, L_H is positive because the resource available at beginning of date 1 are smaller than the share of wealth he wants to dedicate to consumption at that period
  - Conversely, if P and λ are not high enough, agent would like to "create" ongoing project, so $L_H = 0$

Date-0 optimal policy

Proposition 1

Let $\lambda(P) = arg\max_{\lambda} U_0(\lambda, P)$ be the set of solution for a given P to the date 0 problem, then:

$$\lambda(P) = \begin{cases} \{1\} & (P > 1) \\ \{[1/2, 1]\} & (P = 1) \\ \{\tilde{\lambda}\} & (P < 1) \end{cases} \tag{5}$$

with $0 < \tilde{\lambda} < 1/2$.

Intuition of proof

Consider date 0 problem conditional on j. The FOC imply optimal $\boldsymbol{\lambda_j}$;

$$(\lambda_L^*(P), \lambda_H^*(P)) = \begin{cases} (1,1) & (P > 1) \\ ([0,1],[1/2,1] & (P = 1) \\ (0,1/2) & (P < 1) \end{cases} \tag{6}$$

For L;

- Given $L_L = \lambda$ for all P and λ, he set λ to maximize date-1 wealth and allocate one half of that to both dates by storage

For H;

- no merit to have positive S if he know he is H at date 0
- If $P > 1$, he don't hesitate to investment all and liquidate by only C_1/P at date 1
- If $P = 1$, date 0-1 storage is indifferent with liquidation
- If $P < 1$, no merit to liquidate if he know he is H at date 0

Supply for claims

Using optimal policy $(L_j(P,\lambda), S_j(P,\lambda))$ and proposition 1, Supply for claims are as follows;

$$L_L(P,\lambda(P)) = \lambda$$

$$L_H(P,\lambda(P)) = \begin{cases} 1/2 & (P > 1) \\ L_1(\lambda) & (P = 1) \\ 0 & (P < 1) \end{cases}$$

where L_1 can be any value in [0,1/2]

Average quality

Define $\eta(P)$ as the proportion of claims to high-return projects for given P;

$$\eta(P) \equiv \frac{L_H(P, \lambda(P))}{L_L(P, \lambda(P)) + L_H(P, \lambda(P))}$$
$$= \begin{cases} \eta_{liq} = 1/3 & (P > 1) \\ \eta_1(\lambda) & (P = 1) \\ \eta_{illiq} = 0 & (P < 1) \end{cases} \quad (7)$$

where η_1 can be any value in $[\eta_{illiq}, \eta_{liq}]$

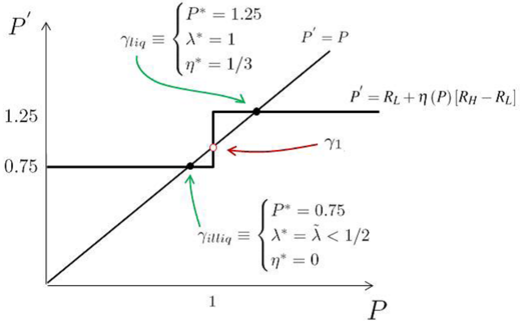
- When anticipated price is low, market participation is anticipated to be low (liquidity dry-ups)
- When anticipated price is high, market participation is anticipated to be high, market liquidity is improved

Equilibrium and liquidity dry-ups

- Define the implied price correspondence as;

$$P'(P) = R_L + \eta(P)[R_H - R_L]$$

- Fixed point $P'(P) = P$ pins down an equilibrium price (P^*) for the economy



Multiple equilibrium

In γ_{illiq};

- low anticipated price reduce investment
- low investment imply low amount of high-return projects in the market
- low amount of high-return projects make anticipated price a self-fulfilling prophecy

In γ_{liq};

- similar argument can be applied

In γ_1;

- not stable with any small perturbation to P
- no further discussion about this equilibria

Proposition 2

Proposition 2

Under assumption 1. $\forall \boldsymbol{R_H > 3 - 2R_L}$, problem (1) has at least two district solution with different level of liquidity.

proof is simple;

$$\begin{aligned} \boldsymbol{P^*_{liq} > 1} &\longrightarrow \boldsymbol{R_L + \eta^*_{liq}(R_H - R_L) > 1} \\ &\longrightarrow \boldsymbol{R_H > 3 - 2R_L} \end{aligned}$$

Welfare comparison

proposition 3

A liquidity dry-ups is a Pareto dominated equilibrium, both from an exante and an expost point of view.

- Resources are how wasted in the storage technology (long-run investment is on average more productive)
- Self-insurance has negative externalities so social cost of self-insurance is therefore higher than the private benefit (it expost decreases market participation which hinders risk sharing)

Numerical examples

- Define ex-interim and ex-post wealth as follows

$$\begin{cases} W_j \equiv 1 - \lambda + \lambda R_j \\ W_j^* \equiv 1 - \lambda + L_j P + (\lambda - L_j) R_j \end{cases}$$

- W_j means the date-2 wealth before liquidation and W_j^* means one after liquidation

First Best (Benchmark)

- Full insurance (same share of pie)
- Maximized aggregate output ($\lambda = 1$)
- Thus, the maximum per capita resources as of date 1 is given by $0.5(W_H + W_L) = 1.5$
- 0.75 unit of good can be available for each date

C_{tj}	Data 1	Data 2
State H	0.75	0.75
State L	0.75	0.75

Table: Consumption in FB

W_j	W_j^*
2.25($=R_H$)	1.5
0.75($=R_L$)	1.5

Table: Wealth in FB

High-liquidity allocation

- All endowment is invested ($\lambda = 1$)
- $W_H = R_H = 2.25$ and $W_L = R_L = 0.75$
- Agent H must transfer resources by the rate 1 to $P^*/R_H = 0.56$ (issuing claims is costly)
- Agent L can transfer resources by the rate 1 to $P^*/R_L = 1.67$ (H's issuance has positive externalities)

C_{tj}	Data 1	Data 2
State H	0.625	1.125
State L	0.625	0.625

Table: Consumption in γ_{liq}

W_j	W_j^*
2.25(=R_H)	1.75
0.75(=R_L)	1.25

Table: Wealth in γ_{liq}

Low-liquidity allocation (dry-ups)

- $\lambda = \tilde{\lambda}$ ($\tilde{\lambda}$ is nearly equal 0.44)
- the size of pie decreases as investment dominates storage $(0.5(W_H + W_L) = 1.22 < 1.5)$
- no transfer from state H to state L ($W_j = W_j^*$)

C_{tj}	Data 1	Data 2
State H	0.57	0.97
State L	0.45	0.45

Table: Consumption in γ_{illiq}

W_j	W_j^*
1.53	1.53
0.9	0.9

Table: Wealth in γ_{illiq}

The role of government

Proposition

A public liquidity insurance implements the second-best

- Government intervene only if $P < 1$ and buy any claims at price of 1 (as promise of a market bailout at a floor price)
- The government levy lump-sum tax τ to balance the budget after observing aggregate agent behavior

$$\tau(P) = \begin{cases} (1 - P)\sum_j \frac{L_j}{2} & (P < 1) \\ 0 & (P \geq 1) \end{cases}$$

Policy implication

- The public liquidity insurance is only effective ex ante.
- If all agents have been self-insured, there would be mostly lemons in the market, insurance would not restore liquidity.
- In fact, in the fall 2008, while public intervention such as liquidity injection (e.g. through Troubled Asset Relief Program), one might easily argue that they did not restore liquidity in the securitized markets.

Application to current financial crisis

The model contribute to a better joint explanation of some empirical observations than traditional cash-in-the-market pricing framework.

Empirical evidence show three stylized observations;

- Observation 1 : Market breakdown
- Observation 2 : Underpricing
- Observation 3 : Surge in demand for safe assets (shown in the Introduction)

Observation 1

The shrinkage of the balance sheet of ABS (Asset backed security) issuers.

F.126 Issuers of Asset-Backed Securities (ABS)
Billions of dollars; quarterly figures are seasonally adjusted annual rates

		2003	2004	2005	2006	2007	2008	2008 Q1	2008 Q2	2008 Q3	2008 Q4	2009 Q1	
1	**Gross saving**	1.1	1.0	0.8	0.7	0.6	0.6	0.6	0.6	0.5	0.5	0.5	1
2	**Fixed nonresidential investment**	0.9	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	2
3	**Net acquisition of financial assets**	249.0	439.3	725.0	807.7	333.2	-422.0	-254.8	-455.8	-374.8	-602.8	-623.4	3
4	Treasury securities	1.9	5.2	19.7	28.7	21.0	-12.3	-2.8	-11.4	-15.7	-19.4	-20.7	4
5	Agency- and GSE-backed securities (1)	82.3	-5.4	-32.4	23.9	19.3	-19.0	9.6	-19.5	-22.4	-43.8	-136.0	5
6	Other loans and advances	5.1	20.2	21.0	55.8	89.1	20.4	19.4	9.1	51.7	1.5	-17.3	6
7	Mortgages (2)	173.3	434.3	687.1	630.5	180.9	-365.2	-302.6	-379.5	-347.7	-430.8	-349.5	7
8	Home	122.9	382.2	572.4	513.7	33.9	-320.6	-269.3	-346.5	-313.1	-353.5	-332.0	8
9	Multifamily residential	7.9	6.4	16.5	13.9	22.0	-11.0	-10.6	-11.5	-9.8	-12.1	-4.9	9
10	Commercial	42.6	45.7	98.1	102.9	125.0	-33.6	-22.7	-21.5	-24.9	-65.2	-12.6	10
11	Consumer credit	-22.5	-25.3	32.5	60.2	19.5	-29.8	-5.2	-2.2	1.7	-113.7	-62.3	11
12	Trade credit	8.8	10.3	-2.8	8.5	3.4	-16.1	26.8	-52.5	-42.4	3.5	-37.6	12
13	**Net increase in liabilities**	248.8	438.6	724.3	807.2	332.7	-422.5	-255.2	-456.3	-375.2	-603.2	-623.8	13
14	Commercial paper	-36.0	-3.9	148.3	162.9	-194.2	-83.9	-134.7	-145.8	-123.1	68.1	-211.8	14
15	Corporate bonds (net) (5)	284.8	442.5	576.0	644.2	527.0	-338.6	-120.6	-310.5	-252.1	-671.3	-412.0	15
16	Discrepancy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16
	Memo:												
	Securitized assets not included above												
17	Consumer leases (3)	-0.2	-0.7	-0.6	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	17
18	REIT assets (4)	15.6	59.6	17.3	2.8	-17.9	-39.7	-79.7	-19.4	-26.2	-33.4	-12.4	18

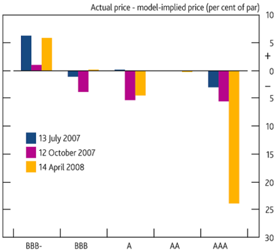
(1) Agency- and GSE-backed mortgage pool securities backing privately issued CMOs.
(2) Mortgages backing privately issued pool securities and privately issued CMOs.
(3) Receivables from operating leases, such as consumer automobile leases, are booked as current income when payments are received and are not included in financial assets (or household liabilities).
The leased automobile is a tangible asset; depreciation flows are included in line 1, and fixed investment flows are included in line 2.
(4) Included in table F.128.
(5) Net issuance less net acquisition of corporate bonds held as assets.

Figure: The balance sheet of ABS issuers

Observation 2

Underpricing of ABX subprime index (Actual price minus model-implied price (per cent of par)).

Chart 5 Anomalies in the prices of the ABX sub-prime index (2007 H1 vintage)(a)(b)



Source: Bank calculations using data from JPMorgan Chase & Co.

(a) The pricing model is an adaptation of that used in 'A simple CDO valuation model', Bank of England Financial Stability Review, Box 1, December 2005, pages 105–06.
(b) The loss given default rate on the underlying collateral is uncertain, but is assumed for the purposes of this chart to be 50%.

Figure: ABX subprime index (BOE)

Cash-in-the-market pricing framework

Allen and gale(1994) assume;

- Cost to enter the market of long-term project (limit of arbitrage).
- Two type agent about frequency of shock (high or low).

This show;

- High-type tend to higher reserve but hesitate to enter the market.
- If High-type agent enter, high liquidity equilibrium is realized.
- If High-type agent does not enter, Dry-ups equilibrium is realized.
- Thus, self-fulfilling liquidity provision.

Possible joint explanation

This model...

- explain facts 1 and 2 together with fact 3.
- does not rely on limits to arbitrage. It might be seen as better suited to capture long lasting effects because such limits of arbitrage are likely to fade away with time.
- does not recommend self-insurance against shocks by higher-reserve possession.

Preference shocks

- At date 1, they learn whether they are normal or early consumers.
- The early agents deriving utility from consumption at date 1 only.
- Adverse selection is indeed reduced because issuing claims by early agents is relatively productive.

High-liquidity equilibrium : before and after

In high-liquidity equilibrium, the proportion of High η_{liq} equal to $\frac{2-p}{4-p}$.

	L-type (Mass(1-q))	H-type (Mass q)
Normal-type (Mass 1)	1 (all project is liquidated)	1/2 (one half of project is liquidated)

Figure: Before extension ($\eta_{liq} = 1/3$)

	L-type (Mass(1-q))	H-type (Mass q)
Early-type (Mass (1-p))	1 (all project is liquidated)	1 (all project is liquidated)
Normal-type (Mass p)	1 (all project is liquidated)	1/2 (one half of project is liquidated)

Figure: After extension ($\eta_{liq} = \frac{2-p}{4-p}$)

Dry-ups equilibrium : before and after

In Dry-ups equilibrium, the proportion of High η_{illiq} equal to $\frac{1-p}{2-p}$.

	L-type (Mass(1-q))	*H-type (Mass q)*
Normal-type (Mass 1)	λ *(all project is liquidated)*	0 *(no project is liquidated)*

Figure: Before extension ($\eta_{illiq} = 0$)

	L-type (Mass(1-q))	*H-type (Mass q)*
Early-type (Mass (1-p))	λ *(all project is liquidated)*	λ *(all project is liquidated)*
Normal-type (Mass p)	λ *(all project is liquidated)*	0 *(no project is liquidated)*

Figure: After extension ($\eta_{illiq} = \frac{1-p}{2-p}$)

Proposition 5

Proposition 5

For any admissible value of R_L, as the probability $(1-p)$ of being hit by an illiquidity shock increases:

- 1.Equilibrium market liquidity increases: $\frac{\partial \eta^*}{\partial (1-p)} > 0$
- 2.The range (of (R_H, R_L)) for a high-liquidity equilibrium increases
- 3.The range (of (R_H, R_L)) for a low-liquidity equilibrium decreases

Corollary 1

Define $\phi_{ij} = W^*_{ij} - W_{ij} = L_{ij}(P - R_j)$ where W^*_{ij} is the total wealth for agent ij after liquidation and W_{ij} is the total wealth for agent ij before liquidation.

Corollary 1

For any given ex-post agent, the wealth gains from trade increases with the proportion of early agents: $\frac{\partial \phi_{ij}}{\partial (1-p)}$, $\forall ij$.

- Increasing (1-p) imply average issued-claim return in the market is high and thus provide more externalities.
- welfare effect is not clear because more frequent shock decrease their investment.

Transparency

- Now, assume there exist technology that enable agents to credibly disclose their patience or not.
- The technology is understood as by which bank could credibly disclose its liquidity position.

Proposition 6

Proposition 6

Early agents are better-off disclosing their liquidity position

For the high-liquidity equilibrium case,

- in shocked-agent market, the amount of High is the same amount of Low ($P = E[R]$).
- in not-shocked-agent market, the price is the same that before extension ($P = P^*_{liq} < E[R]$).
- as a consequence, the effect of transparency on ex-ante risk sharing is ambiguous.

Future research

- The introduction of moral hazard.
- The introduction of aggregate shocks to preferences or productivity.