Savings Glut and Financial Fragility

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Some observations

- In period preceding the crisis
  - The US financial sector accounted for an increasing fraction of corporate profits
  - Strong growth in compensation in the financial services industry
  - Finance as a favorite occupation
  - Deterioration of origination incentives
  - Increase in balance sheet size and leverage among some financial intermediaries (IBs and broker-dealers)
  - Growth of the “originate and distribute” model

- With Patrick and Tano: Models that aim to shed light on these facts
Motivation for this paper

• Relationship between large increases in liquidity and:
  1. Deterioration of origination standards among asset originators.
  2. Across the board drop in asset yields.
  3. More debt and increased leverage.
Savings Glut

1. Excess savings view: Bernanke (2005):
   - World savings glut and current account deficits
     - Precautionary savings shocks in the 90s: Asia, Russia, Germany, ...
     - In US, Spain etc.: Asset appreciation, low yields.

   - Excess savings view incomplete: What is key is financing:
   - The financial crisis reflected disruptions in financing channels, in borrowing and lending patterns, about which saving and investment flows are largely silent.
   - Adrian and Shin (2010)
Secular rise of institutional cash-pools (Pozsar)

- Surveys indicate that 90% of these pools subject to written cash policies with safety of principal as dominant consideration.
Percent of loans in private mortgage market with incomplete documentation (Piskorky et al.)
Cumulative default path of subprime mortgages

- Source: Corelogic-Blackbox
Broker dealers: Leverage (Assets/equity) and Assets
Outline of model

- Model where financial sector “recycles” savings into assets of endogenous quality, impacting:
  1. The quality of asset origination.
  2. The balance sheet of financial intermediaries.
  3. Later will consider
     - Incentives for distribution
     - Financial stability

- Three ingredients:
  - Liquidity: cash-in-the-market pricing
    - Allen and Gale, “cheap” risk-aversion
  - Coexistence of OTC and exchange.
  - Endogenous distribution of capital and knowledge
Agents

• Three types of risk-neutral agents
  • A unit measure of originators
  • A measure $N$ of informed investors.
    • In the equilibrium we will describe, informed will look like “financial intermediaries”.
  • A measure $M = 1 - N$ of uninformed investors.
    • In the equilibrium we will describe, uninformed will provide cash pools.

• Two dates $\tau = 1, 2$
  • $\tau = 1$: Assets originated and distributed in two markets
  • $\tau = 2$: Payoffs are realized
Originators

- At $\tau = 1$ each originator originates one asset of high ($x_h$) or low quality ($x_l = 0$)
- Originators exert effort $e \in [\underline{e}, 1)$, where $\underline{e} > 0$

$$\Pr(x = x_h \mid e) = e$$

- Private cost of effort: $\psi(e - \underline{e})$

  - $\psi(0) = \psi'(0) = 0$, $\psi' > 0$, if $e > \underline{e}$, $\psi'' > 0$ and $\lim_{e \to 1} \psi'(e - \underline{e}) = +\infty$

- $u^o(e, c_1) = -\psi(e - \underline{e}) + c_1$, if $c_1 \geq 0$

- Later: $\tau = 1$ distribute a fraction $\pi$ of those assets at $\tau = 1$
Investors

• Every investor has endowment $K$ in period 1.
• Utility of all investors,

$$U(c_1, c_2) = c_1 + c_2, \text{ if } c_i \geq 0.$$  

• Two types of investors

1. Measure $N$ of informed investors. For each project they can see a signal $\sigma \in \{\sigma_\ell, \sigma_h\}$:

   $$\text{Prob}(\sigma_h|x_h) = 1 \quad \text{and} \quad \text{Prob}(\sigma_h|x_l) = \alpha, \quad \alpha \quad \text{small.}$$

   $$g := \text{Prob}(x_h|\sigma_h) = \frac{e}{e + \alpha(1 - e)}. \quad (1)$$

2. $M = 1 - N$ measure of uninformed investors
1. Private markets (OTC)

- Private deals between an originator and investor.
- Only accessible by informed dealers.
- Originators only know effort $e$.
- If each informed investor buys $q^i$, originator with a project with a good signal sells to an informed trader with probability

$$m := \min \left\{ \frac{Nq^i}{e + (1 - e)\alpha}; 1 \right\}. \quad (2)$$

- Price in this market $p^d$: As in Bolton, Santos and Scheinkman (2015), if $p$ is price in exchange,

$$p^d = \kappa g x_h + (1 - \kappa)p, \quad (3)$$
Public markets or exchanges

- $T$ amount of cash brought to exchange.
- Two candidate prices:
  \[ p^f = \frac{e(1 - m)x_h}{1 - em - (1 - e)\alpha m}, \quad p^{\text{cim}} = \frac{T}{1 - em - (1 - e)\alpha m} \]
- Prices in the exchange
  \[ p = \min \left\{ p^{\text{cim}}, p^f \right\} \] (4)
- $p \leq p^f \Rightarrow p \leq gx_h \text{ or } p \leq p^d$. (inequalities strict if $m > 1$.)
Market for collateralized lending

- Investors can lend against collateral:
  - $D$: Amount borrowed
  - $r$: Interest (repo) rate

- Leverage constraint: $\eta \in (0, 1)$. An investor that owns $q$ units of asset can borrow $D$ provided:

$$ (1 - \eta) qp \geq D $$
Expected payoffs I

- Originator’s expected payoff

\[-\psi (e - e) + e \left( mp^d + (1 - m)p \right) + (1 - e) \left[ \alpha \left( mp^d + (1 - m)p \right) + (1 - \alpha)p \right] \]

- Uninformed choose \( q^u \geq 0 \) and borrows \( D^u = q^u p - K \). Leverage constraint implies \( \eta pq^u \leq K \). Expected payoff is:

\[ V^u(Q^u) := q^u pr^x - D^u r, \]

\[ r^x = \frac{e(1 - m)x_h}{(1 - em - (1 - e)\alpha m)p} \]
Expected payoffs II

- Informed investor chooses \( q^i \geq 0 \) amount bought in OTC and \( y - q^i \geq 0 \) bought in exchange. Borrows 
\[
D^i = K - py - (p^d - p)q^i .
\]
Leverage constraint 
\[
\Rightarrow \eta py \leq K - (p^d - p)q^i .
\]
Expected payoff: 
\[
V^i (q^i, y) = q^i p^d (R - r) + p(y - q^i)(r^x - r) + Kr
\]
where 
\[
R = \frac{gxh}{p^d}.
\]
Equilibrium

- Given \((K, N, \alpha)\)
- A vector of equilibrium prices and allocations is a vector \((p, r, p^d, m, g, r^x, R, q^u, D^u, q^i, y, D^i)\) such that \(g, p^d\) and \(m\) satisfy equations (1)-(3), \(p\) satisfies (4) when 
  \(T = p(q^u + y), (e, q^u, D^u, q^i, y, D^i)\) solves the maximization problems of agents and furthermore,
  \[ Mq^u + N(q^i + y) = 1; \quad MD^u + ND^i = 0. \]
- Focus on equilibria in which capital in the hands of informed scarce relative to the number of good projects, that is \(m < 1\).
Strict CIM equilibria

- A strict CIM equilibrium satisfies

\[ R > r^x > 1 \]

2. Informed investors obtain higher returns by investing in private markets than in exchanges.
Strict CIM equilibria

- In strict CIM equilibrium uninformed investors must be indifferent between deploying capital in the exchange or in the secured lending market

\[ r^x = r. \]

- \( q^i = y \) and \( (1 - \eta) q^i p = D^i > 0 \)

- Uninformed provide loans. Informed are intermediaries. The balance sheet of the intermediaries in private markets is:

\[ qp^d = K + D^i. \]
Incentives: $e$

Informed investors: $N$

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q^i p^d$</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td>$K$</td>
</tr>
</tbody>
</table>

$\text{Dr}$

Uninformed investors

$MK - ND$

$p = \min \left\{ \frac{MK - ND}{1 - m(e + \alpha(1-e))}, \frac{e(1-m)x_h}{1 - m(e + \alpha(1-e))} \right\}$

$\frac{e(1-m)x_h}{1 - m(e + \alpha(1-e))}$

Cream skimming
Remaining time

- Existence of a strict CIM equilibrium
- Comparative statics: How does an increase in $K$ affect
  - Prices in exchange: $p$
  - Origination standards: $e$
  - Debt: $D := D^i$
  - Leverage:
    \[ \ell := \frac{K + D}{K} = 1 + \frac{D}{K} \]
- Increase in capital in hands of all investors, zero supply response from originators.
- Extensions: Increase in uninformed capital only, mistakes in $\alpha$, originate and distribute.
CIM equilibrium equations I

Given \((p, r)\) and candidate choices \((e, q^u, q^i)\), define:

\[
m := \min \left\{ \frac{Nq^i}{e + \alpha (1 - e)}, 1 \right\}
\]

\[
g := \frac{e}{e + \alpha (1 - e)}
\]

\[
p^d := \kappa gx_h + (1 - \kappa) p
\]

\[
r^x := \frac{e(1 - m)x_h}{p(1 - m(e + \alpha (1 - e)))}
\]

\[
D^u := q^u p - K
\]

\[
D^i := q^i p^d - K
\]

and

\[
R := \frac{gx_h}{p^d}
\]
CIM equilibrium equations II

- First order conditions and market clearing: \( (p, r) \) and candidate choices \( (e, q^u, q^i) \) form an equilibrium

\[
0 \geq D^u \\
D^i = (1 - \eta) pq^i \\
p = \min \left\{ \frac{MK - ND^i}{1 - m(e + \alpha (1 - e))}, \frac{e(1 - m)x_h}{1 - m(e + \alpha (1 - e))} \right\} \\
\psi'(e - e) = (1 - \alpha) m^k (gx_h - p) \\
r = r^x \\
Mq^u + Nq^i = 1 \\
MD^u + ND^i = 0
\]
A system of equations in $p$ and $e$

- If $(p, r)$ is a strict CIM equilibrium then:
  
  \[
  f^1(p, e, K, N, \alpha) := p - K (M + N\gamma) = 0 \\
  f^2(p, e, K, N, \alpha) := (e + \alpha (1 - e)) \psi'(e - \bar{e}) - (1 - \alpha) NK(1 - \gamma) = 0
  \]

  where
  
  \[
  \gamma = \frac{\eta p}{\kappa (g x_h - p) + \eta p}
  \]

- A “converse” also holds. If $(p, e)$ solves $f(p, e, K, N, \alpha) = 0$ we can calculate $(g, m, p^d, r^x, R)$. If $m < 1$ and $R > r^x > 1$, can construct strict CIM equilibrium.

- Do the math with $f(\cdot) = 0$ but results are necessarily local.
Existence

**Proposition 1.** Suppose that

$$\frac{e\kappa x_h}{1 - e + e\kappa} < \tilde{K} < e x_h. \quad (5)$$

Then there exists a neighborhood $\mathcal{N}$ of $(\tilde{K}, 0, 0)$ such that for $(K, N, \alpha) \in \mathcal{N}$, $N > 0$ and $\alpha \geq 0$, there exists a unique equilibrium and this equilibrium is a strict CIM equilibrium with $m < 1$. 
Proposition 2. There exists a continuous non-increasing function $\bar{\alpha} : [0, \infty) \to (0, 1]$ with $\bar{\alpha}(0) = 1$ such that if $K_1 < K_2$ and there are continuous functions $p(K)$ and $r(K)$ defined in $(K_1, K_2)$ such that $(p(K), r(K))$ is a strict CIM equilibrium for parameters $(K, N, \alpha)$ and $\alpha < \bar{\alpha}(K_2N)$, then $p(K)$ is smooth with $p'(K) > 0$. 
Rates of return in OTC and exchange
Effort

- The first order condition for effort
  \[ \psi_e = m \left( p^d - p \right) = m\kappa (x_h - p) \]

- The two sides of liquidity:
  - Informed liquidity: An increase in \( m \) increases origination incentives
  - Uninformed liquidity: An increase in \( p \) decreases origination incentives
Effort is single peaked

**Proposition 3.** (*Single peakedness of effort*) Let $K_1 < K_2$ and suppose that there are continuous functions $p(K)$ and $r(K)$ defined in $(K_1, K_2)$ such that $(p(K), r(K))$ is a strict CIM equilibrium for parameters $(K, N, \alpha)$ with $\alpha < \bar{\alpha}(K_2 N)$. Then if $\eta < \kappa$ the function $e(K) = e(p(K), r(K))$ is either monotone or has a single global maximum.

- Recall $g$ is monotone on $e$. 
$e, p$ and $m$. 

Panel A

$e(K)$ vs Capital

$\alpha = 0$

$\alpha = 0.2$

Panel B

$p(K)$ vs Capital

$(x_h - p)$

$m(K)$ vs Capital
Leverage

- **Proposition 4.** In a strict CIM equilibrium, If either (i) $e'(K) < 0$ or (ii) $\alpha$ is small, then The leverage ratio $D/K$ satisfies

$$\left( \frac{D(K)}{K} \right)' > 0.$$

- **Reasons for increase in leverage ratio:** Demand
  - An increase in $p$ increases debt capacity
  - In addition, $p^d$ goes up by less than $p$: Less equity needed to buy assets

- **Supply:** An increase in $p$, lowers $r^x$ and investors reallocate part of the funds to the repo market.
Financial Fragility

- Total assets and leverage ratios correlate positively
- When liquidity is abundant, additional liquidity:
  1. Increases leverage
  2. and leads to a deterioration of origination standards
- Moreover the worse the quality of the information of informed investors (high $\alpha$), the higher the leverage
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Fragility

Panel A: Asset

\[ g(K) \]

Panel B: Liability

\[ \ell(K) \]

\[ K \]

\[ \alpha = 0 \]

\[ \alpha = .2 \]
Extensions: Effect of “dumb” capital

**Proposition 5.** (For $\alpha$ small?), in a strict CIM equilibrium, (a) the price $p$ is an increasing function of the proportion of capital held by uninformed investors, $M$, and (b) origination incentives, $e$, are a decreasing function of the proportion of capital held by the uninformed investors, $M$. 
Extensions: Mistakes by a single intermediary

- Informed investor believes that her $\hat{\alpha} < \alpha^{true}$.
- The rest of the market has the correct beliefs: $\alpha = \alpha^{true}$
- Mistaken investor bids more aggressively in OTC; chooses

$$\hat{q} = \frac{K}{\kappa (\hat{g}x_h - p^*) + \eta p^*} \quad \text{and} \quad \hat{D} = \frac{(1 - \eta) p^* K}{\kappa (\hat{g}x_h - p^*) + \eta p^*}.$$ 

- The equity capital at $\tau = 2$ under the wrong beliefs is

$$\text{Equity Capital}_{wrong} = \hat{q}\hat{g}x_h - r^* \hat{D}$$

- Comparison of true capital and capital under wrong beliefs

$$\text{Equity Capital}_{true} = \hat{q}^* x_h - r^* \hat{D} < \text{Equity Capital}_{wrong}.$$ 

- The mistaken intermediary has
  - lower leverage than the rest of the informed investors but
  - less equity capital at $\tau = 2$
Mistakes by all

- Agents are sure that $\alpha = 0$.
- The equilibrium that obtains is one that is consistent with $\alpha = 0$.
- Ex-post, if they were mistaken about $\alpha$, they are “surprised” to realize losses.
  - Leverage is lower than in the case $\alpha > 0$ for all institutions, but
  - True capital is lower than assumed capital.
Fragility

Capital under wrong beliefs

Equity capital at $\tau = 2$

$\alpha = .2$

$\alpha = .4$
Evidence of Mistakes (Willen)

Table 2. Conditional Forecasts of Losses on Subprime Investments from Lehman Brothers. This table shows that investors knew that subprime investments would turn sour if housing prices fell. The “meltdown” scenario for housing prices above implies cumulative losses of 17.1 percent on subprime-backed bonds; such losses would be large enough to wipe out all but the highest-rated tranches of most subprime deals. The table also shows that investors placed small probabilities on these adverse price scenarios, a fact...
Let the utility of the originator be

\[ U^e(e) \equiv -\psi(e - e) + \pi \left[ e \left( mp^d + (1 - m)p \right) + (1 - e) \left[ \alpha \left( mp^d + (1 - m)p \right) + (1 - \alpha)p \right] \right] + (1 - \pi) ex_h + B(\pi) \]

- \( B(\pi) \): Benefits of distribution, \( B_{\pi} > 0 \) and \( B_{\pi\pi} < 0 \)
- When \( \alpha = 0 \), \( \pi_K > 0 \).
Conclusion

• Model where financial sector “recycles” savings into assets of endogenous quality:
  • Increase in capital decreases yields
  • Lower quality of assets
  • Lower the quality of assets held by financial intermediaries
  • Increases leverage

• To do
  • Consider change in supply of assets and endogenize distribution decision
  • Dynamics
  • ...