Self-fulfilling Fire Sales

Fragility of Collateralised Short-term Debt Markets

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Motivation: Systemic run & illiquid collateral

Observations in the Global Financial Crisis 07-09:

(1) "Systemic runs" on short-term debt collateralised with

- private-label ABS, corporate bond, agency bond
- debt yields and borrower default risks increased
- margin increased and/or borrowing collapsed ▸ more evidence

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(2) Fire sales of illiquid collateral: e.g. He, Khang and Krishnamurthy (2010), from 2007Q4 to 2009Q1

- Hedge fund and broker/dealer holdings of securitised asset decreased by $800 billion
- Commercial banks absorbed $550 billion. Remaining by gov't

What's new to be explained?

Difference from traditional bank run: no first-come-first-served nature as in deposit contract.

E.g. a quote from Gary Gorton (2012) (emphasis by me)

> *...we know that crises are exits from bank debt... In this form of money (repo), each "depositor" receives a bond as collateral. There is no common pool of assets on which bank debt holders have a claim. So, strategic considerations about coordinating with other agents do not arise. This is a challenge for theory and raises issues concerning notions of liquidity and collateral...*

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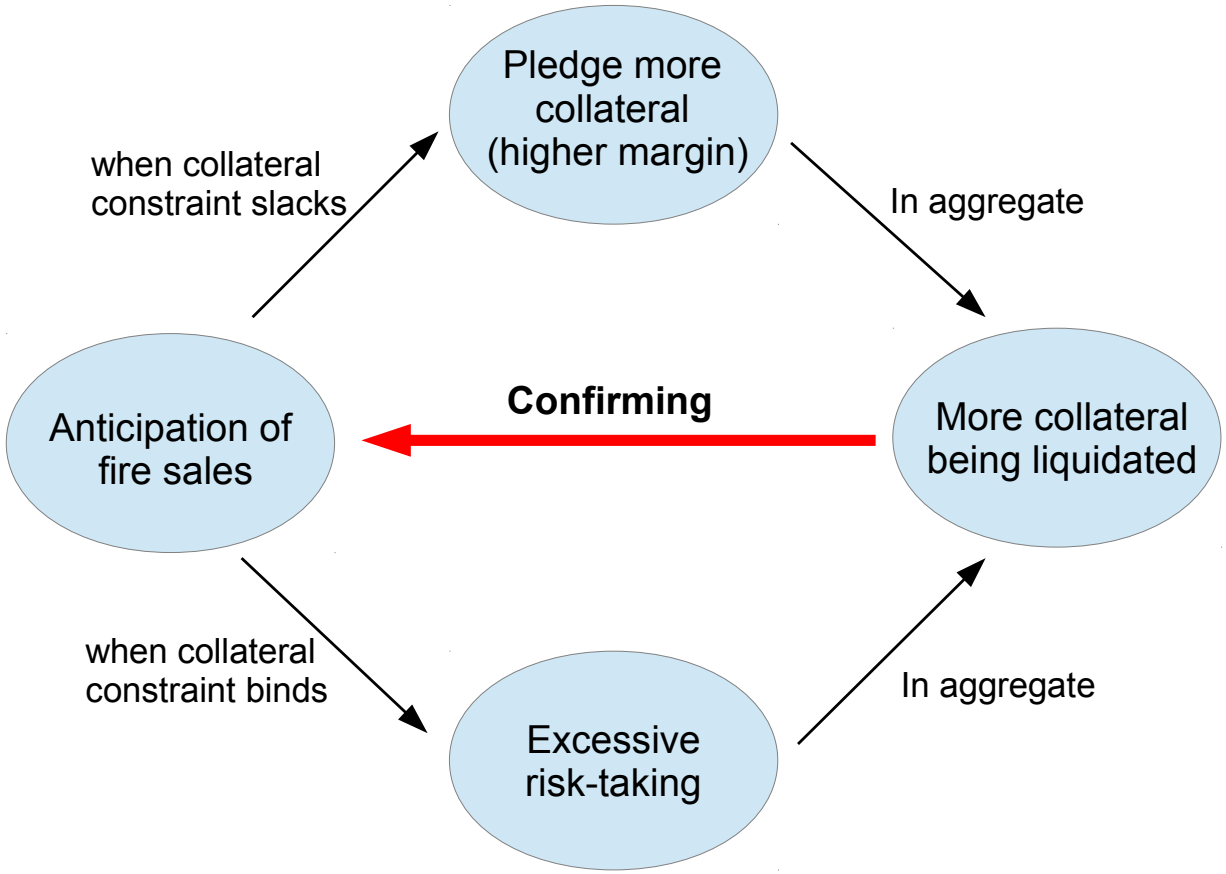
Contribution: A new form of coordination failure between borrowers' ex-ante **margin** and **risk-taking decision**, generating

- self-fulfilling fire sales of certain collateral
- 'systemic run' phenomenon in debt markets

Policy: Social planner's commitment to purchase collateral can improve welfare and stability

- Automatic stay may be undesirable

Mechanism of the self-fulfilling fire sales equilibrium



Model Setup

Timing & Preferences: Three dates ($t = 0, 1, 2$). Zero riskfree rate. Risk-neutral agents

Agents: A continuum of **firm-creditor** pairs, and a representative **collateral buyer**

Goods: one goods, i.e. cash

Firms with moral hazard problem

Each firm starts with no cash and debt but is endowed with:

1. **a divisible asset-in-place** that pays an expected dividend v at $t = 2$
2. **a project** which needs \$1 investment and pays X at $t = 2$ when succeeds and 0 otherwise.

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Risk-taking: each firm can choose the success probability $p_1 > p_2 > p_3$ by incurring a private effort cost $c(p_i) = c_i$, where

$$p_1 X - c_1 > p_2 X - c_2 > 1 > p_3 X - c_3$$

e.g. hedge funds that could manage its portfolio risk

Project risk is independent

Collateralised short-term debt

The firm issues collateralised short-term debt

- pledges $k \in [0, 1]$ fraction of the collateral (**margin**) and promises to repay $r \geq 0$ (**debt yield**) at $t = 1$

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- pledges $k \in [0, 1]$ fraction of the collateral (**margin**) and promises to repay $r \geq 0$ (**debt yield**) at $t = 1$
- At $t = 1$, both the firm and its creditor know whether the project has succeeded. Creditor seizes the collateral if failed.

Creditors' valuation and liquidation decision of collateral

Assumption: Creditors' expected utility from receiving the risky collateral dividend at $t = 2$ is $\underline{l} \leq v$

- interpretation: less sophisticated and more regulated creditors. Can be micro-founded by risk-aversion. Think of money market mutual fund
- $\underline{l}$ as **"collateral quality"**. For instance, $\underline{l} \simeq v$ for safe collateral like US Treasuries

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Liquidation decision: sell the collateral at $t = 1$ when the (endogenous) market clearing price $l \geq \underline{l}$

Capital constrained collateral buyer

A competitive but capital constrained collateral buyer clears the collateral market

- market-clearing price is downward-sloping in supply
- e.g. commercial banks with alternative investment opportunities, capacity constrained market-maker

(more discussion later)

Roadmap

Equilibrium concept: symmetric (mixed-strategy) rational expectation equilibria.

I first study the individual firm investment and contracting problem at $t = 0$, for any conjectured liquidation value l.

Then I discuss how the collateral liquidation value is determined at $t = 1$ in equilibrium.

In equilibrium, the conjecture is correct.

Analysis: Individual firm-creditor contracting problem

Taking l as given, at $t = 0$ each firm offers a contract $\{r, k\}$ to its creditor to maximise its expected payoff, subject to (among others)

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Firm's incentive constraint (IC):

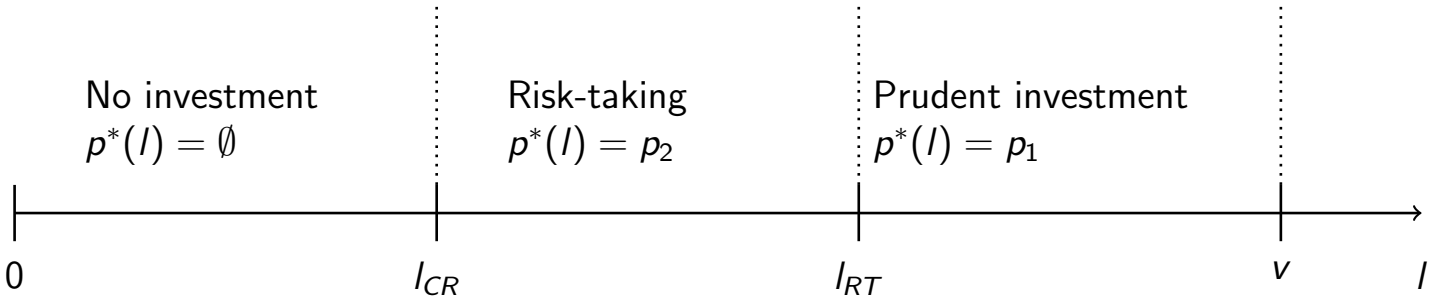
$$p(r,k) \equiv \underset{p \in \{p_1,p_2,p_3\}}{\text{argmax}} \quad p(X-r) - (1-p)kv - c(p)$$

$$\text{or} \quad p(r,k) = \begin{cases} p_1 & \text{for} \quad r \leq \bar{r}_1(k) \\ p_2 & \text{for} \quad r \in (\bar{r}_1(k), \bar{r}_2(k)] \\ p_3 & \text{otherwise} \end{cases} \tag{1}$$

$\bar{r}_i(k)$ increase in $k \rightarrow$ pledging collateral discourages risk-taking

Result: Anticipation of fire sales induces risk-taking

Under some parameter restrictions, the optimal investment strategy $p^*(l)$



Optimal contract:

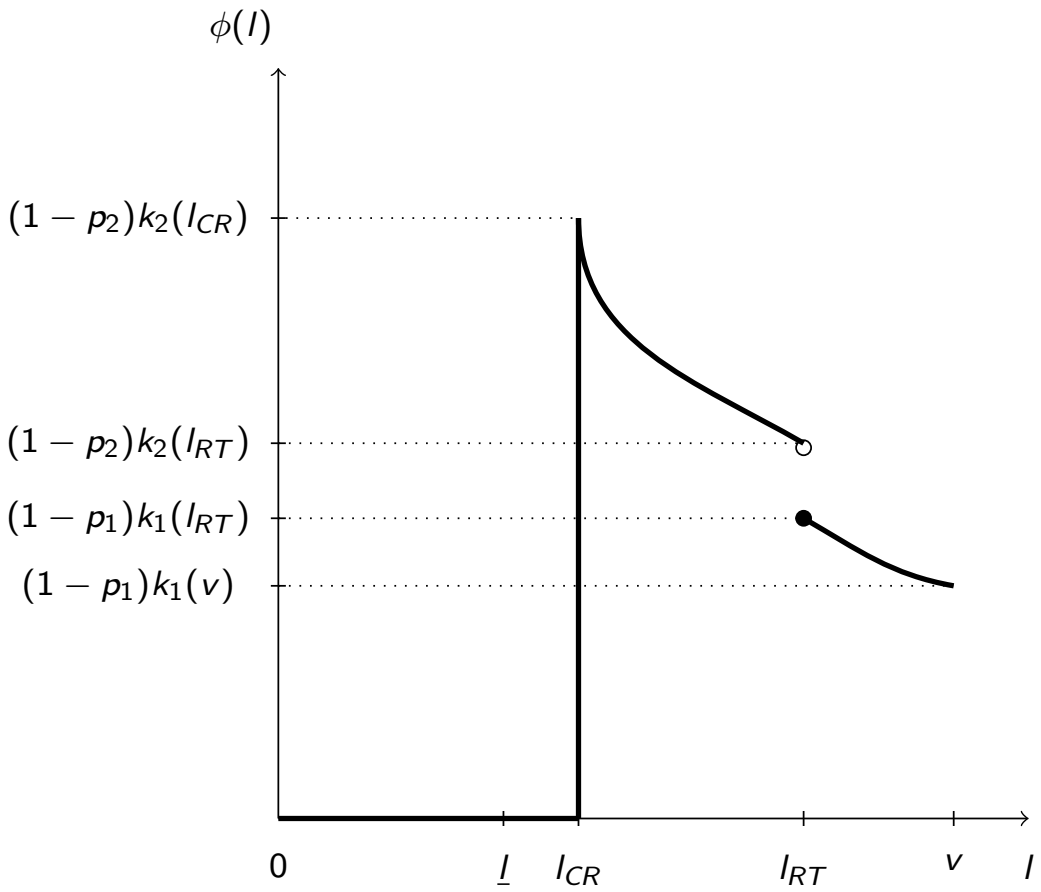
- Margin $k_i(l)$: decreasing and convex in l
- Debt yields $r_i(l)$: decreasing in l.

Lower l leads to higher margin $k_i^*(l)$ and risk-taking.

Next, the illiquid collateral asset market

Amount of collateral liquidated $\phi(l)$

At $t = 1$, by symmetry $\lambda(l)(1 - p^*(l))k(l)$ collateral transferred to creditors, who sell when $l \geq \underline{l}$ hence



Collateral buyer and endogenous liquidation value

There is a competitive collateral buyer to clear the market.

He has an exogenous amount of cash $\theta \in (0, +\infty)$ at $t = 0$

- can also invest in a decreasing-return-to-scale technology

Thus the market-clearing price function $L(\phi; \theta)$ is

- decreasing in ϕ the amount of collateral supplied
- increasing in θ the amount of cash available

θ is common knowledge and an important state variable.

Equilibrium

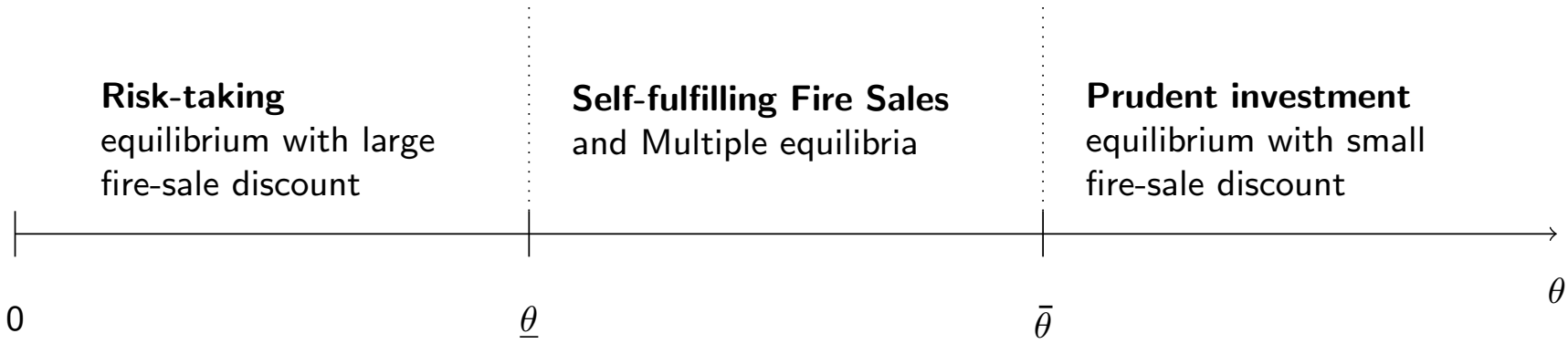
For any given θ, a symmetric, competitive REE consists of an $\{I^*\}$ such that

1. At $t = 0$, agents conjecture the equilibrium liquidation value to be I^*. Firms maximise profit with $p^*(I^*)$ and $\{r(I^*), k(I^*)\}$;
2. At $t = 1$, creditors sell $\phi(I^*)$ units of collateral ;
3. Collateral buyer with θ clears the market at price $L(\phi(I^*); \theta)$;
4. In equilibrium, agents' conjecture is correct. That is,

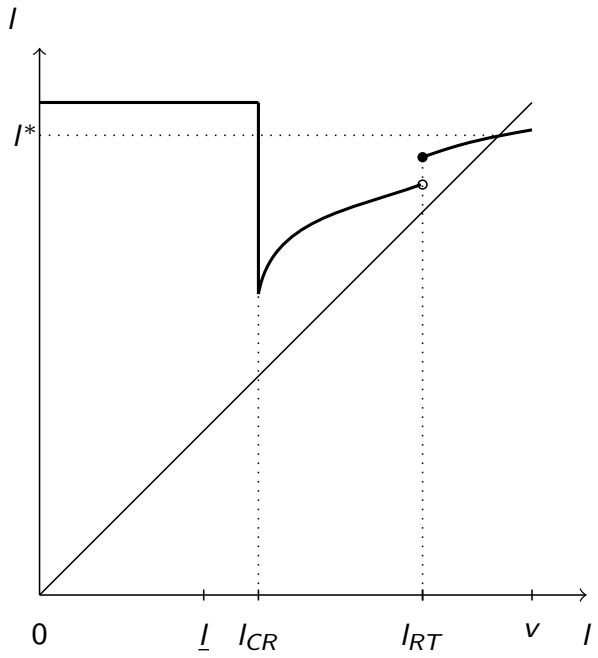
$$I^* = L(\phi(I^*); \theta)$$

Self-fulfilling fire sales: multiple solutions I^*.
Existence of equilibria proved in the paper.

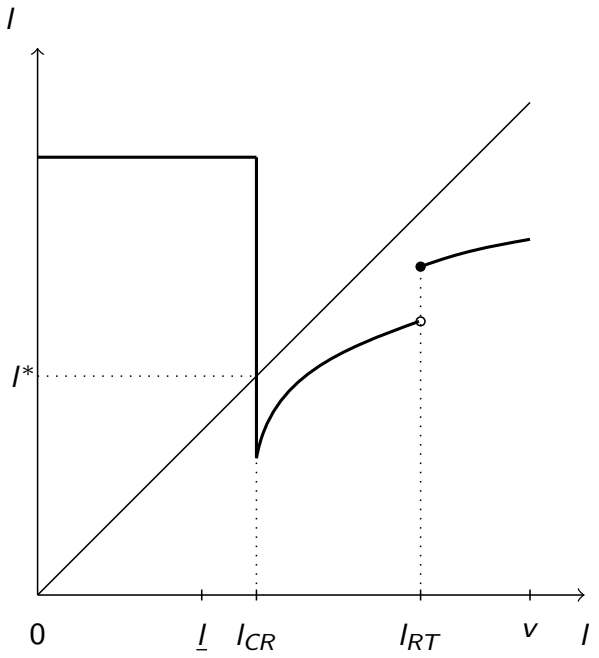
Results: equilibria under different θ



Results: Unique equilibrium under extreme values of θ



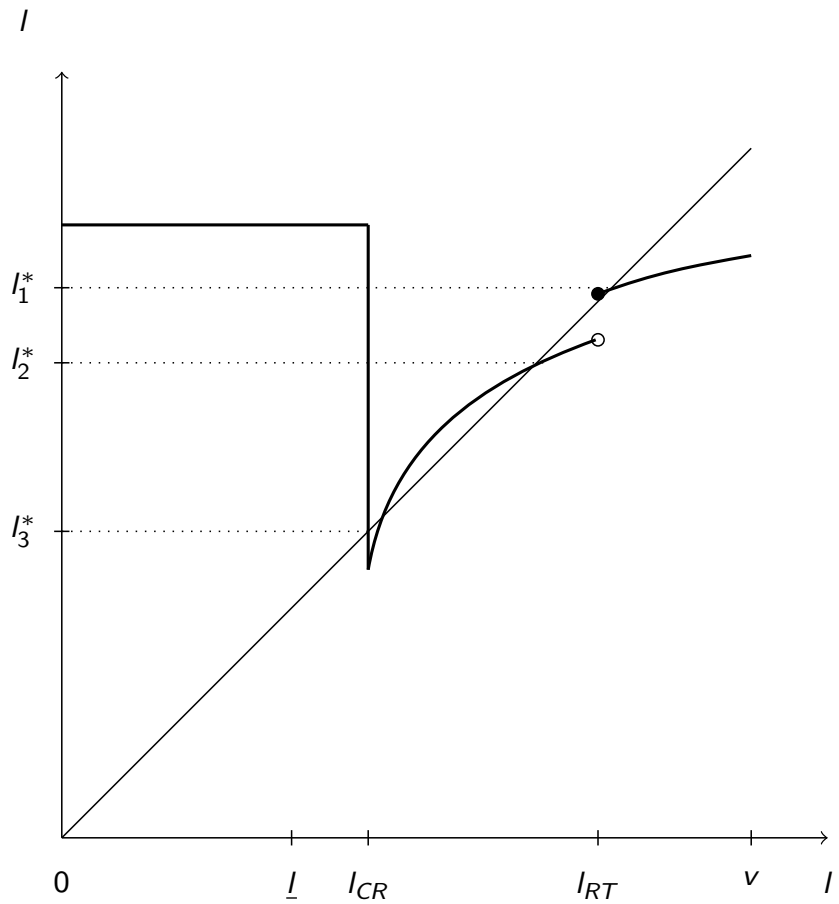
(a) when $\theta \geq \bar{\theta}$



(b) when $\theta \leq \underline{\theta}$

Amplification: effects of changes in liquidity for collateral amplified by moral hazard problem.

Multiple equilibria for $\theta \in (\underline{\theta}, \bar{\theta})$



1. **Risk-taking channel** $l_1^* \to l_2^*$ and
2. **Margin channel** $l_2^* \to l_3^*$

Source of fragility

Strategic complementarities in firms' margin & risk-taking decision

- a firm's increases in default risk or margin exert pecuniary externality on others through fire sales
- lower liquidation value tightens others' incentive constraint
- triggering more margin requirement or risk-taking

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Different kind of coordination failures from Diamond-Dybvig

- 'Systemic run': ex ante in the contracts and collateral specific
- Not from first-come-first-served properties

Market Maker of Last Resort: Asset price guarantee

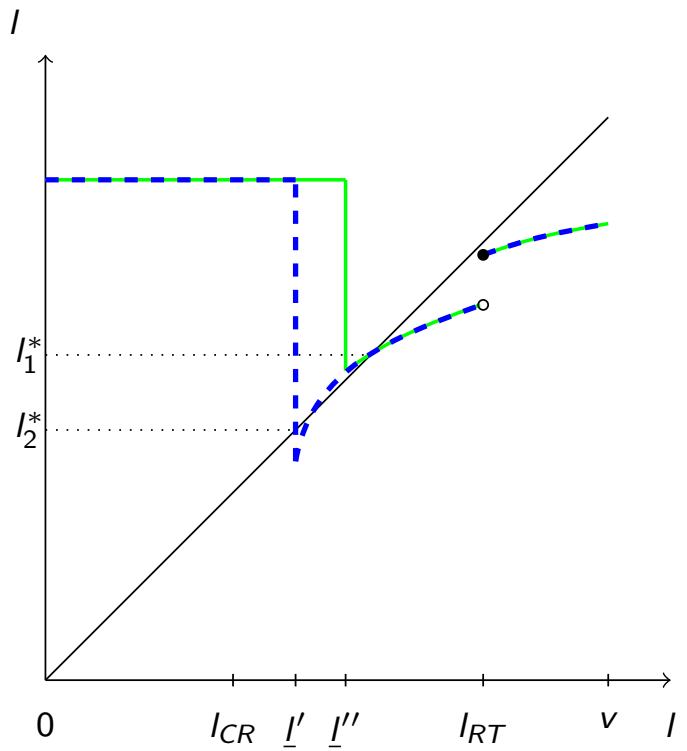
Welfare: equilibria with higher liquidation value are more efficient

Central banks can eliminate the inefficient equilibria by **committing to buy any amount of the collateral at some price** l_{PG}

- **Market Maker of Last Resort** coined by Willem Buiter
- As long as $l_{PG} < l_1^*$, the facility will not be used in equilibrium

Collateral quality and fragility

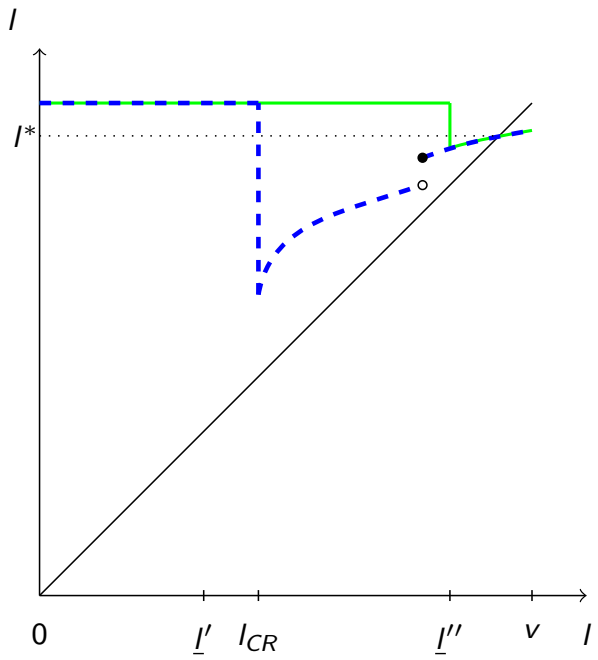
Cross-section: Fix a state θ', low quality collateral breeds fragility.



Implication: possible jumps in spreads and borrowing terms for lower quality collateral.

Counter-cyclical credit spreads

Business-cycles: Compare two collateral in different states θ



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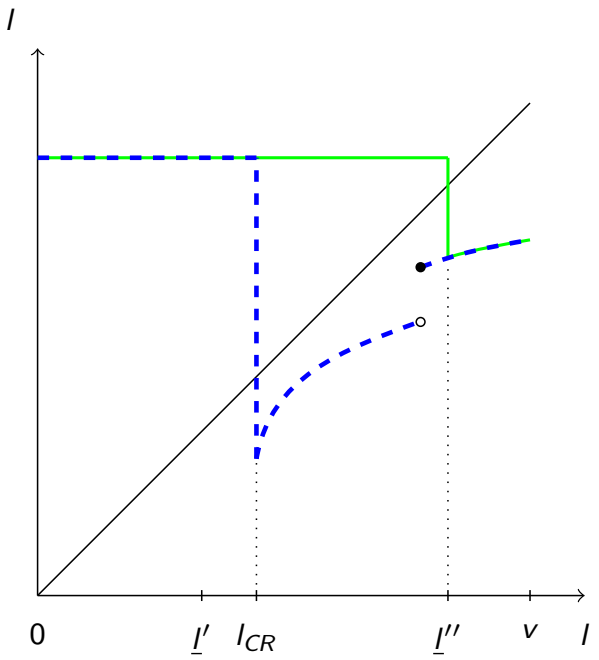

(b) when $\theta \leq \underline{\theta}$

Implication: differences in spreads and borrowing terms between two collateral are more apparent in bad states.

Repo as optimal contract

Optimality:

- Debt: wipes out downside payoff $\rightarrow$ motivates effort
- Collateralised: increases 'liability' when failed $\rightarrow$ relax IC
- Short-term: creditors value the option to liquidate early

Cost of automatic stay

Common repo is **exempted from automatic stay** provision

- allows lender to timely seize the collateral
- valued by lenders as bankruptcy is time-consuming
- argued to have caused fire sales (Roe, 2008)

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Is imposing automatic stay a good idea? **No** from this model

Automatic stay creates ex-post renegotiation problem

Assuming bankruptcy is time-consuming. With automatic stay, an insolvent firm can threaten to invoke bankruptcy protection and delay repayment to $t = 2$

- Suppose k units of collateral is pledged, the firm can make a take-it-or-leave-it offer to the lender with a lower k' such that

$$k' l^* = k \underline{l}$$

- amount of collateral that firm can **credibly** pledge is reduced
- the ex-ante incentive problem worsened

Related Literature (incomplete)

Fragility in secured debt market: Martin, Skeie, and von Thadden (2012)

- OLG Diamond-Dybvig with large unanticipated shocks

Self-fulfilling crises and financial market runs:

- Malherbe (2012): adverse selection and cash-hoarding
- Bernardo and Welch (2004), Morris and Shin (2004): first-come-first-serve + liquidity shock or loss limit

Fire sales and aggregate uncertainty: Lorenzoni (2008) Stein (2011), Eisenbach (2013)

- Excessive (short-term) debt under aggregate uncertainty

Amplifying mechanism: Gromb and Vayanos (2002), Brunnermeier and Pedersen (2009), Danielsson, Shin, and Zigrand (2012)

- exogenous margin constraints with unanticipated shocks

Endogenous margins and externality:

- Biais, Heider, and Hoerova (2014): excessive margining in insurance-derivative market
- Hombert (2009): fire sales *lessen* incentive problem by rewarding prudent firms
- Acharya and Viswanathan (2011): more highly leveraged firms being financed in good times caused more severe bust in bad times

Conclusion

- A panic-like financial fragility in modern collateral-based financial system.
- Feedback: firms' ex-ante risk-taking $\leftrightarrow$ fire-sale discount of collateral

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Conclusion

- A panic-like financial fragility in modern collateral-based financial system.
- Feedback: firms' ex-ante risk-taking $\leftrightarrow$ fire-sale discount of collateral
- Can generate non-linear cross-sectional and time-series variations in collateral credit spreads, firms' default risk, debt yields, and credit rationing.
- Policy implication: Central Bank as Market-Maker of Last Resort $\rightarrow$ improve stability and *reduce* risk-taking.
- Imposing automatic stay may worsen incentives and *increases* fire sales.

Thank you!

Assumption

(NPV and moral hazard intensity of the project) Define $\Delta p_i \equiv p_i - p_{i+1}$, $\Delta c_i \equiv c(p_i) - c(p_{i+1})$, *and*

$$A_i \equiv 1 - p_i(X - \frac{\Delta c_i}{\Delta p_i}) \text{ for } i = 1, 2$$

(i) $A_1 > A_2 > 0$ *and*

(ii) $(1 - p_1)A_1 \leq (1 - p_2)A_2$

Assumption

(Parameter assumptions on v and the NPV of risk-taking)

(i) $v \in (A_1, \bar{v})$ *where*

$$\bar{v} = \frac{A_1}{1 - [(1 - p_1)(NPV_2)]/[(1 - p_2)(A_2 + NPV_2)]}$$

(ii) $NPV_2 \leq \min\{v - A_2, \frac{1 - p_2}{p_2} A_2\}$

back

Spreads for CMBS escalate

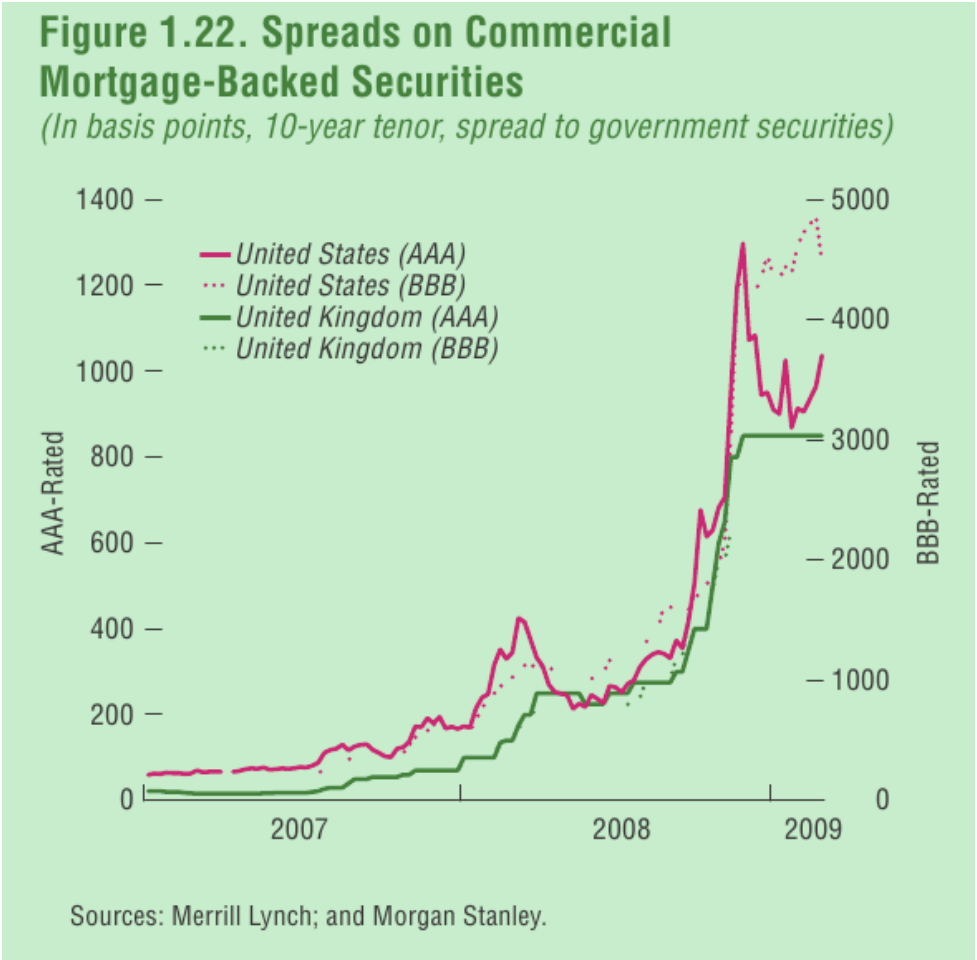

Figure: From IMF Global Financial Stability Report (2009, January)

Counterparty risk and fire sales

Figure 9: LIB-OIS and Non-Subprime-Related Asset Classes

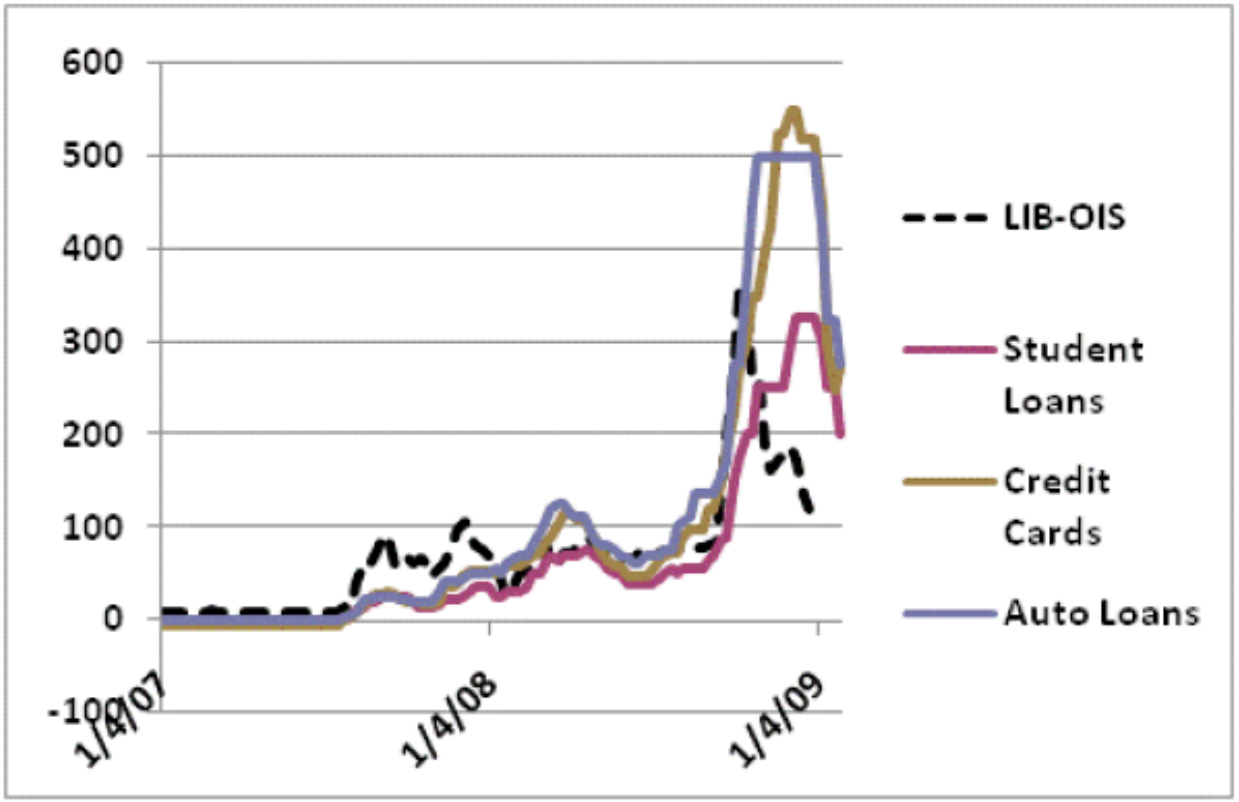

Figure: From Gorton & Metrick (2010). LIBOR-OIS and AAA-rated asset-backed securities spreads. Scale is basis point.

Repo rates increase

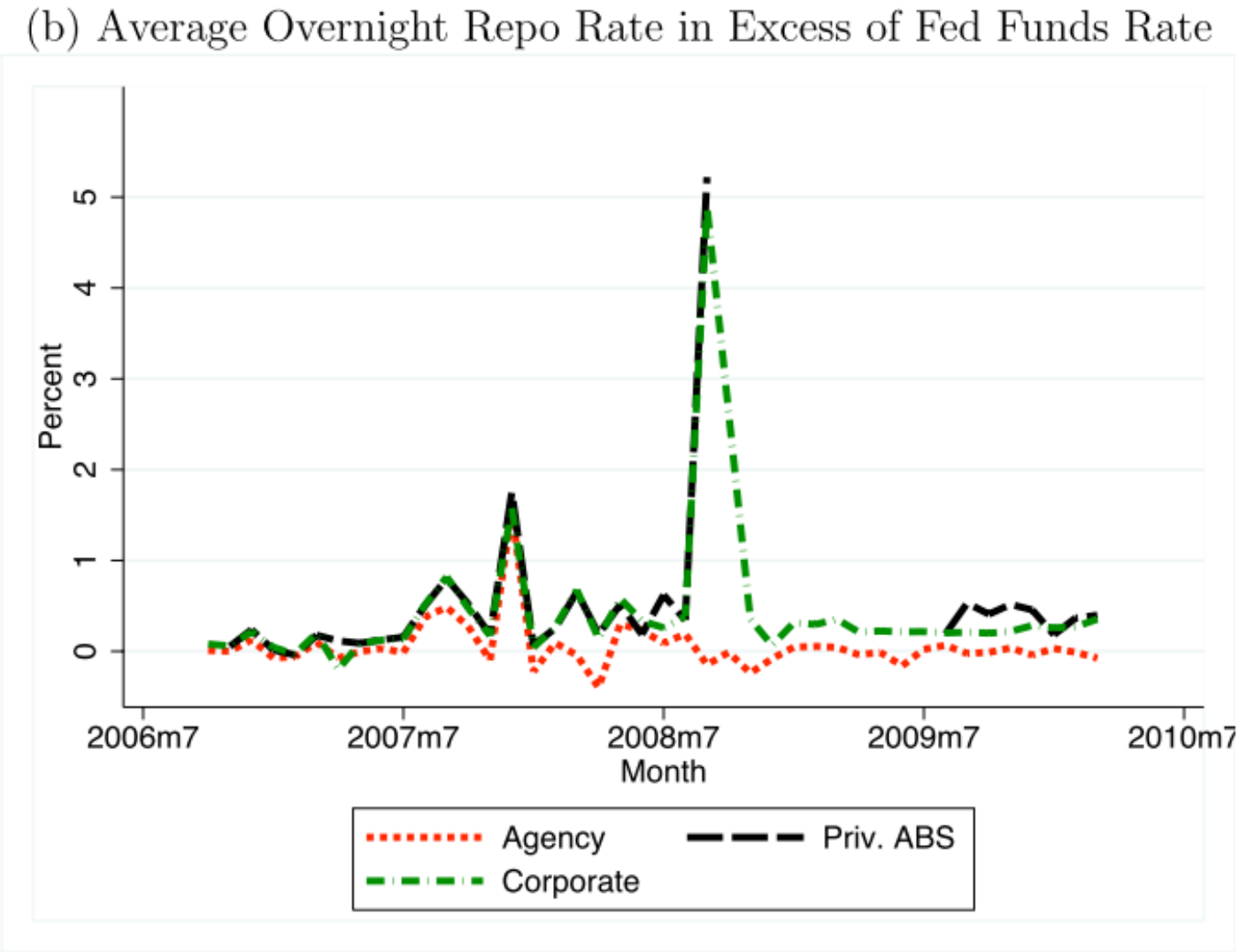

Figure: Average Overnight Repo Rates (Weighted by notional value) from Krishnamurthy et al (2013)

Repo haircuts differ

Table 4

Repo Haircuts

(percent)

	Repo haircuts (%)			
	Spring 2007	*Spring 2008*	*Fall 2008*	*Spring 2009*
U.S. Treasuries (short-term)	2	2	2	2
U.S. Treasuries (long-term)	5	5	6	6
Agency mortgage-backed securities	2.5	6	8.5	6.5
Corporate bonds, A–/A3 or above	5	10	20	20
Collateralized mortgage obligations, AAA	10	30	40	40
Asset-backed securities, AA/Aa2 and above	10	25	30	35

Figure: From Krishnamurthy (2010). Data from Depository Trust and Clearing Corporation.

ABCP yield spreads increase

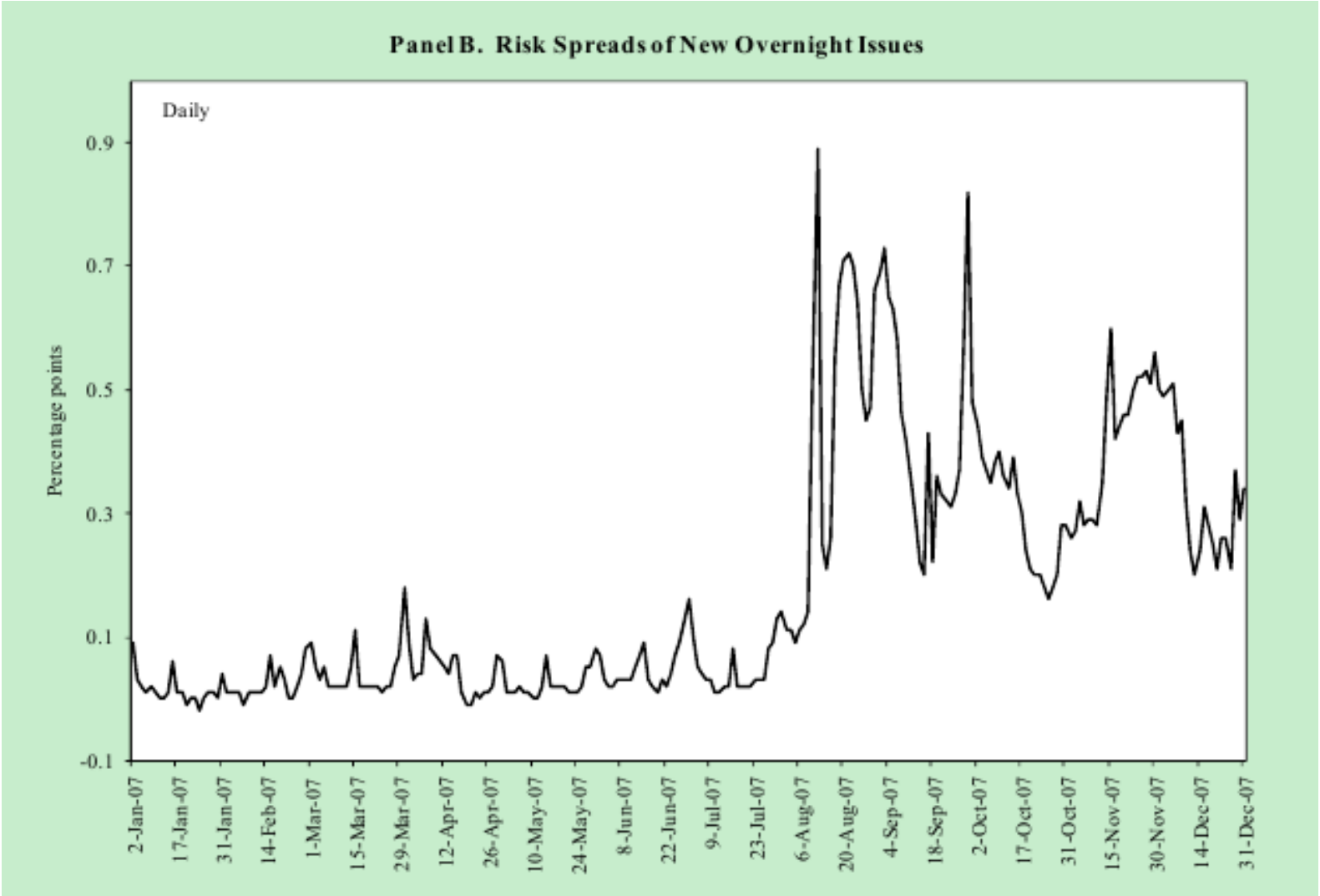

Figure: Spread of rates on AA-rated ABCP over target fund rate for paper with 1-4 day maturity from Covitz et al (2012) back