Collateral Runs

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[1] The views of this presentation are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.

Motivation

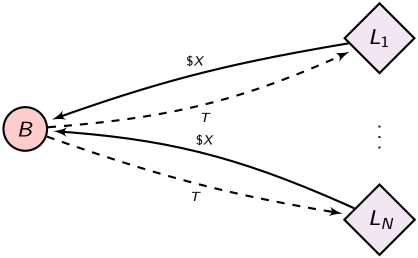
...Thursday had brought an onslaught of new client demands for their cash back, as well as demand for collateral from numerous funding counter parties, leaving the firms with only about $5 billion....

"Okay, where are we in terms of cash we can raise? What collateral can we pledge?"

— Kelly (2009), quoting Sam Molinaro, CFO of Bear Sterns, evening of March 13th 2008.

Motivation – Classic *'Repo runs'*

- Repo contract: Borrower borrows $\$X$ from Lender(s) after pledging collateral T



- Collateral is risky and may take values between $\left(T^D, T^U\right)$
- If low values are likely, lenders may get "spooked" and run to withdraw their cash
- Classic view of repo runs: *Run from liabilities' side*
- **Solution**: Over-collateralization/Zero VaR contracts whereby $X \leq T^D$

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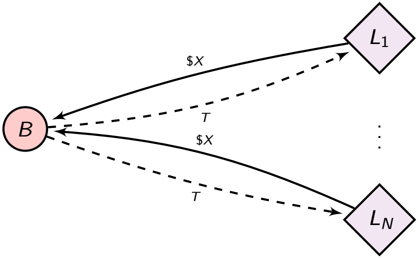

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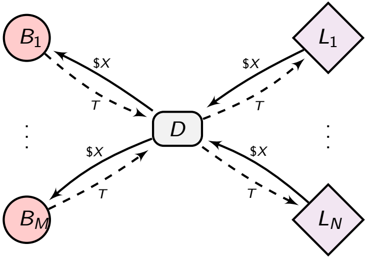
Motivation – Dealer and Rehypothecation

- Lenders and borrowers do not interact directly: a dealer engages in a repo and a reverse repo, and *rehypothecates* the collateral
- What if dealer extends fewer funds than the ones received: $X' < X$?



Dealer's Balance Sheet

Assets	Liabilities
Reverse repos $\sum_M X$	Repos $\sum_N X$

- By investing $\sum_N X - \sum_M X'$ in risky assets, borrowers may get "spooked" and *run to withdraw their collateral*
- **Note:** zero VaR contract, $X \leq T^D$ does not protect collateral providers

Inst. Details

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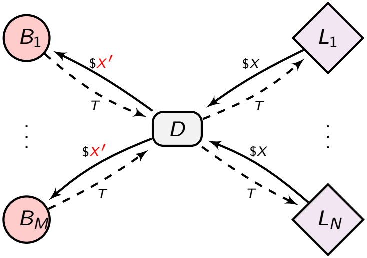

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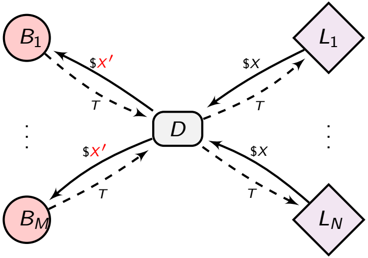

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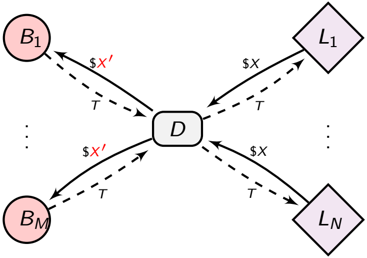

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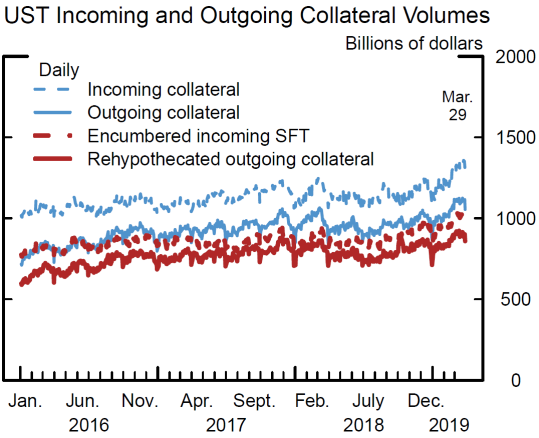
How Important Is Rehypothecation?



Source: Infante, Press, Saravay (2020)

What we do

- Characterize the coordination problem amongst collateral providers, giving rise to a multiplicity of equilibria
- Use traditional global games framework to find the unique threshold equilibrium
- Solve for the optimal contracting terms that result in the unique equilibrium

Main Ingredients for Collateral Runs

1) Rehypothecation of collateral:

   Otherwise bankruptcy regimes could protect the collateral provider

2) Dealers ability to set different contracting terms (market power):

   Dealers need to extract liquidity from matched book activity

3) Dealers discretion to use excess funds for own needs:

   Investment in illiquid (but profitable) projects

Literature Review

- Collateralized lending
  - Geanakoplos (2003), Fostel & Geanakoplos (2008, 2015), Donaldson, Piacentino & Thakor (2019)
- Repo & Rehypothecation
  - Gorton & Metrick (2012), Duffie (2013), Martin et al. (2014), Copeland, Martin & Walker (2015), Krishnamurthy, Nagel & Orlov (2015), Baklanova et al. (2017), Gottardi et al. (2017), Infante (2019)
- Bank Runs & Global Games
  - Diamond & Dybvig (1983), Rochet & Vives (2004), Ahnert et al. (2018), Goldstein & Pauzner (2005), Kashyap, Tsomocos & Vardoulakis (2017)

Model Setup

- 3 periods: $t \in \{0, 1, 2\}$
- 2 assets in perfectly elastic supply:
  - 1 safe asset — valued at 1 in all periods, serves as collateral: T
  - 1 risky asset — payoff in $t = 2$ depends on state $\theta \sim U(0,1)$ which is realized in $t = 1$

$$\tilde{R} = \begin{cases} R^U > 1 & \text{with prob } \theta \\ R^D \in [0,1) & \text{with prob } 1 - \theta \end{cases}$$

valued at 1 in $t = 0$ and in $t = 1$ has liquidation value $\lambda \cdot E(\tilde{R}|\theta)$ with $\lambda \leq 1$

- 3 types of agents that consume in $t = 2$:
  - Money funds (M): Continuum of "very" risk averse, invest in repo backed by T
  - Hedge funds (H): Continuum of risk neutral, additional preference for T between $t = 1, 2$:

$$\eta T > T \rightarrow \text{Incentives to take leverage}$$

  - Dealer (D): Single intermediary with no initial wealth, who intermediates funds and collateral between H and M

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Timeline Overview

- $t = 0$: Initial financing period
  - D sets one period repo contracting terms for both counterparties & invests in risky asset
- $t = 1$: Intermediate period, θ is realized
  - H receives individual noisy signal of state θ & decides whether to roll over or withdraw its collateral
  - Give the fraction of withdrawers, D pays M to recover collateral of withdrawing H & possibly liquidating part of its risky asset
  - If withdrawals are severe, entire risky asset position is liquidated $\longrightarrow$ collateral run!
- $t = 2$: Final period, if collateral run does not occur
  - Asset outcome realized & contracts settled
  - D protected by limited liability: consider contracts were D can default

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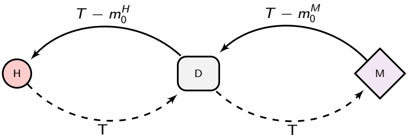
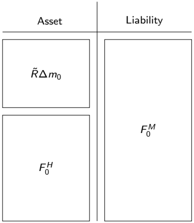
Contracting Terms & Rehypothecation

- D offers take-it-or-leave-it repo contracting terms
- Repo contract at time $t \in \{0, 1\}$ for agent $i \in \{H, M\}$:
  - Margin: degree of overcollateralization $m_t^i \longrightarrow$ initial loan amount $T - m_t^i$
  - Repurchase price: final repayment to repo F_t^i
- Relevant cash flows for dealer:
  - $\Delta m_t := m_t^H - m_t^M$: net inflow in the initial leg
  - $\Delta F_t := F_t^H - F_t^M$: net "inflow" in the closing leg

D's balance sheet at $t = 0$

- $t = 0$: Initial financing period
  - D sets one period repo contracting terms such that $m_0^H > m_0^M$
  - $(T - m_0^M) - (T - m_0^H) = \Delta m_0 > 0$
  - D buys risky asst with liquidity windfall Δm_0





D's balance sheet at $t = 1$

- H receives noisy signal about θ & decides whether to roll over its repo
  - If H withdraws, D receives ΔF_0
  - If H rolls over, D receives $\Delta F_0 + \Delta m_1$ (case ≥ 0)
- Depending on the portion of H withdrawing, $\mu \in [0, 1]$:
  (a) μ "small": D does not need to sell: $\mu \Delta F_0 + (1 - \mu)(\Delta F_0 + \Delta m_1) \geq 0$

  (b) μ "intermediate": D must sell ξ of risky asset position:
  $\mu \Delta F_0 + (1 - \mu)(\Delta F_0 + \Delta m_1) + \xi \lambda \mathbb{E}(\tilde{R}|\theta) = 0$

  (c) μ "severe": Full liquidation, M seize collateral & H (sequentially) served with probability f: $f \mu \Delta F_0 + (1 - \mu)(\Delta F_0 + \Delta m_1) + \lambda \mathbb{E}(\tilde{R}|\theta) = 0$

Small withdrawals | Inter. withdrawals | Severe withdrawals

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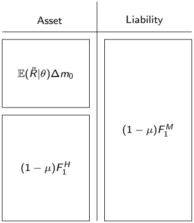

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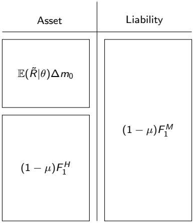

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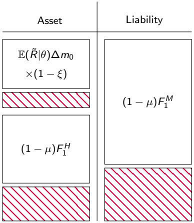

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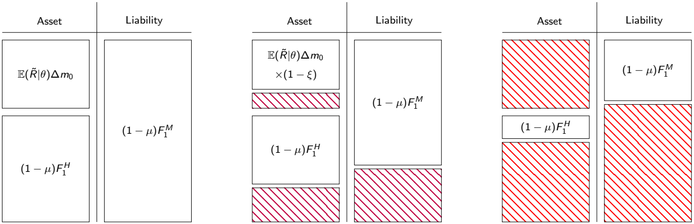


Small withdrawals | Inter. withdrawals | Severe withdrawals

Hedge Fund Incentives & Coordination Failure

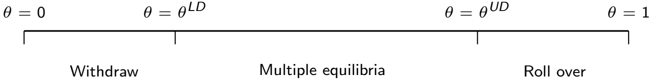
- Rolling over:
  - Upside proportional to *levered position* $\eta T - F$
  - But exposure to run risk
- Early withdrawal:
  - Reduces exposure to run risk
  - But upside proportional to *unlevered position* $\eta(T - F)$
- H's decision to withdraw depends on signal over θ **and** beliefs over number of other hedge funds withdrawing$\rightarrow$ Coordination problem!

HF Payoff

Global Game

- At beginning of $t = 1$ H receive a noisy signal $x_i = \theta + \epsilon_i$, $\epsilon_i \sim U(-\epsilon, \epsilon)$, i.i.d.

- With complete information about state ($\epsilon_i = 0$)$\rightarrow$ multiple equilibria



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  - If signal in-between, coordination failure$\rightarrow$ individual action depends on others

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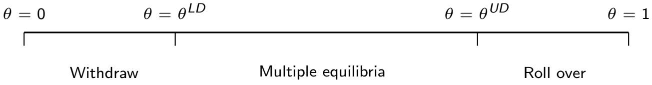

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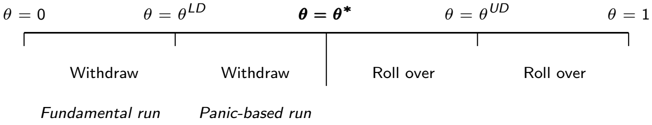
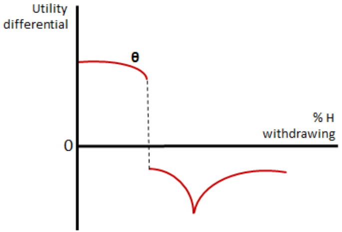


Existence and Uniqueness of Collateral Run

Proposition

Given $0 < \theta^{LD} < \theta^{UD} < 1$, there exists a unique threshold strategy determined by x^* and a unique threshold state θ^* such that a run occurs only for $\theta < \theta^*$

- Define $\nu(\mu, \theta)$ the utility differential between rolling over and withdrawing



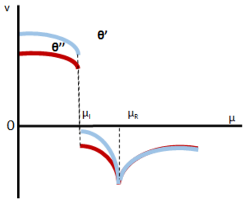
- θ^* is the level of fundamentals that makes H indifferent

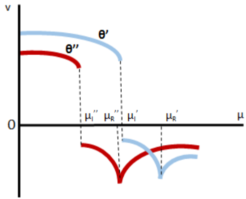
$$V(\theta^*, \Delta m_t, \Delta F_t) = \int_0^1 \nu(\mu, \theta^*) d\mu = 0$$

Details

Technical point

Usual proof requires global strategic complementarities and state monotonicity





- Bank-run models exhibit one-sided strategic complementarities
  - Given that a run occurs, the incentives to withdraw are *lower* as μ increases
- Existing literature relied on fixed liquidation value
- We endogenize the liquidation value at the cost of losing global state monotonicity
  - Given that a run occurs, the incentives to withdraw are higher as θ increases

Threshold Equilibria

- In $t = 0$, D sets contracting terms $(\Delta m_t, \Delta F_t)$ to maximize

$$\int_{\theta^*}^{1} \theta \cdot u(R^U \Delta m_0 + \Delta F_0 + \Delta m_1 + \Delta F_1) d\theta$$

subject to how contracting terms affect the probability of a run , θ^*, through hedge funds' indifference condition:

$$V(\theta^*, \Delta m_t, \Delta F_t) = 0$$

- Contracting terms are pinned down implicitly, but some intuition:
  - D internalizes that a higher liquidity windfall, Δm_0, increases the probability of a run
  - D would like to increase liquidity in the interim period, Δm_1, but only impacts agents who were **already** rolling over

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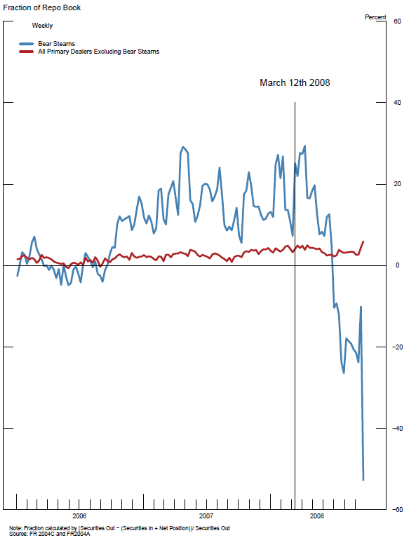
Case Study: Bear Stearns Windfall as a Fraction of Repo Book



Data details

Comparing Collateral Runs and Bank Runs

- Similarities

  agents have an unsecured claim on a financial intermediary and liquidation falls short of repaying all agents.

- Important Differences

  1) Conceptual:

     Cash borrowers (asset side) can be the source of fragility rather than cash lenders (liability side)—notion of collateral liability

  2) Incentives for intermediation:

     Traditional bank runs are liquidity provision (risk sharing) while collateral runs are for investor to take levered positions—no maturity mismatch

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     Newly regulation does little to reduce collateral run risk & monitor asset side contracting terms and rehypothecation activity

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Monitoring & Impact of Recent Regulation

- Monitoring:
  - In equilibrium collateral runs and repo runs happen simultaneously
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- Regulatory framework:
  - FSB proposes introduction of haircut floors to make repo markets more resilient
  - Model extension shows haircut floors **increases** the probability of a run
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Monitoring & Impact of Recent Regulation

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- Main ingredients for collateral runs are:
  1) Rehypothecation of collateral
  2) Dealers ability to set different contracting terms (market power)
  3) Dealers discretion to use excess funds for own needs
- Policy proposals to reduce collateral run risk (working progress)
  P1) Limits to rehypothecation:
  Cannot raise secured funds to finance H's repo $\longrightarrow$ part of the windfall used to finance it
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Concluding Remarks

- Paper highlights symmetry in dealer balance sheet:
  - Loss of securities introduces runs risk from the asset side
- Use of global games to refine equilibria to eliminate multiplicity
  - Characterize the existence of panic-based collateral runs
- Policy prescription:
  - Regulators should consider stability threats from collateral runs

    $\longrightarrow$ limits to haircuts, reinvestment, and rehypothecation
  - Comprehensive cost benefit analysis of limits to rehypothecation

Back-up slides

Institutional Details

- Two main segments of the U.S. repo market:
  - Tri-party repo market ($\approx$ \$ 2.5 trillion for all collateral, \$ 1.2 trillion for UST):
    Cash investors (i.e., money funds, securities lenders, corporate cash managers) provide secured funding to dealers
  - Bilateral repo market ($\approx$ \$ 1.8 trillion for all collateral)[2]:
    Securities dealers provide secured funding to investors and source specific collateral
- Dealers borrow funds to finance inventory and conduct "matched book"
- Regulatory treatment of repo:
  - Exempt from automatic stay: cash lenders has immediate access to collateral
  - No limits to repo rehypothecation: SEC Rule 15c3-3 does not apply

Back

[2] Source: Baklanova et. al (2019)

Hedge Fund Payoffs

$$U^H(\mu,\theta;\text{roll over}) = \begin{cases} \theta(\eta T - F_1^H) + (1-\theta)G_S^D(\mu,\theta) + & \\ \eta\left(T - m_0^H - F_0^H - m_1^H\right) & \mu \in [0,\mu_S) \\ \theta(\eta T - F_1^H) + (1-\theta)G_I^D(\mu,\theta) + & \\ \eta\left(T - m_0^H - F_0^H - m_1^H\right) & \mu \in [\mu_S,\mu_I) \\ \theta G_I^U(\mu,\theta) + (1-\theta)G_I^D(\mu,\theta) + & \\ \eta\left(T - m_0^H - F_0^H - m_1^H\right) & \mu \in [\mu_I,\mu_R) \\ \eta\left(T - m_0^H - F_0^H - m_1^H\right) & \mu \in [\mu_R,1] \end{cases}$$

$$U^H(\mu,\theta;\text{withdraw}) = \begin{cases} \eta\left(T - F_0^H\right) - \eta m_0^H & \mu \in [0,\mu_R) \\ \eta\left(f(\mu,\theta)\cdot(T - F_0^H)\right) - \eta m_0^H & \mu \in [\mu_R,1] \end{cases}$$

where

- G_S^D value of defaulted portfolio with no sales when $\tilde{R} = R^D$
- G_I^D value of defaulted portfolio with sales when $\tilde{R} = R^D$
- G_I^U value of defaulted portfolio when $\tilde{R} = R^U$
- $f(\mu,\theta)$ pro-rata probability of getting paid conditional on a run

HF Incentives

ν Function

$$\nu(\mu,\theta) = \begin{cases} \theta\left[(\eta-1)T - \Delta F_1\right] + (1-\theta)G_S^D(\mu,\theta) - \eta\Delta m_1 & \mu \in [0,\mu_S) \\ \theta\left[(\eta-1)T - \Delta F_1\right] + (1-\theta)G_I^D(\mu,\theta) - \eta\Delta m_1 & \mu \in [\mu_S,\mu_I) \\ \theta G_I^U(\mu,\theta) + (1-\theta)G_I^D(\mu,\theta) - \eta\Delta m_1 & \mu \in [\mu_I,\mu_R) \\ -\eta\frac{\lambda\overline{R}_\theta\Delta m_0 + \Delta F_0 + \Delta m_1}{\mu} & \mu \in [\mu_R, 1] \end{cases}$$

Back

Dealer Optimization

$$\max_{\{\Delta m_0, \Delta F_0, \Delta m_1, \Delta F_1\}} \frac{1}{2}(1-\theta^{*2})u^D(R^U \Delta m_0 + \Delta F_1 + \Delta F_0 + \Delta m_1)$$

s.t.

$$\begin{aligned}
\Delta m_1 + \Delta F_0 \quad & \geq \quad 0 \text{ (Positive Liquidity Injection)} \\
R^D \Delta m_0 + \Delta F_0 + \Delta m_1 + \Delta F_1 \quad & \leq \quad 0 \text{ (Dealer default in bad state)} \\
PC_0 \quad & \geq 0 \quad \text{(HF Participation in } t = 0\text{)} \\
PC_1 \quad & \geq 0 \quad \text{(HF Participation in } t = 1\text{)} \\
\Delta m_0, \Delta m_1 \quad & \in \quad [0, T] \text{ (Feasible Haircuts)} \\
\Delta F_0, \Delta F_1 \quad & \leq 0
\end{aligned}$$

where

$$\begin{aligned}
PC_0 \quad & : \quad \int_{\theta^*}^{1} \eta \cdot (T - F_0^H) d\theta + \int_0^{\theta^*} \eta \cdot f(1,\theta) \cdot (T - F_0^H) d\theta - \eta \cdot m_0^H \geq 0 \\
PC_1 \quad & : \quad \theta(\eta \cdot T - F_1^H) + (1-\theta) G_S^D(0,\theta) - \eta \cdot m_1^H \geq 0,
\end{aligned}$$

Th Eq.

Comparative Statics when $R^D = 0$ and r.n. D

- If $R^D = 0$ and r.n. D then θ^* only depends on the liquidation value of the asset
- $\frac{\partial \theta^*}{\partial \lambda R^U} > 0$:
  - For given contracting terms, a higher λR^U increases the payoff from running
  - D reacts by reducing Δm_0, but not enough to counterbalance H's increased incentive to run
  - Result is not robust to a risk averse D
- $\frac{\partial \theta^*}{\partial \eta} = 0$:
  - Increase in η do not change the probability of a run, but increases Δm_0

Th Eq.

Estimate of Liquidity Windfall: FR 2004

- FR 2004 reports funds paid or received in short-term financing transactions
- Estimate of cash windfall:

$$CW = (R - m_R) - (RR - m_{RR}) + (L - S) = -\text{"}BoxConstraint\text{"} + \Delta m_0 \leq \Delta m_0$$

- Box Constraint: budget constraint for securities that must be positive (Huh & Infante, 2018)

Back