Motivation

▪ Aim: Bridge the gap between
  ▫ Macro/monetary research
  ▫ Finance research

▪ Financial sector helps to
  ▪ overcome financing frictions and
  ▪ channels resources
  ▪ creates money

... but
  ▫ Credit crunch due to adverse feedback loops & liquidity spirals
    ▪ Non-linear dynamics

▪ New insights to monetary and international economics
Systemic risk – a broad definition

- Systemic risk build-up during (credit) bubble ... and materializes in a crisis
  - “Volatility Paradox” → contemp. measures inappropriate

- Spillovers/contagion – externalities
  - Direct contractual: domino effect (interconnectedness)
  - Indirect: price effect (fire-sale externalities) credit crunch, liquidity spirals

- Adverse GE response amplification, persistence
Minsky moment – Wile E. Coyote Effect
Instruments

- Price stability
  Monetary policy
  - Short-term interest
  - Policy rule (terms structure)

- Financial stability
  Macroprudential policy
  - Reserve requirements
  - Capital/liquidity requirements
  - Collateral policy
  - Margins/haircuts
  - Capital controls

Output (gap)
Methodology – relation to finance

- **Verbal Reasoning** *(qualitative)*
  - Fisher, Keynes, ...

**Macro**
- Growth theory
  - Dynamic *(cts. time)*
  - Deterministic
- Introduce stochastic
  - Discrete time
    - Brock-Mirman, Stokey-Lucas
    - DSGE models
- **Cts. time macro with financial frictions**

**Finance**
- Portfolio theory
  - Static
  - Stochastic
- Introduce dynamics
  - Continuous time
    - Options Black Scholes
    - Term structure CIR
    - Agency theory Sannikov

- Timeline

- **Growth theory**
  - Dynamic *(cts. time)*
  - Deterministic

- **Introduce stochastic**
  - Discrete time
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- **Finance**
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- Introduce dynamics
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Heterogeneous agents + frictions

- Lending-borrowing/insuring since agents are different

  - Poor-rich
  - Productive
  - Less patient
  - Less risk averse
  - More optimistic

  ➔

  - Rich-poor
  - Less productive
  - More patient
  - More risk averse
  - More pessimistic

- Limited direct lending due to frictions

- Friction ➔ $p_s MRS_s$ different even after transactions

- Wealth distribution matters! (net worth of subgroups)

- Financial sector is not a veil
Liquidity – Persistence & Amplification

Markus Brunnermeier and Yuliy Sannikov

Princeton University
Liquidity Concepts

- Financial instability arises from the fragility of liquidity

Technological liquidity
  - Reversibility of investment

Market liquidity
  - Specificity of capital
    - Price impact of capital sale

Funding liquidity
  - Maturity structure of debt
    - Can’t roll over short term debt
  - Sensitivity of margins
    - Margin-funding is recalled

Liquidity mismatch determines severity of amplification
### Types of Funding Constraints

- **Equity constraint**
  - “Skin in the game constraint”

- **Debt constraints**
  - None
  - Costly state verification a la Townsend
    - Borrowing cost increase as net worth drops
  - Collateral/leverage/margin constraints
    - Quantity constraint on borrowing
    - Incomplete contracts a la Hart-Moore
    - Commitment problem
    - Credit rationing a la Stiglitz-Weiss

BruSan, He-Krishnamurthy

CF, BGG

KM, BP, G
Macro-literature on Frictions

1. Net worth effects:
   a. Persistence: Carlstrom & Fuerst
   b. Amplification: Bernanke, Gertler & Gilchrist
   c. Instability: Brunnermeier & Sannikov

2. Volatility effects: impact credit quantity constraints
   a. Margin spirals: Brunnermeier & Pederson
   b. Endogenous constraints: Geanakoplos

3. Demand for liquid assets & Bubbles – “self insurance”
   a. OLG, Aiyagari, Bewley, Krusell-Smith, Holmstrom-Tirole,…

4. Financial intermediaries & Theory of Money
Amplification & Instability - Overview

  - Perfect (technological) liquidity, but persistence
  - Bad shocks erode net worth, cut back on investments, leading to low productivity & low net worth of in the next period
Amplification & Instability - Overview

  - Perfect (technological) liquidity, but persistence
  - Bad shocks erode net worth, cut back on investments, leading to low productivity & low net worth of in the next period

  - Technological/market illiquidity
  - KM: Leverage bounded by margins; BGG: Verification cost (CSV)
  - Stronger amplification effects through prices (low net worth reduces leveraged institutions’ demand for assets, lowering prices and further depressing net worth)

- Brunnermeier & Sannikov (2010)
  - Instability and volatility dynamics, volatility paradox

- Brunnermeier & Pedersen (2009), Geanakoplos
  - Volatility interaction with margins/haircuts (leverage)
Persistence

- Even in standard real business cycle models, temporary adverse shocks can have long-lasting effects.
- Due to feedback effects, persistence is much stronger in models with financial frictions:
  - Bernanke & Gertler (1989)
  - Carlstrom & Fuerst (1997)
- Negative shocks to net worth exacerbate frictions and lead to lower capital, investment and net worth in future periods.
Key friction in previous models is **costly state verification**, i.e. CSV, a la Townsend (1979)

Borrowers are subject to an idiosyncratic shock
- Unobservable to lenders, but can be verified at a cost

Optimal solution is given by a contract that resembles standard debt
CSV: Contracting

- Competitive market for capital
  - Lender’s expected profit is equal to zero
  - Borrower’s optimization is equivalent to minimizing expected verification cost

- Financial contract specifies:
  - Debt repayment for each reported outcome
  - Reported outcomes that should be verified
Incentive compatibility implies that
- Repayment outside of VR is constant
- Repayment outside of VR is weakly greater than inside

Maximizing repayment in VR reduces the size and thus the expected verification cost
Output is produced according to $Y_t = A_t f(K_t)$

Fraction $\eta$ of entrepreneurs and $1 - \eta$ of households

- Only entrepreneurs can create new capital from consumption goods

Individual investment yields $\omega i_t$ of capital

- Shock is given by $\omega \sim G$ with $E[\omega] = 1$
- This implies consumption goods are converted to capital one-to-one in the aggregate
- *No technological illiquidity!*
Households can verify $\omega$ at cost $\mu i_t$

- Optimal contract is debt with audit threshold $\bar{\omega}$
- Entrepreneur with net worth $n_t$ borrows $i_t - n_t$ and repays $\min\{\omega_t, \bar{\omega}\} \times i_t$

Auditing threshold is set by HH breakeven condition

- $\left[ \int_0^{\bar{\omega}} (\omega - \mu) d g(\omega) + (1 - G(\bar{\omega})) \bar{\omega} \right] i_t q_t = i_t - n_t$
- Here, $q_t$ is the price of capital

No positive interest (within period borrowing) and no risk premium (no aggregate investment risk)
CF: Supply of Capital

- Entrepreneur’s optimization:
  \[
  \max_{i_t} \int_{\omega_t}^{\infty} (\omega - \bar{\omega}_t) dG(\omega) \ i_t \ q_t
  \]
  Subject to HH breakeven constraint

- Linear investment rule \( i_t = \psi(q_t)n_t \)
  - Leverage \( \psi(q_t) \) is increasing in \( q_t \)

- Aggregate supply of capital is increasing in
  - Price of capital \( q_t \)
  - Aggregate net worth \( N_t \)
CF: Demand for Capital

- Return to holding capital:
  \[ R_{t+1}^k = \frac{A_{t+1}f'(K_{t+1}) + (1-\delta)q_{t+1}}{q_t} \]

- Risk averse HH have discount factor \( \beta \)
  - Standard utility maximization
  - Budget constraint:
    \[ c_t \leq A_t f'(K_t)k_t + q_t[(1-\delta)k_t - k_{t+1}] \]
  - Euler equation: \( u'(c_t) = \beta E_t[R_{t+1}^k u'(c_{t+1})] \)
CF: Demand for Capital

- Risk-neutral entrepreneurs are less patient, $\beta < \beta$
  - Euler equation: $1 = \beta E_t[R_{t+1}^{\kappa} \rho(q_t)]$
  - Return on internal funds:
    \[ \rho(q_t) \equiv \int_{\omega_t}^{\infty} (\omega - \bar{\omega}_t) dG(\omega) \psi(q_t) q_t \]
- Aggregate demand for capital is decreasing in $q_t$
CF: Persistence & Dampening

- Negative shock in period $t$ decreases $N_t$
  - This increases financial friction and decreases $I_t$
- Decrease in capital supply leads to
  - Lower capital: $K_{t+1}$
  - Lower output: $Y_{t+1}$
  - Lower net worth: $N_{t+1}$
  - Feedback effects in future periods $t + 2, \ldots$
- Decrease in capital supply also leads to
  - Increased price of capital $q_t$
  - Dampening effect on propagation of net worth shock
Bernanke, Gertler and Gilchrist (1999) introduce *technological illiquidity* in the form of nonlinear adjustment costs to capital.

- Negative shock in period $t$ decreases $N_t$
  - This increases financial friction and decreases $I_t$

- In contrast to the dampening mechanism present in CF, decrease in capital supply leads to
  - Decreased price of capital due to adjustment costs
  - *Amplification* effect on propagation of net worth shock
BGG assume separate investment sector
- This separates entrepreneurs’ capital decisions from adjustment costs

\( \Phi(\cdot) \) represents *technological illiquidity*
- Increasing and concave with \( \Phi(0) = 0 \)
- \( K_{t+1} = \Phi \left( \frac{I_t}{K_t} \right) K_t + (1 - \delta)K_t \)

FOC of investment sector
- \( \max_{I_t} \{ q_t K_{t+1} - I_t \} \Rightarrow q_t = \Phi' \left( \frac{I_t}{K_t} \right)^{-1} \)

*jump to KM97*
Entrepreneurs alone can hold capital used in production

At time $t$, entrepreneurs purchase capital for $t + 1$

- To purchase $k_{t+1}$, an entrepreneur borrows $q_t k_{t+1} - n_t$
- Here, $n_t$ represents entrepreneur net worth

Assume gross return to capital is given by $\omega R_{t+1}^k$

- Here $\omega \sim G$ with $E[\omega] = 1$ and $\omega$ i.i.d.
- $R_{t+1}^k$ is the endogenous aggregate equilibrium return
Entrepreneurs borrow from HH in a CSV framework.

If $R_{t+1}^k$ is deterministic, then threshold satisfies:

$$\left[(1 - \mu) \int_0^{\bar{\omega}} \omega dG(\omega) + (1 - G(\bar{\omega}))\bar{\omega}\right] R_{t+1}^k q_t k_{t+1} = R_{t+1}(q_t k_{t+1} - n_t)$$

Here, $R_{t+1}$ is the risk-free rate and $\mu \omega$ the verification cost.

If there is aggregate risk in $R_{t+1}^k$ then BGG argue that entrepreneurs will insure HH against risk.

This amounts to setting $\bar{\omega}$ as a function of $R_{t+1}^k$.

As in CF, HH perfectly diversify against entrepreneur idiosyncratic risk.
Entrepreneurs solve the following problem:

\[ \max_{k_{t+1}} E \left[ \int_{\bar{\omega}}^{\infty} (\omega - \bar{\omega}) dG(\omega) \right. \]
\[ \left. R_{t+1}^k q_t k_{t+1} \right] \]

- Subject to HH breakeven condition (state-by-state)

Optimal leverage is again given by a linear rule

\[ q_t k_{t+1} = \psi \left( \frac{E[R_{t+1}^k]}{R_{t+1}} \right) n_t \]

- In a log-linearized solution, the remaining moments are insignificant

Aggregate capital supply is increasing in \( E[R_{t+1}^k] \) and aggregate net worth \( N_t \)
BGG: Demand for Capital

- Return on capital is determined in a general equilibrium framework
  - Gross return to holding a unit of capital
    
    
    \[
    E[R_{t+1}^k] = E \left[ \frac{A_{t+1}f'(K_{t+1}) + q_{t+1}(1-\delta) + q_{t+1}\Phi(I_{t+1}/K_{t+1}) - I_{t+1}/K_{t+1}}{q_t} \right]
    \]

- Capital demand is decreasing in expected return

\[
E[R_{t+1}^k]
\]
Shocks to net worth $N_t$ are persistent
  - They affect capital holdings, and thus $N_{t+1}$, ...

*Technological illiquidity* introduces amplification effect
  - Decrease in capital leads to reduced price of capital from
    \[ q_t = \Phi' \left( \frac{I_t}{K_t} \right)^{-1} \]
  - Lower price of capital further decreases net worth
Kiyotaki & Moore 97

- Kiyotaki, Moore (1997) adopt a
  - collateral constraint instead of CSV
  - *market illiquidity* – second best use of capital
- Output is produced in two sectors, differ in productivity
- Aggregate capital is fixed, resulting in extreme 
  *technological illiquidity*
  - Investment is completely irreversible
- Durable asset has two roles:
  - Collateral for borrowing
  - Input for production
KM: Amplification

- **Static** amplification occurs because fire-sales of capital from productive sector to less productive sector depress asset prices
  - Importance of *market liquidity* of physical capital
- **Dynamic** amplification occurs because a temporary shock translates into a persistent decline in output and asset prices
Two types of infinitely-lived risk neutral agents

Mass $\eta$ of productive agents

- Constant-returns-to-scale production technology yielding $y_{t+1} = ak_t$
- Discount factor $\beta < 1$

Mass $1 - \eta$ of less productive agents

- Decreasing-returns-to-scale production $y_{t+1} = F(k_t)$
- Discount factor $\beta \in (\beta, 1)$
KM: Frictions

- Since productive agents are less patient, they will want to borrow $b_t$ from less productive agents
  - However, friction arises in that each productive agent’s technology requires *his* individual human capital
  - Productive agents cannot pre-commit human capital
- This results in a collateral constraint
  \[ Rb_t \leq q_{t+1}k_t \]
  - Productive agent will never repay more than the value of his asset holdings, i.e. collateral
Since there is no uncertainty, a productive agent will borrow the maximum quantity and will not consume any of the output

- Budget constraint: \( q_t k_t - b_t \leq (a + q_t)k_{t-1} - Rb_{t-1} \)
- Demand for assets: \( k_t = \frac{1}{q_t} \left[ (a + q_t)k_{t-1} - Rb_{t-1} \right] \)

Unproductive agents are not borrowing constrained

- \( R = \beta^{-1} \) and asset demand is set by equating margins
- Demand for assets: \( R = \frac{F'(k_t) + q_{t+1}}{q_t} \)

Rewritten to \( \frac{1}{R} F'(k_t) = q_t - \frac{1}{R} q_{t+1} \)
KM: Equilibrium

- With fixed supply of capital, market clearing requires $\eta K_t + (1 - \eta)K_t = \bar{K}$
  - This implies $M(K_t) \equiv \frac{1}{R} F' \left( \frac{\bar{K} - \eta K_t}{1 - \eta} \right) = q_t - \frac{1}{R} q_{t+1}$
  - Note that $M(\cdot)$ is increasing
- Iterating forward, we obtain: $q_t = \sum_{s=0}^{\infty} \frac{1}{R^s} M(K_{t+s})$
In steady state, productive agents use tradable output $a$ to pay interest on borrowing:

This implies that steady state price $q^*$ must satisfy:

$$q^* - \frac{1}{R} q^* = a$$

Further, steady state capital $K^*$ must satisfy:

$$\frac{1}{R} F' \left( \frac{\bar{K} - \eta K^*}{1-\eta} \right) = a$$

This reflects inefficiency since marginal products correspond only to *tradable* output.
KM: Productivity Shock

- Log-linearized deviations around steady state:
  - Unexpected one-time shock that reduces production of all agents by factor $1 - \Delta$

- % change in assets for given change in asset price:
  - $\Delta\hat{K}_t = -\frac{\xi}{1+\xi} \left(\Delta + \frac{R}{R-1} \hat{q}_t\right)$, $\Delta\hat{K}_{t+s} = \frac{\xi}{1+\xi} \Delta\hat{K}_{t+s-1}$
  - $\frac{1}{\xi} = \frac{d \log M(K)}{d \log K} \bigg|_{K=K^*}$ (elasticity)

- Reduction in assets comes from two shocks:
  - Lost output $\Delta$
  - Capital losses on previous assets $\frac{R}{R-1} \hat{q}_t$, amplified by leverage
  - $\frac{\xi}{1+\xi}$ terms dampens effect since asset can reallocated
KM: Productivity Shock

- Change in price for given change in assets:
  - Log-linearize the equation $q_t = \sum_{s=0}^{\infty} \frac{1}{R^s} M(K_{t+s})$
  - This provides: $\hat{q}_t = \frac{1}{\xi} \frac{R-1}{R} \sum_{s=0}^{\infty} \frac{1}{R^s} \hat{K}_{t+s}$

- Combining equations:

<table>
<thead>
<tr>
<th>Multiplier</th>
<th>static</th>
<th>dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{K}_t =$</td>
<td>$-\Delta$</td>
<td>$-\frac{1}{(\xi + 1)(R - 1)} \Delta$</td>
</tr>
<tr>
<td>$\hat{q}_t =$</td>
<td>$-\frac{(R - 1)}{R} \frac{1}{\xi} \Delta$</td>
<td>$-\frac{1}{R \xi} \Delta$</td>
</tr>
</tbody>
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- Static effect results from assuming $q_{t+1} = q^*$
BruSan10: Instability & Non-Linear Effects

- Previous papers only considered log-linearized solutions around steady state
- Brunnermeier & Sannikov (2010) build a continuous time model to study full dynamics
  - Show that financial system exhibits inherent instability due to highly non-linear effects
  - These effects are asymmetric and only arise in the downturn
- Agents choose a *capital cushion*
  - Mitigates moderate shocks near steady state
  - High volatility away from steady state
1. **Net worth effects:**
   a. Persistence: Carlstrom & Fuerst
   b. Amplification: Bernanke, Gertler & Gilchrist
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2. **Volatility effects:** impact credit quantity constraints
   a. Margin spirals: Brunnermeier & Pederson
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3. **Demand for liquid assets & Bubbles** – “self insurance”
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4. **Financial intermediaries & Theory of Money**
Credit Rationing – Quantity Rationing

Credit rationing refers to a failure of market clearing in credit
- In particular, an excess demand for credit that fails to increase market interest rate
- Pool of loan applicants worsens
- Stiglitz & Weiss (1981) show how asymmetric information on risk can lead to credit rationing
Entrepreneurs borrow from competitive lenders at interest rate $r$
- Risky investment projects with $R \sim G(\cdot |\sigma_i)$
- Mean preserving spreads, so heterogeneity is only in risk

Assume entrepreneur borrows $B$

Entrepreneur’s payoff is convex in $R$
- $\pi_e(R, r) = \max\{R - (1 + r)B, 0\}$

Lender’s payoff is concave in $R$
- $\pi_l(R, r) = \min\{R, (1 + r)B\}$
Due to convexity, entrepreneur’s expected payoff is increasing in riskiness $\sigma_i$

- Only entrepreneurs with sufficiently risky projects will apply for loans, i.e. $\sigma_i \geq \sigma^*$

Zero-profit condition: $\int \pi_e(R, r) dG(R | \sigma^*) = 0$

- This determines cutoff $\sigma^*$
- Note that $\sigma^*$ is increasing in $r$

Lender’s payoff is not monotonic in $r$

- Ex-post payoff is increasing in $r$
- Higher cutoff $\sigma^*$ leads to riskier selection of borrowers
SW: Credit Rationing

- Lenders will only lend at the profit maximizing interest rate $r$
- Excess demand for funds from borrowers will not increase the market rate
  - There exist entrepreneurs who would like to borrow, willing to pay a rate higher than the prevailing one
- Adverse selection leads to failure of credit markets
For collateralized lending, debt constraints are directly linked to the volatility of collateral

- Constraints are more binding in volatile environments
- Feedback effect between volatility and constraints

These margin spirals force agents to delever in times of crisis

- Collateral runs
- Counterparty bank run
- Multiple equilibria
BP: Margins – Value at Risk (VaR)

- How are margins set by brokers/exchanges?
  - Value at Risk: \( \Pr(-(p_{t+1} - p_t) \geq m) = 1\% = \pi \)
BP: Leverage and Margins

- Financing a *long position* of $x_{jt}^+ > 0$ shares at price $p_{jt}=100$:
  - Borrow $90$ dollar per share;
  - Margin/haircut: $m_{jt}^+ = 100 - 90 = 10$
  - Capital use: $10 \times x_{jt}^+$

- Financing a *short position* of $x_{jt}^- > 0$ shares:
  - Borrow securities, and lend collateral of 110 dollar per share
  - Short-sell securities at price of 100
  - Margin/haircut: $m_{jt}^- = 110 - 100 = 10$
  - Capital use: $10 \times x_{jt}^-$

- Positions frequently marked to market
  - payment of $x_{jt}(p_{jt} - p_{j,t-1})$ plus interest
  - margins potentially adjusted – *more later on this*

- Margins/haircuts must be financed with capital:

\[
\sum_j (x_{jt}^+ m_{jt}^+ + x_{jt}^- m_{jt}^-) \leq W_t, \text{ where } x_j = x_{jt}^+ - x_{jt}^-
\]

- with perfect cross-margining: $M_t (x_{t,1}, \ldots, x_{t,J}) \leq W_t$
BP: Liquidity Spirals

- Borrowers’ balance sheet
  - Loss spiral – net worth drops
    - Net wealth > $\alpha \times$
      for asym. info reasons
    - constant or increasing leverage ratio
  - Margin/haircut spiral
    - Higher margins/haircuts
    - No rollover
    - redemptions
    - forces to delever

- Mark-to-market vs. mark-to-model
  - worsens loss spiral
  - improves margin spiral

• Both spirals reinforce each other
BP: Margin Spiral – Increased Volatility

\[ v_t = v_{t-1} + \Delta v_t = v_{t-1} + \sigma_t \varepsilon_t \]
\[ \sigma_{t+1} = \sigma + \theta |\Delta v_t| \]

- Selling pressure
  - initial customers

- complementary customers
BP: Margin Spirals - Intuition

1. Volatility of collateral increases
   - Permanent price shock is accompanied by higher future volatility (e.g. ARCH)
     - Realization how difficult it is to value structured products
   - Value-at-Risk shoots up
   - Margins/haircuts increase = collateral value declines
   - Funding liquidity dries up
   - Note: all “expert buyers” are hit at the same time, SV 92

2. Adverse selection of collateral
   - As margins/ABCP rate increase, selection of collateral worsens
   - SIVs sell-off high quality assets first (empirical evidence)
   - Remaining collateral is of worse quality
BP: Model Setup

- **Time:** $t=0,1,2$
- **Asset with final asset payoff $v$ follows ARCH process**
  - $v_t = v_{t-1} + \Delta v_t = v_{t-1} + \sigma_t \varepsilon_t$, where $v_t := E_t[v]$
  - $\sigma_{t+1} = \sigma + \theta |\Delta v_t|$
- **Market illiquidity measure:** $\Lambda_t = |v_t - p_t|$
- **Agents:**
  - *Initial customers* with supply $S(z, v_t - p_t)$ at $t=1,2$
  - *Complementary customers’ demand* $D(z, v_2 - p_2)$ at $t=2$
  - *Risk-neutral dealers* provide immediacy and
    - face capital constraint: $xm(\sigma, \Lambda) \leq W(\Lambda) := \max\{0, B + x_0(E[v_1] - \Lambda)\}$
  - *Financiers* set margins
    - cash “price” of stock holding
BP: Financiers’ Margin Setting

- Margins are set based on Value-at-Risk
- *Financiers* do not know whether price move is due to
  - *Likely*, movement in fundamental (based on ARCH process)
  - *Rare*, Selling/buying pressure by customers who suffered asynchronous endowment shocks.

\[ m_1^+ = \Phi^{-1}(1 - \pi)\sigma_2 = \bar{\sigma} + \bar{\theta} |\Delta p_1| = m_1^- \]

Recall \( \sigma_{t+1} = \sigma + \theta |\Delta v_t| \)
BP: Margin Spiral – Increased Volatility

$$v_t = v_{t-1} + \Delta v_t = v_{t-1} + \sigma_t \epsilon_t$$

$$\sigma_{t+1} = \sigma + \theta |\Delta v_t|$$

Selling pressure initial customers
complementary customers
1. Margin Spiral – Increased Volatility

\[ x_1 < \frac{W_1}{m_1} = \frac{W_1}{\bar{\sigma} + \bar{\theta} |\Delta p_1|} \]

\[ \gamma = 0.01 \quad \sigma^2 = 16 \quad \beta_0 = 20 \quad \beta_1 = 20 \quad \beta_0 = 140 \quad \beta_1 = 120 \]

\[ p_0 = 130 \quad k = 10 \quad \delta = 0.3 \quad \eta_1 = 0 \quad W_0 = 700 \quad x_0 = 0 \]
1. Margin Spiral – Increased Volatility

\[
x_1 < \frac{W_1}{m_1} = \frac{W_1}{\bar{\sigma} + \bar{\theta}|\Delta p_1|}
\]

\[
\gamma = 0.025 \quad \sigma^2 = 11 \quad z_0 = 20 \quad z_1 = 20 \quad \nu_0 = 140 \quad \nu_1 = 120
\]

\[
p_0 = 130 \quad k = 5 \quad \vartheta = 0.3 \quad \eta_1 = 0 \quad W_0 = 750 \quad x_0 = 0
\]

customers’ supply
1. Margin Spiral – Increased Volatility

\[ x_1 < \frac{W_1}{m_1} = \frac{W_1}{\bar{\sigma} + \bar{\theta} |\Delta p_1|} \]

\[
g = 0.025 \quad \sigma^2 = 11 \quad z_0 = 20 \quad z_1 = 20 \quad \nu_0 = 140 \quad \nu_1 = 120 \]
\[
p_0 = 130 \quad k = 5 \quad \theta = 0.3 \quad \eta_1 = 0 \quad W_0 = 600 \quad x_0 = 0 \]
Data Gorton and Metrick (2011)

Haircut Index

“The Run on Repo”
Margins **stable** in tri-party repo market
- contrasts Gorton and Metrick
- no general run on certain collateral

**Run (non-renewed financing) only on select counterparties**
- Bear Stearns (anecdotally)
- Lehman (in the data)

Like 100% haircut...
*(counterparty specific!)*
Bilateral and Tri-party Haircuts?

Differences in Median Haircuts

Source: FRBNY Calculations
BP: Multiple Assets

- Dealer maximizes expected profit per capital use
  - Expected profit: \( E_{1}[v^j] - p^j = \Lambda^j \)
  - Capital use: \( m^j \)

- Dealers
  - Invest only in securities with highest ratio \( \Lambda^j/m^j \)

- Hence, illiquidity/margin ratio \( \Lambda^j/m^j \) is constant
BP: Commonality & Flight to Quality

- **Commonality**
  - Since funding liquidity is driving common factor

- **Flight to Quality**
  - Quality=Liquidity
    - Assets with lower fund vol. have better liquidity
  - Flight
    - Liquidity differential widens when funding liquidity becomes tight
BP: Flight to Quality

$m^2 = \text{Volatility of Security}_2 = 2 > 1 = \text{Volatility of Security}_1 = m^1$

$\gamma = 0.015 \quad z_0 = 20 \quad z_1 = 20 \quad \nu_0 = 140 \quad \nu_1 = 120$

$\rho_0 = 130 \quad \sigma_1 = 10 \quad \sigma_2 = 15 \quad \omega = 0.3 \quad \eta_1 = 2000 \quad x_0 = 0$
Overview

1. Net worth effects:
   a. Persistence: Carlstrom & Fuerst
   b. Amplification: Bernanke, Gertler & Gilchrist
   c. Instability: Brunnermeier & Sannikov

2. Volatility effects: Credit quantity constraints
   a. Margin spirals: Brunnermeier & Pederson
   b. Endogenous constraints: Geanakoplos

3. Demand for liquid assets & Bubbles – “self insurance”
   a. OLG, Aiyagari, Bewley, Krusell-Smith, Holmstrom Tirole,…

4. Financial intermediaries & Theory of Money