Definition of Systemic risk

- 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
Imbalances and Amplification

- Trigger versus amplification
  - Trigger varies from crisis to crisis and difficult to nail down
  - Amplification effects are similar from crisis to crisis

- Amplification and indirect spillover effects are due to liquidity problems
  - Depends on endogenous response
    - Depends on expectations/beliefs
    - There is hope: “driven by constraints” (rather than maximization)
  - Focus on endogenous response indicator $\rightarrow$ LMI

- General equilibrium phenomenon
  - Risk managers have partial equilibrium perspective
  - Split task

- Shadow banking vs. regulated sector

position data needed for direct spillover effects
Data collection (macro-prudential)

1. Partial equilibrium response to (orthogonal) stress factors
   - In value \( \Delta \text{Value} \)
   - In liquidity mismatch index \( \Delta \text{LMI} \)

   - Collect long-run panel data set!

2. General equilibrium effects
   - Amplification, persistence

   - ... reaction function

   - financial industry

   - macro-prudential regulators
General equilibrium

- **Direct** responses to 5%, 10%, 15%,... drop in factor to
  - ΔValue
  - ΔLiquidity Mismatch Index
- **Predict response**
  - hold out - “fire” sell assets - credit crunch
- **Derive likely indirect** equilibrium response to
  - this stress factor
  - other factors

Find out whether plans were mutually consistent!
(if not → tail risk)
### Liquidity Mismatch Index (LMI)

<table>
<thead>
<tr>
<th>A</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Market liquidity</strong></td>
<td><strong>Funding liquidity</strong></td>
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<tr>
<td>- Can only sell assets at <strong>fire-sale prices</strong></td>
<td>- Can’t <strong>roll over</strong> short term debt</td>
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<tr>
<td>Ease with which one can raise money by <strong>selling</strong> the asset</td>
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**Maturity mismatch**

Brunnermeier, Gorton, Krishnamurthy
Liquidity Mismatch Index (LMI)

Market liquidity
- Can only sell assets at fire-sale prices

Ease with which one can raise money by selling the asset

Funding liquidity
- Can’t roll over short term debt
- Margin-funding is recalled

Ease with which one can raise money by borrowing using the asset as collateral

Liquidity Mismatch Index = liquidity of assets minus liquidity promised through liabilities

Brunnermeier, Gorton, Krishnamurthy
## Liquidity Mismatch Index (LMI)

<table>
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<tr>
<th>Market liquidity</th>
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<tr>
<td>Treasuries/cash: ( \lambda = 1 )</td>
<td>Overnight debt: ( \lambda = 1 )</td>
</tr>
<tr>
<td>Overnight repo: ( \lambda = .99 )</td>
<td>Long-term debt: ( \lambda = .50 )</td>
</tr>
<tr>
<td>Agency MBS: ( \lambda = .95 )</td>
<td>Equity: ( \lambda = .10 )</td>
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<tr>
<td>Private-label MBS: ( \lambda = .90 )</td>
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**Liquidity Mismatch Index** = liquidity of assets \text{ minus } liquidity promised through liabilities

Basel 3: Net Stable Funding Ratio, Liquidity Coverage Ratios implicitly assign some \( \lambda \) weights
Liquidity Risk

- $\{\lambda^\omega\}$ for different macro states $\omega$
- Firm (or sector) liquidity risk:
  - the vector $\{\text{LMI}^\omega\}$ - LMI for each state $\omega$
- $\{\text{LMI}^\omega\}$ is the liquidity risk taken by the firm
  - Portfolio decision at date 0 is over assets/liabilities
  - Asset/liability choices + realization of uncertainty result in $\{\text{LMI}^\omega\}$
- $\Delta^{\text{LMI}}$ along different risk factors

Brunnermeier, Gorton, Krishnamurthy
Example 1: Liquidity Mismatch

- *LMI places a larger weight on repo debt than Agency MBS*
- *This bank’s LMI* < 0

<table>
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<th>Liabilities</th>
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<tr>
<td>$50 1-Year Loan</td>
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<td>$30 5-Year debt</td>
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Brunnermeier, Gorton, Krishnamurthy
Example 1: Liquidity Mismatch

- The asset-side is less liquid (lower liquidity weight)
- LMI is more negative

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Brunnermeier, Gorton, Krishnamurthy
Example 2: Rehypothecation

- Dealer lends $90 to a hedge fund against $90 of MBS collateral in an overnight repo
- Dealer posts $90 of MBS collateral to money market fund and borrows $90 in an overnight repo

<table>
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<tr>
<td>$10 Treasuries</td>
<td>$10 Equity</td>
</tr>
<tr>
<td>$90 Loan to Hedge Fund</td>
<td>$90 of Repo Debt</td>
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- \( LMI > 0 \) because of Treasury holdings
- **What if hedge fund loan was 10 days?** \( LMI \) falls...
Example 3: Credit Lines

- Bank with $20 of equity and $80 of debt
- The bank buys $100 of U.S. Treasuries
- Offers a credit line to a firm to access up to $100.
- $LMI < 0$ in state(s) $\omega \in \Omega$ where credit line is accessed.
Example 4: Derivatives

- Bank with $20 of equity and $80 of debt
- The bank buys $100 of U.S. Treasuries
- Writes protection on a diversified portfolio of 100 investment-grade U.S. corporates, each with a notional amount of $10; so there is a total notional of $1,000.
- $LMI < 0$ in state(s) $\omega \in \Omega$ where CDS causes a mark-to-market
Liquidity Pockets

- Sectorial LMI
  - Guess: Banking sector is net short liquidity
    - But, to whom, how much, etc.
    - LMI of shadow banking
  - Guess: Corporate, household sectors are long liquidity

- 2000 to 2008 build up
  - Guess: Aggregate liquidity rises (good), but LMI for financial sector is more negative (bad)

- Identify systemically important institutions
  - LMI<0 identifies “financial intermediary”
  - Lowest LMIs are the systemically important ones

- Liquidity chains
  - Asymmetric asset vs. liability $\lambda$
Liquidity Chains

- Baseline case: Symmetric weights \( \{\lambda\} \)
  - i.e. Asset weights \( \{\lambda\} \) match liability weights \( \{\lambda\} \)

- Consider asymmetric case:
  - Bank A owns $100 short-term repo issued by bank B:
    - Asset weight = 0.95
  - Bank B issues $100 short-term repo:
    - Liability weight = 1

- Measurement: liquidity chains (A owes to B owes to C...) causes a contraction in aggregate liquidity
Stress Testing

- Define $\Lambda = \{\lambda\}$
- Consider stress scenarios as specifying $\Lambda^\omega$
  - Move all $\{\lambda\}$ in a percentage shift
  - Move all $\lambda$s of MBS in a percentage shift
  - Move all $\lambda$s of long-term assets in a percentage shift
- Measurement: Identify states of the world where imbalances are high
Liquidity Risk

- \{\text{LMI}^\omega\} is the *liquidity risk* taken by the firm
  - Portfolio decision at date 0 is over assets/liabilities
  - Asset/liability choices result in \{\text{LMI}^\omega\}

- Research: Given a time series of \{\text{LMI}^\omega\}, we can build empirical models of firm liquidity choices.
  - Analogy: We use the CEX to model household spending behavior and test asset pricing models.

Brunnermeier, Gorton, Krishnamurthy
Example 5: Spillovers

- Many identical banks: $20 equity, $80 debt
- Debt is $40 overnight repo, $50 of 5-year debt.
- Each bank owns $40 of private-MBS, $40 of repo loans (at 0% haircut) to other banks
- Liquidity management: Bank has liquidity to cover losses if MBS prices fall by 5%, but if they fall by more, the bank will not renew its repo loans/raise repo haircuts.

Issue: Liquidity management in general equilibrium
In addition, to liquidity, let use measure value (equity or enterprise value) of firm(s) in each state.

Data presents a history of “date 0”s in varying conditions.

- Each date is a portfolio choice, $\Delta$, as a function of current firm value/liquidity and current state of economy.
- Panel data
- Estimate/model the portfolio choice of firms.
In sum...

- Risk Topography – 2 step approach
  - 100 factor exposure
    - Value
    - LMI response indicator
  - General equilibrium amplification
- Liquidity Mismatch replaces Maturity Mismatch
  - Also captures derivatives