Risk Topography

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Objective

- Tools and data needed for assessing systemic risk
- Supervisory efforts currently underway
  - Fed stress tests (SCAP)
  - Proposed Office of Financial Research (OFR)
    - What data should be collected?

Defining Systemic Risk

- Systemic risk builds-up in a period of low volatility
- Materializes when negative shock hits susceptible financial sector balance sheets
- Spillovers
  - Direct contractual: domino effect (interconnectedness)
  - Indirect: price effect, credit crunch, liquidity hoarding, haircut/margin increases
  - System wide dislocations due to collection partial equilibrium responses
  - Unknown risk pockets/concentrations, crowded trades
  - Endogenous multiplier effects
    - Externalities, multiple equilibria, disequilibrium, ...

Defining Systemic Risk

- Systemic risk describes a possible adverse general equilibrium response of the financial system to a shock

- What data do we need to diagnose when the financial system is susceptible to adverse feedback loops?

Outline

1. Motivating examples
   - Reported data offers poor proxies for risk and liquidity.
   - Systemic risk is about a general-equilibrium feedback.
2. Risk topography
3. Uses of data to manage systemic risk
   - Regulatory use
   - Private sector use in risk management
4. Comparisons

Example 1: Liquidity Mismatch

- Bank with $20 of equity and $80 of debt
- Debt: $50 of overnight repo financing; rest is 5-year debt.
- The bank buys one Agency mortgage-backed security for $50 (which is financed via repo at a 0% haircut)
- Loans $50 to a firm for one year.

Example 1: Liquidity Mismatch

Assets	Liabilities
$50 1-Year Loan	$20 Equity
$50 Agency-MBS	$50 Repo debt
	$30 5-Year debt

- *Liquidity risk: What if the firm cannot renew financing?*
- *Leverage is a crude measure…*

Example 1: Liquidity Mismatch

Assets	Liabilities
$50 1-Year Loan	$20 Equity
~~$50 Agency-MBS~~	$50 Repo debt
$50 Private-Label-MBS	$30 5-Year debt

- *The asset-side is less liquid*
- *More liquidity mismatch in this example*

Example 2: Rehypothecation

- Dealer starts with $10 of equity, invested in $10 of Treasuries
  - Initially no leverage
- 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

Assets	Liabilities
$10 Treasuries	$10 Equity
$90 Loan to Hedge Fund	$90 of Repo Debt

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

Assets	Liabilities
$10 Treasuries	$10 Equity
$90 Loan to Hedge Fund	$90 of Repo Debt

- *Leverage = 9X*
- *But, little asset risk; little liquidity risk*
- *What if hedge fund loan was 10 days? Liquidity falls…*

Example 3: 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.
- *Risk measurement problem: Derivatives…*
- *Liquidity measurement problem: Dynamic collateral calls are a liquidity drain.*

Example 4: Crowded Trade

- Many identical banks: $20 equity, $80 debt
- Debt is overnight repo.
- Each bank owns $50 of private-MBS, $50 of Treasuries
- Risk management: Bank can withstand losses if MBS prices fall by 5%, but if they fall by more, the bank will sell MBS or hedge exposure in ABX.

- *Issue: Risk management in general equilibrium*

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: Risk and liquidity management in general equilibrium*

Summary

- Current reports (accounting, regulatory filings) are inadequate to measure liquidity mismatch and risk exposures.
- Data exists in important cases
  - Bank risk management
  - Regulatory stress tests
- Bank risk management is partial equilibrium; Systemic risk management is general equilibrium.

Two-step approach – the idea

Split into two subtasks

1. Partial equilibrium response to (orthogonal) stress factors
   a. In value (equity value, enterprise value)
   b. In liquidity index

   Financial Industry, Risk Managers

   - ***COLLECT LONG-RUN PANEL DATA SET!***

   - ... reaction function

2. General equilibrium effects
   - Amplification, multiple equilibria

   Regulators, Academics, Financial industry

Example

- Date 0: measurement date
- Date 1: Possible crisis. State $\omega \in \Omega$
- Firm i
  - (A)ssets: Securities/loans, derivatives, repo loans, cash
  - (L)iabilities: short-term debt, long-term debt, equity
- Measure **value** and **liquidity** of each firm in each possible state
  - Most theoretical analyses of feedback mechanisms map value (e.g., capital) and/or liquidity into decisions.

Two-Factor Example

- Focus on “risk factors” and “liquidity factors”
  - N possible date 1 real estate prices (risk factor)
  - M possible date 1 repo haircuts (liquidity factor)
  - States s = M X N matrix
- Elicit information on value and liquidity for orthogonal movements in each factor
- *Ideally, this measurement is as close to current risk management practice as possible*
- Plus select cross-factors

Value

- Value = A(s)
- Equity value = A(s) – L(s)
- Suppose real estate prices decline by 5%, 10%, 15%,...; suppose margins double, triple, ...

- Non-linear effects in choice of scenarios

Liquidity Mismatch Index (LMI)

A	L
Market liquidity	**Funding liquidity**
• Can only sell assets at **fire-sale prices**	▪ Can't **roll over** short term debt ▪ **Margin**-funding is recalled
Ease with which one can raise money by selling the asset	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

Liquidity Mismatch Index (LMI)

A	L
• Asset "liquidity weight": λ ○ Treasuries/cash: $\lambda = 1$ ○ Overnight repo: $\lambda = 1$ (or close to one) ○ Agency MBS: $\lambda = 0.95$ ○ Private-label MBS: $\lambda = 0.90$	• Liability "liquidity weight": λ ○ Overnight debt: $\lambda = 1$ ○ Long-term Debt: $\lambda = 0.5$ ○ Equity: $\lambda = 0.20$

LMI = liquidity of assets minus liquidity promised through liabilities

Basel 3: Net Stable Funding Ratio, Liquidity Coverage Ratios implicitly assign some λ weights

Modeling Response Function

- We want to know how a firm will respond to a shock that changes value and liquidity
  - Shed risk
  - Hoard liquidity
  - Raise financing

- Feedbacks when placed in general equilibrium

Data collected from firms

- Two pieces of information
  1. Capital and liquidity in each future stress scenario

  2. Measure of date 0 portfolio choice:
     - Δ(value,liquidity) with respect to each factor
     - How much risk exposure is the firm taking?
     - How much liquidity exposure is the firm taking?

Calibrating Response Function

- Data presents a history of "date 0"s in varying conditions
  - Each date is a portfolio choice, Δ, as a function of current firm value/liquidity and current state of economy
  - Panel data

- *Key feature of our approach: entire history is useful.*

General equilibrium modeling

- In each state we know direct responses to 5%, 10%, 15%,... drop in factor in terms
  - Value, Liquidity index
- Predict response function
  - Try to "fire" sell assets, hoard liquidity, credit crunch
- Derive likely indirect equilibrium response to
  - this stress factor
  - other factors

Externalities, multiple equilibria, amplification, mutually inconsistent plans,...

- *Competition among systemic risk models*

Choice of stress scenarios

- Issue 1: Need core data to form panel data set on which to calibrate response functions
  - Orthogonal stress scenarios on baseline set of factors
  - Repeated observations
- Issue 2: Much of the interest at any time t is on special cases
  - Correlated scenarios (cross-scenarios)
  - Tailored scenarios (e.g., Greek default)

- Need both …

Choice of stress scenarios

- Orthogonal scenarios
  - Market risk scenarios: Interest rate, credit spread, exchange rate, stock price, VIX, commodity prices, commercial and residential real estate
  - Liquidity risk scenarios: Haircut/margin spikes, can't issue debt/sell assets,...
  - Counterpart risk ...
- Cross-scenarios
  - Participants report on combination of factors that lead to worst outcome. Worst vector in ellipse.
  - Informs stress scenario in next round

Risk and Liquidity Pockets

- Risk measures aggregate across firms and sectors
  - What is sensitivity of a sector to a 10% fall in real estate prices?
  - Aggregate risk equals physical supply of risk
- Liquidity measures aggregate
  - Banking sector is net short liquidity
  - But, to whom, how much, etc.
  - Aggregated firm-level liquidity equals a “liquidity aggregate”
- Note: Measures designed to allow for some cross-checking, like Flow of Funds.

Data revelation – "financial stability report"

Transparency with delay

- Institutions react
  - Good..., but becomes more risk-taking
- Data react (form of Lucas critique)
  - Cross-checks are essential
- Idea:
  - Competition for best model among researchers in regulatory institutions, academia and financial industry
  - Improve models over time
    e.g. call reports helped to understand commercial banks

Externality Regulation

- Externality regulation
- Described systemic risk-states are once subject to underinsurance
  - E.g. Caballero-Krishnamurthy
- How much is optimal insurance?
- How can we implement optimum?

Other issues

- Horizontal cross-check across institutions
  - Compare valuation models
- Complexity/simplicity
  - Standardization – more correlation
  - Hiding risks
- Snapshots versus average (quarter/year end spikes)
- Close cooperation with Fed

Different approaches to data collection

1. "Catch-all approach"
   - X terabytes in each second – insurmountable task(?)
     - IT firms (like Google/IBM) apply search/network algorithm
   - Complexity
   - Ownership of asset and hence investor reaction matters
     - deep pocket vs. leveraged investor
2. Our 2-Step approach – Risk Topography
   - Motivation:
     - Make use of 1000s of highly trained risk managers in financial industry
     - Risk managers are not trained to assess GE effects
     - Systemic risk is about GE effects

Difference to repeated SCAP

- **Risk topography**
  - "Core stress factors" that don't change over time
  - Effect from tailored scenario
  - **Aim:** Describe GE feedback effects important in systemic risk
    - Create panel data to estimate GE effects
  - All financial institutions (including hedge funds, insurance companies, …)

- **Repeated SCAP**
  - Single interlinked stress scenario
  - Stress scenarios change over time
  - **Aim:** Partial equilibrium stress analysis at each point in time
  - Focus on main financial institutions

Data collection – existing data sets

- Existing data sets
  - Flow of funds – Copeland (1947, 1952)
    - Characterizes money flows within economy
  - Call reports – National Bank Act (1863), FDIC
  - SEC filings
- Problems
  - Not focused on systemic interactions (direct, price effects)
  - Old days: risky position was association w/ initial cash flow

    Nowadays: risky position is divorced from initial cash flow
  - Leverage is an outdated concept – risk sensitivities

Summary

- Risk taking and initial cash flows are divorced
  - Flow of funds, Call Reports, outdated
- 2 step approach
  - Partial equilibrium response to risk factors (sensitivities – delta + nonlinear effects)
  - Build up panel data set to estimate response functions
  - General equilibrium modeling (competing models)