



SYSTEMIC RISK MONITORING

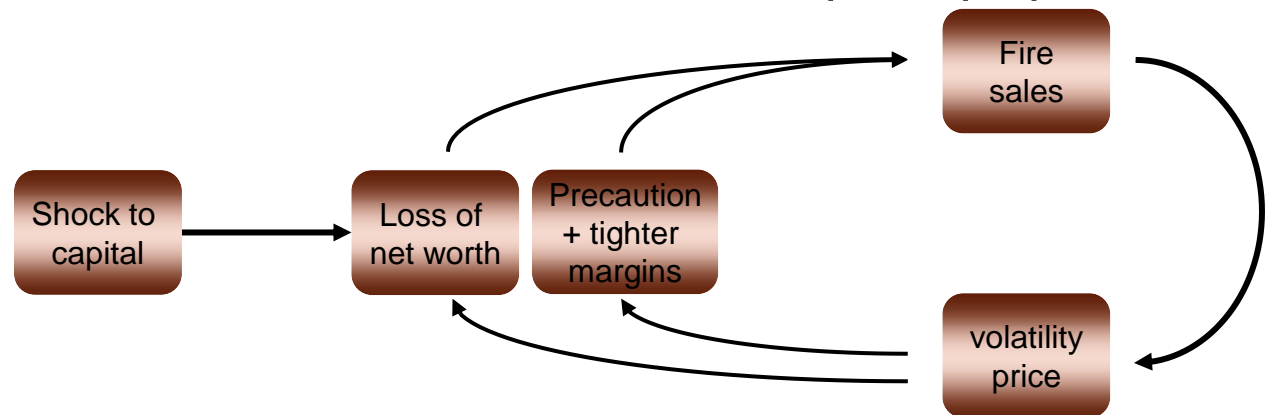
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- Chicago Fed – IMF conference -

Chicago, IL, Sept. 23rd, 2010

Definition of Systemic risk

- Systemic **risk build-up** during (credit) bubble ... and materializes in a crisis
 - contemporaneous measures are inappropriate
- Spillovers – **externalities**
 - Direct contractual: domino effect (interconnectedness)
 - Indirect: price effect (fire-sale externalities)
credit crunch, liquidity spirals, haircut



▫ *Adverse GE response* → **amplification, persistence**

Overview

- **Definition:** Systemic Risk
 - Risk build-up view
 - Spillovers – externalities – propagation
- **Data Collection** – “Risk Topography”
 - with *Gary Gorton* and *Arvind Krishnamurthy*
- Systemic Risk **Measurement** – “CoVaR”
 - with *Tobias Adrian*
- **Regulation:** Systemic Risk Charges

|| Data collection – “Risk topography”


- Existing data sets
 - Flow of funds – Copeland (1947, 1952), Fed
 - 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 - Leverage is an outdated concept → risk sensitivities

|| Data collection - different approaches

1. “Catch-all approach”

- X megabytes – insurmountable task(?)
 - IT firms (like Google/IBM) apply search/network algorithm
- Complexity
- Investor response is ignored
 - Owners: deep pocket vs. leveraged investor

2. Two-Step approach – Risk Topography

- *Brunnermeier-Gorton-Krishnamurthy* (work in progress)
 - Motivation:
 - Make use of 1000s of highly trained risk managers in financial industry
 - Risk managers are not trained to assess GE effects
-  **Reaction function** of investors matter (depends on funding structure)

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

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

- ... reaction function

2. General equilibrium effects

- Amplification, multiple equilibria

*Regulators,
Academics,
Financial industry*

|| Step 1: a) Value + liquidity sensitivity

- Suppose real estate prices decline by 5%, 10%, 15%,
 1. Direct “value sensitivity”
 - Risk sensitivity
 - Capture non-linear effects
(not only delta – partial derivative)
 2. Direct “liquidity sensitivity”
 - Helps to figure out reaction of various market participants

$\Delta(\text{value, liquidity})$ w.r.t. factors

|| Liquidity mismatch index (LMI)

A

L

Funding liquidity

- Can't **roll over** short term debt
- **Margin**-funding is recalled

Liquidity mismatch index (LMI)

A

L

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

Each asset has **two** values/prices

1. price
2. collateral value

Liquidity mismatch index (LMI)

A

L

Market liquidity

- Can only sell assets at **fire-sale prices**

- Measures
 - Not bid-ask spread/volatility
 - Price impact** in case of crisis (comovement with crisis)
 - “superliquid”** gold/Treasuries appreciate in times of crisis

Funding liquidity

- Can't **roll over** short term debt
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- Measures:
 - Not Haircut/margin
 - Haircut/margin increase** in case of crisis

Maturity mismatch



Liquidity mismatch index (LMI)

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Funding liquidity

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Liquidity
~~Maturity mismatch~~



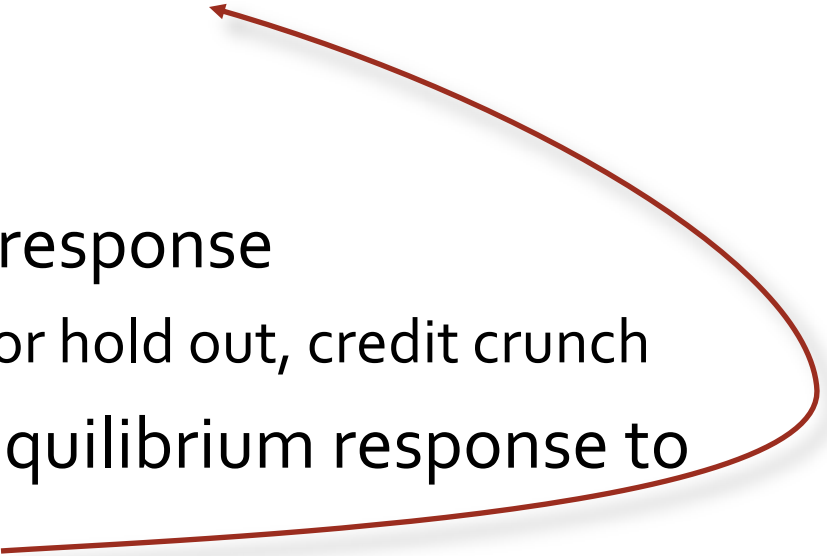
"Goldfield:" HF -> I-banks levered up, but no maturity mismatch (only CPR)

||| Calibrating 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
- To determine feedbacks, these responses need to be placed in a general equilibrium

Step 2: General equilibrium modeling

- **Direct** responses to 5%, 10%, 15%,... drop in factor to
 - Value
 - Liquidity index
 - Elicit/predict position response
 - Try to “fire” sell assets or hold out, credit crunch
 - Derive likely **indirect** equilibrium response to
 - this stress factor
 - other factors

Externalities, multiple equilibria, amplification, mutually inconsistent planes,...
 - Role of cross-scenarios – for nonlinear “cross effect”
- 

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, ...
 - Counterparty risk, ...
- Cross scenarios
 - Participants report on combination of factors that lead to worst outcome. "Worst vector in ellipse"
 - Informs stress scenario in next round

|| Difference to repeated SCAP

- Risk topography
 - Response to a list of factors
 - Core stress factors
 - “Core stress factors” don’t change over time
 - **Aim:** create **panel data**
 - Future research for GE effects
 - All financial institutions (including hedge funds, insurance companies, ...)
- Repeated SCAP
 - Response to a single stress scenario
 - Interlinked stress scenario
 - Stress scenarios change over time
 - **Aim:** best stress analysis at each **point in time**
 - Focus on main financial institutions

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3. Systemic Risk Measurement

- **Issue 1:** procyclicality – “build-up view of risk”

- Contemporaneous risk measures are not reliable
- Rely on other variables

not at high frequency

- **Issue 2:** externalities – spillover effects

- **CoVaR method**

only indirect

$$\text{CoVaR} = f(\text{frequently observed } X_{t-\tau})$$

(1986-2009)

- Drivers: in cross section: maturity mismatch, leverage, credit
in time-series: macrovariables, credit growth, VIX,
risk sensitivities w.r.t. stress factors

- What is the **optimal mix** weight one should put on each driver?
e.g. tradeoff between size and leverage (capital ratio)

Predictive regressions

3. Definition: CoVaR

- VaR_q^i is implicitly defined as quantile

$$\Pr(X^i \leq VaR_q^i) = q$$

- $CoVaR_q^{j|i}$ is the VaR_q^j conditional on institute i (index) being in distress (i.e., at its VaR level)

$$\Pr(X^j \leq CoVaR_q^{j|i} \mid \underbrace{X^i = VaR_q^i}_{\text{q-prob. event}}) = q$$

- $\Delta CoVaR_q^{j|i} = CoVaR_q^{j|i} - VaR_q^j |_{\text{normal times}}$ q-prob. event

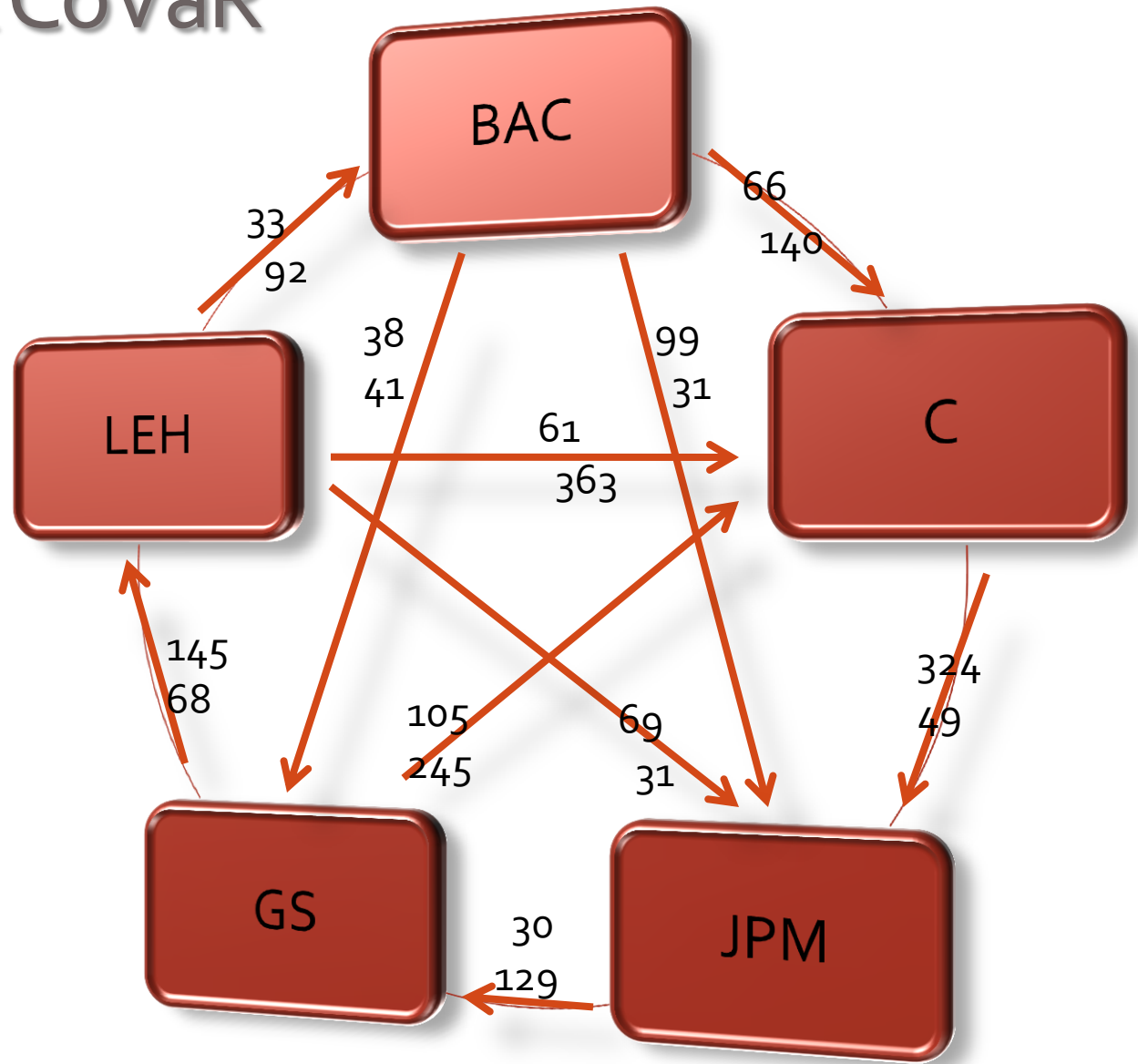
- Various conditionings? (direction matters!)



$\Delta CoVaR$

- **Q1:** Which institutions move system (in a non-causal sense)
- $VaR^{\text{system}} |$ institution i in distress
- **Exposure $\Delta CoVaR$**
 - **Q2:** Which institutions are most exposed if there is a systemic crisis?
 - $VaR^i |$ system in distress
- **Network $\Delta CoVaR$**
 - VaR of institution j conditional on i in non-causal sense!
- **Asset by asset $\Delta CoVaR$**

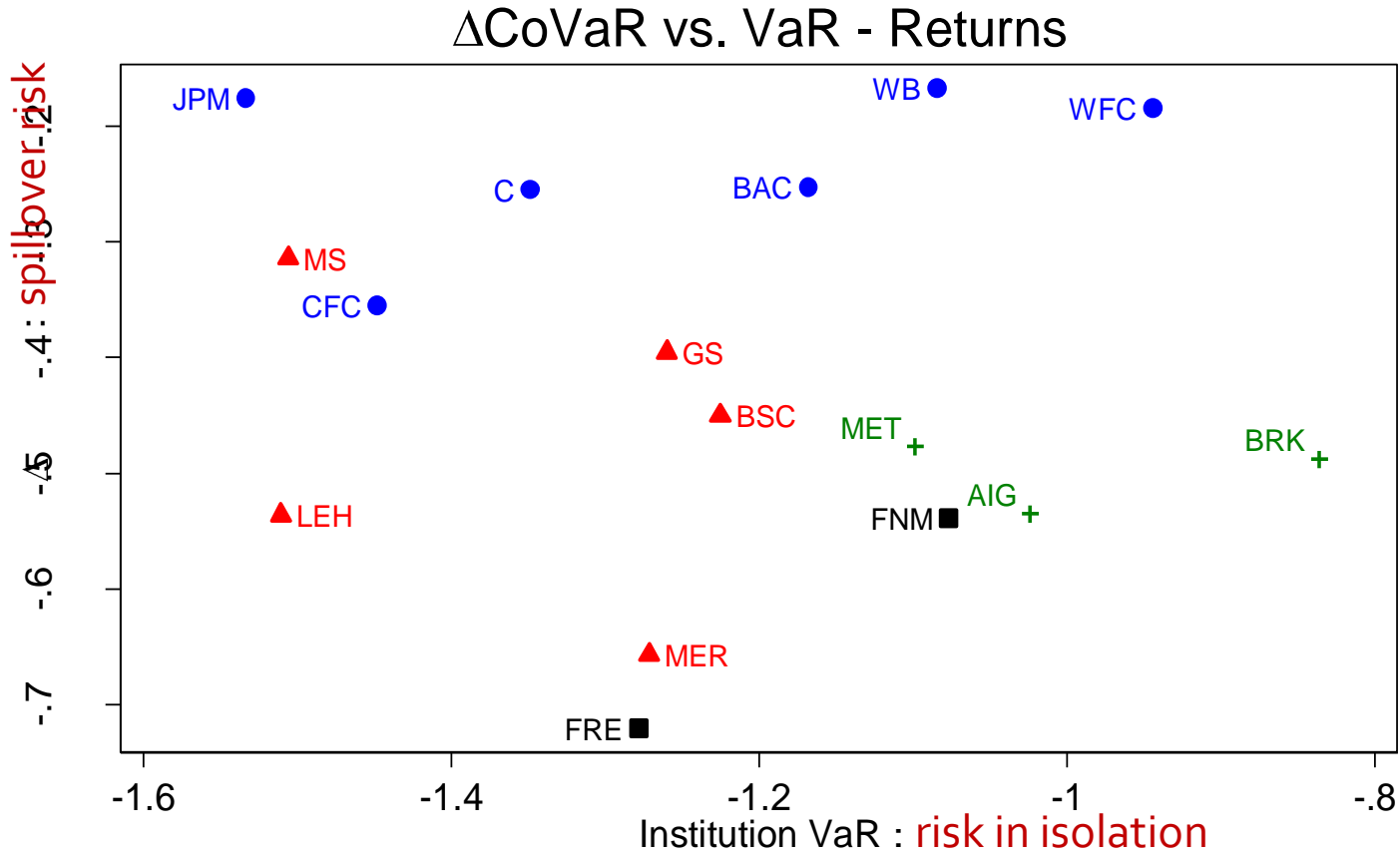
3. Network CoVaR



- conditional on origin of arrow



3. Δ CoVaR and VaR in cross-section



VaR does not capture systemic risk contribution

Δ CoVaR_{contri}

Data up to 2006/12



ΔCoVaR Forecasts: 1-Year Horizon (Table 3B)

COEFFICIENT	1%	5%	10%
VaR (lagged)	0.041***	0.073***	0.073***
Leverage (lagged)	-0.132***	-0.141***	-0.077***
Maturity mismatch (lagged)	-13.319***	-7.921***	-5.281***
Relative size (lagged)	-5.961***	-2.800***	-2.079***
2-year asset growth (lagged)	-0.249	-0.285***	-0.198***
Foreign	-4.004**	-0.821	-0.530
Investment Bank FE	2.911***	7.982***	5.925***
Insurance Company FE	-14.081***	-1.548***	-0.109
Real Estate FE	11.454***	17.370***	14.345***
Constant	-25.262***	-23.999***	-19.666***
Observations	9787	9787	9787
R ²	0.540	0.739	0.755

4. Translation into systemic risk charges

- *Suppose*
 - 8 % microprudential capital requirement = leverage < 12.5 : 1
 - Focus on 5% CoVaR, 1 year in the future
- **Size-leverage tradeoff**
 - Small bank with 5% market share has 8.0% capital requirement
 - Large bank with 10% market share has 8.7% capital requirement
- **Maturity mismatch-leverage tradeoff**
 - Bank with 50% MMM has 8.0% capital requirement
 - Bank with 55% MMM has 10.3% capital requirement,
where $MMM = (\text{short-term debt} - \text{cash}) / \text{total assets}$
- Tax-base for “bank levy” can be based on same analysis

4. Macro- vs. micro-prudential regulation

▪ Fallacy of the Composition:

what's micro-prudent need not be macro-prudent

Balance sheet	action	micro-prudent	macro-prudent
Asset side	(fire) sell assets	Yes	Not feasible in the aggregate
	no new loans/assets	Yes	Forces others to fire-sell + credit crunch
Liability side	(raise long-term debt)		
	raise equity	Yes	Yes

- Micro: based on risk in isolation
- Macro: Classification on systemic risk contribution measure, e.g. CoVaR
- Ratios versus Dollars

|| Conclusion

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