SYSTEMIC RISK MONITORING

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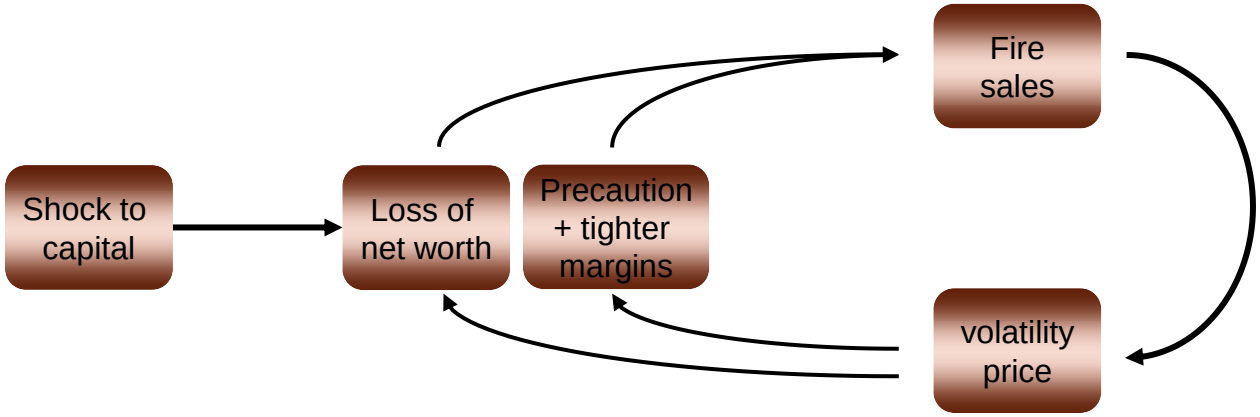
Definition of Systemic risk

- 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  - Leverage is an outdated concept ⇒ risk sensitivities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

Δ(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 (comovment with crisis)
    - "superliquid" gold/Treasuries appreciate in times of crisis

Funding liquidity

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- Measures:
  - Not Haircut/margin
  - Haircut/margin increase in case of crisis

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

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 repot 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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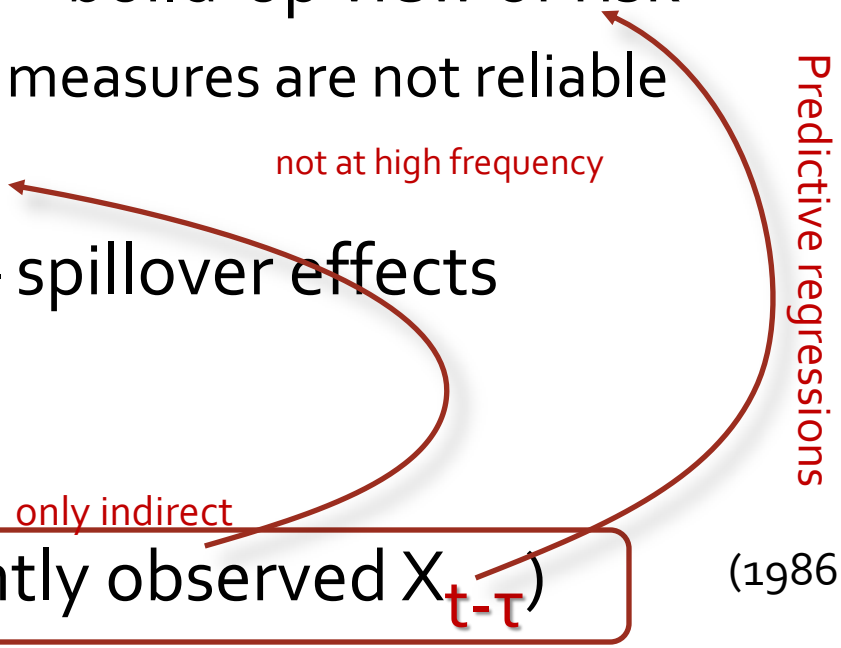
3. Systemic Risk Measurement

- Issue 1: procyclicality – "build-up view of risk"
  - Contemporaneous risk measures are not reliable
  - Rely on other variables
- Issue 2: externalities – spillover effects



- CoVaR method

  CoVaR = f(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)

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 it's VaR level)

$$\Pr(X^j \leq CoVaR_q^{j|i} \mid X^i = VaR_q^i) = q$$

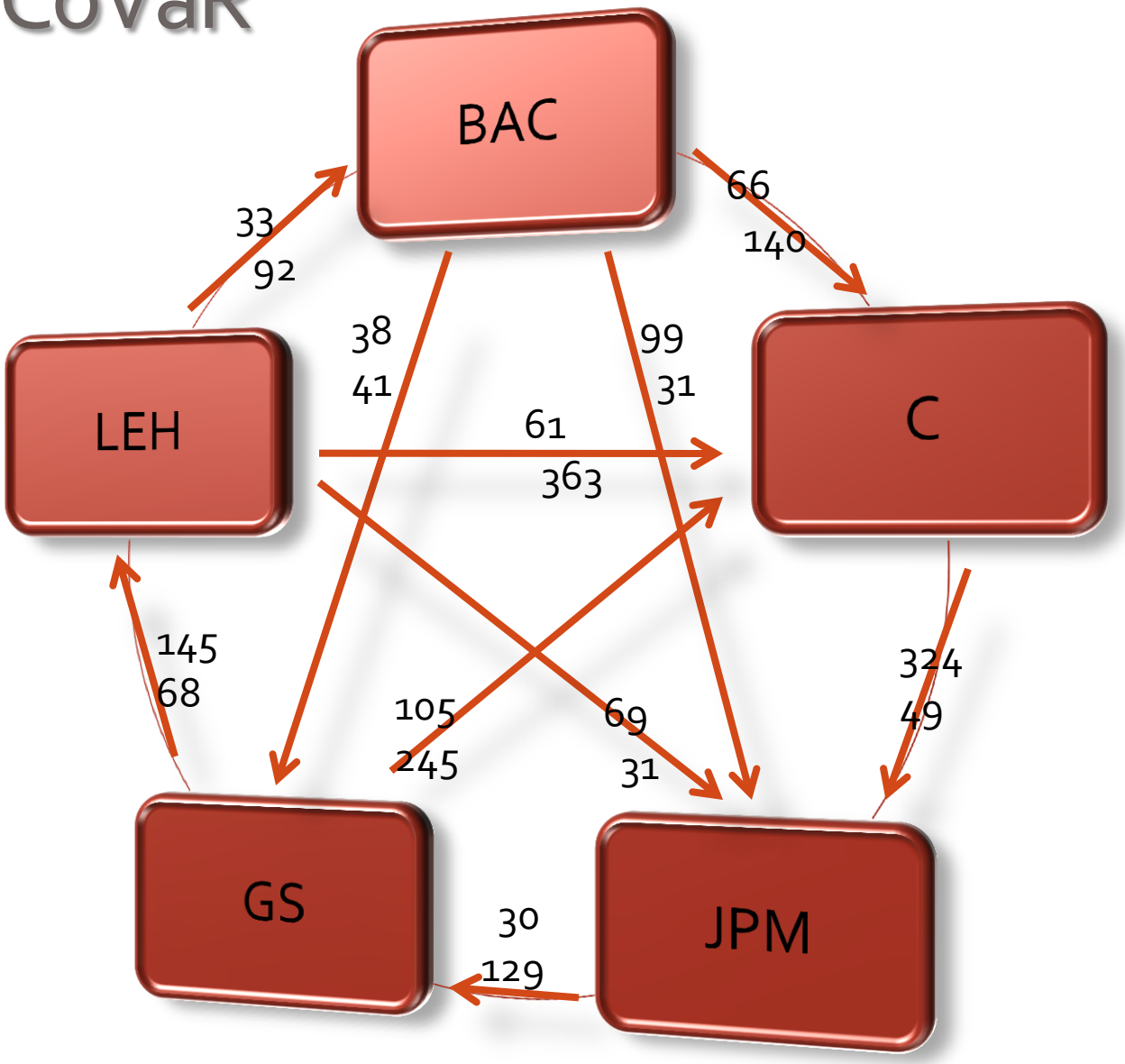
- $\Delta CoVaR_q^{j|i} = CoVaR_q^{j|i} - VaR_q^j|_{\text{normal times}}$

q-prob. event

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

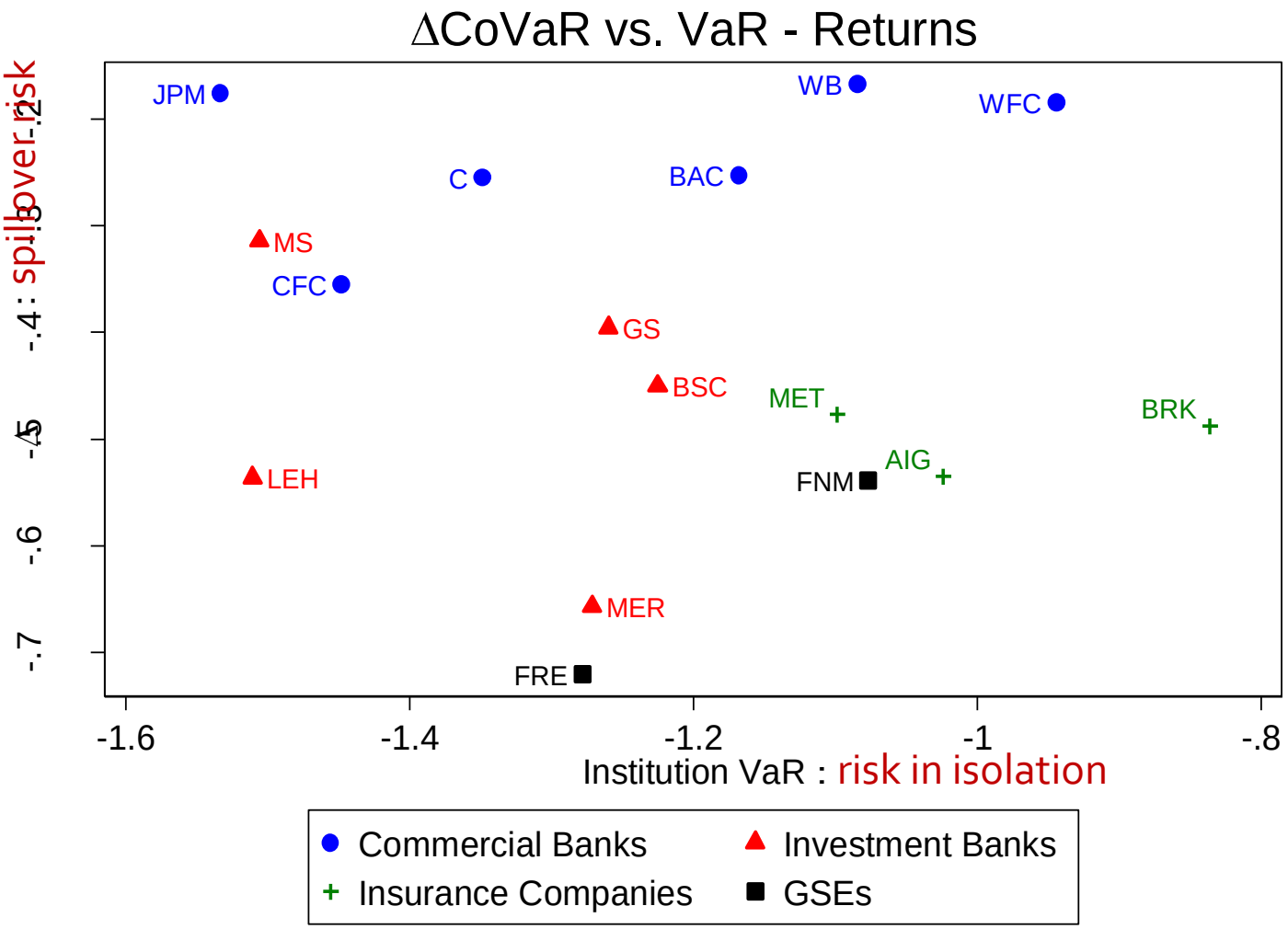
in non-causal sense!

3. Network CoVaR



- conditional on origin of arrow

3. ΔCoVaR 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 = (short-term debt – cash) / 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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