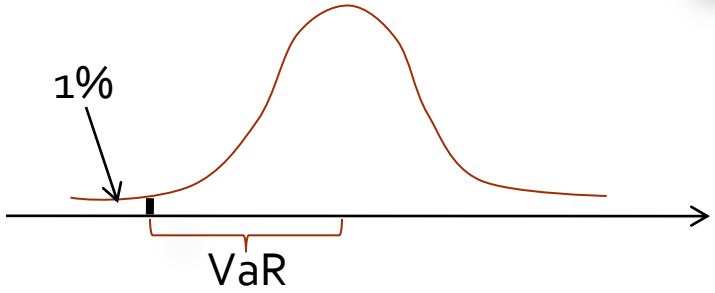
CoVaR – Macroprudential regulatoin

Eco 467/Fin 567 – Lecture 11

Markus K. Brunnermeier (joint with Tobias Adrian)

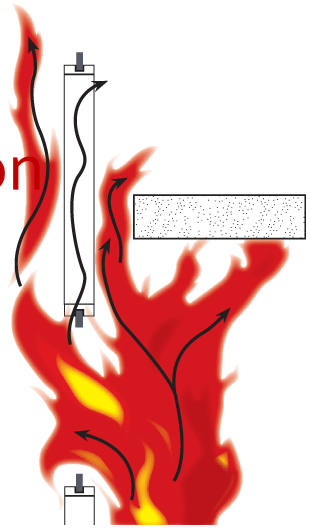
Current regulation

1. Risk of each institution in isolation ➡ Value at Risk



2. Procyclical capital requirements
   - VaR and ratings are countercyclical
3. Focus on asset side of the balance sheet
4. Differential capital treatment across industries.

Challenges ….



1. Focus on externalities – systemic risk contribution
   - Internalize externalities (… just like pollution)
   - Fire-code analogy: fire-protection wall
   - $CoVaR^i = VaR^{system} | i \text{ in distress}$
2. Countercyclical regulation
   - Regulate based on characteristics that give rise to *future* systemic risk contributions
3. Incorporate funding structure
   - asset-liability interaction, debt maturity, liquidity risk
4. Objective regulatory criteria across financial institutions
   - Banks, broker-dealers, insurance companies, hedge funds,…

…. Bankruptcy procedure, living will, …. (see Geneva Report)

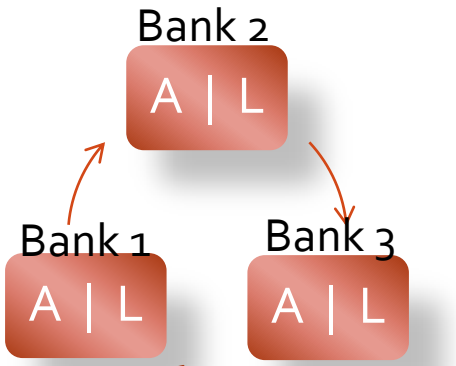
1. Externalities

"stability is a public good"

1. Fire-sale externality
   - Maturity mismatch + Leverage
     - Raise new funds — **FUNDING LIQUIDITY** *(rollover risk)*
     - Sell off assets (at fire sale prices) — **MARKET LIQUIDITY**

⇒ *Fire-sales depress price also for others*

2. Hoarding externality
   - micro-prudent response: can be individually rational, but
   - not macro-prudent



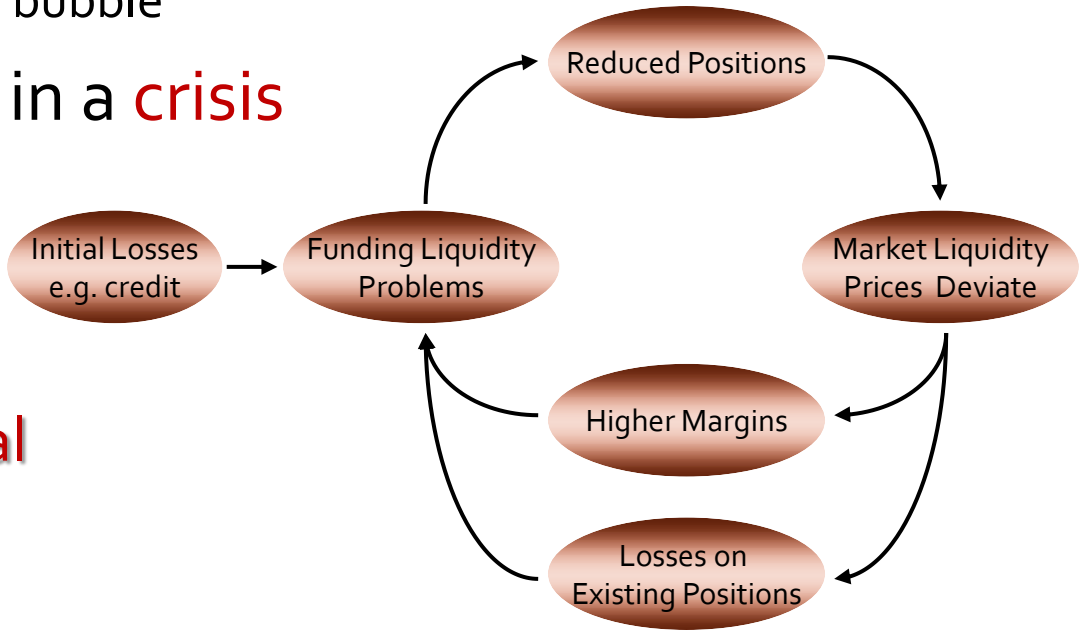
3. Runs – dynamic co-opetition
4. Network Externality
   - counterparty credit risk due to interlocking of claims
   - Hiding own's commitment ⇒ uncertainty for counterparties

Response to current regulation: "hang on to others and take positions that drag others down when you are in trouble" (maximize bailout probability)

⇒ become big, interconnected, hold similar positions

2. Procyclicality: Bubbles & Liquidity spirals

- Risk *builds up* during (credit) bubble
  - Why did nobody delever/act against it earlier?
    - Ride bubble: "dance as long as the music plays" Abreu-Brunnermeier (2003)
    - Lack of coordination/synchronization when to go against the bubble
- … and materializes in a crisis
  - Loss spiral
    - *same leverage*
    - mark-to-market
  - Margin/haircut spiral
    - *delever!*
    - mark-to-model



Brunnermeier-Pedersen (2009)

How to measure externalities: CoVaR

- VaR_q^i is implicitly defined as quantile

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

- $CoVaR_q^{j|i}$ is the VaR conditional on institute *i* (index) is in distress (at it's VaR level)

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

q-prob. event

- $\Delta CoVaR_q^{j|i} = CoVaR_q^{j|i} - VaR_q^j$

- Various conditionings? (direction matters!)

Contribution ΔCoVaR

- Q1: Which institutions contribute (in a non-causal sense)
- VaR^{system}| institution *i* in distress

Exposure ΔCoVaR

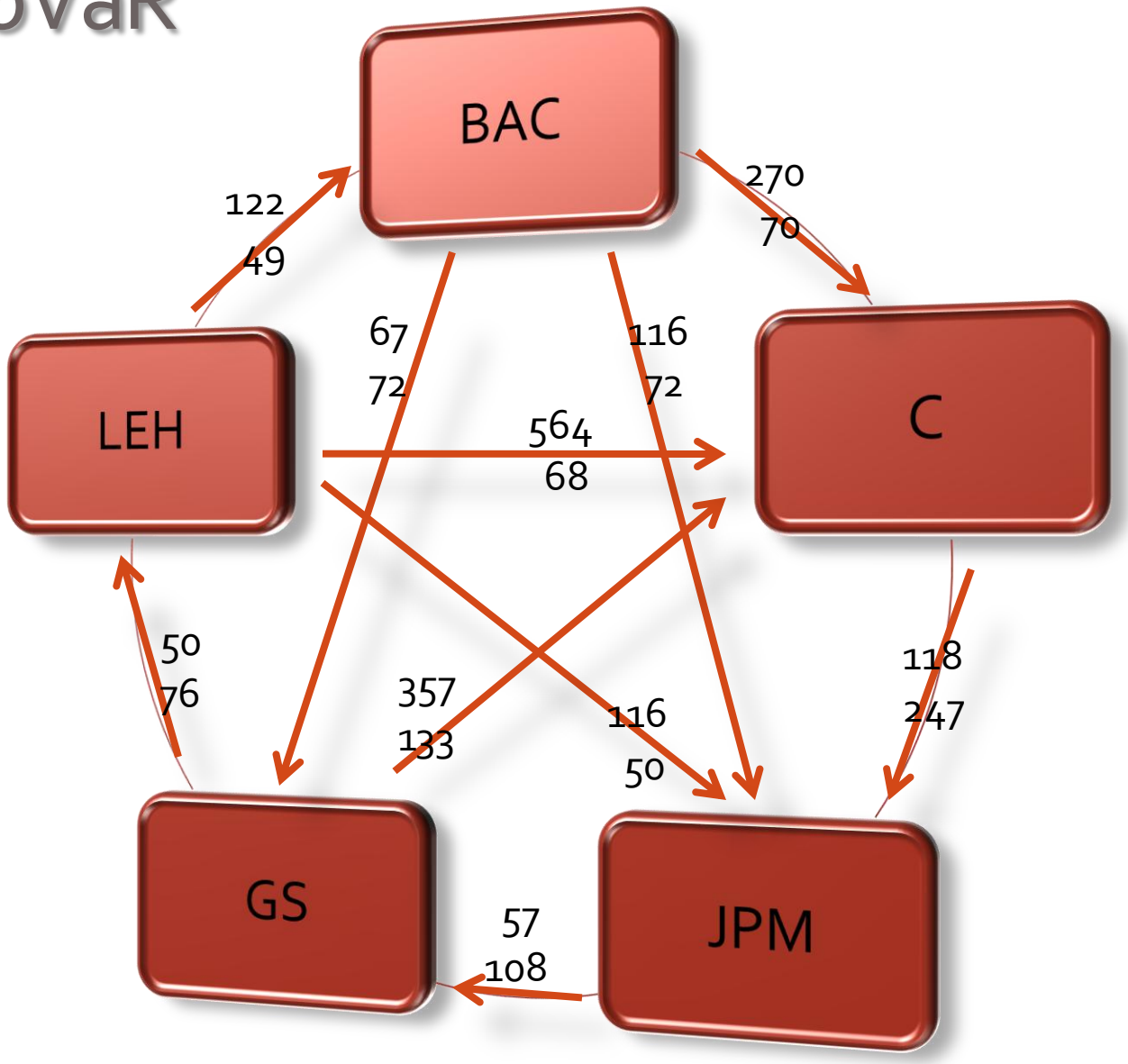
- Q2: Which institutions are most exposed if there is a systemic crisis?
- VaR^i | system in distress

Network ΔCoVaR

- VaR of institution *j* conditional on *i*

in non-causal sense!

Network CoVaR



- conditional on origin of arrow

Quantile Regressions: A Refresher

- OLS Regression: min sum of squared residuals

$$\beta^{OLS} = \arg\min_{\beta} \Sigma_t \quad y_t - \alpha - \beta x_t \quad ^2$$

  - *Predicted value:* $E[y \mid x] = \alpha + \beta x$

- Quantile Regression: min weighted absolute values

$$\beta^q = \arg\min_{\beta} \Sigma_t \begin{cases} q\left|y_t - \alpha - \beta x_t\right| & \text{if} \quad y_t - \alpha - \beta x_t \geq 0 \\ 1-q \ \left|y_t - \alpha - \beta x_t\right| & \text{if} \quad y_t - \alpha - \beta x_t < 0 \end{cases}$$

  - *Predicted value:* $VaR_q \mid x = F_y^{-1}(q \mid x) = \alpha_q + \beta_q x$

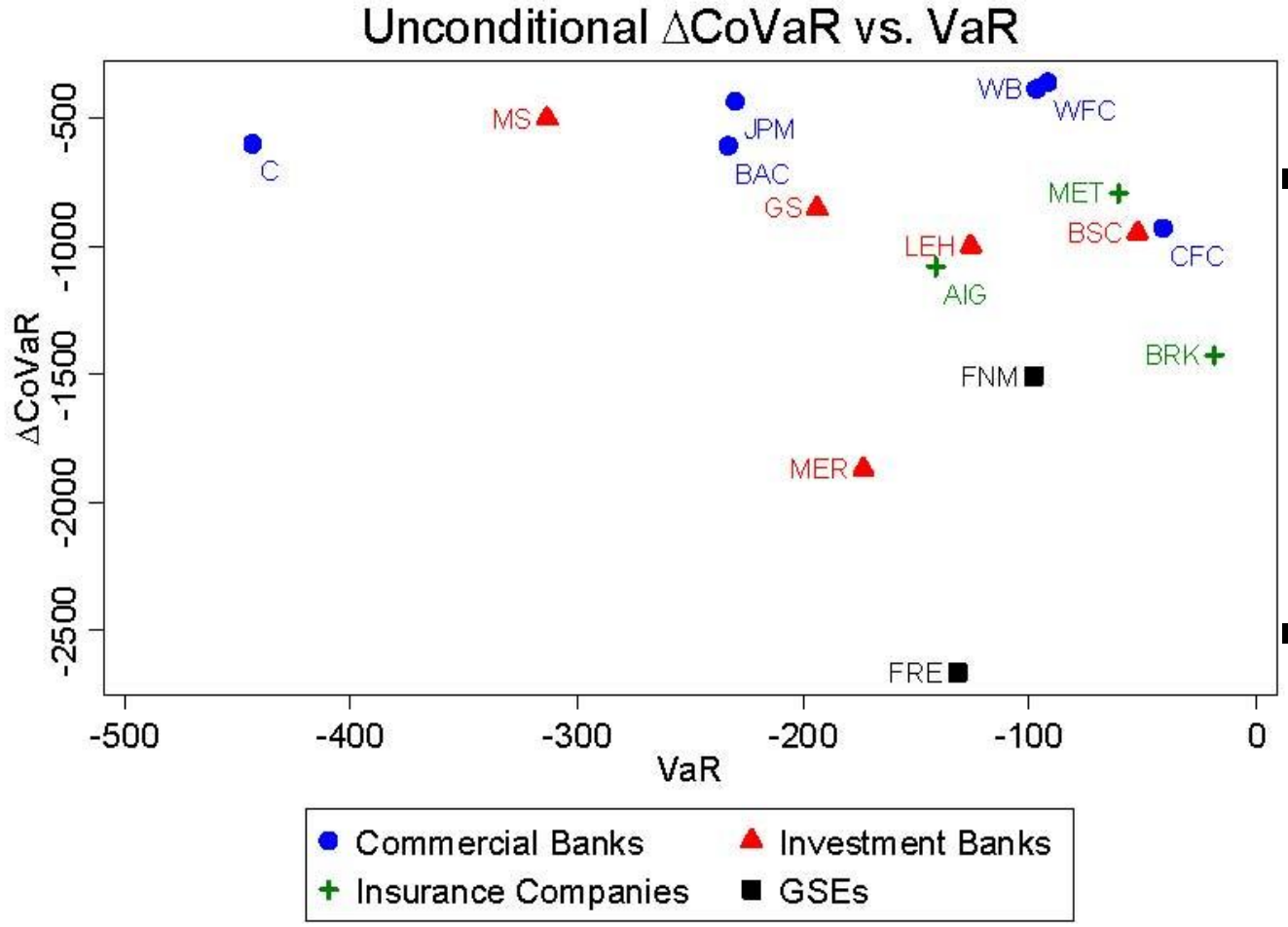
Note out (non-traditional) sign convention!

Who should be regulated?

group	examples	macro-prudential	micro-prudential
"individually systemic"	International banks (national champions)	Yes	Yes
"systemic as part of a herd"	Leveraged hedge funds	Yes	No
non-systemic large	Pension funds	No	Yes
"tinies"	unlevered	No	No

- Micro: risk in isolation
- Macro: systemic risk contribution measure, CoVaR
- ***Clone property:*** split i in n identical clones, $CoVaR^i = n\ CoVaR^c$

ΔCoVaR and VaR unrelated in cross-section



- VaR does not capture systemic risk contribution $\Delta\,\text{CoVaR}_{\text{contri}}$
- Data up to 2007/12

How to regulate?

- Size limits:
  - **Problem 1:** "too big to fail" ≠ "too systemic to fail"
  - split "individually systemic" institution in 10 clones
    - (clones perfectly comove with each other)

    "systemic as part of a herd"

    → Lessons:
    - Regulation should provide incentive to be heterogeneous
    - Spillover risk measure should satisfy "clone property"
  - **Problem 2:**
    one-dimensional threshold
    "bunching" below threshold

    → Lesson: Smooth transition -- "have to pay" in leverage …
- Mix of size, leverage, maturity mismatch, connectedness, risk pockets, crowded trades, business model, …
  …. but what weights?

CoVaR method

1. Find optimal mix/trade-offs between size, leverage, …., across institutions — objective weights
2. Countercyclical implementation — forward looking weights

Method:

- *Predict* ΔCoVaR to frequently observed characteristics
  - Size, maturity mismatch, leverage,
  - …. special data only bank supervisors have
    (e.g. crowdedness , interconnectedness measures)
- Step-procedure:
  1. Form portfolios
  2. Time-varying CoVaR (linked to lagged macro variables: VIX, Repo spread, term spread, credit spread, market return, housing)
  3. Predict future CoVaR with size, leverage ,…

Step 1: Portfolio sorted on Characteristics

- Individual financial institution have changed the nature of their business over time
- Institutional characteristics matter
- Form quintile portfolios on
  - Size
  - Leverage
  - Maturity Mismatch
  - Book-to- Market
  - Equity volatility

  … each quarter, according to previous quarter

  for each of the following 4 "industries"
  - Banks, Security broker-dealers, Insurance companies, Real Estate companies.

Step 3: CoVaR prediction: 1% (quarterly)

Variable	2 Years	1 Year	1 Quarter
$\Delta CoVaR^i$ (lagged)	0.623***	0.706***	0.876***
VaR^i (lagged)	-0.044***	-0.033***	-0.016***
Leverage (lagged)	-0.093***	-0.083***	-0.049***
Maturity mismatch (lagged)	-2.799***	-1.948***	-1.146***
Relative size (lagged)	-0.731	-1.002***	-0.520**
Market-to-book (lagged)	-0.002*	-0.001**	-0.001
Foreign dummy	0.121	0.035	0.632
Commercial Bank FE	3.051***	2.322***	1.290***
Investment Bank FE	-1.103***	-0.732**	-0.109
Insurance Company FE	-2.562***	-2.411***	-0.961***
Constant	-10.168***	-7.568***	-3.325***
Observations	8102	8497	8798
R^2	0.597	0.650	0.800

Result 1: Size-Leverage tradeoff

- Suppose
  - 8 % microprudential capital requirement = leverage < 12.5 : 1
  - Focus on 1% CoVaR, 1 year in the future
- Coefficient on size is -1.002, on leverage -0.083
- An increase in size, say from 1% to 21 % market share (measured in total assets) requires
- Decrease in leverage by
  (1.002/0.83)*(21%-1%)= 12*20%=2.4 to 10.1
  or
  increase in capital requirements from 8% to roughly 10%

Result 2: MMM-Leverage tradeoff

- Coefficient on MMM is -1.948, on leverage -0.083
- An increase in MMM (=short-term debt to total assets), say from 20% to 30% requires
- Decrease in leverage by
  (1.948/0.83)*(0.1) = 2.3469 to 10.2
  or
  increase in capital requirements from 8% to 9.85%

Results based on US data

- Suppose
  - 8 % microprudential capital requirement = leverage < 12.5 : 1
  - Focus on 1% CoVaR, 1 year in the future
- Size-leverage tradeoff
  - Small bank with 1% market share has 8% capital requirement
  - Large bank with 21% market share has 10% capital requirement
- Maturity mismatch-leverage tradeoff
  - Bank with 20% MMM has 8 % capital requirement
  - Bank with 30% MMM has 9.85% capital requirement,

  where MMM=short-term debt to total assets

Predicting with market variables

COEFFICIENT	2 Years	1 Year	1 Quarter
$\Delta CoVaR$ (lagged)	0.60***	0.79***	0.94***
VaR (lagged)	-1.84	0.05	-0.08
CDS beta (lagged)	-1,727**	787.92	95.37
CDS (lagged change)	1,320	-2,211	-40.26
Implied Vol beta (lagged)	-8.30	-590.28**	-85.78
Implied Vol (lagged change)	-144.60	111.02	234.56***
Constant	-335.30	-147.72	-114.07*
Observations	114	154	184
R-squared	0.36	0.57	0.77

1) beta w.r.t. first principal component on changes in CDS spreads within quarter
2) panel regression with FE – (no findings with FE+TE)

Countercyclical Regulation

- *When market is relaxed*
  Strict Laddered Response
  - **Step 1:** supervision enhanced
  - **Step 2:** forbidden to pay out dividends
    - See connection to debt-overhang problem)
  - **Step 3:** No Bonus for CEOs
  - **Step 4:** Recapitalization within two months + debt/equity swap
- *When market is strict*
  Relax regulatory requirement

Macro-prudential instruments

- Lean against credit bubbles/buildup of risk + capture externalities
  - Time-varying capital/liquidity requirements – Loan-to-Value
  - Dynamic provisioning
  - Pigouvian tax/private insurance scheme
  - Lending criteria
  - Communication policy – warnings of risk buildup
    - Coordinate investors to go against a bubble
    - use financial stability reports.
  - Interest rate policy
    - SIV financing would have been much less attractive

Independence of a political pressure!

Financial versus monetary stability

- When there is a trade-off?
  - Times of "great moderation":
    - Inflation is (seems to be) contained
    - Credit and asset price expansion – "credit bubble"
    - *Build-up of risk*, which will only materialize later
    - After burst,
      - deflationary pressure
      - monetary transmission mechanism can be impaired
      - bailouts + government deficits (potentially leading to long-run inflation?)
  - Should interest rate be increased
    - Price stability (inflation targeting) No
    - Financial stability Yes
- New rationale for modified monetary aggregates
  - Was the ECB ahead of the Fed?
  - Modify monetary aggregates to reflect new rationale

Conclusion

- Macro-prudential regulation
  - Focus on externalities
  - Measure for systemic risk is needed, e.g. CoVaR
- Countercyclical regulation
  - Find variables that *predict* average future CoVaR
  - Forward-looking measures, spreads, …
- CoVaR method determines "right" tradeoff across
  - Size, leverage, maturity mismatch, investment vs. commercial bank, interdependence measure, …