



# CoVAR

Tobias Adrian and Markus K. Brunnermeier

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# Current bank regulation

1. Risk of each **bank in isolation** → Value at Risk
2. Focus on **asset side** of the balance sheet matter
  - Asset side
    - Asset by asset – risk weighted → diversify in off-balance SPV
    - Value at Risk (VaR)
  - Liability side – maturity mismatch is ignored
    - Maturity rat race
    - Implicit subsidies for short-term funding

# Two challenges ....

## 1. Focus on externalities – systemic risk contribution

- What are the externalities?
- How to measure contribution to systemic risk?
  - CoVaR influences
    - Who should be regulated? (AIG, ...)
    - What is the optimal capital charge (cap), Pigouvian tax?

## 2. Countercyclical regulation

- How to avoid procyclicality?

+ incorporate liquidity risk – asset-liability interaction

# Externalities

## 1. Fire-sale externality

- Maturity mismatch + Leverage

- Raise new funds
- Sell off assets  
(at fire sale prices)

**FUNDING LIQUIDITY**

*liquidity*

*(rollover risk)*

**MARKET LIQUIDITY**



*Fire-sales depress price also for others*

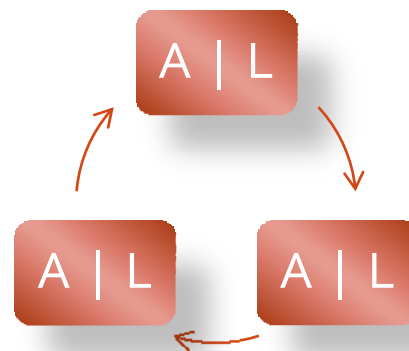
## 2. Hoarding externality

- micro-prudent response:  
Hoard funds/reduce lending
- not macro-prudent

## 3. Runs – dynamic co-opetition

## 4. Network Externality

- Hiding own's commitment → uncertainty for counterparties



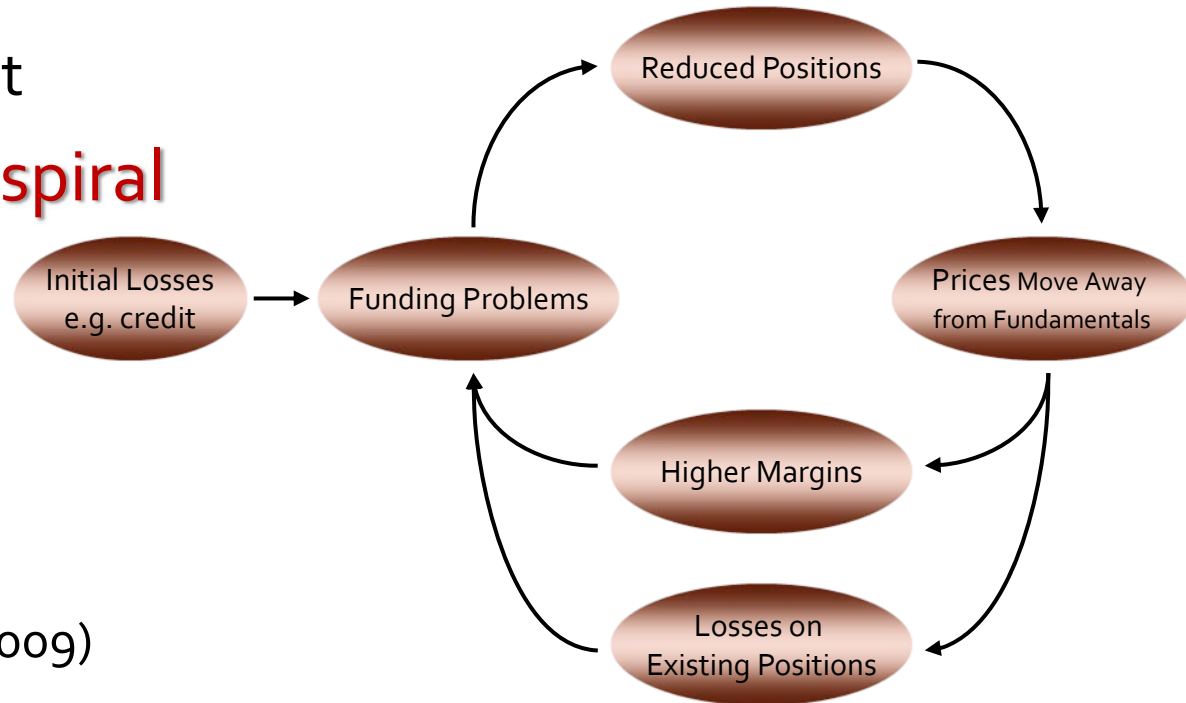
# Procyclicality - Liquidity spirals

- **Loss spiral**

- ➔ same leverage
  - mark-to-market

- **Margin/haircut spiral**

- ➔ delever!
  - mark-to-model



Brunnermeier Pedersen (2009)

Adrian Shin (2009)

# Procyclicality – Margin/haircut spiral

- Margins/haircut increase in times of crisis → delever  
margin =  $f(\text{VaR})$

- Three Reasons

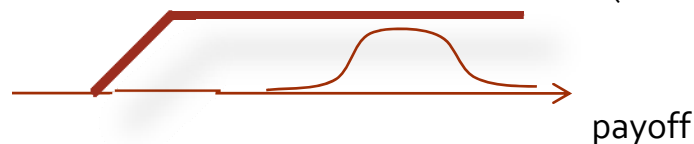
1. Backward-looking estimation of VaR

- Use forward looking measures
- Use long enough data series

2. Time-varying volatility

3. Adverse selection

- Debt becomes more information sensitive (not so much out of the money anymore)



- Credit bubbles

- whose bursting undermines financial system

→ **Countercyclical regulation**

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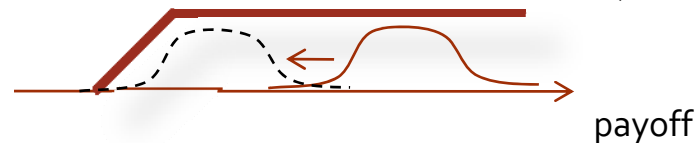
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→ **Countercyclical regulation**

# Macro-prudential regulation

- **Externality:**
  - Measure contribution of institution to systemic risk: **CoVaR**
- **Procyclicality:**
  - Impose Capital requirements/Pigouvian tax/Private insurance scheme
    - not directly on  $\Delta\text{CoVaR}$ , but on frequently observed factors, like maturity mismatch, leverage, B/M...

# Overview

1. Systemic Risk Measure + Procyclicality
2. Definition of CoVaR
  - Contribution CoVaR vs. Exposure CoVaR
3. Quantile Regressions
4. Data
5. CoVaR vs. VaR
6. Time-varying CoVaR
7. Addressing Procyclicality
8. Related Literature and Conclusion

# CoVaR

- CoVaR = VaR conditional on institute  $i$  (index) is in distress (at its VaR level)
- Exposure CoVaR
  - Q1: Which institutions are most exposed if there is a systemic crisis?  
→  $VaR^i | \text{system in distress}$
- Contribution CoVaR
  - Q2: Which institutions contribute (in a non-causal sense)  
→  $VaR^{\text{system}} | \text{institution } i \text{ in distress}$

| Cover both types       | Institutions                 |
|------------------------|------------------------------|
| Risk spillovers        | "individually systemic"      |
| Tail risk correlations | "systemic as part of a herd" |

- Non-causal, can be driven by common factor

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# Quantile Regressions: A Refresher

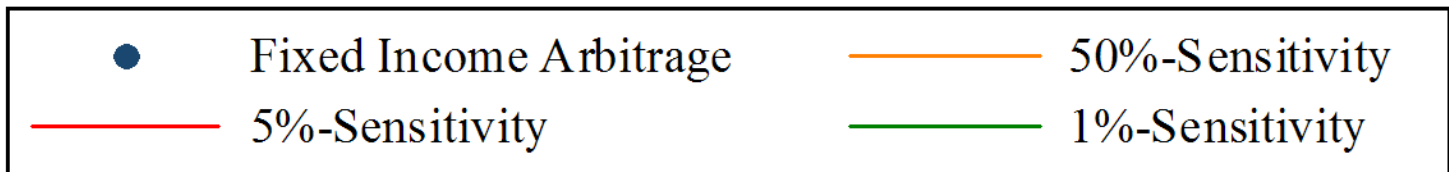
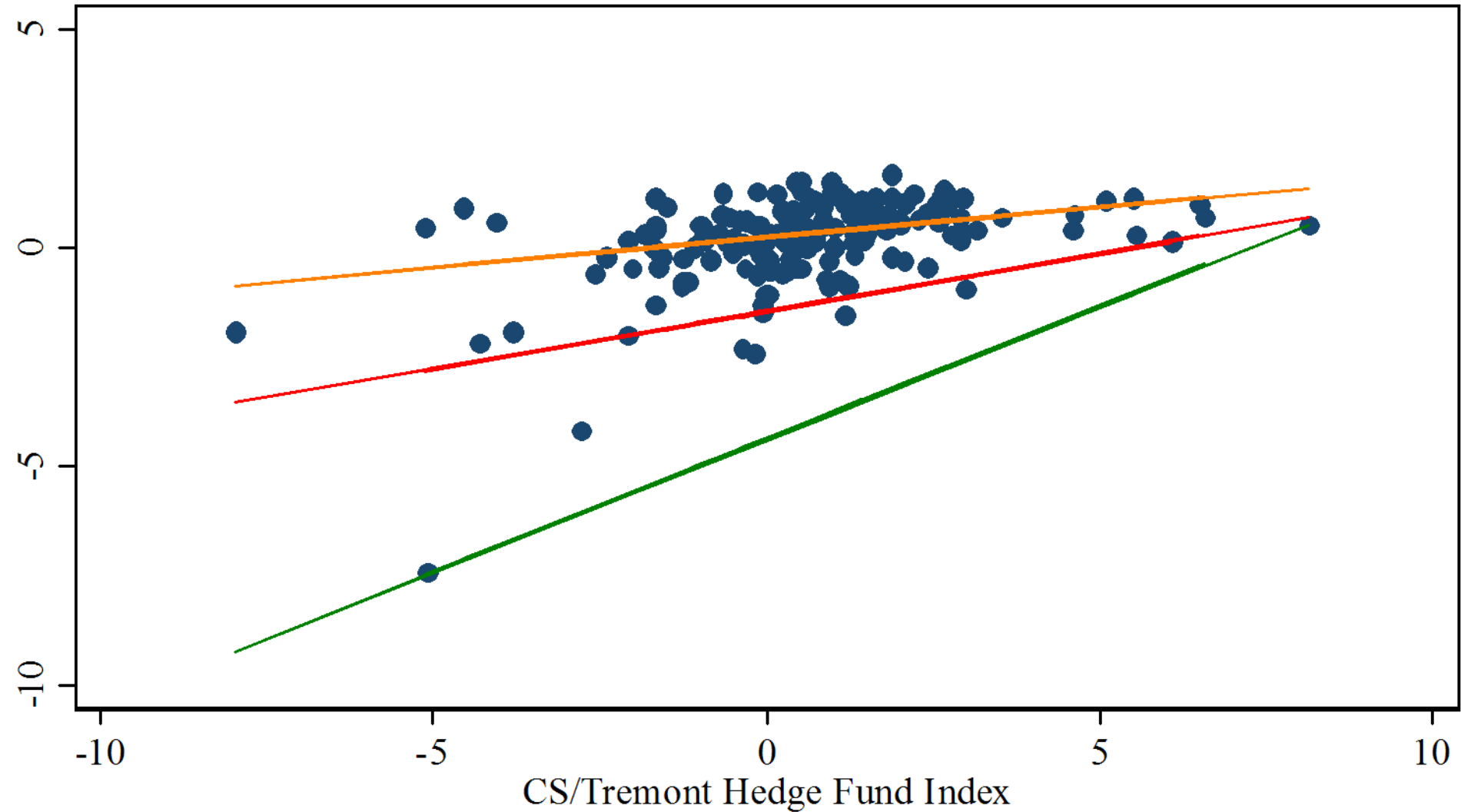
- OLS Regression: min sum of squared residuals

$$\beta^{OLS} = \arg \min_{\beta} \sum_t (y_t - \alpha - \beta x_t)^2$$

- Quantile Regression: min weighted absolute values

$$\beta^q = \arg \min_{\beta} \sum_t \begin{cases} q|y_t - \alpha - \beta x_t| & \text{if } (y_t - \alpha - \beta x_t) \geq 0 \\ (1-q)|y_t - \alpha - \beta x_t| & \text{if } (y_t - \alpha - \beta x_t) < 0 \end{cases}$$

# q-Sensitivities



# Quantiles = - Value-at-Risk

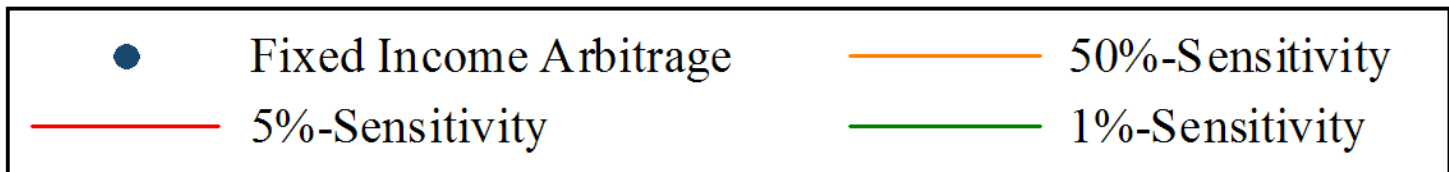
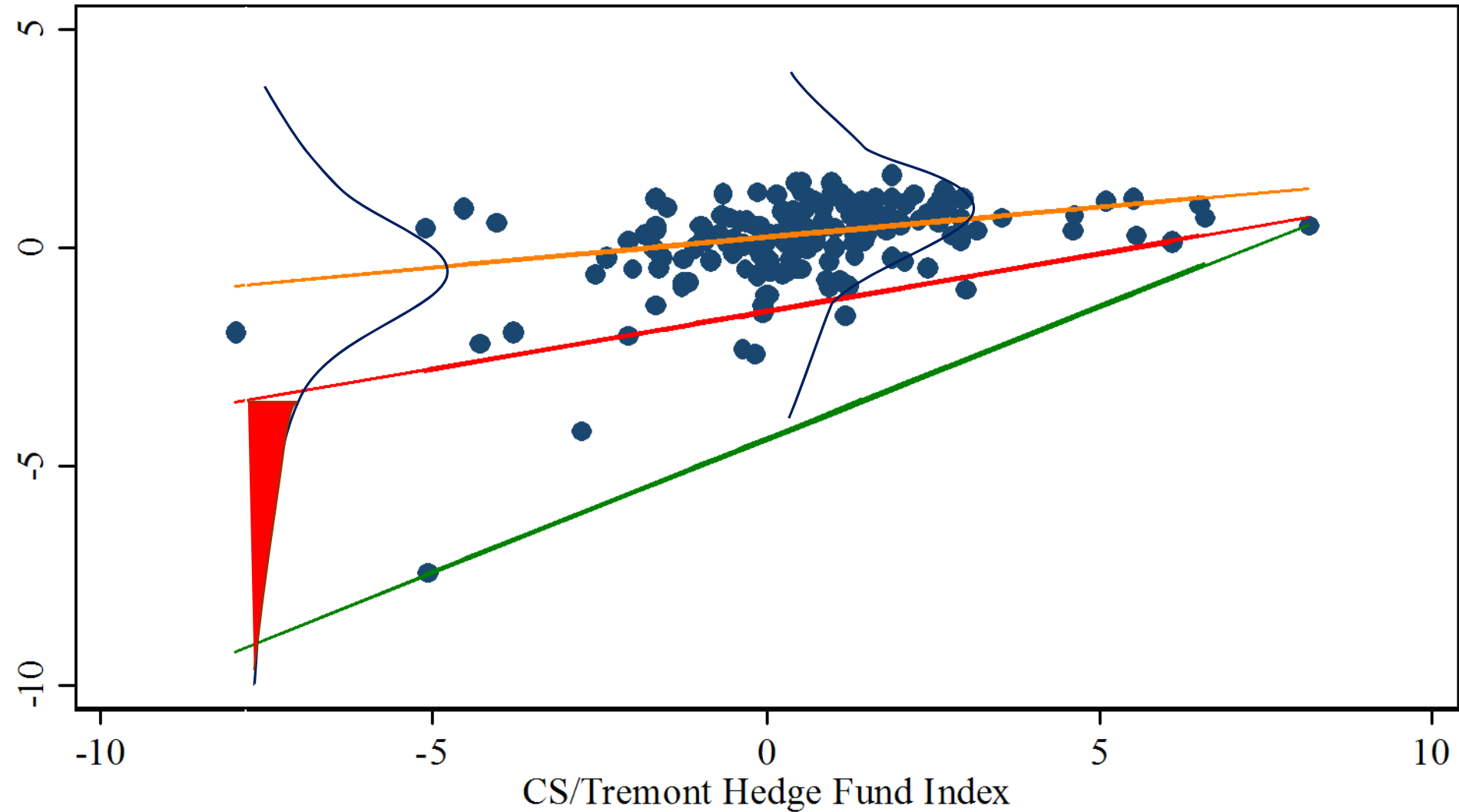
- Quantile regression:
  - Quantile  $q$  of  $y$  as a linear function of  $x$

$$\hat{y}_q | x = F_y^{-1}(q | x) = \alpha_q + \beta_q x$$

where  $F^{-1}(q|x)$  is the inverse CDF conditional on  $x$

- Hence,  $F^{-1}(q|x) = q\% \text{ Value-at-Risk}$  conditional on  $x$ .
  - Note out (non-traditional) sign convention!

# q-Sensitivities



# CoVaR - using quantile regressions

$$CoVaR_q^{ij} = VaR_q^i | VaR_q^j = \alpha_q^{ij} + \beta_q^{ij} VaR_q^j$$

$$\Delta CoVaR_q^{ij} = CoVaR_q^{ij} - VaR_q^i$$

## ■ Conditioning

1. Individual institution on financial index
  - Who is vulnerable/exposed to?
2. Financial index on individual institution
  - Who contributes?
3. Institution/strategy  $i$  on institution/strategy  $j$

## ■ Conditioning shifts

- Mean contagion effect
- Variance
  - Lower
  - Increase due to heteroskedasticity + tail behavior

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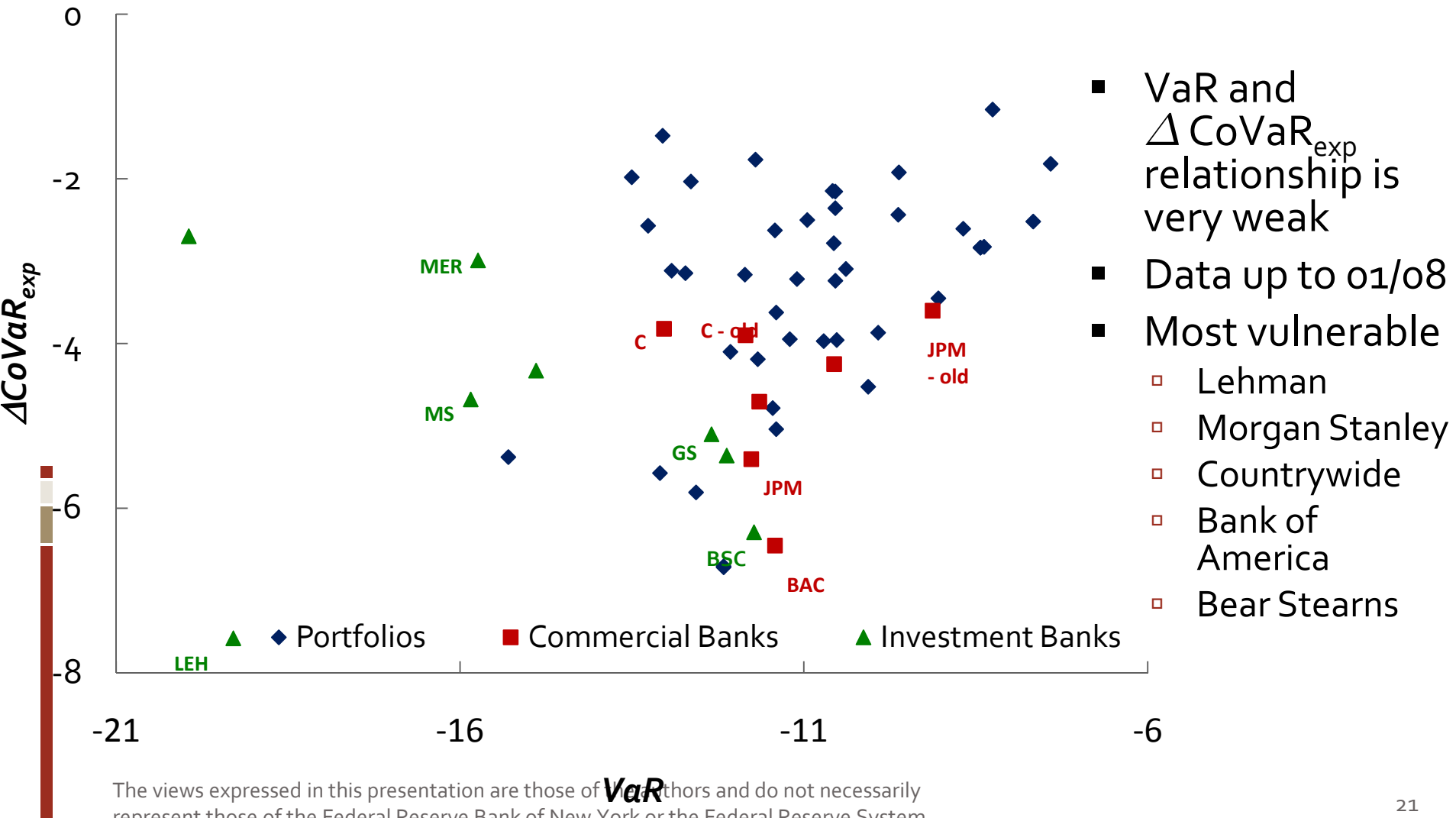
# ■ Data

- NYFed primary dealer (US): CRSP returns 1986/01-2008/12 (weekly)  
[equity returns to also capture asset and liability]
  - Commercial banks
  - Investment banks
  - Portfolios sorted in quintiles based on
    - Maturity mismatch, liquidity, size, B/M, cash/asset, equity vol.
- CSFB/Tremont hedge fund strategies 1994/1-2008/12 (monthly)
  - Long/Short Equity, Global Macro, Event Driven, Fixed Income Arbitrage, Multi-Strategy, Emerging Markets, Equity Market Neutral, Convertible Arbitrage, Managed Futures, Dedicated Short Bias

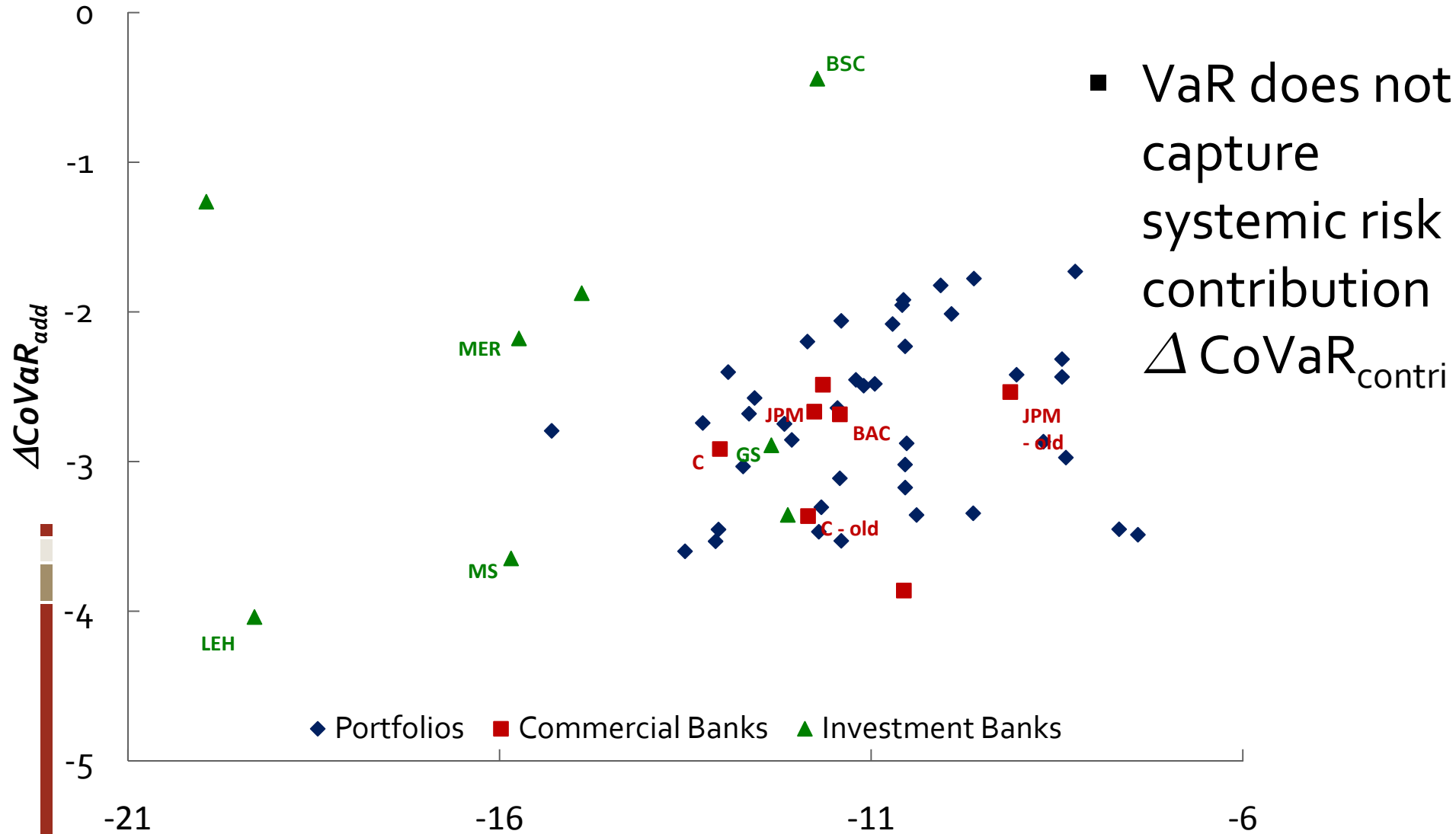
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# Q1: Who is in distress during systemic crisis?



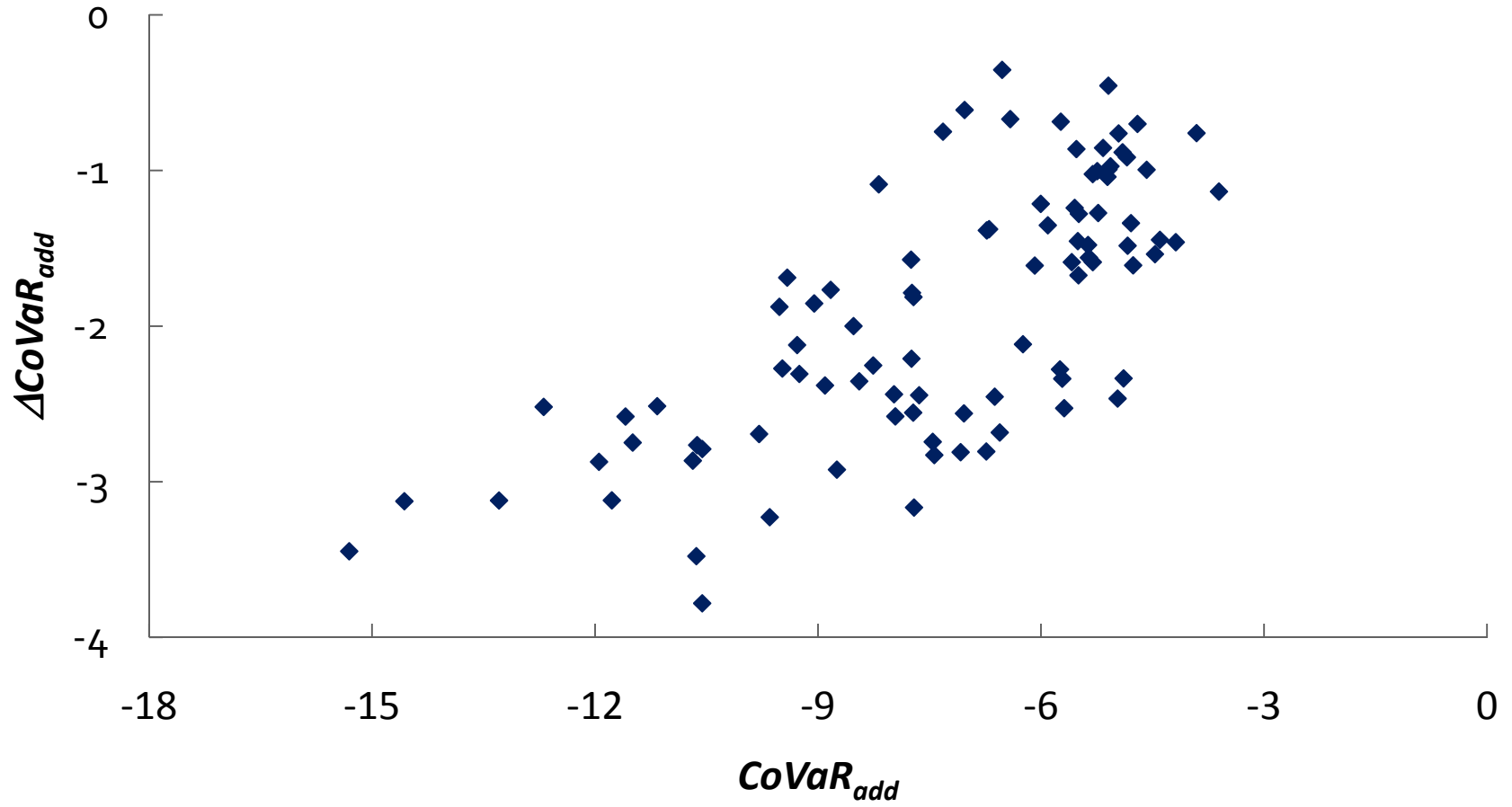
# Q2: Who "contributes" to systemic risk?



■ VaR does not capture systemic risk contribution  
 $\Delta \text{CoVaR}_{contri}$

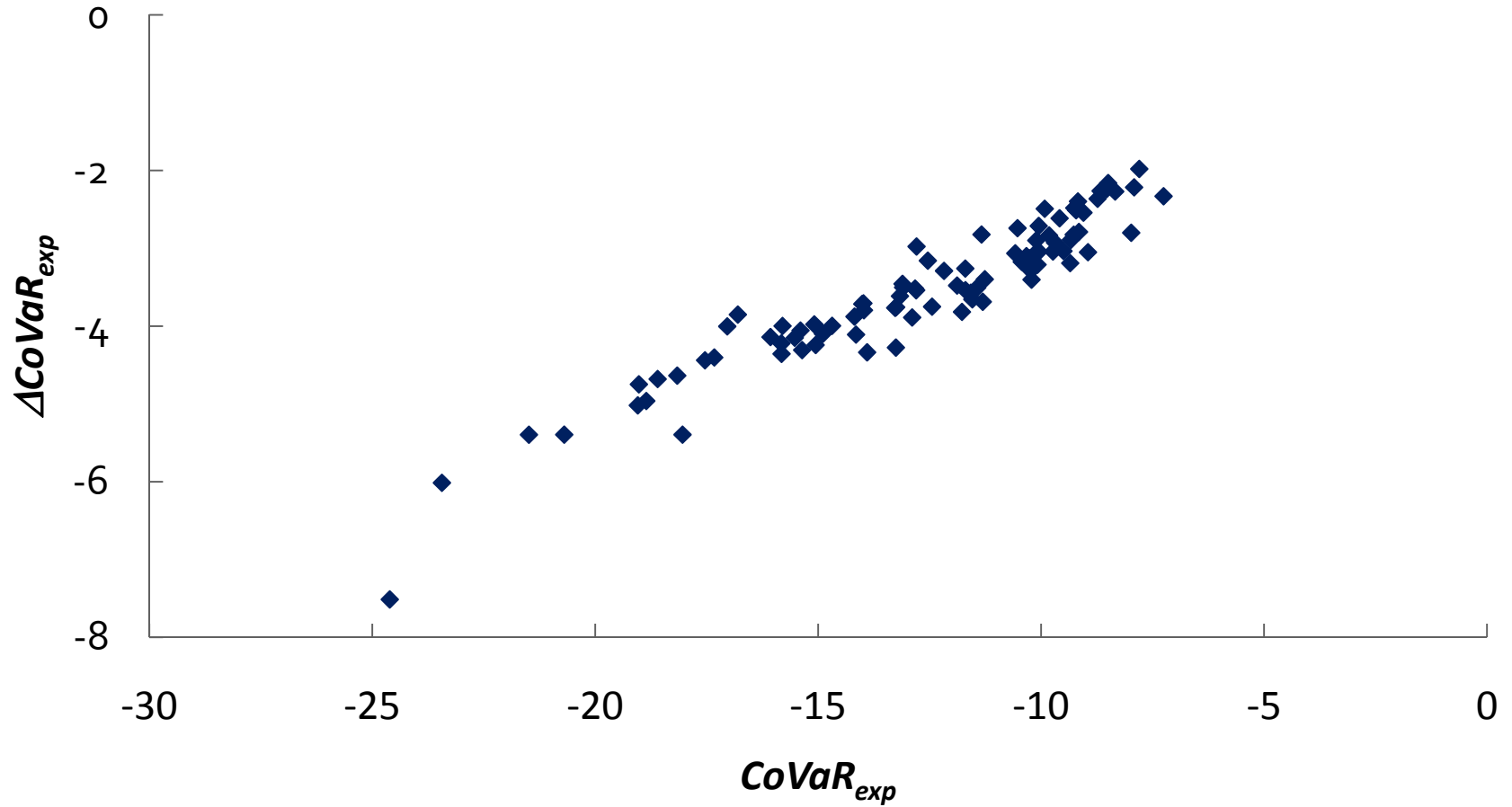
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# || In the time-series ...



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|                                    |      | COMMERCIAL |      |        |        | INVESTMENT BANKS |      |        |        | HEDGE FUNDS |      |        |       |
|------------------------------------|------|------------|------|--------|--------|------------------|------|--------|--------|-------------|------|--------|-------|
|                                    |      | Mean       | Sd   | Min    | Max    | Mean             | Sd   | Min    | Max    | Mean        | Sd   | Min    | Max   |
| VaR <sup>i</sup>                   | all  | -10.14     | 3.95 | -60.32 | -2.11  | -11.81           | 4.68 | -68.95 | -3.11  | -2.84       | 2.81 | -17.39 | 2.02  |
|                                    | betw |            | 1.93 | -15.69 | -6.86  |                  | 1.59 | -14.89 | -10.47 |             | 2.09 | -6.4   | -0.37 |
|                                    | w/in |            | 3.42 | -60.13 | -0.05  |                  | 4.45 | -65.86 | -1.11  |             | 1.99 | -14.54 | 4.87  |
| CoVaR <sup>i</sup> <sub>add</sub>  | all  | -6.91      | 2.53 | -36.65 | -2.1   | -6.88            | 2.63 | -36.41 | -2.01  | -7.48       | 3.87 | -25.26 | 1.66  |
|                                    | betw |            | 0.68 | -7.75  | -5.76  |                  | 0.85 | -8.04  | -5.96  |             | 1.67 | -9.11  | -3.61 |
|                                    | w/in |            | 2.45 | -36.11 | -1.71  |                  | 2.51 | -35.46 | -1.36  |             | 3.52 | -24.24 | -0.44 |
| ΔCoVaR <sup>i</sup> <sub>add</sub> | all  | -1.84      | 1.18 | -13.23 | 2.9    | -1.62            | 1.24 | -10.27 | 1.41   | -1.27       | 1.99 | -8.71  | 4.43  |
|                                    | betw |            | 0.54 | -2.58  | -0.57  |                  | 0.61 | -2.55  | -0.97  |             | 1.68 | -2.92  | 2.58  |
|                                    | w/in |            | 1.08 | -13.05 | 2.28   |                  | 1.11 | -9.62  | 1.45   |             | 1.17 | -7.62  | 2.27  |
| CoVaR <sup>i</sup> <sub>exp</sub>  | all  | -14.48     | 5.07 | -73.15 | -5.05  | -16.12           | 7.11 | -91.33 | -4.32  | -2.97       | 3.21 | -20.04 | 1.88  |
|                                    | betw |            | 2.82 | -21.74 | -10.98 |                  | 4.05 | -24.68 | -11.6  |             | 2.6  | -8.24  | -0.47 |
|                                    | w/in |            | 4.22 | -69.4  | -4.46  |                  | 6.02 | -82.77 | 0.96   |             | 2.03 | -14.77 | 5.3   |
| ΔCoVaR <sup>i</sup> <sub>exp</sub> | all  | -4.34      | 2.52 | -31.75 | 4.41   | -4.31            | 3.89 | -29.76 | 7      | -0.14       | 0.95 | -6.06  | 2.82  |
|                                    | betw |            | 1.55 | -7.91  | -2.17  |                  | 3.17 | -9.79  | 1.26   |             | 0.9  | -2.55  | 0.81  |
|                                    | w/in |            | 2.11 | -32.03 | 4.9    |                  | 2.58 | -24.29 | 5.92   |             | 0.4  | -3.64  | 1.88  |
| Obs                                | N    | 15200      |      |        |        | 6902             |      |        |        | 1845        |      |        |       |
|                                    | n    | 19         |      |        |        | 9                |      |        |        | 11          |      |        |       |
|                                    | T    | 500        |      |        |        | 767              |      |        |        | 168         |      |        |       |

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COMMERCIAL

INVESTMENT BANKS

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# Time-varying CoVaR

- Relate to macro factors

- VIX Level
- 3 month yield
- Repo – 3 month Treasury
- Moody's BAA – 10 year Treasury
- 10Year – 3 month Treasury

## interpretation

“Volatility”

“Flight to Quality”

“Credit indicator”

“Business Cycle”

- Recall portfolios approach

# Average factor exposure

|                   | INSTITUTIONS         |                   |                                   |                                   | PORTFOLIOS       |                                   |                                   |
|-------------------|----------------------|-------------------|-----------------------------------|-----------------------------------|------------------|-----------------------------------|-----------------------------------|
|                   | VaR <sup>index</sup> | VaR <sup>i</sup>  | CoVaR <sup>i</sup> <sub>add</sub> | CoVaR <sup>i</sup> <sub>exp</sub> | VaR <sup>i</sup> | CoVaR <sup>i</sup> <sub>add</sub> | CoVaR <sup>i</sup> <sub>exp</sub> |
| VIX               | -0.27<br>(-11.85)    | -0.44<br>(-9.50)  | -0.21<br>(-15.55)                 | -0.18<br>(-9.03)                  | -0.39<br>(-3.34) | -0.2<br>(-6.13)                   | -0.18<br>(-2.48)                  |
| 3 Month Yield     | 0.65<br>(3.34)       | 0.2<br>(-0.10)    | 0.22<br>-3.12                     | -0.75<br>(-2.98)                  | 0.46<br>-1.22    | 0.23<br>-1.8                      | -0.06<br>(-0.14)                  |
| Repo spread       | -0.08<br>(-1.59)     | 1.47<br>-1.67     | 0.08<br>(-0.16)                   | 0.96<br>-3.09                     | 0.46<br>-0.2     | -0.85<br>(-1.01)                  | 0.42<br>-0.23                     |
| Credit spread     | -0.05<br>(-0.50)     | -0.31<br>-0.72    | -0.25<br>(-0.62)                  | -2.16<br>(-6.32)                  | -1.42<br>(-0.73) | -0.31<br>(-0.77)                  | -1.15<br>(-1.26)                  |
| Term spread       | 0.5<br>-1.62         | 0.58<br>-3.48     | 0.27<br>-2.13                     | -0.69<br>(-3.65)                  | 0.73<br>-1.17    | 0.15<br>-0.76                     | 0.36<br>-0.97                     |
| Leverage          | -1.15<br>(-4.66)     | -1.67<br>(-4.71)  | -0.79<br>(-5.76)                  | -0.83<br>(-7.74)                  | -1.28<br>(-3.91) | -0.56<br>(-4.74)                  | -0.4<br>(-1.73)                   |
| Maturity Mismatch | 0.81<br>(-1.64)      | 18.52<br>(-1.59)  | -3.78<br>-0.41                    | -2.78<br>(-0.95)                  | -1.89<br>(-0.03) | -0.64<br>-0.01                    | 0.78<br>-0.01                     |
| Book to Market    | -10.55<br>(-3.65)    | -15.67<br>(-3.00) | -6.71<br>(-3.85)                  | -10.12<br>(-6.98)                 | -1.24<br>(-0.22) | 0.16<br>-0.09                     | 4.61<br>-0.7                      |

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Average t-stats in parenthesis

# Average factor exposure

|                   | INSTITUTIONS         |                   |                                   |                                   | PORTFOLIOS       |                                   |                                   |
|-------------------|----------------------|-------------------|-----------------------------------|-----------------------------------|------------------|-----------------------------------|-----------------------------------|
|                   | VaR <sup>index</sup> | VaR <sup>i</sup>  | CoVaR <sup>i</sup> <sub>add</sub> | CoVaR <sup>i</sup> <sub>exp</sub> | VaR <sup>i</sup> | CoVaR <sup>i</sup> <sub>add</sub> | CoVaR <sup>i</sup> <sub>exp</sub> |
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| Term spread       | 0.5<br>(-1.62)       | 0.58<br>(-3.48)   | 0.27<br>(-2.13)                   | -0.69<br>(-3.65)                  | 0.73<br>(-1.17)  | 0.15<br>(-0.76)                   | 0.36<br>(-0.97)                   |
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| Book to Market    | -10.55<br>(-3.65)    | -15.67<br>(-3.00) | -6.71<br>(-3.85)                  | -10.12<br>(-6.98)                 | -1.24<br>(-0.22) | 0.16<br>(-0.09)                   | 4.61<br>(-0.7)                    |

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# Average factor exposure

|                   | INSTITUTIONS         |                   |                                   |                                   | PORTFOLIOS       |                                   |                                   |
|-------------------|----------------------|-------------------|-----------------------------------|-----------------------------------|------------------|-----------------------------------|-----------------------------------|
|                   | VaR <sup>index</sup> | VaR <sup>i</sup>  | CoVaR <sup>i</sup> <sub>add</sub> | CoVaR <sup>i</sup> <sub>exp</sub> | VaR <sup>i</sup> | CoVaR <sup>i</sup> <sub>add</sub> | CoVaR <sup>i</sup> <sub>exp</sub> |
| VIX               | -0.27<br>(-11.85)    | -0.44<br>(-9.50)  | -0.21<br>(-15.55)                 | -0.18<br>(-9.03)                  | -0.39<br>(-3.34) | -0.2<br>(-6.13)                   | -0.18<br>(-2.48)                  |
| 3 Month Yield     | 0.65<br>(3.34)       | 0.2<br>(-0.10)    | 0.22<br>(-3.12)                   | -0.75<br>(-2.98)                  | 0.46<br>(-1.22)  | 0.23<br>(-1.8)                    | -0.06<br>(-0.14)                  |
| Repo spread       | -0.08<br>(-1.59)     | 1.47<br>(-1.67)   | 0.08<br>(-0.16)                   | 0.96<br>(-3.09)                   | 0.46<br>(-0.2)   | -0.85<br>(-1.01)                  | 0.42<br>(-0.23)                   |
| Credit spread     | -0.05<br>(-0.50)     | -0.31<br>(-0.72)  | -0.25<br>(-0.62)                  | -2.16<br>(-6.32)                  | -1.42<br>(-0.73) | -0.31<br>(-0.77)                  | -1.15<br>(-1.26)                  |
| Term spread       | 0.5<br>(-1.62)       | 0.58<br>(-3.48)   | 0.27<br>(-2.13)                   | -0.69<br>(-3.65)                  | 0.73<br>(-1.17)  | 0.15<br>(-0.76)                   | 0.36<br>(-0.97)                   |
| Leverage          | -1.15<br>(-4.66)     | -1.67<br>(-4.71)  | -0.79<br>(-5.76)                  | -0.83<br>(-7.74)                  | -1.28<br>(-3.91) | -0.56<br>(-4.74)                  | -0.4<br>(-1.73)                   |
| Maturity Mismatch | 0.81<br>(-1.64)      | 18.52<br>(-1.59)  | -3.78<br>(-0.41)                  | -2.78<br>(-0.95)                  | -1.89<br>(-0.03) | -0.64<br>(-0.01)                  | 0.78<br>(-0.01)                   |
| Book to Market    | -10.55<br>(-3.65)    | -15.67<br>(-3.00) | -6.71<br>(-3.85)                  | -10.12<br>(-6.98)                 | -1.24<br>(-0.22) | 0.16<br>(-0.09)                   | 4.61<br>(-0.7)                    |

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# Overview

1. Systemic Risk Measure + Procyclicality
2. Definition of CoVaR
  - Contribution CoVaR vs. Exposure CoVaR
3. Quantile Regressions
4. Data
5. CoVaR vs. VaR
6. Time-varying CoVaR
7. Addressing Procyclicality
  - Linking CoVaR to institution's characteristics
  - Predicting ...
8. Related Literature and Conclusion

# || Avoid Procyclicality

- Regulatory charges on  $\Delta\text{CoVaR}_{\text{contri}}$  may introduce procyclicality
  - Like VaR does in Basel II framework
- **Way out:**  
Link + *predict*  $\Delta\text{CoVaR}_{\text{contri}}$  to frequently observed characteristics (use Panel data structure)
  - Maturity mismatch
  - Leverage
  - .... special data only bank supervisors have
- **Extra:**
  - Show that these variable carry information beyond VaR

# Contemporaneous

## PANEL A: INSTITUTIONS

## PANEL B: PORTFOLIOS

|                | CoVaR <sup>i</sup> <sub>add</sub> |                    | CoVaR <sup>i</sup> <sub>exp</sub> |                    | CoVaR <sup>i</sup> <sub>add</sub> |                    | CoVaR <sup>i</sup> <sub>exp</sub> |                    |
|----------------|-----------------------------------|--------------------|-----------------------------------|--------------------|-----------------------------------|--------------------|-----------------------------------|--------------------|
|                | (1)<br>FE, TE                     | (2)<br>FE          | (3)<br>FE, TE                     | (4)<br>FE          | (1)<br>FE, TE                     | (2)<br>FE          | (3)<br>FE, TE                     | (4)<br>FE          |
| VaR            | 0.19***<br>(0.01)                 | 0.17***<br>(0.01)  | -0.1<br>(0.07)                    | 0.15***<br>(0.03)  | 0.34***<br>(0.01)                 | 0.24***<br>(0.01)  | -0.55***<br>(0.03)                | 0.22***<br>(0.02)  |
| Maturity Mism. | 0.49<br>(0.3)                     | -0.94***<br>(0.32) | -1.92*<br>(1.08)                  | -2.76***<br>(0.94) | -0.13<br>(0.24)                   | -1.94***<br>(0.28) | 0.71<br>(0.48)                    | 0.35<br>(0.55)     |
| Leverage       | -0.03***<br>(0.01)                | -0.05***<br>(0.01) | -0.01<br>(0.02)                   | -0.01<br>(0.02)    | -0.01**<br>(0.0)                  | -0.06***<br>(0.01) | 0<br>(0.01)                       | 0<br>(0.01)        |
| Book to Market | -0.03<br>(0.06)                   | -0.20***<br>(0.05) | 0.07<br>(0.15)                    | 0.05<br>(0.14)     | 0.05<br>(0.09)                    | -0.42***<br>(0.06) | -0.55***<br>(0.14)                | -0.19<br>(0.12)    |
| Weight         | 26.36***<br>(5.16)                | 31.91***<br>(5.92) | -13.57<br>(15.26)                 | -25.41*<br>(13.48) | 0.38<br>(0.93)                    | 2.57**<br>(1.04)   | 5.22***<br>(1.4)                  | 1.37<br>(1.98)     |
| Constant       | 0.24<br>(0.31)                    | 1.36***<br>(0.3)   | -3.88**<br>(1.51)                 | -0.6<br>(0.93)     | 0.99***<br>(0.24)                 | 2.93***<br>(0.23)  | -8.99***<br>(0.46)                | -1.74***<br>(0.47) |
| Observations   | 1539                              | 1539               | 1539                              | 1539               | 2668                              | 2668               | 2668                              | 2668               |
| R-squared      | 0.73                              | 0.57               | 0.59                              | 0.49               | 0.78                              | 0.58               | 0.73                              | 0.374              |

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# Contemporaneous

PANEL A: INSTITUTIONS

PANEL B: PORTFOLIOS

|                | CoVaR <sub>add</sub> <sup>i</sup> |                    | CoVaR <sub>exp</sub> <sup>i</sup> |                    | CoVaR <sub>add</sub> <sup>i</sup> |                    | CoVaR <sub>exp</sub> <sup>i</sup> |                    |
|----------------|-----------------------------------|--------------------|-----------------------------------|--------------------|-----------------------------------|--------------------|-----------------------------------|--------------------|
|                | (1)<br>FE, TE                     | (2)<br>FE          | (3)<br>FE, TE                     | (4)<br>FE          | (1)<br>FE, TE                     | (2)<br>FE          | (3)<br>FE, TE                     | (4)<br>FE          |
| VaR            | 0.19***<br>(0.01)                 | 0.17***<br>(0.01)  | -0.1<br>(0.07)                    | 0.15***<br>(0.03)  | 0.34***<br>(0.01)                 | 0.24***<br>(0.01)  | -0.55***<br>(0.03)                | 0.22***<br>(0.02)  |
| Maturity Mism. | 0.49<br>(0.3)                     | -0.94***<br>(0.32) | -1.92*<br>(1.08)                  | -2.76***<br>(0.94) | -0.13<br>(0.24)                   | -1.94***<br>(0.28) | 0.71<br>(0.48)                    | 0.35<br>(0.55)     |
| Leverage       | -0.03***<br>(0.01)                | -0.05***<br>(0.01) | -0.01<br>(0.02)                   | -0.01<br>(0.02)    | -0.01**<br>(0.0)                  | -0.06***<br>(0.01) | 0<br>(0.01)                       | 0<br>(0.01)        |
| Book to Market | -0.03<br>(0.06)                   | -0.20***<br>(0.05) | 0.07<br>(0.15)                    | 0.05<br>(0.14)     | 0.05<br>(0.09)                    | -0.42***<br>(0.06) | -0.55***<br>(0.14)                | -0.19<br>(0.12)    |
| Weight         | 26.36***<br>(5.16)                | 31.91***<br>(5.92) | -13.57<br>(15.26)                 | -25.41*<br>(13.48) | 0.38<br>(0.93)                    | 2.57**<br>(1.04)   | 5.22***<br>(1.4)                  | 1.37<br>(1.98)     |
| Constant       | 0.24<br>(0.31)                    | 1.36***<br>(0.3)   | -3.88**<br>(1.51)                 | -0.6<br>(0.93)     | 0.99***<br>(0.24)                 | 2.93***<br>(0.23)  | -8.99***<br>(0.46)                | -1.74***<br>(0.47) |
| Observations   | 1539                              | 1539               | 1539                              | 1539               | 2668                              | 2668               | 2668                              | 2668               |
| R-squared      | 0.73                              | 0.57               | 0.59                              | 0.49               | 0.78                              | 0.58               | 0.73                              | 0.375              |

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# Predictive

(quarterly)

PANEL A: INSTITUTIONS

PANEL B: PORTFOLIOS

|                | CoVaR <sup>i</sup> <sub>add</sub> |           | CoVaR <sup>i</sup> <sub>exp</sub> |           | CoVaR <sup>i</sup> <sub>add</sub> |           | CoVaR <sup>i</sup> <sub>exp</sub> |           |
|----------------|-----------------------------------|-----------|-----------------------------------|-----------|-----------------------------------|-----------|-----------------------------------|-----------|
|                | (1)<br>FE, TE                     | (2)<br>FE | (3)<br>FE, TE                     | (4)<br>FE | (1)<br>FE, TE                     | (2)<br>FE | (3)<br>FE, TE                     | (4)<br>FE |
| VaR (lag)      | 0.15***                           | 0.13***   | -0.07                             | 0.11***   | 0.27***                           | 0.19***   | -0.41***                          | 0.15***   |
| Mat-Mism(lag)  | 0.46                              | -0.77**   | -2.07**                           | -2.81***  | -0.03                             | -1.03***  | 1.87***                           | 0.39      |
| Leverage (lag) | -0.03***                          | -0.06***  | -0.01                             | -0.02     | -0.01                             | -0.08***  | 0.01                              | -0.02     |
| B/M (lag)      | -0.05                             | -0.14**   | -0.04                             | 0.13      | -0.01                             | -0.22***  | -0.52***                          | 0.29***   |
| Weight (lag)   | 30.65***                          | 34.57***  | -14.3                             | -29.65**  | -0.82                             | 2.12*     | 4.96***                           | 0.38      |
| Constant       | -0.24                             | 0.86**    | -3.35***                          | -0.66     | 0.32                              | 2.05***   | -8.86***                          | -2.40***  |
|                | -0.37                             | -0.36     | -1.23                             | -0.88     | -0.27                             | -0.26     | -0.49                             | -0.47     |
| Observations   | 1544                              | 1544      | 1544                              | 1544      | 2668                              | 2668      | 2668                              | 2668      |
| R-squared      | 0.69                              | 0.46      | 0.59                              | 0.48      | 0.74                              | 0.43      | 0.69                              | 0.3       |

# Countercyclical regulation

- Lean against “credit bubbles”
  - Bubbles that impair financial (leveraged) sector
  - (NASDAQ vs. Housing bubble)
  - Combination of “bubbles + maturity mismatch” are toxic
- Margin/haircut spiral causes procyclicality
  - Steep yield curve in booms induces investors to finance themselves more short-term (“rollover risk” with negative fire-sale externalities)
- Look out for excesses in funding liquidity
  - Credit growth
  - Credit spreads
  - Haircuts/margins (LTV ratios)
- Laddered response (act early!) & prompt corrective action

# ||| Aside: Encourage long-term funding

- Liquidity charge
  - Capital charge
    - Strictly binding
    - Might stifle competition
  - Pigouvian tax + government insurance
    - Generates revenue
    - In times of crisis it is cheap to issue government debt
  - Private insurance scheme (Kashap, Rajan & Stein, 2008)
- Mark-to-funding accounting rule + mark-to-market
  - Dual role of accounting
    - Transparency *two balance sheets*
    - Constrain business decision (for capital requirements) *creditor protection*  
*economy-wide concern*

# Related Literature

- **Risk measures**  
Jorion, Artzner et al. (1999)
- **Dependence / contagion:**  
Boyson, Stahel, Stulz (2008), Chan, Getmansky, Haas, Lo (2006), Adrian (2007), Forbes, Rigobon (2002)
- **Pricing factors:**  
Fung and Hsieh (2001, 2002, 2003), Hasanhodzic & Lo (2007)
- **Finance applications of quantile regressions:**  
Bassett and Chen (2001), Chernozhukov and Umantsev (2001)

# Conclusion

- Macro-prudential regulation
  - Focus on externalities
  - Measure for systemic risk is needed, e.g. CoVaR
  - Maturity mismatch (+ Leverage) – encourage long-term funding
- Countercyclical regulation
  - Find variables that predict average CoVaR
  - Forward-looking measures, spreads, ...
- Also,
  - VaR measure is not sufficient – incorrect focus
  - Quantile regressions are simple and efficient way to calculate CoVaR