

# Measuring Systemic Risk

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# Systemic Risk

- What is systemic risk?
  - Widespread failure of financial institutions or freezing of capital markets that impair financial intermediation – payments system and lending to corporations/households.
- When does it emerge?
  - Financial sector has too little capital to cover its liabilities.
- In this crisis,
  - In early Fall of 08, the GSEs, Lehman, Merrill Lynch, Wamu, Wachovia, Citigroup, ... effectively failed. Markets were already or began to freeze.
  - Outcome of systemic risk in the Fall of '08 and Winter '09:
    - Stock Markets: US -42%, UK -46%, Europe -49%, Japan -35%, Latin America -50%
    - GDP: Advanced economies -3.2%, Global -0.8%
    - International Trade -12%

# Traditional regulation

- Traditional approach: Firm-level risk
  - Goal: Limit risk of individual bank
  - Challenge: Detailed knowledge of activities inside the firm, impose VaR limits, concentration limits, capital ratios, etc.
- Traditional approach ignores systemic risk
  - Distress of entire financial system with negative externalities on the real economy
- Traditional measures not grounded in any economic theory of systemic risk

# Simple Motivation: Stress Tests of 2009

- Time line
  - Feb 25: Fed, FDIC, OCC to examine 19 largest Bk. Hold. Cos. Capital Assistance Program (CAP) as backstop.
  - May 7: Results: Overall losses of 19 banks for 2009-2010 estimated as \$600B under adverse scenario. 9 of 19 have enough capital and future earnings to withstand losses. Other 10 need to raise a total of \$75B.
- Two key points
  - **Aggregate shortfall** of \$75 billion
  - Not all banks are undercapitalized → **need to differentiate**

# Challenges for Systemic Regulation

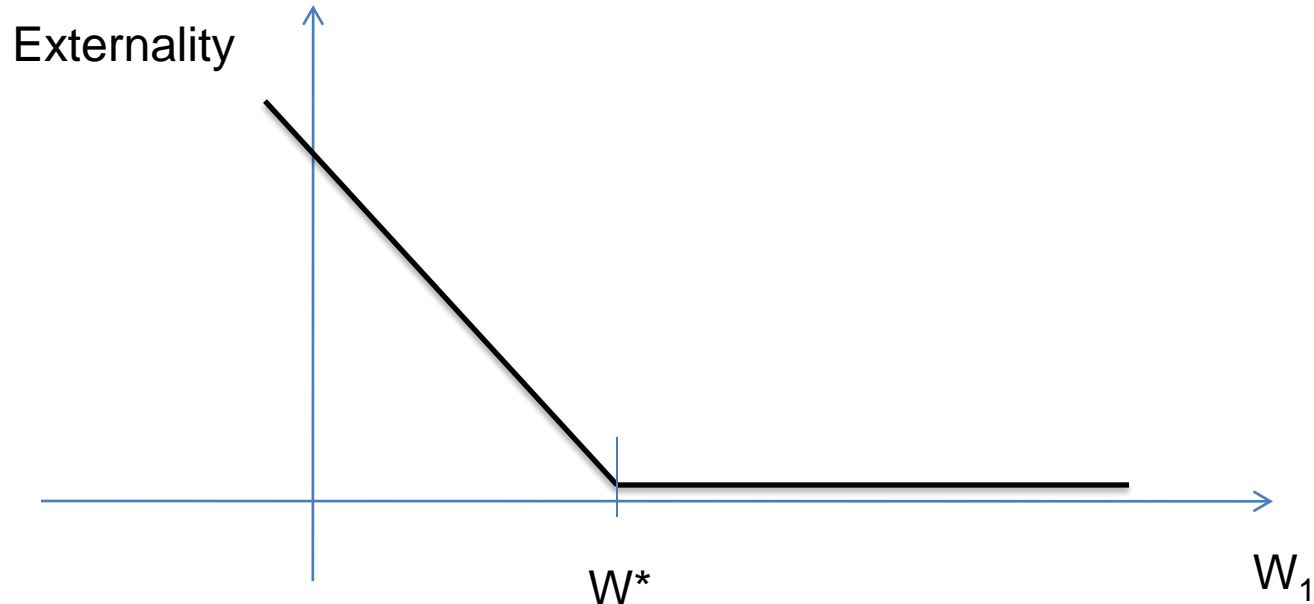
- Identify ex-ante the firms that pose greater systemic risk
- Make firms internalize external costs of systemic risk
- Outline of our work
  - Start from simple economic theory
  - Identify sensible measure of systemic risk
  - Provide empirical evidence of its usefulness: (i) stress tests of Spring 2009; (ii) Equity decline in 2007-08; (iii) CDS widening in 2007-08
  - Propose a regulatory system to achieve regulatory goals (“A Tax on Systemic Risk”, forthcoming, NBER proceedings on *Quantifying Systemic Risk*, Joe Haubrich and Andy Lo, eds. 2010)

# Our model

- Many banks  $i=1,..N$  and two dates
- Time 0: Choice of investments & leverage
  - Each bank has given initial level of capital  $w_{i,0}$
  - Issue debt/deposits implicitly or explicitly insured by government
  - Allocate investments among  $s=1..S$  risky assets and cash
- Time 1: Returns are realized
  - Returns realized. Pay creditors, keep profits.
  - Limited liability: if insolvent, government bails out depositors & debt holders

# Our model: Externality

- Let  $W_1$  be aggregate net worth of financial system at time 1
- Systemic distress happens if  $W_1$  falls below some cutoff  $W^*$
- Imposes negative externality  $e(W^*-W_1)$  on economy



# Economic model - results

- Without government intervention,
  - Banks choose leverage level and exposures  $x=(x_I, \dots, x_S)$  with a risk level higher than socially optimal.
- To correct this, government could regulate
  - Leverage level (capital requirements)
  - Exposures  $x=(x_I, \dots, x_S)$  (Glass-Steagall)
  - Or, optimally, charge a “tax”/”insurance premium”
- What is the “best” regulation?
  - We assume sufficient metrics of systemic risk contributions available to design optimal taxation (a normative benchmark)



# Efficient regulation

- Tax system with two components

$$\tau_i = DES_i + e \cdot SES_i$$

- Default Expected Shortfall (DES):

- *The bank's expected losses upon default*
- Analogous to the FDIC insurance premium. Justified by government guarantees on deposits.

- Systemic Expected Shortfall (SES):

- *The bank's expected losses in a crisis*
- Expected contribution of bank to the aggregate shortfall of capital during a crisis. Justified by  $e$ .

# Systemic Expected Shortfall

- A bank's SES is larger if
  - the externality is more severe ( $e$ ),
  - systemic under-capitalization is more likely ( $Pr[W_i < W^*]$ )
  - the bank takes a larger exposure ( $x_s$ ) in an asset  $s$  that experiences losses when other banks are in trouble
  - the bank is more leveraged ( $w_0$ )
- In our empirical work, we focus on the cross-sectional part of SES, taking as given (i) the size of externality or the level of tax; (ii) the likelihood of systemic crisis, the time-series part

# Measuring SES

- Analogy with risk management inside firms
  - Banks compute contribution of segment  $s$  (business line, geographical region, etc.) to overall VaR of the bank

$$MVaR_s = \frac{\partial VaR}{\partial v_s}$$

- Define marginal expected shortfall
  - Choose cutoff (say 5% risk level) for aggregate return
  - Compute bank's equity return on the days where market return below cutoff

$$MES_i = E \left[ -r_i \mid R < R^{\%} \right]$$

# Empirical methodology

- MES: Very simple non-parametric estimation:
  - find the 5% worst days for the market
  - compute each institution's return on these days
- From MES to SES
  - MES measured on 5% worst days in “normal” times, while SES should correspond to much higher risk as it is in the “tail”
    - For example, -50% aggregate return on a 6 month period would imply a Great Recession or a Depression
  - Leverage should thus matter too (more for OTM option strategies, e.g., insurance companies, liquidity puts sold by Citigroup, etc.)

# Test I: Stress Tests of 2009

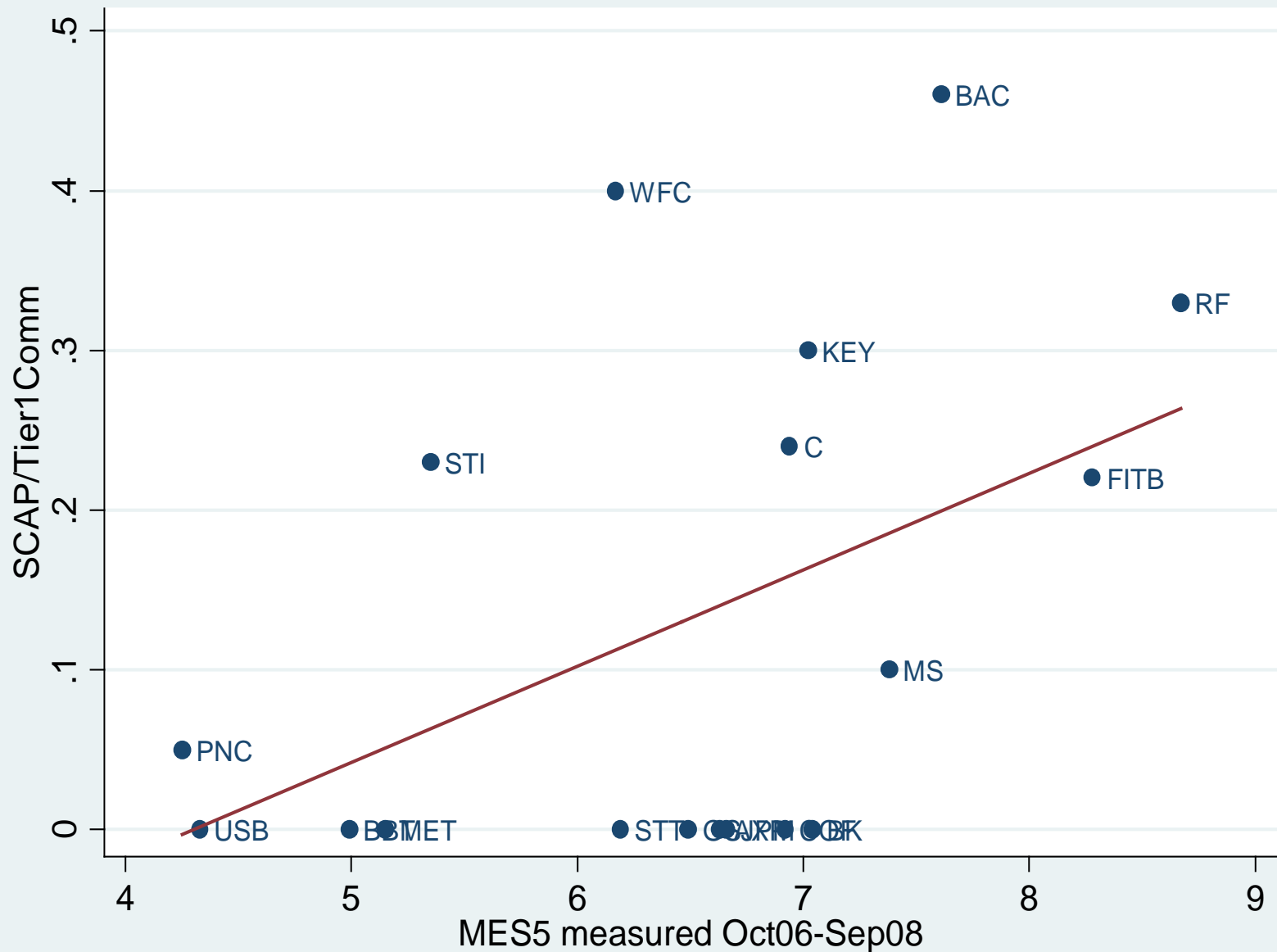
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# Example #3:

## Stress test of Spring 2009: Summary results

Panel A							
Bank Name	SCAP	Tier1	Tier1Comm	SCAP/Tier1	SCAP/Tier1Comm	MES	LVG
REGIONS FINANCIAL CORP							
NEW	2.5	12.1	7.6	20.66%	32.89%	14.8	44.42
BANK OF AMERICA CORP	33.9	173.2	75	19.57%	45.50%	15.05	50.38
WELLS FARGO & CO NEW	13.7	86.4	34	15.86%	40.41%	10.57	20.58
KEYCORP NEW	1.8	11.6	6	15.52%	30.00%	15.44	24.36
SUNTRUST BANKS INC	2.2	17.6	9.4	12.50%	23.40%	12.91	39.85
FIFTH THIRD BANCORP	1.1	11.9	4.9	9.24%	22.45%	14.39	67.16
CITIGROUP INC	5.5	118.8	23	4.63%	24.02%	14.98	126.7
MORGAN STANLEY DEAN							
WITTER & CO	1.8	47.2	18	3.81%	10.11%	15.17	25.39
P N C FINANCIAL SERVICES							
GRP INC	0.6	24.1	12	2.49%	5.13%	10.55	21.58
AMERICAN EXPRESS CO	0	10.1	10	0.00%	0.00%	9.75	7.8
B B & T CORP	0	13.4	7.8	0.00%	0.00%	9.57	14.78
BANK NEW YORK INC	0	15.4	11	0.00%	0.00%	11.09	6.46
CAPITAL ONE FINANCIAL CORP	0	16.8	12	0.00%	0.00%	10.52	33.06
GOLDMAN SACHS GROUP INC	0	55.9	34	0.00%	0.00%	9.97	18.94
JPMORGAN CHASE & CO	0	136.2	87	0.00%	0.00%	10.45	20.43
METLIFE INC	0	30.1	28	0.00%	0.00%	10.28	26.14
STATE STREET CORP	0	14.1	11	0.00%	0.00%	14.79	10.79
U S BANCORP DEL	0	24.4	12	0.00%	0.00%	8.54	10.53

# Stress tests: Predictive power of MES (equity)



# Stress test: Predictive power of MES and LVG

## Panel A: Dependent Variable is SCAP Shortfall/Tier1

April08-March09

	OLS			Probit		
	(I)	(II)	(III)	(IV)	(V)	(VI)
<b>Intercept</b>	-17.29 (-2.2)	3.14 (1.16)	-17.33 (-2.00)	-5.44 (-2.72)	-2.43 (-2.26)	-6.04 (-2.24)
<b>MES</b>	1.91 (3.00)		1.91 (2.46)	0.45 (2.72)		0.34 (1.65)
<b>LVG</b>		0.09 (1.35)	-0.001 (-0.01)		0.10 (2.16)	0.09 (1.61)
<b>Adj. R<sup>2</sup></b>	32.03%	4.65%	27.5%	40.68%	45.09%	53.22%
<b>No. Obs</b>	18	18	18	18	18	18

Oct07-Sep08

OLS		
(VII)	(VIII)	(IX)
-13.46 (-1.50)	3.94 (1.12)	-14.19 (-1.50)
3 (2.19)		3.29 (2.04)
	0.15 (0.66)	-0.09 (-0.37)
18.27%	-3.46%	13.61%
18	18	18

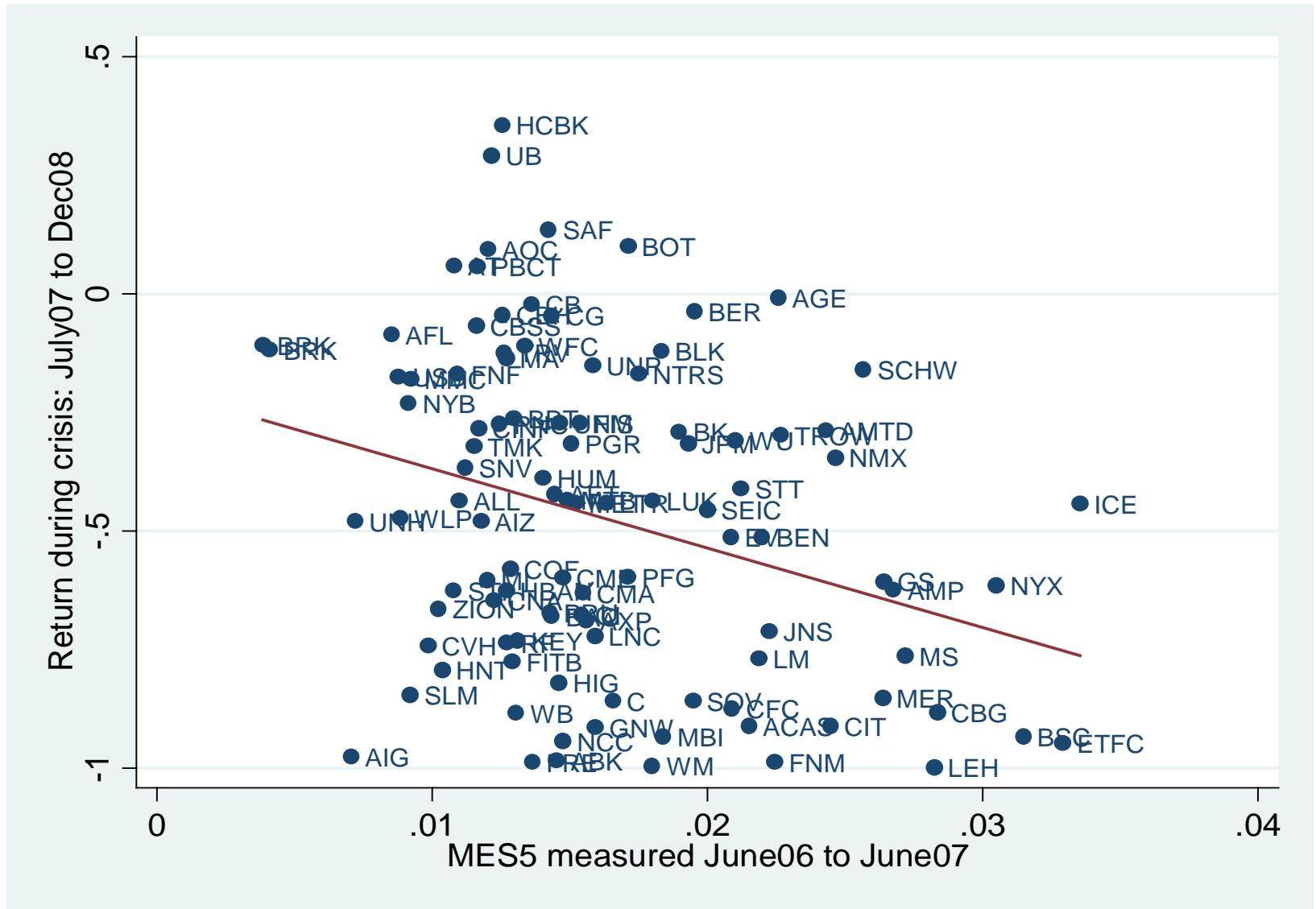


# Test II: Systemic risk during 2007-08 (equity)

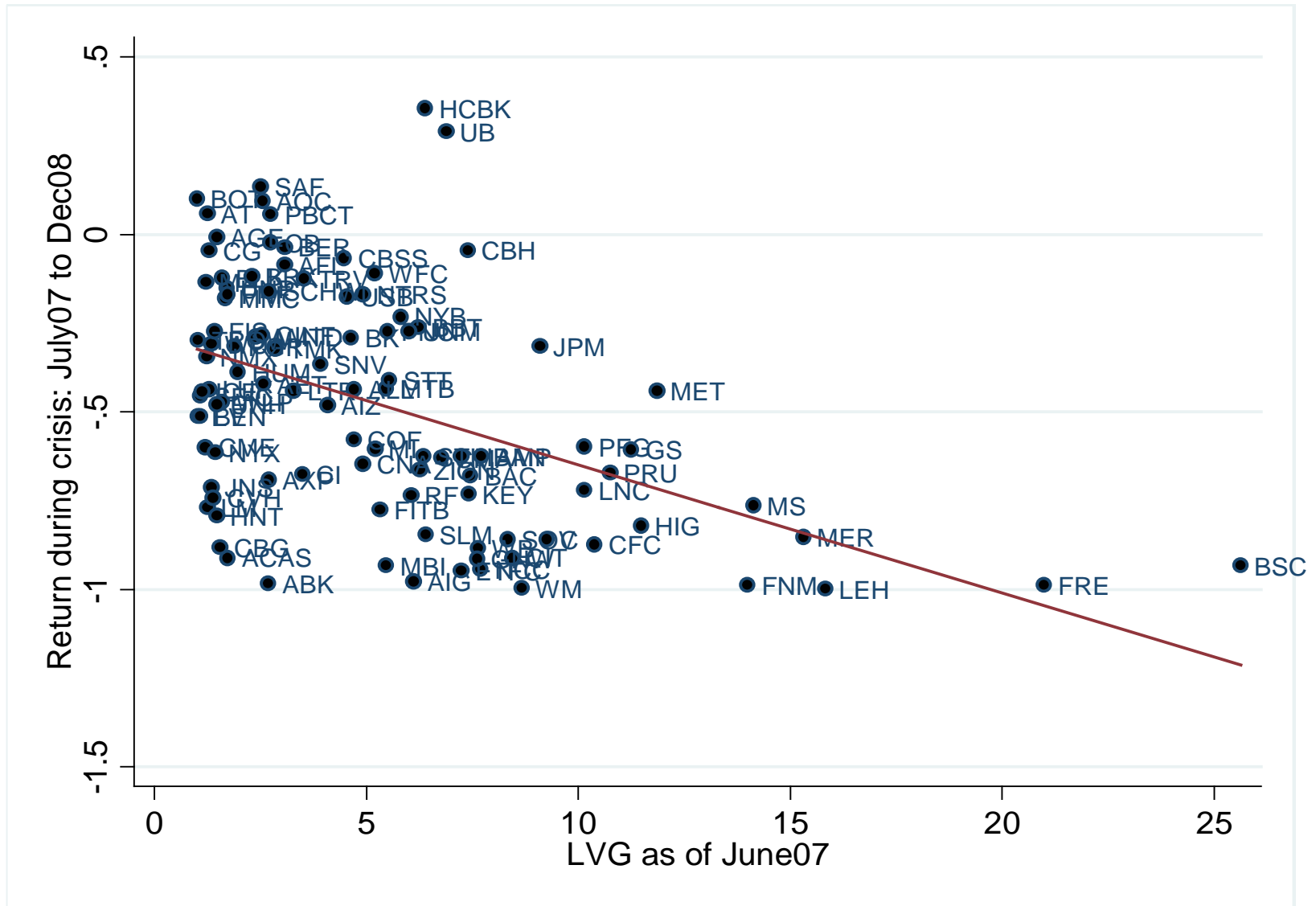
**Panel A: Descriptive statistics of the measures Realized SES, ES, MES, Vol, Beta, LVG, Log-Assets and ME.**

	<b>Realized SES</b>	<b>ES</b>	<b>MES</b>	<b>Vol</b>	<b>Beta</b>	<b>LVG</b>	<b>Log-Assets</b>	<b>ME(blns)</b>
<b>Average</b>	-47%	2.73%	1.63%	21%	1.00	5.25	10.84	31.25
<b>Median</b>	-46%	2.52%	1.47%	19%	0.89	4.54	10.88	15.85
<b>Std. dev.</b>	34%	0.92%	0.62%	8%	0.37	4.40	1.78	42.88
<b>Min</b>	-100%	1.27%	0.39%	10%	0.34	1.01	6.43	5.16
<b>Max</b>	36%	5.82%	3.36%	49%	2.10	25.62	14.61	253.70

# 2007-08: Predictive power of MES (equity)



# 2007-08: Predictive power of LVG





# Fitted (MES, LVG, Industry) rankings

Name of Company	Realized SES	MES	Avg \$Loss(bln)	Avg Contribution	LVG	Fitted Rank	Assets (bln)	ME(bln)
INTERCONTINENTALEXCHANGE INC	-44.24%	3.36%	0.24	0.28%	1.12	16	2.55	10.40
E TRADE FINANCIAL CORP	-94.79%	3.29%	0.33	0.42%	7.24	21	62.98	9.39
BEAR STEARNS COMPANIES INC	-93.28%	3.15%	0.55	0.68%	25.62	1	423.30	16.66
N Y S E EURONEXT	-61.48%	3.05%	0.43	0.53%	1.43	19	16.93	19.44
C B RICHARD ELLIS GROUP INC	-88.16%	2.84%	0.20	0.25%	1.55	24	5.95	8.35
LEHMAN BROTHERS HOLDINGS INC	-99.82%	2.83%	1.08	1.26%	15.83	4	605.86	39.51
MORGAN STANLEY DEAN WITTER & CO	-76.21%	2.72%	2.09	2.51%	14.14	9	1199.99	88.40
AMERIPRISE FINANCIAL INC	-62.41%	2.68%	0.35	0.43%	7.72	7	108.13	14.95
GOLDMAN SACHS GROUP INC	-60.59%	2.64%	2.13	2.41%	11.25	15	943.20	88.54
MERRILL LYNCH & CO INC	-85.21%	2.64%	1.93	2.25%	15.32	5	1076.32	72.56
SCHWAB CHARLES CORP NEW	-15.95%	2.57%	0.59	0.66%	2.71	88	49.00	25.69
NYMEX HOLDINGS INC	-34.46%	2.47%	0.28	0.33%	1.23	98	3.53	11.57
C I T GROUP INC NEW	-91.08%	2.45%	0.26	0.32%	8.45	8	85.16	10.52
T D AMERITRADE HOLDING CORP	-28.75%	2.43%	0.24	0.30%	2.40	26	18.53	11.92
T ROWE PRICE GROUP INC	-29.83%	2.27%	0.27	0.32%	1.03	101	3.08	13.76
EDWARDS A G INC	-0.71%	2.26%	0.11	0.13%	1.46	100	5.24	6.43
FEDERAL NATIONAL MORTGAGE ASSN	-98.78%	2.25%	1.24	1.51%	14.00	3	857.80	63.57
JANUS CAP GROUP INC	-71.12%	2.23%	0.09	0.10%	1.34	35	3.76	5.16
FRANKLIN RESOURCES INC	-51.23%	2.20%	0.62	0.66%	1.08	40	9.62	33.07
LEGG MASON INC	-76.98%	2.19%	0.29	0.30%	1.25	38	10.08	12.97
AMERICAN CAPITAL STRATEGIES LTD	-91.08%	2.15%	0.15	0.17%	1.73	32	12.15	7.75
STATE STREET CORP	-41.07%	2.12%	0.46	0.52%	5.54	28	112.27	23.01
WESTERN UNION CO	-30.84%	2.10%	0.36	0.42%	1.34	83	5.33	16.09
COUNTRYWIDE FINANCIAL CORP	-87.46%	2.09%	0.48	0.57%	10.39	6	216.82	21.57



# Different estimation periods and weights

**Panel A (MES): The dependent variable is Realized SES, the company stock returns during the crisis**

	<b>June06-May07</b>	<b>May06-Apr07</b>	<b>Apr06-Mar07</b>	<b>Mar06-Feb07</b>
<b>Intercept</b>	-0.14* (-1.75)	-0.20** (-2.42)	-0.20** (-2.48)	-0.23*** (-3.09)
<b>MES</b>	-0.10** (-2.30)	-0.05 (-1.26)	-0.05 (-1.24)	-0.04 (-0.98)
<b>LVG</b>	-0.04*** (-5.06)	-0.04*** (-5.09)	-0.04*** (-5.21)	-0.04*** (-5.20)
<b>Adj. R<sup>2</sup></b>	24.87%	21.84%	22.61%	21.00%
<b>No. Obs</b>	102	102	102	102

**Panel B (W-MES): The dependent variable is Realized SES, the company stock returns during the crisis**

<b>Intercept</b>	-0.21*** (-3.22)	-0.09 (-1.11)	-0.09 (-1.15)	-0.18* (-1.96)
<b>W-MES</b>	-0.07* (-1.73)	-0.10*** (-2.96)	-0.10*** (-2.94)	-0.03 (-1.30)
<b>LVG</b>	-0.04*** (-5.01)	-0.03*** (-4.49)	-0.03*** (-4.61)	-0.04*** (-5.25)
<b>Adj. R<sup>2</sup></b>	23.15%	27.11%	27.76%	21.97%
<b>No. Obs</b>	102	102	102	102

**Panel C (D-MES): The dependent variable is Realized SES, the company stock returns during the crisis**

<b>Intercept</b>	-0.12 (-1.40)	-0.06 (-0.66 )	-0.11 (-1.24)	-0.18* (-2.27)
<b>D-MES</b>	-0.12* (-2.23)	-0.13** (-2.86)	-0.12* (-2.36)	-0.08 (-1.92)
<b>LVG</b>	-0.03** (-5.25 )	-0.03** (-4.82 )	-0.03** (-4.13 )	-0.03** (-5.02)
<b>Adj. R<sup>2</sup></b>	24.14%	26.44%	24.58%	23.15%
<b>No. Obs</b>	102	102	102	102

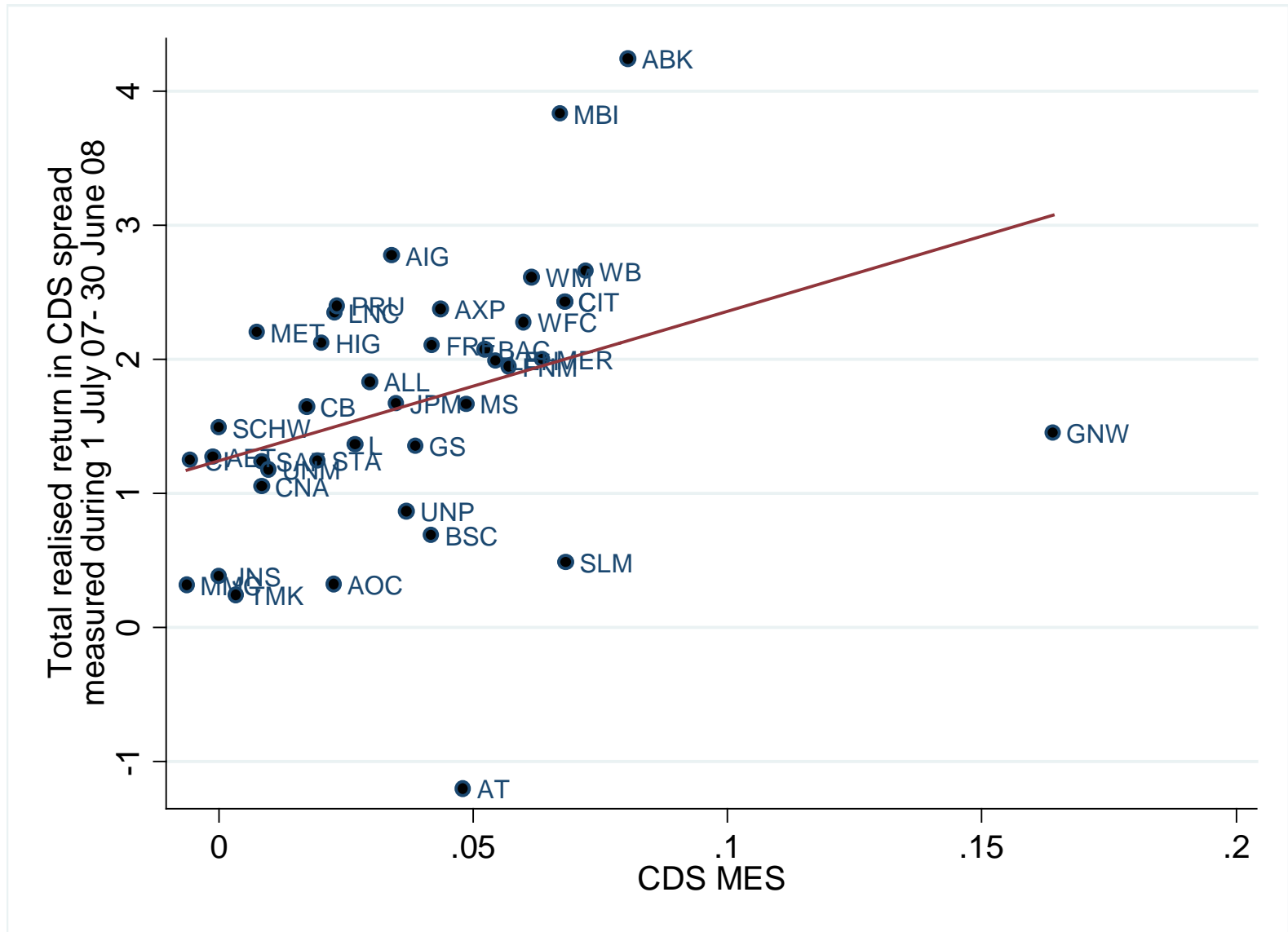
# Test III: Systemic risk during 2007-08 (cds)

**Panel A: Descriptive statistics of the MES measures of CDS and SES measures of CDS and stock**

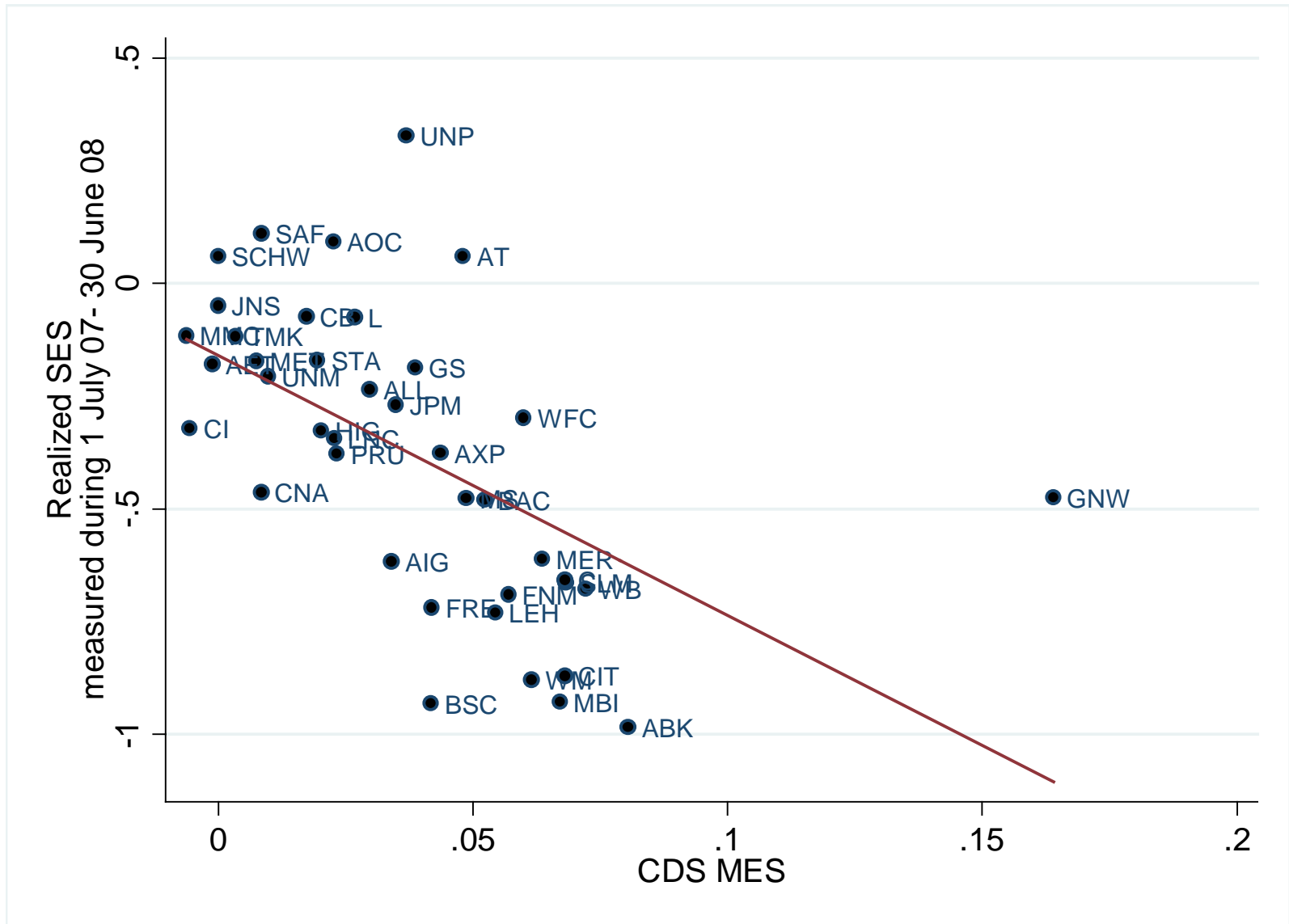
	CDS (log returns)			CDS (arithmetic changes) in b.p		
	MES	Realized SES (1 July 06- 30 June 07)	Realized SES (1 July 06- 30 Dec 07)	MES	Realized SES (1 July 06- 30 June 07)	Realized SES (1 July 06- 30 Dec 07)
<b>Average</b>	3.46%	167.29%	218.04%	1.02	150.96	379.53
<b>Median</b>	3.59%	166.91%	214.69%	0.57	64.64	187.05
<b>Std. dev.</b>	3.21%	99.62%	116.37%	1.54	316.68	802.39
<b>Min</b>	-0.63%	-119.93%	-103.25%	-0.25	3.00	-204.11
<b>Max</b>	16.40%	424.10%	436.42%	6.84	1580.27	3550.28



# 2007-08: Predictive power of MES (cds)



# 2007-08: Predictive power of MES (cds)



# Predictive power of CDS MES for CDS SES

Panel A: The dependent variable is total realized return on CDS spread during the crisis, CDS MES is measured as log returns

	1 July07-30 June 08	1 July07-14 Sep 08	1 July07-30 Sep 08	1 July07-10 Oct 8	1 July07-30 Dec 08
<b>CDS MES</b>	10.21** (2.06)	9.67* (1.83)	13.11** (2.15)	10.72 (1.65)	11.56* (2.02)
<b>LVG</b>	0.05 (1.43)	0.05 (1.41)	0.05 (1.33)	0.06 (1.45)	0.03 (0.81)
<b>Constant</b>	1.34** (2.68)	1.75** (3.28)	1.80*** (2.93)	1.90*** (2.91)	1.71*** (2.96)
<b>Other</b>	-0.95* (-1.93)	-1.29** (-2.46)	-1.22* (-2.02)	-0.97 (-1.52)	-1.09* (-1.92)
<b>Insurance</b>	-0.14 (-0.32)	-0.48 (-1.01)	-0.44 (-0.81)	-0.03 (-0.04)	0.35 (0.68)
<b>Broker dealers</b>	-0.87 (-1.52)	-0.91 (-1.49)	-0.72 (-1.02)	-0.80 (-1.07)	-0.63 (-0.96)
<b>Adj. R<sup>2</sup></b>	17.86%	19.94%	19.37%	10.80%	19.30%
<b>No. Obs</b>	40	40	40	40	40

# Predictive power of CDS MES for Equity SES

Panel A: The dependent variable is realized stock return during the crisis, CDS MES is measured as log returns

	1 July07-30 June 08	1 July07-14 Sep 08	1 July07-30 Sep 08	1 July07-10 Oct 8	1 July07-30 Dec 08
<b>CDS MES</b>	-4.38*** (-3.33)	-5.20*** (-3.52)	-6.05*** (-3.83)	-4.48*** (-3.19)	-4.11*** (-2.77)
<b>LVG</b>	-0.03*** (-3.82)	-0.04*** (-4.31)	-0.04*** (-4.13)	-0.04*** (-4.17)	-0.03 (-3.64)
<b>Constant</b>	-0.03 (-0.26)	0.19 (1.29)	0.25 (1.57)	-0.007 (-0.05)	-0.14 (-0.91)
<b>Other</b>	0.09 (0.69)	-0.11 (-0.76)	-0.16 (-0.99)	-0.13 (-0.90)	-0.09 (-0.62)
<b>Insurance</b>	0.03 (0.24)	-0.08 (-0.62)	-0.17 (-1.19)	-0.19 (-1.53)	-0.06 (-0.44)
<b>Broker dealers</b>	0.19 (1.26)	0.07 (0.43)	0.03 (0.19)	0.03 (0.21)	0.07 (0.39)
<b>Adj. R<sup>2</sup></b>	46.79%	51.66%	50.94%	45.52%	40.76%
<b>No. Obs</b>	40	40	40	40	40

# CDS MES rankings

Name of company	Type of institution	CDS MES ranking	Realized CDS SES (July 07-June 08)	Realized CDS SES (July 07-Dec 08)	CDS MES
GENWORTH FINANCIAL INC	Insurance	1	145.38%	403.03%	16.40%
AMBAC FINANCIAL GROUP INC	Insurance	2	424.10%	389.12%	8.05%
WACHOVIA CORP 2ND NEW	Depository	3	266.11%	219.94%	7.21%
S L M CORP	Other	4	48.88%	113.08%	6.82%
CITIGROUP INC	Depository	5	243.16%	278.96%	6.80%
C I T GROUP INC NEW	Other	6	243.16%	278.96%	6.80%
M B I A INC	Insurance	7	383.11%	303.44%	6.71%
MERRILL LYNCH & CO INC	Broker-Dealer	8	200.27%	160.20%	6.37%
WASHINGTON MUTUAL INC	Depository	9	261.19%	436.42%	6.15%
WELLS FARGO & CO NEW	Depository	10	227.79%	233.43%	6.00%
FEDERAL NATIONAL MORTGAGE ASSN	Other	11	194.89%	78.69%	5.70%
LEHMAN BROTHERS HOLDINGS INC	Broker-Dealer	12	199.25%	282.25%	5.44%
BANK OF AMERICA CORP	Depository	13	207.86%	215.70%	5.23%
MORGAN STANLEY DEAN WITTER & CO	Broker-Dealer	14	166.88%	248.96%	4.86%
ALLTEL CORP	Other	15	-119.93%	-103.25%	4.80%
AMERICAN EXPRESS CO	Other	16	237.53%	293.40%	4.36%
FEDERAL HOME LOAN MORTGAGE CORP	Other	17	210.58%	94.57%	4.20%
BEAR STEARNS COMPANIES INC	Broker-Dealer	18	68.72%	84.96%	4.18%
GOLDMAN SACHS GROUP INC	Broker-Dealer	19	135.50%	213.68%	3.87%
UNION PACIFIC CORP	Other	20	86.69%	123.56%	3.69%
JPMORGAN CHASE & CO	Depository	21	166.95%	182.80%	3.49%
AMERICAN INTERNATIONAL GROUP INC	Insurance	22	277.42%	369.20%	3.40%

# Systemic regulation: Theoretical motivation

- Goal: Limit risk of collapse of the system
- Regulation needed: firms will not manage their systemic risk
  - Incentive to take correlated risk
    - Acharya (2001, 2009), Acharya and Yorulmazer (2007), Farhi and Tirole (2009)
  - Externalities
    - Liquidity spirals (Brunnermeier and Pedersen (2009), Pedersen (2009))
    - Bank runs (Diamond and Dybvig (1983), Allen and Gale (1998))
    - Debt market freezes (Acharya, Gale, and Yorulmazer (08), He and Xiong (2009))
    - Tightening risk management (Garleanu and Pedersen (2007))

# Related literature

- Contingent claims analysis
  - Lehar (2005), Gray, Merton, and Bodie (2008), Gray and Jobst (2009)
- Statistical measures:
  - Huang, Zhou, and Zhu (2009), Adrian and Brunnermeier (2009)
- Other proposals
  - Kashyap, Rajan, and Stein (2008), Wall (1989), Doherty and Harrington (1997), Flannery (2005), Hart and Zingales (2009), Squam lake group's report, NYU book (chapter 13), ...

# Conclusion

- Economic model of systemic risk gives rise to SES
- Systemic expected shortfall (SES)
  - Measures each financial institution's *contribution* to systemic crisis
  - Increases in: tail-dependence with the economy/market/financial sector as a whole, and in leverage
  - An SES tax/insurance incentivizes banks to contribute less to crisis
- Empirically
  - Ex ante SES predicts ex post crisis losses
  - We analyze its cross-sectional properties
  - In different periods, different markets, predicts “worst” systemic firms



# Implementation: Our proposal

- Based on our other contributions
  - Chapter 13 of *Restoring Financial Stability* (“Regulating Systemic Risk”) and
  - “A Tax on Systemic Risk”, forthcoming, NBER proceedings on *Quantifying Systemic Risk*, Joe Haubrich and Andy Lo, eds. 2010
- SES signals institutions likely to contribute to aggregate crises
- Three approaches to limit systemic risk
  1. **Systemic Capital Requirement**
    - Capital requirement proportional to estimated systemic risk
  2. **Systemic Fees** (FDIC-style)
    - Fees proportional to estimated systemic risk
    - Create systemic fund
  3. **Private/public systemic insurance**

# Our systemic insurance proposal

- Compulsory insurance against own losses during crisis
  - Payment goes to systemic fund, not the bank itself
  - Insurance from government, prices from the market
    - Say 5 cents from private; 95 cents from the government
    - Analogy to terrorism reinsurance by the government (TRIA, 2002)
- Advantages of private/public proposal
  - A market-based estimate of the contribution to crises and externalities
  - Private sector has incentives to be forward looking
  - Gives bank an incentive to be less systemic and more transparent:
    - to lower their insurance payments

# Systemic insurance

- Illustrative calculations (40% drop in the market, required capitalization of 10% equity/assets)
  - Tables of systemic firm ranking based on insurance charges over the period 2004-2007 as a function of \$ charges and of \$ charges as a % of equity value, using contingent claims valuation and as inputs
    - Firm's equity volatility
    - Market volatility
    - Correlation of firm and market returns
    - Leverage
    - Risk-free rate

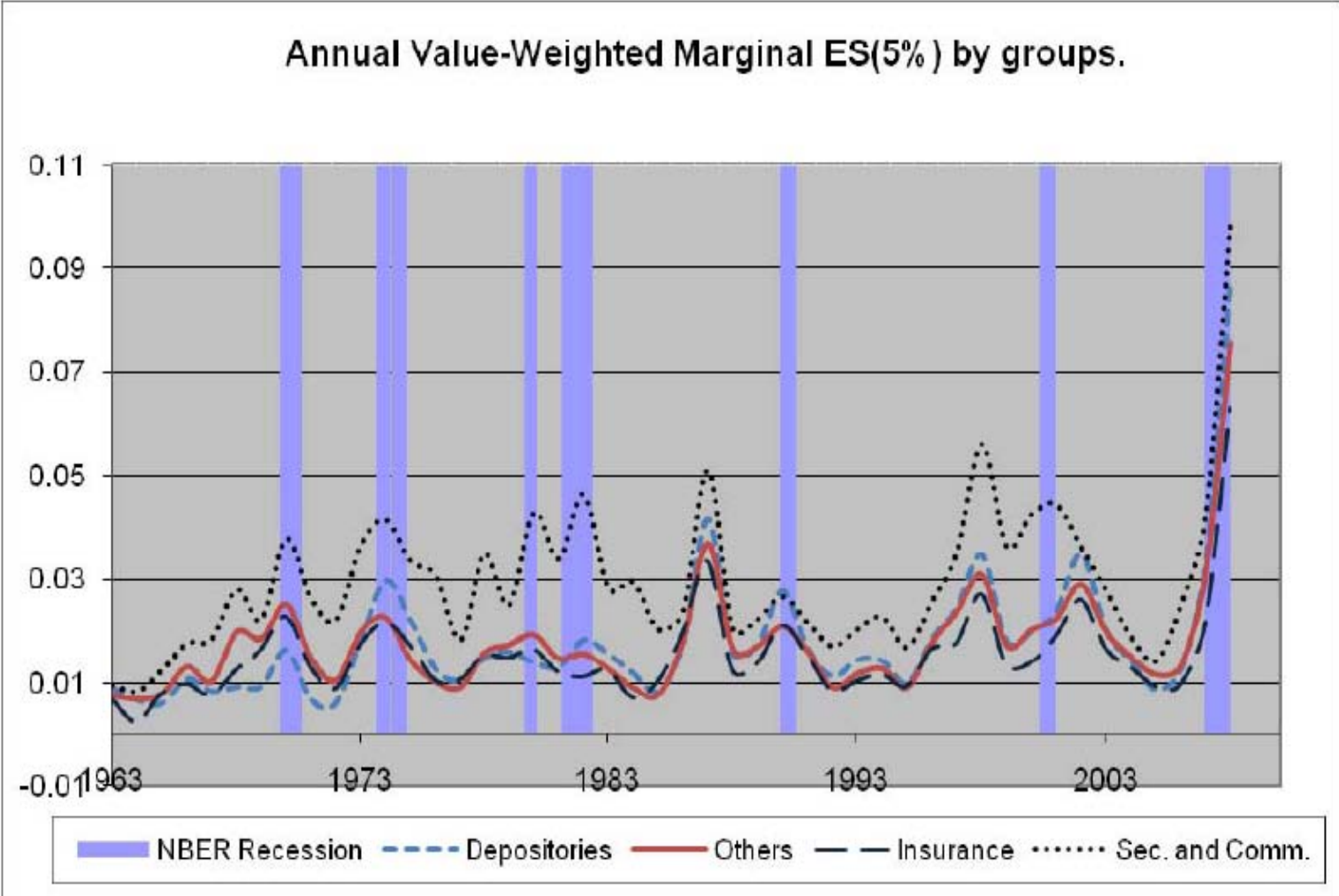
# Rankings of (% eqty) insurance cost '04-07

Rank	2004	2005	2006	2007
1	BEAR STEARNS COMPANIES INC	BEAR STEARNS COMPANIES INC	BEAR STEARNS COMPANIES INC	BEAR STEARNS COMPANIES INC
2	GENWORTH FINANCIAL INC	FEDERAL HOME LOAN MORTGAGE CORP	FEDERAL NATIONAL MORTGAGE ASSN	FEDERAL HOME LOAN MORTGAGE CORP
3	LEHMAN BROTHERS HOLDINGS INC	FEDERAL NATIONAL MORTGAGE ASSN	MORGAN STANLEY DEAN WITTER & CO	LEHMAN BROTHERS HOLDINGS INC
4	PRUDENTIAL FINANCIAL INC	MORGAN STANLEY DEAN WITTER & CO	LEHMAN BROTHERS HOLDINGS INC	MERRILL LYNCH & CO INC
5	MORGAN STANLEY DEAN WITTER & CO	LINCOLN NATIONAL CORP IN	GOLDMAN SACHS GROUP INC	MORGAN STANLEY DEAN WITTER & CO
6	LINCOLN NATIONAL CORP IN	LEHMAN BROTHERS HOLDINGS INC	MERRILL LYNCH & CO INC	FEDERAL NATIONAL MORTGAGE ASSN
7	FEDERAL NATIONAL MORTGAGE ASSN	GOLDMAN SACHS GROUP INC	METLIFE INC	GOLDMAN SACHS GROUP INC
8	HARTFORD FINANCIAL SVCS GROUP I	MERRILL LYNCH & CO INC	HARTFORD FINANCIAL SVCS GROUP I	COUNTRYWIDE FINANCIAL CORP
9	METLIFE INC	HARTFORD FINANCIAL SVCS GROUP I	PRUDENTIAL FINANCIAL INC	METLIFE INC
10	MERRILL LYNCH & CO INC	PRUDENTIAL FINANCIAL INC	LINCOLN NATIONAL CORP IN	HARTFORD FINANCIAL SVCS GROUP I
11	GOLDMAN SACHS GROUP INC	GENWORTH FINANCIAL INC	AMERIPRISE FINANCIAL INC	PRINCIPAL FINANCIAL GROUP INC
12	JPMORGAN CHASE & CO	METLIFE INC	COUNTRYWIDE FINANCIAL CORP	LINCOLN NATIONAL CORP IN
13	PRINCIPAL FINANCIAL GROUP INC	PRINCIPAL FINANCIAL GROUP INC	JPMORGAN CHASE & CO	PRUDENTIAL FINANCIAL INC
14	E TRADE FINANCIAL CORP	JPMORGAN CHASE & CO	UNUM GROUP	JPMORGAN CHASE & CO
15	UNUM GROUP	E TRADE FINANCIAL CORP	SOVEREIGN BANCORP INC	CITIGROUP INC
16	TRAVELERS COMPANIES INC	UNUM GROUP	PRINCIPAL FINANCIAL GROUP INC	AMERIPRISE FINANCIAL INC
17	C I G N A CORP	WASHINGTON MUTUAL INC	E TRADE FINANCIAL CORP	E TRADE FINANCIAL CORP
18	SOVEREIGN BANCORP INC	C N A FINANCIAL CORP	WASHINGTON MUTUAL INC	C I T GROUP INC NEW
19	WASHINGTON MUTUAL INC	COUNTRYWIDE FINANCIAL CORP	COMMERCE BANCORP INC NJ	WASHINGTON MUTUAL INC
20	COMMERCE BANCORP INC NJ	COMMERCE BANCORP INC NJ	HUNTINGTON BANCSHARES INC	COMMERCE BANCORP INC NJ

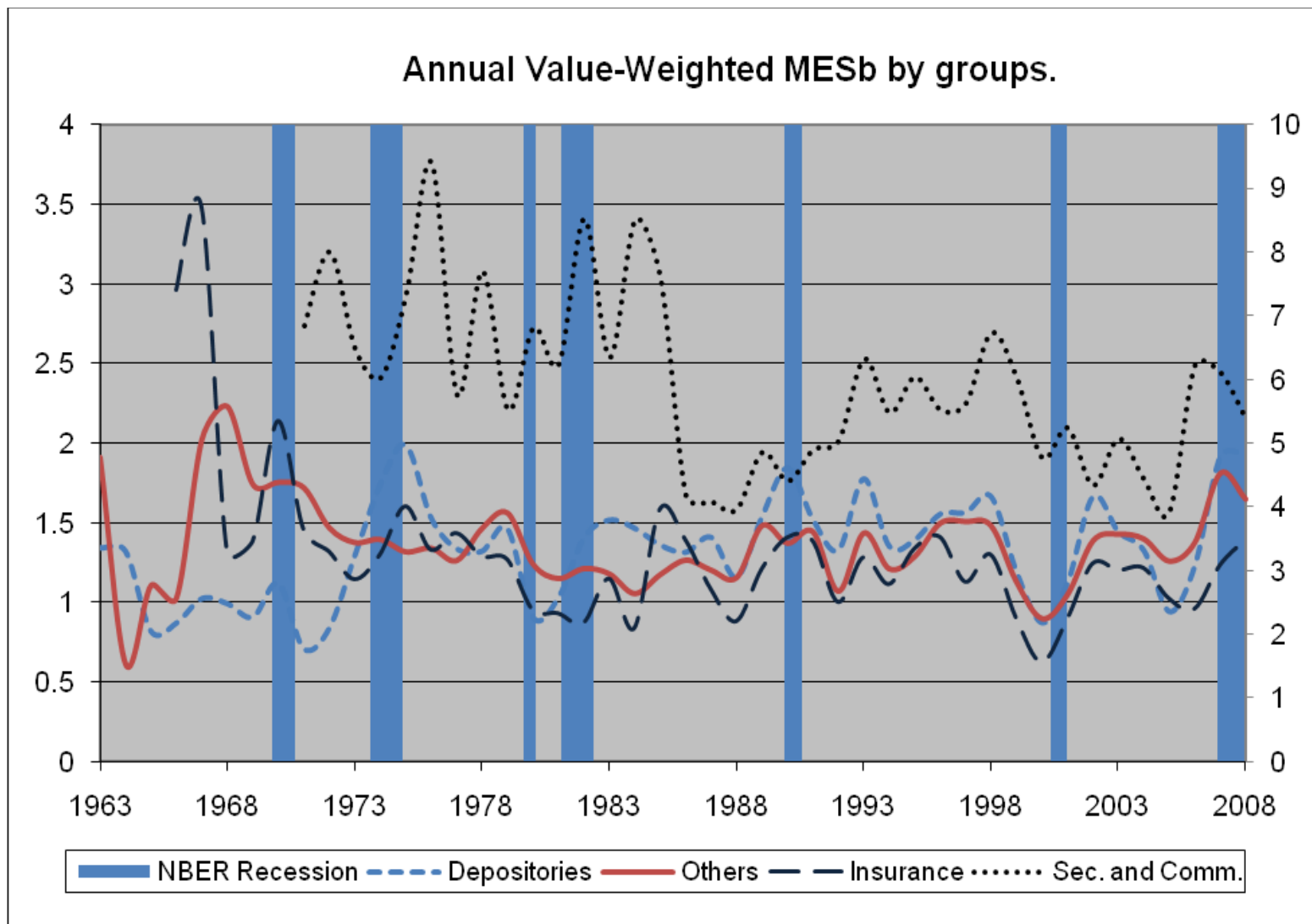
# Rankings of (\$) insurance costs in '04-07

Rank	2004	2005	2006	2007
1	FEDERAL NATIONAL MORTGAGE ASSN	FEDERAL NATIONAL MORTGAGE ASSN	MORGAN STANLEY DEAN WITTER & CO	MORGAN STANLEY DEAN WITTER & CO
2	MORGAN STANLEY DEAN WITTER & CO	MORGAN STANLEY DEAN WITTER & CO	FEDERAL NATIONAL MORTGAGE ASSN	CITIGROUP INC
3	JPMORGAN CHASE & CO	FEDERAL HOME LOAN MORTGAGE CORP	GOLDMAN SACHS GROUP INC	MERRILL LYNCH & CO INC
4	MERRILL LYNCH & CO INC	JPMORGAN CHASE & CO	MERRILL LYNCH & CO INC	JPMORGAN CHASE & CO
5	GOLDMAN SACHS GROUP INC	MERRILL LYNCH & CO INC	JPMORGAN CHASE & CO	GOLDMAN SACHS GROUP INC
6	LEHMAN BROTHERS HOLDINGS INC	GOLDMAN SACHS GROUP INC	LEHMAN BROTHERS HOLDINGS INC	FEDERAL HOME LOAN MORTGAGE CORP
7	PRUDENTIAL FINANCIAL INC	LEHMAN BROTHERS HOLDINGS INC	METLIFE INC	FEDERAL NATIONAL MORTGAGE ASSN
8	CITIGROUP INC	PRUDENTIAL FINANCIAL INC	BEAR STEARNS COMPANIES INC	LEHMAN BROTHERS HOLDINGS INC
9	BEAR STEARNS COMPANIES INC	METLIFE INC	PRUDENTIAL FINANCIAL INC	BEAR STEARNS COMPANIES INC
10	METLIFE INC	CITIGROUP INC	HARTFORD FINANCIAL SVCS GROUP I	METLIFE INC
11	HARTFORD FINANCIAL SVCS GROUP I	BEAR STEARNS COMPANIES INC	CITIGROUP INC	BANK OF AMERICA CORP
12	BANK OF AMERICA CORP	BANK OF AMERICA CORP	BANK OF AMERICA CORP	PRUDENTIAL FINANCIAL INC
13	WACHOVIA CORP 2ND NEW	AMERICAN INTERNATIONAL GROUP IN	WASHINGTON MUTUAL INC	HARTFORD FINANCIAL SVCS GROUP I
14	WASHINGTON MUTUAL INC	HARTFORD FINANCIAL SVCS GROUP I	COUNTRYWIDE FINANCIAL CORP	COUNTRYWIDE FINANCIAL CORP
15	LINCOLN NATIONAL CORP IN	WACHOVIA CORP 2ND NEW	WACHOVIA CORP 2ND NEW	WACHOVIA CORP 2ND NEW

# Time-series determinants of systemic risk

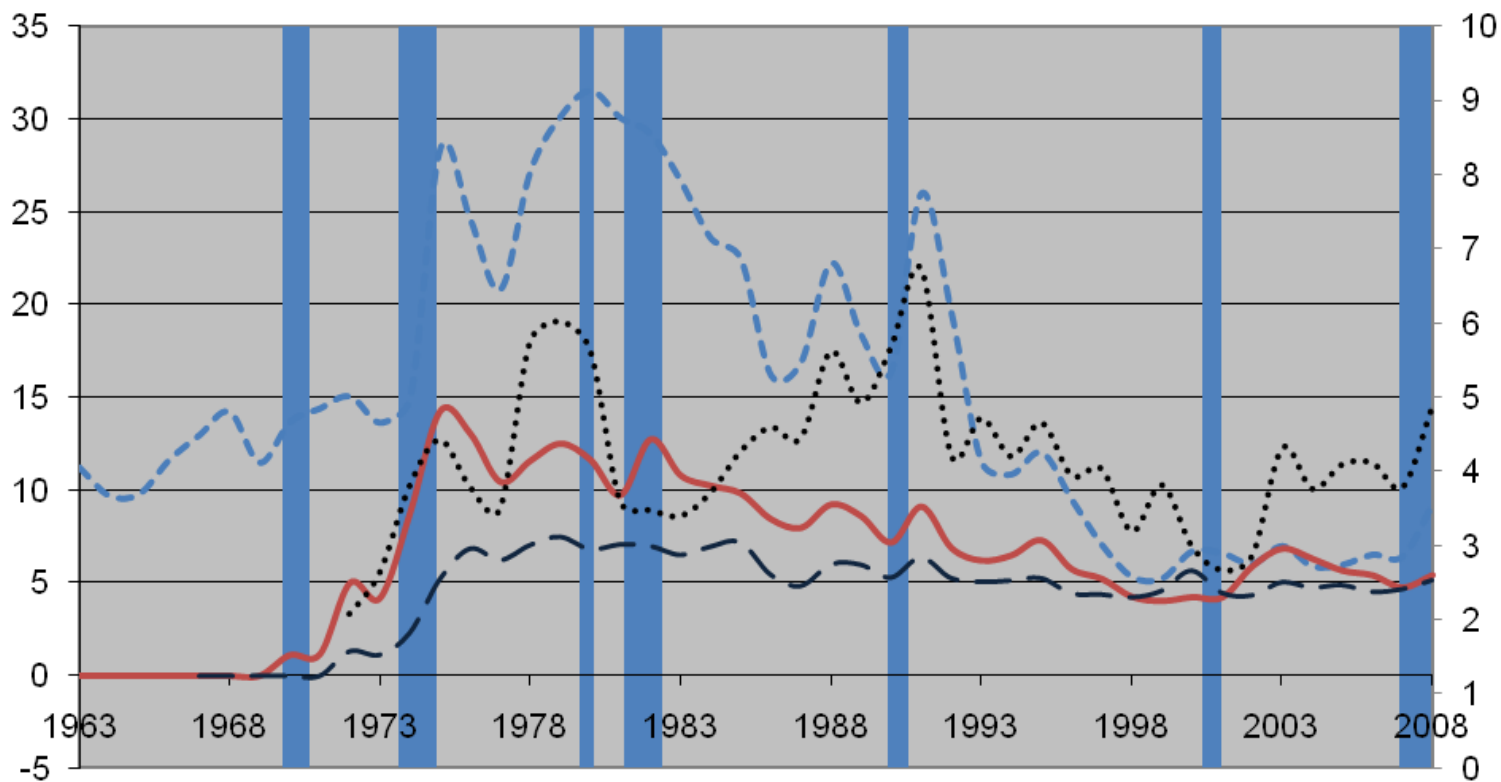


# Time-series determinants of systemic risk



# Time-series determinants of systemic risk

Annual Value-Weighted Quasi Market Leverage by groups.



■ NBER Recession --- Depositories — Others — Insurance ..... Sec. and Comm.