NYU STERN SYSTEMIC RISK RANKING

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Definition

- “Financial institutions are systemically important if the failure of the firm to meet its obligations to creditors and customers would have significant adverse consequences for the financial system and the broader economy.” (Governor Daniel Tarullo).

- Our view is that systemic risk emerges when aggregate capitalization of the financial sector is low. When a financial firm’s capital is low, re-intermediation of financial services is difficult, and, when capital is low in the aggregate, it is not possible for other financial firms to step into the breach.

WHAT CAUSES SYSTEMIC FAILURE?

- To a first approximation, a systemic financial crisis occurs if and only if there is a capital shortfall of the aggregate financial sector:
  - Financial firms could all be highly leveraged and face aggregate market exposure. A large shock to the economy could therefore cause large aggregate losses and a capital shortfall.
  - The financial sector, possibly starting from a weak point, could suffer a capital shortfall if a highly interconnected firm fails and losses reverberate throughout the sector.
  - The financial sector could also suffer a capital shortfall if a large financial firm fails and liquidation of illiquid assets leads to fire sales which pose funding problems for other financial firms which in turn lead to greater liquidations and more funding problems, et cetera.
  - The failure of a firm providing an essential service such as clearing or short term repo, will be systemic if the sector is weak so that no competitor can purchase the business even at an advantageous price.
- What should be clear from the above examples is that systemic risk is really a statement about co-dependence.

THE APPROACH

- We want to estimate for firm i, the expected capital requirements in a future crisis: (e.g. Stress Test)

$$E\left(Capital\ Shortfall_i \middle| Crisis\right)$$

- As we have little data on crises, it is necessary to carefully structure the problem.
- Estimate the expected equity losses for a firm from a modest decline in overall returns, MES
- Extrapolate this to a full financial crisis.
- Calculate capital shortages.

ALTERNATIVE APPROACHES

- Supervisory Data Available
  - Stress Tests such as Supervisory Capital Assessment Program
  - Network models with explicit counterparty exposure information to trace shocks such as Duffie 10 x 10 x 10
  - Analysis of specific risks - who holds Greek debt and how vulnerable are these firms?
- Public Data Only
  - CoVaR and its variations
  - VAR of VaR, CAViaR
  - CDS as in IMF and FED?
  - MES

STRESS TESTS

- The role of stress tests is similar. If the economy weakens in particular ways, how much capital will the firm require?
- Typically these are “bottom up” measures that look at individual assets and assess their prospects under the stress.
- If the stress is designed to reflect a future financial crisis, then the goals are the same.
- Stress tests and market based measures provide checks for each other.

INTERPRETATION

- If there is a crisis, which firms will need the most capital?
- Capital shortages in a crisis have major impacts on the rest of the economy.
- Crisis is an endogenous variable.

- *So firms that have big shortfalls in a crisis are really the major contributors to the crisis.*

MARGINAL EXPECTED SHORTFALL

- The expected shortfall of a market index is defined by

$$ES_t = E_{t-1}\left(-R_{m,t} \,\middle|\, R_{m,t} < c\right)$$

- ES is a useful and coherent measure of risk.
- Recognizing that the market return is a weighted average of individual firm returns,

$$ES_t = \sum_{i=1}^{N} w_i E_{t-1}\left(-R_{i,t} \,\middle|\, R_{m,t} < c\right)$$

- MES can be interpreted as each firm's contribution to system losses.

$$MES_{i,t} = E_{t-1}\left(-R_{i,t} \,\middle|\, R_{m,t} < c\right)$$

HOW TO ESTIMATE MES DYNAMICALLY

- Use flexible time series approaches to modeling volatilities, correlations and tails.
- The Model:

$$R_{m,t} = \sigma_{m,t}\varepsilon_{m,t}$$

$$R_{i,t} = \sigma_{i,t}\left(\rho_t \varepsilon_{m,t} + \sqrt{1-\rho_t^2}\,\xi_{i,t}\right)$$

$$\left(\varepsilon_{m,t}, \xi_{i,t}\right) \sim F$$

- Disturbances are serially independent, mean zero, variance one, uncorrelated but not independent random variables. Copula.
- Volatilities are Asymmetric GARCH models
- Correlations are Asymmetric DCC.

MARGINAL EXPECTED SHORTFALL

- At time t, MES is given by

$$MES_{i,t} = E_{t-1}\left(-R_{i,t} \middle| R_{m,t} < c\right)$$

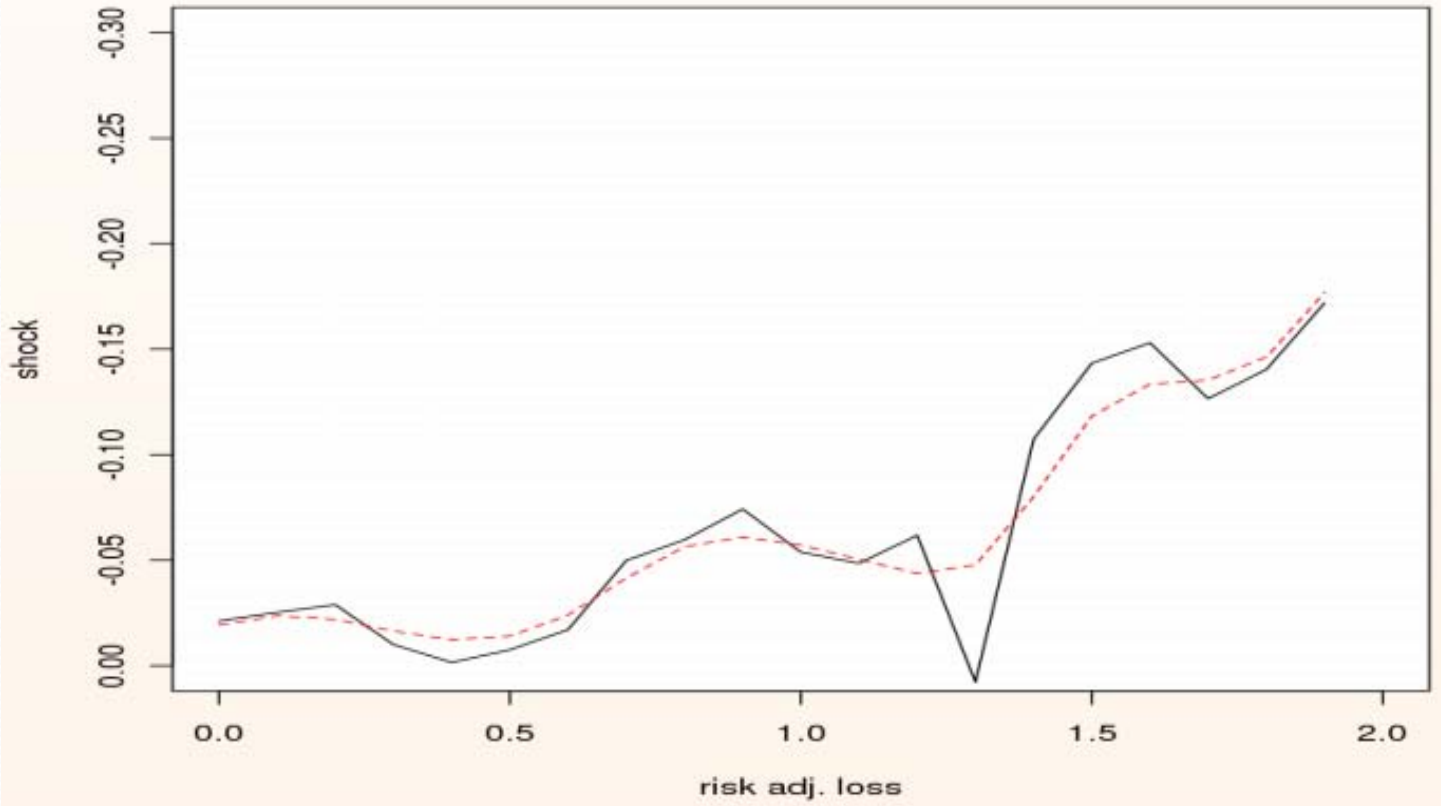
$$= \sigma_{i,t}\rho_{i,t}E_{t-1}\left(\varepsilon_{m,t} \middle| \varepsilon_{m,t} < c/\sigma_{m,t}\right) + \sigma_{i,t}\sqrt{1-\rho_t^2}\,E_{t-1}\left(\xi_{i,t} \middle| \varepsilon_{m,t} < c/\sigma_{m,t}\right)$$

- Firms are risky if they have high volatility
- Firms are systemically risky if they also have high correlations.
- Market ES is the same for all firms
- Estimate tail probabilities non-parametrically

TAILS

- Estimate tail probabilities non-parametrically
- Calculate how often this firm's return is in the negative tail when the market return is in the negative tail?
- Use a kernel to smooth the estimates.

SMOOTHING THE TAILS



$$\mathrm{E}_{t-1}\left(\xi_{i\,t} \middle| \epsilon_{m\,t} < \kappa\right) \text{ for CIT}$$

Equity Loss in Crisis

- To estimate the fall in equity value in a crisis, an adjustment is made to MES
  - MES is adjusted to measure the expected fall in equity prices that would occur in six months if the market return is worse than a 40% decline.
  - Approximately this is 18 times daily MES. The factor 18 is constant across firms and reflects the severity of the crisis.
- This is the extrapolation step.

MULTI-STEP FORECASTING

- Simulate the bivariate outcome of (r_i, r_m) for six months starting on date t using the estimated model for volatilities, correlations and copula.
- Examine all the scenarios where market return falls by at least 40%. Find average loss for firm i. R are fractional returns.

$$\theta = \frac{E_t\left(\sum_{j=1}^{126} R_{i,t+j} \,\middle|\, \sum_{j=1}^{126} R_{m,t+j} < -.40\right)}{E_t\left(R_{i,t+1} \,\middle|\, R_{m,t+1} < .02\right)} \approx 18$$

- Factor of 18 is slightly too big, particularly after converting to fractional returns, and does not incorporate mean reversion.

SRISK : CAPITAL SHORTFALL IN A CRISIS

- As equity values fall in a crisis, leverage increases until the firm is in distress.
- Nominal debt is taken from Bloomberg and changes little over time. It is from 10-K and 10-Q filings.

- SRISK=min(0,E-*k*A)=min(0,(1-k)E-kD) where *k* is a prudential standard ratio of equity to assets such as 8%. E is equity, D is debt and A is asset value = E+D

SRISK%

- When equity falls dramatically, CAPITAL SHORTFALL becomes positive and it is the contribution by each firm to aggregate SHORTFALL that is the Stern Systemic Risk measure.

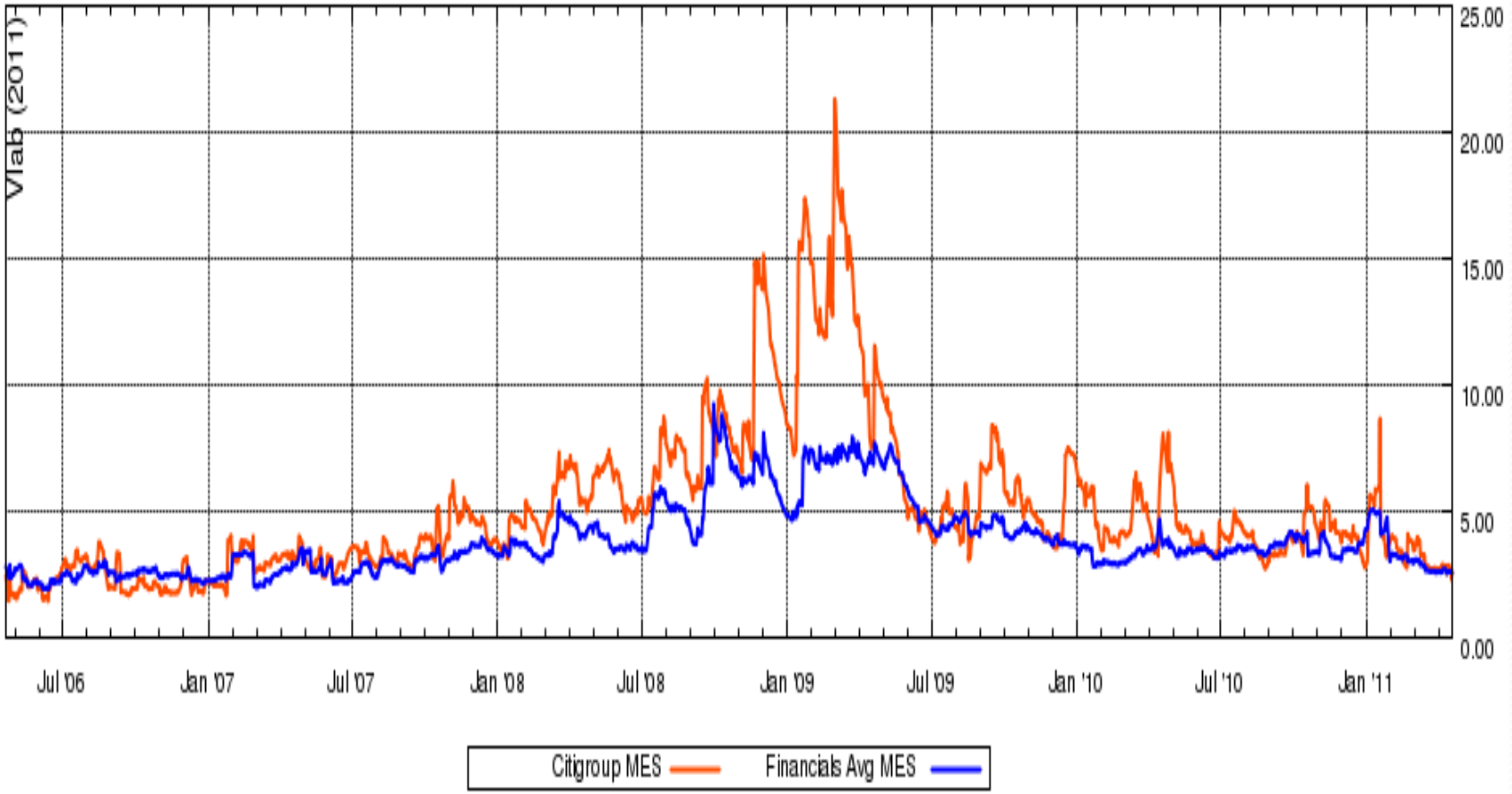
- $SRISK\%_{i,t} = SRISK_{i,t} / (\text{Total } SRISK_t)$

- This is the calculation step.

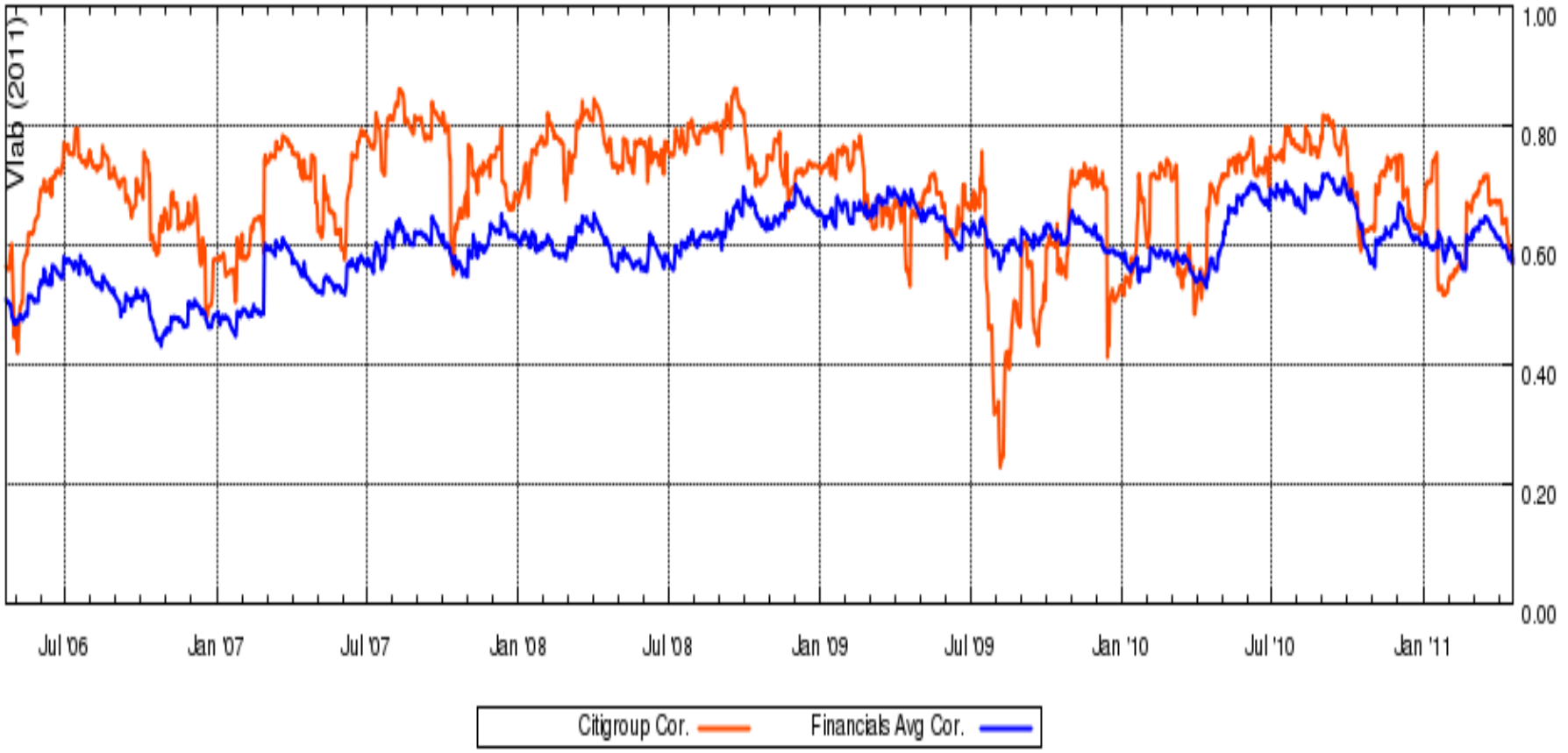
VLAB.STERN.NYU.EDU

- Daily updates of volatilities and correlations of hundreds of assets with a variety of methodologies
- New measures of Long Term Risk called the LTR Forecasts
- Systemic Risk Measures with details on the components. These are updated weekly.

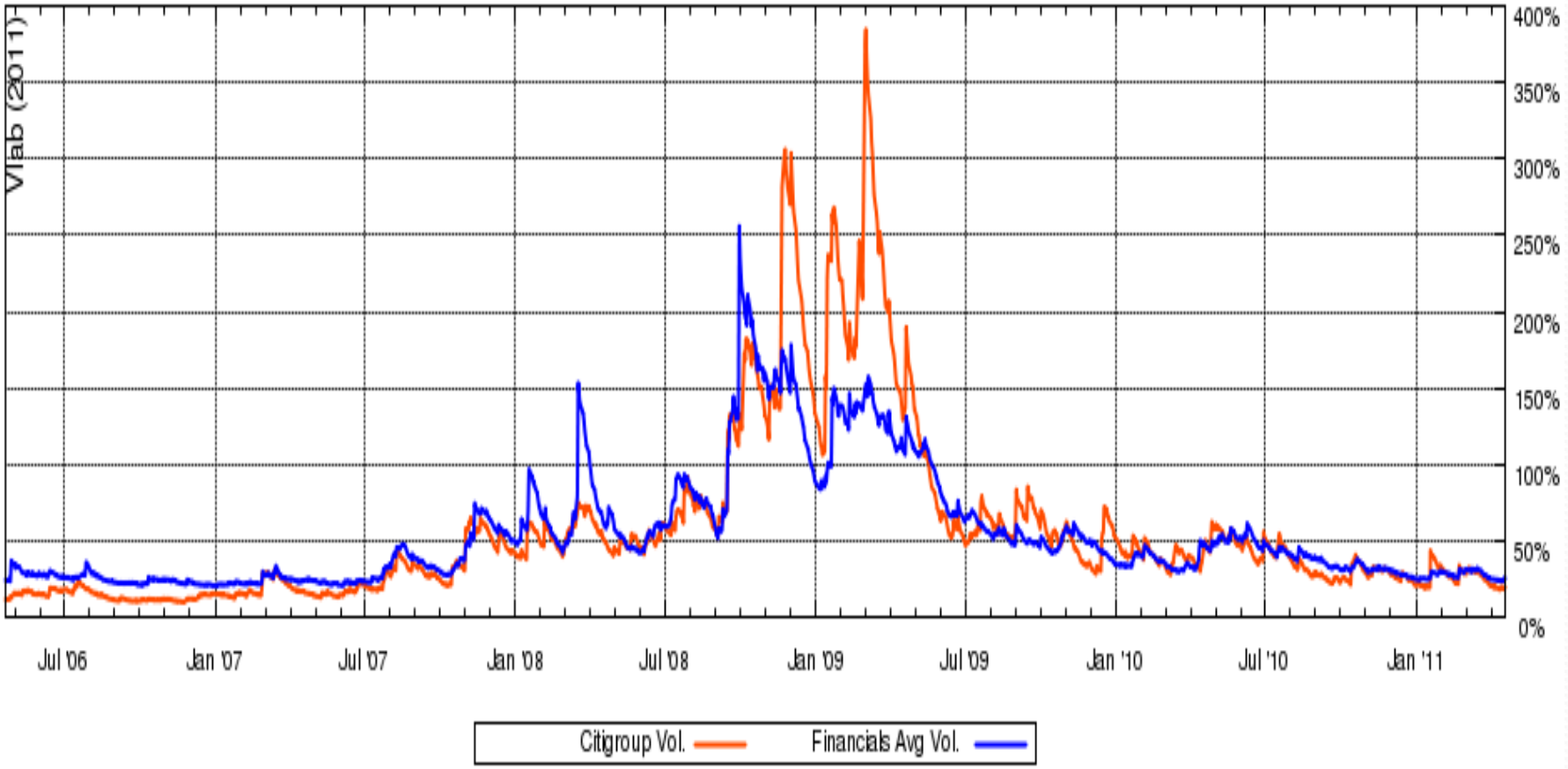
Citigroup MES



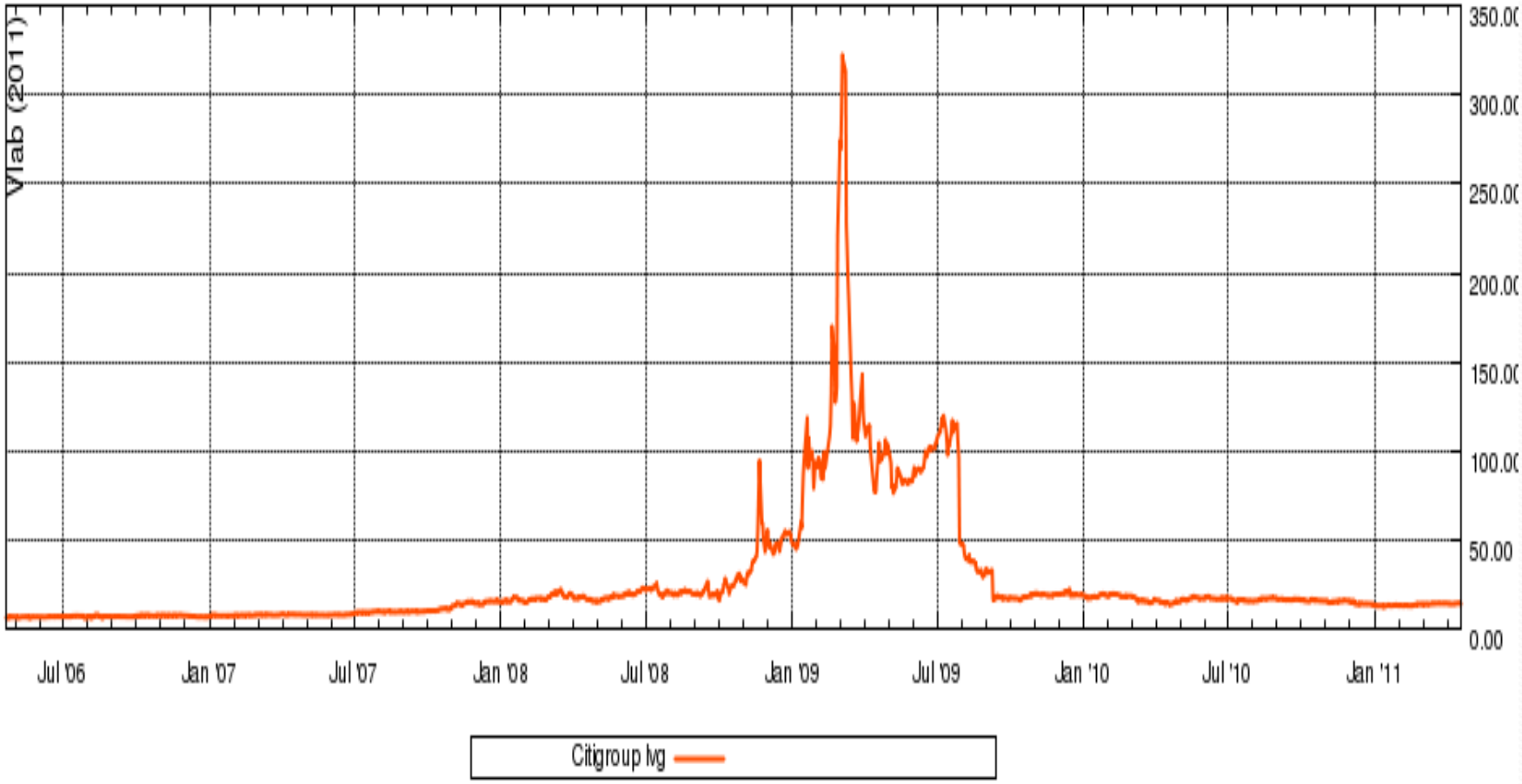
Citigroup Correlation



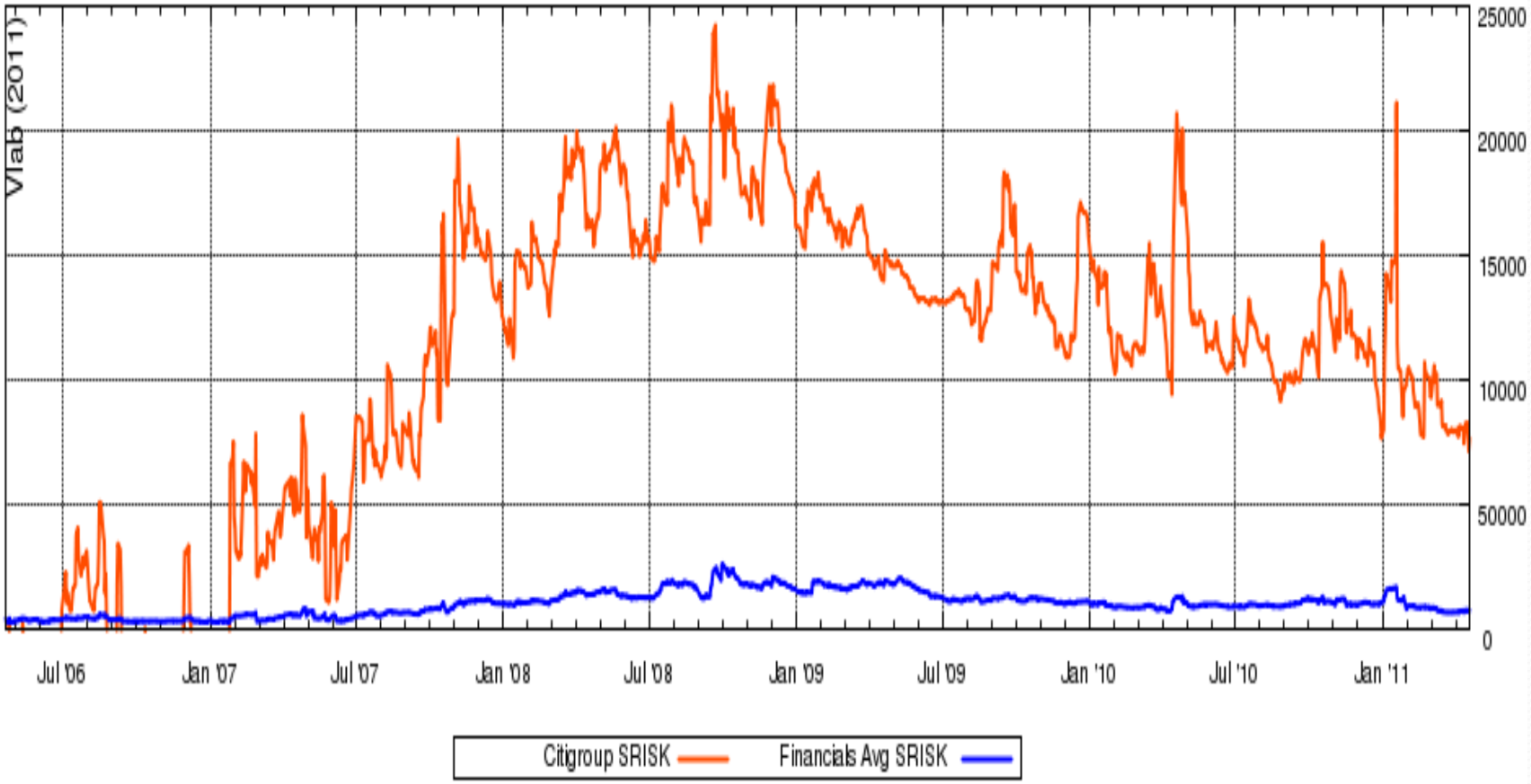
Citigroup Volatility



Citigroup Leverage



Citigroup SRISK



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TOP 10	SRISK%	MES	LVG
Bank Of America	20.4	3.17	17.40
JP Morgan Chase	16.6	3.24	12.34
Citigroup	13.9	2.64	14.35
Morgan Stanley	8.2	3.59	19.14
MetLife	6.4	3.13	15.56
Goldman Sachs	5.7	3.12	10.69
Prudential Financial	5.2	3.30	17.90
American Internation Group	5.2	3.81	10.86
Hartford Financial Services	3.5	3.57	25.33
SLM Corporation	2.3	3.64	24.06

DETAILS

Systemic Risk Rankings for 2011-04-20 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK %	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Bank Of America	20.7%	1	122,668	3.57	1.19	0.55	27.4	17.46	124186.6
JP Morgan Chase	16.3%	2	96,512	3.35	1.35	0.70	24.3	12.37	177505.2
Citigroup	12.9%	3	76,697	2.59	0.91	0.58	19.8	14.33	133071.9
Morgan Stanley	7.8%	4	46,069	3.56	1.36	0.70	24.4	19.44	40248.3
MetLife	5.9%	5	35,043	3.01	1.16	0.63	23.0	15.74	46258.0
Wells Fargo	5.2%	6	31,170	3.27	1.19	0.61	24.7	8.31	151878.7
Goldman Sachs	5.1%	7	30,370	2.99	1.12	0.58	24.4	10.74	85493.1
Prudential Financial	4.9%	8	29,048	3.21	1.43	0.72	25.0	18.12	29612.0
American Internation Group	4.8%	9	28,707	3.80	1.07	0.46	29.4	10.80	58123.8
Hartford Financial Services	3.1%	10	18,649	2.96	1.20	0.55	27.2	25.66	12087.9

SORT BY SIZE

Systemic Risk Rankings for 2011-04-20 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK %	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Berkshire Hathaway Shares	0.0%	77	-91,699	2.31	0.80	0.69	14.5	2.04	201983.1
JP Morgan Chase	16.3%	2	96,512	3.35	1.35	0.70	24.3	12.37	177505.2
Wells Fargo	5.2%	6	31,170	3.27	1.19	0.61	24.7	8.31	151878.7
Citigroup	12.9%	3	76,697	2.59	0.91	0.58	19.8	14.33	133071.9
Bank Of America	20.7%	1	122,668	3.57	1.19	0.55	27.4	17.46	124186.6
Goldman Sachs	5.1%	7	30,370	2.99	1.12	0.58	24.4	10.74	85493.1
American Internation Group	4.8%	9	28,707	3.80	1.07	0.46	29.4	10.80	58123.8
American Express	0.0%	75	-20,075	2.32	0.96	0.68	17.7	3.25	56513.2
UnitedHealth Group	0.0%	76	-20,562	2.62	0.96	0.45	26.6	1.77	48385.1
US Bancorp	0.0%	45	-1,812	2.49	0.93	0.58	20.3	6.87	47741.1

SORT BY MES

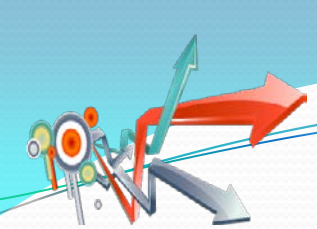
Systemic Risk Rankings for 2011-04-20 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK %	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
MBIA	0.4%	21	2,090	4.80	2.15	0.47	57.0	14.97	2107.4
Regions Financial	1.1%	14	6,646	3.81	1.42	0.64	28.1	13.97	8879.7
American Internation Group	4.8%	9	28,707	3.80	1.07	0.46	29.4	10.80	58123.8
T. Rowe Price	0.0%	61	-5,035	3.78	1.58	0.83	23.8	1.02	17189.4
Charles Schwab	0.0%	34	198	3.75	1.67	0.70	30.2	4.85	22412.2
Janus Capital	0.0%	36	-592	3.74	1.71	0.68	31.6	1.62	2352.1
SLM Corporation	2.3%	11	13,703	3.72	1.44	0.61	29.6	27.29	7619.1
Lincoln National	1.9%	12	11,506	3.61	1.49	0.71	26.5	20.62	9224.5
Bank Of America	20.7%	1	122,668	3.57	1.19	0.55	27.4	17.46	124186.6
Morgan Stanley	7.8%	4	46,069	3.56	1.36	0.70	24.4	19.44	40248.3

SORT BY LEVERAGE

Systemic Risk Rankings for 2011-04-20 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK%	RNK	SRISK ($m)	MES	Beta	Cor	Vol	Lvg	MV
SLM Corporation	2.3%	11	13,703	3.72	1.44	0.61	29.6	27.29	7619.1
Hartford Financial Services	3.1%	10	18,649	2.96	1.20	0.55	27.2	25.66	12087.9
Lincoln National	1.9%	12	11,506	3.61	1.49	0.71	26.5	20.62	9224.5
Morgan Stanley	7.8%	4	46,069	3.56	1.36	0.70	24.4	19.44	40248.3
Prudential Financial	4.9%	8	29,048	3.21	1.43	0.72	25.0	18.12	29612.0
Genworth Financial	1.0%	15	5,712	3.43	1.33	0.56	29.3	17.50	5905.9
Bank Of America	20.7%	1	122,668	3.57	1.19	0.55	27.4	17.46	124186.6
MetLife	5.9%	5	35,043	3.01	1.16	0.63	23.0	15.74	46258.0
MBIA	0.4%	21	2,090	4.80	2.15	0.47	57.0	14.97	2107.4
Synovus Financial	0.2%	30	933	1.79	0.73	0.29	31.5	14.68	1978.9



WHAT IS NEW IN VLAB?

- The entire calculation and web display is now recursive so that the risk measures at any point in time use only information that was available at that time.
- We can look back at past rankings to see how well they worked.

Systemic Risk Rankings

"A Look Back"

2007 - 3-30

Systemic Risk Rankings for 2007-03-30 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK%	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Morgan Stanley	16.5%	1	78,503	4.62	1.71	0.77	33.1	14.65	83845.3
Merrill Lynch	12.4%	2	58,876	4.19	1.45	0.73	29.4	14.02	72223.7
Goldman Sachs	10.0%	3	47,777	4.16	1.63	0.84	28.8	10.33	92734.3
Fannie Mae	9.5%	4	45,368	3.42	1.21	0.67	26.7	16.08	53218.4
Freddie Mac	8.3%	5	39,315	2.04	0.79	0.59	20.1	20.76	39338.0
Citigroup	7.9%	6	37,785	3.08	1.12	0.77	21.6	8.01	251694.5
Lehman Brothers	7.8%	7	36,910	4.50	1.83	0.73	37.3	15.71	36863.0
JP Morgan Chase	5.9%	8	28,211	3.02	1.24	0.78	23.7	8.35	168040.7
Bear Stearns	5.7%	9	27,253	4.47	1.64	0.70	34.9	22.18	17997.9
MetLife	3.7%	10	17,426	2.76	1.02	0.71	21.3	11.36	47531.1
Hartford Financial Services	2.1%	11	9,932	2.66	0.97	0.73	19.6	11.05	30606.4
Ameriprise Financial	2.0%	12	9,548	6.36	2.06	0.81	31.4	8.06	13668.2
Prudential Financial	1.6%	13	7,463	1.71	0.74	0.63	17.3	11.17	42421.3
Washington Mutual	1.6%	14	7,392	2.53	1.13	0.56	29.7	9.83	35899.2
Countrywide Financial	1.2%	15	5,605	2.74	1.33	0.51	38.7	10.36	19841.4
Lincoln National	1.1%	16	5,120	2.92	1.16	0.80	21.4	9.86	18764.9
Bank Of America	1.0%	17	4,907	2.88	1.02	0.79	19.2	6.80	228177.5

DID THIS PREDICT WELL?

- EIGHT OUT OF TOP TEN FAILED OR NEARLY FAILED IN CRISIS
- Morgan Stanley, Merrill Lynch, Goldman Sachs, Fannie Mae, Freddie Mac, Citigroup, Lehman Bros, J.P. Morgan Chase, Bear Stearns, Met Life.

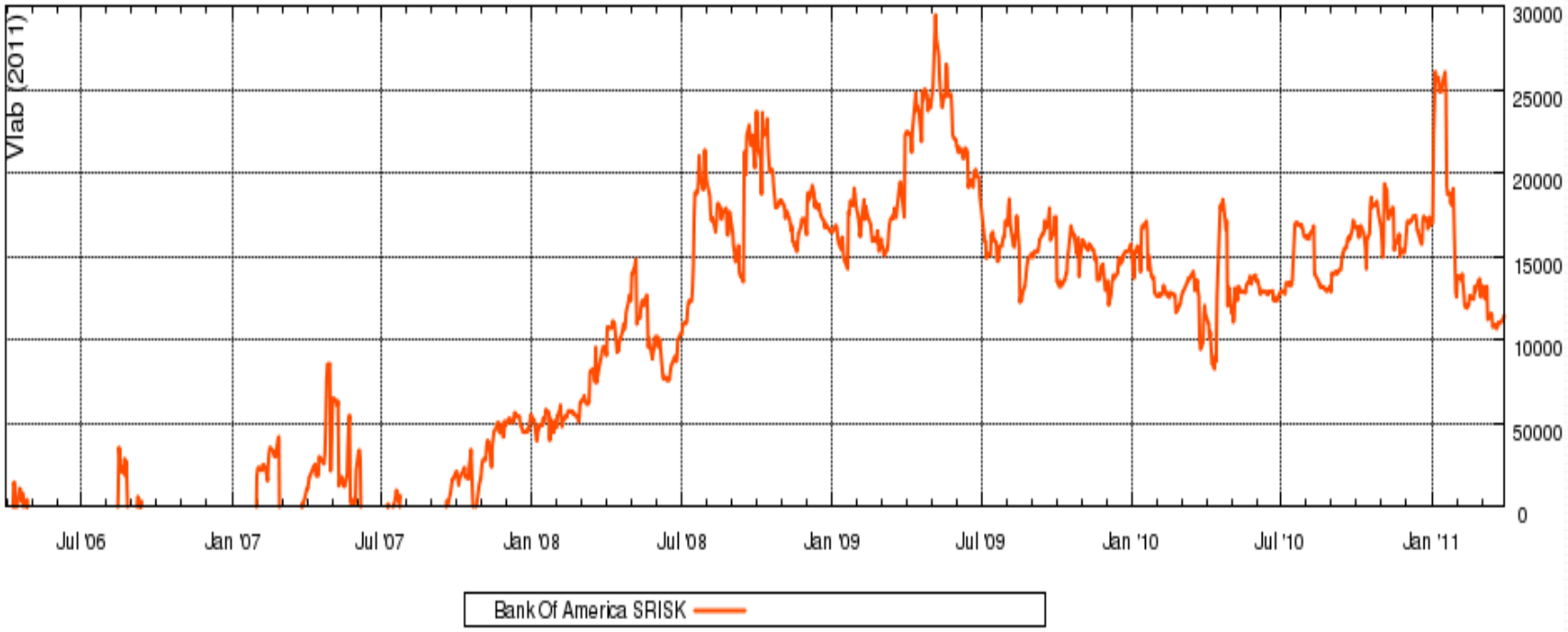
- Where are Bank of America and AIG?

Systemic Risk Ranking Progressions

Bank of America

Date	Rank	SRISK %	MES	LVG
6/29/2007	87	0.0%	2.07	7.30
1/30/2008	11	4.8%	3.15	9.01
7/31/2008	1	11.9%	8.78	11.61
6/30/2009	1	18.6%	7.01	19.12
6/30/2010	1	17.1%	3.73	15.78
Current	1	21.5%	3.38	16.10

BAC Predicted Capital Shortfall

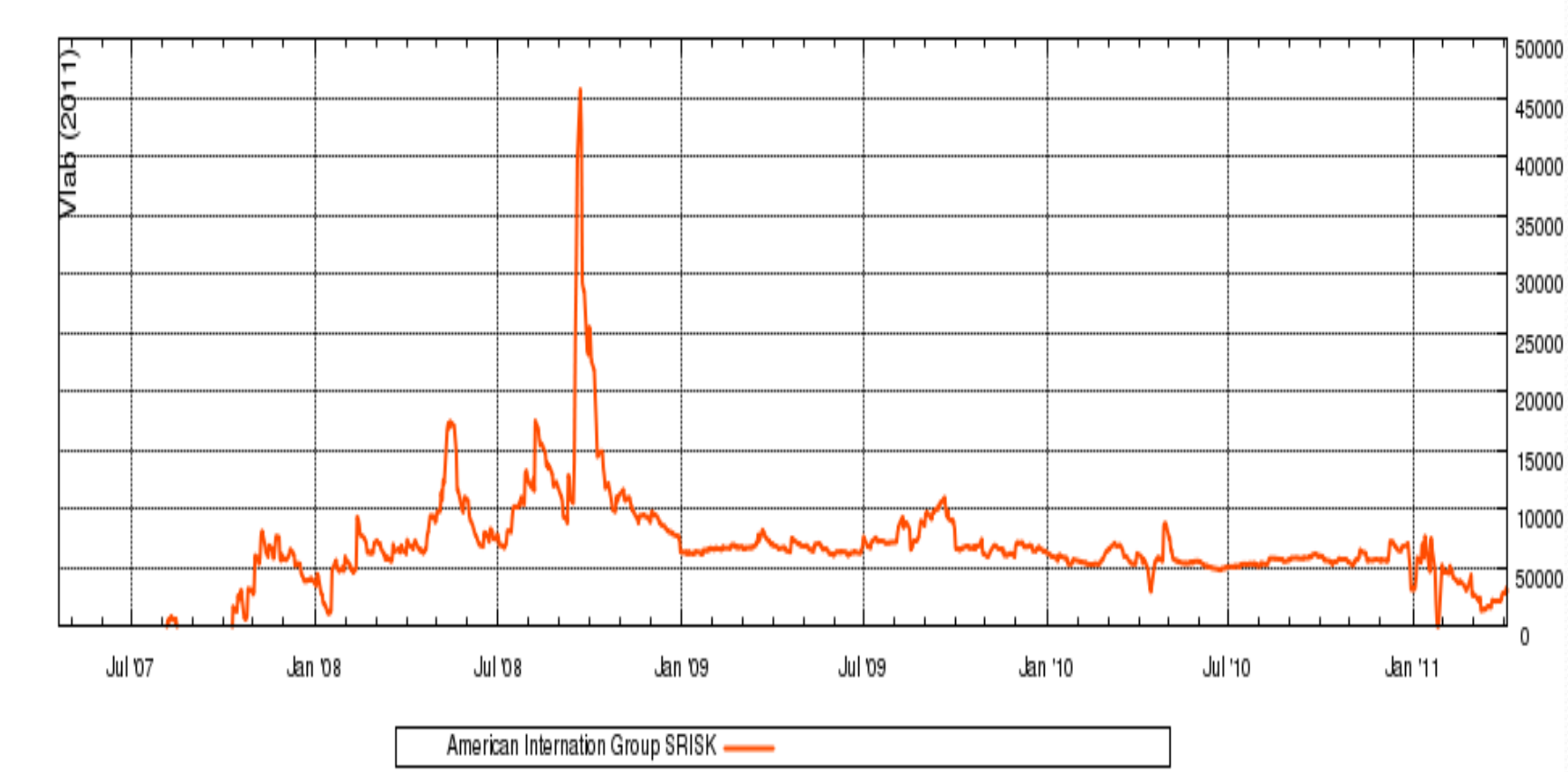


Systemic Risk Ranking Progressions

American International Group

Date	Rank	SRISK %	MES	LVG
6/29/2007	91	0.0%	1.99	5.89
10/31/2007	9	3.7%	3.80	6.92
7/31/2008	4	7.3%	9.58	14.85
6/30/2009	5	6.4%	6.72	48.42
6/30/2010	4	6.9%	3.37	32.03
Current	8	4.1%	3.30	10.03

AIG Predicted Capital Shortfall



BEFORE BEAR STERNS

Systemic Risk Rankings for 2008-02-29 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK%	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Citigroup	12.6%	1	132,746	3.93	1.51	0.69	41.8	17.80	123441.8
JP Morgan Chase	7.8%	2	81,776	4.08	1.64	0.70	44.8	11.51	136884.8
Merrill Lynch	7.5%	3	78,614	5.50	2.08	0.72	54.9	21.52	48150.0
Morgan Stanley	7.2%	4	75,642	4.39	1.61	0.72	42.6	23.73	46527.5
American Internation Group	6.3%	5	66,263	5.09	1.81	0.58	59.3	8.97	118196.7
Goldman Sachs	6.0%	6	62,977	3.28	1.38	0.61	43.0	16.29	74467.6
Bank Of America	5.9%	7	62,295	3.39	1.31	0.71	35.3	9.89	176534.2
Fannie Mae	5.7%	8	59,501	3.92	1.46	0.52	53.5	31.88	27049.6
Lehman Brothers	5.6%	9	58,873	5.10	2.04	0.73	53.6	29.14	27054.7
Freddie Mac	5.5%	10	57,920	4.26	1.60	0.47	65.5	48.18	16267.9
Wachovia Bank	4.7%	11	49,299	4.87	1.86	0.72	49.1	12.58	60688.4
Bear Stearns	2.9%	12	29,937	4.90	1.74	0.66	51.4	42.05	9430.7
Prudential Financial	2.7%	13	27,873	3.86	1.49	0.63	46.9	15.21	32544.6
MetLife	2.5%	14	25,854	3.23	1.24	0.68	34.7	13.64	41316.1
Washington Mutual	2.2%	15	22,689	4.97	1.99	0.51	73.7	23.92	13061.8

BEFORE FREDDIE AND FANNIE, LEHMAN and A.I.G.

Systemic Risk Rankings for 2008-08-29 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK %	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Citigroup	11.7%	1	173,289	6.50	2.51	0.80	59.1	19.99	103408.0
Bank Of America	11.5%	2	171,334	7.55	2.94	0.75	74.8	11.94	142001.9
JP Morgan Chase	9.8%	3	145,537	6.20	2.48	0.75	62.7	13.42	132291.7
American Internation Group	8.2%	4	121,658	10.24	3.72	0.70	99.9	17.62	57783.0
Merrill Lynch	6.7%	5	100,114	9.12	3.46	0.78	84.0	22.45	43417.0
Morgan Stanley	5.4%	6	79,906	5.58	2.10	0.75	52.9	23.01	45281.0
Fannie Mae	5.3%	7	78,878	14.84	5.55	0.51	205.3	115.68	7363.9
Freddie Mac	4.9%	8	72,801	12.85	5.00	0.43	220.4	297.76	2918.0
Wachovia Bank	4.9%	9	72,553	7.99	3.09	0.66	88.3	22.40	34304.2
Goldman Sachs	4.4%	10	65,839	4.11	1.70	0.76	42.7	15.73	70113.6
Lehman Brothers	4.2%	11	61,849	12.47	5.07	0.74	129.9	55.88	11172.9
Wells Fargo	2.6%	12	38,418	5.17	1.99	0.71	53.3	6.60	100162.3
MetLife	2.0%	13	30,041	3.72	1.44	0.79	34.5	14.56	38470.0
Prudential Financial	1.7%	14	25,515	3.50	1.35	0.72	36.0	15.39	31474.2
Washington Mutual	1.6%	15	23,898	6.88	2.74	0.45	116.4	41.50	6906.7

DURING STRESS TEST

Systemic Risk Rankings for 2009-04-30 **(MES is equity loss for a 2% daily market decline)**

Institution	SRISK%	RNK	SRISK ($ m)	MES	Beta	Cor	Vol	Lvg	MV
Bank Of America	17.3%	1	244,409	13.78	4.58	0.77	174.2	37.43	57160.5
JP Morgan Chase	14.2%	2	200,222	7.87	2.63	0.80	95.6	16.39	124004.1
Wells Fargo	11.3%	3	159,404	10.17	3.40	0.75	131.4	14.82	85270.6
Citigroup	10.4%	4	146,658	10.05	3.33	0.67	144.7	100.72	16814.0
American Internation Group	4.9%	5	69,757	8.23	2.71	0.56	140.4	40.77	19248.5
Goldman Sachs	4.5%	6	64,115	5.15	1.81	0.74	71.5	13.28	70070.7
Morgan Stanley	3.8%	7	53,748	7.35	2.46	0.74	96.4	23.55	25583.2
MetLife	3.1%	8	43,975	7.18	2.55	0.75	98.8	20.23	24337.9
Prudential Financial	3.0%	9	42,322	10.09	3.30	0.76	129.9	34.81	12245.1
US Bancorp	2.9%	10	41,061	9.75	3.23	0.76	123.8	8.37	31978.7
Hartford Financial Services	1.7%	11	24,394	10.30	3.38	0.74	132.9	72.87	3732.7
PNC Financial Services	1.6%	12	22,131	6.07	2.08	0.65	93.5	15.61	17639.2
American Express	1.6%	13	21,968	8.33	2.81	0.81	101.4	4.58	29457.0
State Street	1.5%	14	21,557	10.16	3.34	0.59	163.8	9.65	14825.3
Capital One Financial	1.4%	15	20,433	13.26	4.48	0.70	186.6	23.92	6573.8
BB&T Corporation	1.3%	16	17,872	9.11	2.98	0.79	109.2	10.74	13065.8
Suntrust Banks	1.3%	17	17,752	11.60	3.92	0.75	151.2	31.57	5150.6
Lincoln National	1.1%	18	15,519	12.92	4.19	0.67	182.2	53.16	2877.9
SLM Corporation	1.0%	19	14,252	8.03	2.90	0.53	159.0	74.76	2258.5
Bank Of New York Mellon	1.0%	20	13,797	5.51	1.84	0.69	78.3	6.96	29389.9

SCAP

FIRM	SCAP	SCAP%
Bank of America	33.9	45.44236
Wells Fargo	13.7	18.36461
GMAC	11.5	15.41555
Citigroup	5.5	7.372654
Regions Financial	2.5	3.351206
SunTrust Banks	2.2	2.949062
Morgan Stanley	1.8	2.412869
KeyCorp	1.8	2.412869
Fifth Third Bancorp	1.1	1.474531
PNC Financial Services	0.6	0.80429
JP Morgan Chase	0	0
Goldman Sachs	0	0
US Bancorp	0	0
Capital One Financial	0	0
American Express	0	0
MetLife	0	0
BB&T Corporation	0	0
State Street	0	0
Bank of NY Mellon	0	0

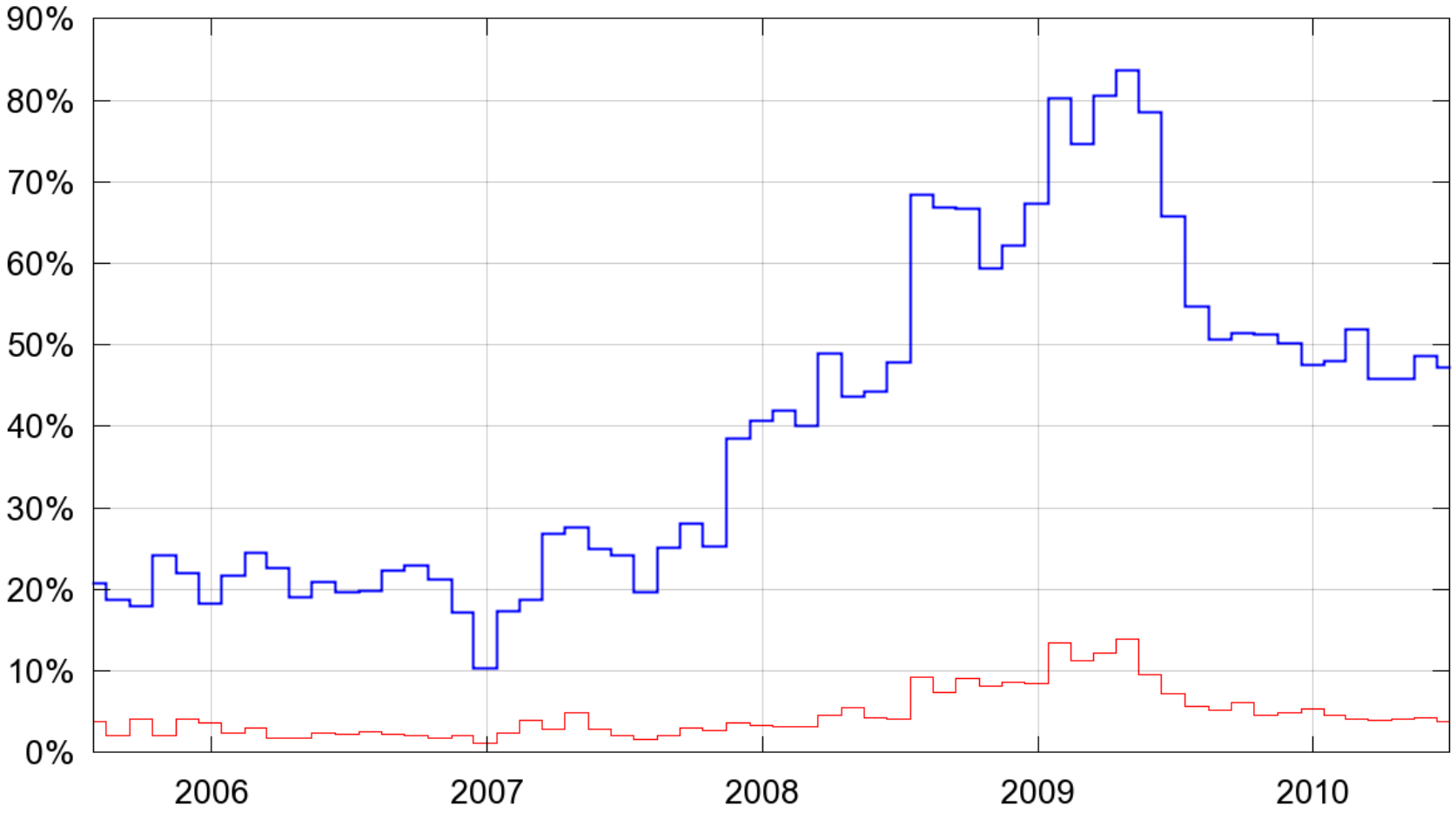
SRISK%

FIRM	SRISK-BHC%
Bank Of America	21.77594
JP Morgan Chase	17.83904
Wells Fargo	14.20231
Citigroup	13.06669
Goldman Sachs	5.71241
Morgan Stanley	4.788748
MetLife	3.91801
US Bancorp	3.658383
PNC Financial Services	1.97179
American Express	1.957268
State Street	1.920649
Capital One Financial	1.820505
BB&T Corporation	1.592329
Suntrust Banks	1.581638
Bank Of New York Mellon	1.229262
Regions Financial	1.11406
Fifth Third Bancorp	0.939253
Keycorp	0.911722

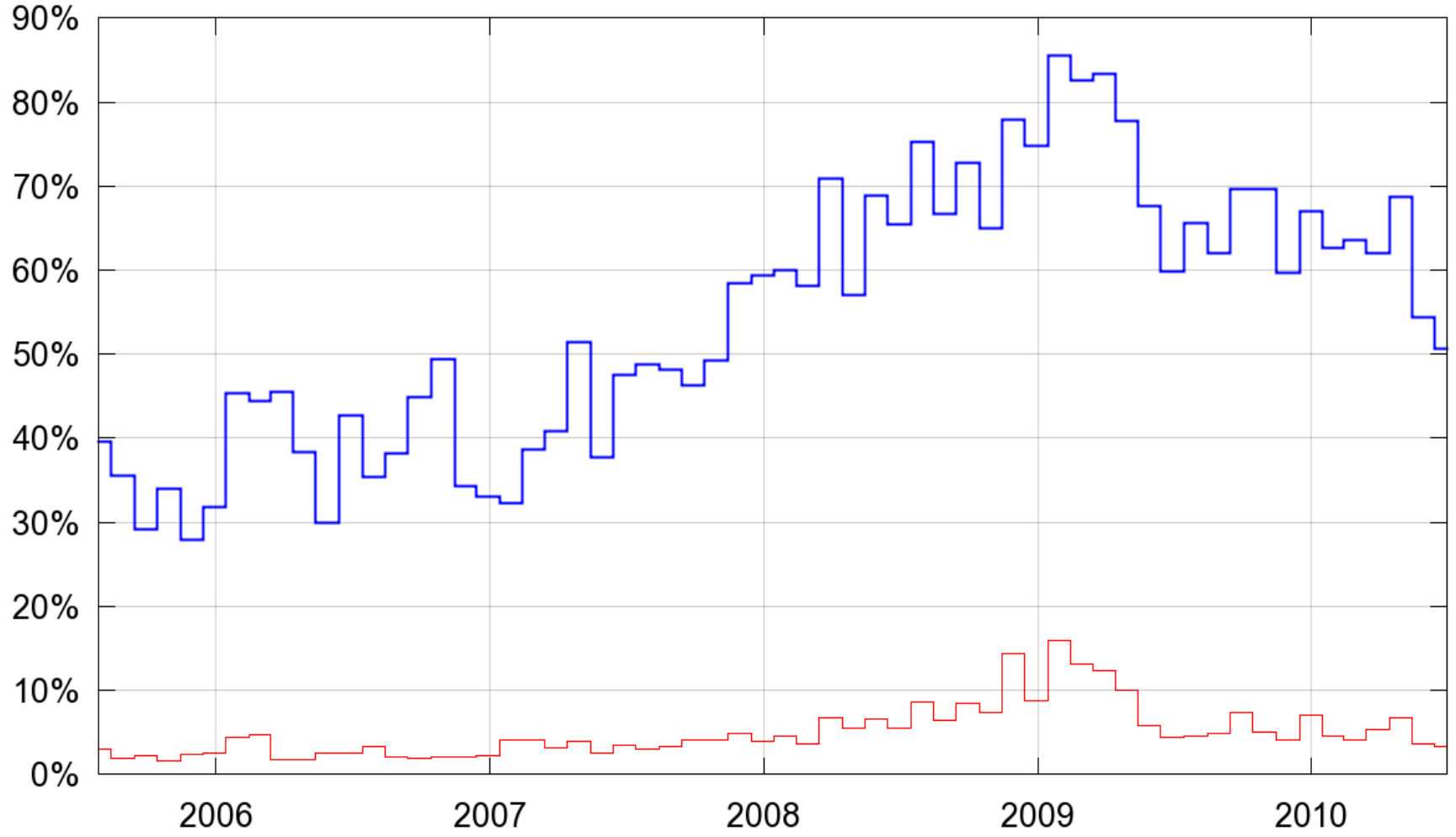
LONG RUN MES

- SIMULATE MARKET RETURN 10000 TIMES FOR SIX MONTHS, AND RECORD ALL SIMULATIONS WHERE FRACTIONAL RETURNS <-40%. Use bootstrap of residuals prior to each date.
- SIMULATE FIRM RETURNS ON THESE PATHS AND RECORD FRACTIONAL RETURN FOR THESE PATHS. THIS IS CALLED LR MES. Again bootstrap from empirical bivariate distribution (copula) and simulate garch and dcc processes.

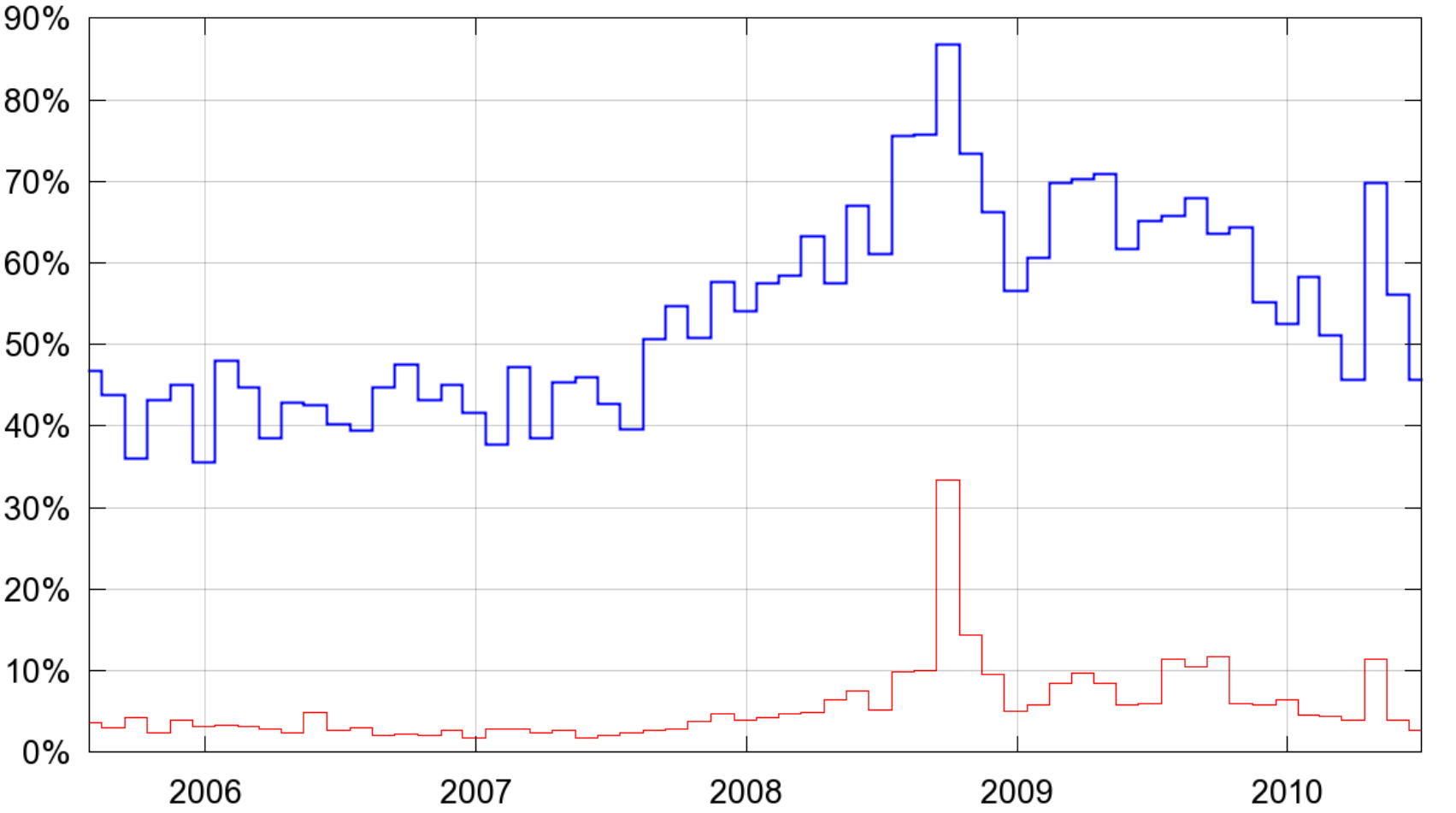
LONG RUN MES - BAC



LR MES CITI



LR MES AIG

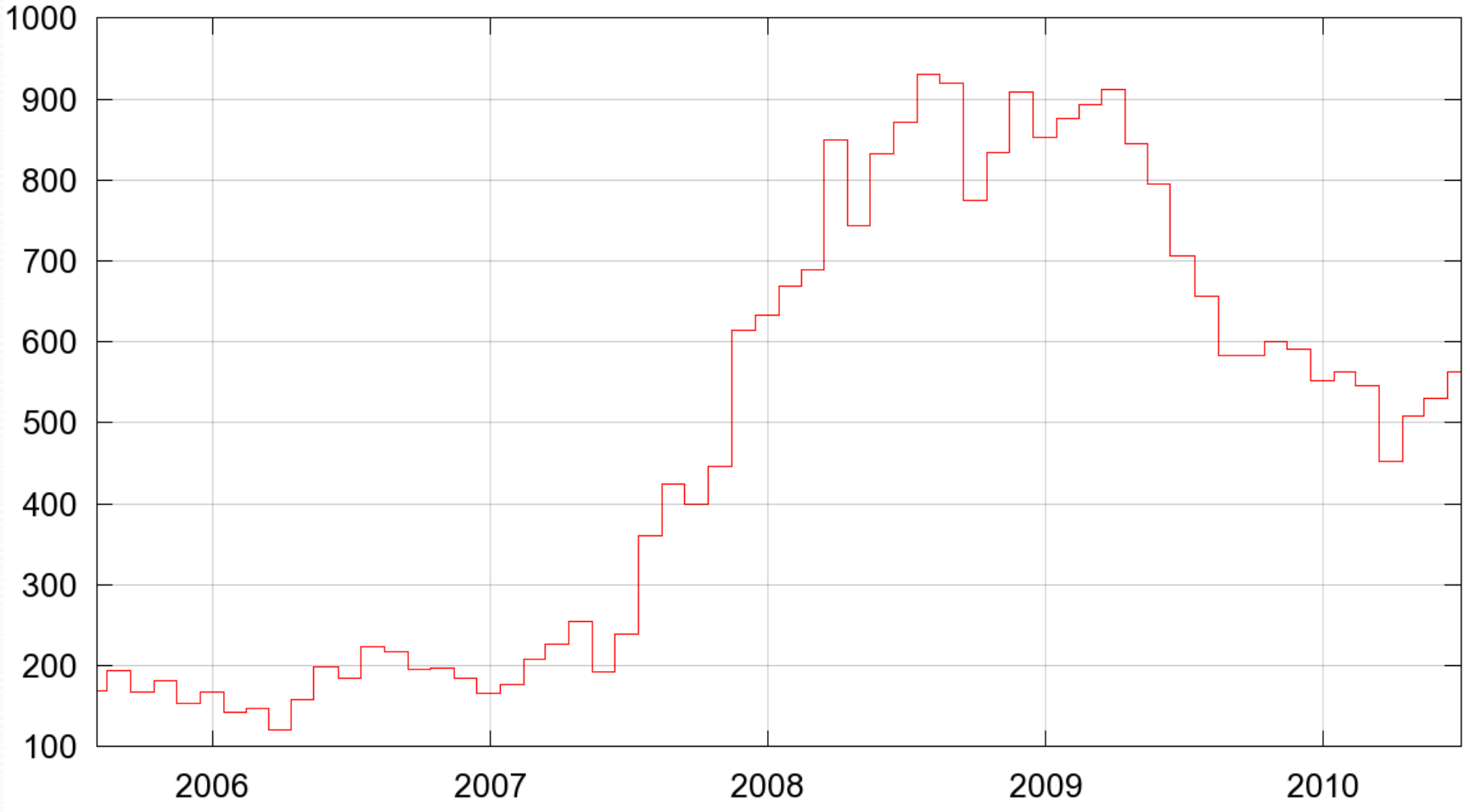


HOW RISKY IS THE ECONOMY TODAY?

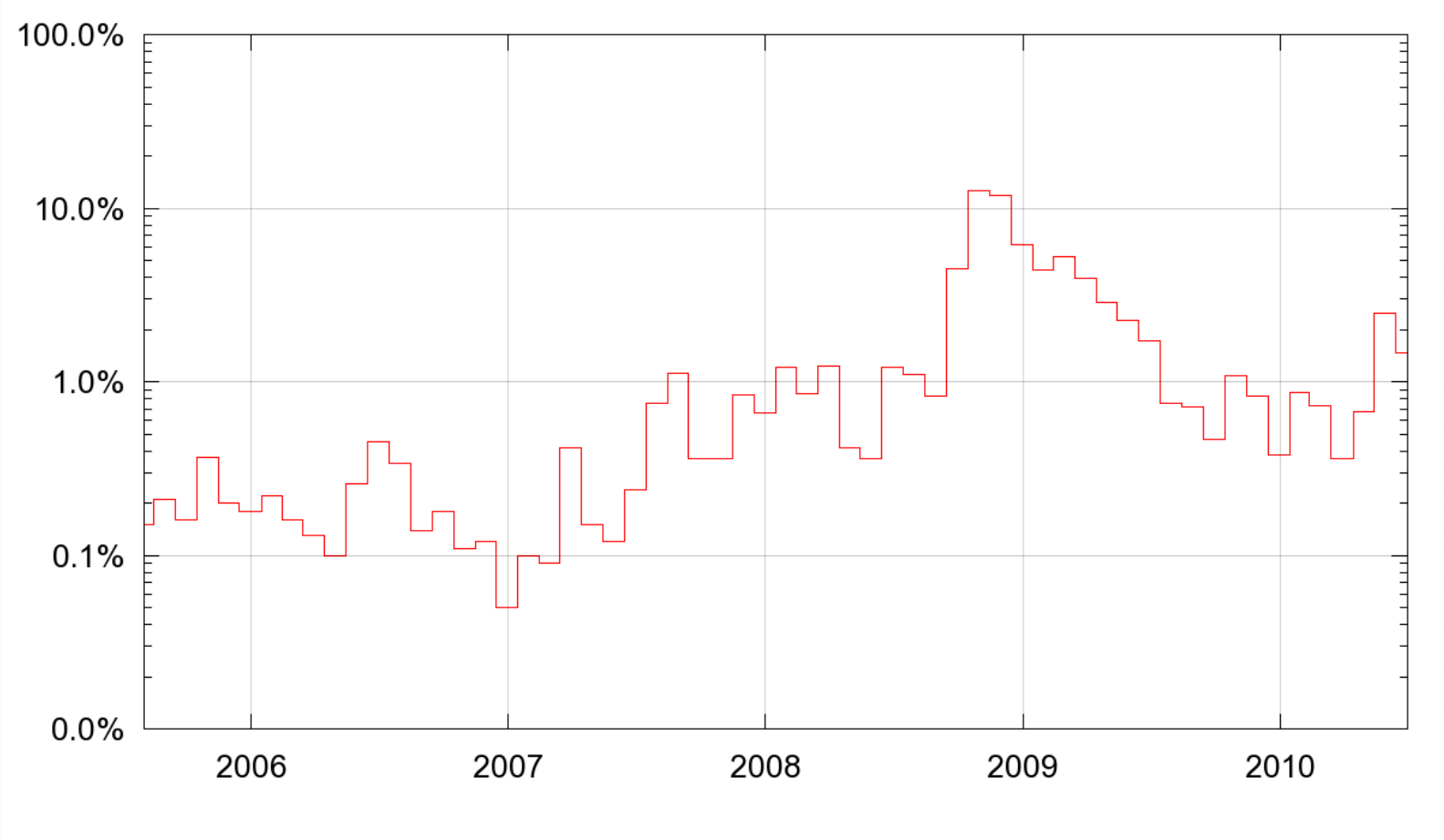
- The total capital shortfall expected if we have another crisis is a measure of the external cost of a crisis today.
- If firms reduce leverage, size, correlation or volatility, their shortfall will be reduced.
- What is total capital shortfall?

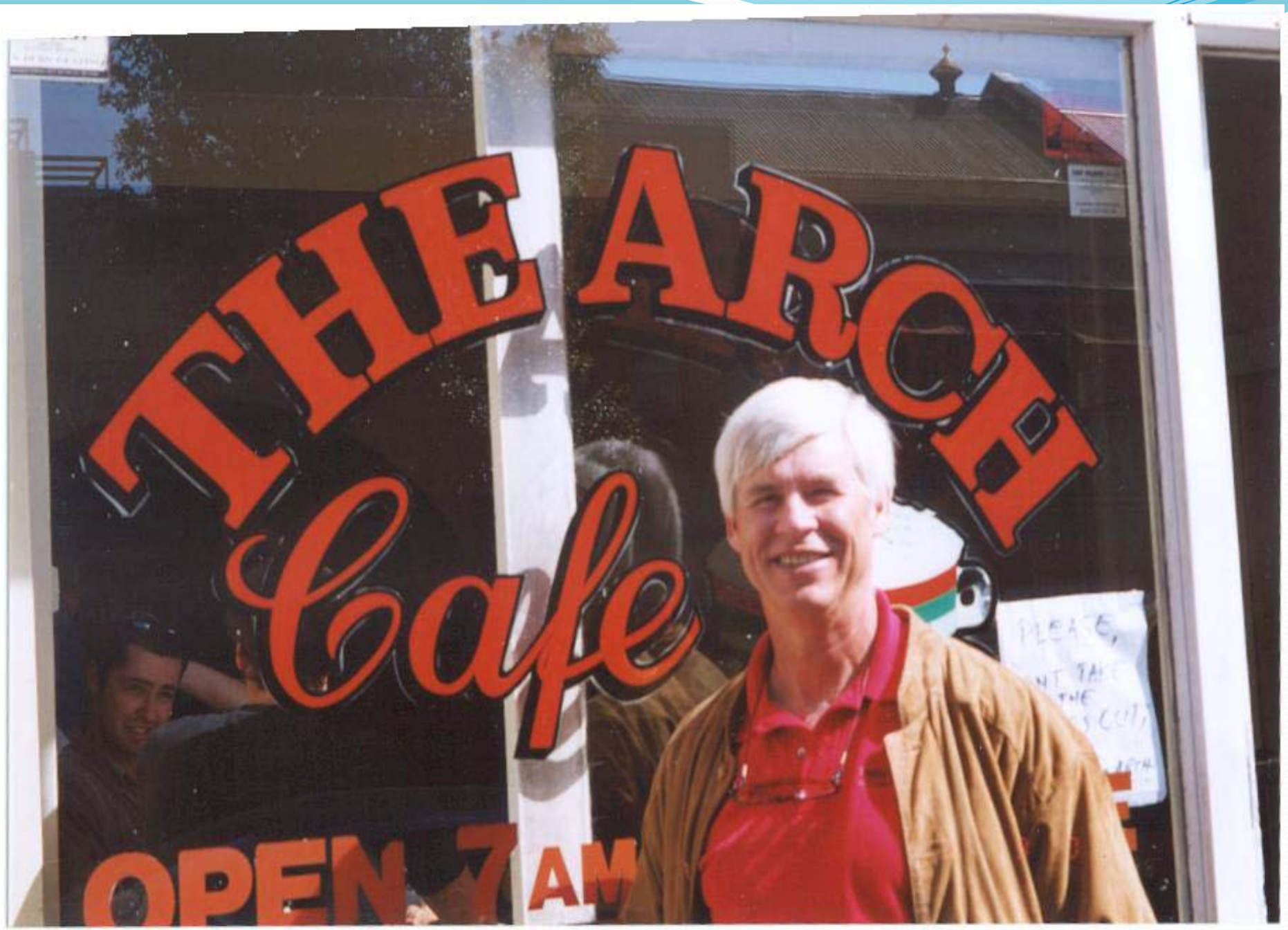
$$Total\ \ Capital\ \ Shortfall = \sum_{i=1}^{N} \left(Firm_i\ Capital\ Shortfall \middle| Crisis \right)$$

SYSTEM CAPITAL SHORTFALL



PROBABILITY OF CRISIS

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