Assessing the Systemic Risk Contributions of Large and Complex Financial Institutions

Xin Huang, Hao Zhou and Haibin Zhu

IMF Conference on Operationalizing Systemic Risk Monitoring
May 27, 2010, Washington DC

*The views presented here are solely those of the authors and do not necessarily represent those of the Federal Reserve Board or the Bank for International Settlements.

Background

- "Macroprudential" (re-)regulation after recent financial crisis
  - Cross-section dimension: systemically important banks
  - Time dimension: procyclicality and capital

- Key ingredients of systemic risk
  - Size or Too-big-to-fail
  - Correlation or concentration or interconnectedness
  - Default probability or vulnerability or leverage ratio

- (An economically meaningful way to aggregate nonlinearly)

Objectives of this paper

- Definition and measurement of systemic risk: market implied hypothetical distress insurance premium (DIP, Huang, Zhou and Zhu 2009 JBF)
- How to allocate systemic risk to individual banks? or how to identify systemically important LCFIs? (Huang, Zhou and Zhu 2010 WP)
- Policy implications: A basis for systemic capital surcharge and comparisons with the leading alternatives (CoVaR, CoES)

Literature

- Market-based systemic risk indicator
  - Probability of joint defaults: IMF GFSR, Lehar (2005)
  - Huang, Zhou and Zhu (2009 JBF)
- Systemic importance of individual banks
  - Adrian and Brunnermeier (2008): CoVaR approach
  - Acharya, Pedersen, Phlippon and Richardson (2010): CoES approach

  - (Implicitly relating to PD, correlation, and size)

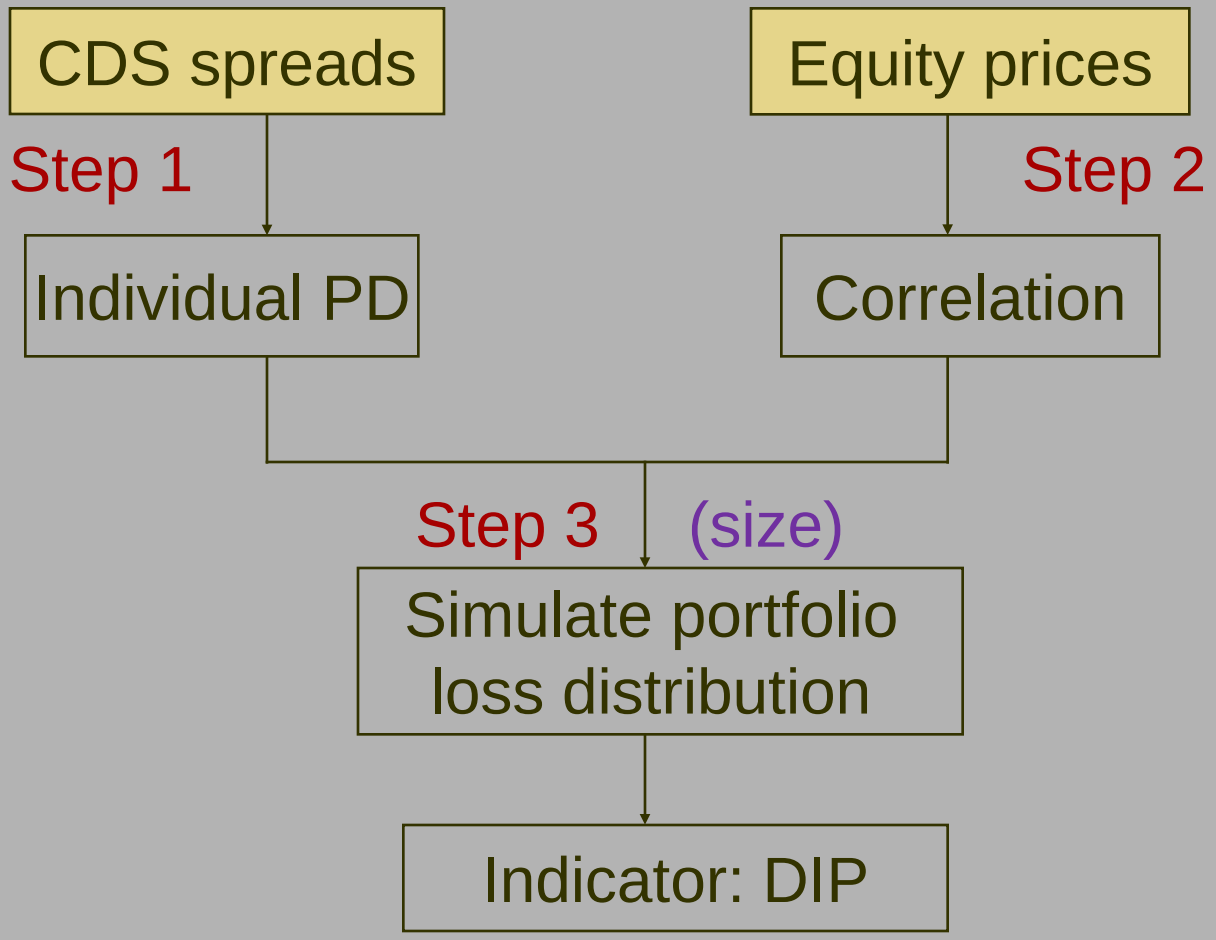
The rest of the presentation

- Construction of the systemic risk indicator
- Various sources of systemic risk
- Allocating systemic risk to individual banks
- Alternative basis for systemic capital surcharge

I. Construct the systemic risk indicator

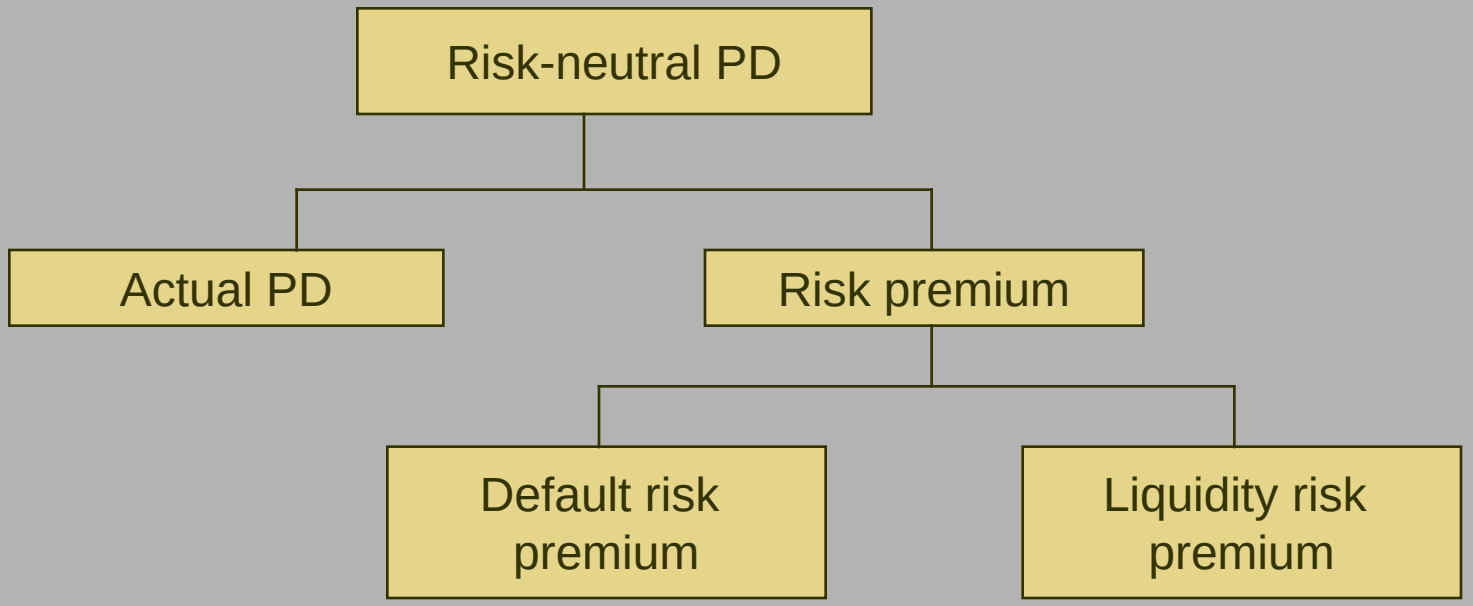
- Distress insurance premium (DIP) for a banking portfolio
- Suppose that a hypothetic insurance contract is issued to protect distressed losses in a banking system (at least a significant portion of total liabilities in default), what is the fair insurance premium?
- Similar to real option, replicated by market prices

Methodology: an overview



Methodology

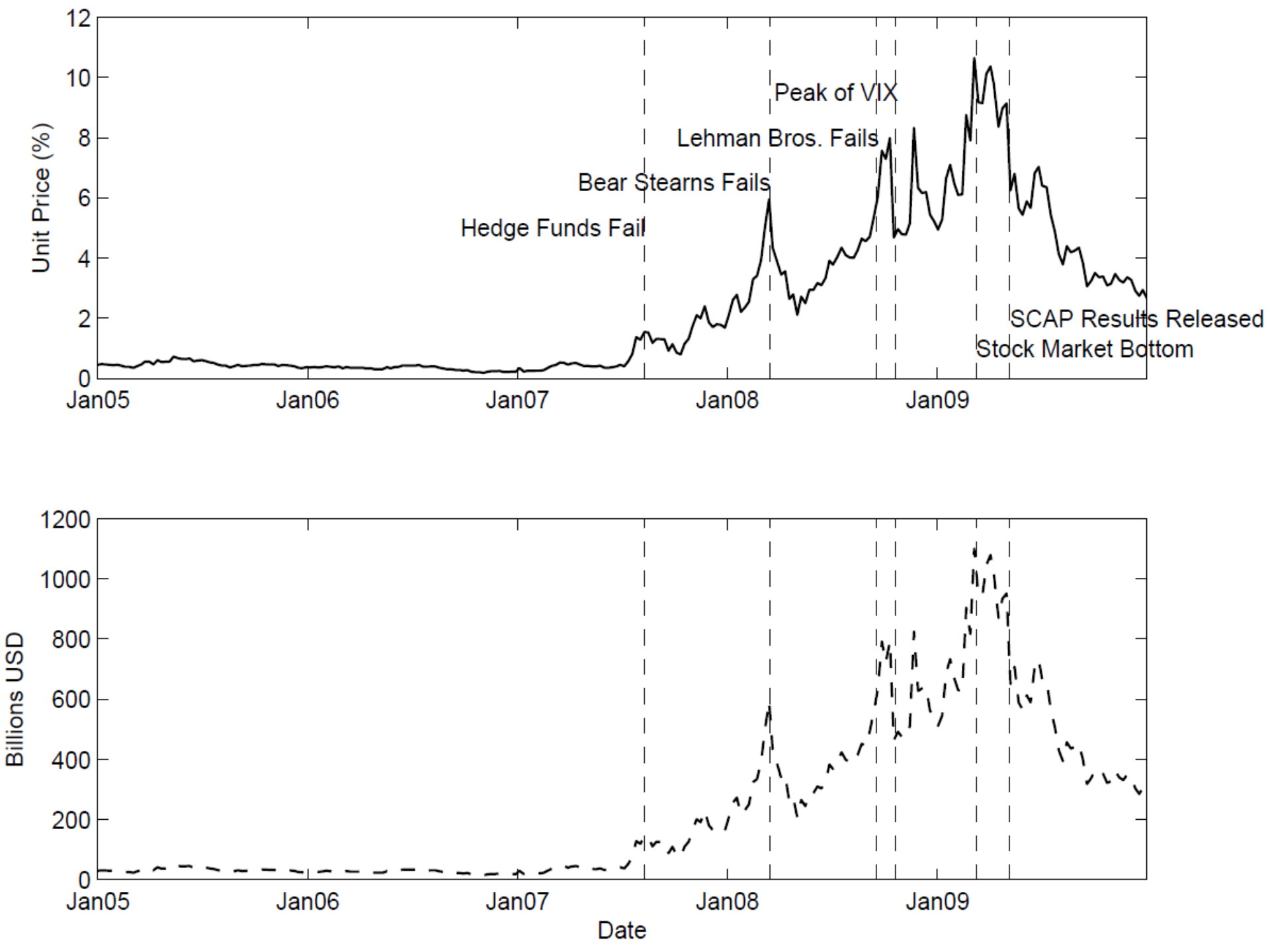
- Step 1: estimating PDs from CDS spreads
  - A standard exercise in the literature: PD ≈ CDS / LGD
  - PDs are *risk-neutral* and *forward-looking*

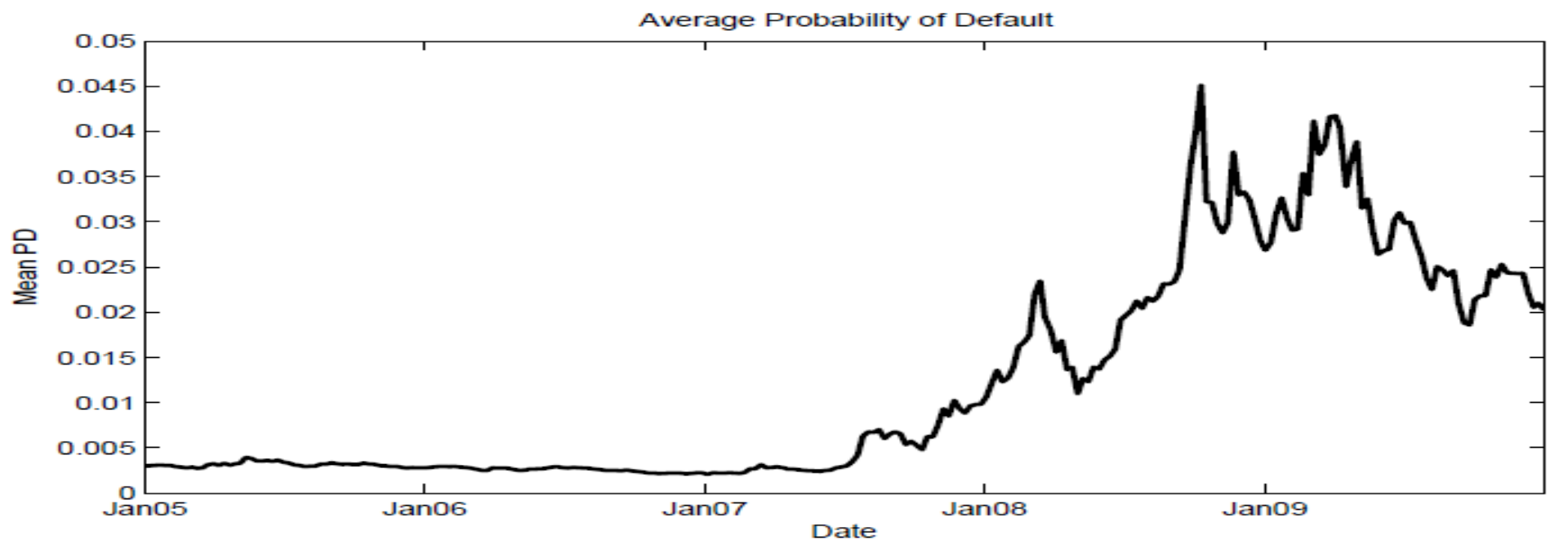


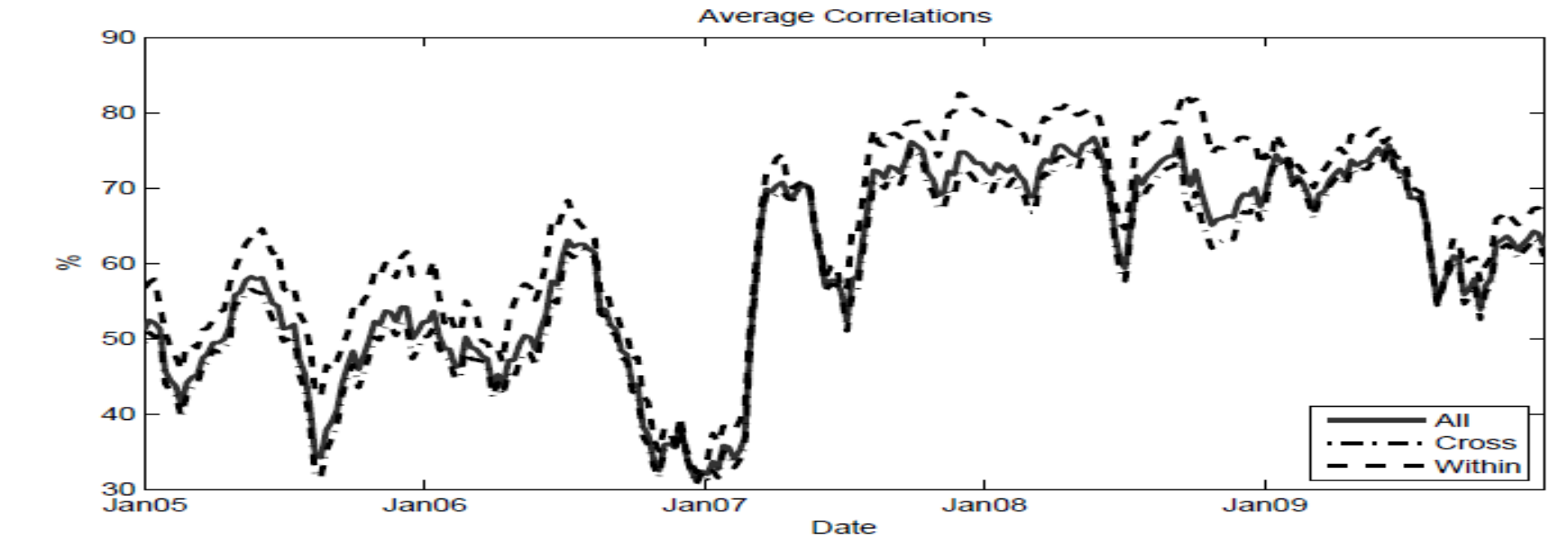
- Step 2: estimating asset return correlations
  - Use equity return correlation proxy, but to ensure consistency:
    - Engle (2002) DCC (Huang, Zhou, Zhu 2010)
    - Vasicek (1991) latent factor approach (this paper)

- Step 3: simulate (risk-neutral) portfolio loss distribution
  - $L = \Sigma L_i$
  - $DIP = E(L \mid L \geq L_{min})$

- Example: 19 BHCs of US SCAP (“stress test”)

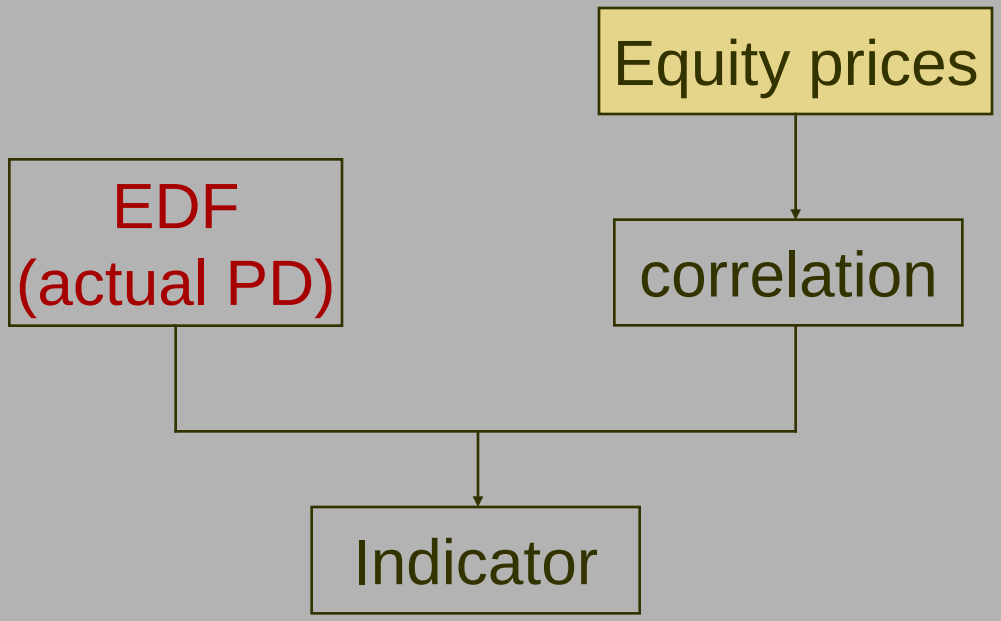

Unit Price (%)
12
10
8
6
4
2
0
Jan05
Jan06
Jan07
Jan08
Jan09
Peak of VIX
Lehman Bros. Fails
Bear Stearns Fails
Hedge Funds Fail
SCAP Results Released
Stock Market Bottom
Billions USD
1200
1000
800
600
400
200
0
Jan05
Jan06
Jan07
Jan08
Jan09
Date


Average Probability of Default
Mean PD
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Jan05
Jan06
Jan07
Jan08
Jan09
Date


Average Correlations
%
90
80
70
60
50
40
30
Jan05
Jan06
Jan07
Jan08
Jan09
Date
All
Cross
Within

II. Driving factors of systemic risk

- Approach 1:
  - Substitute risk-neutral PDs with actual PDs (EDF) → DIP on an (expected) incurred cost basis
  - That is, the risk premium is set to be zero always

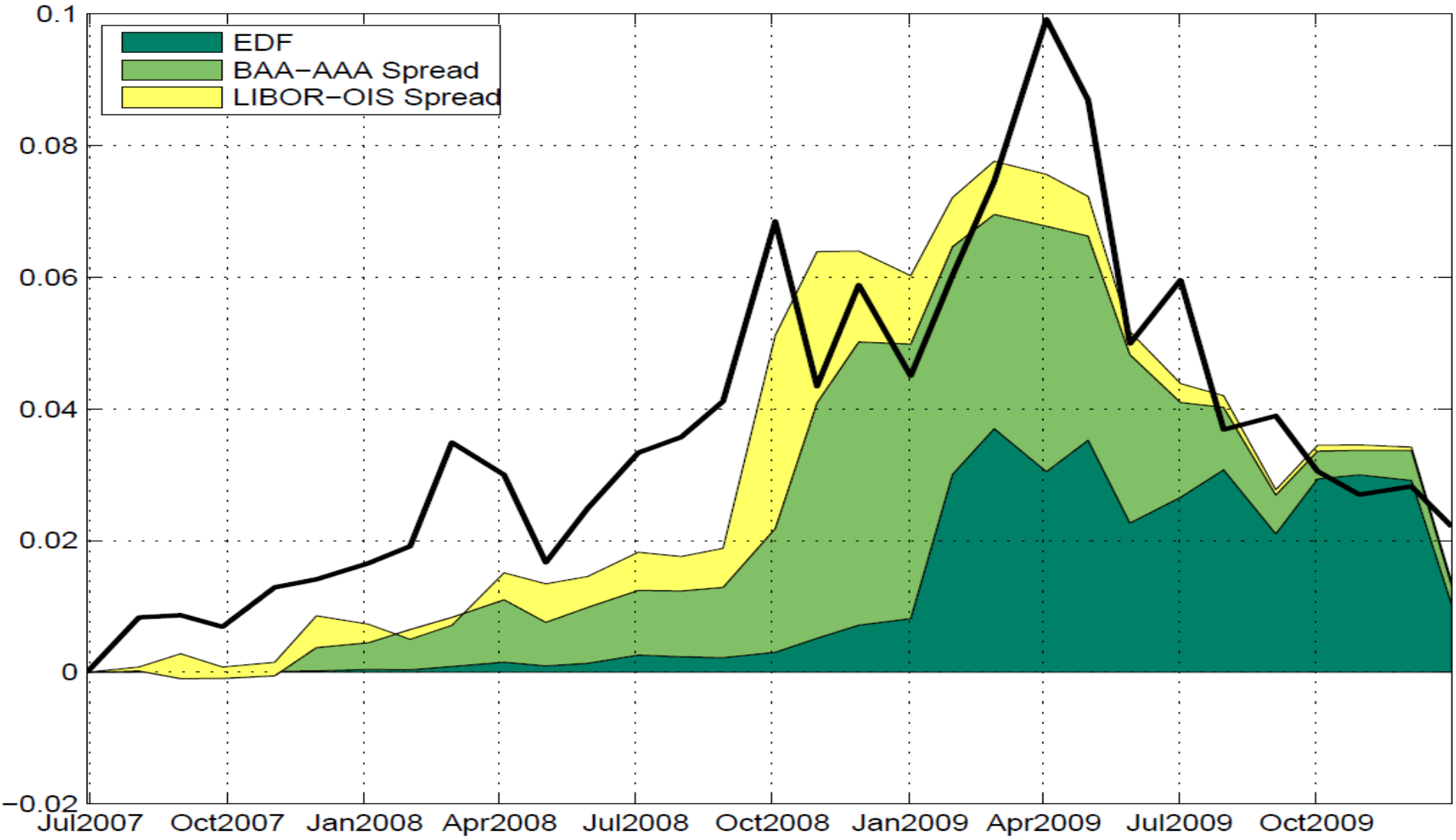


II. Driving factors of systemic risk

- Decomposition of systemic risk
  - Actual default
  - Default risk premium
  - Liquidity risk premium

Independent Variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant	1.08	-1.67	0.94	-0.93
	(5.2)	(6.0)	(3.2)	(3.9)
Average EDF (%)	1.83			1.06
	(9.8)			(7.6)
BAA-AAA Spread (%)		3.07		1.69
		(15.2)		(6.4)
LIBOR-OIS Spread (%)			2.49	0.84
			(6.1)	(3.2)
Adjusted-R^2	0.57	0.77	0.34	0.87

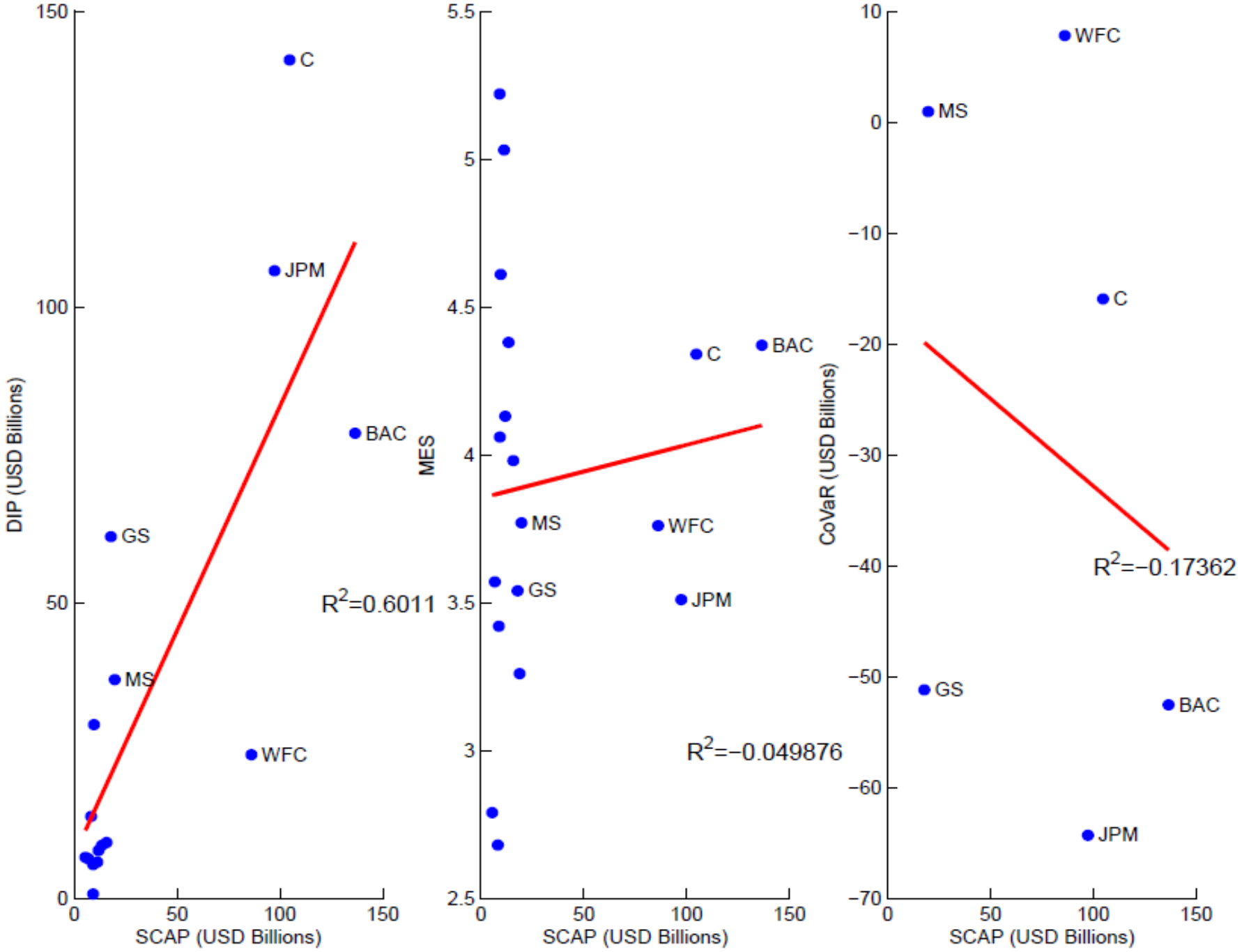
Example 2: 19 US BHCs included in the SCAP exercise

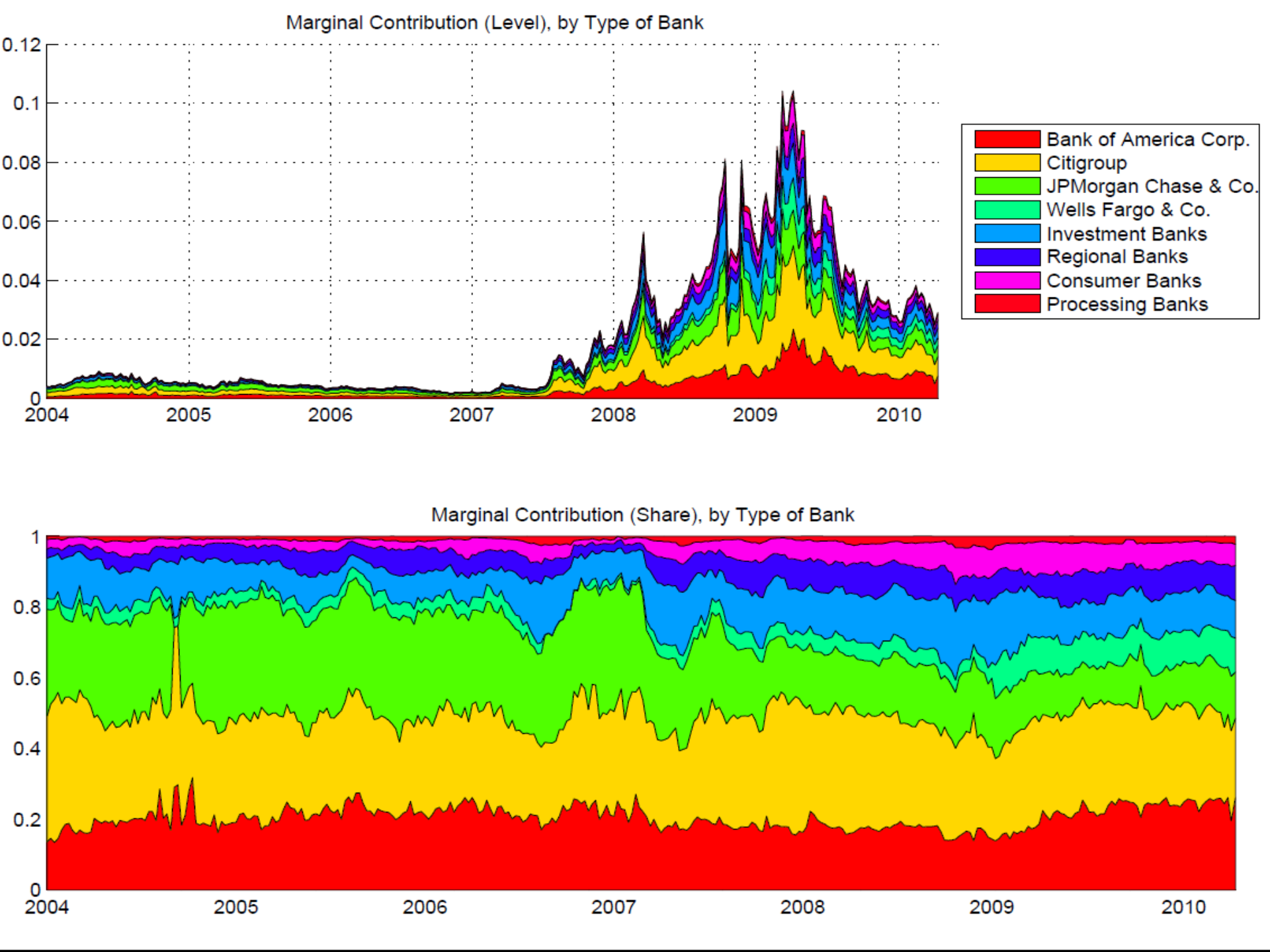


III. Allocating systemic risk to each bank

- Marginal contribution of bank i to the systemic risk
  - Definition: $MC_i = \frac{\partial DIP}{\partial L_i} = E[L_i \mid L \geq L_{\min}]$
  - $DIP = \Sigma MC_i \Rightarrow$ *additive property*

- Comparison to two other approaches
  - DIP: $E[L_i \mid L \geq L_{\min}]$
  - CoVaR: Prob (VaR=q | VaR_i=q)
  - CoES: E(L | $L_i \geq VaR_i$)
    - Implicitly relating to PD, size, and correlation (explicit)
    - Objective distribution (risk-neutral insurance price)
    - Reverse directions
    - VaR is not sub-additive but ES is
    - ES is more sensitive to tail distribution than VaR
    - Implementation on equity/bond returns (liability size)


DIP (USD Billions)
SCAP (USD Billions)
C
JPM
BAC
GS
MS
WFC
R^2=0.6011
MES
SCAP (USD Billions)
C
BAC
MS
WFC
GS
JPM
R^2=−0.049876
CoVaR (USD Billions)
SCAP (USD Billions)
WFC
MS
C
GS
BAC
JPM
R^2=−0.17362


Marginal Contribution (Level), by Type of Bank
0.12
0.1
0.08
0.06
0.04
0.02
0
2004
2005
2006
2007
2008
2009
2010
Bank of America Corp.
Citigroup
JPMorgan Chase & Co.
Wells Fargo & Co.
Investment Banks
Regional Banks
Consumer Banks
Processing Banks
Marginal Contribution (Share), by Type of Bank
1
0.8
0.6
0.4
0.2
0
2004
2005
2006
2007
2008
2009
2010

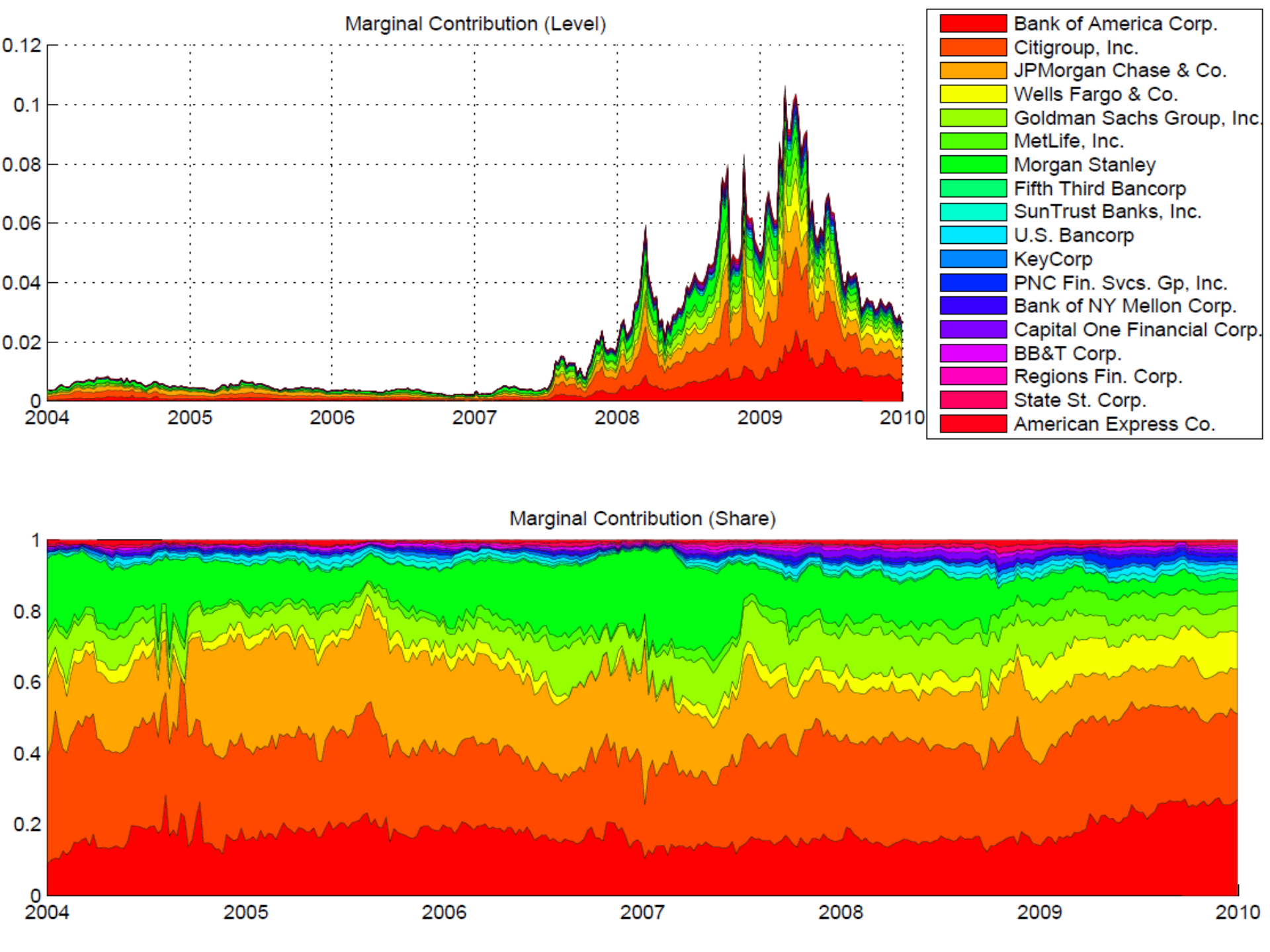
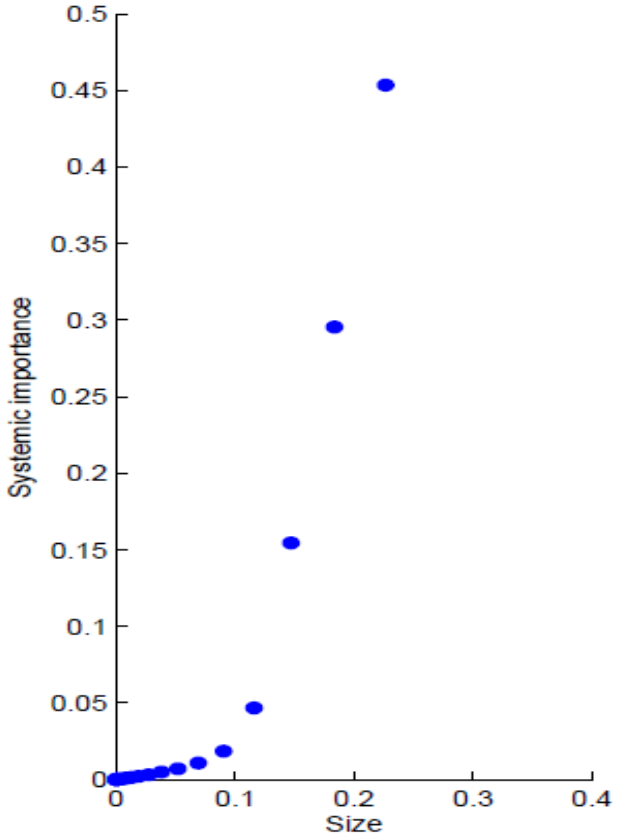

Marginal Contribution (Level)
0.12
0.1
0.08
0.06
0.04
0.02
0
2004
2005
2006
2007
2008
2009
2010
Bank of America Corp.
Citigroup, Inc.
JPMorgan Chase & Co.
Wells Fargo & Co.
Goldman Sachs Group, Inc.
MetLife, Inc.
Morgan Stanley
Fifth Third Bancorp
SunTrust Banks, Inc.
U.S. Bancorp
KeyCorp
PNC Fin. Svcs. Gp, Inc.
Bank of NY Mellon Corp.
Capital One Financial Corp.
BB&T Corp.
Regions Fin. Corp.
State St. Corp.
American Express Co.
Marginal Contribution (Share)
1
0.8
0.6
0.4
0.2
0
2004
2005
2006
2007
2008
2009
2010

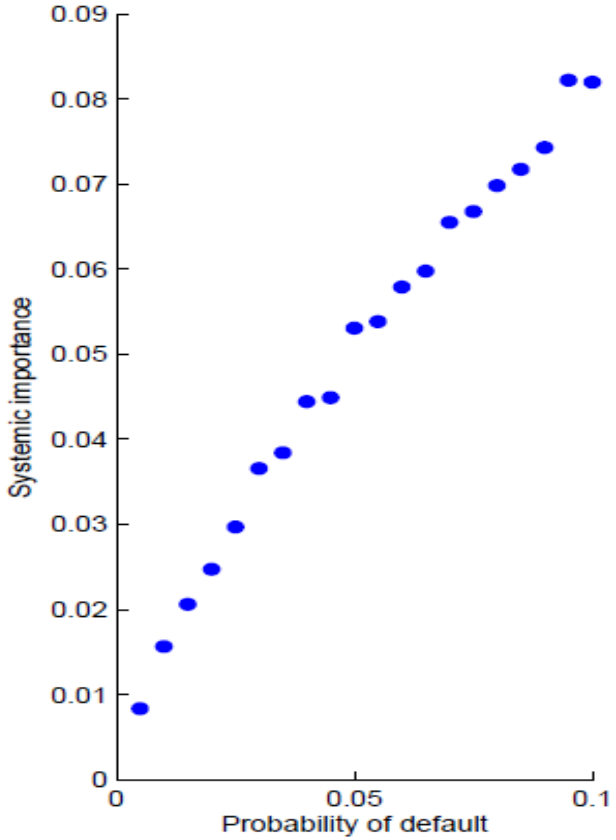
Table 5: Marginal contribution to systemic risk on specific dates, by bank

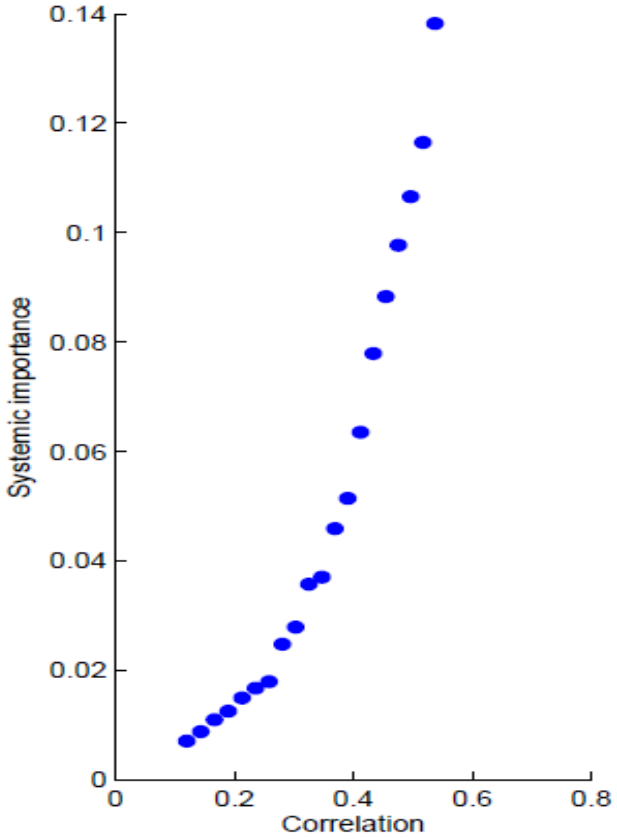
Bank Name	Marginal contribution							*SCAP*
	08.10.2007	03.16.2008	09.16.2008	10.20.2008	03.09.2009	05.07.2009	12.31.2009	*Losses*
American Express Co.	1.2166	5.2337	5.9973	9.2470	13.0093	6.1227	1.5246	11.2000
Bank of America Corp.	22.1759	60.3770	86.4964	75.2953	166.9977	141.3691	74.9210	136.6000
BB&T	1.1283	3.0902	6.2102	5.2712	NaN	6.2020	2.3333	8.7000
Bank of NY Mellon Corp.	0.5738	4.5084	6.8332	7.9201	9.4436	6.9616	3.0299	5.4000
Capital One Financial Corp.	1.4505	7.6867	8.3777	9.1147	9.3966	7.1278	2.5832	13.4000
Citigroup, Inc.	39.0768	131.4266	137.0604	131.8051	295.2236	170.1679	66.4760	104.7000
Fifth Third Bancorp	0.9203	1.6545	NaN	NaN	1.7571	1.5092	4.3955	9.1000
Goldman Sachs Group, Inc.	19.9124	50.6938	94.7383	53.3536	71.5075	40.2911	20.3340	17.8000
JPMorgan Chase & Co.	25.3379	56.5739	105.8873	93.3564	127.8809	83.1355	35.0215	97.4000
KeyCorp	0.5644	2.3103	8.6605	6.6348	9.0279	6.4293	3.1573	6.7000
MetLife, Inc.	4.2261	16.3159	21.1198	24.6166	66.6895	47.4179	11.7248	9.6000
Morgan Stanley	15.0804	54.0533	103.2178	35.2844	58.5511	30.7770	9.4018	19.7000
PNC Fin. Svcs. Gp, Inc.	0.5849	2.3604	NaN	NaN	NaN	18.6405	3.0840	18.8000
Regions Fin. Corp.	0.8131	0.7859	0.9751	0.8390	0.9491	0.8287	2.0700	9.2000
State St. Corp.	0.5088	4.7466	7.6622	8.0528	8.4503	7.6297	1.6802	8.2000
SunTrust Banks, Inc.	1.6875	6.0661	6.5968	6.3854	8.9735	7.3076	3.4433	11.8000
U.S. Bancorp	2.2158	6.7648	10.5390	7.1482	9.9643	9.7485	3.2295	15.7000
Wells Fargo & Co.	6.3572	17.7285	21.4084	17.6306	90.4426	58.9489	28.6469	86.1000
Total	143.8307	432.3766	631.7807	491.9551	948.2645	650.6152	277.0568	590.1000

Note: All numbers are in billions of US dollars

- Factors behind systemic importance
  - Size matters most → “too big to fail”
  - Correlation → common exposures, interconnection
  - PD → leverage







Conclusions

- Our approach provides a tool for macro-prudential regulation
  - To identify systemically important financial institutions
  - To understand sources of systemic risk
  - To impose capital surcharge based several measures

- Challenges remain
  - Time-dimension (counter-cyclical capital buffer)?
  - As a public policy, should systemic capital charge be based on risk-neutral price or actuarial expected loss?