Assessing the Systemic Risk of a Portfolio of Heterogeneous Banks During the Recent Financial Crisis

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*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)

- Challenges on the operational side: systemic risk
  - How to measure systemic risk?
  - How to allocate systemic risk to individual banks?
  - How to connect systemic importance to bank regulation?
    - Systemic capital charge (cross-section)
    - Counter-cyclical reserve (time-series)

  - Endogeneity problem: Will the new regulatory framework change bank behavior and prevent the future systemic failure of financial sector? (not addressed here)

Objectives of this paper

- Extension of Huang, Zhou and Zhu (2009)
- Measuring systemic risk: distress insurance premium
  - A market-based indicator
- Identifying sources of systemic risk
  - What explains the movements in the systemic risk? – actual default risk, credit risk or liquidity risk premium
  - How to allocate systemic risk to individual banks? or how to identify systemically important LCFIs?

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)

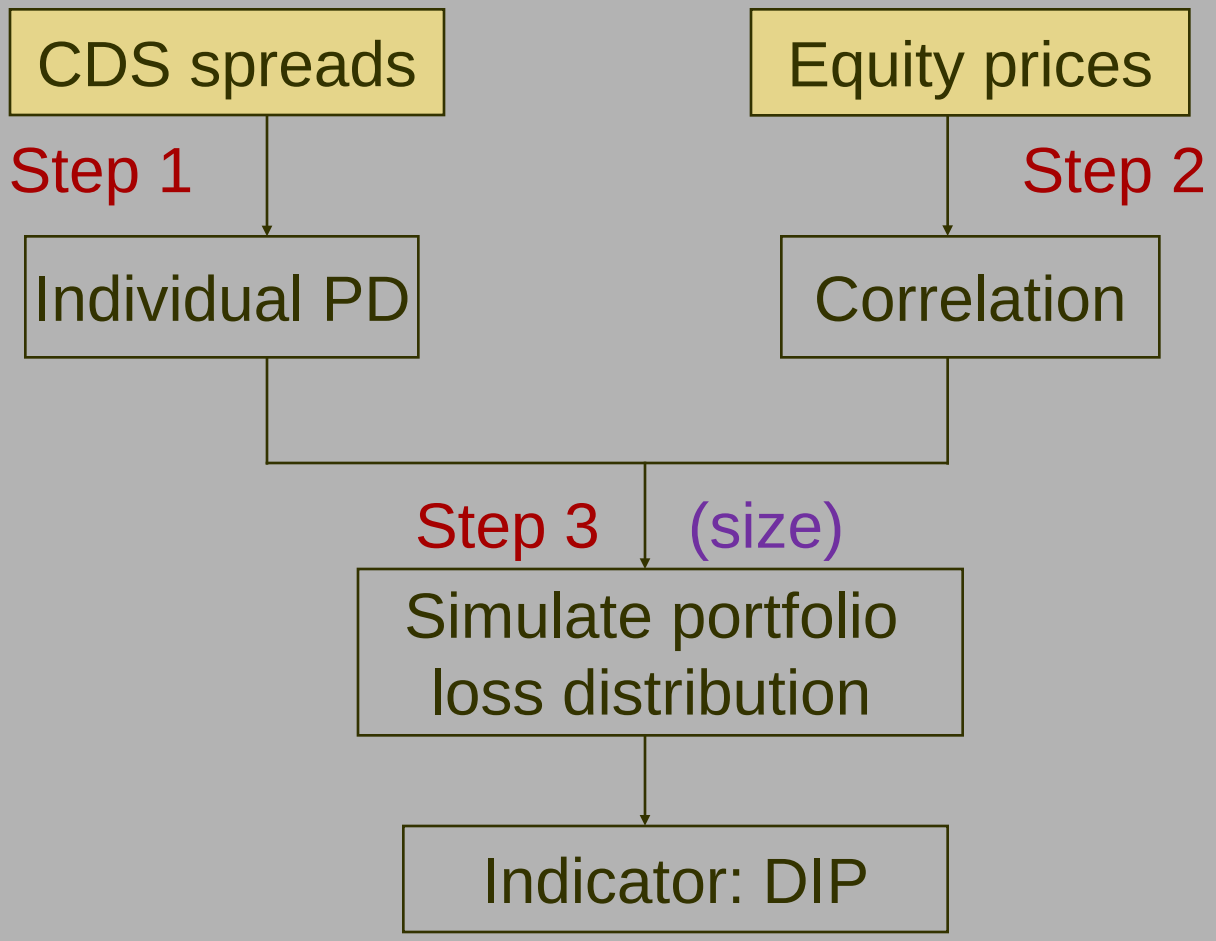
The rest of the presentation

- Construction of the systemic risk indicator
- Decomposition of systemic risk
- Allocating systemic risk to individual banks
- “Additional factors” behind systemic importance

I. Construct the systemic risk indicator

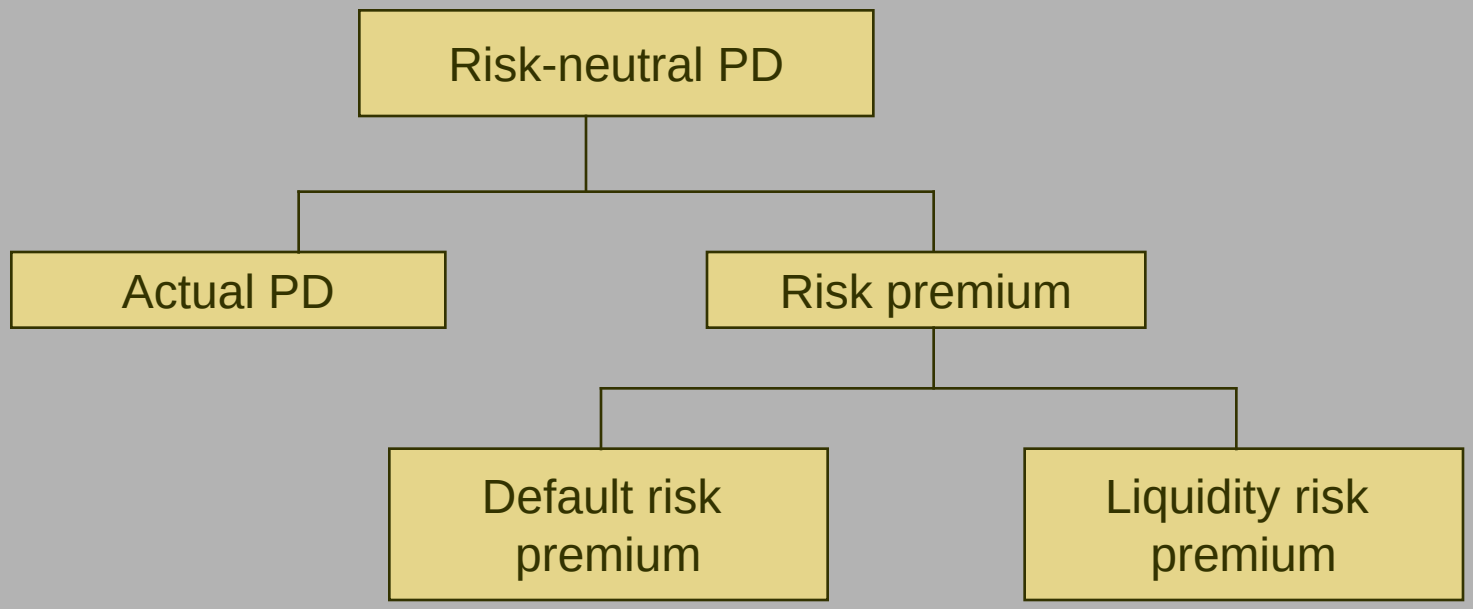
- Distress insurance premium (DIP)
- Suppose that a hypothetic insurance contract is issued to protect distressed losses in a banking system (at least a significant portion of total liabilities in default), what is the fair insurance premium?
- Similar to the real option concept

Methodology: an overview



Methodology

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



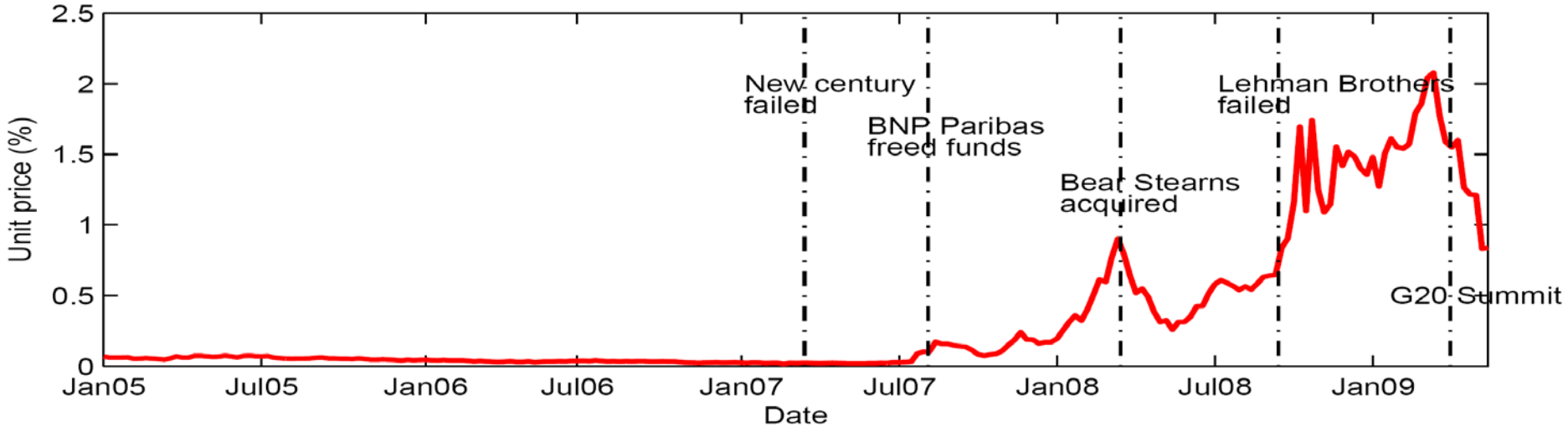
- Step 2: estimating asset return correlations
  - Use equity return correlations as a proxy
  - Use Dynamic Conditional Correlation (DCC) approach by Engle (2002)
  - (or latent factor model as in Vasicek 1991)

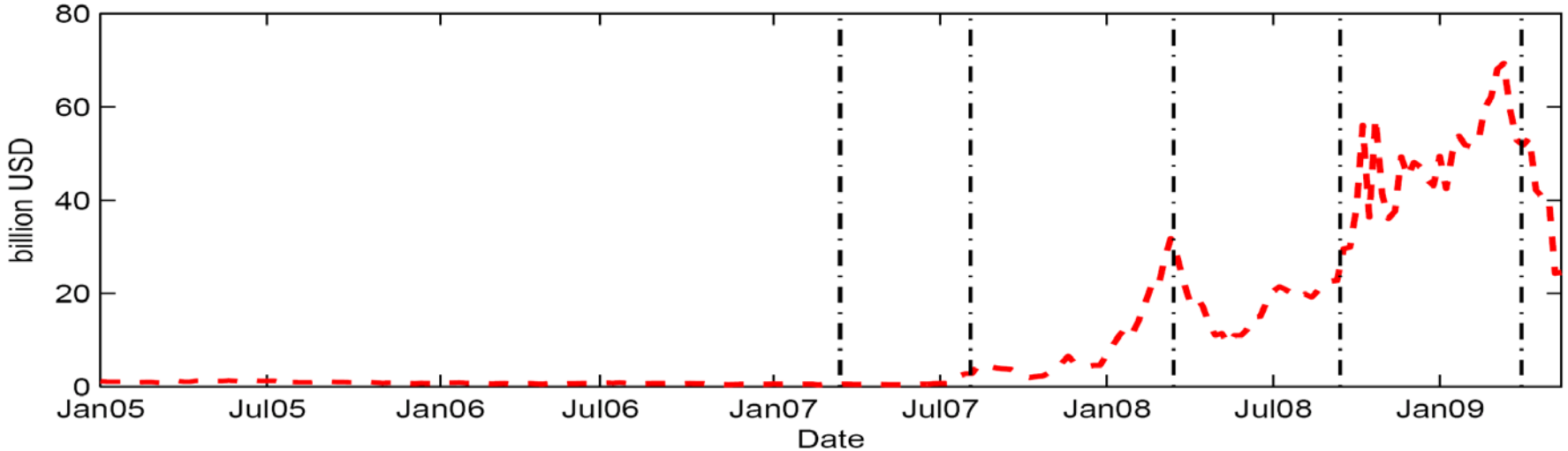
- Step 3: simulate (risk-neutral) portfolio loss distribution
  - $L = \Sigma L_i$
  - $DIP = E(L \mid L \geq L_{min})$

Example 1: Major banks in Asia-Pacific
Example 2, US 19 banks in SCAP

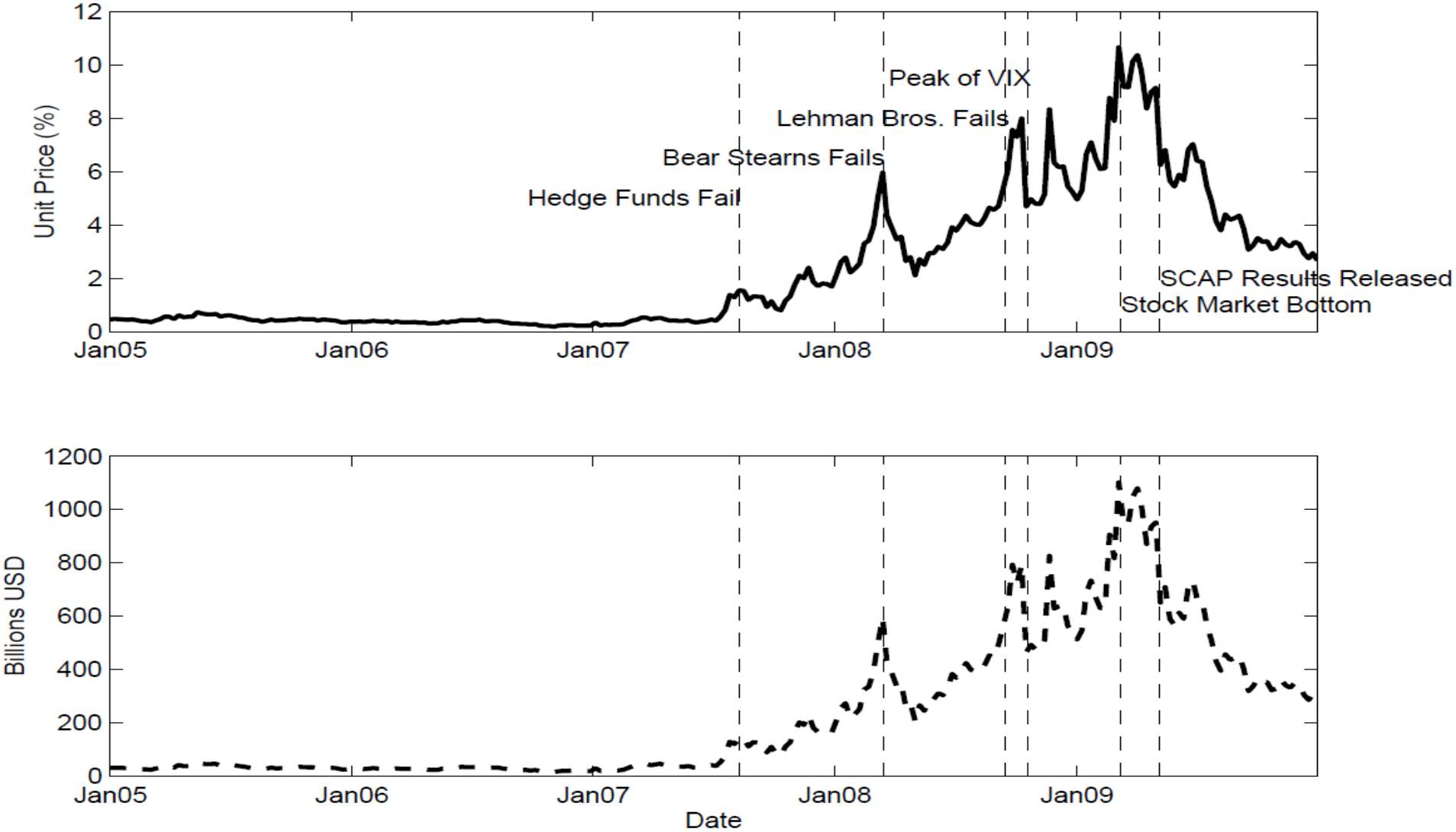
- 22 major banks in Asia-Pacific
  - Australia (6), Hong Kong (2), India (2), Indonesia (1), Korea (4), Malaysia (2), Singapore (3) and Thailand (2)
  - Selection criteria
    - Tier-1 capital > 2.5 billion USD in 2007 or the largest bank in its own jurisdiction
    - Data availability: CDS, equity prices, EDF
- The 22 banks combined held 3.95 trillion USD in 2007, compared to the aggregate GDP of 4.2 trillion USD
- "Distress": total losses ≥ 10% of total liabilities

Example 1: 22 major banks in Asia-Pacific region





Example 2: 19 US BHCs included in the SCAP exercise



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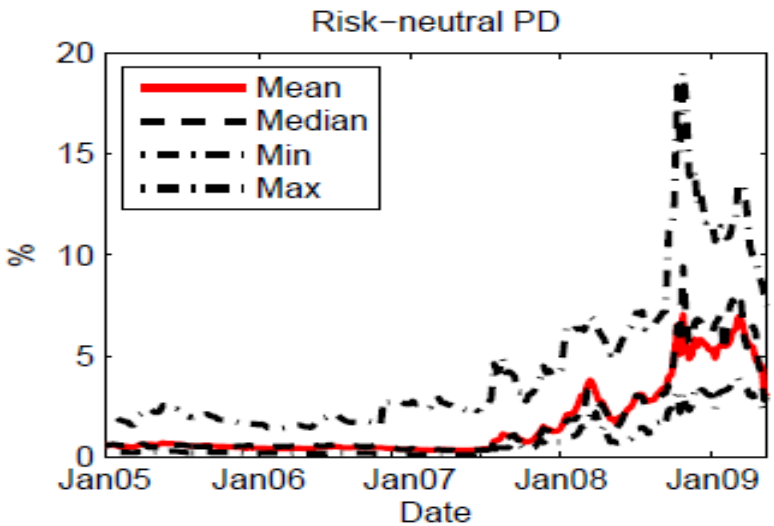

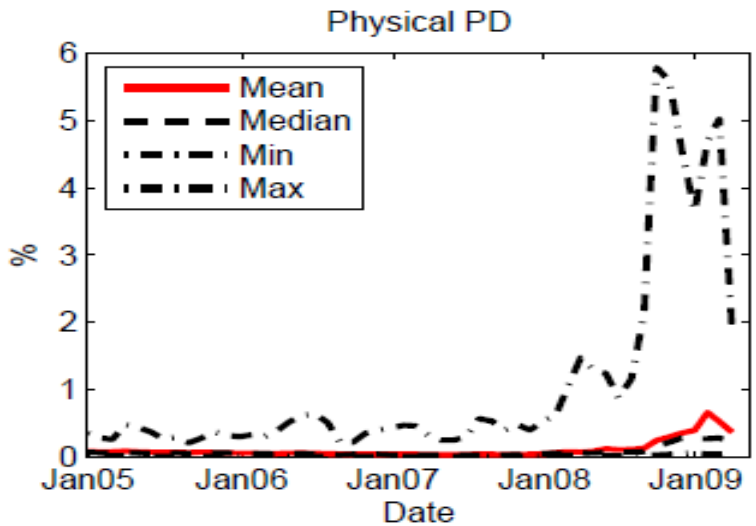

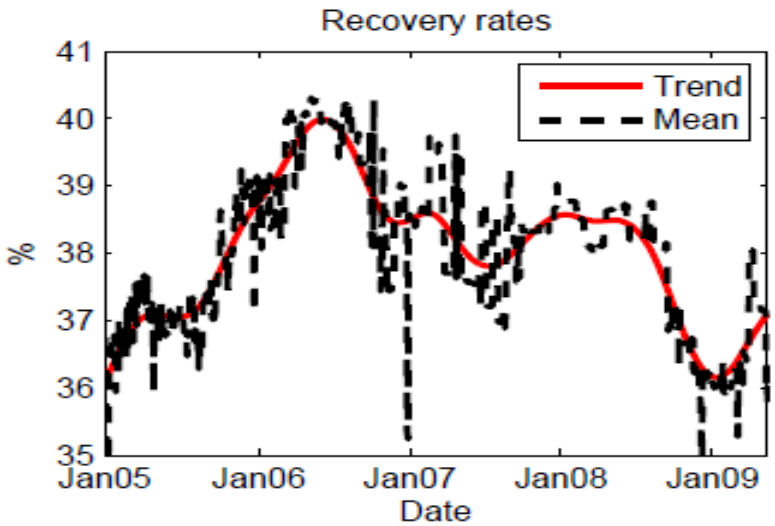

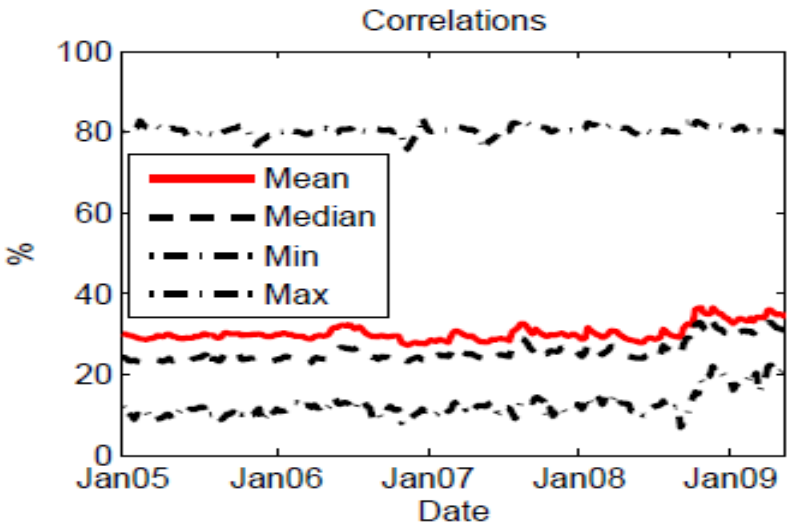

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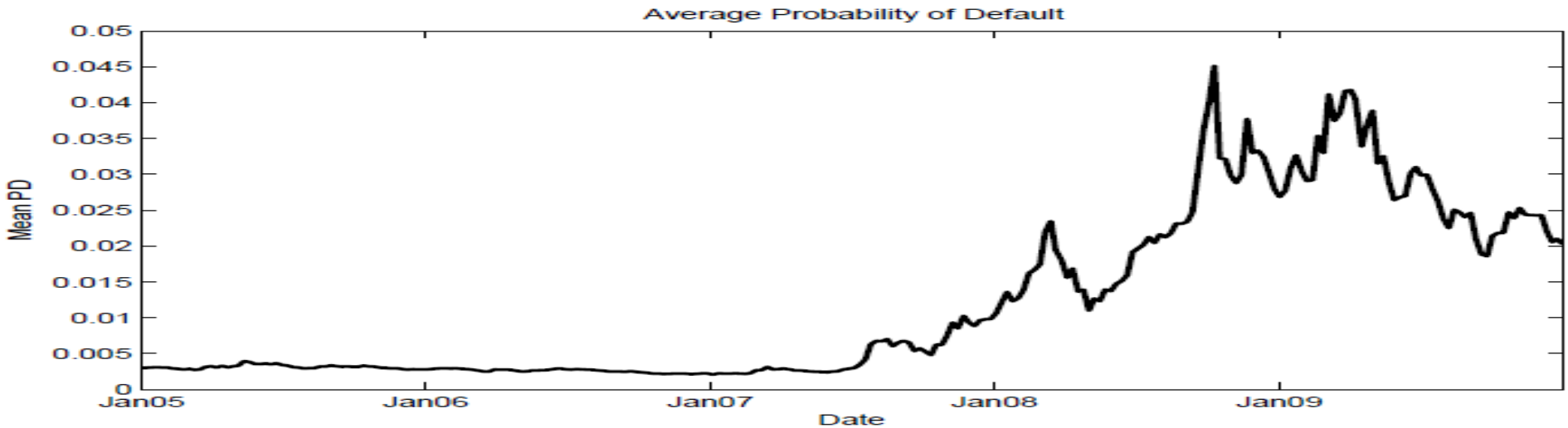
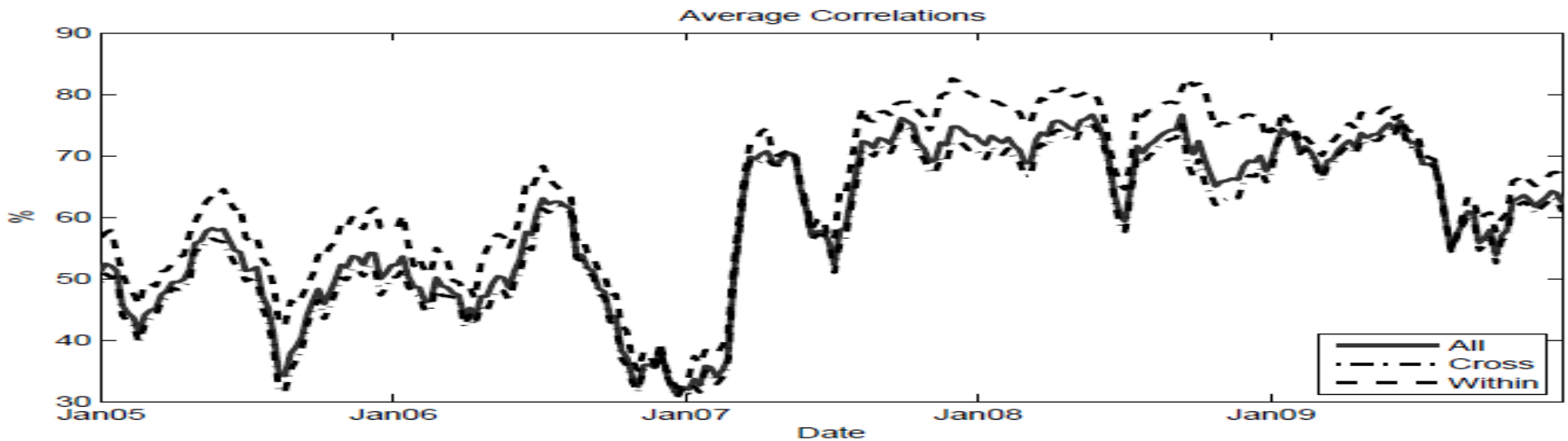
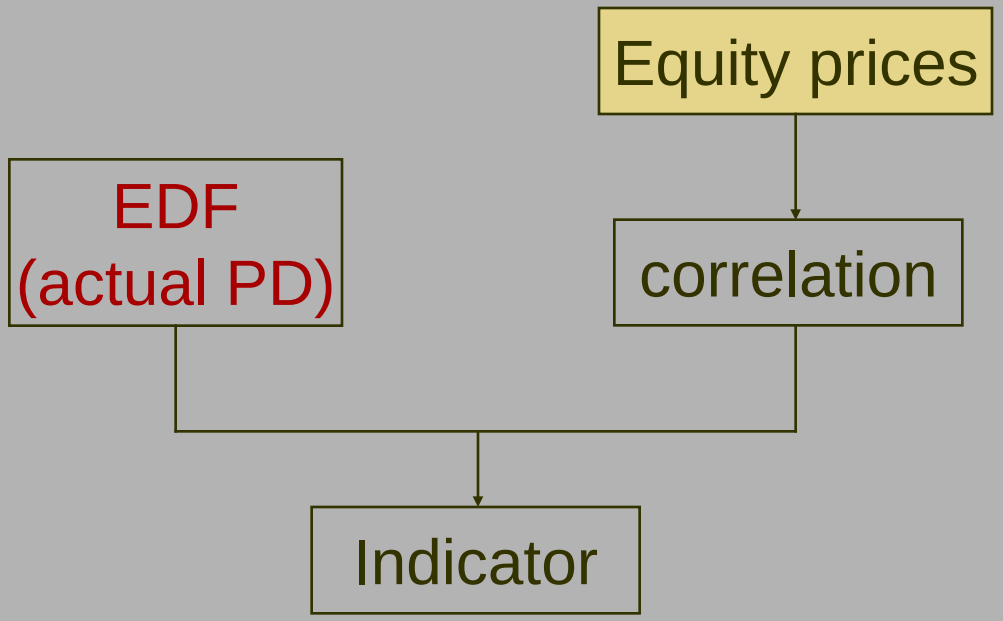


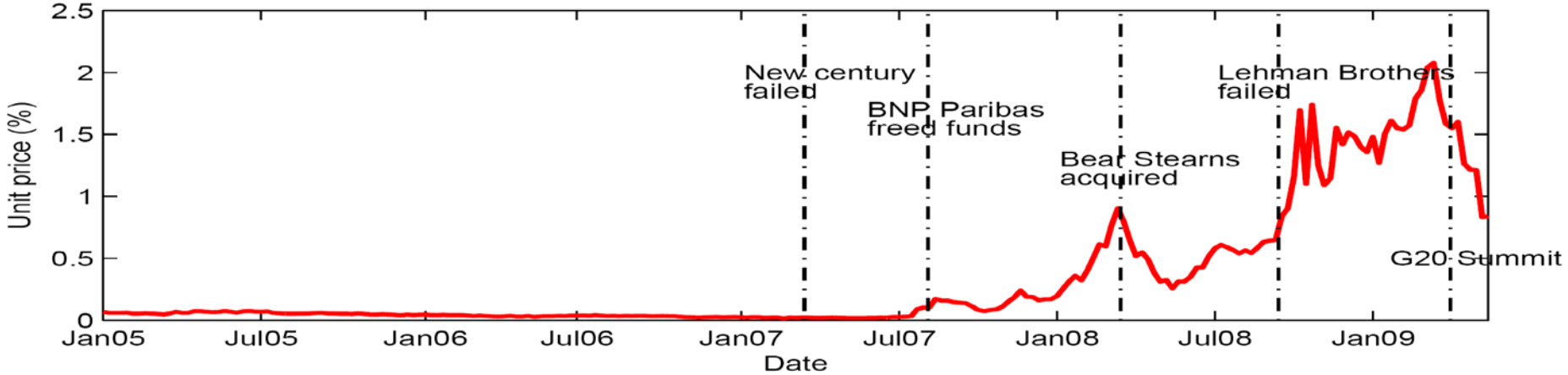


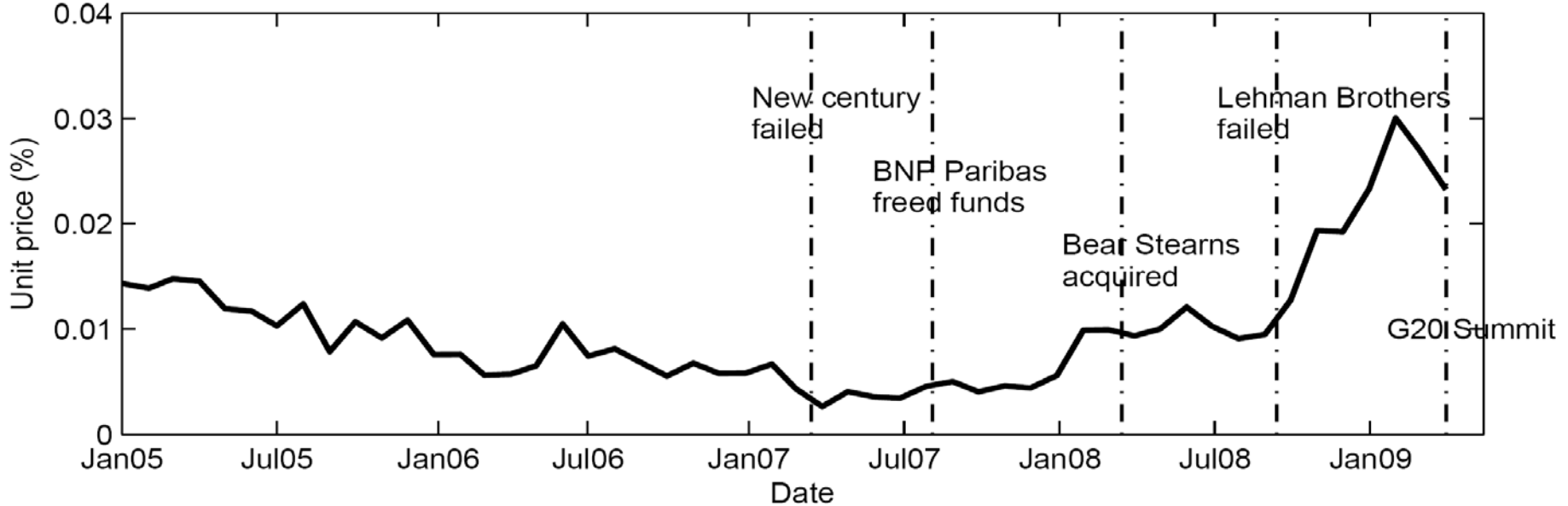
II. Driving factors of systemic risk

- 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



Example 1: 22 major banks in Asia-Pacific region





II. Driving factors of systemic risk

- Approach 2: regression-based analysis
  - Actual default
  - Default risk premium
  - Liquidity risk premium

Dependent variables	Regression 1	Regression 2	Regression 3	Regression 4
Constant	-0.061	-0.49	0.013	-0.31
	(1.9)	(12.5)	(0.2)	(7.8)
Average EDF (%)	3.44			1.50
	(17.6)			(5.6)
Baa-Aaa spread (%)		0.64		0.33
		(23.6)		(5.5)
LIBOR-OIS spread (%)			0.68	0.13
			(8.6)	(2.8)
Adjusted-R^2	0.86	0.92	0.60	0.95

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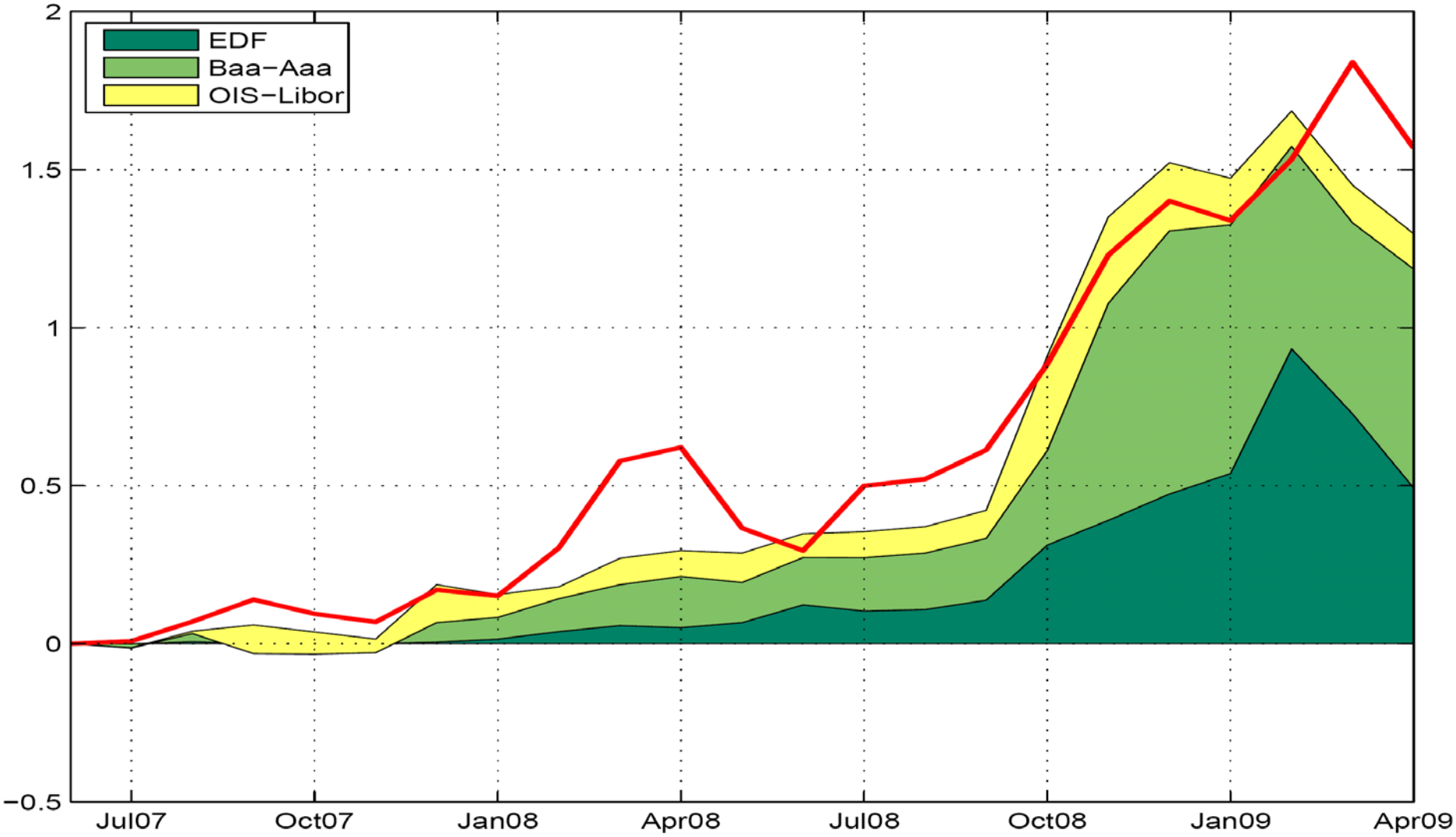
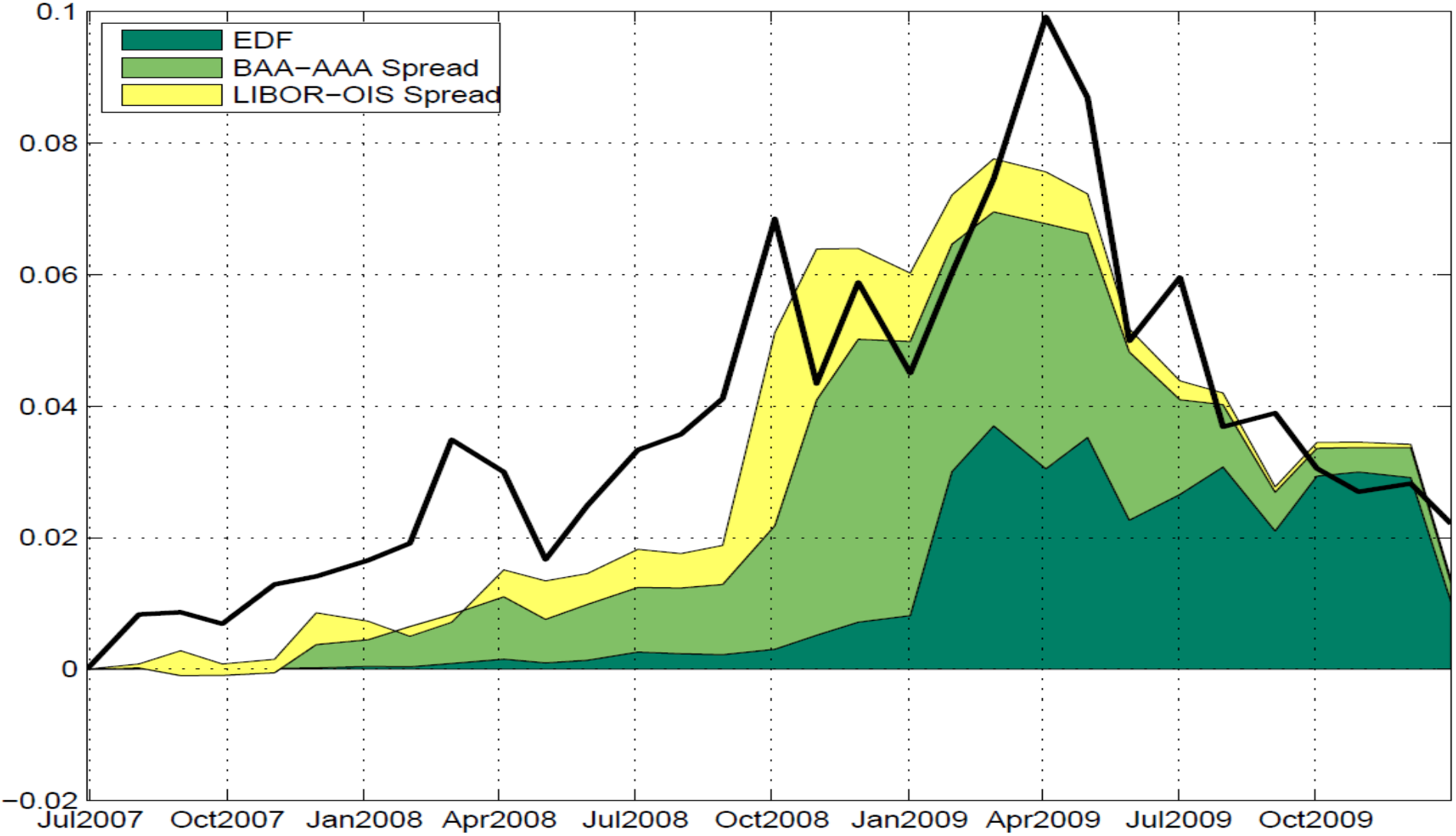


Example 2: 19 US BHCs included in the SCAP exercise

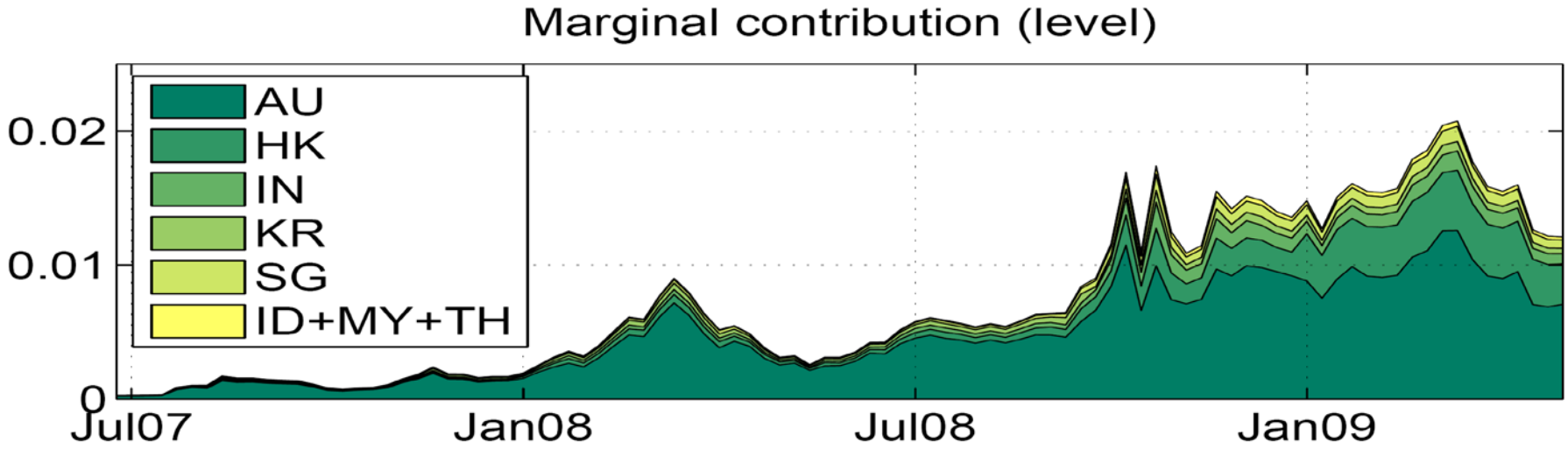


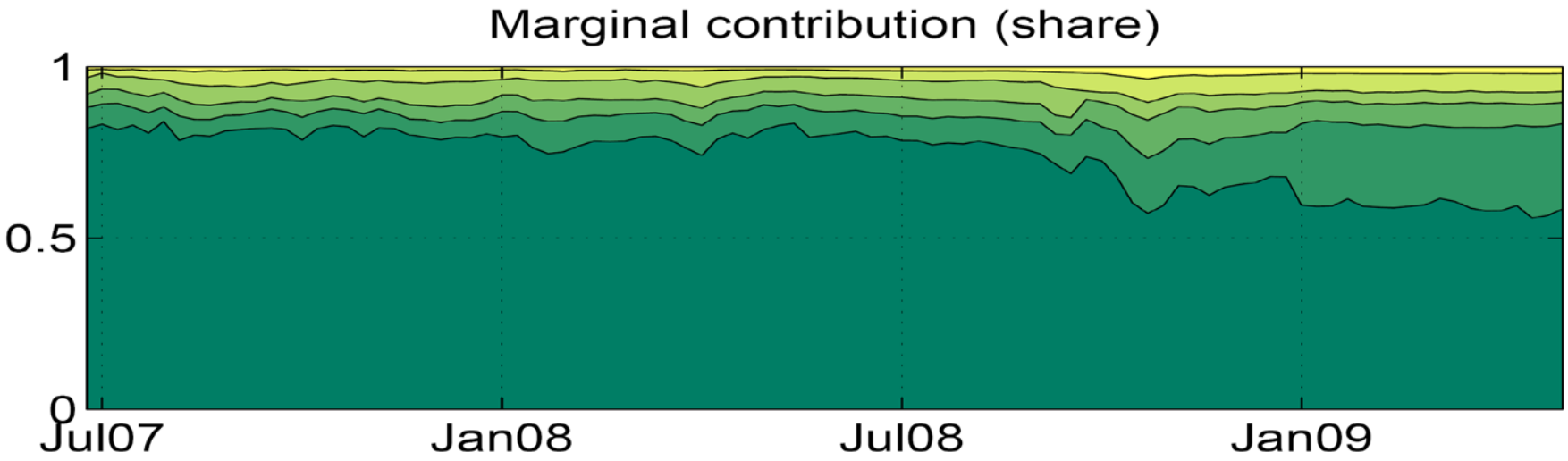
III. Allocating systemic risk to each bank

- 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* = Σ *MC*$_i$ $\Rightarrow$ *additive property*

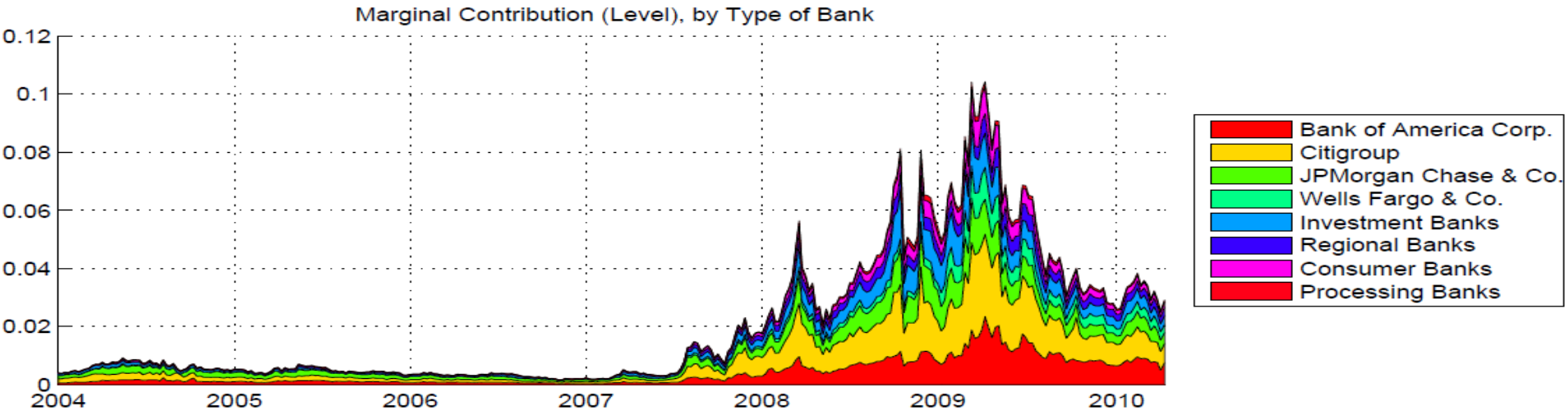
- Comparison to two other approaches
  - DIP: $E[L_i \mid L \geq L_{\min}]$
  - CoVaR: Prob (VaR=q | VaR_i=q)
  - CoES: E(L | $L_i \geq VaR_i$)
    - Implicitly relating to PD, size, and correlation (explicit)
    - Objective distribution (risk-neutral insurance price)
    - Reverse directions and CoVaR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

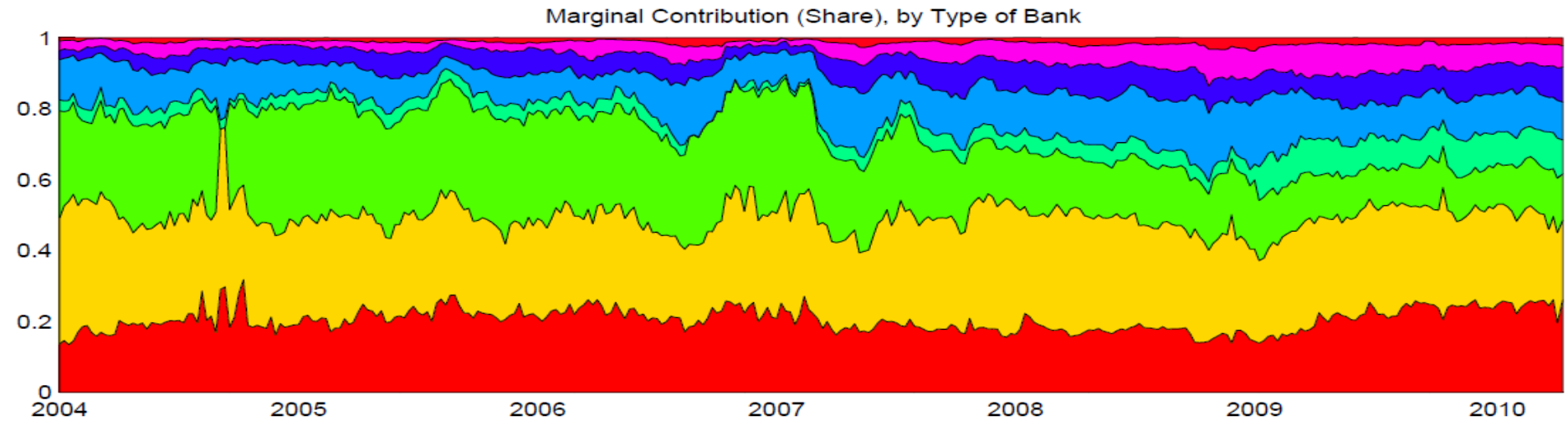
Systemic importance: Asia-Pacific example





Systemic importance: US example





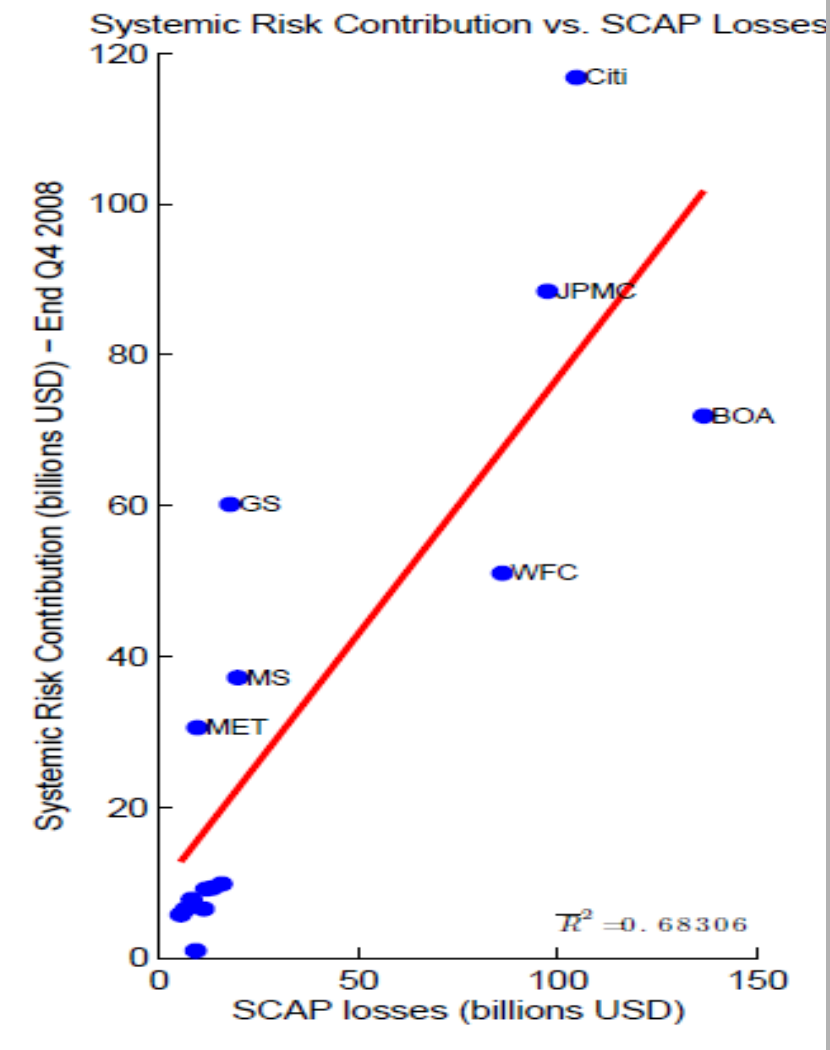
Bank Name	Country	Marginal contribution by bank					*Memo: Bank*
		06.30.2007	03.15.2008	10.25.2008	03.07.2009	05.02.2009	*equity in 2007*
ANZ National Bank	Australia	0.0771	4.3900	5.7229	7.7300	4.2279	19.53
Commonwealth Bank Group	Australia	0.2156	6.5001	8.2839	10.6668	5.8130	25.01
Macquarie Bank	Australia	0.0254	1.5436	3.1761	3.6251	1.9618	9.19
National Australia Bank	Australia	0.1678	7.6246	9.4217	12.8181	7.7941	26.47
St George Bank	Australia	0.0153	1.2026	1.2868	n.a.	n.a.	5.21
Westspac Banking Corp	Australia	0.0829	4.1081	5.0966	7.1203	3.8562	15.79
Bank Negara Indonesia	Indonesia	0.0010	0.0355	0.1880	0.1634	0.0736	1.84
ICICI Bank	India	0.0076	0.4466	2.2754	1.6353	0.8748	11.42
State Bank of India	India	0.0203	0.8543	4.2207	2.8282	1.6166	15.77
Bank of East Asia	Hong Kong	0.0006	0.0766	0.4563	0.4446	0.2293	3.90
Standard Chartered Bank	Hong Kong	0.0427	2.1363	8.7825	13.9914	9.8628	21.45
Industrial Bank of Korea	Korea	0.0082	0.3868	1.8831	1.4536	0.7631	7.14
Kookmin Bank	Korea	0.0227	1.0698	n.a.	n.a.	n.a.	17.13
Korea Exchange Bank	Korea	0.0031	0.2298	1.0202	0.8903	0.5462	7.11
Woori Bank	Korea	0.0000	0.0079	0.0298	0.0337	0.0176	14.05
Malayan Banking Berhad	Malaysia	0.0017	0.1153	0.6716	0.5053	0.2547	6.15
Public Bank Berhad	Malaysia	0.0009	0.0478	0.4375	0.3564	0.1675	3.02
DBS Bank	Singapore	0.0083	0.4285	1.7736	1.6141	0.9914	16.10
Oversea Chinese Banking Corp	Singapore	0.0040	0.2743	1.1038	0.9588	0.5424	11.71
United Overseas Bank Ltd	Singapore	0.0040	0.2372	1.0737	0.9895	0.5696	12.32
Bangkok Bank	Thailand	0.0013	0.0672	0.3921	0.3688	0.2682	5.62
Kasikombank	Thailand	0.0008	0.0396	0.3130	n.a.	n.a.	3.37
Total		0.7113	31.8225	57.6092	68.1939	40.4308	259.32

Table 1: Marginal contribution to systemic risk on specific dates, by bank

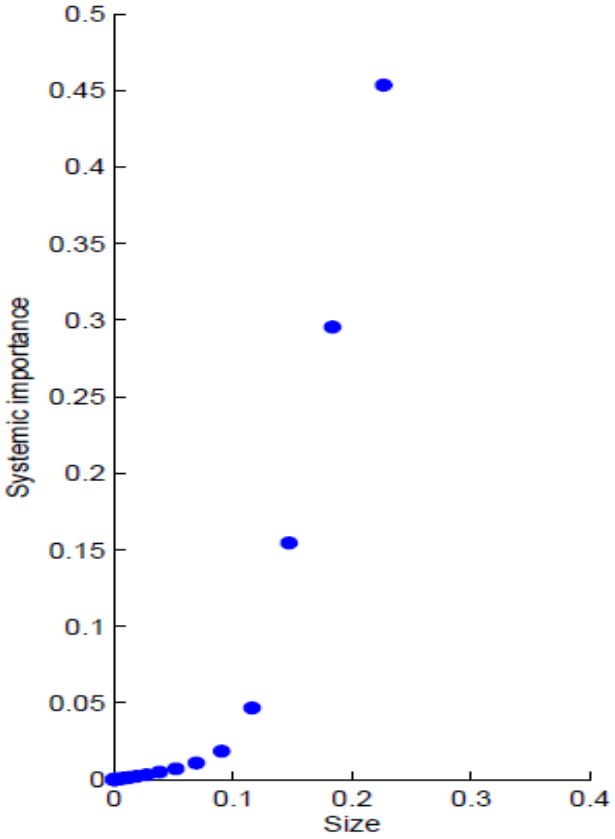
Bank Name	Sector	Marginal contribution						*SCAP*
		06.29.2007	03.14.2008	10.10.2008	11.21.2008	03.06.2009	03.26.2010	*Losses*
American Express Co.	Consumer	0.1103	4.3564	11.2648	8.9336	11.8824	1.3141	11.2000
Bank of America Corp.	LCFI	6.5783	89.0372	115.3855	113.7524	197.3568	80.4678	136.6000
BB&T	Regional	0.2626	3.5706	8.4486	6.7101	NaN	3.1629	8.7000
Bank of NY Mellon Corp.	Processing	0.2220	4.0386	7.9192	7.9336	9.5486	3.1165	5.4000
Capital One Financial Corp.	Regional	0.0801	9.7471	13.2452	10.5724	10.7946	1.7511	13.4000
Citigroup, Inc.	LCFI	9.9896	167.9319	232.1214	293.6022	314.9927	72.2338	104.7000
Fifth Third Bancorp	Regional	0.1377	1.7985	NaN	NaN	1.7415	3.8289	9.1000
GMAC LLC	Consumer	0.1000	6.1894	14.1160	14.7534	10.3699	1.6615	9.2000
Goldman Sachs Group, Inc.	Investment	2.5131	41.2036	93.1600	69.1573	84.9471	18.7823	17.8000
JP Morgan Chase & Co.	LCFI	8.3843	89.9052	125.6070	129.0701	160.3044	41.5042	97.4000
KeyCorp	Regional	0.0978	2.6285	10.7468	8.8907	9.6527	3.4519	6.7000
MetLife, Inc.	Consumer	0.6553	19.7449	41.5619	43.9580	67.7141	15.4632	9.6000
Morgan Stanley	Investment	1.6914	31.4958	76.5376	44.9418	64.2955	11.8782	19.7000
PNC Fin. Svcs. Gp, Inc.	Regional	0.2823	2.4525	NaN	NaN	NaN	2.6487	18.8000
Regions Fin. Corp.	Regional	0.2833	0.9125	0.9971	0.9166	0.9700	4.5508	9.2000
State St. Corp.	Processing	0.2784	3.8897	9.3803	11.7877	9.2705	2.7552	8.2000
SunTrust Banks, Inc.	Regional	0.3106	6.5160	13.1509	10.5460	9.5568	3.6545	11.8000
U.S. Bancorp	Regional	0.3748	7.4078	11.4230	9.0631	10.7429	4.2704	15.7000
Wells Fargo & Co.	LCFI	1.0954	24.9586	32.6814	28.1531	117.3237	31.2821	86.1000
Total		33.4475	517.7848	817.7467	812.7420	1091.4642	307.7780	599.3000

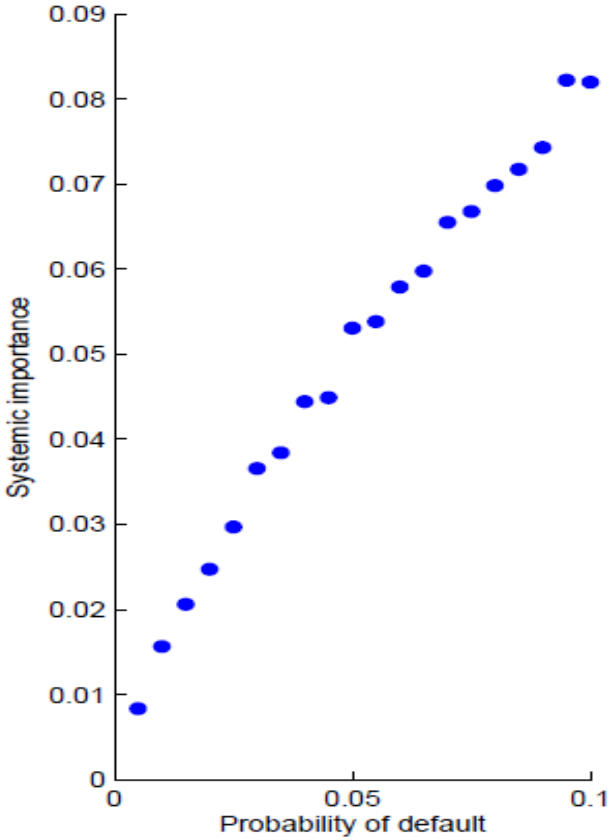
Note: All numbers are in billions of US dollars

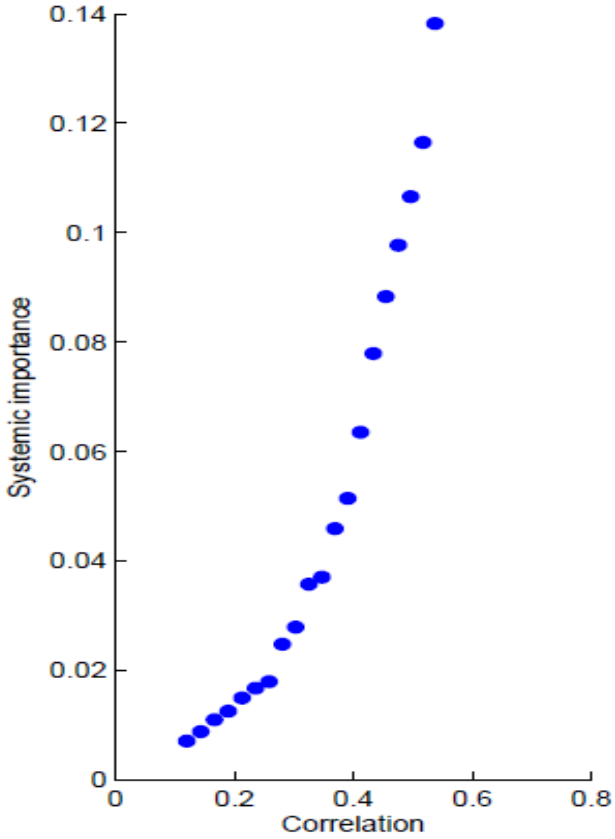
- Systemic importance: US end-2008, DIP versus SCAP results



- 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 for systemic banks

- Challenges remain
  - Time-dimension (counter-cyclical capital buffer)?
  - Is there a unified framework (all DIP, CoVaR, CoES)?
  - As public policy, should systemic capital charge be based on risk-neutral price or actuarial expected loss? (James Wilcox discussion at Chicago Bank Structure Conference)