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

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Background

- The global financial crisis has led bank supervisors and regulators to rethink about the rationale of banking regulation.
- Complement "micro-" with "macro-" prudential approach.
  - National, regional and international levels.
  - Financial stability and economic performance.

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Objectives of this paper

- Measuring systemic risk: distress insurance premium (Huang, Zhou and Zhu (2009)).
- Decompose systemic risk into physical default risk and risk premia.
- Allocate systemic risk to individual banks.
  Or identify systemically important FIs.

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Literature

- Market-based systemic risk indicator
    - Probability of joint defaults: Lehar (2005), Chan-Lau and Gravelle (2005), Avesani et al (2006).
- Systemic importance of individual banks
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Main findings

- Both spillover effects and real economy affect the movement of the systemic risk indicator.
- Risk premia are the main driving factors of systemic risk.
- Size effect is important in determining the systemic importance of individual banks, supporting "too-big-to-fail".

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Outlines of the presentation

- Construct the systemic risk indicator.
- Driving factors of systemic risk.
- Allocating systemic risk to each bank.
- Conclusion.

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Risk Indicator
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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?
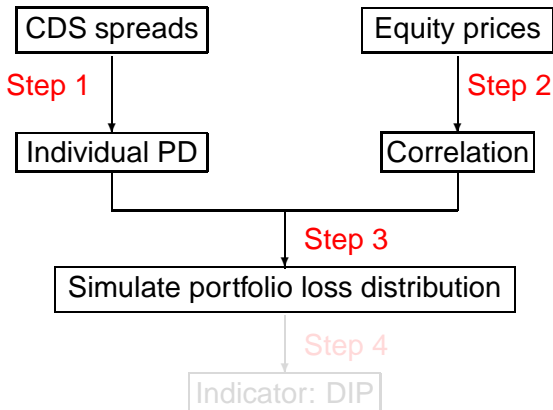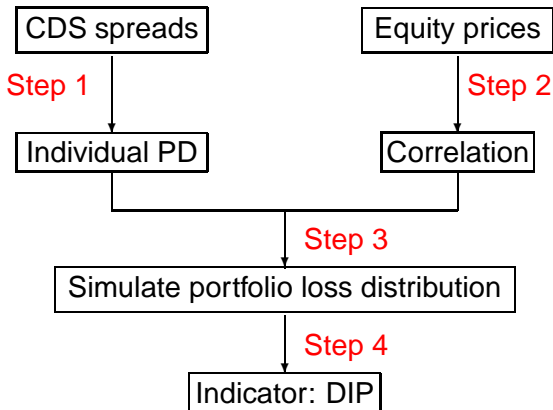
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Methodology

- Step 1: estimating PDs from CDS spreads ($s_{i,t}$) (Duffie (1999) and Tarashev and Zhu (2008))

$$PD_{i,t} = \frac{a_t s_{i,t}}{a_t LGD_{i,t} + b_t s_{i,t}} \tag{1}$$

- PDs are forward-looking.
- PDs are risk-neutral.

Risk-neutral PD

Actual PD   Risk premium

Default risk premium   Liquidity risk premium

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Methodology (cont.)

- Step 2: estimating asset return correlations.
    - Use equity return correlations as a proxy (Hull & White): short time horizon.
    - Use Dynamic Conditional Correlation (DCC) approach by Engle (2002).
        - Daily data for Asian and the Pacific region.
        - Heterogeneous correlations.

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- Step 3: simulate (risk-neutral) portfolio loss distribution.
  - A hypothetical weighted portfolio of debt instruments of all banks, weighted by bank liabilities.
  - $L = \sum L_i$
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The banking system in this study

- 22 major banks in Asia-Pacific.
    - 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.
    - Australia (6), Hong Kong (2), India (2), Indonesia (1), Korea (4), Malaysia (2), Singapore (3) and Thailand (2).
- 22 banks combined held 3.95 trillion USD in 2007 (compared to the aggregate GDP of 4.2 trillion USD)
- "distress": total losses $\geq$ 10% of total liabilities.
- Sample period: January 2005 to May 2009, weekly frequency.
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Systemic Risk Indicator for Asian-Pacific Banking Sector

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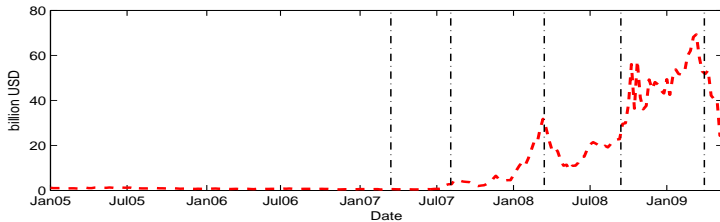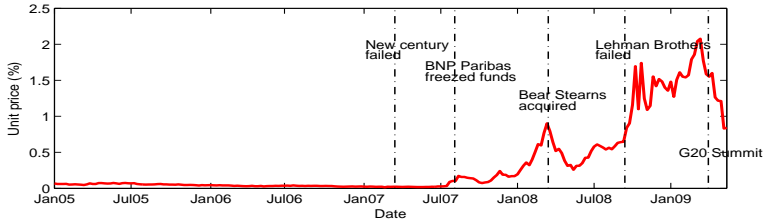
Systemic Risk Indicator for 19 US Banks
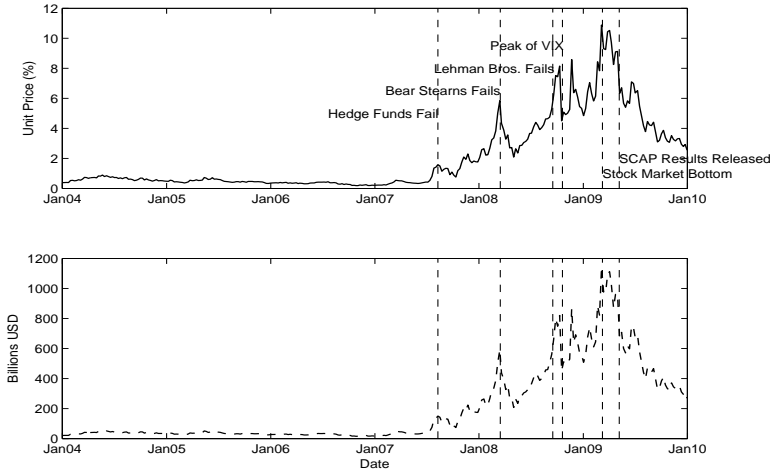
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II. Driving factors of systemic risk

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

Equity prices

EDF (actual PD)   Correlation

Indicator

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                        │ Equity prices│
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│ EDF (actual PD)  │    │ Correlation  │
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         │                     │
         └──────────┬──────────┘
                    ▼
              ┌──────────┐
              │ Indicator│
              └──────────┘
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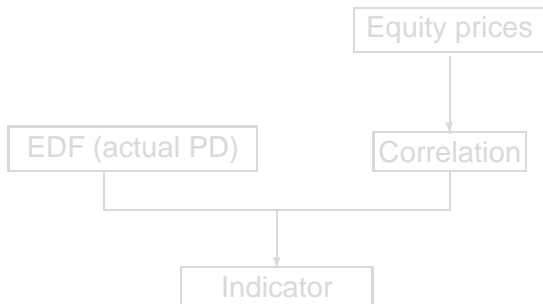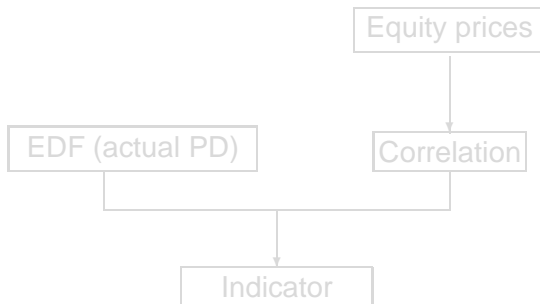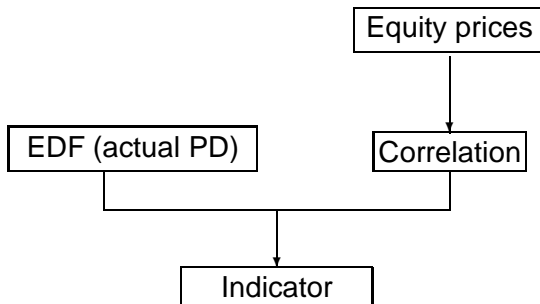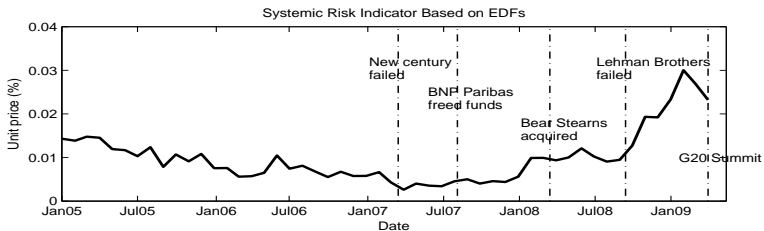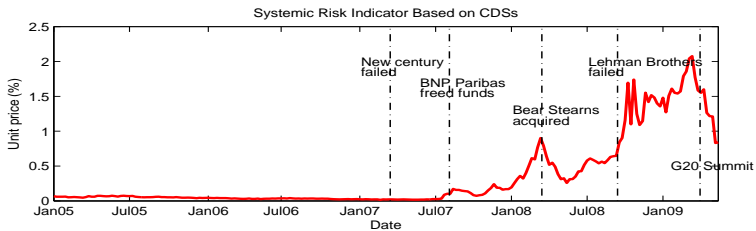
- Approach 2: regression-based analysis.
  - Actual default.
  - Default risk premium.
  - Liquidity risk premium.

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)	(-7.1)
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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III. Allocating systemic risk to each bank

- Marginal contribution of bank i to the systemic risk.
  - Definition: $MC_i = \frac{\partial DIP}{\partial L_i} = E[L_i | L \geq L_{min}]$
  - Computation: Importance sampling method (Glassmerman and Li (2005)).
  - $DIP = \sum MC_i \Rightarrow$ additive property

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Marginal contribution (level)

Marginal contribution (share)

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
Kasikornbank	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

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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
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Kasikornbank	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

| 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
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What explains systemic importance?

- Size matters most $\rightarrow$ "too big to fail"
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Dependent variables	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
1. Level regressions						
	Regression 1		Regression 2		Regression 3	
Constant	-5.24	(-2.2)	-0.45	(-2.2)	5.28	(3.1)
$PD_{i,t}$	0.78	(2.4)			-0.51	(-2.2)
$Cor_{i,t}$	9.30	(1.4)			-16.05	(-3.7)
$Weight_{i,t}$	54.89	(7.8)	-160.83	(-4.0)	-253.29	(-4.2)
$PD_{i,t} \times Weight_{i,t}$			27.88	(5.0)	36.05	(4.7)
$Cor_{i,t} \times Weight_{i,t}$			485.31	(5.0)	730.86	(5.0)
Adjusted-R^2	0.40		0.81		0.86	
2. Relative-term regressions						
	Regression 1		Regression 2		Regression 3	
Constant	-7.52	(-2.2)	-2.07	(-2.6)	9.57	(4.1)
$PD_{i,t}$	0.22	(0.5)			-0.15	(-0.3)
$Cor_{i,t}$	4.05	(1.1)			-12.04	(-5.4)
$Weight_{i,t}$	172.72	(5.1)	-165.09	(-2.1)	-355.35	(-3.7)
$PD_{i,t} \times Weight_{i,t}$			15.53	(0.9)	23.45	(1.2)
$Cor_{i,t} \times Weight_{i,t}$			272.35	(4.9)	450.35	(6.2)
Adjusted-R^2	0.83		0.89		0.92	

Conclusions

- Our approach provides a possible 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)
    - A unified framework?
    - How banks may react to new regulatory regime?

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