The Value of Implicit Guarantees

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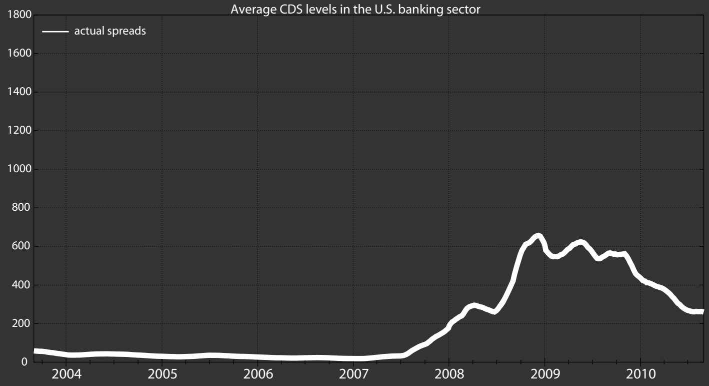
MIT

Minneapolis Fed TBTF Workshop, November 2013

1. Introduction



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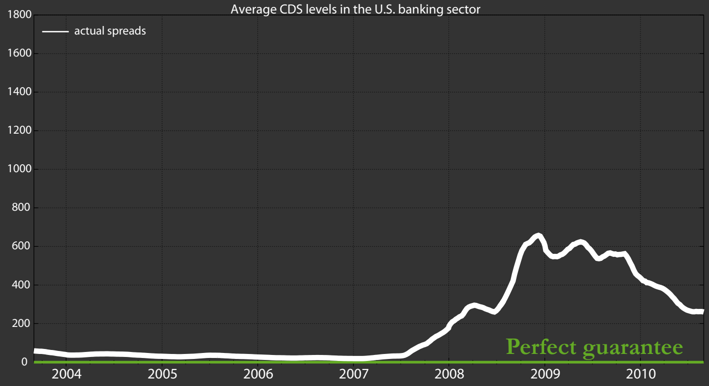

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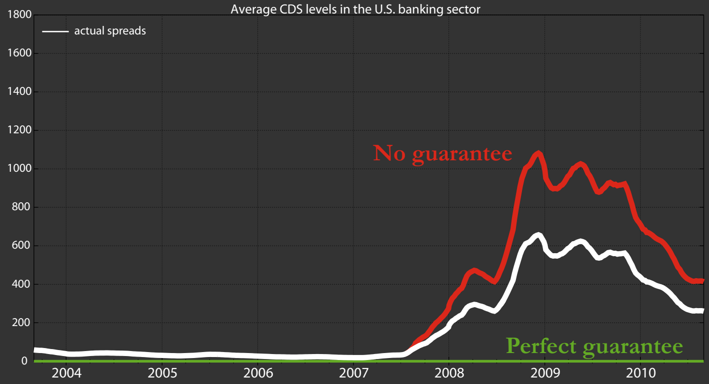

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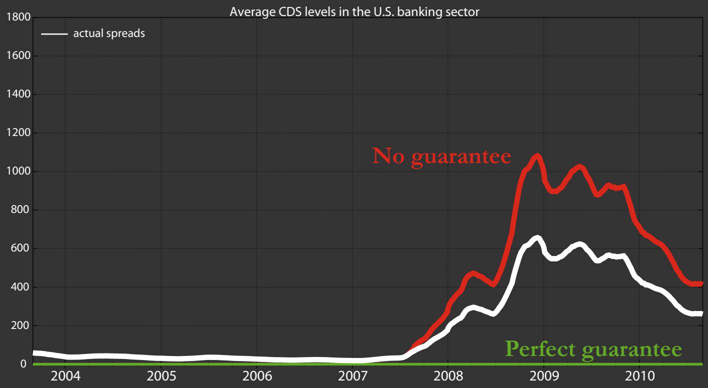

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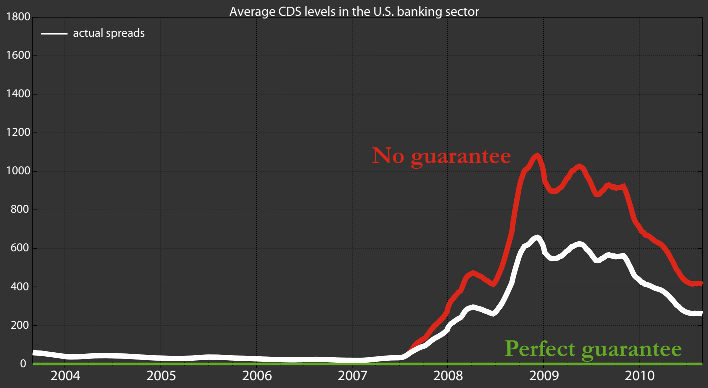

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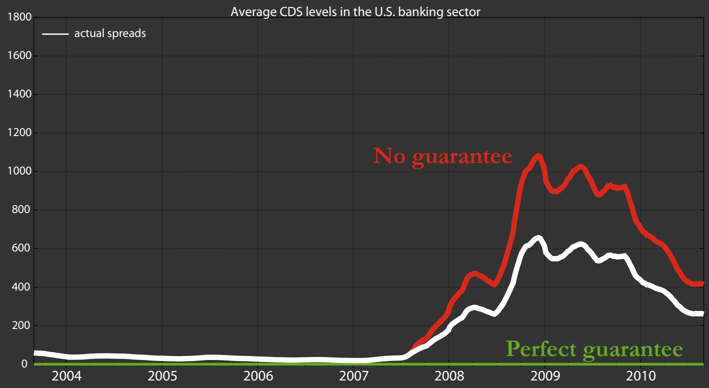

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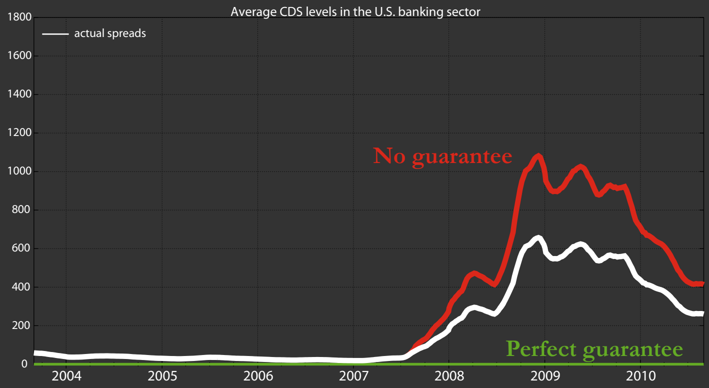

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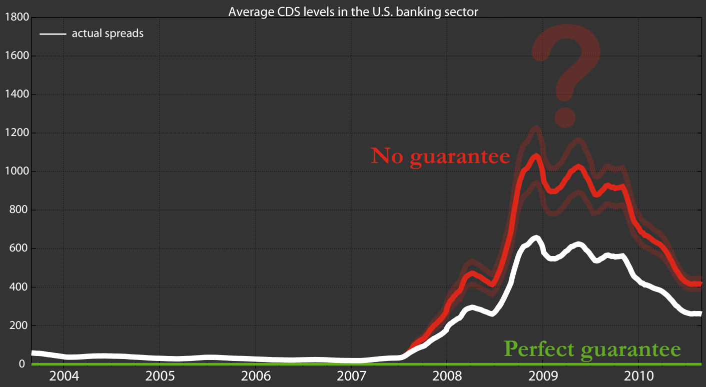

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Crisis prevention: Regulatory approaches

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  - Better gauge of financial health than observed CDS price (cf. Hart and Zingales, 2009)

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Crisis prevention: Regulatory approaches

- ▷ Standalone credit risk
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- ▷ Taxation
  - ◦ Bank levy based on funding advantage backed out of debt prices net of guarantees

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- Q. Which financial institutions benefit from these subsidies, to what extent, and how are these gains split up between shareholders and creditors?
- Q. How do guarantees influence the financing strategy of banks?

- Findings point to a significant funding advantage of major banks during the crisis, that is less pronounced or even inexistent for non-banks
  - Structural break in the pricing assumptions for U.S. bank debt
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- In the course of the interventions, U.S. banks shifted to fixed-rate short-term financing to exploit their TBTF status

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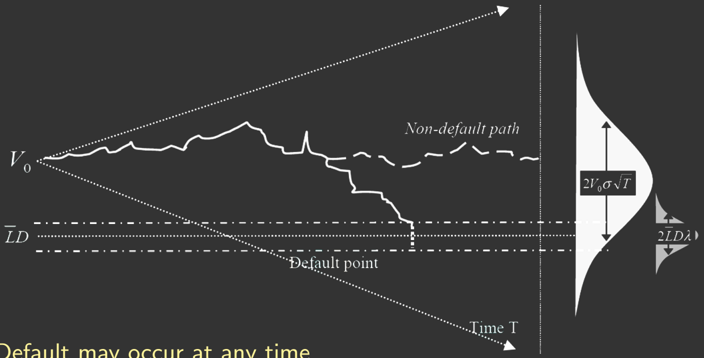
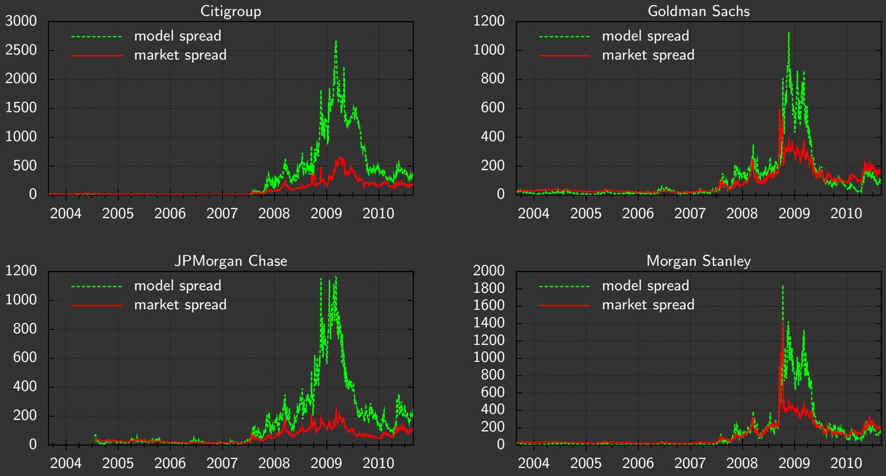
  - ⇒ Contrast default risk as explicitly priced in the CDS market to the default risk as it is implicitly priced in the stock market (Schweikhard and Tsesmelidakis, 2012)
- ▷ Exploit the divergence between the model-implied and actual CDS prices and adjust for counterparty risk to derive the funding advantage financial institutions enjoy from being TBTF

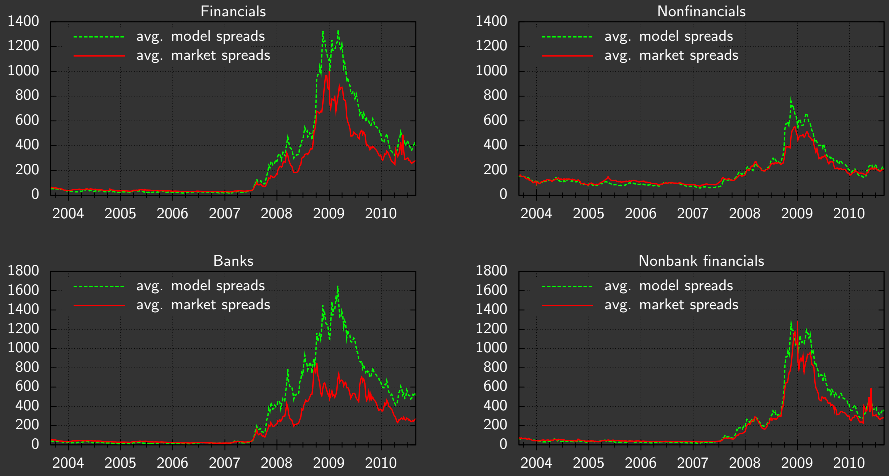


- ▷ Default may occur at any time
- ▷ Stochastic default barrier, which is only revealed at default
  - ○ Barrier $B = LD$, where $L \sim LN(\overline{L}; \lambda)$
  - ⇒ Increases short-term default probabilities by capturing the possibility of instantaneous default

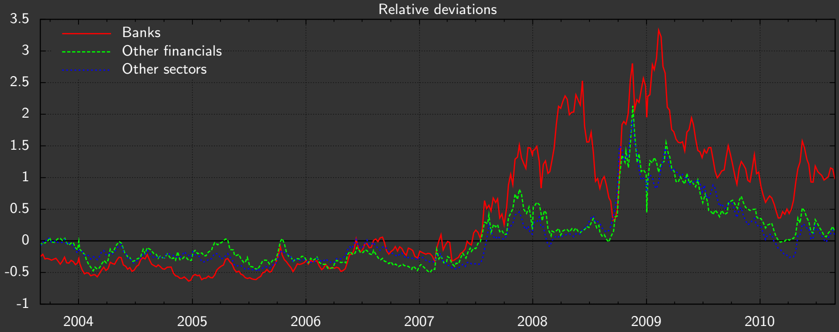
Firm-level results



Sector aggregates



Relative deviations



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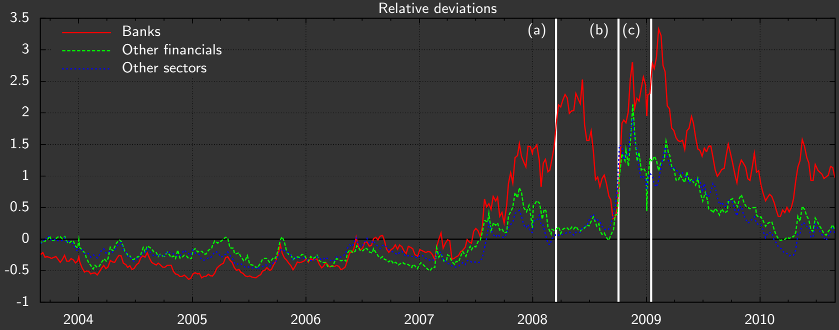
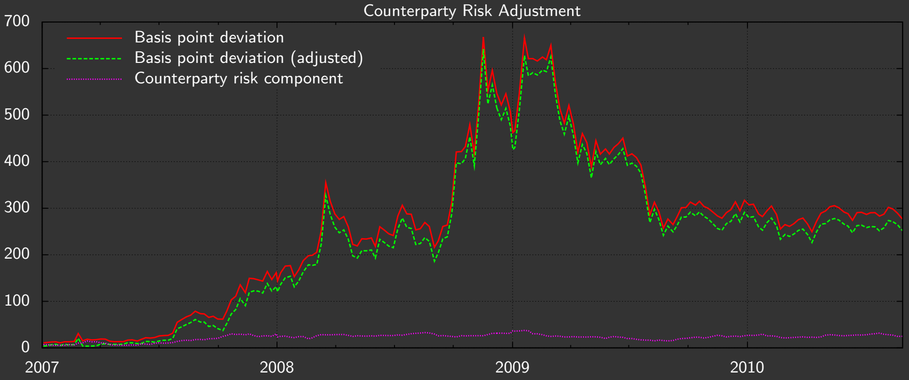
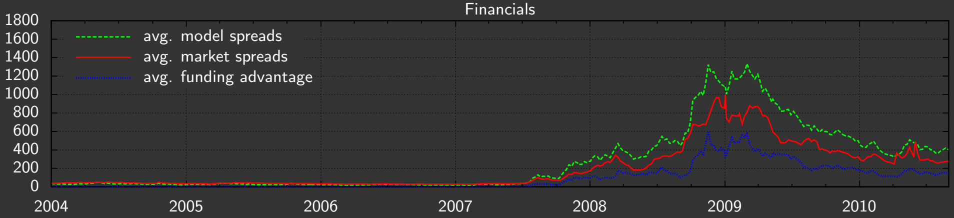


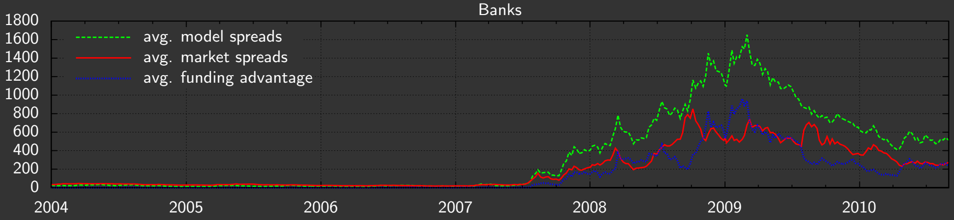
(a) Acquisition of Bear Stearns by JPMorgan

(b) TARP

(c) Rescue package for Bank of America


Counterparty Risk Adjustment
Basis point deviation
Basis point deviation (adjusted)
Counterparty risk component
700
600
500
400
300
200
100
0
2007
2008
2009
2010





*All numbers are in basis points per annum.

		Offering Amounts					Maturities				Weighted Maturities				Trading Volumes				
	Issues	FCB	VCB	ZCB	$\sum$	$\frac{OAO}{TD}$	FCB	VCB	ZCB	$\varnothing$	FCB	VCB	ZCB	$\varnothing$	$V_{T\leq 5y}$	$V_{5y<T\leq 10y}$	$V_{T>10y}$	$V_{\sum}$	TT
										Pre-Crisis Period									
Sectors																			
Banks	4,587	213.41	545.90	34.81	794.13	0.28	7.99	5.51	2.34	5.41	14.55	5.64	3.36	7.93	148.21	369.77	901.52	1,419.51	3,104
Insurance	1,292	50.02	63.09	0.12	113.22	0.56	8.71	9.44	14.96	8.87	12.10	16.32	9.52	14.45	94.20	132.82	220.86	447.88	2,613
Real Estate	91	35.10	2.46	0.00	37.56	0.70	11.12	6.84	0.00	10.70	12.48	3.83	0.00	11.91	5.50	36.17	104.62	146.29	151
Others	8	1.88	1.25	0.00	3.12	0.11	8.04	28.38	0.00	15.66	8.50	47.47	0.00	24.09	0.00	0.00	17.00	17.00	9
Financials	5,978	300.40	612.70	34.93	948.03	0.30	8.35	6.10	2.39	6.25	13.86	6.82	3.38	8.92	247.91	538.76	1,244.00	2,030.68	5,877
										Crisis Period									
Sectors																			
Banks	5,513	517.45	255.01	45.06	817.53	0.29	2.50	8.54	2.17	2.96	5.77	4.78	2.58	5.28	692.97	312.51	425.76	1,431.24	2,923
Insurance	761	46.03	35.51	0.61	82.15	0.47	7.80	12.30	5.88	8.27	9.64	26.44	12.20	16.92	13.12	56.14	133.50	202.75	999
Real Estate	34	13.57	0.80	0.00	14.37	0.73	9.44	4.98	0.00	9.30	10.01	4.98	0.00	9.73	0.00	12.26	15.31	27.56	390
Others	12	7.34	1.95	0.00	9.29	0.15	4.38	2.50	0.00	4.21	4.49	1.86	0.00	3.94	14.32	4.50	5.00	23.82	28
Financials	6,320	584.39	293.27	45.68	923.34	0.30	3.66	9.02	2.18	3.64	6.16	7.38	2.71	6.37	720.40	385.41	579.57	1,685.37	4,340
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Sectors																			
Banks	5,078	177.11	60.05	30.22	267.38	0.28	2.87	14.51	2.17	4.83	8.14	11.17	1.99	8.12	1,061.56	3,459.59	3,794.43	8,315.57	6,3375
Insurance	71	39.80	5.60	0.00	45.40	0.61	11.21	2.07	0.00	10.18	9.24	1.98	0.00	8.34	45.28	146.86	718.05	910.18	1104
Real Estate	47	21.99	0.00	0.00	21.99	0.76	10.33	0.00	0.00	10.33	9.81	0.00	0.00	9.81	0.00	276.25	363.08	639.32	690
Others	10	4.10	0.25	0.00	4.35	0.26	6.07	3.01	0.00	5.77	6.45	3.01		6.25	3.75	39.51	35.70	78.96	88
Financials	5,206	243.00	65.90	30.22	339.12	0.30	3.35	14.40	2.17	4.95	8.44	10.36	1.99	8.24	1,110.59	3,922.20	4,911.26	9,944.03	65,257

*Monetary amounts are in billions of US$.

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Insurance	1,292	50.02	63.09	0.12	113.22	0.56	8.71	9.44	14.96	8.87	12.10	16.32	9.52	14.45	94.20	132.82	220.86	447.88	2,613
Real Estate	91	35.10	2.46	0.00	37.56	0.70	11.12	6.84	0.00	10.70	12.48	3.83	0.00	11.91	5.50	36.17	104.62	146.29	151
Others	8	1.88	1.25	0.00	3.12	0.11	8.04	28.38	0.00	15.66	8.50	47.47	0.00	24.09	0.00	0.00	17.00	17.00	9
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Insurance	761	46.03	35.51	0.61	82.15	0.47	7.80	12.30	5.88	8.27	9.64	26.44	12.20	16.92	13.12	56.14	133.50	202.75	999
Real Estate	34	13.57	0.80	0.00	14.37	0.73	9.44	4.98	0.00	9.30	10.01	4.98	0.00	9.73	0.00	12.26	15.31	27.56	390
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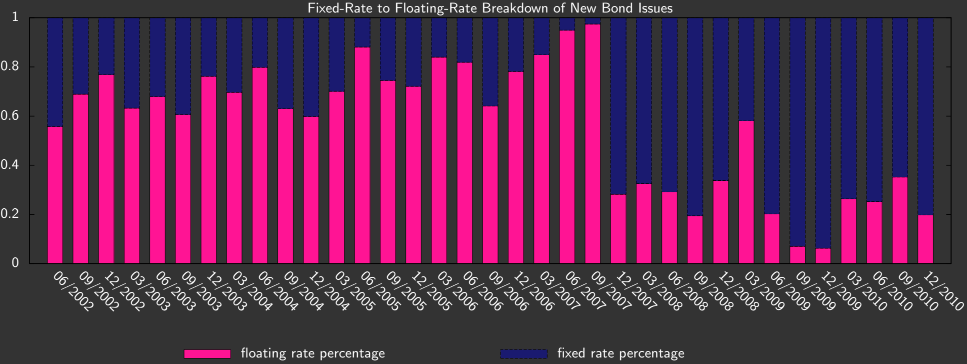
Fix-to-floating ratio



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Financials	5,206	243.00	65.90	30.22	339.12	0.30	3.35	14.40	2.17	4.95	8.44	10.36	1.99	8.24	1,110.59	3,922.20	4,911.26	9,944.03	65,257

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	Issues	Offering Amounts					Maturities				Weighted Maturities				Trading Volumes				
	Issues	FCB	VCB	ZCB	$\sum$	$\frac{OAO}{TD}$	FCB	VCB	ZCB	$\varnothing$	FCB	VCB	ZCB	$\varnothing$	$V_{T\leq 5y}$	$V_{5y<T\leq 10y}$	$V_{T>10y}$	$V_{\sum}$	TT
Pre-Crisis Period																			
Sectors																			
Banks	4,587	213.41	545.90	34.81	794.13	0.28	7.99	5.51	2.34	5.41	14.55	5.64	3.36	7.93	148.21	369.77	901.52	1,419.51	3,104
Insurance	1,292	50.02	63.09	0.12	113.22	0.56	8.71	9.44	14.96	8.87	12.10	16.32	9.52	14.45	94.20	132.82	220.86	447.88	2,613
Real Estate	91	35.10	2.46	0.00	37.56	0.70	11.12	6.84	0.00	10.70	12.48	3.83	0.00	11.91	5.50	36.17	104.62	146.29	151
Others	8	1.88	1.25	0.00	3.12	0.11	8.04	28.38	0.00	15.66	8.50	47.47	0.00	24.09	0.00	0.00	17.00	17.00	9
Financials	5,978	300.40	612.70	34.93	948.03	0.30	8.35	6.10	2.39	6.25	13.86	6.82	3.38	8.92	247.91	538.76	1,244.00	2,030.68	5,877
Crisis Period																			
Sectors																			
Banks	5,513	517.45	255.01	45.06	817.53	0.29	2.50	8.54	2.17	2.96	5.77	4.78	2.58	5.28	692.97	312.51	425.76	1,431.24	2,923
Insurance	761	46.03	35.51	0.61	82.15	0.47	7.80	12.30	5.88	8.27	9.64	26.44	12.20	16.92	13.12	56.14	133.50	202.75	999
Real Estate	34	13.57	0.80	0.00	14.37	0.73	9.44	4.98	0.00	9.30	10.01	4.98	0.00	9.73	0.00	12.26	15.31	27.56	390
Others	12	7.34	1.95	0.00	9.29	0.15	4.38	2.50	0.00	4.21	4.49	1.86	0.00	3.94	14.32	4.50	5.00	23.82	28
Financials	6,320	584.39	293.27	45.68	923.34	0.30	3.66	9.02	2.18	3.64	6.16	7.38	2.71	6.37	720.40	385.41	579.57	1,685.37	4,340
Post-Crisis Period																			
Sectors																			
Banks	5,078	177.11	60.05	30.22	267.38	0.28	2.87	14.51	2.17	4.83	8.14	11.17	1.99	8.12	1,061.56	3,459.59	3,794.43	8,315.57	6,3375
Insurance	71	39.80	5.60	0.00	45.40	0.61	11.21	2.07	0.00	10.18	9.24	1.98	0.00	8.34	45.28	146.86	718.05	910.18	1104
Real Estate	47	21.99	0.00	0.00	21.99	0.76	10.33	0.00	0.00	10.33	9.81	0.00	0.00	9.81	0.00	276.25	363.08	639.32	690
Others	10	4.10	0.25	0.00	4.35	0.26	6.07	3.01	0.00	5.77	6.45	3.01		6.25	3.75	39.51	35.70	78.96	88
Financials	5,206	243.00	65.90	30.22	339.12	0.30	3.35	14.40	2.17	4.95	8.44	10.36	1.99	8.24	1,110.59	3,922.20	4,911.26	9,944.03	65,257

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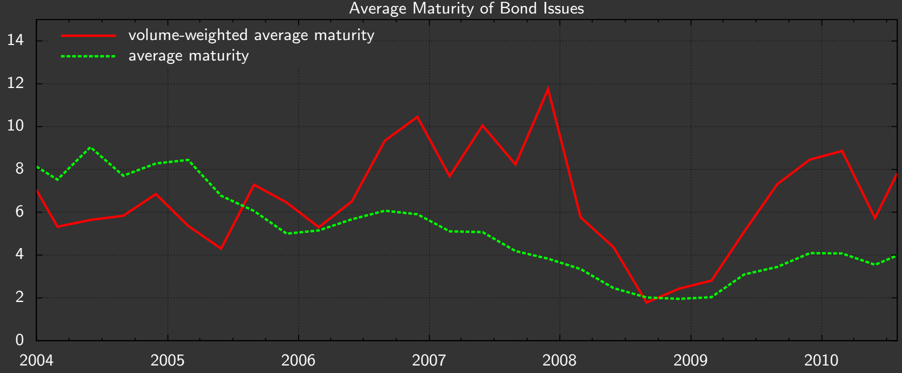
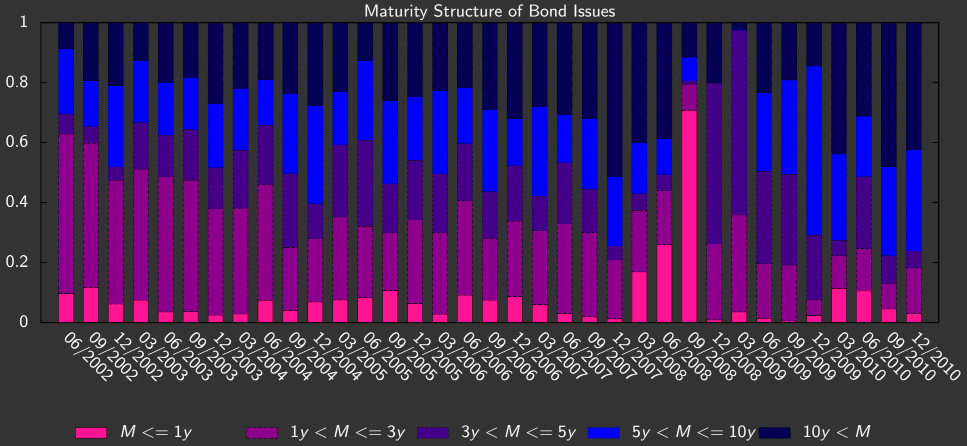
**The pre-crisis period is from June 2005 to July 2007, the crisis period ranges from August 2007 to September 2009, and the post-crisis period lasts until November 2011.


Average Maturity of Bond Issues
volume-weighted average maturity
average maturity
14
12
10
8
6
4
2
0
2004
2005
2006
2007
2008
2009
2010


Maturity Structure of Bond Issues
1
0.8
0.6
0.4
0.2
0
06/2002
09/2002
12/2002
03/2003
06/2003
09/2003
12/2003
03/2004
06/2004
09/2004
12/2004
03/2005
06/2005
09/2005
12/2005
03/2006
06/2006
09/2006
12/2006
03/2007
06/2007
09/2007
12/2007
03/2008
06/2008
09/2008
12/2008
03/2009
06/2009
09/2009
12/2009
03/2010
06/2010
09/2010
12/2010
M <= 1y
1y < M <= 3y
3y < M <= 5y
5y < M <= 10y
10y < M

	Issues	Offering Amounts FCB	VCB	ZCB	$\sum$	$\frac{OAO}{TD}$	Maturities FCB	VCB	ZCB	$\varnothing$	Weighted Maturities FCB	VCB	ZCB	$\varnothing$	Trading Volumes $V_{T\leq 5y}$	$V_{5y<T\leq 10y}$	$V_{T>10y}$	$V_{\sum}$	TT
Pre-Crisis Period																			
Sectors																			
Banks	4,587	213.41	545.90	34.81	794.13	0.28	7.99	5.51	2.34	5.41	14.55	5.64	3.36	7.93	148.21	369.77	901.52	1,419.51	3,104
Insurance	1,292	50.02	63.09	0.12	113.22	0.56	8.71	9.44	14.96	8.87	12.10	16.32	9.52	14.45	94.20	132.82	220.86	447.88	2,613
Real Estate	91	35.10	2.46	0.00	37.56	0.70	11.12	6.84	0.00	10.70	12.48	3.83	0.00	11.91	5.50	36.17	104.62	146.29	151
Others	8	1.88	1.25	0.00	3.12	0.11	8.04	28.38	0.00	15.66	8.50	47.47	0.00	24.09	0.00	0.00	17.00	17.00	9
Financials	5,978	300.40	612.70	34.93	948.03	0.30	8.35	6.10	2.39	6.25	13.86	6.82	3.38	8.92	247.91	538.76	1,244.00	2,030.68	5,877
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Sectors																			
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Insurance	761	46.03	35.51	0.61	82.15	0.47	7.80	12.30	5.88	8.27	9.64	26.44	12.20	16.92	13.12	56.14	133.50	202.75	999
Real Estate	34	13.57	0.80	0.00	14.37	0.73	9.44	4.98	0.00	9.30	10.01	4.98	0.00	9.73	0.00	12.26	15.31	27.56	390
Others	12	7.34	1.95	0.00	9.29	0.15	4.38	2.50	0.00	4.21	4.49	1.86	0.00	3.94	14.32	4.50	5.00	23.82	28
Financials	6,320	584.39	293.27	45.68	923.34	0.30	3.66	9.02	2.18	3.64	6.16	7.38	2.71	6.37	720.40	385.41	579.57	1,685.37	4,340
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Sectors																			
Banks	5,078	177.11	60.05	30.22	267.38	0.28	2.87	14.51	2.17	4.83	8.14	11.17	1.99	8.12	1,061.56	3,459.59	3,794.43	8,315.57	6,3375
Insurance	71	39.80	5.60	0.00	45.40	0.61	11.21	2.07	0.00	10.18	9.24	1.98	0.00	8.34	45.28	146.86	718.05	910.18	1104
Real Estate	47	21.99	0.00	0.00	21.99	0.76	10.33	0.00	0.00	10.33	9.81	0.00	0.00	9.81	0.00	276.25	363.08	639.32	690
Others	10	4.10	0.25	0.00	4.35	0.26	6.07	3.01	0.00	5.77	6.45	3.01		6.25	3.75	39.51	35.70	78.96	88
Financials	5,206	243.00	65.90	30.22	339.12	0.30	3.35	14.40	2.17	4.95	8.44	10.36	1.99	8.24	1,110.59	3,922.20	4,911.26	9,944.03	65,257

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		Offering Amounts					Maturities				Weighted Maturities				Trading Volumes				
	Issues	FCB	VCB	ZCB	$\sum$	$\frac{OAO}{TD}$	FCB	VCB	ZCB	$\varnothing$	FCB	VCB	ZCB	$\varnothing$	$V_{T\leq 5y}$	$V_{5y<T\leq 10y}$	$V_{T>10y}$	$V_{\sum}$	TT
											Pre-Crisis Period								
Sectors																			
Banks	4,587	213.41	545.90	34.81	794.13	0.28	7.99	5.51	2.34	5.41	14.55	5.64	3.36	7.93	148.21	369.77	901.52	1,419.51	3,104
Insurance	1,292	50.02	63.09	0.12	113.22	0.56	8.71	9.44	14.96	8.87	12.10	16.32	9.52	14.45	94.20	132.82	220.86	447.88	2,613
Real Estate	91	35.10	2.46	0.00	37.56	0.70	11.12	6.84	0.00	10.70	12.48	3.83	0.00	11.91	5.50	36.17	104.62	146.29	151
Others	8	1.88	1.25	0.00	3.12	0.11	8.04	28.38	0.00	15.66	8.50	47.47	0.00	24.09	0.00	0.00	17.00	17.00	9
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Banks	5,513	517.45	255.01	45.06	817.53	0.29	2.50	8.54	2.17	2.96	5.77	4.78	2.58	5.28	692.97	312.51	425.76	1,431.24	2,923
Insurance	761	46.03	35.51	0.61	82.15	0.47	7.80	12.30	5.88	8.27	9.64	26.44	12.20	16.92	13.12	56.14	133.50	202.75	999
Real Estate	34	13.57	0.80	0.00	14.37	0.73	9.44	4.98	0.00	9.30	10.01	4.98	0.00	9.73	0.00	12.26	15.31	27.56	390
Others	12	7.34	1.95	0.00	9.29	0.15	4.38	2.50	0.00	4.21	4.49	1.86	0.00	3.94	14.32	4.50	5.00	23.82	28
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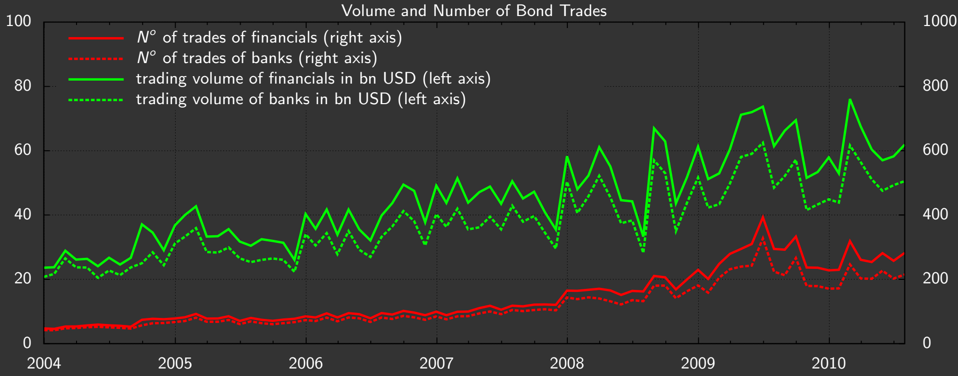
Volume and Number of Bond Trades
N^o of trades of financials (right axis)
N^o of trades of banks (right axis)
trading volume of financials in bn USD (left axis)
trading volume of banks in bn USD (left axis)
0
20
40
60
80
100
0
200
400
600
800
1000
2004
2005
2006
2007
2008
2009
2010

5. Capitalized subsidies

Estimate implicit subsidies resulting from the funding cost advantage.

$$P = PV(Bond) = \sum_{t=1}^{T} \frac{cN}{(1+y)^t} + \frac{N}{(1+y)^T}$$

Shareholders' subsidies

Q. *How much more would a bank have to pay (in PV terms) to raise the debt?*

- ▷ Re-value bond issues by increasing coupon rate to obtain non-guaranteed issue price $P_{c_{NG}}$

$$P_{c_G} < P_{c_{NG}} \Rightarrow S_c = P_{c_{NG}} - P_{c_G}$$

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$$P_{c_G} < P_{c_{NG}} \Rightarrow S_c = P_{c_{NG}} - P_{c_G}$$

Bondholders' subsidies

Q. *By how much is the deterioration of bond prices offset due to the guarantee?*

- ▷ Re-value transactions by increasing YTM to obtain non-guaranteed transaction price $P_{y_{NG}}$

$$P_{y_G} > P_{y_{NG}} \Rightarrow S_y = P_{y_G} - P_{y_{NG}}$$

5. Capitalized subsidies

Bondholders' subsidies are estimated in two ways:

5. Capitalized subsidies

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◇ Incremental secondary-market subsidies

- Merge TRACE transaction data with issue information from Mergent FISD.
- Calculated once per issue, i.e., for each reference entity that is traded between 2007-2010, select the day with the largest funding advantage and calculate the subsidy S_y.
- Scale the resulting S_y by the corresponding offering amount.
- To avoid double-counting, subtract any primary-market subsidy, if there is.

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- ▷ Scale the resulting S_y by the corresponding offering amount.
- ▷ To avoid double-counting, subtract any primary-market subsidy, if there is.

◇ Continuous secondary-market subsidies

- ▷ Calculated daily.
- ▷ Combine contemporaneous values for the funding advantage with the day-matched trading volume as inferred from TRACE.
- ▷ Trading volume replaces the issue volume and gives an impression of the actual impact through time.

Subsidy-to-Issue-Volume Ratios

*All numbers are in millions of US$.

5. Capitalized subsidies

Panel A – Primary Market Subsidies Implied by a Lower Coupon Rate					
	2007	2008	2009	2010	*Total*
Banks	3.31	38.25	77.15	2.58	121.29
Insurance	0.17	1.76	1.44	2.05	5.42
Real Estate	0.14	0.11	0.83	0.24	1.32
Others	0.00	0.27	0.86	0.01	1.14
Total	3.62	40.39	80.28	4.88	129.17
Panel B – Secondary Market Subsidies Implied by a Lower Yield					
	2007	2008	2009	2010	*Total*
Banks	0.47	93.34	109.13	0.00	202.94
Insurance	0.04	6.13	19.56	0.00	25.73
Real Estate	0.01	3.71	2.89	0.00	6.61
Others	0.00	0.27	0.51	0.00	0.78
Total	0.52	103.45	132.09	0.00	236.06
Panel C – Overall Subsidies					
	2007	2008	2009	2010	*Total*
Banks	3.78	131.59	186.28	2.58	324.23
Insurance	0.21	7.90	21.00	2.05	31.16
Real Estate	0.16	3.82	3.71	0.24	7.93
Others	0.00	0.54	1.36	0.01	1.91
Total	4.15	143.85	212.35	4.88	365.23

*All values are in billions of US$.

5. Capitalized subsidies

Panel A – Primary Market Subsidies Implied by a Lower Coupon Rate

	2007	2008	2009	2010	*Total*
Banks	3.31	38.25	77.15	2.58	121.29
Insurance	0.17	1.76	1.44	2.05	5.42
Real Estate	0.14	0.11	0.83	0.24	1.32
Others	0.00	0.27	0.86	0.01	1.14
Total	3.62	40.39	80.28	4.88	129.17

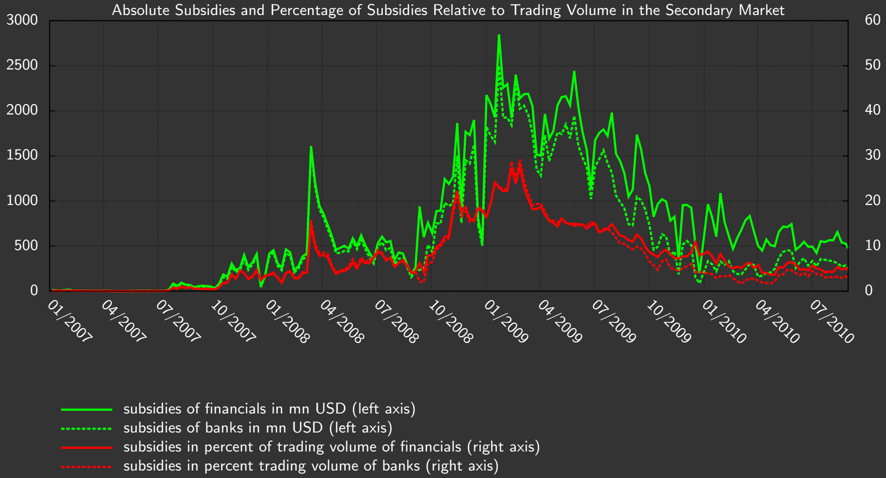
Panel B – Secondary Market Subsidies Implied by a Lower Yield

	2007	2008	2009	2010	*Total*
Banks	0.47	93.34	109.13	0.00	202.94
Insurance	0.04	6.13	19.56	0.00	25.73
Real Estate	0.01	3.71	2.89	0.00	6.61
Others	0.00	0.27	0.51	0.00	0.78
Total	0.52	103.45	132.09	0.00	236.06

Panel C – Overall Subsidies

	2007	2008	2009	2010	*Total*
Banks	3.78	131.59	186.28	2.58	324.23
Insurance	0.21	7.90	21.00	2.05	31.16
Real Estate	0.16	3.82	3.71	0.24	7.93
Others	0.00	0.54	1.36	0.01	1.91
Total	4.15	143.85	212.35	4.88	365.23

*All values are in billions of US$.


Absolute Subsidies and Percentage of Subsidies Relative to Trading Volume in the Secondary Market
3000
2500
2000
1500
1000
500
0
60
50
40
30
20
10
0
01/2007
04/2007
07/2007
10/2007
01/2008
04/2008
07/2008
10/2008
01/2009
04/2009
07/2009
10/2009
01/2010
04/2010
07/2010
subsidies of financials in mn USD (left axis)
subsidies of banks in mn USD (left axis)
subsidies in percent of trading volume of financials (right axis)
subsidies in percent trading volume of banks (right axis)

	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
VIX	0.190	3.27	***	0.196	3.23	***	0.180	3.19	***	0.137	2.41	**	0.130	2.59	**	0.126	2.48	**
Rating (AA)				12.743	3.11	***	12.613	3.09	***	9.807	2.81	***						
Rating (A)				1.540	3.00	***	1.767	3.81	***	-0.446	-0.54							
Rating (BBB)				0.458	1.22		1.565	2.75	***									
r_S	-1.343	-0.85		-1.196	-0.72		-1.763	-1.06		-6.871	-2.19	**	-6.501	-2.51	**	-6.100	-2.65	**
Size	12.116	5.39	***										11.230	5.64	***	2.824	2.61	**
$\beta_{r_S}^{DF}$							4.002	2.47	**									
MES										144.255	3.37	***	133.754	3.70	***	137.554	3.91	***
TARP													0.466	0.28				
TARP Amounts																0.414	7.80	***
Constant	-5.172	-3.14	***	-5.091	-3.12	***	-8.953	-3.18	***	-7.442	-3.30	***	-9.319	-3.62	***	-8.739	-3.44	***
Observations	34143			34273			34273			23937			23835			23835		
$Adj.R^2$	0.221			0.138			0.151			0.199			0.274			0.345		
Coef. Estimates	OLS			OLS			OLS			OLS			OLS			OLS		
Standard Errors	CL-F			CL-F			CL-F			CL-F			CL-F			CL-F		

*Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	(1)			(2)			(3)			(4)			(5)			(6)		
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Coef. Estimates	OLS			OLS			OLS			OLS			OLS			OLS		
Standard Errors	CL-F			CL-F			CL-F			CL-F			CL-F			CL-F		

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	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
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Standard Errors	CL-F			CL-F			CL-F			CL-F			CL-F			CL-F		

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	(1)			(2)			(3)			(4)			(5)			(6)		
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	(1)			(2)			(3)			(4)			(5)			(6)		
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6. Conclusion

- Estimate the pecuniary subsidies financial institutions enjoy from being TBTF.

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- Apply a structural model framework and adjust for counterparty risk to calculate the funding advantage.
- Merge with bond issue and transaction data and re-value bonds to calculate subsidies to share- and bondholders.
- Capitalized subsidies amount to $365.2 billion in total.
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- Capitalized subsidies amount to $365.2 billion in total.
- Banks shifted financing to short-term fixed-rate bond issues to further profit from their TBTF status.
- CDS prices are biased to the downside and thus unreliable for monitoring the health of the financial system.


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Role of counterparty risk in CDS markets

- ▷ Degree to which counterparty risk affects CDS prices depends on the joint default probability of the insurer and the reference entity.

$\Rightarrow$ High in the case of contracts written on major financials as they happen to be the primary CDS dealers.

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Adjust CDS-equity wedge for counterparty risk

1. Construct a primary dealer CDS index.
2. Measure each firm's daily beta between its CDS and the index.
3. Regress wedge on betas and control variables related to liquidity, business climate, and ratings.
4. Multiply the coefficient estimates with the beta values to obtain the counterparty risk adjustment for a given firm, maturity, and date.

	T_{issue}									$\frac{V_{fix}}{V_{fix}+V_{flo}}$								
	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
T_{mat}	0.362	2.84	***	0.298	1.99	**	0.253	2.25	**									
T_{issue}										0.006	3.41	***	0.006	3.39	***	0.01	2.72	***
V_{fix}				1.511	2.26	**												
$\frac{V_{fix}}{V_{fix}+V_{flo}}$	3.563	3.25	***				2.367	2.63	***									
$\frac{V_{fix}^{mat}}{V_{fix}^{mat}+V_{flo}^{mat}}$										0.253	7.85	***	0.251	7.92	***	0.16	5.04	***
Term Spread	-0.826	-3.32	***	-0.342	-1.07					0.059	6.38	***	0.057	6.28	***	0.06	6.73	***
Funding Adv.	-0.172	-1.93	*	-0.244	-2.05	**				0.027	4.71	***	0.025	4.87	***	0.03	5.28	***
Bank Dummy							-1.564	-2.04	**							-0.11	-4.25	***
Crisis Dummy													0.206	5.65	***			
Post-crisis Dummy													0.212	2.48	**			
$V_{fix} \times$ Bank Dummy				-1.732	-2.68	***												
AA							3.880	2.71	***									
A							4.178	3.03	***							0.10	4.02	***
BBB							4.212	2.76	***							0.31	8.97	***
Constant	5.854	9.11	***	8.199	7.20	***	2.330	1.42		0.296	10.91	***	0.279	10.31	***	0.36	9.77	***
Observations	636			245			773			636			636			636		
$Adj.R^2$	0.062			0.056			0.046			0.197			0.231			0.29		
Coef. Estimates	OLS			OLS			OLS			OLS			OLS			OLS		
Standard Errors	robust			robust			robust			robust			robust			robust		

*Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Determinants of the bond structure

	T_{issue}									$\frac{V_{fix}}{V_{fix}+V_{flo}}$								
	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
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	T_{issue}									$\frac{V_{fix}}{V_{fix}+V_{flo}}$								
	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
T_{mat}	0.362	2.84	***	0.298	1.99	**	0.253	2.25	**									
T_{issue}										0.006	3.41	***	0.006	3.39	***	0.01	2.72	***
V_{fix}				1.511	2.26	**												
$\frac{V_{fix}}{V_{fix}+V_{flo}}$	3.563	3.25	***				2.367	2.63	***									
$\frac{V_{fix}^{mat}}{V_{fix}^{mat}+V_{flo}^{mat}}$										0.253	7.85	***	0.251	7.92	***	0.16	5.04	***
Term Spread	-0.826	-3.32	***	-0.342	-1.07					0.059	6.38	***	0.057	6.28	***	0.06	6.73	***
Funding Adv.	-0.172	-1.93	*	-0.244	-2.05	**				0.027	4.71	***	0.025	4.87	***	0.03	5.28	***
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BBB							4.212	2.76	***							0.31	8.97	***
Constant	5.854	9.11	***	8.199	7.20	***	2.330	1.42		0.296	10.91	***	0.279	10.31	***	0.36	9.77	***
Observations	636			245			773			636			636			636		
$Adj.R^2$	0.062			0.056			0.046			0.197			0.231			0.29		
Coef. Estimates	OLS			OLS			OLS			OLS			OLS			OLS		
Standard Errors	robust			robust			robust			robust			robust			robust		

*Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

	T_{issue}						$\frac{V_{fix}}{V_{fix}+V_{flo}}$					
	(1)		(2)		(3)		(4)		(5)		(6)	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
T_{mat}	0.362	2.84 ***	0.298	1.99 **	0.253	2.25 **						
T_{issue}							0.006	3.41 ***	0.006	3.39 ***	0.01	2.72 ***
V_{fix}			1.511	2.26 **								
$\frac{V_{fix}}{V_{fix}+V_{flo}}$	3.563	3.25 ***			2.367	2.63 ***						
$\frac{V_{fix}^{mat}}{V_{fix}^{mat}+V_{flo}^{mat}}$							0.253	7.85 ***	0.251	7.92 ***	0.16	5.04 ***
Term Spread	-0.826	-3.32 ***	-0.342	-1.07			0.059	6.38 ***	0.057	6.28 ***	0.06	6.73 ***
Funding Adv.	-0.172	-1.93 *	-0.244	-2.05 **			0.027	4.71 ***	0.025	4.87 ***	0.03	5.28 ***
Bank Dummy					-1.564	-2.04 **					-0.11	-4.25 ***
Crisis Dummy									0.206	5.65 ***		
Post-crisis Dummy									0.212	2.48 **		
$V_{fix} \times$ Bank Dummy			-1.732	-2.68 ***								
AA					3.880	2.71 ***						
A					4.178	3.03 ***					0.10	4.02 ***
BBB					4.212	2.76 ***					0.31	8.97 ***
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$$\frac{dV_t}{V_t} = \mu_V dt + \sigma_V dW_t$$

where W_t is a Brownian motion, σ_V the asset volatility, and μ_V the drift

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  - ⇒ Hence, we assume a stationary leverage, implying $\mu_E = \mu_D = \mu_V$
  - ⇒ Pricing credit is rather about the relation between μ_V and μ_D than about μ_V per se, therefore set $\mu_V = 0$ for simplicity

The risk-neutral survival probability $P(t)$ that the firm value does not hit the default boundary until time t, i.e.,

$$V(\tau) > LD \ , \quad \forall \ \tau < t$$

is given by the approximate closed-form solution

$$P(t) = \Phi\left(-\frac{A_t}{2} + \frac{log(d)}{A_t}\right) - d \cdot \Phi\left(-\frac{A_t}{2} - \frac{log(d)}{A_t}\right)$$

with

$$d = \frac{S_0 + \overline{L}D}{\overline{L}D} \exp \lambda^2 \qquad \text{and} \qquad A_t^2 = \sigma_V^2 t + \lambda^2$$

$$\underbrace{(1 - R)\left[1 - P(0) + \int_0^t dsf(s)e^{-rs}\right]}_{\text{protection leg}}$$

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$$\Rightarrow \quad c = r(1-R)\frac{1-P(0)+e^{r\xi}(G(t+\xi)-G(\xi))}{P(0)-P(t)e^{-rt}-e^{r\xi}(G(t+\xi)-G(\xi))}$$

where $\xi = \frac{\lambda^2}{\sigma^2}$ and R is the expected recovery rate to a specific debt class

- In the Merton model, it follows from Ito's lemma that

$$\sigma_S = \frac{V}{S} \underbrace{\frac{\partial S}{\partial V}}_{0 \leq \ldots \leq 1} \sigma_V \quad \Leftrightarrow \quad \sigma_V = \frac{S}{V} \underbrace{\frac{\partial V}{\partial S}}_{\geq 1} \sigma_S$$

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- CreditGrades:

$V = S + \bar{L}D$	and the following *approximation*
$\frac{\partial S}{\partial V} = 1$	result from *boundary conditions*
$\sigma_S \approx \sigma_S^{imp}$	*ATM implied volatility*

$$\Rightarrow \quad \sigma_S = \frac{S + \bar{L}D}{S} \sigma_V \quad \Leftrightarrow \quad \sigma_v = \frac{S}{S + \bar{L}D} \sigma_s$$

- In our boundary examinations we focus on the distance to default since its behavior is relevant for determining the survival probability:

$$\eta = \frac{1}{\sigma} log\left(\frac{V}{LD}\right) = \frac{V}{\sigma_S S}\frac{\partial S}{\partial V} log\left(\frac{V}{LD}\right)$$

- First (at/near to default) boundary condition
  - Assume that as default approaches, $S \to 0$
  - Thus at the boundary, $V|_{S=0} = LD$, and near the boundary $V \approx LD + \frac{\partial V}{\partial S}S$
  - Substituting into η gives $\eta \approx \frac{1}{\sigma_S}(1 + \frac{\partial V}{\partial S}\frac{S}{LD}) \approx \frac{1}{\sigma_S}$
- Second (far from default) boundary condition
  - Assume that as V goes to infinity, $\frac{S}{V} \to 1$, i.e. V and S increase at the same rate, $\frac{\partial S}{\partial V} \to 1$
  - Substitution leads to $\eta \approx \frac{1}{\sigma_S} log\left(\frac{S}{LD}\right)$
- The simplest expressions satisfying both boundary conditions are:

$$\eta = \frac{S + LD}{\sigma_S S} log\left(\frac{S + LD}{LD}\right) \quad \text{and} \quad V = S + LD$$

$$\sigma_S = \frac{V}{S}\frac{\partial S}{\partial V}\sigma_V \quad \Rightarrow \quad \sigma_S = \frac{S + \bar{L}D}{S}\sigma_V$$

How sensitive are our results to $\frac{\partial S}{\partial V} < 1$?

$\Rightarrow \sigma_V \nearrow$ as $\frac{\partial V}{\partial S} \nearrow$, i.e. stock-implied credit spreads would be even higher!

Alternatives:

- Obtain σ_V from $P(S, t, B, \sigma_V)$, the price of an equity put option as a function of σ_V, which can be equated to the market price of a put (Finger and Stamicar (2006)). Our own test runs confirm their conclusion that the differences to the baseline approach are marginal.
- Iterative approach suggested by Crosbie and Bohn (2003) and Vassalou and Xing (2004) applies to strict Merton setup (in which default may not occur at any point in time):
  - Using either the historical or implied stock volatility as initial value for σ_V and applying the BS formula, one can infer a time series of asset values to calculate the historical asset volatility, which is used as input for the next iteration. The described procedure is repeated until the historical volatility estimates from consecutive iterations converge.
  - Iterative approach was shown to provide hardly any improvement over the direct approach (Bharath and Shumway (2008)).
  - Through our calibration over $\bar{L}$, we determine V and σ_V simultaneously to be consistent with market observations.

Approximating the local by the ATM implied volatility

- Implied equity volatility is approximately an average of local volatilities (Derman, Iraj, and Zou (1995)):

$$\sigma_S^{imp} \approx \frac{1}{X-S}\int_S^X \sigma_S dS$$

- Substituting the local relation $\sigma_S = \sigma(1+\frac{B}{S})$

$$\sigma_S^{imp} \approx \sigma\left\{1+\frac{B}{X-S} log\left(\frac{X}{S}\right)\right\}$$

- At the money, i.e. for $S \to X$,

$$\sigma_S^{imp} \approx \sigma\left\{1+B \lim_{S\to X}\frac{log\left(\frac{X}{S}\right)}{X-S}\right\}$$

- Applying l'Hôpital's rule gives

$$\sigma_S^{imp} \approx \sigma\frac{S+B}{S} \approx \sigma_S$$

- The standard deviation of the adjustment factor L, λ, is set to 0.3 (Finger et al. (2002)).
- The debt class specific recovery rate, R, is set to 0.5 (Yu (2006)).
- The debt per share, D, is calculated as $\frac{\text{total liabilities}}{\#\text{ common shares outstanding}}$.
- The risk-free interest rate, r, is assumed to be the five-year constant maturity zero-coupon swap rate inferred from swap rates.
- The equity volatility, σ_S, is the one-year at-the-money implied volatility from put options.
- Apply the Act/360 day counting convention.

- Determine $\bar{L}_i$ by minimizing the sum of squared errors between model ($\widehat{CDS}$) and market spreads (CDS) over a number of observations N in the period 01/2003–07/2007:

$$\min_{\bar{L}_i} \sum_{n=1}^{N} (\widehat{CDS}_{i,n}(\bar{L}_i) - CDS_{i,n})^2$$

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	Whole Sample Period					Pre-Crisis Period		Crisis Period		Post-Crisis Period	
Ival	$\bar{N}$	$\bar{\bar{L}}$	cRMSE	ME	RMSE	ME	RMSE	ME	RMSE	ME	RMSE
50	16	1.053	40.97	20.14	159.70	-9.17	46.92	68.38	246.92	30.48	141.67
10	76	1.070	39.80	20.60	158.14	-8.90	44.79	69.16	246.30	31.05	138.96
3	253	1.076	39.35	20.47	158.40	-8.84	44.71	68.85	246.89	30.54	138.76
1	757	1.077	38.93	19.94	158.77	-8.93	44.72	67.84	247.60	29.27	138.75

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- Results very robust to choice of grid density. Reducing the interval from 50 to 10 slightly improves the estimates, therefore, focus on an interval of 10 in the following.
- In the pre-crisis period the model underpredicts observed spreads due to nondefault components, like illiquidity, in line with the literature (Eom, Helwege, and Huang (2004), Longstaff (2004), Tang and Yan (2007)).

- Determine $\bar{L}_{i,t}$ daily by minimizing the sum of squared errors between model $(\widehat{CDS})$ and market spreads (CDS) based on a trailing window (with $N = 5$ and an interval between calibration points $= 2$):

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	β	p-value	$\bar{\bar{L}}$	ME	RMSE	$\bar{\bar{L}}$	ME	RMSE	$\bar{\bar{L}}$	ME	RMSE	$\bar{\bar{L}}$	ME	RMSE
All	-7.95E+07	0.97	1.133	-4.10	48.84	1.284	-0.87	11.35	0.935	-9.11	74.07	1.081	-3.36	37.48
Fin	-0.0004991	0.01	0.549	-1.92	76.67	0.616	-1.75	7.46	0.455	2.80	111.89	0.524	-14.02	129.38
Nonfin	-1.57E+08	0.95	1.232	-4.47	43.98	1.402	-0.71	12.03	1.013	-11.05	67.47	1.168	-1.68	22.08

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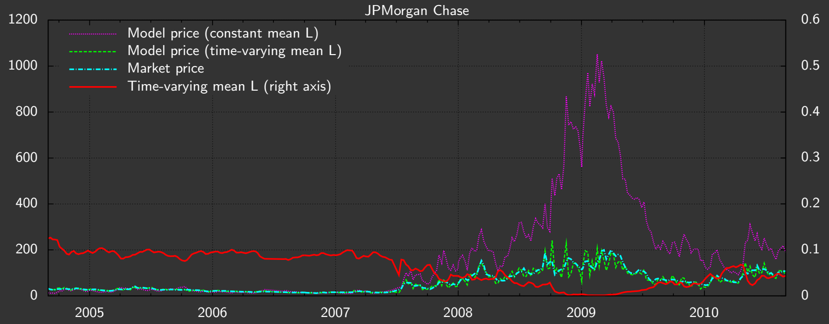
- The default boundary generally lowers during the crisis and slopes upwards in economic recovery without necessarily closing up to pre-crisis levels.
- The average percentage decrease of $\bar{L}$ is about 25% over all sectors.
- However, a trend regression of daily percentage changes of $\bar{L}$ against time points t reveals a significant negative trend only in the case of financials, not for the other companies.

Time-varying default barrier



- The level of $\bar{L}$ can change exactly once from $\bar{L}_1$ to $\bar{L}_2$ at split date t_2. The estimation window ranges from 01/2004–12/2009 with a grid interval of 10. The minimization problem under these assumptions becomes:

$$\min_{\bar{L}_{i,1},\bar{L}_{i,2},t_{i,2}} \sum_{n=1}^{N} \left(\widehat{CDS}_{i,n}(\bar{L}_{i,1}) - CDS_{i,n}\right)^2 I_{\{\tau_{i,n}<t_{i,2}\}} + \left(\widehat{CDS}_{i,n}(\bar{L}_{i,2}) - CDS_{i,n}\right)^2 I_{\{\tau_{i,n}\geq t_{i,2}\}}$$

	Whole Sample Period					Pre-Crisis Period		Crisis Period		Post-Crisis Period	
	$\bar{\bar{L}}_1$	$\bar{\bar{L}}_2$	Median t_2	ME	RMSE	ME	RMSE	ME	RMSE	ME	RMSE
All	1.056	0.920	09/30/2008	-14.84	91.96	-6.68	53.74	-10.01	110.24	-60.63	125.71
Fin	0.465	0.246	11/04/2008	-26.16	124.73	-16.86	39.84	-21.41	171.21	-81.82	258.29
Nonfin	1.159	1.038	09/30/2008	-12.90	86.24	-4.84	56.17	-8.14	99.60	-57.30	103.43

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Nonfin	1.159	1.038	09/30/2008	-12.90	86.24	-4.84	56.17	-8.14	99.60	-57.30	103.43

- The median split date falls well within the tumultuous period following the bankruptcy of Lehman Brothers on 09/15/2008.

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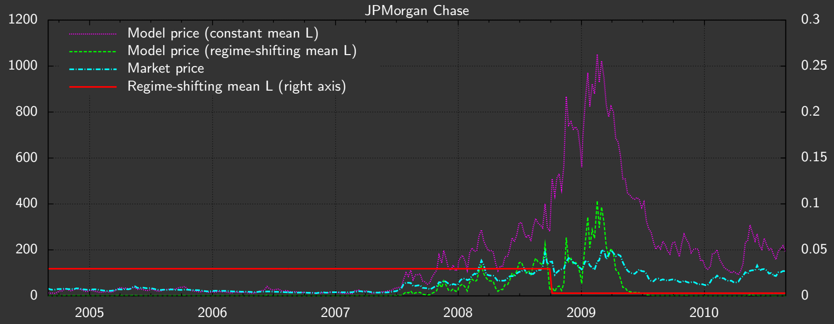
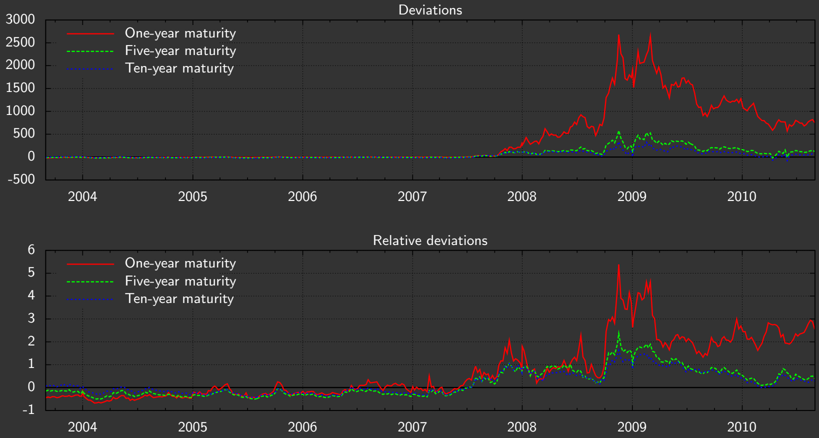
$$\min_{\bar{L}_{i,1},\bar{L}_{i,2},t_{i,2}} \sum_{n=1}^{N} \left(\widehat{CDS}_{i,n}(\bar{L}_{i,1}) - CDS_{i,n}\right)^2 I_{\{\tau_{i,n}<t_{i,2}\}} + \left(\widehat{CDS}_{i,n}(\bar{L}_{i,2}) - CDS_{i,n}\right)^2 I_{\{\tau_{i,n}\geq t_{i,2}\}}$$

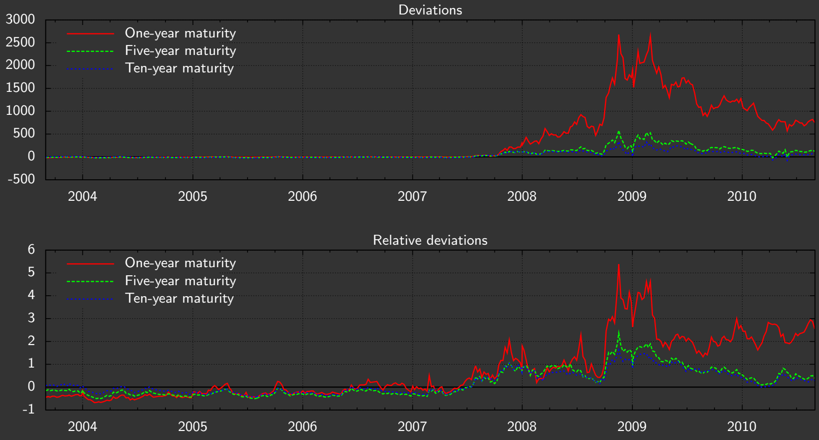
	Whole Sample Period					**Pre-Crisis Period**		**Crisis Period**		**Post-Crisis Period**	
	$\bar{\bar{L}}_1$	$\bar{\bar{L}}_2$	Median t_2	ME	RMSE	ME	RMSE	ME	RMSE	ME	RMSE
All	1.056	0.920	09/30/2008	-14.84	91.96	-6.68	53.74	-10.01	110.24	-60.63	125.71
Fin	0.465	0.246	11/04/2008	-26.16	124.73	-16.86	39.84	-21.41	171.21	-81.82	258.29
Nonfin	1.159	1.038	09/30/2008	-12.90	86.24	-4.84	56.17	-8.14	99.60	-57.30	103.43

- The median split date falls well within the tumultuous period following the bankruptcy of Lehman Brothers on 09/15/2008.
- The post-crisis period is poorly fitted with negative mean errors, suggesting a second upward regime shift around mid 2009.

Default barrier with a regime shift




Deviations
3000
2500
2000
1500
1000
500
0
-500
One-year maturity
Five-year maturity
Ten-year maturity
2004
2005
2006
2007
2008
2009
2010
Relative deviations
6
5
4
3
2
1
0
-1
One-year maturity
Five-year maturity
Ten-year maturity
2004
2005
2006
2007
2008
2009
2010



▷ The anticipation of bailouts matters most to short-term investors.