

**Supplementary Appendix accompanying “Herding behavior and rating convergence among Credit Rating Agencies: Evidence from the Subprime Crisis”**

**Table A.1 Ratings distribution and average differences for jointly-rated securities before the crisis**

This table reports the distribution among different ratings of HEL securities jointly rated by Moody’s and S&P (Panel A), Moody’s and Fitch (Panel B) and S&P and Fitch (Panel C) in June 2007. Average GAP is measured averaging all rating differences in notches (including tranches rated equally) between the two given CRAs for each rating class of the agency labeled as (1). For the sake of readability we just use Moody’s notation for alphabetic rating scale in each panel. AGAP if (1) is higher (lower), is the average GAP only on tranches with a higher (lower) rating by the agency labeled as (1) relative to the agency labeled as (2).

Rating	(1) frequency	(2) frequency	Average GAP	AGAP if (1) Higher	AGAP if (1) Lower	(1) Lower	Same	(1) Higher
<b>Panel A: (1) Moody's vs (2) S&amp;P</b>								
Aaa	37.18%	37.50%	0.05	2.73	Na	Na	98.08%	1.92%
Aa	22.39%	25.19%	0.18	2.22	-1.18	25.30%	69.36%	5.34%
A	19.61%	19.44%	0.53	2.26	-1.73	37.24%	57.59%	5.17%
Baa	16.71%	14.68%	0.51	2.71	-1.79	34.06%	62.21%	3.73%
Ba	2.38%	1.72%	1.05	2.82	-2.76	47.54%	43.17%	9.29%
B	0.66%	0.58%	2.94	1.73	-4.97	66.67%	11.76%	21.57%
Caa-Below	1.07%	0.88%	3.72	1.61	-7.59	53.66%	24.39%	21.95%
All Ratings	100%	100%	0.29	2.37	-1.88	20.81%	75.04%	4.15%
<b>Panel B: (1) Moody's vs (2) Fitch</b>								
Aaa	30.68%	26.65%	2.76	4.57	Na	Na	39.66%	60.34%
Aa	22.84%	24.41%	1.14	4.36	-1.93	43.96%	10.04%	46.00%
A	21.56%	23.60%	-1.15	2.79	-4.00	55.72%	10.29%	33.99%
Baa	19.63%	20.10%	-2.95	2.24	-4.64	71.80%	10.85%	17.35%
Ba	2.85%	3.25%	-3.15	2.50	-4.78	73.23%	12.60%	14.17%
B	0.96%	0.65%	-2.91	3.00	-6.35	60.47%	11.62%	27.91%
Caa-Below	1.48%	1.34%	-4.62	1.75	-8.12	62.12%	13.64%	24.24%
All Ratings	100%	100%	0.10	3.95	-3.80	39.74%	19.56%	40.70%
<b>Panel C: (1) S&amp;P vs (2) Fitch</b>								
Aaa	29.11%	26.28%	2.78	4.58	Na	Na	39.33%	60.67%
Aa	25.37%	24.31%	1.25	4.43	-1.76	43.73%	10.82%	45.45%
A	22.07%	23.06%	-0.77	2.99	-3.52	52.82%	10.65%	36.53%
Baa	18.84%	20.92%	-2.67	2.38	-4.63	67.70%	12.67%	19.63%
Ba	2.66%	3.41%	-2.78	3.57	-4.95	67.97%	15.62%	16.41%
B	0.71%	0.73%	-4.32	3.00	-7.04	67.65%	17.64%	14.71%
Caa-Below	1.25%	1.29%	-5.10	1.43	-6.72	78.33%	10.00%	11.67%
All Ratings	100%	100%	0.29	4.01	-3.57	38.77%	19.59%	41.64%

**Table A.2 Descriptive statistics for control variables**

This table reports some descriptive statistics on tranche characteristics across our whole sample, as well as across subsamples of tranches rated by only one or all three agencies. *Credit Support* is the additional credit support, expressed as a percentage relative to the notional amount in June 2007 and July 2011. *FICO Score* is the mean value-weighted FICO score of underlying loans borrowers. *Amount* is the tranche notional amount expressed in USD million. *WAI* is the mean value-weighted interest rate paid on underlying mortgages, expressed as a percentage. *No. of loans* is the number of loans in the collateral pool. *Mezzanine* and *Subordinated* are dummy variables indicating the seniority of each tranche; *Principal Only (Interest Only)* is an indicator variable equal to 1 if the tranche payments derive only from principal (interest) payments on the collateral and zero otherwise. *Pass-through* is an indicator variable equal to 1 if payments are based on actual or scheduled payments on the underlying and zero otherwise. *(Non) Acc. Security* is an indicator variable equal to 1 if the tranche receives payments faster (more slowly) than its collateral and zero otherwise. *Sequential Payer* is an indicator variable equal to 1 if the tranche starts paying principal only when other tranches in the same deal have paid it off and zero otherwise. *t Diff* is the t-statistic for a test on the equality of mean for each continuous variable between the one CRA and the three CRAs subsamples. \*\*\*, \*\* and \* indicate, respectively, significance levels of 1%, 5% and 10%.

Panel A: Continuous variables							
	N	Mean	St. Dev.	Percentile			t Diff 1-3 CRAs
				25th	50th	75th	
Panel A: Continuous variables							
<i>Credit support, 2007</i>	8,080	22.46	16.93	10.02	19.20	29.86	4.42***
- 1 CRA	186	18.94	16.88	6.5	14.91	26.3	
- 3 CRAs	3,965	24.65	17.25	11.9	21.43	32.86	
<i>Credit support, 2011</i>	7,258	19.34	21.19	3.00	12.61	26.90	4.95***
- 1 CRA	158	13.19	17.01	1.74	7.84	18.32	
- 3 CRAs	3,663	21.76	21.48	5.92	15.1	31.05	
Other controls							
<i>FICO score</i>	4,384	633.86	35.31	613.44	623.96	643.53	3.28***
- 1 CRA	58	615.36	43.14	588.35	600.25	621.44	
- 3 CRAs	1,791	626.77	25.30	612.94	622.65	635.86	
<i>Amount</i>	9,229	61.57	127.56	10.40	21.85	51.21	5.44***
- 1 CRA	611	33.45	115.03	4.16	9.55	24.4	
- 3 CRAs	4,118	65.74	139.94	12.50	23.80	51.40	
<i>WAI</i>	8,697	6.98	1.73	5.96	6.53	7.49	8.64***
- 1 CRA	208	7.68	2.16	6.24	6.84	9.03	
- 3 CRAs	4,109	6.79	1.39	5.96	6.48	7.12	
<i>No. of Loans</i>	8,295	1,119.00	1,254.71	402	800	1,400	6.73***
- 1 CRA	181	546.58	992.28	172	270	470	
- 3 CRAs	4,037	1,039.42	963.29	432	800	1,357	
Panel B: Structure Indicators							
Mezzanine	9,242	0.51	0.50	0	1	1	
Subordinated	9,242	0.10	0.30	0	0	0	
Pass-through	9,242	0.00	0.06	0	0	0	
Acc. Security	9,242	0.08	0.27	0	0	0	
Non Acc. Security	9,242	0.13	0.34	0	0	0	
Sequential Payer	9,242	0.03	0.18	0	0	0	
Interest Only	9,242	0.01	0.09	0	0	0	
Principal Only	9,242	0.00	0.04	0	0	0	

**Table A.3 Articulation of empirical predictions with research method setup**

This table summarizes the three basic empirical predictions and cross-references each with the: relevant results tabulation, estimation method, dependent variable(s), key test variable(s) and prediction in the context of the chosen modeling setup.

Table	Model	Dependent Variable(s)	Key Test Variable(s) and prediction
<b>Panel A: P1 - The timing of downgrades by either Moody's or S&amp;P is more influenced by rating actions taken by the other main rival than those taken by Fitch.</b>			
Table 2	Cox proportional hazard model	Timing of 1 <sup>st</sup> rating downgrade: number of days since June 1, 2007	Downgrade dummy for each rival CRA  <b>Prediction:</b> Fitch-induced hazard increase for Moody's (S&P) < S&P (Moody's)-induced hazard increase for Moody's (S&P)
Table 3	Cox proportional hazard model	Timing of 1st rating downgrade: number of days since June 1, 2007	Downgrade/negative watch list dummy for each rival CRA  <b>Prediction:</b> Fitch-induced hazard increase for Moody's (S&P) < S&P (Moody's)-induced hazard increase for Moody's (S&P)
<b>Panel B: P2 - Moody's and S&amp;P exhibit a stronger tendency toward rating convergence with each other than with Fitch</b>			
Table 4	Cox proportional hazard model	Timing of 1st rating downgrade: number of days since June 1, 2007	Higher rating dummy: CRA under analysis assigns higher rating than rivals pre crisis  <b>Prediction:</b> Fitch-induced hazard increase for Moody's (S&P) < S&P (Moody's)-induced hazard increase for Moody's (S&P)
<b>Panel C: P3 - Fitch rating actions tend to be influenced more by Moody's or S&amp;P actions, compared to the (lesser) influence of Fitch rating actions on Moody's or S&amp;P.</b>			
Table 2	Cox proportional hazard model	Timing of 1 <sup>st</sup> rating downgrade: number of days since June 1, 2007	Downgrade dummy for each rival CRA  <b>Prediction:</b> Fitch-induced hazard increase for Moody's (S&P) < Moody's (S&P)-induced hazard increase for Fitch
Table 3	Cox proportional hazard model	Timing of 1 <sup>st</sup> rating downgrade: number of days since June 1, 2007	Downgrade/negative watch list dummy for each rival CRA  <b>Prediction:</b> Fitch-induced hazard increase for Moody's (S&P) < Moody's (S&P)-induced hazard increase for Fitch
Table 4	Cox proportional hazard model	Timing of 1 <sup>st</sup> rating downgrade: number of days since June 1, 2007	Higher rating dummy: CRA under analysis assigns higher rating than rivals pre crisis  <b>Prediction:</b> Fitch-induced hazard increase for Moody's (S&P) < Moody's (S&P)-induced hazard increase for Fitch
Table 5	Multinomial logit model	Dummy for equal post-crisis rating Dummy for higher post-crisis rating	Dummy for equal pre-crisis rating Dummy for higher pre-crisis rating  <b>Prediction:</b> marginal effect of higher rating by Fitch on the likelihood of rating convergence with Moody's (S&P) < marginal effect of higher rating by Moody's (S&P) on the likelihood of rating convergence with Fitch

**Table A.4 The effect of downgrades by rival CRAs on the time taken to first downgrade – Issuer fixed effects**

This table reports analyses similar to those presented in Table 2, using indicators instead of a shared-frailty approach to control for within-issuer correlation in downgrades.

	Moody's			S&P			Fitch		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Downgraded by:</i>									
- Moody's	-	-	-	0.841*** (0.034)	-	0.876*** (0.034)	0.510*** (0.047)	-	0.449*** (0.048)
- S&P	0.870*** (0.030)	-	0.861*** (0.030)	-	-	-	-	0.564*** (0.052)	0.489*** (0.053)
- Fitch	-	0.227*** (0.036)	0.182*** (0.036)	-	0.389*** (0.038)	0.489*** (0.039)	-	-	-
<i>p-value rival (A) vs. (B)</i>			[0.000]			[0.000]			[0.597]
No. of CRAs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Structure indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vintage indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. Observations	178,657	178,657	178,657	142,465	142,465	142,465	64,658	64,658	64,658
No. Tranche	7,588	7,588	7,588	6,458	6,458	6,458	3,975	3,975	3,975
No. Issuers	141	141	141	171	171	171	114	114	114

**Table A.5 The effect of downgrades by rival CRAs on the time taken to first downgrade – At risk since January 2007**

This table reports analyses similar to those presented in Table 2 considering securities at risk of downgrade since January 2007 instead of June 2007. Securities issued since January 2007 are excluded from the analysis.

	Moody's			S&P			Fitch		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Downgraded by:</i>									
- Moody's	-	-	-	0.822*** (0.036)	-	0.862*** (0.036)	0.496*** (0.048)	-	0.439*** (0.048)
- S&P	0.875*** (0.033)	-	0.863*** (0.033)	-	-	-	-	0.538*** (0.054)	0.465*** (0.055)
- Fitch	-	0.271*** (0.036)	0.226*** (0.037)	-	0.457*** (0.039)	0.557*** (0.040)	-	-	-
<i>p-value rival (A) vs (B)</i>			[0.000]	.	.	[0.000]	.	.	[0.737]
No. of CRAs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Structure indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vintage indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Frailty variance	0.515*** (0.079)	0.624*** (0.094)	0.494*** (0.077)	0.290*** (0.048)	0.341*** (0.054)	0.253*** (0.044)	0.873*** (0.148)	0.866*** (0.149)	0.845*** (0.145)
No. Observations	163,098	163,098	163,098	123,216	123,216	123,216	62,265	62,265	62,265
No. Tranche	6,654	6,654	6,654	5,497	5,497	5,497	3,791	3,791	3,791
No. Issuers	129	129	129	152	152	152	111	111	111

**Table A.6 The effect of downward rating revisions by rival CRAs on the time taken to first downward rating revision**

This table reports analyses similar to those presented in Table 3, where time at risk is measured as the number of days elapsed since June 2007 to the first downgrade or negative watchlist (whichever occurs first).

	Moody's			S&P			Fitch		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<i>Down. Rating revision by:</i>									
- Moody's	-	-		0.974*** (0.029)	-	0.993*** (0.029)	0.559*** (0.044)	-	0.484*** (0.045)
- S&P	0.544*** (0.029)	-	0.529*** (0.029)	-	-	-	-	0.675*** (0.045)	0.609*** (0.045)
- Fitch	-	0.266*** (0.034)	0.225*** (0.034)	-	0.245*** (0.034)	0.347*** (0.035)	-	-	-
<i>p-value rival (A) vs. (B)</i>			[0.000]			[0.000]			[0.067]
No. of CRAs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Structure indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vintage indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unknown indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Frailty variance	0.750*** (0.108)	0.860*** (0.123)	0.730*** (0.106)	0.357*** (0.052)	0.458*** (0.063)	0.317*** (0.048)	1.276*** (0.120)	1.287*** (0.202)	1.208*** (0.190)
No. Observations	156,085	156,085	156,085	148,047	148,047	148,047	59,951	59,951	59,951
No. Tranche	7,977	7,977	7,977	7,632	7,632	7,632	4,045	4,045	4,045
No. Issuers	141	141	141	171	171	171	114	114	114

**Table A.7 The effect of downgrades by rival CRAs on the time taken to first downgrade – controlling for future credit disruption**

This table reports analyses similar to those presented in Table 2, including among control variables up to 3-month lead values for *Credit Support*.

	Moody's			S&P			Fitch		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Downgrade by:									
- Moody's	-	-	-	0.834*** (0.034)	-	0.871*** (0.034)	0.497*** (0.047)	-	0.437*** (0.048)
- S&P	0.871*** (0.030)	-	0.862*** (0.030)	-	-	-	-	0.562*** (0.052)	0.491*** (0.053)
- Fitch	-	0.224*** (0.035)	0.178*** (0.036)	-	0.408*** (0.037)	0.514*** (0.039)	-	-	-
<i>p-value rival (A) vs.(B)</i>			[0.000]			[0.000]			[0.475]
Lead Credit Support:									
- 1 month	-0.260*** (0.018)	-0.267*** (0.018)	-0.259*** (0.018)	-0.037 (0.027)	-0.075*** (0.027)	-0.032 (0.027)	-0.049 (0.036)	-0.065* (0.037)	-0.058 (0.037)
- 2 months	0.015 (0.012)	0.013 (0.011)	0.015 (0.011)	-0.002 (0.013)	-0.008 (0.013)	-0.005 (0.014)	-0.033 (0.024)	-0.029 (0.024)	-0.029 (0.025)
- 3 months	-0.025*** (0.006)	-0.026*** (0.006)	-0.024*** (0.006)	-0.047*** (0.007)	-0.051*** (0.007)	-0.045*** (0.007)	-0.032** (0.015)	-0.035** (0.015)	-0.032** (0.015)
No. of CRAs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Structure indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vintage indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating indicators	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Frailty variance	0.488*** (0.075)	0.613*** (0.092)	0.472*** (0.073)	0.333*** (0.049)	0.375*** (0.054)	0.296*** (0.045)	0.942*** (0.154)	0.936*** (0.155)	0.913*** (0.150)
No. Observations	178,657	178,657	178,657	142,465	142,465	142,465	64,658	64,658	64,658
No. Tranche	7,588	7,588	7,588	6,458	6,458	6,458	3,975	3,975	3,975
No. Issuers	138	138	138	165	165	165	114	114	114