

THE INTERACTION BETWEEN MICROBLOG SENTIMENT AND STOCK RETURNS: AN EMPIRICAL EXAMINATION

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Appendix A

Summary Statistics

Variable Abbreviations

Return (%): RTN
 StockTwits Positive Sentiment (%): POS
 StockTwits Negative Sentiment (%): NEG
 News Sentiment: NS
 News Volume (log): NV
 StockTwits Message Volume (log): SV
 Volatility: VLT
 VIX: VIX
 Trading Volume (log): VOL
 Agreement Index (%): AGI

Table A1. Summary Statistics of Variables in Model 1 (Market-Day)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL	AGI
Mean	0.05	26.00	17.66	6.69	7.98	9.36	-7.23	17.24	18.65	2.06
SD	0.89	2.16	1.55	1.35	0.45	0.93	0.48	6.82	0.42	1.46
Min	-5.55	20.96	11.02	0.00	0.00	6.18	-8.50	0.00	15.94	0.00
25%	-0.36	24.66	16.72	5.93	7.84	8.53	-7.57	13.59	18.40	1.16
50%	0.06	26.17	17.60	6.80	8.02	9.42	-7.28	16.27	18.65	1.90
75%	0.52	27.29	18.62	7.58	8.26	10.15	-6.94	19.06	18.88	2.68
Max	4.24	48.96	22.36	14.13	8.63	10.97	-5.46	48.00	22.60	18.16

Table A2. Summary Statistics of Variables in Model 2 (Market-Hour)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL	AGI
Mean	0.01	26.30	17.70	6.81	5.29	7.06	10.38	17.21	17.03	2.48
SD	0.32	3.63	2.53	2.04	1.09	1.21	7.11	6.90	3.49	2.97
Min	-3.34	0.00	0.00	-2.91	0.00	0.00	1.26	0.00	0.00	0.00
25%	-0.11	24.38	16.25	5.65	4.72	6.09	5.81	13.63	17.22	0.95
50%	0.01	26.40	17.62	6.68	5.03	7.19	8.64	16.23	17.72	1.98
75%	0.13	28.02	19.14	7.73	5.42	7.90	12.93	19.08	18.15	3.22
Max	4.61	77.59	37.88	24.00	8.39	10.48	124.01	46.38	19.80	100.00

Table A3. Summary Statistics of Variables in Model 3 (Stock-Day)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL	AGI
Mean	0.07	20.67	15.10	0.41	0.13	2.83	-6.13	17.24	15.94	21.94
SD	3.10	13.81	12.22	2.57	0.55	1.52	0.56	6.82	1.33	36.67
Min	-65.99	0.00	0.00	-33.00	0.00	0.00	-7.89	0.00	11.52	0.00
25%	-1.16	11.54	4.35	0.00	0.00	1.79	-6.53	13.59	15.03	0.17
50%	0.00	22.07	15.00	0.00	0.00	2.83	-6.15	16.27	15.84	3.69
75%	1.27	28.83	22.22	0.00	0.00	3.74	-5.77	19.06	16.88	17.30
Max	132.30	90.00	80.00	98.00	5.67	8.97	-2.16	48.00	20.57	100.00

Table A4. Summary Statistics of Variables in Model 4 (Stock-Hour)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL	AGI
Mean	0.01	11.56	8.59	0.20	0.03	1.10	0.17	17.21	15.05	26.64
SD	1.15	17.18	14.77	2.02	0.23	1.22	0.32	6.90	1.48	42.33
Min	-89.88	0.00	0.00	-33.00	0.00	0.00	0.00	0.00	8.66	0.00
25%	-0.35	0.00	0.00	0.00	0.00	0.00	0.03	13.63	14.07	0.00
50%	0.00	0.00	0.00	0.00	0.00	0.69	0.07	16.23	15.03	0.00
75%	0.34	23.68	15.38	0.00	0.00	1.79	0.18	19.08	16.10	25.46
Max	86.70	90.91	88.89	111.00	5.57	8.41	11.62	46.38	20.55	100.00

Table A5. Correlations of Variables in Model 1 (Market-Day)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL
POS	0.05								
NEG	-0.21	-0.30							
NS	0.02	-0.18	-0.01						
NV	0.00	-0.40	0.07	0.54					
SV	-0.01	0.42	0.18	0.19	-0.18				
VLT	-0.09	-0.36	0.43	-0.02	0.20	-0.32			
VIX	-0.11	-0.57	0.31	0.11	0.38	-0.37	0.64		
VOL	-0.04	-0.35	0.12	-0.05	0.22	-0.49	0.46	0.42	
AGI	0.10	0.78	-0.76	-0.13	-0.26	0.04	-0.39	-0.42	-0.21

Table A6. Correlations of Variables in Model 2 (Market-Hour)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL
POS	0.04								
NEG	-0.14	-0.27							
NS	0.00	-0.05	-0.08						
NV	0.03	-0.17	-0.02	0.14					
SV	0.01	0.16	0.05	0.10	0.50				
VLT	-0.01	-0.10	0.20	0.02	0.17	0.04			
VIX	-0.04	-0.30	0.17	0.07	0.16	-0.22	0.41		
VOL	0.01	-0.07	0.01	0.24	0.12	0.16	0.07	0.54	
AGI	0.07	0.66	-0.66	-0.03	-0.13	-0.09	-0.13	-0.21	-0.13

Table A7. Correlations of Variables in Model 3 (Stock-Day)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL
POS	0.06								
NEG	-0.09	-0.05							
NS	0.01	0.03	0.00						
NV	0.00	0.03	0.00	0.64					
SV	0.04	0.38	0.33	0.02	0.01				
VLT	0.01	-0.01	0.02	-0.08	-0.06	0.08			
VIX	-0.06	-0.10	-0.04	-0.05	-0.06	-0.18	0.28		
VOL	0.01	0.09	0.14	0.03	0.11	0.30	0.05	0.06	
AGI	0.01	0.09	-0.15	0.01	0.01	-0.31	-0.06	0.05	-0.05

Table A8. Correlations of Variables in Model 4 (Stock-Hour)

	RTN	POS	NEG	NS	NV	SV	VLT	VIX	VOL
POS	0.03								
NEG	-0.03	0.08							
NS	0.00	0.01	0.00						
NV	0.00	0.03	0.02	0.57					
SV	0.03	0.50	0.44	0.01	0.05				
VLT	0.00	0.11	0.09	0.03	0.00	0.23			
VIX	-0.02	-0.07	-0.04	-0.04	-0.04	-0.11	0.08		
VOL	0.00	0.04	0.06	-0.04	-0.04	0.06	-0.30	0.02	
AGI	0.01	0.44	0.28	0.02	0.02	0.14	0.02	-0.03	0.01

Appendix B

Coefficient Estimates for Main Models

Table B1. Coefficient Estimates for Model 1 (Market-Day)									
Independent Variable	Dependent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value
Return									
Lag 1	-0.0748	0.0500	0.135	0.1332	0.0669	0.047	-0.2997	0.0528	<0.001
Lag 2	0.0540	0.0669	0.420	-0.0018	0.0794	0.981	-0.0694	0.0537	0.196
Lag 3	-0.0891	0.0531	0.094	-0.0057	0.0803	0.943	0.0229	0.0532	0.668
Lag 4	0.0314	0.0549	0.568	0.0677	0.0673	0.315	-0.0260	0.0509	0.610
Lag 5	-0.0821	0.0482	0.089	-0.0541	0.0542	0.319	0.0958	0.0431	0.027
Positive Sentiment									
Lag 1	0.0468	0.0650	0.472	0.4653	0.1100	<0.001	-0.0331	0.0764	0.665
Lag 2	0.0171	0.0609	0.778	0.1532	0.0854	0.073	0.0256	0.0686	0.709
Lag 3	-0.0372	0.0607	0.540	0.1855	0.0891	0.038	-0.0283	0.0700	0.686
Lag 4	0.0163	0.0666	0.806	0.0308	0.0889	0.729	0.1113	0.0745	0.136
Lag 5	-0.1201	0.0683	0.079	0.1050	0.1191	0.378	0.0095	0.0749	0.899
Negative Sentiment									
Lag 1	-0.0099	0.0695	0.887	-0.2305	0.0974	0.018	0.4851	0.0845	<0.001
Lag 2	-0.0570	0.0706	0.420	-0.1541	0.1155	0.182	0.1311	0.0770	0.089
Lag 3	0.0471	0.0687	0.493	0.0357	0.1259	0.777	0.0584	0.0812	0.472
Lag 4	0.0023	0.0784	0.977	0.1046	0.1187	0.378	0.1007	0.0874	0.249
Lag 5	0.0966	0.0749	0.198	-0.0312	0.1469	0.832	-0.0351	0.0816	0.668
News Sentiment									
Lag 1	0.0524	0.0440	0.234	-0.2506	0.0723	0.001	-0.0826	0.0556	0.138
Lag 2	-0.0267	0.0451	0.554	0.0856	0.1006	0.395	0.0495	0.0525	0.346
Lag 3	0.0037	0.0451	0.935	0.0218	0.0796	0.784	-0.0886	0.0572	0.122
Lag 4	-0.0450	0.0474	0.342	0.0304	0.0652	0.642	0.0454	0.0500	0.364
Lag 5	-0.0268	0.0431	0.534	0.0066	0.0665	0.921	0.0760	0.0471	0.107
News Volume									
Lag 1	-0.1533	0.1421	0.281	0.2706	0.1660	0.103	0.0859	0.1045	0.411
Lag 2	0.1379	0.0755	0.068	-0.0127	0.5123	0.980	-0.0049	0.2347	0.983
Lag 3	-0.0011	0.0827	0.989	-0.0353	0.3244	0.913	-0.0002	0.0963	0.998
Lag 4	-0.0417	0.2145	0.846	-0.1519	0.2790	0.586	0.0887	0.2002	0.658
Lag 5	-0.0795	0.0775	0.305	-0.2386	0.1636	0.145	-0.0161	0.1713	0.925

Table B1. Coefficient Estimates for Model 1 (Market-Day) (Continued)

Independent Variable	Dependent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	<i>p</i> value	Coef.	Std. Err.	<i>p</i> value	Coef.	Std. Err.	<i>p</i> value
Message Volume									
Lag 1	-0.4641	0.2529	0.067	-0.2846	0.4928	0.564	0.8542	0.2884	0.003
Lag 2	0.3608	0.2633	0.171	0.0911	0.5316	0.864	-0.5982	0.3012	0.047
Lag 3	0.0242	0.2491	0.923	0.4312	0.3709	0.245	0.0747	0.2608	0.775
Lag 4	-0.3470	0.2918	0.235	-0.1188	0.4546	0.794	0.4192	0.3031	0.167
Lag 5	0.4698	0.1810	0.010	0.1080	0.5190	0.835	-0.6619	0.2684	0.014
Volatility									
Lag 1	-0.0685	0.0978	0.484	-0.2130	0.1557	0.172	-0.0336	0.1159	0.772
Lag 2	0.1427	0.0960	0.137	0.1780	0.1470	0.226	-0.1868	0.1141	0.102
Lag 3	-0.1368	0.1049	0.192	0.1294	0.1806	0.474	0.1097	0.1186	0.355
Lag 4	-0.0706	0.0945	0.455	-0.1677	0.1727	0.332	0.0472	0.1112	0.671
Lag 5	0.0932	0.0989	0.346	0.2894	0.2057	0.160	0.0232	0.1108	0.834
VIX									
Lag 1	0.0267	0.0205	0.193	0.0575	0.0320	0.072	0.0050	0.0188	0.790
Lag 2	-0.0171	0.0183	0.352	-0.0115	0.0252	0.648	0.0174	0.0180	0.332
Lag 3	-0.0001	0.0170	0.996	0.0000	0.0209	0.998	0.0024	0.0160	0.883
Lag 4	0.0212	0.0267	0.429	-0.0175	0.0224	0.434	-0.0156	0.0185	0.397
Lag 5	-0.0248	0.0131	0.059	-0.0284	0.0234	0.225	0.0182	0.0137	0.182
Trading Volume									
Lag 1	0.0148	0.0815	0.856	-0.2130	0.1557	0.172	0.1687	0.1143	0.140
Lag 2	0.1191	0.0883	0.178	0.1780	0.1470	0.226	-0.2997	0.1131	0.008
Lag 3	-0.1020	0.0990	0.304	0.1294	0.1806	0.474	-0.0771	0.0987	0.435
Lag 4	-0.0376	0.0958	0.695	-0.1677	0.1727	0.332	0.1662	0.1059	0.117
Lag 5	0.0495	0.0950	0.602	0.2894	0.2057	0.160	0.0298	0.1061	0.779
Agreement									
Lag 1	-0.0702	0.1050	0.504	-0.4521	0.1808	0.013	0.1357	0.1392	0.330
Lag 2	-0.0395	0.0999	0.693	-0.1653	0.1453	0.255	-0.0504	0.1139	0.658
Lag 3	0.0588	0.0982	0.549	-0.0943	0.1953	0.629	0.0539	0.1259	0.669
Lag 4	-0.0158	0.1118	0.888	0.0521	0.1782	0.770	-0.0954	0.1389	0.492
Lag 5	0.2117	0.1164	0.069	0.0131	0.2311	0.955	-0.1155	0.1341	0.389

Table B2. Coefficient Estimates for Model 2 (Market -Hour)									
Independent Variable	Dependent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value
Return									
Lag 1	-0.0475	0.0288	0.099	0.1980	0.1401	0.158	-0.2784	0.1052	0.008
Lag 2	0.0222	0.0266	0.403	-0.0457	0.1399	0.744	-0.2410	0.1155	0.037
Lag 3	-0.0193	0.0240	0.421	-0.0545	0.1579	0.730	-0.1384	0.1167	0.236
Lag 4	-0.0185	0.0192	0.334	0.1025	0.1682	0.542	-0.0875	0.1148	0.446
Lag 5	0.0229	0.0169	0.176	0.0217	0.1713	0.899	-0.1230	0.1228	0.316
Lag 6	-0.0071	0.0261	0.787	0.2642	0.1638	0.107	-0.0942	0.1144	0.410
Lag 7	-0.0481	0.0236	0.041	-0.0148	0.1002	0.883	0.0225	0.0745	0.763
Positive Sentiment									
Lag 1	0.0056	0.0033	0.095	0.2330	0.0439	<0.001	-0.0322	0.0187	0.085
Lag 2	0.0003	0.0019	0.868	0.0602	0.0329	0.067	0.0359	0.0200	0.072
Lag 3	-0.0021	0.0022	0.333	0.0851	0.0250	0.001	-0.0069	0.0218	0.752
Lag 4	-0.0006	0.0018	0.718	0.0098	0.0319	0.758	0.0031	0.0244	0.899
Lag 5	0.0009	0.0025	0.714	0.0276	0.0806	0.732	-0.0128	0.0274	0.641
Lag 6	0.0029	0.0023	0.198	0.0662	0.0386	0.086	0.0338	0.0216	0.117
Lag 7	0.0002	0.0017	0.918	0.1215	0.0522	0.020	0.0140	0.0413	0.735
Negative Sentiment									
Lag 1	-0.0225	0.0037	<0.001	0.0886	0.0449	0.048	0.1788	0.0274	<0.001
Lag 2	0.0040	0.0028	0.153	0.0082	0.0362	0.822	0.0987	0.0260	<0.001
Lag 3	-0.0002	0.0029	0.933	0.0269	0.0299	0.370	0.0888	0.0267	0.001
Lag 4	0.0025	0.0027	0.346	0.0178	0.0372	0.633	0.0950	0.0285	0.001
Lag 5	-0.0012	0.0032	0.713	-0.0085	0.0822	0.918	0.0799	0.0294	0.007
Lag 6	0.0058	0.0028	0.039	-0.0144	0.0414	0.727	0.0444	0.0258	0.086
Lag 7	0.0014	0.0022	0.530	0.0788	0.0535	0.141	0.1294	0.0424	0.002
Tuesday	0.0288	0.0130	0.026	0.7692	0.1373	<0.001	0.3748	0.1036	<0.001
Wednesday	0.0218	0.0132	0.098	0.7815	0.1312	<0.001	0.2820	0.1009	0.005
Thursday	0.0220	0.0131	0.093	0.8537	0.1367	<0.001	0.2040	0.1000	0.041
Friday	0.0182	0.0139	0.190	1.4696	0.1412	<0.001	0.3297	0.1009	0.001
10 a.m. – 11 a.m.	0.1295	0.0781	0.097	2.3846	0.9778	0.015	-1.0271	0.6428	0.110
11 a.m. – 12 a.m.	-0.0387	0.0870	0.656	2.4284	1.0061	0.016	-0.3561	0.6653	0.592
12 a.m. – 1 p.m.	0.0773	0.0801	0.334	3.4098	0.8591	<0.001	-1.1326	0.5904	0.055
1 p.m. – 2 p.m.	-0.0216	0.0740	0.770	0.8934	0.9178	0.330	-0.4462	0.6079	0.463
2 p.m. – 3 p.m.	0.0195	0.0761	0.798	2.4086	1.1421	0.035	-0.0632	0.6561	0.923
3 p.m. – 4 p.m.	0.1232	0.0851	0.148	5.6501	0.9822	<0.001	-2.1419	0.6189	0.001
FOMC	-0.0431	0.0254	0.090	0.1882	0.2069	0.363	0.0321	0.1511	0.832

Table B2. Coefficient Estimates for Model 2 (Market -Hour) (Continued)

Independent Variable	Dependent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	ρ value	Coef.	Std. Err.	ρ value	Coef.	Std. Err.	ρ value
News Sentiment									
Lag 1	0.0004	0.0026	0.888	0.0069	0.0206	0.738	-0.0166	0.0158	0.294
Lag 2	-0.0029	0.0022	0.195	0.0173	0.0234	0.461	-0.0033	0.0175	0.851
Lag 3	0.0000	0.0022	0.992	0.0016	0.0245	0.947	-0.0024	0.0183	0.893
Lag 4	-0.0017	0.0020	0.404	-0.0550	0.0214	0.010	0.0030	0.0173	0.862
Lag 5	0.0001	0.0020	0.946	-0.0154	0.0226	0.496	-0.0090	0.0167	0.588
Lag 6	0.0033	0.0022	0.142	-0.0516	0.0204	0.012	-0.0392	0.0161	0.015
Lag 7	-0.0024	0.0019	0.215	-0.0330	0.0241	0.170	-0.0455	0.0180	0.012
News Volume									
Lag 1	-0.0135	0.0170	0.428	-0.0914	0.1927	0.635	0.0213	0.1367	0.876
Lag 2	0.0082	0.0227	0.717	-0.1656	0.2226	0.457	-0.0525	0.1658	0.752
Lag 3	0.0024	0.0206	0.905	-0.2485	0.2261	0.272	0.2541	0.1669	0.128
Lag 4	0.0136	0.0200	0.497	0.2707	0.2298	0.239	0.1442	0.1566	0.357
Lag 5	0.0023	0.0171	0.891	0.3801	0.2297	0.098	-0.0676	0.1662	0.684
Lag 6	-0.0151	0.0172	0.378	-0.6545	0.2427	0.007	0.1437	0.1640	0.381
Lag 7	0.0044	0.0143	0.758	0.7855	0.2863	0.006	0.2360	0.1385	0.088
Message Volume									
Lag 1	-0.0251	0.0207	0.225	-0.0101	0.2667	0.970	0.3229	0.2655	0.224
Lag 2	0.0151	0.0198	0.444	0.3148	0.2654	0.236	0.0377	0.1810	0.835
Lag 3	-0.0003	0.0185	0.989	-0.0129	0.2706	0.962	0.0519	0.2129	0.808
Lag 4	0.0071	0.0166	0.667	0.5082	0.2458	0.039	-0.0691	0.1683	0.681
Lag 5	-0.0012	0.0166	0.940	0.1345	0.2348	0.567	0.0372	0.1889	0.844
Lag 6	-0.0101	0.0187	0.589	-0.1034	0.2274	0.649	0.3295	0.1850	0.075
Lag 7	0.0228	0.0218	0.297	-0.4063	0.2112	0.054	-0.4847	0.1406	0.001
Volatility									
Lag 1	0.0014	0.0018	0.439	0.0137	0.0557	0.806	-0.0517	0.0506	0.307
Lag 2	-0.0020	0.0011	0.075	0.0455	0.0761	0.550	0.0371	0.0586	0.527
Lag 3	-0.0001	0.0011	0.902	-0.0093	0.0853	0.913	0.0195	0.0725	0.788
Lag 4	-0.0005	0.0011	0.670	-0.1036	0.1179	0.380	-0.0726	0.0551	0.188
Lag 5	-0.0006	0.0012	0.626	0.0013	0.1218	0.992	0.0244	0.0717	0.733
Lag 6	-0.0012	0.0014	0.372	0.1379	0.1112	0.215	-0.1013	0.0620	0.102
Lag 7	0.0006	0.0012	0.631	-0.0498	0.0702	0.478	0.1034	0.0522	0.048
VIX									
Lag 1	-0.0003	0.0076	0.965	0.0216	0.0524	0.680	0.0177	0.0491	0.718
Lag 2	0.0237	0.0136	0.081	-0.1285	0.0721	0.075	-0.0076	0.0621	0.903
Lag 3	-0.0352	0.0223	0.115	0.0854	0.0830	0.303	-0.0864	0.0758	0.254
Lag 4	0.0126	0.0110	0.255	0.0881	0.1148	0.443	0.0613	0.0532	0.249
Lag 5	-0.0024	0.0061	0.693	-0.0978	0.1214	0.420	0.0422	0.0735	0.566
Lag 6	-0.0061	0.0078	0.433	0.0379	0.1102	0.731	0.0479	0.0620	0.439
Lag 7	0.0130	0.0103	0.208	-0.0406	0.0659	0.537	-0.0401	0.0514	0.435

Table B2. Coefficient Estimates for Model 2 (Market -Hour) (Continued)

Independent Variable	Dependent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	<i>p</i> value	Coef.	Std. Err.	<i>p</i> value	Coef.	Std. Err.	<i>p</i> value
Trading Volume									
Lag 1	-0.0008	0.0076	0.913	0.0137	0.0557	0.806	-0.0517	0.0506	0.307
Lag 2	-0.0249	0.0132	0.059	0.0455	0.0761	0.550	0.0371	0.0586	0.527
Lag 3	0.0359	0.0217	0.098	-0.0093	0.0853	0.913	0.0195	0.0725	0.788
Lag 4	-0.0118	0.0106	0.263	-0.1036	0.1179	0.380	-0.0726	0.0551	0.188
Lag 5	0.0018	0.0062	0.769	0.0013	0.1218	0.992	0.0244	0.0717	0.733
Lag 6	0.0078	0.0076	0.307	0.1379	0.1112	0.215	-0.1013	0.0620	0.102
Lag 7	-0.0165	0.0100	0.099	-0.0498	0.0702	0.478	0.1034	0.0522	0.048
Agreement									
Lag 1	-0.0091	0.0055	0.099	0.1835	0.0833	0.028	-0.0206	0.0302	0.496
Lag 2	0.0004	0.0020	0.835	0.0193	0.0625	0.758	-0.0234	0.0293	0.425
Lag 3	0.0001	0.0029	0.972	0.0002	0.0459	0.997	0.0094	0.0384	0.807
Lag 4	0.0002	0.0022	0.915	0.0227	0.0628	0.718	0.0233	0.0482	0.629
Lag 5	-0.0018	0.0044	0.685	-0.0109	0.1602	0.946	0.0391	0.0524	0.456
Lag 6	0.0007	0.0028	0.798	-0.0799	0.0750	0.287	-0.0135	0.0391	0.730
Lag 7	-0.0007	0.0022	0.757	0.0045	0.1005	0.964	0.0709	0.0795	0.373

Table B3. Coefficient Estimates for Model 3 (Stock-Day)									
Independent Variable	Independent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value
Return									
Lag 1	-0.0536	0.0162	0.001	0.0921	0.0199	<0.001	-0.2565	0.0186	<0.001
Positive Sentiment									
Lag 1	0.0010	0.0012	0.436	0.0596	0.0063	<0.001	0.0235	0.0055	<0.001
Negative Sentiment									
Lag 1	-0.0013	0.0013	0.307	0.0180	0.0065	0.006	0.0941	0.0060	<0.001
Tuesday	0.1735	0.0508	0.001	-1.5205	0.2122	<0.001	-0.9145	0.1895	<0.001
Wednesday	0.0182	0.0512	0.723	-0.6186	0.2079	0.003	-0.3232	0.1824	0.076
Thursday	0.1173	0.0506	0.020	-0.2662	0.2015	0.186	-0.6758	0.1761	<0.001
Friday	-0.0032	0.0518	0.951	-0.6987	0.2082	0.001	-0.3674	0.1845	0.046
FOMC	-0.2041	0.0795	0.010	0.0789	0.3709	0.832	-0.6582	0.3267	0.044
PEAD	-0.0271	0.3079	0.930	0.1915	0.3459	0.580	1.1249	0.3274	0.001
News Sentiment									
Lag 1	0.0086	0.0058	0.134	0.0645	0.0325	0.047	-0.0067	0.0292	0.817
News Volume									
Lag 1	0.1698	0.5260	0.747	-3.7972	2.5617	0.138	0.4477	2.2482	0.842
Message Volume									
Lag 1	-0.0432	0.0470	0.358	3.2745	0.2316	<0.001	2.0024	0.2035	<0.001
Volatility									
Lag 1	0.0042	0.1530	0.978	-3.8870	0.6941	<0.001	2.2547	0.6077	<0.001
VIX									
Lag 1	0.0011	0.0037	0.762	-0.0255	0.0142	0.074	-0.0724	0.0124	<0.001
Trading Volume									
Lag 1	0.0146	0.1228	0.905	1.6066	0.6091	0.008	-0.5719	0.5333	0.284
Agreement									
Lag 1	-0.0005	0.0004	0.185	-0.0011	0.0023	0.613	0.0021	0.0020	0.286

Table B4. Coefficient Estimates for Model 4 (Stock-Hour)									
Independent Variable	Dependent Variable								
	Return			Positive Sentiment			Negative Sentiment		
	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value	Coef.	Std. Err.	p value
Return									
Lag 1	-0.0386	0.0044	<0.001	0.2189	0.0244	<0.001	-0.3314	0.0262	<0.001
Positive Sentiment									
Lag 1	0.0000	0.0002	0.907	0.0340	0.0025	<0.001	0.0067	0.0021	0.002
Negative Sentiment									
Lag 1	-0.0028	0.0002	<0.001	0.0060	0.0025	0.018	0.0537	0.0023	<0.001
Tuesday	0.0417	0.0065	<0.001	-0.4288	0.0951	<0.001	-0.1723	0.0829	0.038
Wednesday	0.0223	0.0075	0.003	-0.4617	0.0992	<0.001	-0.1370	0.0864	0.113
Thursday	0.0335	0.0069	<0.001	-0.0562	0.0951	0.555	-0.2606	0.0813	0.001
Friday	0.0226	0.0067	0.001	-0.3288	0.0946	0.001	-0.2459	0.0818	0.003
10 a.m. – 11 a.m.	-0.0131	0.0324	0.687	-27.7970	0.4722	<0.001	-18.7036	0.4093	<0.001
11 a.m. – 12 a.m.	-0.0121	0.0184	0.509	-16.6040	0.2779	<0.001	-10.9033	0.2423	<0.001
12 a.m. – 1 p.m.	-0.0209	0.0133	0.117	-14.7638	0.2181	<0.001	-9.8097	0.1899	<0.001
1 p.m. – 2 p.m.	-0.0439	0.0112	<0.001	-13.4422	0.1862	<0.001	-9.1971	0.1611	<0.001
2 p.m. – 3 p.m.	-0.0541	0.0098	<0.001	-12.0974	0.1650	<0.001	-8.4166	0.1419	<0.001
3 p.m. – 4 p.m.	-0.0505	0.0090	<0.001	-13.3846	0.1452	<0.001	-9.7542	0.1235	<0.001
FOMC	-0.0321	0.0118	0.007	0.3142	0.1773	0.076	-0.2665	0.1508	0.077
PEAD	-0.0943	0.0416	0.023	3.5966	0.2919	<0.001	2.9476	0.2565	<0.001
News Sentiment									
Lag 1	-0.0024	0.0053	0.649	-0.0577	0.0232	0.013	-0.0606	0.0176	0.001
News Volume									
Lag 1	0.0031	0.0143	0.830	-0.7478	0.2577	0.004	-0.5715	0.2101	0.007
Message Volume									
Lag 1	0.0313	0.0049	<0.001	6.3246	0.0646	<0.001	4.4020	0.0557	<0.001
Volatility									
Lag 1	-0.0089	0.0204	0.663	2.5138	0.2603	<0.001	1.6059	0.2261	<0.001
VIX									
Lag 1	0.0008	0.0004	0.043	-0.1015	0.0041	<0.001	-0.0428	0.0036	<0.001
Trading Volume									
Lag 1	0.0541	0.0172	0.002	-4.8178	0.1880	<0.001	-2.9987	0.1632	<0.001
Agreement									
Lag 1	0.0002	0.0001	<0.001	-0.0031	0.0009	0.001	-0.0056	0.0008	<0.001

Appendix C

Results Using the Sentiment Lexicon from Loughran and McDonald (2011)¹

Notes: *** and ** denote statistical significance at 1% and 5%, respectively.

Table C1. Coefficient Estimates: The Effect of Sentiment on Return				
Impulse	Response: Return			
	Market		Stock	
	Daily	Hourly	Daily	Hourly
Positive				
Lag 1	0.0360	0.0059	0.0010	0.0000
Lag 2	0.0273	0.0005	–	–
Lag 3	-0.0343	-0.0020	–	–
Lag 4	0.0251	-0.0004	–	–
Lag 5	-0.1119	0.0009	–	–
Lag 6	–	0.0027	–	–
Lag 7	–	0.0003	–	–
Negative				
Lag 1	0.0042	-0.0224***	-0.0013	-0.0028***
Lag 2	-0.0569	0.0044	–	–
Lag 3	0.0516	0.0001	–	–
Lag 4	0.0112	0.0027	–	–
Lag 5	0.0952	-0.0012	–	–
Lag 6	–	0.0057**	–	–
Lag 7	–	0.0015	–	–

Table C2. Coefficient Estimates: The Effect of Return on Sentiment								
Impulse	Response							
	Market				Stock			
	Daily		Hourly		Daily		Hourly	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Return								
Lag 1	0.1300	-0.3114***	0.1854	-0.2864***	0.0952***	-0.2566***	0.2191***	-0.3311***
Lag 2	0.0085	-0.0619	-0.0564	-0.2422**	–	–	–	–
Lag 3	-0.0215	0.0197	-0.0630	-0.1397	–	–	–	–
Lag 4	0.0919	-0.0380	0.1001	-0.0872	–	–	–	–
Lag 5	-0.0618	0.0970**	0.0442	-0.1096	–	–	–	–
Lag 6	–	–	0.2722	-0.0834	–	–	–	–
Lag 7	–	–	-0.0162	0.0260	–	–	–	–

¹Loughran, T., and McDonald, B. 2011. “When Is a Liability Not a Liability? Textual Analysis, Dictionaries, and 10-Ks,” *The Journal of Finance* (66:1), pp. 35-65.

Appendix D

Results after Applying Lee and Ready's (1991)² Algorithm

Notes: *** and ** denote statistical significance at 1% and 5%, respectively.

Table D1. Coefficient Estimates: The Effect of Sentiment on Return		
Impulse	Response: Return	
	Hourly	
	Market	Stock
Positive		
Lag 1	0.0056	0.0000
Lag 2	0.0004	–
Lag 3	-0.0021	–
Lag 4	-0.0008	–
Lag 5	0.0010	–
Lag 6	0.0030	–
Lag 7	0.0001	–
Negative		
Lag 1	-0.0229***	-0.0028
Lag 2	0.0038	–
Lag 3	0.0000	–
Lag 4	0.0028	–
Lag 5	-0.0014	–
Lag 6	0.0059**	–
Lag 7	0.0015	–

Table D2. Coefficient Estimates: The Effect of Return on Sentiment				
Impulse	Response			
	Hourly			
	Market		Stock	
	Positive	Negative	Positive	Negative
Return				
Lag 1	0.1892	-0.2807***	0.2195***	-0.3311***
Lag 2	-0.0605	-0.2342**	–	–
Lag 3	-0.0592	-0.1343	–	–
Lag 4	0.1212	-0.0898	–	–
Lag 5	0.0211	-0.1281	–	–
Lag 6	0.2706	-0.0916	–	–
Lag 7	-0.0140	0.0159	–	–

²Lee, C., and Ready, M. J. 1991. "Inferring Trade Direction from Intraday Data," *The Journal of Finance* (46:2), pp. 733-746.

Appendix E

Stocks Included in Models 3 and 4

Symbol	Company Name
AAPL	Apple Inc
AMD	Advanced Micro Devices Inc
AMZN	Amazon.com Inc
ANR	Alpha Natural Resources Inc
ARIA	Ariad Pharmaceuticals Inc
ARNA	Arena Pharmaceuticals Inc
BAC	Bank Of America Corp
BBRY	Blackberry Ltd
BBY	Best Buy Company Inc
BIDU	Baidu Inc
CAT	Caterpillar Inc
CLF	Cliffs Natural Resources Inc
CMG	Chipotle Mexican Grill Inc
CRM	Salesforce.com Inc
CSCO	Cisco Systems Inc
EBAY	Ebay Inc
F	Ford Motor Co
FCX	Freeport-McMoRan Inc
FSLR	First Solar Inc
GILD	Gilead Sciences Inc
GMCR	Keurig Green Mountain Inc
GS	Goldman Sachs Group Inc
HLF	Herbalife Ltd
HPQ	Hewlett Packard Co
IBM	International Business Machs Corp
INTC	Intel Corp
JCP	J C Penney Co Inc
JPM	JPMorgan Chase & Co
LULU	Lululemon Athletica Inc
LVS	Las Vegas Sands Corp
MA	Mastercard Inc
MNKD	Mannkind Corp
MSFT	Microsoft Corp
MU	Micron Technology Inc
NFLX	Netflix Inc
NOK	Nokia Corp
PCLN	Priceline Group Inc
S	Sprint Nextel Corp
SBUX	Starbucks Corp
SINA	Sina Corp
V	Visa Inc
VVUS	Vivus Inc
WLT	Walter Energy Inc
YHOO	Yahoo Inc