

**Internet Appendix to:
“Measuring institutional trading costs and
the implications for finance research: The
case of tick size reductions”**

This document provides additional results and robustness checks associated with the paper “Measuring institutional trading costs and the implications for finance research: The case of tick size reductions.”

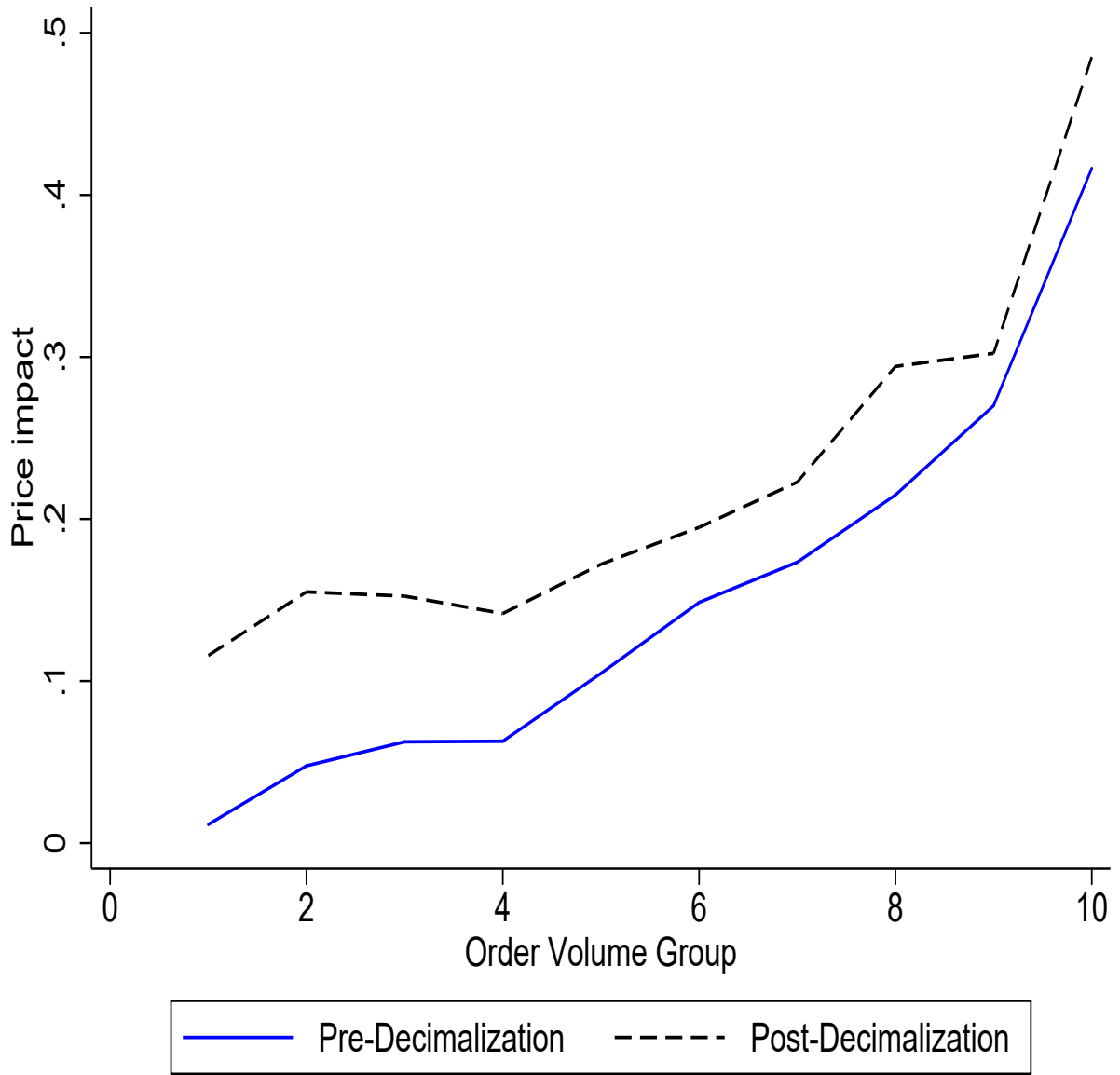


Figure IA1

Institutional trading costs as a function of order volume

This figure presents *Price impact* values for various order share volume groups before and after decimalization. Order group 1 includes the smallest orders, whereas order group 10 includes the largest orders.

Table IA1

Correlations between monthly stock liquidity measures, where liquidity values are portfolio averages

This table presents correlations for alternative monthly stock liquidity measures, where liquidity values are portfolio averages. Specifically, for each liquidity measure, we group stocks into ten portfolios each month based on their estimated liquidity value. We then compute the average liquidity value across stocks within each portfolio, and assign stocks the average liquidity value of their respective portfolios. We allow portfolio assignment to update each month. Panel A presents cross-sectional correlations, where Pearson correlations are computed across firms each month then averaged across months. Panel B presents firm-level time series correlations, where correlations are computed over time (months) for each firm then averaged across firms. See the main paper for details on variable construction.

	<i>PI</i>	<i>Ami</i>	<i>CSprd</i>	<i>CS</i>	<i>ETick</i>	<i>FHT</i>	<i>Roll</i>	<i>Zeros</i>	<i>ESprd</i>
Panel A: Firm-level cross-sectional correlations									
<i>Price impact</i>	1								
<i>Amihud</i>	0.006	1							
<i>Closing spread</i>	0.013	0.762	1						
<i>Corwin Schultz</i>	0.063	0.174	0.262	1					
<i>Effective tick</i>	0.018	0.460	0.514	0.387	1				
<i>FHT</i>	0.011	0.358	0.391	0.250	0.455	1			
<i>Roll</i>	0.021	0.209	0.213	0.414	0.205	0.164	1		
<i>Zeros</i>	-0.019	0.348	0.348	0.050	0.368	0.816	0.046	1	
<i>Percent effective spread</i>	0.018	0.819	0.834	0.381	0.579	0.436	0.259	0.363	1
Panel B: Firm-level time-series correlations									
<i>Price impact</i>	1								
<i>Amihud</i>	0.054	1							
<i>Closing spread</i>	0.059	0.548	1						
<i>Corwin Schultz</i>	0.055	0.266	0.373	1					
<i>Effective tick</i>	0.041	0.372	0.471	0.250	1				
<i>FHT</i>	0.020	0.183	0.290	0.136	0.331	1			
<i>Roll</i>	0.023	0.197	0.200	0.394	0.132	0.102	1		
<i>Zeros</i>	-0.012	0.087	0.151	-0.050	0.235	0.779	-0.033	1	
<i>Percent effective spread</i>	0.069	0.620	0.734	0.424	0.496	0.298	0.211	0.140	1

Table IA2

Correlations between monthly stock liquidity measures: Subsample analysis

This table presents cross-sectional correlations for alternative monthly stock liquidity measures, where we compute correlations separately for the pre- and post-decimalization sample periods. We present cross-sectional correlations, where Pearson correlations are computed across firms each month then averaged across months (within the subsample period). Panel A presents results for the pre-decimalization period and Panel B presents results for the post-decimalization period. See the main paper for details on variable construction.

	<i>PI</i>	<i>Ami</i>	<i>CSprd</i>	<i>CS</i>	<i>ETick</i>	<i>FHT</i>	<i>Roll</i>	<i>Zeros</i>	<i>ESprd</i>
Panel A: Pre-decimalization cross-sectional correlations									
<i>Price impact</i>	1								
<i>Amihud</i>	-0.001	1							
<i>Closing spread</i>	-0.004	0.517	1						
<i>Corwin Schultz</i>	0.007	0.254	0.182	1					
<i>Effective tick</i>	-0.007	0.497	0.469	0.457	1				
<i>FHT</i>	-0.004	0.415	0.429	0.316	0.573	1			
<i>Roll</i>	0.000	0.248	0.134	0.445	0.256	0.240	1		
<i>Zeros</i>	-0.012	0.368	0.381	0.002	0.409	0.707	0.015	1	
<i>Percent effective spread</i>	-0.002	0.638	0.526	0.450	0.600	0.494	0.279	0.354	1
Panel B: Post-decimalization cross-sectional correlations									
<i>Price impact</i>	1								
<i>Amihud</i>	0.017	1							
<i>Closing spread</i>	0.021	0.790	1						
<i>Corwin Schultz</i>	0.047	0.217	0.378	1					
<i>Effective tick</i>	0.008	0.356	0.434	0.314	1				
<i>FHT</i>	0.007	0.302	0.368	0.253	0.367	1			
<i>Roll</i>	0.020	0.241	0.283	0.434	0.181	0.211	1		
<i>Zeros</i>	-0.014	0.283	0.310	0.066	0.323	0.739	0.047	1	
<i>Percent effective spread</i>	0.025	0.773	0.875	0.407	0.450	0.373	0.287	0.313	1

Table IA3

The effects of decimalization on trading costs: Pilot stocks only

This table presents the mean change in estimated trading costs from the 30 days before to the 30 days after decimalization implementation for pilot stocks only. Pilot stocks were groups of stocks in which decimalization was piloted before full implementation. *Percent quoted spread* is the best offer quote minus the best bid quote, divided by the midpoint of the quotes. *Dollar quoted spread* is defined in a similar manner except that it is not scaled by the midpoint quote. *Dollar effective spread* is defined as twice the absolute value of the difference between the trade price and the prevailing midpoint of the best bid and offer quotes. *Percent effective spread* scales dollar effective spread by the prevailing midpoint. *Price impact* is measured as the difference between the volume-weighted execution price and the price prevailing at the time the broker receives the order. The difference is scaled by the price prevailing at order time and is multiplied by -1 for sell orders. *Percent quoted spread*, *Percent effective spread*, and *Price impact* is in percentage units. All of the measures are averaged within each firm-day. We then average the measures within each firm-month (30 days). This table reports equally weighted averages across firms. Panel A presents results for the full sample, Panel B for NYSE-listed stocks, and Panel C for Nasdaq-listed stocks.

	N	Mean pre-dec.	Mean post-dec.	Mean change	<i>t</i> -stat
Panel A: Full sample					
<i>Dollar quoted spread</i>	181	0.150	0.112	-0.038	-2.12
<i>Percent quoted spread (%)</i>	181	0.899	0.702	-0.197	-2.18
<i>Dollar effective spread</i>	181	0.139	0.109	-0.030	-2.43
<i>Percent effective spread (%)</i>	181	0.840	0.684	-0.156	-2.16
<i>Price impact (%)</i>	181	0.172	0.315	0.143	1.09
Panel B: NYSE-listed stocks					
<i>Dollar quoted spread</i>	75	0.164	0.118	-0.046	-1.67
<i>Percent quoted spread (%)</i>	75	0.783	0.609	-0.174	-1.40
<i>Dollar effective spread</i>	75	0.136	0.109	-0.026	-1.35
<i>Percent effective spread (%)</i>	75	0.640	0.544	-0.096	-1.00
<i>Price impact (%)</i>	75	0.138	0.219	0.081	0.54
Panel C: Nasdaq-listed stocks					
<i>Dollar quoted spread</i>	106	0.140	0.108	-0.032	-1.36
<i>Percent quoted spread (%)</i>	106	0.981	0.768	-0.213	-1.68
<i>Dollar effective spread</i>	106	0.141	0.109	-0.032	-2.04
<i>Percent effective spread (%)</i>	106	0.982	0.783	-0.199	-1.99
<i>Price impact (%)</i>	106	0.196	0.383	0.188	0.94

Table IA4

The effects of decimalization on alternative measures of Price impact

This table presents the mean change in alternative measures of *Price impact* from the 30 days before to the 30 days after decimalization implementation. Each version of *Price impact* is measured as the difference between the volume-weighted execution price and a benchmark price, and the difference is scaled by the benchmark price and multiplied by -1 for sell orders. The benchmark price for *Price impact benchmark 1* and *Price impact benchmark 2* is the closing price from the day before first execution and the opening price on day of first execution, respectively. We also consider a measure that adds the costs of commissions (the benchmark price for this measure is the price when the broker receives the order). All of the measures are volume weighted averages within each firm-day. We then average the measures within each firm and within the two time groups. This table reports equally weighted averages across firms. All of the measures of *Price impact* are in percentage units. Panel A presents results for the full sample, Panel B for NYSE-listed stocks, and Panel C for Nasdaq-listed stocks.

	N	Mean pre-dec.	Mean post-dec.	Mean change	<i>t</i> -stat
Panel A: Full sample					
<i>Price impact benchmark 1</i> (%)	3,383	0.249	0.353	0.104	2.70
<i>Price impact benchmark 2</i> (%)	3,384	0.260	0.385	0.124	3.39
<i>Price impact with commissions</i> (%)	3,399	0.444	0.500	0.056	1.71
Panel B: NYSE-listed stocks					
<i>Price impact benchmark 1</i> (%)	1,412	0.334	0.257	-0.077	-2.15
<i>Price impact benchmark 2</i> (%)	1,408	0.318	0.260	-0.058	-1.77
<i>Price impact with commissions</i> (%)	1,412	0.463	0.394	-0.069	-2.22
Panel C: Nasdaq-listed stocks					
<i>Price impact benchmark 1</i> (%)	1,971	0.187	0.421	0.234	3.84
<i>Price impact benchmark 2</i> (%)	1,976	0.219	0.473	0.254	4.38
<i>Price impact with commissions</i> (%)	1,987	0.431	0.575	0.144	2.84

Table IA5

Probit regression estimates for propensity score matching – innovation analysis

This table presents probit regression estimates used in propensity score matching tests to analyze effects of liquidity on innovation. We present results for three samples—the full sample, NYSE stocks, and Nasdaq stocks. We consider two alternative stock liquidity measures, *Percent effective spread* and *Price impact*. For each liquidity measure and each sample, we sort firms into three groups based on change in liquidity from the month before to the month after decimalization. The stocks with the largest improvement in stock liquidity are considered the “treatment” group, while the stocks with the worst improvement are considered the “control” group. The dependent variable in the probit regressions is an indicator variable equaling 1 for treatment and 0 for control firms. We present estimated slope coefficients and associated *t*-statistics (in parentheses), computed with heteroskedasticity-consistent standard errors. All independent variables are winsorized at the one percent tails. See the main paper for further details on variable construction.

	<i>Percent effective spread</i>			<i>Price impact</i>		
	Full sample	NYSE	Nasdaq	Full sample	NYSE	Nasdaq
<i>ROA</i>	-0.428 (-1.37)	0.839 (1.00)	-0.205 (-0.63)	0.273 (1.07)	-0.552 (-0.68)	0.353 (1.22)
<i>Investment</i>	0.151 (3.13)	0.118 (0.68)	0.049 (1.16)	0.011 (0.30)	0.052 (0.34)	0.003 (0.09)
<i>log(market value equity)</i>	-0.429 (-15.27)	-0.379 (-9.28)	-0.513 (-12.04)	0.026 (1.13)	-0.029 (-0.83)	0.003 (0.09)
<i>Q</i>	-0.136 (-0.81)	0.460 (1.41)	-0.308 (-1.29)	0.313 (2.12)	0.261 (0.83)	0.061 (0.28)
<i>PPE</i>	-0.457 (-1.88)	-0.000 (-0.00)	-0.773 (-2.03)	0.254 (1.16)	-0.070 (-0.23)	0.313 (0.91)
<i>Capex</i>	1.611 (1.95)	-0.475 (-0.37)	2.238 (2.10)	-0.804 (-1.08)	0.584 (0.45)	-1.049 (-1.09)
<i>R&D</i>	1.928 (2.90)	0.213 (0.08)	1.687 (2.78)	0.465 (0.91)	-0.853 (-0.38)	0.671 (1.30)
<i>log(1+cites) growth</i>	-0.027 (-0.62)	-0.067 (-0.85)	0.069 (1.32)	-0.021 (-0.53)	-0.081 (-1.09)	0.011 (0.25)
<i>log(1+patents) growth</i>	0.043 (0.35)	0.157 (0.77)	-0.181 (-1.21)	-0.027 (-0.26)	0.009 (0.05)	-0.004 (-0.03)
<i>Leverage</i>	0.145 (0.86)	-0.584 (-1.92)	0.317 (1.34)	-0.309 (-2.08)	-0.230 (-0.77)	-0.053 (-0.24)
<i>log(age)</i>	-0.147 (-3.18)	-0.088 (-1.39)	-0.106 (-1.57)	0.020 (0.49)	0.020 (0.33)	-0.025 (-0.40)
Observations	1,469	661	808	1,469	661	808
Pseudo R^2 (%)	27.55	19.71	20.84	0.760	0.636	0.367

Table IA6

Differences in pre-decimalization observables – innovation analysis

This table presents tests for differences in observables between treatment and control groups for the innovation. We consider two liquidity measures, *Percent effective spread* and *Price impact*. We sort firms into three groups based on change in the liquidity measure surrounding decimalization. The stocks with the largest improvement in liquidity are in the “treatment” group, while the stocks with the worst improvement are in the “control” group. We match treatment and control stocks using propensity scores. We present the mean differences in pre-decimalization firm characteristics between treatment and control firms and *t*-tests for equality of means. All independent variables are winsorized at the one percent tails. See the main paper for further details on variable construction.

	<i>Percent effective spread</i>				<i>Price impact</i>			
	Treated	Control	Diff.	<i>t</i> -stat	Treated	Control	Diff.	<i>t</i> -stat
Panel A: Full sample								
<i>ROA</i>	0.052	0.064	-0.013	-1.24	0.100	0.103	-0.003	-0.39
<i>Investment</i>	0.532	0.383	0.149	2.68	0.451	0.462	-0.010	-0.19
<i>log(market value equity)</i>	5.234	5.090	0.144	2.41	6.096	6.096	-0.001	-0.01
<i>Q</i>	2.563	2.182	0.381	2.54	2.614	2.536	0.078	0.50
<i>PPE</i>	0.223	0.242	-0.019	-1.69	0.256	0.255	0.001	0.08
<i>Capex</i>	0.063	0.064	-0.001	-0.44	0.062	0.061	0.001	0.37
<i>R&D</i>	0.071	0.055	0.016	3.09	0.051	0.050	0.001	0.18
<i>log(1+cites) growth</i>	0.001	-0.035	0.036	0.42	-0.004	0.055	-0.059	-0.79
<i>log(1+patents) growth</i>	0.050	0.049	0.001	0.05	0.050	0.062	-0.012	-0.45
<i>Leverage</i>	2.142	1.746	0.397	2.64	2.146	2.069	0.077	0.49
<i>log(age)</i>	2.010	2.007	0.002	0.06	2.268	2.272	-0.004	-0.08
Panel B: NYSE sample								
<i>ROA</i>	0.142	0.133	0.009	1.38	0.147	0.150	-0.003	-0.52
<i>Investment</i>	0.138	0.115	0.022	1.02	0.176	0.176	0.000	0.01
<i>log(market value equity)</i>	6.110	6.046	0.064	0.62	6.923	7.008	-0.085	-0.63
<i>Q</i>	1.365	1.331	0.034	0.54	1.720	1.778	-0.058	-0.55
<i>PPE</i>	0.324	0.318	0.006	0.29	0.331	0.318	0.013	0.71
<i>Capex</i>	0.060	0.060	0.000	0.00	0.064	0.061	0.003	0.68
<i>R&D</i>	0.009	0.010	-0.001	-0.74	0.012	0.013	-0.001	-0.41
<i>log(1+cites) growth</i>	-0.135	-0.115	-0.020	-0.20	-0.141	-0.205	0.064	0.68
<i>log(1+patents) growth</i>	-0.013	-0.008	-0.005	-0.12	-0.013	-0.036	0.022	0.59
<i>Leverage</i>	0.794	0.782	0.012	0.18	1.156	1.221	-0.065	-0.59
<i>log(age)</i>	2.518	2.577	-0.059	-0.83	2.691	2.666	0.025	0.34
Panel C: Nasdaq sample								
<i>ROA</i>	0.008	0.027	-0.019	-1.14	0.058	0.071	-0.013	-0.91
<i>Investment</i>	0.555	0.516	0.039	0.46	0.702	0.726	-0.024	-0.23
<i>log(market value equity)</i>	4.848	4.750	0.098	1.47	5.477	5.463	0.014	0.15
<i>Q</i>	2.907	2.676	0.231	0.93	3.240	3.090	0.150	0.58
<i>PPE</i>	0.197	0.207	-0.010	-0.73	0.200	0.192	0.007	0.54
<i>Capex</i>	0.065	0.064	0.000	0.09	0.061	0.059	0.003	0.66
<i>R&D</i>	0.103	0.078	0.024	2.63	0.085	0.080	0.005	0.61
<i>log(1+cites) growth</i>	0.118	0.148	-0.031	-0.25	0.087	0.022	0.065	0.57
<i>log(1+patents) growth</i>	0.072	0.087	-0.015	-0.36	0.094	0.057	0.036	0.88
<i>Leverage</i>	2.538	2.310	0.228	0.90	2.867	2.714	0.153	0.59
<i>log(age)</i>	1.899	1.893	0.006	0.12	1.925	1.947	-0.022	-0.42

Table IA7

Probit regression estimates for propensity score matching – default risk analysis

This table presents probit regression estimates used in propensity score matching tests to analyze effects of liquidity on default risk. We present results for three samples—the full sample, NYSE stocks, and Nasdaq stocks. We consider two alternative stock liquidity measures, *Percent effective spread* and *Price impact*. For each liquidity measure and each sample, we sort firms into three groups based on change in liquidity from the month before to the month after decimalization. The stocks with the largest improvement in stock liquidity are considered the “treatment” group, while the stocks with the worst improvement are considered the “control” group. The dependent variable in the probit regressions is an indicator variable equaling 1 for treatment and 0 for control firms. We present estimated slope coefficients and associated *t*-statistics (in parentheses), computed with heteroskedasticity-consistent standard errors. All independent variables are winsorized at the one percent tails. See the main paper for further details on variable construction.

	<i>Percent effective spread</i>			<i>Price impact</i>		
	Full sample	NYSE	Nasdaq	Full sample	NYSE	Nasdaq
<i>log(equity)</i>	-0.097 (-3.26)	-0.325 (-5.02)	0.013 (0.32)	-0.011 (-0.49)	-0.002 (-0.05)	-0.018 (-0.59)
<i>log(debt)</i>	-0.058 (-3.07)	0.077 (1.75)	-0.050 (-2.32)	0.040 (2.71)	-0.034 (-0.97)	0.028 (1.48)
<i>1/sigma</i>	-0.354 (-7.99)	-0.245 (-4.23)	-0.225 (-3.81)	0.038 (1.06)	-0.034 (-0.65)	0.027 (0.51)
<i>Excess return</i>	-0.145 (-2.54)	-0.168 (-1.61)	-0.130 (-1.91)	0.058 (1.20)	0.131 (1.50)	0.001 (0.02)
<i>Income/assets</i>	-1.344 (-4.40)	-0.053 (-0.05)	-0.980 (-3.62)	-0.141 (-0.68)	-1.123 (-1.31)	-0.294 (-1.38)
<i>Percent effective spread</i>	0.603 (8.83)	0.979 (3.96)	0.734 (9.14)			
Observations	1,933	799	1,134	1,933	799	1,134
Pseudo R^2 (%)	35.10	31.02	30.72	0.500	0.493	0.278

Table IA8

Differences in pre-decimalization observables – default risk analysis

This table presents tests for differences in observables between treatment and control groups for the analysis of the effects of liquidity on default risk. We present results for three samples—the full sample, NYSE stocks, and Nasdaq stocks. We consider two alternative stock liquidity measures, *Percent effective spread* and *Price impact*. For each liquidity measure and each sample, we sort firms into three groups based on change in liquidity from the month before to the month after decimalization. The stocks with the largest improvement in stock liquidity are considered the “treatment” group, while the stocks with the worst improvement are considered the “control” group. Using the propensity scores estimated from the probit regressions, we match treatment and control stocks using a one-to-many (5) approach. We present the mean differences in pre-decimalization firm characteristics between treatment and control firms and *t*-tests for equality of means. All independent variables are winsorized at the one percent tails. See the main paper for further details on variable construction.

	<i>Percent effective spread</i>				<i>Price impact</i>			
	Treated	Control	Diff.	<i>t</i> -stat	Treated	Control	Diff.	<i>t</i> -stat
Panel A: Full sample								
<i>log(equity)</i>	5.553	5.149	0.404	7.40	6.171	6.211	-0.039	-0.58
<i>log(debt)</i>	3.065	2.879	0.187	1.85	3.804	3.800	0.004	0.04
<i>1/sigma</i>	1.585	1.707	-0.122	-3.58	1.810	1.810	0.000	0.00
<i>Excess return</i>	-0.018	-0.013	-0.005	-0.19	0.158	0.165	-0.007	-0.24
<i>Income/assets</i>	-0.059	-0.038	-0.021	-2.82	-0.011	-0.012	0.001	0.16
<i>Percent effective spread</i>	1.887	1.902	-0.016	-0.30				
Panel B: NYSE sample								
<i>log(equity)</i>	6.113	5.812	0.301	4.05	6.892	6.979	-0.087	-0.78
<i>log(debt)</i>	4.827	4.462	0.365	3.79	5.189	5.257	-0.068	-0.54
<i>1/sigma</i>	2.137	2.126	0.011	0.20	2.258	2.255	0.003	0.05
<i>Excess return</i>	0.090	0.098	-0.008	-0.24	0.276	0.305	-0.029	-0.72
<i>Income/assets</i>	0.033	0.024	0.009	2.30	0.045	0.047	-0.002	-0.36
<i>Percent effective spread</i>	1.019	0.942	0.077	1.60				
Panel C: Nasdaq sample								
<i>log(equity)</i>	5.285	4.838	0.447	6.57	5.725	5.726	-0.001	-0.01
<i>log(debt)</i>	2.637	2.363	0.273	2.02	2.943	2.918	0.025	0.20
<i>1/sigma</i>	1.501	1.552	-0.051	-1.19	1.527	1.549	-0.022	-0.47
<i>Excess return</i>	-0.075	-0.104	0.029	0.87	0.086	0.088	-0.002	-0.04
<i>Income/assets</i>	-0.096	-0.095	-0.001	-0.06	-0.056	-0.056	0.000	0.00
<i>Percent effective spread</i>	2.346	2.341	0.004	0.06				