RISK AVERSION AND STOCK PRICES

By

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Abstract

This paper uses data on companies that have been in the S&P 500 index since 1957 to examine whether risk aversion has decreased since 1995. The evidence suggests that it has not. There is no evidence that more risky companies have had larger increases in their price-earnings ratios since 1995 than less risky companies.

1 Introduction

It is clear that there has been a huge increase in the average price-earnings (PE) ratio of U.S. stocks since 1995. For example, the median S&P 500 PE ratio for 1996–2000 is 26.41, which compares to the median of 15.45 for 1957–1994.[1] Earnings fell on average more than stock prices in 2001, and the S&P 500 PE ratio

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[1]As discussed in Section 4, medians seem more appropriate than means as measures of average PE ratios. For the S&P 500 PE ratio, however, medians and means are close. For 1996–2000 the mean is 26.61 (versus 26.41), and for 1957–1994 the mean is 15.02 (versus 15.45). For 1985–1994 the median is 15.45 and the mean is 17.33, both still much lower than the median and mean for 1996–2000. Note that 1995 is not used in these calculations; it is treated as a transition year. The S&P 500 PE ratio is defined as the value of the S&P 500 stock price index at the end of the year divided by S&P 500 reported earnings for that year.

for 2001 is 46.50! The PE ratio for 2002 is 31.08. The ratios for 2001 and 2002 are obviously high because earnings are unusually low, but they are much higher than existed in previous low-earnings periods. For example, earnings were low in 1991, and the PE ratio for 1991 is 26.22.

There was, on the other hand, no corresponding large decrease in real long term interest rates after 1995. The median real AAA bond rate[2] for 1996–2000 is .053, which compares to the median of .031 for 1957–1994 and .057 for 1985–1994. (The respective means are .054, .037, and .059.)

Why PE ratios have risen so much since 1995 with little change in real long term interest rates is a key question in finance. Does this signal the end of the equity premium puzzle, about which so much has been written?[3] The possibility that is examined in this paper is that the degree of risk aversion of the average investor fell in the last half of the 1990s. This could account at least in part for the increase in PE ratios relative to real long term interest rates. The paper uses data on companies that have been in the S&P 500 index since 1957, which is the first year that the S&P index included 500 companies. The data are discussed in Section 2, and the 65 companies that were used are listed in Tables 1 and 2.

The basic idea of the paper is the following. Although the 65 companies are obviously solid established companies, they do differ somewhat in risk. The first step (Section 3) is to estimate the risk of each company using data from 1957

[2]The real AAA bond rate used for these calculations is the nominal AAA bond rate minus the percentage change in the GDP deflator over the previous two years (at an annual rate).

[3]See Kocherlakota (1996) and Siegel and Thaler (1997) for reviews of the literature on the equity premium puzzle prior to the possible change in the premium in the last half of the 1990s. For more recent discussions of a possibly falling equity premium, see Siegel (1999) and Jagannathan, McGrattan, and Scherbina (2000). For an interesting set of results on the views of financial economists on the equity premium, see Welch (2000).

through 1994. Two measures of risk are computed per company. The first is the estimate of β from the CAPM model, and the second is a measure of the variability of real earnings growth. The second step (Section 4) is to compute the change in each company's average PE ratio for the period before 1995 to the period after 1995. Once this is done, one can compare the changes in the average PE ratios across companies. If the degree of risk aversion of the average investor fell after 1995, one should expect the changes in the average PE ratios for the more risky companies to be on average larger than the changes for the less risky companies.[4] The results in Section 5 show that this is not the case. There is no evidence from these results that risk aversion has fallen. Other explanations are needed for the large increase in PE ratios since 1995.

An advantage of using companies that have been in the S&P 500 index for a long time (in addition to data availability) is that these companies are less likely than others to have changed in large ways since 1995. The hypothesis tested in this paper is that the degree of risk aversion of investors has changed since 1995, not the inherent riskiness of companies. If the riskiness of the companies has also changed, any differences found after 1995 might be due to these changes rather than to changes in investors' risk aversion. Note that survival bias is not a problem here. In fact, long run survival is good here because this makes it more likely that the risk characteristics of the firm have not changed. There would be selection bias if firms were selected on the basis of how much their PE ratios changed since 1995, but this is not the case.

[4] A proof of the proposition that PE ratios increase more for more risky companies when risk aversion falls is presented in the appendix for a particular model.

A number of people have suggested that at least some of the increase in PE ratios since 1995 may be due to a fall in risk aversion. Shiller (2000, p. 41) suggests that the rise of gambling opportunities may have led to "changed attitudes toward risk taking in other areas." Campbell and Cochrane (1999) have a model in which risk aversion is lower in expansions than in recessions. Since the period between 1995 and 2000 was one of robust growth, this model implies lower risk aversion in this period than otherwise.

Glassman and Hassett (1999, p. 97) argue that in the last half of the 1990s people have been lowering their estimates of the overall riskiness of stocks relative to bonds, which has driven up the price of stocks. While this is not necessarily a change in risk aversion, it is a change that this paper tests. If there has been a decrease in investors' estimates of the overall riskiness of stocks (and not, say, also a decrease in risk aversion), it still should be the case that more risky companies have larger increases in their PE ratios than less risky ones.

2 Data on the 65 Companies

A number of companies have been in the S&P 500 index since the inception of the 500-company index in 1957. For this paper 65 companies were chosen. These are companies for which data existed back to (or nearly back to) 1957 and which were not affected by large mergers. The 65 companies are listed in Tables 1 and 2 along with various variables for each company. The variables are explained as the paper proceeds. The companies are ranked in the tables by the size of their β's, which are estimated in the next section.

Table 1
Results from the β Regressions

i	Company	β_i^a	$SE_{\beta i}$	$t_{\alpha i}$	AP_i	p-val end$_i$	p-val beg$_i$
1	Alcan Inc.	0.466	0.235	0.42	0.74	0.750	0.778
2	TXU Corp.	0.545	0.109	0.21	1.19	0.393	0.370
3	Procter & Gamble Co.	0.597	0.196	1.71	0.33	0.821	0.000
4	PG&E Corp.	0.651	0.141	0.70	0.10	0.286	0.556
5	Phillips Petroleum Co.	0.678	0.211	1.00	0.13	0.714	1.000
6	AT&T Corp.	0.697	0.198	-0.14	0.16	0.321	0.630
7	Minnesota Mining & Mfg Co.	0.781	0.171	0.74	0.22	1.000	0.000
8	Alcoa Inc.	0.795	0.201	-0.26	0.31	0.786	0.259
9	American Electric Power	0.836	0.125	-0.23	0.60	0.964	0.444
10	Public Service Entrp	0.845	0.155	0.45	0.59	1.000	0.407
11	Hercules Inc.	0.851	0.223	0.67	0.04	0.000	0.889
12	Air Products & Chemicals I	0.865	0.226	1.39	0.14	0.679	0.000
13	Bristol Myers Squibb	0.866	0.206	2.46	0.30	0.393	0.000
14	Kimberly-Clark Corp.	0.869	0.161	1.21	0.11	0.821	0.074
15	Aetna Inc.	0.894	0.210	0.13	0.40	0.692	0.440
16	Wrigley (WM) Jr Co.	0.898	0.216	2.05	2.41	0.357	0.852
17	Halliburton Co.	0.906	0.297	0.80	0.06	0.536	0.926
18	Deere & Co.	0.916	0.269	1.02	0.11	0.179	0.630
19	Kroger Co.	0.931	0.257	1.34	0.25	0.571	1.000
20	Intl Business Machines Corp	0.944	0.248	0.38	3.93	0.000	0.333
21	Caterpillar Inc.	0.952	0.231	0.57	1.96	0.000	1.000
22	Goodrich Corp.	0.958	0.181	-1.39	0.21	0.786	0.111
23	General Mills Inc.	0.965	0.171	1.75	0.37	0.143	0.926
24	Winn-Dixie Stores Inc.	0.973	0.237	1.12	0.14	0.000	0.333
25	Heinz (H J) Co.	0.979	0.207	2.32	0.06	0.964	0.000
26	Eastman Kodak Co.	0.983	0.232	0.28	0.87	0.750	0.481
27	Campbell Soup Co.	0.986	0.199	1.17	1.56	0.929	0.370
28	Philip Morris Cos Inc.	0.993	0.233	3.30	0.09	0.393	0.630
29	Southern Co.	0.995	0.155	0.27	0.70	0.964	0.667
30	Du Pont (E I) de Nemours	0.996	0.143	-1.03	0.13	0.964	0.222
31	Phelps Dodge Corp.	1.008	0.294	0.51	0.02	0.286	1.000
32	Pfizer Inc.	1.019	0.244	1.27	0.29	0.000	0.259
33	Hershey Foods Corp.	1.022	0.232	1.31	0.41	1.000	0.370
34	Ingersoll-Rand Co.	1.024	0.226	0.04	0.54	0.607	1.000
35	FPL Group Inc.	1.048	0.137	-0.11	1.05	0.964	0.556
36	Pitney Bowes Inc.	1.064	0.295	1.18	0.59	0.857	0.593
37	Archer-Daniels-Midland Co.	1.073	0.348	1.56	1.21	0.393	0.778
38	Rockwell Intl Corp.	1.075	0.220	0.90	0.28	0.643	0.519
39	Dow Chemical	1.081	0.215	0.48	0.12	0.750	0.667
40	General Electric Co.	1.091	0.140	0.26	1.17	0.786	0.185
41	Abbott Laboratories	1.097	0.194	2.24	0.89	0.179	0.815
42	Merck & Co.	1.122	0.236	1.66	0.24	0.036	0.630
43	Penney (J C) Co.	1.133	0.206	0.55	0.03	0.214	1.000
44	Union Pacific Corp.	1.136	0.266	0.63	2.68	0.783	0.818
45	Schering-Plough	1.137	0.229	1.60	1.26	1.000	0.556
46	Pepsico Inc.	1.147	0.195	2.06	0.27	0.643	0.444
47	McGraw-Hill Companies	1.150	0.275	0.86	0.50	1.000	0.185
48	Household International Inc	1.184	0.222	0.29	0.03	0.304	0.591
49	Emerson Electric Co.	1.196	0.209	1.99	3.19	1.000	0.000
50	General Motors Corp.	1.206	0.233	-0.16	2.22	0.000	0.963

Table 1
Results from the β Regressions

i	Company	β_i^a	$SE_{\beta i}$	$t_{\alpha i}$	AP_i	p-val end$_i$	p-val beg$_i$
51	Colgate-Palmolive Co.	1.213	0.201	1.39	7.98	0.857	0.000
52	Eaton Corp.	1.216	0.189	1.06	0.46	0.964	0.148
53	Dana Corp.	1.222	0.295	0.80	4.03	0.250	0.778
54	Sears Roebuck & Co.	1.256	0.213	-0.05	0.81	0.464	0.667
55	Corning Inc.	1.258	0.232	-0.29	1.22	0.464	0.444
56	General Dynamics Corp.	1.285	0.386	0.43	1.81	0.000	0.481
57	Coca-Cola Co.	1.290	0.223	2.35	0.07	0.321	0.074
58	Boeing Co.	1.306	0.427	1.34	0.09	1.000	0.630
59	Ford Motor Co.	1.308	0.337	1.09	0.18	0.321	0.185
60	Peoples Energy Corp.	1.454	0.402	0.47	0.43	1.000	0.000
61	Goodyear Tire & Rubber Co.	1.464	0.347	0.11	0.47	0.000	1.000
62	May Department Stores Co.	1.525	0.257	0.62	0.23	0.893	1.000
63	ITT Industries Inc.	1.630	0.197	0.03	1.43	0.893	0.148
64	Raytheon Co.	1.821	0.375	0.69	0.90	0.857	0.000
65	Cooper Industries Inc.	1.857	0.289	0.79	0.34	1.000	0.630

Notes:
β_i^a = estimate of β from Section 3 (1958–1994 estimation period).
$SE_{\beta i}$ = estimated standard error of β_i^a
$t_{\alpha i}$ = t-statistic for estimate of the constant term.
AP_i = Andrews-Ploberger statistic.
p-val end$_i$ = p-value for end-of-sample test.
p-val beg$_i$ = p-value for beginning-of-sample test.

Table 2
Constructed Variables for the 65 Companies

i	Company	β_i^a	PE_i^a	PE_i^b	e_i^a	e_i^b	d_i^a	d_i^b	$\widehat{PE}_i^{b1}$	σ_i^a	$\widehat{PE}_i^{b2}$
1	Alcan Inc.	0.466	12.64	15.83	0.169	0.178	-0.013	-0.014	12.72	1.588	12.72
2	TXU Corp.	0.545	10.80	12.92	0.016	-0.036	0.014	0.029	10.79	0.096	10.72
3	Procter & Gamble Co.	0.597	19.90	32.78	0.066	0.112	0.050	0.109	24.37	0.173	23.56
4	PG&E Corp.	0.651	11.30	17.32	0.021	-0.426	0.014	-0.021	7.05	0.147	7.30
5	Phillips Petroleum Co.	0.678	13.27	13.36	0.071	0.172	0.006	0.003	14.29	0.523	14.27
6	AT&T Corp.	0.697	13.71	21.10	-0.004	-0.236	-0.008	-0.019	10.94	0.179	11.09
7	Minnesota Mining & Mfg Co.	0.781	17.61	22.74	0.054	0.381	0.051	0.014	20.92	0.196	21.11
8	Alcoa Inc.	0.795	15.97	18.41	0.120	0.162	-0.015	0.217	31.66	1.265	27.84
9	American Electric Power	0.836	10.68	16.75	-0.001	-0.056	-0.021	-0.019	10.24	0.194	10.25
10	Public Service Entrp	0.845	9.63	13.70	-0.018	-0.062	-0.011	-0.019	9.09	0.213	9.14
11	Hercules Inc.	0.851	16.07	17.10	0.077	0.018	-0.008	0.066	18.82	1.001	18.11
12	Air Products & Chemicals I	0.865	16.20	18.53	0.051	0.026	0.074	0.054	15.02	0.233	15.20
13	Bristol Myers Squibb	0.866	17.01	30.57	0.068	0.119	0.110	0.116	18.06	0.131	17.97
14	Kimberly-Clark Corp.	0.869	13.42	21.16	0.063	0.220	0.018	0.024	15.57	0.232	15.43
15	Aetna Inc.	0.894	8.98	14.30	-0.137	-0.042	0.007	-0.021	8.99	1.029	9.10
16	Wrigley (WM) Jr Co.	0.898	14.49	33.04	0.062	0.068	0.044	0.042	14.49	0.208	14.50
17	Halliburton Co.	0.906	17.84	32.08	0.120	0.542	-0.011	-0.019	24.88	0.688	24.63
18	Deere & Co.	0.916	12.15	15.41	-0.010	0.137	0.004	-0.014	13.06	1.077	13.12
19	Kroger Co.	0.931	11.82	24.84	0.010	0.036	0.000	0.000	12.07	0.743	12.06
20	Intl Business Machines Corp	0.944	16.08	18.56	0.081	0.184	0.045	0.096	20.23	0.282	19.60
21	Caterpillar Inc.	0.952	16.95	11.03	-0.043	0.119	-0.005	0.177	32.36	1.137	29.12
22	Goodrich Corp.	0.958	12.06	14.41	0.028	0.208	-0.015	-0.019	13.87	2.555	13.82
23	General Mills Inc.	0.965	17.16	22.42	0.060	0.043	0.048	0.006	15.05	0.215	15.41
24	Winn-Dixie Stores Inc.	0.973	16.10	32.12	0.045	-0.095	0.047	0.050	14.44	0.124	14.48
25	Heinz (H J) Co.	0.979	13.49	33.21	0.079	0.240	0.079	0.067	14.95	0.122	14.96
26	Eastman Kodak Co.	0.983	28.28	16.74	0.023	0.021	0.009	-0.014	26.48	0.398	26.82
27	Campbell Soup Co.	0.986	16.33	24.92	0.028	0.003	0.025	0.083	18.82	0.232	18.25
28	Philip Morris Cos Inc.	0.993	12.25	14.71	0.129	0.150	0.130	0.075	10.71	0.173	11.02
29	Southern Co.	0.995	11.26	16.54	0.034	-0.007	0.000	0.012	11.26	0.227	11.20
30	Du Pont (E I) de Nemours	0.996	14.16	14.55	0.099	0.131	0.001	0.078	18.04	0.588	17.28
31	Phelps Dodge Corp.	1.008	11.47	15.51	0.186	-0.358	-0.011	-0.010	7.31	1.065	7.43
32	Pfizer Inc.	1.019	17.63	42.36	0.052	0.155	0.062	0.132	23.41	0.114	22.44
33	Hershey Foods Corp.	1.022	14.66	26.13	0.025	0.045	0.058	0.082	15.93	0.257	15.72
34	Ingersoll-Rand Co.	1.024	14.24	15.19	0.045	0.144	-0.018	0.041	18.25	0.426	17.61
35	FPL Group Inc.	1.048	11.86	16.01	0.038	0.042	0.019	0.025	12.12	0.273	12.08
36	Pitney Bowes Inc.	1.064	16.11	20.30	0.049	0.117	0.086	0.117	18.62	0.356	18.26
37	Archer-Daniels-Midland Co.	1.073	14.43	28.29	0.073	-0.116	-0.011	0.037	14.10	0.468	13.82
38	Rockwell Intl Corp.	1.075	9.42	17.36	0.062	-0.042	0.020	-0.019	7.74	0.271	7.94
39	Dow Chemical	1.081	15.25	15.60	0.042	-0.006	0.026	0.015	14.20	0.763	14.31
40	General Electric Co.	1.091	15.16	35.92	0.051	0.122	0.015	0.143	23.08	0.178	21.46
41	Abbott Laboratories	1.097	17.58	24.08	0.114	0.109	0.098	0.107	17.96	0.091	17.87
42	Merck & Co.	1.122	23.29	27.68	0.066	0.155	0.072	0.124	29.02	0.228	28.12
43	Penney (J C) Co.	1.133	13.14	21.31	0.094	-0.354	-0.003	0.006	9.25	0.301	9.34
44	Union Pacific Corp.	1.136	12.99	14.84	0.010	-0.117	0.021	-0.019	10.44	0.252	10.72
45	Schering-Plough	1.137	18.18	31.54	0.112	0.183	0.060	0.125	23.15	0.145	22.28
46	Pepsico Inc.	1.147	18.94	30.28	0.082	0.022	0.046	0.038	17.62	0.147	17.73
47	McGraw-Hill Companies	1.150	16.93	28.19	0.051	0.136	0.052	0.074	19.29	0.314	19.01
48	Household International Inc	1.184	8.36	17.37	0.019	0.209	0.008	0.093	12.46	0.356	11.81
49	Emerson Electric Co.	1.196	17.52	21.61	0.047	0.087	0.044	0.080	20.01	0.106	19.59
50	General Motors Corp.	1.206	11.21	7.77	0.052	-0.175	-0.023	-0.012	9.55	1.554	9.57

Table 2 (continued)
Constructed Variables for the 65 Companies

i	Company	β_i^a	PE_i^a	PE_i^b	e_i^a	e_i^b	d_i^a	d_i^b	$\widehat{PE}_i^{b1}$	σ_i^a	$\widehat{PE}_i^{b2}$
53	Colgate-Palmolive Co.	1.213	16.60	33.05	0.067	0.138	0.025	0.048	18.78	0.322	18.50
52	Eaton Corp.	1.216	10.64	14.46	0.137	-0.095	0.001	0.011	9.00	0.696	9.02
53	Dana Corp.	1.222	10.26	10.84	0.069	-0.057	-0.011	0.068	11.54	0.604	11.09
54	Sears Roebuck & Co.	1.256	12.41	14.74	0.030	-0.047	-0.014	-0.019	11.45	0.273	11.52
55	Corning Inc.	1.258	19.33	26.32	0.052	0.165	-0.013	-0.019	20.92	0.448	20.90
56	General Dynamics Corp.	1.285	9.06	17.25	0.056	0.131	-0.023	0.063	12.27	1.173	11.68
57	Coca-Cola Co.	1.290	21.68	46.85	0.085	-0.121	0.055	0.058	18.41	0.128	18.51
58	Boeing Co.	1.306	11.93	28.13	0.169	-0.042	0.017	-0.012	9.21	0.961	9.42
59	Ford Motor Co.	1.308	8.62	8.67	0.016	0.019	0.026	0.078	9.97	1.466	9.69
60	Peoples Energy Corp.	1.454	9.58	14.01	0.000	-0.069	0.005	0.002	8.98	0.136	9.01
61	Goodyear Tire & Rubber Co.	1.464	12.02	18.22	0.022	0.355	0.012	0.040	17.18	0.538	16.73
62	May Department Stores Co.	1.525	11.32	15.74	0.050	0.077	0.006	0.023	12.15	0.233	12.03
63	ITT Industries Inc.	1.630	9.92	12.87	0.038	-0.016	0.018	-0.019	8.53	0.394	8.73
64	Raytheon Co.	1.821	11.75	22.14	0.112	-0.328	0.050	-0.014	6.79	0.230	7.14
65	Cooper Industries Inc.	1.857	12.41	12.75	0.108	0.100	0.037	-0.014	10.69	0.512	10.99
	Mean of the 65	**1.057**	**14.21**	**20.99**	**0.056**	**0.044**	**0.023**	**0.040**	**15.36**	**0.488**	**15.11**

Notes:
β_i^a = estimates of β from Section 3 (1958–1994 estimation period).
PE_i^a = median PE ratio 1957–1994.
PE_i^b = median PE ratio 1996–2000.
e_i^a = median earnings growth rate 1958–1994.
e_i^b = median earnings growth rate 1996–2000.
d_i^a = median dividend growth rate 1958–1994.
d_i^b = median dividend growth rate 1996–2000.
$\widehat{PE}_i^{b1}$ = predicted median PE ratio 1996–2000 from equation (3) in Table 3. $[= \exp(\widehat{\log PE_i^{b1}})]$
σ_i^a = estimate of the variability of the earnings growth rate 1958–1994.
$\widehat{PE}_i^{b2}$ = predicted median PE ratio 1996–2000 from equation (4) in Table 3. $[= \exp(\widehat{\log PE_i^{b2}})]$

For each company i annual data were collected for 1957–2000 on its stock price at the end of the year (P_t^i), its earnings per share for the year (E_t^i), and its dividends per share for the year (D_t^i). Adjustments were made for stock splits. The data were obtained from the CRSP/COMPUSAT Merged Database from the website of Wharton Research Data Services.

One company, International Paper Company (IP), was not used even though data existed for all the years. Earnings of IP for all five years between 1996 and 2000 are very low, and the median PE ratio is 127.5 for this period. This is not a sensible number, and if this observation were used for the empirical work in Section 5 it would be a huge outlier. Rather than try to adjust the PE ratio down in some way, the IP company was just not used.

3 Estimates of Risk

The β Regressions

As noted in the Introduction, two measures of risk are computed per company. The first is β from the CAPM model. Let P_t^m denote the value of the S&P 500 stock price index at the end of year t, and let D_t^m denote S&P 500 dividends for year t. The market rate of return, R_t^m, that is used for the β regressions is taken to be $(P_t^m + D_t^m)/P_{t-1}^m$. The risk free rate, R_t^f, is taken to be the one-year Treasury bill rate (average for the year).[5]

[5]Because of data limitations, the six-month rate is used for 1958 (average for the year). The data were obtained from the web site of the Board of Governors of the Federal Reserve System. The bill rates are for the secondary market.

The rate of return for company i, R_t^i, is taken to be $(P_t^i + D_t^i)/P_{t-1}^i$, where P_t^i and D_t^i are defined in Section 2. Observations on R_t^i are available beginning in 1958 for all but three companies, where the beginning year is 1960 for Aetna and 1963 for Household International and Union Pacific. For each of the 65 companies the following regression was run for the period beginning in 1958 (or later for the three) and ending in 1994:

$$R_t^i - R_t^f = \beta(R_t^m - R_t^f) + \epsilon_t, \qquad t = 1958, \ldots, 1994$$

The 65 estimates of β, denoted β_i^a, are presented in Table 1, where the companies are ranked by the size of the estimates. The estimated standard error of β_i^a, denoted $SE_{\beta i}$, is also presented. The remaining four columns in Table 1 include the results of various tests of the β regressions. The first test is to add a constant term to each regression. The CAPM model does not call for a constant term in the regression, and so testing the hypothesis that the constant term is zero is one test of the model. The t-statistic for the constant term estimate, denoted $t_{\alpha i}$, is presented in the table for each of the 65 regressions. In only 7 of the 65 cases is the t-statistic greater than 2.0 in absolute value, and so the hypothesis of a zero constant term is generally not rejected.

The last three tests are stability tests. The first hypothesis tested is that there is no structural break in the equation between 1974 and 1977. The test due to Andrews and Ploberger (AP) (1994) was used. This test has the advantage that a single break point does not have to be specified, only a range of possible break points. Each regression has 37 observations, and the 5 percent critical value for the AP statistic for this number of observations and one coefficient is 2.00.[6] In Table 1 only 7 of the 65 values of AP_i are greater than 2.00, and so the stability hypothesis is generally not rejected.

The next test is of the hypothesis that there is no structural break near the end of the sample period—in 1990. The test due to Andrews (2002) was used. The p-values from this test are presented in the table. Only 9 of the 65 p-values are less than .05, and so the end-of-sample stability hypothesis is generally not rejected.

The final test is of the hypothesis that there is no structural break near the beginning of the sample period—in 1963.[7] The Andrews (2002) test was also used for this purpose. The p-values from this test are presented in the table. Again, only 9 of the 65 p-values are less than .05, and so the beginning-of-sample stability hypothesis is generally not rejected.

The overall results are thus fairly supportive of the CAPM model for this set of companies. The regressions are mostly stable, and most of the estimates of the constant term are not significant. On the negative side, most of the estimates of β are not significantly different from 1.0, which means that there is not much precision in the ranking of the β estimates. It will be seen in Section 5, however, that there is some evidence that the estimates of β are picking up risk differences across companies.

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[6] See Andrews and Ploberger (1994), Table I.

[7] For Aetna the year was 1965, and for Household International and Union Pacific the year was 1968.

Variation of Earnings

Another measure of the risk of a company, not consistent with the CAPM model, is the variation of its earnings. Maybe the average investor looks only at a company's earnings fluctuations in judging how risky it is? The measure that was used is as follows. In the next section the growth rates of each company's real earnings are computed for 1958–1994.[8] These growth rates are ranked, and the median, denoted e_i^a, is computed. The variation in the growth rate of earnings, denoted σ_i^a, is then taken from this ranking to be the difference between the value above which 20 percent of the growth rates lie and the value below which 20 percent of the growth rates lie. This range was used as the measure of variation because it is not sensible to compute variances in the usual way due to extreme values at both ends of the ranking. The values of σ_i^a are presented in the second-to-last column of Table 2.

4 Computing PE Ratios, Earnings Growth, and Dividend Growth

Computing average PE ratios is problematic because earnings can be very small or negative. For the present calculations the PE ratio for a given year was taken to be large (and positive) if earnings for the year were negative. The ratio was taken to be large enough to put the observation at the top when the observations are ranked. The average PE ratio was then taken to be the median of the ranked observations. This way of treating negative earnings affects the calculation of the average value

[8] In some cases the first year was later than 1958.

only in that the large values are put at the top before the median is taken.

For each company the median was computed for the 1957–1994 period. For a few companies the earnings data began after 1957, and for these companies the median was computed for the period consisting of the first available observation through 1994. The median for company i for this period will be denoted PE_i^a, where a denotes the 1957–1994 (or slightly shorter) period.

The median for each company was also computed for the 1996–2000 period, which meant ranking the five yearly observations and taking the third one. For one company, Corning, three of the five PE ratios were very large because of very low earnings, and for Corning the average PE ratio was taken to be the second lowest rather than the third. The median for company i for this period will be denoted PE_i^b, where b denotes the 1996–2000 period. Both PE_i^a and PE_i^b are presented in Table 2.

The last row in Table 2 presents the mean of the 65 observations for each variable. The mean of PE_i^a is 14.21, and the mean of PE_i^b is 20.99. There has thus been on average a large increase in the median PE ratio from before to after 1995 for these companies, which is consistent with the S&P 500 data discussed in Section 1.

Four other variables per company were also computed: the median growth rates of earnings for the two periods, denoted e_i^a and e_i^b, and the median growth rates of dividends for the two periods, denoted d_i^e and d_i^b. Earnings and dividends from Section 2 were first deflated by the GDP deflator: $ER_t^i = E_t^i / GDPD_t$ and $DR_t^i = D_t^i / GDPD_t$, where $GDPD_t$ is the GDP deflator for year t, ER denotes real earnings, and DR denotes real dividends. The growth rate of real earnings was then computed as $(ER_t^i - ER_{t-1}^i)/ER_{t-1}^i$ when ER_{t-1}^i was positive. When ER_{t-1}^i was zero or negative, the growth rate was taken to be a large positive number if $ER_t^i > ER_{t-1}^i$ and a large negative number if $ER_t^i < ER_{t-1}^i$. For each period the growth rates were ranked and the median of the ranked observations was taken.[9] (As discussed in the previous section, these growth rates of real earnings for 1958–1994 were used to compute σ_i^a, the variability measure.) The same procedure was followed for dividends, where there are zero values for a few of the D_t^i but no negative values. Again, medians were computed for the period up to 1994 and for the period 1996–2000. The four median growth rates per company are presented in Table 2.

It can be seen from the last row in Table 2 that on average earnings growth was less after 1995 (mean of .044 versus .056) and dividend growth was greater (mean of .040 versus .023).

5 The Cross Company Regressions

1957–1994 Period

If 1957–1994 was a period in which there were no large shifts in the risk characteristics of the 65 companies, then the estimates of β_i^a or σ_i^a may be reasonable approximations of the riskiness of the companies. One would expect, other things being equal, for more risky companies to have on average lower PE ratios. If,

[9]For the second period, which consists of only five observations, this procedure did not result in sensible growth rates for five companies (Boeing, Goodyear, Halliburton, ITT, and Phillips). For each of these five companies total real earnings were computed for 1990–1994 and 1996–2000, and the growth rate (at an annual rate) between these two periods was used for e_i^b.

therefore, either β_i^a or σ_i^a is a good measure of risk, it should have a negative effect on PE_i^a. One would also expect companies with higher average growth rates of earnings and dividends to have higher average PE ratios, so that e_i^a and d_i^a should have positive effects on PE_i^a.

Using the data in Table 2, log PE_i^a was regressed on a constant, β_i^a, e_i^a, and d_i^a for the 65 company observations. This regression is equation (1) in Table 3. The coefficient estimate for β_i^a is negative, as expected, and it has a t-statistic of -1.99, which is significant at the 5 percent level for a one-tailed test. The coefficient estimates for the two growth rates are positive, as expected, although the estimate for earnings growth only has a t-statistic of 1.46. The significance of β_i^a thus provides further support for the CAPM model for this set of companies. The results provide some evidence that the estimates of β are picking up risk differences across companies. If the estimates were not, they should not have a negative effect on the average PE ratios.

Regarding the other possible measure of risk, σ_i^a, log PE_i^a was regressed on a constant, σ_i^a, e_i^a, and d_i^a for the 65 company observations. This regression is equation (2) in Table 3. The coefficient estimate for σ_i^a is of the expected negative sign, but it only has a t-statistic of -1.01. From this regression there is not much support for σ_i^a being a good measure of risk.

1996–2000 Period

Equation (1) in Table 3 can be used to predict what the average PE ratio of a company should be in the 1996–2000 period if there were no structural breaks. Let $\hat{\nu}_i^{a1}$ be the estimated error in equation (1) for company i. This error captures

Table 3
Regressions Across Companies
Dependent Variable is log PE_i^a

	Explanatory Variables						
Eq.	cnst	β_i^a	e_i^a	d_i^a	σ_i^a	SE	R^2
(1)	2.74	-.218	.839	2.802		.229	.232
	(22.79)	(-1.99)	(1.46)	(3.33)			
(2)	2.56		.805	2.254	-.073	.234	.195
	(41.44)		(1.36)	(2.26)	(-1.01)		

(3) $\log \widehat{PE}_i^{b1} = 2.74 - .218\beta_i^a + .839e_i^b + 2.802d_i^b + \hat{\nu}_i^{a1}$

(4) $\log \widehat{PE}_i^{b2} = 2.56 - .073\sigma_i^a + .805e_i^b + 2.254d_i^b + \hat{\nu}_i^{a2}$

Notes:
t-statistics are in parentheses.
obs. = 65.
$\hat{\nu}_i^{a1}$ = estimated error in equation (1) for company i.
$\hat{\nu}_i^{a2}$ = estimated error in equation (2) for company i.
See Table 2 for the other notation.

all the effects on a company's average PE ratio that are not picked up by its β, growth rate of earnings, and growth rate of dividends. If it is assumed for each company that β_i^a and $\hat{\nu}_i^{a1}$ have not changed (no structural breaks in this sense), but that perceived earnings growth and dividend growth have changed (from e_i^a to e_i^b and from d_i^a to d_i^b), then the prediction of the average PE ratio for 1996–2000 is as listed in equation (3) in Table 3. This calculation uses the coefficients estimated for the 1958–1994 period, but the 1996–2000 values of earnings growth and dividend growth.

The predictions of PE_i^b from equation (3) are presented in Table 2, where $\widehat{PE}_i^{b1} = \exp(\log \widehat{PE}_i^{b1})$. It is clear from Table 2 that these predictions, which are the predicted average PE ratios for 1996–2000, are close to the actual average PE ratios for 1957–1994. Because β_i^a and $\hat{\nu}_i^{a1}$ are used in equation (3), the only reason $\log PE_i^a$ and $\widehat{\log PE}_i^{b1}$ differ for a given company is because the growth rates of earnings and dividends differ between the two periods. The net effect of these differences is in general not large, i.e., $\log PE_i^a$ and $\widehat{\log PE}_i^{b1}$ are in general close.

Note that the βs have not been reestimated for the predictions: β_i^a is used in equation (3). It would not have been practical to reestimate the βs because five observations per company is not enough to get trustworthy estimates. More to the point, however, as discussed above, the analysis in this paper is based on the assumption that the risk characteristics of the companies have not changed, i.e., that a company's β has not changed.

Equation (2) in Table 3 can also be used to predict what the average PE ratio of a company should be in the 1996–2000 period if there were no structural breaks. This is done in equation (4), where $\hat{\nu}_i^{a2}$ is the estimated error in equation (2) for company i. This prediction, of course, uses as the measure of risk σ_i^a instead of β_i^a. The predictions of PE_i^b from equation (4) are also presented in Table 2, where it is again clear that these predictions are close to the actual average PE ratios for 1957–1994.

The main interest of this paper is to examine the difference between the actual average PE ratio for 1996–2000 (PE_i^b) and the predicted average under the assumption of no structural changes ($\widehat{PE}_i^{b1}$ or $\widehat{PE}_i^{b2}$). Table 2 shows that on average this difference is large and positive. Now, if the increase in the average PE ratios is due to a fall in investors' risk aversion, more risky companies should have had larger increases. (See the appendix for a proof of this for a particular model.)

The tests are presented in Table 4. Row 1 is a regression of $\log PE_i^b - \widehat{\log PE}_i^{b1}$ on a constant and β_i^a. If there has been a decrease in risk aversion, the coefficient estimate of β_i^a should be positive and significant. The estimate is positive but not significant, with a t-statistic of 1.18. There is thus little evidence that high β companies had on average more of a non predicted increase in their PE ratios than did low β companies.

The regression in row 1 in Table 4 uses the predictions of $\log PE_i^b$ from equation (3) in Table 3. Any misspecification in equation (3) will affect the results in row 1 in Table 4. A simpler test, which does not depend on equation (3), is to regress the actual log change in the average PE ratios, $\log PE_i^b - \log PE_i^a$, on a constant and β_i^a. From the perspective of equation (3), the assumption is being made that $e_i^b = e_i^a$ and $d_i^b = d_i^a$. In other words, the assumption is that the perceived growth rates of earnings and dividends have not changed from 1957–1994 to 1996–2000 (as well as β_i^a and $\hat{\nu}_i^{a1}$ not changing). This regression is in row 2 in Table 4, where the coefficient estimate for β_i^a is still not significant. The main conclusion is thus not sensitive to whether or not the predictions from equation (3) are used.

The above analysis can be repeated with σ_i^a in place of β_i^a and $\widehat{\log PE}_i^{b2}$ in place of $\widehat{\log PE}_i^{b1}$. This is done in rows 3 and 4 of Table 4. The coefficient estimate of σ_i^a in both rows is negative and significant. These results say that if we take σ_i^a as measuring risk, the least risky companies have had the largest increase in their PE ratios. This, of course, is opposite to what would be the case if risk aversion has fallen. It is unclear, however, how much weight should be put on this result given that σ_i^a is not significant in equation (2) in Table 3, but at the least there is

Table 4
Regressions Across Companies

	Dependent Variable	Explanatory Variables cnst	β_i^a	σ_i^a	SE	R^2
1	$\log PE_i^b - \widehat{\log PE}_i^{b1}$	.081	.219		.392	.022
		(0.40)	(1.18)			
2	$\log PE_i^b - \log PE_i^a$	.285	.063		.304	.003
		(1.82)	(0.44)			
3	$\log PE_i^b - \widehat{\log PE}_i^{b2}$	.465		-.293	.352	.134
		(7.34)		(-3.12)		
4	$\log PE_i^b - \log PE_i^a$	.461		-.222	.285	.119
		(8.97)		(-2.92)		

Notes:
t-statistics are in parentheses.
obs. = 65.
See Table 3 for the computation of $\widehat{\log PE}_i^{b1}$ and $\widehat{\log PE}_i^{b2}$.
See Table 2 for the other notation.

no support for the hypothesis that risk aversion has fallen.

6 Conclusion

A remarkable feature of the data for the 65 companies is on average the large increase in the median PE ratio from 1957–1994 to 1996–2000. This increase is not explained by higher earnings or dividend growth in 1996–2000, since the predicted PE ratios from equations (3) and (4) in Table 3 are much lower on average than the actual ratios. (Earnings growth was in fact on average lower in 1996–2000 than earlier, although dividend growth was higher.)

The main point of this paper is to show that larger increases in PE ratios did not occur for the more risky companies. This is contrary to what one would expect if there were a fall in the degree of risk aversion of the average investor after 1995. Some other explanation is needed for the large average PE increases.

The results in this paper may have implications for the future growth of stock prices. Since the degree of risk aversion does not appear to have fallen, the reason for the large PE increases may be due to something less fundamental and permanent. If, for example, they have been due to unrealistically large expectations of future earnings or dividends, the PE increases are less likely to last than if they have been due to a fall in risk aversion.

Appendix

Consider a particular company. Let P = price per share, E = earnings per share, D = dividends per share, g = the growth rate of dividends, r = the risk free rate, γ = the coefficient of risk aversion, β = the risk of the company, and σ^2 = the variance of consumption changes. γ, β, and σ^2 are non negative; a decrease in γ is a fall in risk aversion; and a decrease in β is a fall in the risk of the company. Following Cochrane (2001), p. 19, the expected return on the company's stock is $r + \beta\gamma\sigma^2$. It is assumed that $r - g > 0$ and thus that $r + \beta\gamma\sigma^2 - g > 0$ since β, γ, and σ^2 are non negative. If r is not greater than g, then the PE ratio below is not defined for all values of $\beta\gamma\sigma^2$. Using the Gordon model, the PE ratio is

$$\frac{P}{E} = \frac{D}{E}\left(\frac{1}{r + \beta\gamma\sigma^2 - g}\right) \tag{1}$$

or in log form

$$\log\frac{P}{E} = \log\frac{D}{E} - \log(r + \beta\gamma\sigma^2 - g) \tag{2}$$

Taking the derivative of equation (11) with respect to $-\gamma$ yields

$$z = \frac{\partial \log(P/E)}{-\partial\gamma} = \frac{\beta\sigma^2}{r + \beta\gamma\sigma^2 - g} > 0 \tag{3}$$

The derivative of z with respect to β is

$$\frac{\partial z}{\partial\beta} = \frac{\sigma^2(r - g)}{(r + \beta\gamma\sigma^2 - g)^2} > 0 \tag{4}$$

Thus when γ falls, the increase in $\log(P/E)$ is larger the larger is β.

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