ANNALS OF ECONOMICS AND FINANCE **1**, 79–100 (2000)

Investment Horizon and the Cross Section of Expected Returns: Evidence from the Tokyo Stock Exchange*

Pin-Huang Chou

Department of Finance, National Central University, Chung Li, Taiwan 320

Yuan-Lin Hsu

Department of Finance, National Chengchi University, Mucha, Taiwan 116

and

Guofu Zhou

Olin School of Business, Washington University at St. Louis, MO 63130, USA

Using data from the Tokyo Stock Exchange, we study how beta, size, and ratio of book to market equity (BE/ME) account for the cross-section of expected stock returns over different lengths of investment horizons. We find that β, adjusted for infrequent trading or not, fails to explain the cross-section of monthly expected returns, but does a much better job for horizons over half- and one-year. However, either the size or the BE/ME alone is still a significant factor in explaining the cross-section expected returns, but the size significance diminishes for longer horizons when β is included as an additional independent variable. *Journal of Economic Literature* Classification Numbers: C13, C53, G14.

Key Words: Investment horizon; Beta; Size; Book-to-market equity; CAPM.

1. INTRODUCTION

A fundamental problem in finance is to examine the tradeoff between risk and return. Sharpe (1964), Lintner (1965), Black (1972), Ross (1976),

* We thank S. Ghon Rhee, Kie Ann Wong, John Wei and participants at the Symposium on Mathematical Finance (Beijing University, 2000), the Time Series Group workshop of Academia Sinica (Taipei, Taiwan), the 1998 Chinese Finance Association Annual Meeting (Taiwan), the 1998 PACAP/FMA Finance Conference (Kuala Lumper, Malaysia) and the National Chengchi University for helpful comments and suggestions.

1529-7373/2000

Merton (1973) and Breeden (1979), among others, develop single and multi-beta asset pricing models which imply that the expected return on a security is a linear function of factor risk premiums and their associated betas. In particular, the Sharpe-Lintner's capital asset pricing model (CAPM) claims that the market portfolio risk is the single factor that drives cross-sectional expected stock returns. Despite the findings of capital market anomalies (e.g., the size effect, price-earning ratio anomaly, the January effect, and the turn-of-the-year effect), the CAPM has long been considered the major model explaining stock returns (see, e.g., the review by Fama (1991)). However, Fama and French (1992) cast serious doubt on the validity of the CAPM. They point out that "the relation between market β and average return is flat, even when β is the only explanatory variable." Rather, the ratio of book to market equity (BE/ME) is found to be capable of accounting for the cross-sectional variation in stock returns. Since then, several "battles" have been initiated on the validity of the market beta as the sole factor explaining the cross-section of expected returns. Black (1993) argues that "announcements of the death of beta seem premature" by showing that the results reported in Fama and French (1992) appear largely attributable to data mining. Some studies also present evidence supporting the view that "reports of beta's death have been greatly exaggerated" (Grundy and Malkiel (1996)) and that "the CAPM is alive and well" (the earlier title of Jagannathan and Wang (1996)). Daniel and Titman (1997) and Davis, Fama and French (2000) provide some of the more recent debates.

This paper analyzes the cross-section of expected stock returns with two extensions. First, unlike most studies, we use data from the Tokyo Stock Exchange (TSE). Although it is the world's third largest stock market, the TSE does not attract much researchers' attention only until recently. In particular, empirical investigation of the cross-sectional predictability on the Japanese market is scarce. Chan, Hamao, and Lakonishok (CHL, 1991) investigate the explanatory power of four fundamental variables: earnings yield, size, BE/ME, and cash flow yield. They use seemingly unrelated regression model and impose the restriction that the coefficients for these variables are the same across portfolios. Hence, their model is much closer to a time-series regression one, exploiting the information of cross-equation correlations in error terms, and their focus is not on the validity of the market beta. As emphasized by Black (1993), use of non-U.S. data may have the benefit of avoiding the problem of data mining because regularities such as size or book-to-market equity effects are well "mined" by using the US data. In addition, it is unclear whether the earlier findings in the "battles" are still valid by using alternative data, and not due to chance alone with the use of the US data.

The second feature of our study is to examine the cross-section of expected returns over different lengths of investment horizons. Presumably, if returns on individual securities and the market portfolio are independently and identically distributed (iid) and are correlated only contemporaneously, the beta estimates should be roughly invariant to the choice of return horizons.[1] Since the *iid* characteristic in returns represents an economy in which the "investment opportunity set" remains constant over time, it appears intuitive that investors in this case will be indifferent to the holding horizons, and the timing for investment is also irrelevant. Consequently, the same inferences should be obtained regardless of return intervals used for analysis. However, it is well documented that asset prices do not follow random walks and that portfolios of different sizes tend to have different correlation structures (see, e.g., Potterba and Summers, 1986; Lo and MacKinlay, 1988, 1990a, 1990b). The conventional wisdom that long-term investment bears relatively lower risk suggests that the markets overreact, and depict mean-reverting phenomenon. In addition, researchers have documented the existence of lead-lag relationship among different securities. Consequently, it is not surprising to find, for example, that the systematic risk of a security varies when data of different return intervals are used. Levy (1972) seems the first to investigate the effect of varying investment horizons on performance measures and optimal portfolio compositions. Estimating betas with annual data, Kothari, Shanken, and Sloan (KSS, 1995) find that the relation between book-to-market equity and returns is weaker and less consistent than that in Fama and French (1992). However, they use the *annual* beta to explain the cross section of *monthly* returns (rather than annual returns) and their study does not seem to focus on how investment horizons affect the expected returns. In contrast, we focus on how investment horizons affect the beta estimations and the associated cross-sectional expected returns.

The rest of the paper is organized as follows. Section 2 describes the data and provides some of the preliminary results and pre-ranking betas for portfolios of different sizes and investment horizons. Section 3 presents the cross-section regression analysis, while the last section briefly concludes the paper.

[1] This condition holds only if the long-horizon return can be represented as the sum of the short-horizon returns because in this case the variance of return on market portfolio and the covariance between stock return and market portfolio return are linearly proportional to the return horizon, thereby leaving the estimate of beta unchanged. However, since the long-horizon returns are compounded short-horizon returns, this linear relation does not hold exactly.

2. DATA AND PRELIMINARY RESULTS

2.1. Data

We use monthly stock return data from 1975-1994 of all non-financial stocks listed on the Tokyo Stock Exchange compiled by the Sandra Ann Morsilli Pacific-Basin Capital Markets (PACAP) Research Center of the University of Rhode Island. The returns are adjusted for stock splits, rights offerings and dividends. Monthly returns are compounded to yield six-month and annual returns. Information on sizes and the ratios of book-to-market equity is also obtained from the PACAP database. Also, a value-weighted index composed of all stocks traded on the TSE, compiled by the PACAP Research Center, is used as the proxy for the market portfolio.

Following Fama and French (1992) and Chan, Hamao, and Lakonishok (1991), we provide cross-sectional regression results for both individual stocks and 100 size-beta portfolios. The 100 equal-weighted size-beta portfolios are compiled according to pre-ranking beta and size. Unlike Fama and French (1992) whose portfolio groupings are based on ranking first on size and then on beta, our portfolio grouping procedure is based on the ranking of size and beta independently. [2] The pre-ranking and post-ranking betas are estimated as the sum of slopes on the current and prior month's market return based on monthly data to mitigate biases due to nonsynchronous trading and other trading frictions (Scholes and Williams (1977)). Availability of returns for two to five years is required for a stock to be included in the sample and to estimate the beta. Also, following Chan, Hamao, and Lakonishok (1991), size is measured as the natural logarithm of market value of equity in millions of Japanese yen in the end of June. As commonly used, the composition of each portfolio is updated in June of each subsequent year. The post-ranking betas for the 100 portfolios are estimated over the period from 1980 to 1994.

2.2. Descriptive Statistics on Betas, Firm Size and Average Returns

Table 1 reports the average returns, average logarithmic market values (Ln(ME)), and post-ranking betas based on one-month, six-month and annual return intervals for the 100 equal-weighted size-beta portfolios for the period from 1980 to 1994.

The time-series averages of portfolio returns are given in Panel A of Table 1. Similar to the U.S. evidence, Panel A of Table 1 indicates that the average return is negatively related to size (see also Figure 1). However, Panel A also suggests a positive relation between the monthly return and beta, a result in sharp contrast with Fama and French's finding. Nevertheless, it is

[2] This procedure is used in KSS (1995), and in their empirical study similar results are obtained using portfolios of different grouping methods.

TABLE 1.
Average Returns, Post-rankingβs and Average Size For Portfolios Formed on Size and β

Panel A: Average Monthly Returns (in percent)

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
All		0.8738	1.1373	1.2309	1.2325	1.3343	1.2736	1.3094	1.4047	1.2496	1.2227
Small-ME	1.9006	1.7963	1.5797	1.9918	2.0082	2.0662	1.7321	1.9441	2.1478	1.5098	2.2294
ME-2	1.4600	1.3570	1.4919	1.8457	1.4462	1.5284	1.5170	1.3771	1.4025	1.3486	1.2859
ME-3	1.4997	1.3793	1.5813	1.3233	1.4451	1.2313	1.3709	1.3675	2.1883	1.8706	1.2392
ME-4	1.3036	1.2122	1.0937	1.2860	1.4345	1.2798	1.4686	1.3149	1.2792	1.3842	1.2830
ME-5	1.1813	0.8075	1.3122	1.1380	1.1140	1.2557	1.1311	1.3020	1.3041	1.2872	1.1617
ME-6	1.0889	0.5950	1.1875	0.7618	1.0472	1.0332	1.2216	1.2578	1.3267	1.2098	1.2478
ME-7	0.9944	0.3351	0.7793	1.0591	1.2727	1.3234	1.1206	1.1599	1.2091	0.8303	0.8547
ME-8	0.9886	0.5565	0.7486	0.9005	0.7645	1.5110	1.2691	1.0907	1.0172	1.0283	0.9994
ME-9	0.9388	0.4090	0.9338	1.0437	0.9145	1.0628	1.0339	0.9497	0.9868	1.0833	0.9708
Large-ME	0.9130	0.2904	0.6651	0.9594	0.8784	1.0515	0.8709	1.3301	1.1851	0.9437	0.9552

the portfolio with the third largest beta (β-8) that has the highest average return (1.4047%). Also, Panel A of Table 1 indicates that the portfolio with the smallest size and largest betas (i.e., the portfolio (Small-ME, High-β)) has the highest average return of 2.2294%, whereas the portfolio at the left bottom with the largest size and smallest beta (Large-ME, Low-β) has the lowest average return of 0.2904%. Inspecting each row and each column of Panel A, one may find that overall returns in the TSE are inversely related to size, and positively related to pre-ranking betas.

TABLE 1—*Continued*

Panel B: Post-Ranking β (for monthly returns)

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
All		0.6748	0.7379	0.8115	0.8178	0.8176	0.8741	0.8861	0.9158	0.9559	1.0351
Small-ME	0.6902	0.5391	0.6308	0.6551	0.7151	0.7452	0.7287	0.7041	0.7132	0.7118	0.7588
ME-2	0.7959	0.6287	0.6162	0.8391	0.7595	0.7549	0.7295	0.8226	0.8614	0.9352	1.0122
ME-3	0.8665	0.6636	0.7200	0.7909	0.7701	0.7912	0.8466	0.9366	0.9352	1.0867	1.1239
ME-4	0.8582	0.6326	0.8095	0.8081	0.7517	0.8223	0.9425	0.8899	0.8362	0.9408	1.1479
ME-5	0.8515	0.6965	0.7466	0.7896	0.8788	0.7760	0.8468	0.8938	0.9551	0.8964	1.0357
ME-6	0.8634	0.6277	0.8546	0.8453	0.8161	0.8325	0.9220	0.8537	0.9284	0.9520	1.0019
ME-7	0.8900	0.7565	0.7393	0.7853	0.7906	1.0038	0.9028	0.8855	1.0107	0.9900	1.0357
ME-8	0.9171	0.6858	0.8503	0.9109	0.9042	0.8301	0.9522	0.9763	0.9944	1.0130	1.0537
ME-9	0.9494	0.9047	0.7535	0.9124	0.9820	0.8744	0.9846	0.9509	0.9664	1.0481	1.1167
Large-ME	0.8446	0.6135	0.6576	0.7788	0.8094	0.7459	0.8856	0.9475	0.9572	0.9854	1.0647

TABLE 1—*Continued*

Panel C: Post-Ranking sum β (for monthly returns)

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
All		0.7728	0.7935	0.8668	0.8546	0.8487	0.8946	0.9201	0.9318	0.9690	1.0350
Small-ME	0.8912	0.7466	0.8714	0.9195	0.8894	0.9323	0.9295	0.9740	0.7958	0.9521	0.9018
ME-2	0.9376	0.8024	0.8451	0.9711	0.9581	0.9056	0.8868	0.9630	0.9421	1.0478	1.0540
ME-3	0.9667	0.8227	0.8716	0.9165	0.9421	0.8909	0.8901	1.0167	1.0553	1.1235	1.1376
ME-4	0.8991	0.8151	0.8415	0.8352	0.8318	0.8555	0.9872	0.8793	0.8950	0.9222	1.1286
ME-5	0.8869	0.7718	0.7665	0.8493	0.9580	0.8317	0.9066	0.8947	0.9572	0.8918	1.0417
ME-6	0.8759	0.7431	0.8556	0.8526	0.8221	0.7811	0.9105	0.8688	0.9288	0.9607	1.0360
ME-7	0.8694	0.7440	0.8345	0.8146	0.7791	0.9099	0.8660	0.8619	1.0127	0.9030	0.9688
ME-8	0.8713	0.7133	0.8032	0.8527	0.7837	0.8493	0.8740	0.9355	0.9131	0.9490	1.0390
ME-9	0.8725	0.9376	0.6557	0.8718	0.8769	0.8042	0.8386	0.8503	0.8970	0.9712	1.0214
Large-ME	0.8161	0.6313	0.5896	0.7845	0.7054	0.7261	0.8562	0.9570	0.9214	0.9689	1.0211

TABLE 1—*Continued*

Panel D: Average Size (ln(ME))

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
All		10.5668	10.5785	10.5713	10.5725	10.5757	10.5706	10.5758	10.5867	10.5907	10.6144
Small-ME	8.4761	8.4202	8.4392	8.4550	8.4497	8.4594	8.4852	8.4301	8.4812	8.5375	8.6031
ME-2	9.1403	9.1315	9.1282	9.1316	9.1286	9.1342	9.1381	9.1404	9.1556	9.1500	9.1647
ME-3	9.5904	9.5823	9.5987	9.5839	9.5813	9.5907	9.5920	9.6019	9.5880	9.5955	9.5897
ME-4	9.9709	9.9814	9.9752	9.9632	9.9754	9.9864	9.9710	9.9614	9.9735	9.9640	9.9575
ME-5	10.3128	10.3080	10.3098	10.3063	10.3213	10.3037	10.3190	10.3116	10.3132	10.3239	10.3112
ME-6	10.6556	10.6389	10.6552	10.6690	10.6532	10.6482	10.6531	10.6636	10.6623	10.6567	10.6562
ME-7	11.0398	11.0146	11.0277	11.0549	11.0405	11.0513	11.0416	11.0502	11.0303	11.0412	11.0461
ME-8	11.4793	11.4882	11.4737	11.4645	11.4759	11.4755	11.4750	11.4717	11.4806	11.4951	11.4926
ME-9	12.0358	11.9901	12.0626	12.0250	12.0564	12.0032	12.0213	12.0302	12.0202	12.0792	12.0695
Large-ME	13.1020	13.1128	13.1141	13.0599	13.0429	13.1046	13.0094	13.0966	13.1622	13.0642	13.2532

TABLE 1—*Continued*

Panel E: Post-Ranking β (for 6-monthly returns)

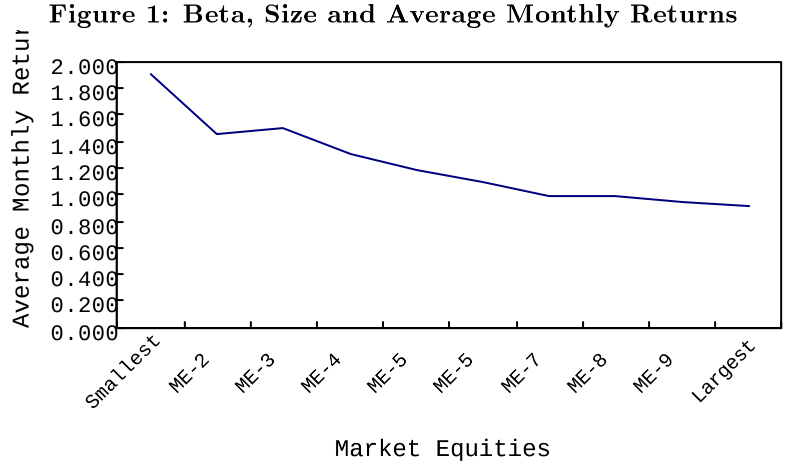
	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
All		0.9283	0.9869	1.0410	1.0887	1.0657	1.0982	1.0371	1.1341	1.1065	1.1024
Small-ME	1.3329	1.2423	1.2703	1.2605	1.4718	1.3891	1.3161	1.3902	1.5321	1.3223	1.1347
ME-2	1.2071	1.0938	1.2984	1.2675	1.2727	1.2223	1.3279	1.0335	1.0085	1.2887	1.2579
ME-3	1.2283	1.0108	1.1819	1.0902	1.4093	1.1525	1.0838	1.2257	1.5773	1.3803	1.1716
ME-4	1.0844	1.1126	0.9494	1.0466	0.9619	1.1507	1.2297	0.9497	1.1419	1.1642	1.1377
ME-5	1.0210	0.9313	1.0751	0.9719	1.1946	1.0123	1.0531	0.9053	1.1606	0.9458	0.9596
ME-6	1.0008	1.0813	0.8884	0.9296	1.0785	0.9118	1.1892	0.9741	0.9742	0.9062	1.0749
ME-7	0.9632	0.7831	0.9511	0.9373	0.8864	1.0954	1.0011	0.9855	0.9838	0.9660	1.0420
ME-8	0.9908	0.8164	0.9959	0.9912	0.8857	0.9850	1.1059	1.0071	0.9893	0.9944	1.1374
ME-9	0.9551	0.8309	0.8158	1.0462	1.0039	0.9797	0.8627	0.8982	0.9653	1.0921	1.0559
Large-ME	0.8051	0.3804	0.4430	0.8688	0.7219	0.7586	0.8124	1.0014	1.0079	1.0046	1.0521

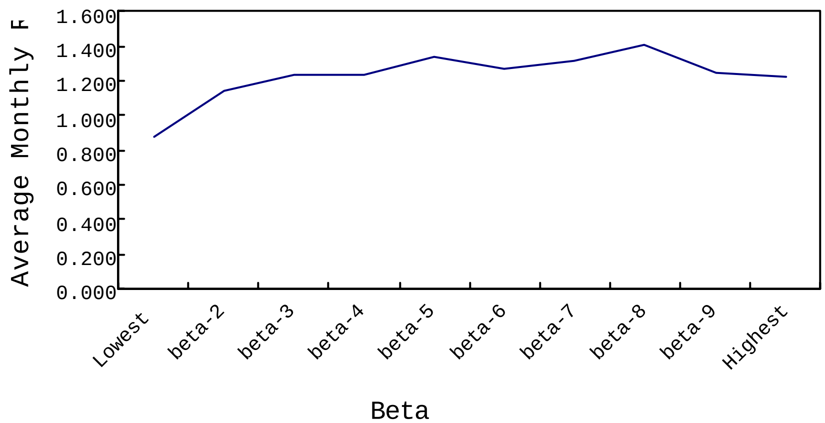
TABLE 1—*Continued*

Panel F: Post-Ranking β (for 12-monthly returns)

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
All		0.8251	0.8636	0.8663	0.8584	0.8341	0.8581	0.7652	0.8872	0.8590	0.8269
Small-ME	1.0359	1.0043	0.9581	0.9183	0.9862	1.0733	1.0260	0.9329	1.2760	1.0023	1.1811
ME-2	0.8657	0.9083	1.0271	1.1200	0.9143	0.9881	0.8670	0.5898	0.6199	0.8037	0.8188
ME-3	0.9483	0.7641	1.0577	0.9546	0.9287	0.7663	0.9339	0.8124	1.2185	1.0804	0.9667
ME-4	0.8188	1.0142	0.8584	0.7677	0.8042	0.7888	0.7322	0.8012	0.7832	0.8929	0.7451
ME-5	0.7394	0.7137	0.7874	0.7710	0.8543	0.8568	0.7541	0.5688	0.8246	0.7098	0.5535
ME-6	0.8014	0.9781	0.8333	0.6568	0.9574	0.7259	0.9347	0.7745	0.6987	0.7468	0.7083
ME-7	0.7360	0.7835	0.8291	0.7659	0.7286	0.7952	0.7214	0.6164	0.7754	0.6846	0.6602
ME-8	0.7847	0.7786	0.7203	0.8801	0.7208	0.7547	0.9371	0.7378	0.6906	0.8215	0.8056
ME-9	0.8794	1.0399	0.8853	0.9863	0.9899	0.8717	0.8258	0.6593	0.8044	0.9479	0.7835
Large-ME	0.8341	0.2659	0.6793	0.8425	0.7002	0.7199	0.8485	1.1591	1.1805	0.8997	1.0458

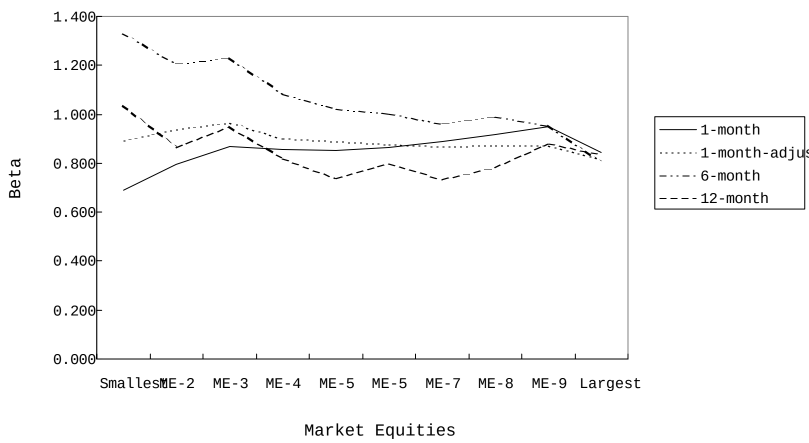
Figure 1: Beta, Size and Average Monthly Returns





Panel B of Table 1 reports the monthly post-ranking beta without including the slope on the lagged market index return, while Panel C reports the adjusted beta as used in Fama and French (1992) (denoted 'sum β'). Interestingly, the first column in Panel B shows that when sorted on size alone, the size is positively related to the post-ranking unadjusted monthly beta, a result that is quite different from the U.S. observation that the size is generally inversely related to beta. This surprising relation, however, is reversed in Panel C of Table 1 for which the size becomes negatively related to beta, after adjusting for nonsynchronous trading. Nevertheless, both Panels B and C indicate that the post-ranking monthly beta, adjusted for nonsynchronous trading or not, is closely related to pre-ranking beta. Also, comparing the numbers in Panels B and C, one can see that the post-ranking monthly betas for small-size portfolios increase more significantly than for large-size portfolios after including the slope on the lagged market index return, indirectly confirming the general observation that small-size portfolios tend to reflect relevant information with lags. For example, the beta for the smallest decile portfolio changes from 0.6902 to 0.8912, while the beta of the largest decile portfolio drops slightly from 0.8446 to 0.8161 after adjustment.[3] The result seems to suggest that nonsynchronous trading problem might be more serious in the Japanese market than in the U.S. market.

Figure2: Size and Beta



Panels E and F of Table 1 further report the post-ranking betas estimated using six-month and annual returns for each of the size-beta portfolios. Overall, the results still show that size is negatively related to beta for long-interval returns. An interesting finding is that the small-size portfolios are riskier for the six-month horizon (six of the ten size decile portfolios have betas greater than 1), but less so for the annual horizon. When beta is estimated with annual data, only the smallest decile portfolio has beta slightly greater than 1. These results seem to suggest that the cross-autocovariances between the market and small size portfolios are positive for short horizon (up to six months), but become negative for longer hori-

[3]It may be noticed that in Table 1 most portfolios have betas that are smaller than one, causing the average beta of all portfolios to be also smaller than one! However, this is possible because in this paper we only incorporate non-financial firms as samples, while the market portfolio is composed of all firms, including the financial firms. Since financial institutions in Japan are generally much larger in size and are known to be closely connected because of cross-holding in shares, including them in the sample might be of interest for future research, but excluding them here from the sample simply follows the current practice in empirical research.

zons. Indeed, Figure 2 shows that smaller-size portfolios have a larger spread in betas for varying return horizons, but the larger-size portfolios have relatively more stable betas.

Panel D of Table 1 reports the average logarithmic market value for each of the size-beta portfolios. As reported in Fama and French (1992), it shows that the average values of Ln(ME) are similar across the beta-sorted portfolios. That is, the numbers within each row of Panel D are very close. This suggests that our grouping approach successfully isolates the relation between size and beta and produces strong variation in post-ranking betas that is unrelated to size. Hence, the positive relation between beta and the average return reported in Panel A is less correlated to size, implying that beta may be capable of accounting for the cross-sectional variation in average returns. However, it is still unclear whether the relation is significant statistically. In the following, we present empirical results based on the cross-sectional regressions.

3. REGRESSION RESULTS

For each return interval (i.e., one-, six-, and twelve-month), we estimate the cross-sectional regressions for individual stocks as well as for the 100 size-beta portfolios. Specifically, for each time interval t we estimate the following cross-sectional regression model as in Fama and French (1992):

$$R_{it} = \gamma_{0t} + \gamma_{1t}\beta_i + \gamma_{2t}Ln(ME)_{i,t-1} + \gamma_{3t}Ln(BE/ME)_{i,t-1} + \varepsilon_{it}, \quad (1)$$

where R_{it} represents return on stock or portfolio i for time t; β_i is the post-ranking beta of portfolio or stock i. The post-ranking beta for individual stock is assigned as the post-ranking beta for the portfolio to which the individual stock belongs. $Ln(ME)_{i,t-1}$ is the natural log of the market capitalization of stock i or the average market capitalization of portfolio i in the end of June of the year prior to time t. The book-to-market equity ratio $Ln(BE/ME)_{i,t-1}$ is defined similarly. As it is well known that the two-pass methodology is subject to an errors-in-variables problem,[4] the use of 'group' beta by many as the beta estimate for individual securities is intended to reduce the EIV problem. The reason behind such a treatment is that if all securities in the same size-beta group have the same "true" beta, then the estimate based on the portfolio returns will be much more accurate than that based on individual stock returns. However, as it is not necessarily true for stocks within the same portfolio to have the same beta, the 'group'

[4]Shanken (1992) provides the asymptotic theory for the two-pass procedure while Kan and Zhang (1999) point out problems of using useless factors. Small sample tests and maximum likelihood and GMM one-pass procedures are provided by Shanken and Zhou (2000).

beta only represents the average beta in the same group. The true beta for an individual security is then the portfolio beta plus a deviation term. Hence, the EIV problem may not necessarily be reduced. In contrast, analysis of regression model (1) based on 100 size-beta portfolios is much less affected by the EIV problem. Hence, estimation based on portfolios may yield more consistent results. The regression model (1) is estimated with ordinary least squares (OLS) for each of the non-overlapping T-month interval observations ($T = 1, 6, 12$). The results are reported in Table 2 through Table 4.

Panel A of Table 2 reports time-series averages of the slopes from the month-by-month Fama-MacBeth regressions of the cross-section of individual stock returns on size, betas, size, and the ratio of book to market equity. The result indicates that when the unadjusted monthly beta, denoted β_1, is used as the sole independent variable, the average slope, which is the average market risk premium, is negative with a t-value of -1.205, confirming the results in Table 1. When the adjusted monthly beta (denoted β_2) is used as the only independent variable, the average slope becomes positive, but remains insignificant.

On the contrary, the coefficients for six-month and annual betas (denoted β_6 and β_{12}, respectively) are statistically significant, similar to results reported in KSS (1995) for the U.S. stock market. The coefficient of 0.0158 for six-month beta implies an annualized risk premium of 20.70%, while the coefficient of 0.0097 for annual beta implies a risk premium of 12.28%. The coefficient on the market value, when used alone as a sole explanatory variable or used with monthly or annual beta, is significantly negative at the 10% level, but not significant when the 6-month beta is incorporated. The coefficient of BE/ME is significantly positive whenever it is used alone or with other variables.

Panel B of Table 2 reports the regression results based on 100 equal-weighted size-beta portfolios. Similar results as in Panel A are obtained. However, there seems to be a stronger size effect in the cross-section of portfolio returns because the coefficient of BE/ME is insignificant when size is also incorporated as an explanatory variable.

Note that although the coefficient of size is generally significant, it is never significant when the six-month beta β_6 is also included as an explanatory variable. This implies that size captures the effect of cross-autocorrelation between the market index and individual stocks or portfolios up to lags of six months when β_6 is excluded in the regression.

Although both β_6 and β_{12} can account for the cross-sectional variability in *monthly* returns, theoretical justification for their usefulness is still un-

TABLE 2.

Average Slopes (t-Statistics) from Monthly Returns Regressions on β, Size and Book-to-Market Ratio

intercept	β_1	β_2(sum β)	β_6	β_{12}	ln(ME)	ln(BE/ME)
Panel A : individual firms						
0.0211	−0.0102					
(2.689)	(−1.205)					
0.0085		0.0044				
(1.028)		(0.450)				
−0.0045			0.0158			
(−0.734)			(2.817)			
0.0040				0.0098		
(0.732)				(2.581)		
0.0327					−0.0019	
(2.612)					(−1.918)	
0.0179						0.0052
(4.338)						(4.594)
0.0312	0.0016				−0.0019	
(2.455)	(0.207)				(−1.879)	
0.0261	−0.0099					0.0049
(3.255)	(−1.179)					(4.362)
0.0363	0.0018				−0.0019	0.0045
(2.878)	(0.224)				(−1.895)	(3.903)
0.0258		0.0065			−0.0018	
(1.685)		(0.676)			(−1.799)	
0.0131		0.0055				0.0052
(1.494)		(0.564)				(4.644)
0.0301		0.0074			−0.0018	0.0045
(1.951)		(0.775)			(-1.818)	(3.982)
0.0153			0.0090		−0.0011	
(1.062)			(2.303)		(-1.092)	
0.0003			0.0162			0.0049
(0.052)			(2.900)			(4.347)
0.0191			0.0097		−0.0011	0.0045
(1.330)			(2.507)		(-1.069)	(3.947)
0.0250				0.0075	−0.0018	
(1.916)				(2.362)	(−1.806)	
0.0087				0.0110		0.0052
(1.604)				(2.877)		(4.631)
0.0292				0.0086	−0.0018	0.0045
(2.266)				(2.670)	(−1.819)	(3.976)
0.0379					−0.0019	0.0045
(3.066)					(−1.950)	(3.941)

TABLE 2—*Continued*

intercept	β_1	β_2(sum β)	β_6	β_{12}	ln(ME)	ln(BE/ME)
Panel B : Portfolios(equal-weighted)						
0.0165	−0.0049					
(2.483)	(−0.647)					
0.0002		0.0136				
(0.031)		(1.461)				
−0.0035			0.0149			
(−0.610)			(2.712)			
0.0016				0.0127		
(0.303)				(3.307)		
0.0331					−0.0020	
(2.612)					(−1.984)	
0.0197						0.0069
(4.044)						(2.791)
0.0318	0.0027				−0.0021	
(2.525)	(0.354)				(−1.997)	
0.0239	−0.0058					0.0062
(3.149)	(−0.744)					(2.452)
0.0373	0.0020				−0.0021	0.0035
(2.900)	(0.244)				(−1.973)	(1.576)
0.0262		0.0062			−0.0018	
(1.802)		(0.689)			(−1.825)	
0.0081		0.0138				0.0073
(0.983)		(1.442)				(2.945)
0.0310		0.0064			−0.0019	0.0035
(2.058)		(0.683)			(−1.861)	(1.610)
0.0114			0.0102		−0.0009	
(0.842)			(2.675)		(−0.886)	
0.0017			0.0150			0.0046
(0.270)			(2.778)			(2.147)
0.0160			0.0100		−0.0010	0.0028
(1.155)			(2.674)		(−0.957)	(1.362)
0.0231				0.0087	−0.0017	
(1.748)				(2.735)	(−1.717)	
0.0079				0.0131		0.0062
(1.460)				(3.556)		(2.566)
0.0270				0.0090	−0.0017	0.0029
(2.033)				(2.916)	(−1.759)(1.405)	
0.0380					−0.0020	0.0033
(2.971)					(−2.036)	(1.566)

clear. Why should systematic risk estimated using long-horizon returns be capable of accounting for the performance of returns in short horizons? If returns are iid, results should remain the same regardless of the return intervals. If returns are not independently distributed and predictable, then cross-sectional regression tests of unconditional asset price models may not be appropriate. This is clearly an interesting issue yet to be answered by future research.

Table 3 reports the regression results based on six-month return intervals for individual stocks and portfolios. The results show that six-month beta β_6 significantly explains the cross-section of half-year returns. Size as a sole explanatory variable can account for some of the cross-sectional variation, but the explanatory power disappears when it is used with beta.

Similar to the results for monthly returns data, the BE/ME ratio is significant for most regressions. Interestingly, the last row in Panel B of Table 3 indicates that when both size and BE/ME variables are used with the six-month beta in the regression, their coefficients become insignificant, suggesting that six-month beta may have captured the "true" beta very well. In addition, the coefficient of 0.1180 for β_6 in Panel A of Table 3 implies an annualized risk premium of about 24.99%, a number larger than 20.70% calculated based on monthly return data. However, the annualized risk premium drops to 14.64% ($= 1.0707^2 - 1$) when other variables are included.

Table 4 presents the results based on annual data. For individual firms, Panel A of Table 4 indicates that the average slope of the annual beta, used alone or together with other variables, is significant. Also, the significance of size disappears for annual return data. The beta risk premium of 17.08% per year is estimated when the annual beta is used alone, but drops when additional variables are incorporated. When both size and BE/ME are included, the estimate of beta risk premium drops to 15.58% per annum and is significant only at the 10% level.

For size-beta portfolios, Panel B of Table 4 indicates that the annual beta, used alone or together with other variables, is significant. A beta risk premium of 23.09% per year is estimated when beta is used alone, but drops to 16.13% when additional variables are incorporated. The coefficient of size is only marginally significant when it is used alone, but its significance disappears when beta is included. The coefficient of BE/ME ratio is significant.

Overall, our empirical results show that the cross-section of *monthly* expected returns cannot be explained by using the monthly β, no matter it

TABLE 3.
Average Slopes (t-Statistics) from 6-Month Returns Regressions on β, Size and Book-to-Market Ratio

intercept	β_6	ln(ME)	ln(BE/ME)
Panel A : individual firms			
−0.0510	0.1180		
(−1.654)	(2.455)		
0.2277		−0.0140	
(2.058)		(−1.794)	
0.1119			0.0339
(3.336)			(4.873)
0.2618		−0.0142	0.0296
(2.359)		(−1.832)	(4.214)
0.0909	0.0707	−0.0082	
(0.858)	(2.305)	(−1.065)	
−0.0186	0.1203		0.0323
(−0.626)	(2.518)		(4.639)
0.1173	0.0744	−0.0080	0.0297
(1.103)	(2.411)	(−1.055)	(4.236)
Panel B : Portfolios (equal-weighted)			
−0.0459	0.1194		
(−1.632)	(2.541)		
0.2520		−0.0160	
(2.241)		(−2.029)	
0.1259			0.0433
(3.490)			(3.061)
0.2799		−0.0162	0.0195
(2.522)		(−2.086)	(1.754)
0.0844	0.0781	−0.0078	
(0.827)	(2.424)	(−1.054)	
−0.0144	0.1189		0.0273
(−0.453)	(2.577)		(2.409)
0.1118	0.0769	−0.0083	0.0163
(1.085)	(2.402)	(−1.122)	(1.489)

TABLE 4.
Average Slopes (t-Statistics) from 12-Month Returns Regressions on β, Size and Book-to-Market Ratio

intercept	$\beta_1 2$	ln(ME)	ln(BE/ME)
Panel A : individual firms			
0.0107	0.1708		
(0.245)	(2.270)		
0.4584		−0.0279	
(1.880)		(−1.506)	
0.2393			0.0796
(3.438)			(4.606)
0.5316		−0.0278	0.0699
(2.159)		(−1.548)	(4.212)
0.3170	0.1391	−0.0257	
(1.390)	(2.111)	(−1.397)	
0.0800	0.1880		0.0805
(1.835)	(2.418)		(4.541)
0.3739	0.1558	−0.0254	0.0708
(1.653)	(2.285)	(−1.424)	(4.197)
Panel B : Portfolios (equal-weighted)			
−0.0221	0.2309		
(−0.510)	(2.624)		
0.5394		−0.0342	
(2.178)		(−1.844)	
0.2788			0.1026
(3.629)			(4.513)
0.6006		−0.0344	0.0482
(2.454)		(1.909)	(2.851)
0.3516	0.1613	−0.0292	
(1.510)	(2.194)	(1.603)	
0.0720	0.2335		0.0929
(1.445)	(2.752)		(4.069)
0.4029	0.1654	−0.0294	0.0436
(1.736)	(2.308)	(−1.658)	(2.677)

is used alone or with other variables. In contrast, betas estimated based on six-month and annual returns explain significantly the cross-sectional variation in average returns over horizons ranging from one month to one year. Size used alone is a significant determinant, but its significance disappears when beta is included for investment horizons of half-year and one year. The ratio of book to market equity is a significant factor for most cases. By and large, the results from the TSE are fairly consistent with the findings in the U.S. market, such as those documented by FF (1992) and KSS (1995).

Finally, as a robust check for our empirical results, we also compile 100 value-weighted size-beta portfolios, and perform the cross-sectional regression analysis for the value-weighted portfolios. The reason we use value-weighted portfolios is that, as documented in Blume and Stambaugh (1983) and Lo and MacKinlay (1988), the time series properties of equal-weighted portfolios are more easily affected by institutional frictions such as bid-ask spread and infrequent trading. However, similar results as those based on the equal-weighted portfolios are obtained. [5]

4. CONCLUSION

Although the CAPM is a one-period model which states that the market beta is the sole factor explaining the cross-sectional variation in expected stock returns, the length of a period is never clearly stated, either theoretically or empirically. This study empirically examines the validity of the CAPM over investment horizons of one month, six months, and one year.

Using return data from the Tokyo Stock Exchange, this study investigates how beta, size, and ratio of book to market equity account for the cross-section of expected returns over different lengths of investment horizons. Parallel to the U.S. results, the empirical results show that β, adjusted for infrequent or not, fails to explain the cross-section of *monthly* expected returns. Nevertheless, it significantly accounts for the cross-section of expected returns over half-year and annual intervals. Size is also a significant factor explaining the cross-sectional variation, especially for monthly horizon. Its significance, however, diminishes for longer horizons when β is also included as an additional independent variable. Even for cross-sectional regression based on monthly data, its coefficient becomes insignificant when beta estimated on six-month returns is included, suggesting that size may have captured some time series properties between individual securities (or portfolios) and the market index, such as cross-autocorrelation, that are not reflected in monthly beta. Like the U. S. evidence, the book-to-market equity (BE/ME) ratio significantly explains the cross-sectional

[5] For brevity, these results are not provided here, but available upon request.

variation in expected returns for various horizons as documented in the literature. Overall, the Japanese data provide evidence for supporting the CAPM for horizons longer than one month. However, the puzzle of book to market equity remains, suggesting there is still the need for searching a better asset pricing model with multiple factors.

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