Do macroeconomic factors subsume market anomalies in long investment horizons?

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Abstract

Purpose – The main purpose of this study is to examine whether macroeconomic variables could subsume the size and book-to-market (BM) anomalies for longer-return intervals using Tokyo Stock Exchange-listed stocks.

Design/methodology/approach – The Fama-MacBeth cross-sectional regressions of various models over time-intervals ranging from one month to one year are performed.

Findings – The empirical results show that most macroeconomic variables explain short-term returns within six months, with the industrial production as the only variable that persistently explains returns of all horizons ranging from one month to one year. Firm size does bear significant risk premium, but its significance diminishes for return-intervals beyond three months when macroeconomic variables are included in the regression. BM is the only variable that significantly accounts for the cross-section of stock returns for all horizons, regardless of the inclusion of macroeconomic variables.

Research limitations/implications – These empirical findings suggest that stock returns are determined by both rational factors such as macroeconomic variables and behavioral factors such as BM.

Practical implications – The findings suggest that potential trading strategies indeed can be formed to exploit the persistent predictability, especially the BM regularity.

Originality/value – This paper is the first study that examines the competing explanatory power of various asset-pricing models over different investment horizons.

Keywords Investments, Macroeconomics, Equity capital

Paper type Research paper

1. Introduction

Over the past three decades, researchers have been attempting to search for a parsimonious theory or model that can explain the cross-section of expected stock returns. Of special interest to the academics is the search of theories to explain the existence of asset-pricing anomalies such as the small-firm effect identified by Banz (1981) and the book-to-market (BM) effect (value effect) identified by Fama and French (1992).

Rationality-based asset-pricing theories assert that the cross-section of expected stock returns can be explained by betas (Black, 1972; Lintner, 1965; Sharpe, 1964) or factor loadings on a set of common factors that are related to the state of the economy (Merton, 1973; Ross, 1976; Breeden, 1979). Merton (1971, 1973) and Cochrane (2001) also

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point out that any sensible economic-based asset-pricing theory would link the "pricing" with some factors, state variables, or sources of priced risk. The sequence of studies by Fama and French (1993, 1995, 1996, 1998) and Davis *et al.* (2000) represent this line of research that attempts to explain stock returns in a rational multifactor framework. Specifically, Fama and French (1993, 1998) argue that size and BM capture certain distressed factors. This view has gained several empirical supports over the past decade.

Enormous recent behavioral evidence suggests, however, that systematic bias in investor behavior may cause asset prices to deviate from their fundamental values. Daniel and Titman (1997) propose a characteristics-based model that refutes the factor-based explanation of asset-pricing anomalies, and argue that it is the firm characteristics, firm size and BM, that account for the cross-section of expected returns. Using Japanese data, Daniel *et al.* (2001) also reject Fama and French's factor specification, and suggest that the documented anomalies are unrelated to risk, but due to mispricing or other behavioral reasons.

Despite of the debates between the rational and behavioral theories, stock markets cannot persistently function in isolation from the macroeconomic conditions. Conceptually, as the return on a security is measured as the sum of its future dividend flows, discounted by a proper discount factor, variables that affect future dividend flows and the discount factor would also affect the stock return. Thus, macroeconomic variables that reflect the state of the economy serve as the natural candidates for the common factors. Chen, Roll, and Ross (CRR, 1986) identify four macroeconomic factors as the "fundamental" forces: changes in industrial production; changes in expected and unexpected inflation; changes in risk premium; changes in term structure. They demonstrate that the macroeconomic factors significantly explain the cross-section of stock returns. Flannery and Protopapadakis (2002) find that stock returns are correlated with inflation and money growth.

To better understand the nature of the size and BM effects, He and Ng (1994) investigate whether size and BM proxy for macroeconomic risks found in CRR (1986). They find that the CRR factors cannot explain either effects, and that size and BM are related to relative distress. However, while relative distress can explain the size effect, it only partially explains the BM effect. Brennan *et al.* (1998) find that the size and BM effects persist even when returns are risk-adjusted using either the Fama–French three-factor model or the Connor and Korajczyk's (1988) APT models based on asymptotic principal components.

Thus, the vast empirical evidence suggests that rational theories alone cannot fully explain the size and value puzzles in the cross-section of monthly stock returns, and suggests a role for behavioral factors. Indeed, Daniel *et al.* (2001) show that security returns are jointly determined by both risk and misevaluation when some investors are overconfident[1]. Hirshleifer (2001) further suggests that in the future "the purely rational paradigm will be subsumed by a broader psychological paradigm that includes the full rationality as a significant special case".

Nevertheless, even if short-term (e.g. monthly) returns deviate from the fundamentals, returns over longer time horizons (e.g. one year or longer) would eventually reflect the fundamental values. As a result, stock returns are expected to "cointegrate" with the state of the economy, suggesting a role for macroeconomic factors in long investment horizons[2]. As the stock market cannot persistently depart from the macro economy, it is reasonable to assume that a macroeconomic multifactor model would be able to explain the variation in stock returns when investment return horizons are lengthened.

Under the CRR framework, if a pricing anomaly survives in short horizons, but disappears in long horizons, short-term "pricing error" may be blamed. However, if an anomaly survives and cannot be explained by any pricing theory for any horizons, some missing factors, maybe behavioral ones, must be identified.

Our purpose is to ascertain whether macroeconomic variables that reflect the state of the economy would subsume the size and BM anomalies for longer return-intervals. This objective is similar to Fama's (1998) view on long-term market efficiency.

Our paper has three main features. First, as almost all past studies on the cross-sectional determinants of average stock returns focus on monthly returns only, we examine the empirical validity of macroeconomic factor-based models, along with betas, firm size, and BM, over various investment horizons ranging from one month to one year. We are interested if the macroeconomic factors can subsume the explanatory power of size and BM. Second, the CAPM beta and factor sensitivities on some factors may be estimated with a higher precision if data of longer intervals are used. Kothari, Shanken, and Sloan (KSS, 1995) find that the size and BM effects in monthly returns are weaker and are less consistent than that in Fama and French (1992) when betas are estimated with annual data[3]. Conceptually, if short-term returns are contaminated by frictions such as bid-ask bounce and nonsynchronous trading, by seasonal patterns in returns, or by pricing errors due to investors' overreaction, they will be autocorrelated. This results in biases in estimates of beta or factor sensitivities, which can be mitigated by using longer measurement-interval returns.

Third, our analysis focuses on the cross-section of stock returns using data from the Tokyo Stock Exchange (TSE), the world's third largest stock market. As emphasized by Black (1993), use of non-US data may have the benefit of avoiding the problem of data mining because regularities such as size and BM effects are well mined by using the US data.

The rest of this study is organized as follows. Section 2 describes the data and some preliminary results. Section 3 presents empirical results. Section 4 presents the findings from cross-sectional regressions. The last section concludes the paper.

2. Data and descriptive statistics

2.1 Data

Our study uses monthly data on common stocks listed on both sections of the TSE from January 1975 to December 1997. Stocks listed on the TSE account for more than 85 per cent of the total market capitalization of Japanese equities. Monthly returns including dividends and market capitalization are from databases compiled by the PACAP Research Center, the University of Rhode Island (1975-1997). The monthly value-weighted market returns of both sections of the TSE are also from this data source. There are no risk-free rates in Japan that are comparable to the US Treasury bill rates. As a result, we follow Chan, Hamao, and Lakonishok (CHL, 1991) by using a combined series of the call money rate (from January 1975 to November 1977) and the 30-day Gensaki (repo) rate (from December 1977 to December 1997) as the risk-free interest rate. This interest rate series is drawn from the PACAP databases (1975-1997). The data on book values are also drawn from both the PACAP databases. Macroeconomic data are collected from various sources including the PACAP database, the International Financial Statistics, and the Bank of Japan.

Our research design follows closely Fama and French (1992), He and Ng (1994), and Kothari *et al.* (1995). Cross-sectional regressions are performed on individual stock returns. The 100 value-weighted size–BM portfolios are compiled according to size and BM. 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 BM independently[4]. Since the grouping is not based on betas, a stock is included as long as its data on financial statements are available.

Also, following Chan *et al.* (1991), size is measured as the natural logarithm of market value of equity in millions of Japanese yen in the end of September. We wish to ensure the accounting data that we use in forming these portfolios are publicly available at the time of portfolio formation to avoid the "look-ahead" bias as emphasized in Banz and Breen (1986). Most firms listed on the TSE have March as the end of their fiscal year and the accounting information becomes publicly available before September. Therefore, we form portfolios on the first trading day of October, and hold them for exactly one year. For portfolios formed in October of year t, we use the book equity (BE) of a firm at the fiscal year-end that falls between April of year $t-1$ and March of year t. BM is set to equal the ratio of BE to the market equity (ME) at the end of March of year t and SZ is set to equal the ME at the end of September of year t. The portfolios are rebalanced every year. The post-ranking betas and factor sensitivities on various factor models for the 100 portfolios are estimated over the period from 1975 to 1997.

2.2 Descriptive statistics on betas, firm size, and average returns

2.2.1 Average firm size, BM, and number of firms. Table I reports the average logarithmic market value, the average ratio of book-to-market equity, and average number of firms for each of the 100 value-weighted size-beta portfolios for the period from 1975 to 1997. Panel A of Table I shows that the average values of ln (ME) are similar across the BM-sorted portfolios. The average firm size within each row of Panel A also varies very little. Panel B of Table I shows that BMs are also about the same across the size-sorted portfolios. The results from Panels A and B suggest that our grouping approach successfully isolates the relation between size and BM. Panel C reports the average number of firms in each size-BM portfolio. Although we use independent sorting for size and BM, the result indicates that the average number of firms, which is about 135, is very close for each size or BM decile portfolio. The average number of firms in each size-BM sub-portfolio each month ranges from 9.4 to 24.0.

2.2.2 Stock returns and betas of different return-measurement intervals. Table II reports the average monthly returns (Panel A) and post-ranking betas (Panels B and C) for the 100 size-BM portfolios for the period from 1975 to 1997. The time-series averages of portfolio returns are given in Panel A of Table II. Similar to the US evidence, Panel A of Table II indicates that the average return is negatively related to size (see the first column of Panel A), and positively related to BM (first row of Panel A). However, it is the portfolio with the highest BM and the largest market value that has the highest average return (2.29 per cent). Inspection of each row and each column of Panel A suggests that overall returns in the TSE stocks are inversely related to size, and positively related to BM. The only exception is probably for those portfolios with the smallest market values. The second row of Panel A exhibits that the average return is not quite correlated with BM for the smallest portfolios.

Size	All	Low	2	3	4	5	6	7	8	9	High
		Book-to-market ratio (BE/ME)									
Panel A: average of annual averages of firm size (ln (ME))											
All	10.39	10.46	10.57	10.65	10.58	10.61	10.45	10.39	10.29	10.15	9.80
Small	8.20	8.10	8.17	8.14	8.15	8.16	8.22	8.19	8.28	8.32	8.31
2	8.90	8.90	8.88	8.90	8.92	8.91	8.91	8.90	8.90	8.90	8.88
3	9.36	9.34	9.35	9.36	9.36	9.36	9.36	9.36	9.36	9.35	9.36
4	9.76	9.75	9.76	9.76	9.76	9.77	9.77	9.75	9.75	9.75	9.75
5	10.10	10.10	10.10	10.10	10.11	10.11	10.11	10.11	10.11	10.10	10.10
6	10.46	10.46	10.45	10.47	10.46	10.46	10.46	10.47	10.45	10.46	10.46
7	10.86	10.85	10.86	10.86	10.86	10.87	10.87	10.87	10.86	10.86	10.86
8	11.32	11.30	11.32	11.32	11.33	11.31	11.31	11.33	11.31	11.30	11.31
9	11.90	11.92	11.92	11.94	11.92	11.90	11.89	11.90	11.88	11.83	11.85
Big	13.07	13.11	13.03	13.04	13.02	13.06	13.03	13.01	13.07	13.20	12.96
Panel B: average of annual BE/ME ratios for portfolios											
All	0.44	0.17	0.28	0.35	0.41	0.46	0.52	0.58	0.65	0.76	0.99
Small	0.55	0.15	0.28	0.35	0.41	0.46	0.52	0.58	0.66	0.77	1.06
2	0.59	0.15	0.28	0.35	0.41	0.46	0.52	0.58	0.66	0.76	1.03
3	0.56	0.17	0.28	0.35	0.41	0.46	0.52	0.58	0.66	0.76	1.01
4	0.54	0.16	0.28	0.35	0.41	0.46	0.52	0.58	0.66	0.76	1.00
5	0.53	0.17	0.28	0.35	0.41	0.46	0.52	0.58	0.66	0.76	0.99
6	0.50	0.17	0.28	0.35	0.41	0.46	0.52	0.58	0.66	0.77	0.99
7	0.51	0.18	0.28	0.35	0.41	0.46	0.52	0.58	0.65	0.76	1.02
8	0.49	0.18	0.28	0.35	0.41	0.46	0.52	0.58	0.65	0.77	0.97
9	0.46	0.18	0.28	0.35	0.40	0.46	0.52	0.58	0.65	0.72	0.91
Big	0.41	0.17	0.28	0.35	0.41	0.46	0.52	0.58	0.65	0.72	0.85
Panel C: average of annual number of firms in portfolios											
All	1,358.2	135.4	135.8	135.8	135.8	136.0	135.7	135.8	135.9	135.8	136.3
Small	135.4	18.1	15.6	13.0	11.9	10.6	11.5	10.3	12.0	13.7	18.5
2	135.8	12.8	10.5	9.4	10.7	10.8	11.6	13.1	14.3	18.7	24.0
3	135.8	12.7	11.9	11.4	11.0	11.4	12.5	13.3	14.2	15.5	21.9
4	135.8	12.0	11.9	11.1	11.8	12.3	14.0	15.2	15.7	15.2	16.7
5	136.0	12.0	11.3	12.0	13.3	11.8	14.6	15.7	16.8	15.9	12.5
6	135.7	13.6	12.9	14.0	14.4	13.9	14.5	14.5	13.7	13.2	10.9
7	135.8	12.3	13.1	13.5	13.5	15.1	14.3	15.4	13.8	13.2	11.5
8	135.9	9.9	14.0	15.7	17.1	16.1	14.9	12.7	13.4	12.7	9.5
9	135.8	11.1	15.3	16.4	16.2	17.4	16.1	14.5	12.6	10.0	7.3
Big	136.3	20.9	19.4	19.3	15.9	16.5	11.6	11.0	9.6	8.4	5.4

Notes: At the end of September of each year from 1975 to 1998 the 100 value-weighted size–BM portfolios are compiled according to firm size and book-to-market equity ratio (BM) of common stocks, which are selected from eligible common stock issues on the PACAP/Japan database. The portfolio grouping procedure is based on independent sorting on size and BM. Size is measured as the natural logarithm of market value of equity in millions of Japanese yen in the end of September. BM is set to equal the ratio of the BE to the ME at the end of March of year t. For portfolios formed at the end of September of year t, we use the book equity of a firm at the fiscal year-end that falls between April of year $t-1$ and March of year t. We break stocks into ten size and ten BM groups based on the ranks of firm size and BM, respectively. Then we construct 100 portfolios from the intersections of the ten size and the ten BM groups. The portfolios are rebalanced every year

Descriptive statistics are provided for the average of annual averages of firm size (ln (ME)), the average of annual BM ratios for portfolio, and the average of annual number of firms in portfolio. The average of annual averages of firm size of a portfolio is the time-series average of annual averages of ln (ME) for stocks in the portfolio at the end of September of each year. A portfolio's BM ratio for the portfolio formation year t is the sum of book equity for the firms in the portfolio for the fiscal year ending in March of year t, divided by the sum of their ME in March of year t. The average of annual BM ratios is the time-series average of portfolios' BM ratios

Table I.
Descriptive statistics for 100 portfolios formed on size and book-to-market equity

Table II. Average monthly returns and post-ranking βs for 100 portfolios formed on size and book-to-market equity

		Book-to-market ratio (BE/ME)									
Size	All	Low	2	3	4	5	6	7	8	9	High
Panel A: average monthly returns (in per cent)											
All	0.78	0.24	0.46	0.52	0.82	0.91	0.99	1.06	1.18	1.21	1.47
Small	1.74	2.05	1.62	1.74	1.43	1.59	1.82	1.70	1.57	2.11	1.76
2	1.44	1.11	1.39	0.92	1.39	1.37	1.61	1.21	1.42	1.60	1.74
3	1.30	1.09	0.90	1.20	1.26	1.44	1.24	1.28	1.06	1.35	1.65
4	1.11	0.42	1.02	0.90	0.96	0.98	1.24	1.17	1.24	1.30	1.69
5	1.03	0.48	0.73	1.13	1.05	1.05	1.10	0.92	1.07	1.27	1.67
6	0.86	0.16	0.65	0.60	0.78	0.80	0.97	0.85	1.00	1.39	1.47
7	0.84	0.59	0.32	0.59	0.88	0.84	0.88	1.16	1.02	0.91	1.29
8	0.77	0.43	0.64	0.60	0.66	0.71	0.70	1.10	0.97	0.91	0.90
9	0.78	0.34	0.56	0.61	0.70	0.80	0.90	0.75	1.09	1.10	1.45
Big	0.76	0.21	0.41	0.49	1.01	0.95	1.04	1.27	1.25	1.32	2.29
Panel B: post-ranking β_1											
All		0.89	0.91	0.88	0.95	0.93	0.95	0.98	0.99	0.94	1.03
Small	1.08	1.21	1.16	0.90	1.20	1.00	1.11	0.96	1.05	1.13	0.98
2	1.11	1.19	1.19	1.11	1.09	1.03	1.05	1.07	1.09	1.04	1.09
3	1.10	1.07	1.11	1.22	1.11	1.10	1.05	1.03	1.17	1.02	1.12
4	1.06	1.03	1.01	1.07	1.05	1.13	1.13	1.04	1.08	1.03	1.05
5	1.04	0.90	1.04	1.05	1.12	0.99	1.04	1.05	1.01	1.06	1.05
6	1.03	1.04	1.10	0.96	1.03	0.99	0.97	1.01	1.04	1.07	1.12
7	0.99	1.06	0.96	1.00	0.93	0.97	0.98	0.98	1.00	1.03	0.99
8	0.95	0.99	0.91	0.99	0.95	0.91	0.93	0.91	0.99	0.96	1.02
9	0.94	0.99	0.94	0.90	0.98	0.97	0.91	0.83	0.95	0.91	1.02
Big	0.90	0.81	0.91	0.87	0.96	0.96	0.90	1.04	0.87	0.82	0.86
Panel C: post-ranking β_{12}											
All		0.84	0.82	0.82	0.95	0.89	0.99	0.97	0.96	1.01	1.20
Small	1.08	1.60	0.63	1.02	0.89	0.86	1.17	1.14	1.09	1.57	0.90
2	1.18	1.18	1.04	0.88	1.07	1.20	1.24	1.12	1.06	1.29	1.36
3	1.14	0.98	1.04	1.02	1.14	1.28	1.06	1.00	1.11	1.03	1.42
4	1.10	1.08	1.06	1.14	1.05	1.10	1.07	1.05	1.09	1.12	1.19
5	1.06	0.74	0.87	1.03	1.06	0.93	1.15	1.03	1.13	1.21	1.45
6	1.07	0.94	1.17	0.91	1.12	0.90	1.00	1.03	1.10	1.33	1.24
7	1.01	0.99	0.91	0.85	1.22	1.01	0.94	1.06	1.10	1.13	1.16
8	0.96	0.84	1.04	0.78	0.93	1.00	1.01	0.86	1.02	0.96	1.00
9	0.93	0.90	0.87	0.93	0.96	0.92	0.86	0.83	0.97	1.17	1.20
Big	0.88	0.86	0.75	0.90	1.07	0.93	1.03	1.10	0.79	0.89	1.62

Notes: At the end of September of each year from 1975 to 1998 the 100 value-weighted size–BM portfolios are compiled according to firm size and book-to-market equity ratio (BM) of common stocks, which are selected from eligible common stock issues on the PACAP/Japan database. The portfolio grouping procedure is based on the ranking of size and BM independently. Size is measured as the natural logarithm of market value of equity in millions of Japanese yen in the end of September. BM is set to equal the ratio of the book equity (BE) to the market equity (ME) at the end of March of year t. For portfolios formed at the end of September of year t, we use the book equity of a firm at the fiscal year-end that falls between April of year $t-1$ and March of year t. We break stocks into ten size and ten BM groups based on the ranked value of firm size and BM, respectively. Then we construct 100 portfolios from the intersections of the ten size and the ten BM groups. The portfolios are rebalanced every year

The average monthly return is the time-series average of the monthly value-weighted portfolio returns, in per cent. The post-ranking βs use the full (October 1975 to September 1999) sample of post-ranking returns for each portfolio. The post-ranking β_1 is the sum of the slopes from a regression of post-ranking portfolio monthly returns on the current and prior month's returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_{12} is the slope from a regression of post-ranking portfolio annual returns on the annual returns of the value-weighted market portfolio of TSE stocks

Panel B of Table II reports the monthly post-ranking adjusted betas as used in Fama and French (1992) (denoted β_1), whereas Panel C reports that post-ranking betas (denoted β_{12}) based on non-overlapping annual returns as used in KSS (1995). The post-ranking monthly betas are estimated as the sum of slopes on the current and prior month's market returns based on monthly data to mitigate biases due to nonsynchronous trading and other trading frictions (Scholes and Williams, 1977). The annual betas are estimated by regressing portfolios' annual returns on the current market annual returns.

Interestingly, the first column in Panel B shows that when sorted on size alone, the size is inversely related to the monthly beta, a result that is quite similar to the US result. But when sorted on BM alone, the first row in Panel B indicates that there appears no conspicuous relation between monthly beta and BM.

In contrast, the first row of Panel C indicates that when portfolios are sorted on BM alone, a positive relation emerges between annual beta and the BM. The first column of Panel C indicates that a negative relation between annual beta and firm size still exists, but the smallest portfolio does not have the highest beta, which is different from the US evidence.

To see how beta estimates change when data of different return-intervals are used, we report the cross-correlations for beta estimates of different return-intervals across all size–BM portfolios in Table III. Table III indicates that all betas are significantly positive, except for the correlation between the unadjusted monthly beta and the annual beta, which is −0.0119. Also, the correlation between betas of different horizons decreases as the difference in return-intervals increases. For example, the second column of Table III shows that the monthly beta has a correlation of 0.8016 with the quarterly beta, 0.4873 with the half-year beta, and only 0.3781 with the annual beta. The last row of Table III reveals the same pattern, and the annual beta has the highest correlation with the semiannual beta, which is 0.7737.

	$\beta_1^{unadj.}$	β_1	β_3	β_6
β_1	0.1973 (0.0492)			
β_3	0.3248 (0.0010)	0.8016 (0.0001)		
β_6	0.3060 (0.0020)	0.4873 (0.0001)	0.6913 (0.0001)	
β_{12}	−0.0119 (0.9066)	0.3781 (0.0001)	0.5664 (0.0001)	0.7737 (0.0001)

Notes: At the end of September of each year from 1975 to 1998 the 100 value-weighted size–BM portfolios are compiled according to firm size and book-to-market equity ratio (BM) of common stocks which are selected from eligible common stock issues on the PACAP database for Japan. The post-ranking βs use the full (October 1975 to September 1999) sample of post-ranking returns for each portfolio. The $\beta_1^{unadj.}$ is not adjusted for nonsynchronous trading, however, the β_1 is adjusted for nonsynchronous trading. The post-ranking $\beta_1^{unadj.}$ is the slope from a regression of post-ranking portfolio monthly returns on the current monthly returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_1 is the sum of the slopes from a regression of post-ranking portfolio monthly returns on the current and prior month's returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_3 is the slope from a regression of post-ranking portfolio quarterly returns on the quarterly returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_6 and β_{12} are based on semiannual and annual data, respectively.
Summary statistics are provided for the Pearson correlation coefficients between post-ranking βs. The numbers in parentheses are the t-statistics for tests of the hypothesis that the parameter of interest is equal to zero

Table III.
Correlation coefficients between post-ranking βs

2.2.3 Fama–French factors and macroeconomic variables. Table IV reports the correlation matrix for Fama–French three factors and macroeconomic variables for different return horizons. "SMB" and "HML" are factor returns on two mimicking portfolios on size and BM. To construct the Fama-French factors, we follow the procedures proposed by Fama and French (1993) and Daniel *et al.* (2001). Specifically, we form factor portfolios based on sorts on market size and BM. Daniel *et al.* (2001) include a detailed description of the construction of the Fama-French factors in the Japanese market.

IPG, UI, CEI, URP, UTS, CG, and OPG are, respectively, growth rate in industrial production, changes in unanticipated inflation, changes in expected inflation, changes in unanticipated default risk premium, unanticipated term-structure spread, changes in consumption growth, and changes in oil prices, as in CRR (1986). Specifically, as in CRR (1986), a moving-average model is used to obtain the estimate of the expected inflation following Fama and Gibbons (1984). The risk premium is the difference between the returns on the low-grade bond and the long-term government bond. "UTS" is the difference between returns on long-term government bonds and one-month T-bills.

There are some interesting features in Table IV. First, by inspecting the first column for each of the panels, one can see that the correlation between market returns and several factors increases as the return-intervals are lengthened. For example, the correlation coefficients between the market return and the SMB factor are −0.07, 0.11, 0.15, and 0.22 for monthly, quarterly, semiannual, and annual returns, respectively. The same patterns can be observed between market returns and variables like industrial production (IPG) and oil price shock (OPG). The correlation between market returns and the industrial production gradually increase from −0.07 to 0.29 for investment horizons ranging from one month to one year. Also, the correlation between the market returns and the oil price changes is −0.07, −0.24, −0.21, and −0.28 for monthly, quarterly, semiannual, and annual horizons, respectively. Overall, the result suggests that the stock market and the state of the economy are "cointegrated" in the sense that the stock market virtually are evolving in the same direction with the economy.

Second, there exist significant relation between firm size and some macroeconomic variables. By inspecting the numbers in the second column of each panel in Table IV, one can see that that the size premium (SMB) is related to industrial production, consumption growth, and oil price change. The correlation between SMB and industrial production increases from 0.13 to 0.38 for horizons from one month to one year. The correlation between SMB and consumption also increases from 0.06 to 0.40 from monthly horizon to annual horizon. The correlation between the size premium and oil price change is weaker, but still takes the values of −0.02, −0.07, 0.03, and 0.10 for monthly, quarterly, semiannual, and annual horizons, respectively. Thus, the result suggests that size premium might be explained by macroeconomic variables in longer investment horizons.

Third, the third column of Table IV exhibits that the value premium, captured by returns on the HML portfolio, is weakly related to industrial production, inflation, and oil prices. The most prominent relation is the correlation between HML and consumption, which is -0.05, 0.01, 0.17, and 0.25 for horizons ranging from one month to one year, respectively.

Overall, the preliminary empirical results reveal that the well-documented premiums on market, size, and BM are at least partially explainable by macroeconomic variables, especially for longer investment horizons.

	MKRT	SMB	HML	IPG	UI	CEI	URP	UTS	CG
Panel A: monthly									
SMB	−0.07								
HML	−0.18	0.13							
IPG	−0.07	0.13	0.10						
UI	−0.03	−0.06	0.00	0.04					
CEI	0.02	−0.15	0.09	0.06	−0.12				
URP	−0.06	0.00	−0.04	−0.07	−0.10	−0.01			
UTS	−0.11	0.00	0.00	0.09	0.23	0.05	−0.53		
CG	0.04	0.06	−0.05	0.00	−0.19	−0.43	0.04	−0.02	
OPG	−0.07	−0.02	−0.08	0.00	0.19	0.10	−0.35	0.19	−0.09
Panel B: quarterly									
SMB	0.11								
HML	0.04	0.19							
IPG	0.11	0.06	0.03						
UI	0.03	−0.07	−0.14	0.13					
CEI	0.05	0.03	−0.05	0.10	−0.27				
URP	0.20	0.04	−0.03	−0.05	−0.16	−0.01			
UTS	−0.17	0.01	0.00	0.10	0.28	−0.07	−0.53		
CG	0.02	0.04	0.01	0.08	0.04	0.06	0.02	0.00	
OPG	−0.24	−0.07	−0.14	0.10	0.20	0.05	−0.42	0.20	−0.06
Panel C: semiannual									
SMB	0.15								
HML	0.04	0.21							
IPG	0.17	0.18	0.13						
UI	−0.11	−0.04	−0.19	0.07					
CEI	0.14	0.03	−0.05	0.18	−0.34				
URP	0.18	−0.01	−0.16	−0.13	−0.20	−0.10			
UTS	−0.21	0.03	0.02	0.08	0.33	−0.03	−0.50		
CG	0.04	0.23	0.17	0.13	−0.02	0.06	−0.02	0.10	
OPG	−0.21	0.03	−0.04	0.19	0.15	0.09	−0.47	0.19	−0.04
Panel D: annual									
SMB	0.22								
HML	0.26	0.38							
IPG	0.29	0.38	0.19						
UI	−0.06	0.04	−0.20	0.35					
CEI	−0.20	−0.19	−0.15	−0.25	−0.37				
URP	0.10	−0.05	−0.16	−0.29	−0.33	0.21			
UTS	−0.11	−0.01	−0.04	0.17	0.34	−0.04	−0.56		
CG	0.17	0.40	0.25	0.48	−0.12	−0.20	−0.02	0.20	
OPG	−0.28	0.10	0.08	0.21	0.33	0.02	−0.43	0.00	−0.10

Notes: Summary statistics are provided for the Pearson correlation coefficients between returns of market portfolio of TSE stocks (MKRT), characteristic factors (SMB and HML), and macroeconomic factors (IPG, UI, CEI, URP, UTS, CG, and OPG) for different return horizons. Sample period is from October 1975 to September 1999. The data used to compile MKRT and SMB, HML are drawn from the PACAP databases. Macroeconomic data are collected from various sources including the PACAP database, the International Financial Statistics, and from the Bank of Japan.
MKRT is the value-weighted market returns with cash dividends reinvested which is drawn directly from PACAP database. SMB and HML are compiled using Fama and French (1993) method to mimic the risk factors in returns related to size and book-to-market equity ratio, respectively. The seven macroeconomic factors are constructed following Chen *et al.* (1986). They are denoted as IPG, growth rate in industrial production; UI, unanticipated inflation; CEI, change in expected inflation; URP, unanticipated changes in risk premium; UTS, unanticipated changes in the term structure; CG, growth rate in real per capita consumption; OPG, growth rate in oil price
Panel A-D are based on monthly, quarterly, semiannual, and annual data, respectively

Table IV.
Correlation matrices for time-series factors

3. Empirical results: Fama-MacBeth two-pass cross-sectional regressions

In this section, we present empirical results based on cross-sectional regressions of various models over time-intervals ranging from one month to one year. For each of the investment horizons (monthly, quarterly, semiannual, and annual), five models as the following are considered:

$$R_{it} = \gamma_{0t} + \gamma_{\beta,t}\beta_i + \varepsilon_{it} \quad (1)$$

$$R_{it} = \gamma_{0t} + \gamma_{\mathrm{size},t}\ln(\mathrm{size})_{i,t-1} + \gamma_{\mathrm{BM},t}\mathrm{BM}_{i,t-1} + \varepsilon_{it} \quad (2)$$

$$R_{it} = \gamma_{0t} + \gamma_{\mathrm{CG},t}\mathrm{CG}_i + \varepsilon_{it} \quad (3)$$

$$R_{it} = \gamma_{0t} + \gamma_{\mathrm{IP},t}\mathrm{IPG}_i + \gamma_{\mathrm{UI},t}\mathrm{UI}_i + \gamma_{\mathrm{CEI},t}\mathrm{CEI}_i + \gamma_{\mathrm{URP}}\mathrm{URP}_i + \gamma_{\mathrm{UTS},t}\mathrm{UTS}_i + \varepsilon_{it} \quad (4)$$

$$R_{it} = \gamma_{0t} + \gamma_{\mathrm{OPG},t}\mathrm{OPG}_i + \varepsilon_{it} \quad (5)$$

R_{it} is the return on stock i for time t; β_i is the post-ranking beta of stock i. ln $(\mathrm{size})_{i,t-1}$ is the natural log of the market capitalization of stock i prior to time t. The book-to-market equity ratio $\mathrm{BM}_{i,t-1}$ is defined similarly. CG_i, IPG_i, UI_i, CEI_i, URP_i, UTS_i, and OPG_i are, respectively, the post-ranking factor loadings on consumption growth, industrial production, unanticipated inflation, changes in expected inflation, unanticipated default risk premium, unanticipated term spread, and changes in oil prices.

Note that for every regression, the betas or factor loadings are estimated based on the time-interval coinciding with the return-interval on the left-hand side of the regression. For example, if the cross-sectional regression is run on quarterly data, then the beta or factor loadings at the right-hand side of the regression model are all estimated based on quarterly data.

The five models above belong to three categories. The first model (1) is a single-factor CAPM, the second model (2) is a characteristic-based model *à la* Fama and French (1992) and Daniel and Titman (1997), and the last three models are macro-based factor models[5]. We consider three macro-based models. Model (3) is the consumption-based CAPM, model (4) is the CRR (1986) macro model, and model (5) further examines if oil shocks are priced, which was originally tested in CRR (1986) using US data.

Finally, to compare the relative explanatory power of those competing models, we consider the following combined model by putting all models together:

$$R_{it} = \gamma_{0t} + \gamma_{\beta,t}\beta_i + \gamma_{\mathrm{size},t}\ln(\mathrm{size})_{i,t-1} + \gamma_{\mathrm{BM},t}\mathrm{BM}_{i,t-1} + \gamma_{\mathrm{CG},t}\mathrm{CG}_i + \gamma_{\mathrm{OPG},t}\mathrm{OPG}_i + \gamma_{\mathrm{IP},t}\mathrm{IPG}_i + \gamma_{\mathrm{UI},t}\mathrm{UI}_i + \gamma_{\mathrm{CEI},t}\mathrm{CEI}_i + \gamma_{\mathrm{URP}}\mathrm{URP}_i + \gamma_{\mathrm{UTS},t}\mathrm{UTS}_i + \varepsilon_{it} \quad (6)$$

For each of the four different time -intervals (i.e. one-, three-, six-, and twelve-months), we perform the Fama and MacBeth (1973) two-pass cross-sectional regressions of various models using non-overlapping data. Specifically, in the first pass, post-ranking CAPM beta or factor sensitivities for a size–BM portfolio are obtained by running time-series regression of the portfolio returns on market returns or factors over the whole sample period. As in Fama and French (1992), the post-ranking beta or factor loadings for an individual stock at a given time are then assigned as those of the size–BM sub-portfolio to which it belongs at that time. In the second pass, a cross-sectional regression is performed by regressing individual stock returns on the associative post-ranking beta or factor sensitivities for each point in time, The resulting coefficients are the associated risk premiums. We report the average risk premium for each explanatory variable, and calculate the associated *t*-statistic with the adjustment of Newey and West (1987) that allows for serial correlation and conditional heteroscedasticity.

The empirical results are reported in Tables V through Table VII. We first consider each model separately, and then the combined models to see how various variables or factors interact with each other.

3.1 The CAPM over different investment horizons

Table V reports time-series averages of the slopes from the Fama-MacBeth regressions of the cross-section of individual stock returns on betas over monthly, quarterly, semiannual, and annual return-intervals. The result in Panel A of Table V indicates that when the unadjusted monthly beta, denoted $\beta_1^{\text{unadj.}}$, is used as the sole independent variable, the average slope, the average market risk premium, is significantly negative with a *t*- value of -2.95, which contradicts the assertion of the CAPM. Interestingly, when the adjusted monthly beta (denoted β_1) is used as the explanatory variable, the average slope becomes significantly positive with a *t*-statistic of 2.25. The coefficients of quarterly, semiannual, and annual betas are also significantly positive. The coefficient of 0.0145 for the annual beta implies an annualized risk premium of 18.86 per cent.

Panels B through D report the regressions of betas of quarterly, semiannual, and annual returns. The results also indicate that the beta risk premium is consistently significantly positive for all investment horizons. Thus, unlike the US evidence, the empirical result indicates that beta survives in Japan.

3.2 The characteristics and the CRR macroeconomic factor models

Table VI reports the empirical results for the Fama-French characteristic model and the CRR macroeconomic factor model.

For the characteristic model, the results show that for all return-intervals the coefficients of size are persistently significantly negative, while the coefficients of BM are always significantly positive.

For the CRR model, Panel A of Table VI indicates that, except for the term-structure factor (UTS), all other variables are significant for monthly returns. The signs are also consistent with the US results, as reported in CRR (1986), except for the changes in expected inflation. The IPG is the only variable among the five CRR factors that remains significant for all horizons. The relevance of inflation factor (i.e. UI and CEI) appears to be less permanent. The coefficients of UI and CEI are significant only for monthly and quarterly returns. Also, the coefficient of the default risk (URP) is significant only for monthly horizon.

Table VI indicates that the consumption CAPM works very well for the Japanese market. The consumption beta is significantly positive for all horizons. The positive sign is also consistent with the prediction of the theory.

For oil shocks, the results show that its premiums are significantly negative for almost all horizons, except for the annual horizon. The result is not surprising for an industrialized country like Japan whose oil consumption relies heavily on imports.

Intercept	$\beta_1^{unadj.}$	β_1	β_3	β_6	β_{12}
Panel A: monthly					
0.0372 (3.68)	−0.0283 (−3.27)				
−0.0139 (−1.56)		0.0244 (2.25)			
−0.0139 (−1.85)			0.0251 (2.54)		
−0.0003 (−0.09)				0.0117 (2.39)	
−0.0044 (−1.21)					0.0145 (3.69)
Panel B: quarterly					
−0.0432 (−1.81)			0.0772 (2.37)		
−0.0024 (−0.24)				0.0369 (2.17)	
−0.0144 (−1.35)					0.0451 (3.32)
Panel C: semiannual					
−0.0115 (−0.54)				0.0769 (2.02)	
−0.0343 (−1.56)					0.0920 (3.00)
Panel D: annual					
−0.0849 (−1.82)					0.2134 (2.80)

Notes: At the end of September of each year from 1975 to 1998 the 100 value-weighted size–BM portfolios are compiled according to firm size and book-to-market equity ratio (BM) of common stocks listed on TSE. The post-ranking βs use the full (October 1975 to September 1999) sample of post-ranking returns for each portfolio. The post-ranking$\beta_1^{unadj.}$ is the slope from a regression of post-ranking portfolio monthly returns on the current monthly returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_1 is the sum of the slopes from a regression of post-ranking portfolio monthly returns on the current and prior month's returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_3 is the slope from a regression of post-ranking portfolio quarterly returns on the quarterly returns of the value-weighted market portfolio of TSE stocks. The post-ranking β_6 and β_{12} are based on semiannual and annual data, respectively.
Stocks are assigned the post-ranking β of the size–BM portfolio they are in at the end of September of year *t*. The average slopes (average risk premium) is the time-series average of the cross-sectional regression slopes for October 1975 to September 1999. The numbers in parentheses are the GMM *t*-statistics for tests of the hypothesis that the parameter of interest is equal to zero. In Panel A, we perform the cross-sectional regressions of individual stock monthly returns on their various βs. In Panels B-D, the individual stock monthly returns are substituted by quarterly, semiannual, and annual returns, respectively

Table V. Average slopes (GMM *t*-statistics) from cross-sectional regressions on β

3.3 Putting all together: the explanatory power of competing models

Table VII reports the results on various combinations of these classes of models in explaining the average returns for varying investment horizons. The different combinations of the models are enumerated as ten models in Table VII.

Panel A of Table VII reports the results on monthly data. The results show little interaction among these different models. The results from models 1 through 10 indicate that most variables remain significant, including the monthly beta, size, BM, industrial production, inflation (UI and CEI), and default risk premium (URP). Monthly beta is significant in models 2 through 4 when various macroeconomic factors are also included in the regressions, but its significance diminishes when size and beta are included in the regressions (see models 1 and 10). The coefficients of consumption and oil shocks become insignificant when size and BM are also included in the regressions (see models 6 and 7). The results from models 5 and 10 indicate that the significance of CRR macroeconomic factors is attenuated with the inclusion of size and BM. As the

Intercept	Characteristics ln (ME)	ln (B/M)	IPG	UI	Macroeconomic factors CEI	URP	UTS	CG	OPG
Panel A: monthly									
0.0331	−0.0019	0.0034							
(2.83)	(−2.22)	(3.42)							
0.0067			0.0102	−0.0020	0.0008	0.0003	0.0000		
(2.11)			(3.41)	(−2.22)	(1.90)	(3.15)	(0.09)		
0.0082								0.0046	
(2.60)								(1.97)	
0.0055									−0.0241
(1.67)									(−3.83)
Panel B: quarterly									
0.0992	−0.0055	0.0108							
(2.58)	(−2.03)	(3.40)							
0.0283			0.0077	−0.0028	−0.0006	0.0003	0.0004		
(2.45)			(1.82)	(−2.61)	(−2.35)	(1.13)	(0.77)		
0.0270								0.0110	
(2.44)								(2.51)	
0.0002									−0.0626
(0.02)									(−3.28)
Panel C: semiannual									
0.1846	−0.0100	0.0239							
(2.37)	(−1.78)	(3.22)							
0.0410			0.0143	−0.0018	−0.0004	0.0004	0.0004		
(2.20)			(1.90)	(−2.01)	(−1.68)	(0.59)	(0.28)		
0.0376								0.0118	
(1.92)								(2.13)	
0.0477									−0.0644
(2.04)									(−3.00)
Panel D: annual									
0.4014	−0.0216	0.0508							
(2.44)	(−1.96)	(2.86)							
0.0427			0.0266	−0.0005	−0.0001	−0.0004	0.0016		
(1.17)			(2.07)	(−0.57)	(−0.97)	(−0.23)	(0.63)		
0.0741								0.0117	
(1.89)								(2.25)	
0.1218									−0.0463
(2.23)									(−1.41)

Notes: ln (ME), size, is measured as the natural logarithm of market value of equity in millions of Japanese yen in the end of September. BM is set to equal the ratio of the BE to the ME at the end of March of year *t*. Stocks are assigned the post-ranking macroeconomic factor loadings of the size–BM portfolio they are in at the end of September of year *t*. The average slopes (average risk premium) is the time-series average of the cross-sectional regression slopes for October 1975 to September 1999. The numbers in parentheses are the GMM *t*-statistics for tests of the hypothesis that the parameter of interest is equal to zero.
In Panel A, we perform the cross-sectional regressions of individual stock monthly returns on their various βs. In Panels B-D, the individual stock monthly returns are substituted by quarterly, semiannual, and annual returns, respectively.
The macroeconomic factors are denoted as: IPG, growth rate in industrial production; UI, unanticipated inflation; CEI, change in expected inflation; URP, unanticipated changes in risk premium; UTS, unanticipated changes in the term structure; CG, growth rate in real per capita consumption; OPG, growth rate in oil price

Table VI.
Average slopes (GMM *t*-statistics) from cross-sectional regressions on size, book-to-market ratio, and macroeconomic factors

Model	Intercept	CAPM	Characteristics				Macroeconomic factors				
		β	ln (ME)	ln (B/M)	IPG	UI	CEI	URP	UTS	CG	OPG
Panel A: monthly											
	0.0316	0.0012	−0.0018	0.0034							
1	(2.95)	(0.27)	(−2.27)	(3.43)							
	−0.0024	0.0114			0.0066	−0.0026	0.0012	0.0003	0.0000		
2	(−0.55)	(2.18)			(2.89)	(−2.66)	(2.81)	(3.36)	(0.01)		
	−0.0099	0.0196								0.0026	
3	(−1.40)	(2.26)								(1.71)	
	−0.0139	0.0240									−0.0154
4	(−1.56)	(2.22)									(−3.40)
	0.0341		−0.0020	0.0032	0.0036	0.0010	0.0007	0.0002	0.0002		
5	(3.14)		(−2.50)	(3.27)	(1.87)	(1.56)	(2.49)	(2.11)	(1.40)		
	0.0320		−0.0018	0.0034						0.0005	
6	(2.81)		(−2.19)	(3.48)						(0.62)	
	0.0303		−0.0018	0.0030							−0.0059
7	(2.64)		(−2.11)	(3.10)							(−1.72)
	0.0057				0.0100	−0.0021	0.0008	0.0003	0.0000	0.0017	
8	(1.81)				(3.41)	(−2.38)	(1.87)	(3.25)	(−0.30)	(1.59)	
	0.0067				0.0102	−0.0016	0.0006	0.0002	0.0001		−0.0155
9	(2.10)				(3.39)	(−1.94)	(1.48)	(2.60)	(0.81)		(−3.50)
	0.0270	0.0037	−0.0017	0.0030	0.0047	0.0004	0.0007	0.0001	0.0002	−0.0001	−0.0034
10	(2.57)	(0.82)	(−2.12)	(3.01)	(2.66)	(0.61)	(2.67)	(1.63)	(1.66)	(−0.11)	(−1.12)
Panel B: quarterly											
	0.0625	0.0301	−0.0048	0.0111							
1	(1.92)	(2.29)	(−1.84)	(3.46)							
	−0.0057	0.0336			0.0066	−0.0026	−0.0005	0.0002	0.0003		
2	(−0.33)	(1.38)			(1.97)	(−2.70)	(−1.82)	(0.99)	(0.72)		
	−0.0347	0.0642								0.0096	
3	(−1.62)	(2.24)								(2.78)	
	−0.0245	0.0513									−0.0599
4	(−1.20)	(1.85)									(−3.39)
	0.0729		−0.0036	0.0100	0.0042	−0.0006	−0.0003	0.0003	0.0004		
5	(1.97)		(−1.33)	(3.24)	(1.36)	(−0.84)	(−1.32)	(1.40)	(0.86)		
	0.0936		−0.0051	0.0107						0.0018	
6	(2.48)		(−1.90)	(3.32)						(1.15)	
	0.0759		−0.0045	0.0093							−0.0223
7	(2.06)		(−1.71)	(3.01)							(−2.30)
	0.0253				0.0065	−0.0024	−0.0005	0.0003	0.0001	0.0043	
8	(2.35)				(1.60)	(−2.63)	(−1.98)	(1.25)	(0.29)	(1.67)	
	0.0163				0.0059	−0.0020	−0.0004	0.0002	0.0006		−0.0345
9	(1.65)				(1.48)	(−2.21)	(−1.60)	(0.86)	(1.07)		(−3.13)
	0.0308	0.0287	−0.0022	0.0097	0.0044	−0.0006	0.0000	0.0002	0.0004	0.0020	−0.0175
10	(0.98)	(2.32)	(−0.90)	(3.07)	(1.40)	(−0.87)	(−0.11)	(0.78)	(0.98)	(1.18)	(−2.02)
Panel C: semiannual											
	0.1542	0.0264	−0.0094	0.0237							
1	(2.16)	(1.00)	(−1.71)	(3.19)							
	0.0347	0.0144			0.0179	−0.0020	−0.0002	0.0002	0.0003		
2	(2.08)	(0.52)			(2.54)	(−2.20)	(−0.96)	(0.24)	(0.25)		
	0.0029	0.0400								0.0122	
3	(0.16)	(1.38)								(2.17)	
	0.0027	0.0649									−0.0698
4	(0.13)	(1.72)									(−3.12)

(continued)

Table VII.
Average slopes (GMM *t*-statistics) from cross-sectional regressions on β, size, book-to-market ratio, and macroeconomic factors

Model	Intercept	CAPM β	Characteristics ln (ME)	ln (B/M)	IPG	UI	Macroeconomic factors CEI	URP	UTS	CG	OPG
	0.1247		−0.0058	0.0234	0.0090	−0.0001	−0.0004	0.0010	0.0000		
5	(1.82)		(−1.15)	(3.56)	(1.64)	(−0.10)	(−1.52)	(1.78)	(0.03)		
	0.1729		−0.0091	0.0235						0.0012	
6	(2.47)		(−1.80)	(3.12)						(0.48)	
	0.1729		−0.0098	0.0222							−0.0405
7	(2.24)		(−1.76)	(3.01)							(−2.11)
	0.0391				0.0124	−0.0017	−0.0003	0.0004	0.0003	0.0040	
8	(2.29)				(1.96)	(−1.84)	(−1.28)	(0.66)	(0.24)	(1.00)	
	0.0392				0.0138	−0.0018	−0.0003	0.0003	0.0005		−0.0149
9	(2.04)				(1.70)	(−1.89)	(−1.51)	(0.48)	(0.38)		(−0.66)
	0.1500	0.0058	−0.0077	0.0228	0.0108	−0.0002	−0.0002	0.0008	0.0000	−0.0014	−0.0221
10	(2.78)	(0.22)	(−1.74)	(3.17)	(1.92)	(−0.23)	(−0.91)	(1.41)	(0.03)	(−0.55)	(−1.21)
Panel D: annual											
	0.2323	0.1082	−0.0166	0.0408							
1	(1.69)	(2.14)	(−1.60)	(2.54)							
	−0.0461	0.1550			0.0268	−0.0006	−0.0001	−0.0007	0.0016		
2	(−1.19)	(2.62)			(2.08)	(−0.56)	(−1.05)	(−0.37)	(0.61)		
	−0.0377	0.1375								0.0100	
3	(−0.84)	(2.37)								(2.00)	
	−0.0852	0.2136									−0.0405
4	(−1.80)	(2.78)									(−1.19)
	0.2357		−0.0112	0.0516	0.0162	0.0005	0.0000	0.0010	0.0013		
5	(1.86)		(−1.22)	(2.78)	(1.57)	(0.49)	(−0.44)	(0.63)	(0.49)		
	0.2509		−0.0102	0.0475						0.0060	
6	(2.02)		(−1.20)	(2.73)						(1.62)	
	0.3934		−0.0227	0.0489							−0.0507
7	(2.41)		(−2.03)	(2.73)							(−1.49)
	0.0413				0.0268	−0.0005	−0.0001	−0.0005	0.0017	0.0087	
8	(1.11)				(2.19)	(−0.52)	(−1.05)	(−0.32)	(0.70)	(1.95)	
	0.0330				0.0261	−0.0004	−0.0001	−0.0004	0.0013		−0.0443
9	(0.95)				(2.09)	(−0.45)	(−1.02)	(−0.23)	(0.52)		(−1.34)
	0.2016	0.0811	−0.0123	0.0474	0.0170	0.0005	−0.0001	0.0007	0.0009	0.0043	−0.0430
10	(1.88)	(1.53)	(−1.60)	(2.99)	(1.62)	(0.46)	(−0.58)	(0.44)	(0.39)	(1.27)	(−1.34)

Notes: Stocks are assigned the post-ranking factor loadings of the size–BM portfolio they are in at the end of September of year *t*. ln (ME), size, is measured as the natural logarithm of market value of equity in millions of Japanese yen in the end of September. BM is set to equal the ratio of the BE to the ME at the end of March of year *t*. The average slopes (average risk premium) is the time-series average of the cross-sectional regression slopes for October 1975 to September 1999. The numbers in parentheses are the GMM *t*-statistics for tests of the hypothesis that the parameter of interest is equal to zero.
In Panel A, we perform the cross-sectional regressions of individual stock monthly returns on their various factor loadings and firm characteristics. In Panels B-D, the individual stock monthly returns are substituted by quarterly, semiannual, and annual returns, respectively.
The macroeconomic factors are denoted as: IPG, growth rate in industrial production; UI, unanticipated inflation; CEI, change in expected inflation; URP, unanticipated changes in risk premium; UTS, unanticipated changes in the term structure; CG, growth rate in real per capita consumption; OPG, growth rate in oil price

Table VII.

coefficients of size and BM are significant for all models, the results from monthly data reveal that the two asset-pricing anomalies play a major role in cross-section of monthly stock returns. While macroeconomic factors do have some explanatory power, they cannot explain either beta or any of the two anomalies.

Panel B of Table VII reports the quarterly results. The results from the combined model (model 10) indicate that the significance of most variables diminishes, including size, consumption, and all CRR factors. Factors that remain significant in the quarterly horizon are quarterly beta, BM, and oil shock. The significance of oil shock suggests that it cannot be absorbed by the either the market or other macroeconomic factors.

Panel C of Table VII reports the half-year results. The results are not significantly different from the quarterly results. The variables that "survive" in the combined model (model 10) are BM and industrial production. For the semiannual data, the beta is never significant when other variables are included (see models 1 through 4 and model 10). Size is only marginally significant. The effect of consumption seems to be absorbed by the inclusion of size and BM (see model 6), and the effect of oil shock is captured by the CRR factors (see model 9).

Panel D of Table VII reports the results on annual returns. As we only have 25 non-overlapping annual data, statistical tests on annual returns based on large-sample Newey-West adjustment may not be valid, especially when several explanatory variables are incorporated into a model at the same time (e.g. model 10). This is because the inclusion of many explanatory variables in a single regression causes reduction in degrees of freedom, thereby causing the loss in estimation efficiency. Thus, the results should be explained with caution. We shall focus on those variables that are significant in one or more models. Panel D of Table VII shows that the annual betas are significant in models 1 through 4, but not in model 10. Size is significant only in model 7. BM is significant for all models that include BM as an explanatory variable. The small-firm effect disappears with the inclusion of either annual beta (model 1), the CRR factors (model 5) or consumption (model 6). Industrial production is significant in models 2, 8, and 9, but not in models 5 and 10. Consumption is significant for models 3 and 8. Overall, the results from annual data indicate that annual beta, BM, industrial production, and consumption are the cross-sectional determinants of the annual returns.

3.4 Summary of the results

Our empirical results exhibit several interesting features. Some of them are different from the US results. In the following, we summarize our findings in terms of the three categories of models, focusing especially on the explanatory power of macroeconomic variables over betas and the characteristics of size and BM.

There are three main findings in terms of the macroeconomic variables. First, most CRR macro factors, except the industrial production, only have "temporary" effect on pricing in that they are significant only for return-intervals up to semiannual returns. Second, we do find some support for the consumption-CAPM, especially for annual returns. For return-intervals shorter than one year, the effect of consumption betas is captured by either beta or the size-BM characteristics. Third, we also find some support for the pricing of oil shocks. The risk premium of oil shocks is significantly negative for return horizons within six months. The sign is the same as the sign of unanticipated inflation, and hence is consistent with our economic intuition. Although the effect of oil shock appears to be absorbed by other variables in monthly and semiannual returns, it appears as an independent pricing factor in quarterly returns.

For the CAPM beta, we find that beta as a sole factor does explain the cross-section of stock returns for all investment horizons. With the inclusion of other variables, beta is still significant in quarterly and annual returns. Thus, macroeconomic factors do not really capture much of the pricing of beta.

Finally, do we find any "fundamentals" in the size or BM anomalies? The answer is yes, but only for the size anomaly. Our Japanese empirical results find strong size and BM effect for all investment horizons when they are included in a single regression. Further investigation shows that the size effect is merely a short-term anomaly because it is significant only for monthly returns with the inclusion of CRR macroeconomic factors; for longer horizons, its significance is surpassed by the CRR macro factors.

We find that BM is the strongest factor in explaining stock returns of all investment horizons, with or without the inclusion of other variables. Two possibilities may account for its existence. The first explanation is that BM indeed captures a missing factor that is missing in the macroeconomic factor models. This is certainly a direction to pursue in the future. The second possibility is that the presence of BM is, at least in part, "behavioral" and that the investment horizon up to one year is not long enough to allow the market to go back to its fundamentals. Extending the present study using a long horizon beyond one year may help understand if the BM effect persists, because past studies have documented that long-term reversals in returns occur within three to five years. However, as emphasized by Potterba and Summers (1988) and Fama and French (1988), the sample we have is limited in size that will not insure any credible inference on long-term predictability.

4. Conclusion

Although most asset-pricing models such as the CAPM state that the cross-sectional variation in expected returns could be explained by a set of variables, the length of a period is never clearly stated, either theoretically or empirically.

Using return data from the TSE, we investigate the empirical validity of market beta, firm size and the ratio of book-to-market equity (BM), and various macroeconomic factors in explaining the cross-section of stock returns over various investment horizons ranging from one month to one year. We find that most macroeconomic variables do explain the cross-section of short-term returns, but only industrial production remains significant in annual returns. Firm size does bear significant risk premium, but its significance diminishes when the macroeconomic factors of Chen *et al.* (1986) are included in the regression. BM is the only variable that significantly accounts for the cross-section of stock returns for all horizons.

In summary, using the Japanese data we find that macroeconomic factors, including consumption, do explain the cross-section of expected returns. Variables like unanticipated inflation, changes in expected inflation, and unexpected risk premium mainly account for the cross-sectional variation in stock returns for horizons within three months, whereas industrial production and consumption explain the cross-section of longer horizons up to one year. Also, we partially save the CAPM by empirically proving the explanatory power of beta for annual horizon. However, the puzzle of book-to-market equity remains, suggesting the need to search for a proper theory in the future.

Notes

1. In a theoretical setting, Barberis *et al.* (2001) show that large size and value premiums in the cross-section of average returns could arise in a model in which investors put different stocks into different baskets (i.e. mental accounts) and treat them separately.
2. Along the same line of thought, Liew and Vassalou (2000) find that information on size and BM help predict future gross domestic product.

3. However, Fama and French (1996) question their results by arguing that post-ranking betas estimated on annual or monthly returns are near perfect transformation of one another. Hence, estimates based on monthly or annual returns yield the same inferences that "beta alone cannot explain expected return".
4. This procedure is used in KSS (1995), and in their empirical study similar results are obtained using portfolios of different grouping methods.
5. We do not include the Fama-French three-factor model because our empirical result indicates that for Japanese data the characteristics model subsumes the Fama-French factor model over various horizons, which merely confirms the findings of Daniel *et al.* (2001). The result is available from the authors upon request.

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