Firm Characteristics, Alternative Factors, and Asset-Pricing Anomalies: Evidence from Japan*

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Abstract

Based on an errors-in-variables-free approach proposed by Brennan, Chordia, and Subrahmanyam (1998), we investigate the competing explanatory abilities of alternative multi-factor models in examining various asset-pricing anomalies using Japanese data over 1978-2006. Surprisingly, we find that turnover and BM are the two major characteristics that significantly explain the average stock returns. A further subperiod analysis reveals that turnover effect is significant only before 1990, but cannot be explained by any multifactor models. In contrast, the BM premium is significant only after 1990, and can be explained by the Fama-French three-factor model. Thus, the results suggest that asset-pricing anomalies documented in the literature are not universal, and may be different across different markets.

Keywords: factors; characteristics; asset-pricing anomalies; Fama-MacBeth cross-sectional regression; least-trimmed squares.

JEL Classification: G1.

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1. Introduction

A well-known debate in finance is whether the explanatory power of firm characteristics such as size and book-to-market ratio (BM) in stock returns could be explained by rationality-based factor models. The debate dates back to Fama and French's (hereafter FF) 1992 seminal paper, which identifies market capitalization and book-to-market ratio as two major determinants of the cross-sectional variations in stock returns. From a rational viewpoint, FF (1993) then propose a three-factor model in the spirit of Merton's (1973) Intertemporal Asset Pricing Model (ICAPM) and Ross's (1976) Arbitrage Pricing Theory (APT) by constructing two factor portfolios to capture the size and the BM premiums (i.e., SMB and HML).

Although FF's (1993) three-factor model is by far the most popular empirical asset-pricing model mainly because of its simplicity, competitive factor model specifications that claim to outperform the Fama-French model have also been proposed. Two such recent models provide additional insight concerning the nature of the asset-pricing anomalies. First, Ferguson and Shockley (hereafter FS, 2003) show that size and BM effects arise because of improper measurement in the equity-only proxy for the market portfolio. They derive two alternative factors based on leverage and distress, and show that the two factors surpass the explanatory power of SMB and HML proposed by FF (1993). Liu (2006) proposes a liquidity-augmented two-factor CAPM that claims to explain anomalies associated with size, long-term contrarian investment, and fundamental (cashflow, earnings, and dividend) to price ratios, thus suggesting that asset-pricing anomalies are related to a missing liquidity factor.

In addition to the debate on the sources of explanatory power of size and BM, researchers also identify several other asset-pricing anomalies. For example, Miller and Scholes (1982) document the low price effect because low-price firms are often in financial distress. Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996) and Acharya and Pedersen (2005), among others, find that liquidity affects expected returns. Lo and MacKinlay (1990a), and Jegadeesh and Titman (1993) document predictability from past returns, which in turn contributes to the profitability of contrarian and momentum strategies. The readers are referred to Schwert (2002) for an excellent survey of the literature on asset-pricing anomalies.

Despite the existence of numerous empirical findings that either support or refute the explanatory power of alternative multi-factor models, those findings are likely to be contaminated by the data-snooping biases documented by Lo and MacKinlay (1990b). Schwert (2002) suggests that a solution to this problem is to test the anomalies on an independent sample. As the world's second largest in terms of market capitalization, the Japanese market differs from the U.S. market in several aspects, such as cultural backgrounds and institutional structures. Thus, the Japanese data represent a good independent sample that allows for testing the robustness of the asset-pricing anomalies in markets with different aspects from those of the U.S market. This provides the first motivation of this paper. Although previous studies have employed Japanese data to examine the factor/characteristics debate on size and BM (e.g., Daniel, Titman and Wei, 2000) and other regularities such as momentum/contrarian profitability (Chou, Wei and Chung, 2007), we conduct a more extensive analysis on the explanatory power of three competing factor models on several asset-pricing anomalies. The three models considered are FF's (1993) three-factor model, FS's (2003) three-factor model, and Liu's

(2006) liquidity-augmented two-factor model.

The second motivation of this paper is inspired by observing the methodology employed in the literature. In most of the empirical studies, Fama and MacBeth's (1973) two-pass cross-sectional regression is often adopted to study portfolio returns constructed by sorting securities on some variables of interest. However, Roll (1977), and Lo and MacKinlay (1990b) argue that biased statistical inference may be induced when the portfolios are sorted on some variables of interest. In addition, Fama-MacBeth's two-pass methodology suffers from the errors-in-variables (EIV) problem (Shanken, 1992), thus causing the statistical inference to be invalid (Kim, 1995; 1997). To avoid the two aforementioned problems, we advocate an empirical methodology proposed by Brennan, Chordia, and Subrahmanyam (hereafter BCS, 1998). Specifically, BCS (1998) suggest using risk-adjusted returns as dependent variables in tests of linear beta pricing models, and demonstrate that the EIV problem can be avoided without the need to group securities into portfolios. As a consequence, the BCS approach is statistically more powerful than the analysis based on portfolio samples, as is argued by Lewellen, Nagel, and Shanken (2006). Furthermore, it avoids the portfolio formation process problem that is commonly encountered in the Fama-MacBeth cross-sectional regression. Finally, with the BCS approach, both conditional and unconditional pricing models can be easily tested.

As a robustness check, we also conduct a subperiod analysis by splitting the sample into two sub-periods, namely 1978-1990 and 1991-2006. The subperiod analysis is special in that the Japanese markets were known to experience an economic bubble in the late 1980s, following which was a decade of stagnant economic growth which contributed to what the Japanese refer to as “the Lost Decade”.[1] To eliminate the deflation problem caused by the collapse of the economic bubble, the Bank of Japan has tried to reduce interest rates since then. In July 2006, the zero-rate policy turned out to be unsuccessful, and was officially ended. This policy has led the time-series of the Japanese interest rates to experience completely different regimes before and after 1990, as demonstrated in Figure 1. This serves as the main reason why we have chosen 1990 as the cutoff point. And, it is of interest to examine how asset-pricing anomalies and competing factor models interact with each other under different economic regimes.

The major findings of this paper can be summarized as follows. Unlike the U.S. evidence where size, BM and momentum are the major determinants of stock returns, we find significant BM and turnover premiums in the Japanese market for 1978-2006. A closer inspection at the subperiods reveals that turnover and low-price effects are major determinants of stock returns for 1978-1990, whereas the BM premium is significant only for 1991-2006. The small-firm effect is surpassed by the low-price and turnover effects. Also, the low-price and turnover effects for 1978-1990 can not be explained by any of three asset-pricing models, whereas the BM effect for 1991-2006 is well explained by a conditional version of the Fama-French three-factor model.

The results suggest that the explanatory ability of different firm characteristics may have different roots. It seems that turnover and low-price premiums before 1990 reflect investors’ irrational reaction to the economic bubble, whereas the BM effect reflects investors’ rational response to a common factor. Among the three competing asset-pricing models, the Fama-French three-factor model remains the best model that

[1] Miyao (2002), for example, attributes the bubble to monetary policy shocks, and Kato (1995) suggests that the bubble crashed as investors’ expectations collapsed.

describes stock returns, indicating that the better performance of later models over the Fama-French three-factor documented based on the U.S. data may have been exaggerated.

The rest of this paper is organized as follows. Section 2 presents the econometric method and the model specifications. Section 3 defines the variables of interest and describes the sample. Regression results and robustness checks are presented in Section 4. The last section concludes the paper.

2. Methodology

2.1. The BCS Approach

Our methodology mainly follows BCS (1998). Consider a *K*-factor asset-pricing model as follows:

$$R_t = B_0 + BF_t + E_t , \qquad (1)$$

where R_t is an $N \times 1$ vector of excess returns in month *t* on the *N* firms, F_t is a $K \times 1$ vector of common factors, *B* is an $N \times K$ matrix of factor loadings, and E_t is an $N \times 1$ vector of residuals. Based on the *K*-factor model, the risk-adjusted returns of individual firms are thus defined as follows:

$$R_t^* \equiv R_t - \hat{B}F_t . \qquad (2)$$

The null hypothesis of the BCS approach suggests that the expected returns are determined by the APT factors, while the alternative hypothesis states that firm characteristics have incremental explanatory power over the factor benchmark. To test the hypothesis, the risk-adjusted returns are regressed on the firm characteristics as follows:

$$R_t^* = C_0 + ZC_t + E_t\,, \qquad (3)$$

where C_0 is an $N \times 1$ vector of intercepts in month t on the N firms, Z is an $N \times M$ matrix of values of N firms on the M characteristics, and C_t is an $M \times 1$ vector of premiums per unit on the M characteristics in month t. If the K factors are able to completely describe expected returns, firm characteristics should have no significant explanatory power for the risk-adjusted returns. Hence, both C_0 and C_t are insignificantly different from zero. Although the BCS approach is free from the EIV problem, the estimates of the risk-adjusted return used as the dependent variable may still be subject to the problem of microstructure effects, such as nonsynchronous trading and bid-ask bounce. To adjust for the infrequent trading problems, we follow Dimson (1979) and FF (1992) by including both current and one-period lagged factors to adjust the estimates of factor loadings as follows:

$$R_t = B_0 + BF_t + B'F_{t-1} + E_t\,. \qquad (4)$$

Correspondingly, the risk-adjusted returns now become:

$$R_t^* \equiv R_t - \hat{B}F_t - \hat{B}'F_{t-1}\,. \qquad (5)$$

2.2. Factor Specification, Firm Characteristics, and Estimations

To implement the BCS approach, we need to explicitly specify the factor models and firm characteristics in consideration. In this paper, we compare the following three alternative factor specifications:[2]

1. The Fama-French (1993) three-factor model. The model specification is:

$$R_{it} = \alpha_i + b_i Mkt_t + s_i SMB_t + h_i HML_t + \varepsilon_{it}\,,$$

[2] Details for the formation of factor portfolios are presented in the Appendix.

where R_i is the excess return on stock *i*, Mkt_t is the market excess return, SMB_t is the return on the mimicking size portfolio controlling for BM, and HML_t is the return on the mimicking BM portfolio controlling for size.

2. The Ferguson-Shockley (2003) three-factor model. The model specification is:

$$R_{it} = \alpha_i + b_i Mkt_t + d_i R_{D/E,t} + z_i R_{Z,t} + \varepsilon_{it} ,$$

where $R_{D/E,t}$ is the return on the relative leverage factor associated with the ratio of debt-to-equity, and $R_{Z,t}$ is the return on the relative distress factor associated with Altman's (1968) Z-score.

3. Liu's (2006) liquidity-augmented two-factor model. The model specification is:

$$R_{it} = \alpha_i + b_i Mkt_t + l_i LIQ_t + \varepsilon_{it} ,$$

where LIQ_t is the return on the liquidity factor, which is based on a multi-dimensional liquidity measure proposed by Liu (2006).

For firm characteristics, we consider eight of them which are mentioned most often in prior studies. They are firm size, BM, reciprocal of share price, turnover, dividend yield, and three lagged return variables, which we discuss in turn as follows. The firm size is included because of the importance of the small size effect mentioned by Banz (1981) and FF (1992). FF (1992) and Lakonishok et al. (1994) find that BM is strongly and positively related to the average returns, so we also include BM. Low price effect is documented by Miller and Scholes (1982), who claim that the low-price firms are often in financial distresses. We include the reciprocal of share price to detect the low price effect. Additionally, we use turnover as the liquidity measure because some studies suggest that the liquidity affects expected returns (Amihud and Mendelson, 1986 and Brennan and Subrahmanyam, 1996). We include dividend yield, since Miller and Scholes (1982) find that it is relevant to stock returns. Finally, we include three lagged return variables because numerous studies on contrarian/momentum strategies find that stock returns are correlated with their past returns (e.g., Lo and MacKinlay, 1990a; Jegadeesh and Titman, 1993).

In estimating factor loadings, we consider both unconditional and conditional cases. For the unconditional version of the model, the factor loadings in Equation (4) are estimated by the time-series estimates over the whole sample period. For the conditional case, we estimate factor loadings each year using returns over past 60 months, which is consistent with BCS (1998). Under the null hypothesis of the K-factor version of the APT, we follow BCS (1998) by applying the Fama-MacBeth approach to estimate Equation (5).

3. Data Description and Definitions of Variables

We obtain monthly data from the database compiled by the PACAP Research Center. The sample consists of monthly returns of common stocks listed on the Tokyo Stock Exchange (TSE) from January 1975 to December 2006. Stocks listed on the TSE account for more than eighty-five percent of the total market capitalization of the Japanese equities (Chan et al., 1991). Since there is no risk-free rate in Japan comparable to the U.S. Treasury bill rates, we follow Chan et al. (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 2006) as the risk-free rate.

We obtain book value data from annual financial statements. Similar to FF (1992), we exclude financial firms from our sample.

To be included in the sample for a given month, a stock must satisfy the following three criteria:

1. Its returns in the current month and in at least 24 out of the previous 60 months are available to facilitate calculation of the ex ante factor loadings.
2. There is sufficient data available to calculate the size, price, turnover, and dividend yield as of the previous month.
3. There is sufficient data available to calculate the book-to-market ratio as of March.[3]

Our final sample contains 2,691 firms, each of which has observations up to 384 monthly returns. On average, there are 1,515 stocks per month. The definitions and calculations of the eight characteristics for each stock are given as follows.

- SIZE is defined as the natural logarithm of the market capitalization of the firms calculated as of the end of the second to last month (in millions of Yens).
- BM is the natural logarithm of the ratio of the book value of equity (BE) to the market value of the equity (ME), using the BE of a firm at the fiscal year-end that falls between April of year t-1 and March of year t.
- TURNOVER is the trading volume divided by shares outstanding in the second to last month.
- PRICE refers to the natural logarithm of the reciprocal of the share prices as reported at the end of the second to last month (in Yens).
- DY is defined as the dividend yield measured by the sum of all cash dividends paid

[3] This is because most firms listed on the TSE use March as the end of their fiscal year.

over the previous 12 months, divided by the share price at the end of the second to last month (in percentage).

- RET2-6 denotes the natural logarithm of the cumulative return over the 5 months ending at the beginning of the previous month.
- RET 7-12 denotes the natural logarithm of the cumulative return over the 6 months ending 6 months previously.
- RET 13-24 denotes the natural logarithm of the cumulative return over the 12 months ending 12 months previously.

As in FF (1992), book-to-market ratio with values greater than the 0.995 fractile or less than the 0.005 fractile are set equal to be the 0.995 and 0.005 fractile values, respectively. To avoid biases arising from bid-ask effects and thin trading, variables such as the lagged return variables, BM, TURNOVER, and PRICE are lagged by one additional month.

The time-series averages of the cross-sectional means, medians, and standard deviations of returns and the raw security characteristics are presented in Table 1. Except DY that may take a zero value, all remaining variables are transformed by natural logarithm because they are considerably skewed. Table 2 reports the averages of the month-by-month cross-sectional correlations of the variables. The correlations for all of the variables are smaller than 0.50 in absolute values, with the most significant one being the correlation between SIZE and PRICE, which is -0.4244. Hence the multicollinearity problem does not seem to be serious in our data.

To give a preview on how various characteristics are related to stock returns in the Japanese markets, Table 3 reports the average returns on the ten decile portfolios sorted on several firm characteristics. The premium on a certain firm characteristics is calculated as the difference in average returns between the highest characteristic decile portfolios and the lowest characteristic decile portfolios. It is notable that the size premium is significant only for full and pre-1990 periods, with values of 1.051% (small minus big) per month for the full sample, 1.482% per month for 1978-1990, and 0.701% per month for 1991-2006. The BM premium, however, is significant across all three periods (with premiums of 1.114%, 0.887%, and 1.299% for full, pre-1990, and post-1990 periods, respectively). Like the size effect, the liquidity effect (low-turnover minus high-turnover) and low-price effect (low-price minus high-price) are also pronounced for the pre-1990 period (0.546% and 2.038% respectively). The preliminary results suggest that the empirical anomalies in the Japanese market exhibit some structural changes.

4. Empirical Results

In this section, we start with the examination of the non-risk adjusted returns to gain an overall understanding of the anomalies in Japan. The results are presented in section 4.1. We then compare competing explanatory abilities of the three alternative factor pricing models in section 4.2 based on the BCS approach using risk-adjusted returns. In Section 4.3, we offer various robustness checks that include examinations of subperiods, extreme returns, and alternative specifications that consider momentum and liquidity as additional factors.

4.1. Results of Excess Returns

Before we formally compare the competing explanatory abilities of the alternative factor pricing models, we first examine the cross-sectional explanatory abilities of the firm characteristics based on the Fama-MacBeth regression. The results are reported in Table 4, in which three different models are estimated with different choices of firm characteristics, labeled as Model (1) through Model (3), respectively. Several interesting results emerge in Table 4.

1. Size effect and turnover effect. For the full period, 1978-2006, the coefficient of firm size is significantly negative (-0.1516; *t*-statistic = -1.99) when only SIZE and BM are included as the sole explanatory variables. A closer look at the subperiod results indicates that the small-firm effect is significant only for the first subperiod, 1978-1990. The size effect completely disappears when other firm characteristics are also included in the regression. The results for the full period and for the first subperiod suggest that the small-firm effect in Japan is subsumed by the turnover effect; the turnover premium is -1.82 (*t*-statistic = -1.90) for the full period, and is -2.32 (*t*-statistic = -3.37) for 1978-1990.
2. BM effect. The BM premium is significantly positive for all models for the full period. But subperiod results indicate that the BM effect is significant only for the second subperiod, 1991-2006. Compared with the size effect, which is significant only for the first sub-period, this displays a sharp contrast. However, this is consistent with the prediction of Zhang (2005), who argues that the value premium would be higher in bad times because of the higher price of risk.[4]
3. Lagged-return patterns. For the full period, the coefficients of RET2-6 and

[4] Zhang (2005) proposes the costly reversibility and countercyclical price of risk hypotheses, and argues that assets in place are harder to reduce in bad times. As a result value (high BM) firms are riskier than growth (low BM) firms because of the higher price of risk.

RET13-24 are significantly negative (see Model (2)), which are consistent with the finding documented in Chou, Wei and Chung (2007) that the Japanese market exhibits negative autocorrelations in both short and long return intervals. However, the past-return premiums become insignificant with the inclusion of TURNOVER in the regression.

Overall, the results indicate that BM and turnover are the two major determinants of stock returns over the full period (see Model (3) for 1978-2006). But the subperiod results indicate that the turnover premium is significant only for the first subperiod, and the BM premium is significant only for the second subperiod. The low-price effect also plays a significant role in the first subperiod; the coefficient of PRICE is 0.54, with a *t*-statistic of 2.34.

The patterns of premiums on the firm characteristics in the Japanese market are apparently different from those of the U.S. market. In particular, there is strong evidence indicating structural changes in the determinants of stock returns over the sample period. Although our results indicate a significant negative premium for stocks with high turnover, it does not refute either rational or behavioral argument; the premium for low-turnover firms can be compensation for liquidity risk (e.g., Amihud, 2002; Liu, 2006), or it can result from overreaction due to pessimism (e.g., Baker and Stein, 2004).

If the Japanese markets were efficient in the sense that determinants such as price, turnover and BM reflect investors' rational behavior, one would expect their premiums to be at least significant over different periods of time; but it does not appear to be the case. On the other hand, if the asset bubble in the 1980s were driven by non-rational forces as advocated by recent behavioral finance studies, variables such as turnover and price may have in fact reflected investors' sentiments that could deviate from the economic fundamentals. Indeed, the Nikkei 225 stock index started from a low of 7,042 in August 1982, and rose to 38,915 in December 1989; a more than fivefold growth in a seven-year period does not appear to be consistent with any of the existing rational economic theory.

What remains as a puzzle is why the BM effect is significant only after 1990? If the "lost decade" following the burst of the bubble signifies investors' irrational pessimistic views about future prospects, the BM premium would still be a behavioral phenomenon. But, this would also imply that behavioral patterns change over time, because the explanatory abilities of turnover and price for stock returns before 1990 are replaced by BM after 1990. On the other hand, if the markets were indeed efficient after 1990, then the significant BM premium would reflect compensation for bearing certain risk, in which case the premium should be captured by certain asset-pricing models.

While we are not yet certain which of the above conjectures is correct, it is clear that asset-pricing anomalies such as the size, BM and turnover effects documented based on the U.S. sample is not universal, and may have been driven by different forces.

4.2. Results of Risk-Adjusted Returns Using the Asset-Pricing Models

To further differentiate the above conjectures, we explore whether the explanatory power of those firm characteristics can be explained by existing asset-pricing models in this subsection. Table 5 reports the results based on the BCS regression for the full sample period for both unconditional and conditional settings. The returns are risk adjusted using the Fama-French three-factor model (denoted FF), the Ferguson-Shockley three-factor model (denoted FS), and Liu's liquidity-augmented CAPM (denoted Liu), respectively.

Let us first focus on the BM effect. The unconditional BM premium is significant regardless of the factor models used to calculate the risk-adjusted returns. But for conditional tests, the BM premium becomes insignificant when returns are adjusted using either the FF or the FS models; the right panel of Table 5 indicates that with the conditional test, the coefficient of BM is 0.13 (*t*-statistics = 1.62) under the FF adjustment, and is 0.14 (*t*-statistic = 1.44) under the FS adjustment. The results suggest that the BM effect in Japan is captured by a conditional version of risk-based factor models (FF and FS), supporting FF's and FS's view that higher returns for higher BM firms are compensations for their higher distress risk. However, the BM effect is not consistent with the liquidity argument advocated in Liu's liquidity-based model.

Second, the coefficient on TURNOVER is significant for *all* scenarios, regardless of the factor models used to calculate the risk-adjusted returns, conditionally or unconditionally. It is interesting to note that although Liu's liquidity factor does take turnover into account, it still fails to fully explain the turnover effect in the Japanese markets. Perhaps the failure of Liu's liquidity-based model is because the liquidity factor is essentially a measure of 'no trading' that only partially adjusts for turnover. If the turnover effect were driven by rational forces, the results suggest that there is a need for a different liquidity factor that places more weights on turnover than on zero-trading. We will explore this in more detail later.

Finally, there is weak evidence of return reversals as some of the coefficients on the past-return variables are statistically significant; the coefficients on RET2-6 and RET13-24 remain significantly negative in some scenarios. The size effect, again, is insignificant for all scenarios, which is consistent with the results reported in Table 4.

4.3. Robustness Checks

We provide several tests to examine whether our results are robust to different market conditions, to the exclusion of extreme observations, and to the use of combined models.

4.3.1. Subperiod Analysis

To further identify how the three competing asset-pricing models perform in terms of explaining the asset-pricing anomalies under different market conditions, we perform the BCS regression on two subperiods, again using 1990 as the cut-off point. Since the results from Table 5 indicate that the conditional asset-pricing models provide a better account of the cross section of stock returns, here in this subsection, we only report the results based on conditional tests.[5] Table 6 reports the results of conditional tests.

Let us first look at the results for 1978-1990, which are reported in the left panel of Table 6. The results are qualitatively similar for all of the three models. The premiums on size and BM are insignificant; this suggests that the two most important anomalies in the U.S. markets are not as important in the Japanese market, thus rendering the debate on rationality and market efficiency irrelevant. The premiums on TURNOVER and PRICE remain significant across all three models. The significant turnover and low-price premiums that can not be explained by the asset-pricing models suggest that they may have been induced by irrational behavioral factors. The long-term contrarian (i.e., the coefficient of RET13-24) is significant for FF-adjusted and

[5] The results of unconditional tests are available upon request.

FS-adjusted returns, but not for liquidity-adjusted returns. Note, however, that past returns do not explain the cross section of excess return in the first subperiod (see the middle panel of Table 4). This suggests that none of the three models serves as a good asset-pricing model, at least for 1978-1990.

Next, we turn our attention to the bearish period, 1991-2006. Recall that BM is the only firm characteristic that significantly explains stock returns in the second subperiod. Here the results are surprising. None of the coefficients on firm characteristics, including BM, is statistically significant under the FF risk adjustment; the coefficient of BM is 0.20 (*t*-statistic = 1.64). In contrast, the BM premium remains significant under either the FS adjustment or Liu's adjustment; the coefficient of BM is 0.30 (*t*-statistic = 2.08) under the FS adjustment, and is 0.48 (*t*-statistic = 3.23) under Liu's adjustment. In addition, the coefficient of RET13-24 is significantly negative (-0.64 with a *t*-statistic of -1.99) under the FS adjustment, and RET2-6 is significantly negative (-0.99 with a *t*-statistic of -2.01) under Liu's adjustment. The results indicate that neither the FS model nor Liu's liquidity-based CAPM serves as an adequate asset-pricing model that explains the cross-sectional variation in stock returns in Japan.

At this moment, we are ready to draw some conclusions. First, the overall impression is that the Japanese market in the first subperiod is inefficient, echoing the view that the asset bubble is caused by behavioral forces. The inefficiency is captured by the turnover and low-price premiums, which can not be explained by any of the three popular asset-pricing models. Second, the markets become efficient after 1990 because "behavioral" factors such as turnover and price lose their explanatory power, and the BM effect, while statistically significant, is well-explained by a conditional version of the

Fama-French three-factor model. None of the firm characteristics have incremental explanatory ability after stock returns are risk-adjusted by the Fama-French three-factor model. The fact that the markets become efficient somehow echoes Schwert's (2002) view that markets are becoming more and more efficient as practitioners start to explore the regularities identified by the academics. Third, the Japanese evidence suggests that, in comparison with the alternative asset-pricing models, the Fama-French three-factor remains the best model that describes stock returns. Although models such as the Ferguson-Shockley three-factor model or Lius's liquidity-based CAPM claim that they outperform the Fama-French three-factor model, the claim is skeptical because they suffer more from the data-snooping bias, as argued by Lo and Mackinlay (1990b).[6] Our Japanese data represent an independent sample free of data-snooping biases, and the results suggest that the performance of the Fama-French three-factor model, though initially motivated by empirical evidence, is perhaps not an artifact. Our last observation is related to the nature of the BM effect. While the academics have not reached a consensus concerning whether it is a behavioral or a rational force that drives the BM premium, our Japanese evidence indicates that the BM effect is rational because it is well-explained by the Fama-French three-factor model.

4.3.2. LTS Regression Results

To examine whether our results are affected by extreme firms, we apply the least-trim squares (LTS) regression method by trimming 1% extreme observations each month (Knez and Ready, 1997). The results are reported in Table 7. The results

[6] There is a potential selectivity bias in that later models would necessarily outperform the earlier ones, because otherwise they would not have been published.

indicate several effects: (1) a significant positive size effect for 1991-2006; (2) significant coefficients on BM, and TURNOVER for the full and two sub-periods; (3) effects of PRICE, RET2-6 and RET13-24 are significant for 1978-1990, while that of DY is significant for 1991-2006. None of these effects is explained by any of the three asset-pricing models. In fact, the coefficients of these characteristic regularities under the factor adjustments are even larger than the numbers under the excess return (denoted ER) adjustment. The last finding reveals interesting results for extreme observations. Contrary to Knez and Ready (1997), we show that the anomalies become more significant when the extreme 1% observations of firms are eliminated, even the returns are adjusted by the risk factors. This implies that the behavior of extreme firms is different with other individual firms, and may lead to relative lower returns.[7]

4.3.3. A Further Examination on Momentum and Liquidity

Since the empirical evidence indicates that during the first subperiod, the regularities related to turnover, price, and past returns are not well explained by the asset-pricing models, we explore some alternative model specifications to see if they can better explain those regularities.

We choose two models, the FF model and the FS model, as the benchmark, and augment them by either including Liu's liquidity factor or a momentum factor constructed *a la* Carhart (1997). In combination, this gives four models. We perform the BCS regression over the full period and the two subperiods based on conditional tests. The results are reported in Table 8.

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[7] It may be of interest to further investigate the firm characteristics of these extreme firms in Japan, for example, using the quantile regression. We leave this issue for future research.

From Table 8, one can observe that the coefficients are qualitatively the same as in Table 5 and Table 6. Turnover, price and RET13-24 retain their significance for 1978-1990, while the Carhart's four-factor model (denoted FF+MOM) remains the best model that explains stock returns for 1991-2006. Yet, adding the momentum factor to the FF three-factor model appears to be unnecessary, because the FF three-factor model alone has provided very good account of the stock returns for 1991-2006.

5. Conclusion

Based on a sample of stocks from the Tokyo Stock Exchange over 1978-2006, we examine the explanatory power of various firm-characteristic-related anomalies documented in the literature, and investigate if those asset-pricing anomalies can be explained by three popular rationality-based multi-factor models, namely the Fama-French (1993) three-factor model, Ferguson-Shockley (2003) three-factor, and the liquidity-augmented CAPM of Liu (2006).

Overall, we identified several interesting findings that are different from the U.S. market. First, we find significant premiums for firms with high turnover and low price before 1990. The premiums cannot be explained by any of the three popular asset-pricing models and appear to reflect investors' irrationality, because the Japanese market experienced an asset bubble during this period, in which the Nikkei stock index significantly deviated from the economic fundamentals. The fact that the explanatory power of turnover and price disappears after the burst of the bubble further strengthens the conjecture that turnover and low-price premiums are behaviorally driven.

Second, we find that the BM premium is the sole firm characteristic that explains the cross-sectional variation in stock returns after 1990, but it provides no incremental explanatory power beyond that of the Fama-French three-factor model. Thus, the Japanese results provide additional evidence supporting a risk-based explanation of the value premium.

Finally, based on the Japanese data that represent an independent sample free of data-snooping biases, we find that the Fama-French three-factor model remains the best model among the three popular asset-pricing models. Our results suggest that the success of those later proposed asset-pricing models, especially in terms of their superiority over the Fama-French three-factor model, may have been overstated.

Appendix: Estimation Procedures in Details

1. Fama-French factors formation

To form FF's (1993) three-factor model, we construct the portfolios of common stocks based on market equity, and on the ratio of the book equity to market equity. Because most firms listed on the TSE have March as the end of their fiscal year, and the accounting information becomes publicly available before September, portfolios are formed on the first trading day of October in year *t*. The portfolios are held for exactly one year and rebalanced every year as in FF (1993). Book equity (BE) in year *t* is defined to be stockholder's equity from PACAP of a firm at the fiscal year-end that falls between April of year *t*-1 and March of year *t*. Market size is the number of shares outstanding times the share price at the end of September of year *t*. BM is calculated as the ratio of the BE to the market equity at the end of March of year *t*.

We exclude firms with negative book-to-market ratio from our sample. We then rank stocks according to their size and BM. The breakpoints are the 50th size percentile and the 30th and 70th BM percentiles. According to these breakpoints, we place all stocks into three BM groups (H, M, and L) and two size groups (B and S) and get six value-weighted portfolios (H/B, H/S, M/B, M/S, L/B, and L/S). Finally, we mimic the performance of the portfolios of SMB by the difference between average return of H/S, M/S, and L/S, and average return of H/B, M/B, and L/B. While the performance of the HML portfolio is mimicked by the difference between average return of H/S and H/B and average return of L/S and L/B. The return on the *Mkt* portfolio is the value weighted return of all firms.

2. Ferguson-Shockley factors formation

Following Ferguson and Shockley's (2003) methodology, we construct two portfolios to mimic the part of common return associated with relative leverage (based on the ratio of debt-to-equity), and the part of return associated with relative distress (based on Altman's Z-score). The way to generate the leverage and distress return time series is the same with the construction of FF's (1993) SMB and HML factors. In October of each year *t*, firms are assigned to one of three debt-to-market equity (BD/ME) portfolios based on the one-third and two-third percentile cutoffs. Independently and simultaneously, firms are assigned to one of two Altman's Z portfolios: $Z \leq 1.8$ and $Z>1.8$. The Altman's Z is defined as follows:

$$Z = 1.2\frac{WC}{TA} + 1.4\frac{RE}{TA} + 3.3\frac{EBIT}{TA} + 0.6\frac{ME}{BD} + 1.0\frac{S}{TA},$$

where *WC* is net working capital, *TA* is total book assets, *RE* is retained earnings, *BD* is book debt, *EBIT* is earnings before interest and taxes, and *S* is total sales revenue, and *ME* is market value of equity.

The intersection of the two sorts based on BD/ME and Z results in six debt-to-equity/Z portfolios as of October of each year. From October of year *t* through September of year *t*+1, we calculate the return on each portfolio as the value-weighted average return of the stocks in the portfolio. In each month *t*, the leverage factor, $R_{D/E}$, is calculated as the simple average return of the two Z portfolios within D/E portfolio 3 (the highest levered firms) minus the simple average return of the two Z portfolios within D/E portfolio 1 (the least levered firms). Similarly, the distress factor, R_Z, is the simple average return of the three D/E portfolios within Z portfolio 2 (the highest-Z firms) minus the simple average return of the three D/E portfolios within Z portfolio 1 (the lowest-Z firms).

3. Liu's factor formation

The construction of Liu's (2006) factor is based on a multi-dimensional measure, which describes the standardized turnover-adjusted number of zero daily trading volumes over the past 12 months, expressed as:

$$LM = \left[Zero12 + \frac{1/TTO12}{Deflator} \right] \times \frac{252}{NoTD},$$

where $Zero12$ is the number of zero daily volumes over the past 12 months, $TTO12$ is the sum of daily turnover over the past 12 months, $NoTD$ is the total number of trading days in the market over the past 12 months, and $Deflator$ is set to be 11,000 such that the turnover-adjusted term ($\frac{1/TTO12}{Deflator}$) falls between 0 and 1.

The construction of the mimicking portfolio on the liquidity factor is similar to the construction of SMB and HML in FF (1993). As in Liu (2006), we form the liquidity factor as the difference between returns on the low-liquidity portfolio and returns on the high-liquidity portfolio for the period from January 1975 to December 2006. We denote LL as the low-liquidity portfolio and HL as the high-liquidity portfolio. The LL portfolio contains the least-liquid stocks with the highest LM values based on a 30% breakpoint and the HL portfolio contains the most-liquid stocks with the lowest LM values based on a 30% breakpoint. We then construct the liquidity factor, LIQ, as the monthly returns from buying one dollar of equally weighted LL and selling one dollar of equally weighted HL.

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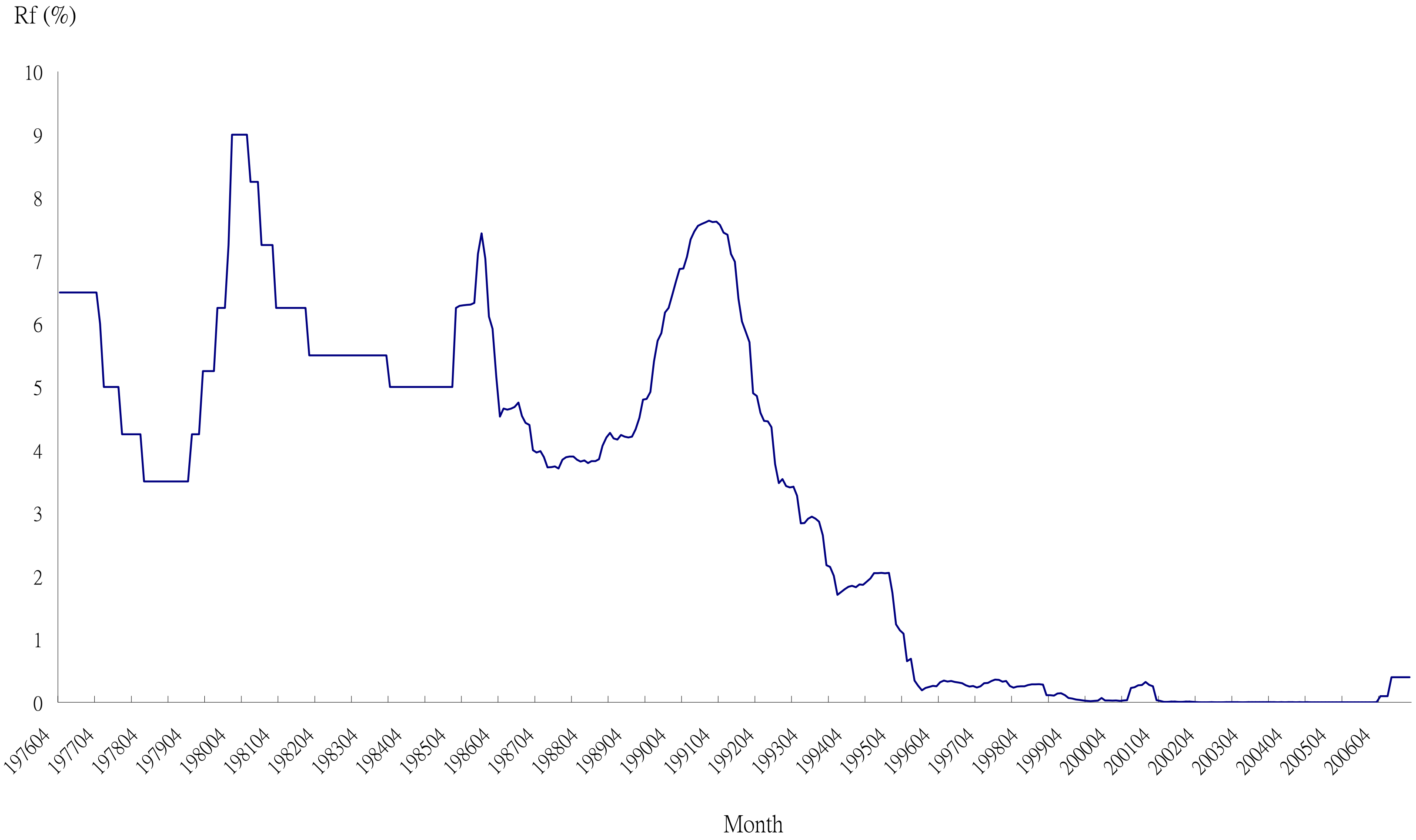

Figure 1 Time Series of Annual Interest Rate in Japan

Table 1
Summary Statistics

The summary statistics present the time-series averages of cross-sectional statistics over 348 months from January 1978 through December 2006. The variables are defined as follows. Return is the raw return. Firm size is the market value of the equity of the firm as of the end of the second to the last month. Book-to-market ratio is the ratio of BE and ME at the end of the second to the last month. TURNOVER is the trading volume divided by shares outstanding in the second to last month. Share price is the share price as reported at the end of the second to the last month. Dividend yield is the sum of all dividends paid over the previous 12 months divided by the share price as reported at the end of the second to the last month.

Variable	MEAN	MEDIAN	STD. Dev.
Return (%)	1.0601	1.3958	5.8232
Firm size (millions of yens)	134466	143035	69489
Book-to-market Ratio	0.7133	0.5908	0.3793
TURNOVER (%)	4.5789	4.0135	2.6246
Share price (yen)	6799.5	2753.9	9980
Dividend yield (%)	1.2479	1.3126	0.4819

Table 2
Correlation Matrix

This table presents time-series of monthly cross-sectional correlations between the transformed firm characteristics used in the regressions. Return is the raw return. SIZE is the natural logarithm of the market value of the equity of the firm as of the end of the second to the last month. BM is the natural logarithm of the ratio of BE and ME at the end of the second to the last month. TURNOVER is the trading volume divided by shares outstanding in the second to last month. PRICE is the natural logarithm of the reciprocal of the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. R2-6, R7-12, R13-24 equal the logarithms of the cumulative returns over the second through the sixth , the seventh through the 12th, and the 13th through the 24th months prior to the current month, respectively. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

Variable	RETURN	SIZE	BM	TURNOVER	PRICE	DY	RET2-6	RET7-12	RET13-24
RETURN	1	-0.0124	0.0279**	-0.0266**	0.0205*	0.0144**	-0.0021	0.0082	-0.0137*
SIZE		1	-0.1801**	0.0658**	-0.4244**	0.0276*	0.0746**	0.0713**	0.0880**
BM			1	-0.0844**	0.2268**	0.4133**	0.0742**	-0.0375*	-0.2280**
TURNOVER				1	-0.3104**	-0.1554**	0.2911**	0.0734**	0.0272**
PRICE					1	0.1031**	-0.0997**	-0.0922**	-0.1240**
DY						1	-0.1752**	-0.1143**	-0.0873**
RET2-6							1	-0.0468**	-0.0529**
RET7-12								1	-0.0605**
RET13-24									1

Table 3
Average Monthly Returns of Characteristic Portfolios

This table presents average monthly returns for portfolios based on different firm characteristics. SIZE is the market value of the equity of the firm as of the end of the second to the last month. BM is the ratio of BE and ME at the end of the second to the last month. TURNOVER is the trading volume divided by shares outstanding in the second to last month. Share price is the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. *S* denotes the lowest characteristic decile portfolio, and B denotes the highest characteristic decile portfolio. The Newey-West adjusted *t*-statistics are in parentheses. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

Period	*S*	*D2*	*D3*	*D4*	*D5*	*D6*	*D7*	*D8*	*D9*	*B*	*B-S*
Panel A: Portfolios sorted by SIZE											
1978-2006	1.791**	1.283**	1.172**	1.021**	0.901*	0.805*	0.756*	0.729*	0.788**	0.741**	-1.051**
	(3.61)	(2.98)	(2.86)	(2.66)	(2.46)	(2.34)	(2.35)	(2.49)	(2.75)	(2.62)	(-2.64)
1978-1990	2.706**	2.158**	2.037**	1.770**	1.600**	1.471**	1.357**	1.280**	1.320**	1.224**	-1.482**
	(4.72)	(4.16)	(4.23)	(4.09)	(3.70)	(3.70)	(3.55)	(3.47)	(3.46)	(3.03)	(-2.59)
1991-2006	1.048	0.572	0.470	0.413	0.333	0.264	0.268	0.282	0.356	0.348	-0.701
	(1.45)	(0.92)	(0.78)	(0.71)	(0.61)	(0.51)	(0.56)	(0.66)	(0.88)	(0.91)	(-1.34)
Panel B: Portfolios sorted by BM											
1978-2006	0.460	0.705*	0.760*	0.905**	0.970**	1.059**	1.102**	1.172**	1.325**	1.574**	1.114**
	(1.18)	(2.08)	(2.28)	(2.72)	(2.89)	(3.06)	(3.17)	(3.24)	(3.45)	(3.54)	(4.05)
1978-1990	1.339**	1.420**	1.419**	1.549**	1.642**	1.689**	1.780**	1.829**	2.067**	2.226**	0.887**
	(2.97)	(3.32)	(3.37)	(3.80)	(3.92)	(4.04)	(4.37)	(4.40)	(4.76)	(4.74)	(2.58)
1991-2006	-0.255	0.124	0.225	0.383	0.423	0.548	0.550	0.638	0.723	1.044	1.299**
	(-0.44)	(0.25)	(0.47)	(0.79)	(0.87)	(1.08)	(1.06)	(1.19)	(1.26)	(1.53)	(3.20)
Panel C: Portfolios sorted by TURNOVER											
1978-2006	0.910**	1.078**	1.087**	1.149**	1.194**	1.099**	1.075**	0.953**	0.838**	0.590	-0.320
	(3.04)	(3.17)	(3.03)	(3.19)	(3.38)	(3.05)	(3.02)	(2.66)	(2.29)	(1.49)	(-1.45)
1978-1990	1.669**	1.892**	1.845**	1.929**	1.902**	1.754**	1.770**	1.588**	1.463**	1.123*	-0.546*
	(4.85)	(4.55)	(4.37)	(4.48)	(4.65)	(4.17)	(4.13)	(3.60)	(3.28)	(2.54)	(-1.95)
1991-2006	0.293	0.416	0.471	0.515	0.618	0.566	0.510	0.437	0.331	0.157	-0.136
	(0.68)	(0.87)	(0.90)	(0.99)	(1.18)	(1.06)	(0.97)	(0.82)	(0.61)	(0.25)	(-0.41)

Table 3 continued

Period	*S*	*D2*	*D3*	*D4*	*D5*	*D6*	*D7*	*D8*	*D9*	*B*	*B-S*
Panel D: Portfolios sorted by Share price											
1978-2006	1.890**	1.463**	1.143**	1.065**	0.872**	0.818**	0.734*	0.611*	0.562	0.718*	-1.171**
	(3.51)	(3.28)	(2.89)	(2.93)	(2.61)	(2.59)	(2.38)	(2.03)	(1.87)	(1.98)	(-2.73)
1978-1990	3.067**	2.372**	2.006**	1.903**	1.662**	1.438**	1.303**	1.103**	1.053*	1.029*	-2.038**
	(5.50)	(4.70)	(4.36)	(4.45)	(4.10)	(3.60)	(3.34)	(2.78)	(2.50)	(2.40)	(-3.73)
1991-2006	0.933	0.726	0.442	0.384	0.231	0.315	0.272	0.211	0.164	0.466	-0.467
	(1.13)	(1.08)	(0.76)	(0.72)	(0.48)	(0.70)	(0.61)	(0.49)	(0.40)	(0.87)	(-0.76)
Panel E: Portfolios sorted by DY											
1978-2006	1.242*	0.496	0.464	0.685*	0.795*	0.890**	1.062**	1.114**	1.238**	1.416**	0.195
	(2.42)	(1.21)	(1.34)	(2.11)	(2.48)	(2.71)	(3.13)	(3.25)	(3.47)	(3.94)	(0.87)
1978-1990	2.246**	0.752	0.990*	1.222**	1.395**	1.541**	1.670**	1.797**	1.999**	2.292**	0.046
	(4.33)	(1.46)	(2.15)	(2.89)	(3.37)	(3.64)	(3.97)	(4.47)	(4.55)	(5.16)	(0.16)
1991-2006	0.056	0.288	0.036	0.249	0.308	0.361	0.567	0.560	0.619	0.704	0.371
	(0.06)	(0.48)	(0.07)	(0.54)	(0.67)	(0.76)	(1.15)	(1.10)	(1.21)	(1.39)	(1.05)

Table 4
Regression Results on Excess Return

Coefficient estimates are time-series average of cross-sectional OLS regressions. The dependent variable is the excess return. The independent variables are defined as follows. SIZE is the natural logarithm of the market value of the equity of the firm as of the end of the second to the last month. BM is the natural logarithm of the ratio of BE and ME at the end of the second to the last month. The values of BM greater than the 0.995 fractile are set equal to 0.995 fractile and those less than the 0.005 fractile are set equal to 0.005 fractile. TURNOVER is the trading volume divided by shares outstanding in the second to last month. PRICE is the natural logarithm of the reciprocal of the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. R2-6, R7-12, R13-24 equal the logarithms of the cumulative returns over the second through the sixth , the seventh through the 12th, and the 13th through the 24th months prior to the current month, respectively. All coefficients are multiplied by 100. The *t*-statistics are in parentheses. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

	1978-2006			1978-1990			1991-2006		
	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)
Intercept	2.7689*	2.1018*	2.8953*	5.2900**	4.9261**	7.0469**	0.7204	-0.1930	-0.4779
	(2.59)	(2.21)	(2.46)	(3.62)	(3.40)	(4.09)	(0.50)	(-0.18)	(-0.34)
SIZE	-0.1516*	-0.1118	-0.0724	-0.3097**	-0.2817*	-0.1586	-0.0231	0.0263	-0.0024
	(-1.99)	(-1.63)	(-1.05)	(-2.72)	(-2.51)	(-1.33)	(-0.24)	(0.34)	(-0.03)
BM	0.3721**	0.2956**	0.2747**	0.2741	0.1809	0.0786	0.4517**	0.3888**	0.4340**
	(3.54)	(3.41)	(2.85)	(1.67)	(1.42)	(0.73)	(3.37)	(3.40)	(2.98)
TURNOVER			-1.8206			-2.3194**			-1.4153
			(-1.90)			(-3.37)			(-0.84)
PRICE			0.1790			0.5353*			-0.1105
			(1.34)			(2.34)			(-0.82)
DY			0.0136			0.0726			-0.0344
			(0.20)			(0.82)			(-0.37)
RET2-6		-0.8496*	-0.4022		-0.8611	-0.3062		-0.8403	-0.4801
		(-2.56)	(-1.27)		(-1.91)	(-0.70)		(-1.69)	(-1.04)
RET7-12		0.0847	0.1551		0.1926	0.4243		-0.0029	-0.0637
		(0.29)	(0.60)		(0.48)	(1.19)		(-0.01)	(-0.17)
RET13-24		-0.4334*	-0.3124		-0.4661	-0.2913		-0.4068	-0.3295
		(-2.20)	(-1.75)		(-1.57)	(-1.14)		(-1.55)	(-1.35)

Table 5
BCS Regression Results

Coefficient estimates are time-series average of cross-sectional OLS regressions. We report the results for both unconditional and conditional tests. The dependent variable is the risk-adjusted return of Fama-French (FF) model in the first column, the risk-adjusted return of Ferguson and Shockley (FS) model in the second column, and the risk-adjusted return of Liu model in the third column. The independent variables are defined as follows. SIZE is the natural logarithm of the market value of the equity of the firm as of the end of the second to the last month. BM is the natural logarithm of the ratio of BE and ME at the end of the second to the last month. The values of BM greater than the 0.995 fractile are set equal to 0.995 fractile and those less than the 0.005 fractile are set equal to 0.005 fractile. TURNOVER is the trading volume divided by shares outstanding in the second to last month. PRICE is the natural logarithm of the reciprocal of the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. R2-6, R7-12, R13-24 equal the logarithms of the cumulative returns over the second through the sixth , the seventh through the 12th, and the 13th through the 24th months prior to the current month, respectively. All coefficients are multiplied by 100. The *t*-statistics are in parentheses. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

	Unconditional test			Conditional test		
	FF	FS	Liu	FF	FS	Liu
Intercept	1.5894*	-0.6866	2.1800*	2.5641**	0.8729	3.0381*
	(2.37)	(-1.11)	(2.04)	(3.39)	(1.15)	(2.48)
SIZE	-0.0404	0.1038	-0.0656	-0.0762	-0.0029	-0.1057
	(-0.99)	(1.75)	(-0.97)	(-1.65)	(-0.04)	(-1.41)
BM	0.1555*	0.2081**	0.2942**	0.1320	0.1401	0.2878**
	(2.03)	(2.60)	(3.16)	(1.62)	(1.44)	(2.88)
TURNOVER	-1.6598*	-2.2156**	-1.7707*	-1.8560*	-2.2003**	-1.8142*
	(-2.14)	(-2.80)	(-2.04)	(-2.33)	(-2.77)	(-2.16)
PRICE	0.1653	0.1149	0.1711	0.2526	0.1291	0.2270
	(1.33)	(1.57)	(1.31)	(1.82)	(1.58)	(1.63)
DY	0.0007	0.0252	-0.0027	0.0304	0.0170	0.0042
	(0.01)	(0.41)	(-0.04)	(0.52)	(0.27)	(0.07)
RET2-6	-0.5575*	-0.6428*	-0.5300	-0.2388	-0.5028	-0.6469
	(-1.97)	(-2.36)	(-1.74)	(-0.66)	(-1.38)	(-1.89)
RET7-12	-0.0121	0.0060	0.1246	0.1827	-0.2867	0.1712
	(-0.05)	(0.03)	(0.50)	(0.49)	(-0.84)	(0.56)
RET13-24	-0.3257	-0.5048**	-0.3205	-0.8142**	-1.0395**	-0.4149
	(-1.92)	(-3.13)	(-1.87)	(-2.87)	(-3.83)	(-1.91)

Table 6
BCS Regression Results of Conditional Tests in Subperiods

Coefficient estimates are time-series average of cross-sectional OLS regressions. We split our sample into two subperiods using 1990 as the cutoff point. The dependent variable is the risk-adjusted return of Fama-French (FF) model in the first column, the risk-adjusted return of Ferguson and Shockley (FS) model in the second column, and the risk-adjusted return of Liu model in the third column. The independent variables are defined as follows. SIZE is the natural logarithm of the market value of the equity of the firm as of the end of the second to the last month. BM is the natural logarithm of the ratio of BE and ME at the end of the second to the last month. The values of BM greater than the 0.995 fractile are set equal to 0.995 fractile and those less than the 0.005 fractile are set equal to 0.005 fractile. TURNOVER is the trading volume divided by shares outstanding in the second to last month. PRICE is the natural logarithm of the reciprocal of the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. R2-6, R7-12, R13-24 equal the logarithms of the cumulative returns over the second through the sixth , the seventh through the 12th, and the 13th through the 24th months prior to the current month, respectively. All coefficients are multiplied by 100. The *t*-statistics are in parentheses. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

	1978-1990			1991-2006		
	FF	FS	Liu	FF	FS	Liu
Intercept	5.1001**	2.9279*	7.0411**	0.5036	-0.7969	-0.2144
	(3.94)	(2.27)	(3.57)	(0.68)	(-0.94)	(-0.17)
SIZE	-0.0534	-0.0549	-0.2150	-0.0947	0.0394	-0.0170
	(-0.73)	(-0.48)	(-1.65)	(-1.65)	(0.56)	(-0.22)
BM	0.0430	-0.0540	0.0551	0.2043	0.2978*	0.4768**
	(0.43)	(-0.46)	(0.48)	(1.64)	(2.08)	(3.23)
TURNOVER	-1.9583**	-1.9676*	-1.7978*	-1.7729	-2.3894	-1.8276
	(-2.62)	(-2.51)	(-2.53)	(-1.31)	(-1.80)	(-1.26)
PRICE	0.6104*	0.2892	0.6047*	-0.0381	-0.0009	-0.0799
	(2.49)	(1.97)	(2.53)	(-0.29)	(-0.01)	(-0.58)
DY	0.0068	0.0605	0.0768	0.0496	-0.0184	-0.0548
	(0.08)	(0.68)	(0.87)	(0.61)	(-0.21)	(-0.61)
RET2-6	-0.3514	-0.6080	-0.2171	-0.1473	-0.4174	-0.9961*
	(-0.62)	(-1.09)	(-0.45)	(-0.32)	(-0.86)	(-2.01)
RET7-12	0.6468	-0.0884	0.6557	-0.1943	-0.4478	-0.2224
	(1.03)	(-0.16)	(1.52)	(-0.47)	(-1.10)	(-0.53)
RET13-24	-1.2406*	-1.5256**	-0.4876	-0.4677	-0.6445*	-0.3558
	(-2.43)	(-3.58)	(-1.37)	(-1.64)	(-1.99)	(-1.35)

Table 7

BCS Regression Results of Conditional Tests with 1% Trimming

Coefficient estimates are time-series average of cross-sectional OLS regressions after trimming 1 percent extreme observations each month. The dependent variable is the excess return (ER) in the first column, the risk-adjusted return of Fama-French (FF) model in the second column, the risk-adjusted return of Ferguson and Shockley (FS) model in the third column, and the risk-adjusted return of Liu model in the fourth column. The independent variables are defined as follows. SIZE is the natural logarithm of the market value of the equity of the firm as of the end of the second to the last month. BM is the natural logarithm of the ratio of BE and ME at the end of the second to the last month. The values of BM greater than the 0.995 fractile are set equal to 0.995 fractile and those less than the 0.005 fractile are set equal to 0.005 fractile. TURNOVER is the trading volume divided by shares outstanding in the second to last month. PRICE is the natural logarithm of the reciprocal of the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. R2-6, R7-12, R13-24 equal the logarithms of the cumulative returns over the second through the sixth , the seventh through the 12th, and the 13th through the 24th months prior to the current month, respectively. All coefficients are multiplied by 100. The *t*-statistics are in parentheses. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

	1978-2006				1978-1990				1991-2006			
	ER	FF	FS	Liu	ER	FF	FS	Liu	ER	FF	FS	Liu
Intercept	0.6930	0.3390	-1.3187	0.8161	4.5522**	2.5826*	0.4176	4.5111*	-2.4425	-1.4839*	-2.7295**	-2.1861
	(0.63)	(0.49)	(-1.88)	(0.71)	(2.83)	(2.14)	(0.35)	(2.43)	(-1.89)	(-2.27)	(-3.55)	(-1.83)
Size	0.1151	0.1096**	0.1837**	0.0805	0.0094	0.1169	0.1145	-0.0454	0.2009**	0.1037	0.2398**	0.1827**
	(1.90)	(2.62)	(3.11)	(1.19)	(0.09)	(1.78)	(1.10)	(-0.38)	(3.26)	(1.95)	(3.65)	(2.67)
BM	0.3342**	0.2017**	0.2143**	0.3558**	0.2323*	0.1938*	0.0950	0.2069*	0.4171**	0.2082*	0.3113**	0.4768**
	(5.36)	(3.39)	(2.75)	(4.90)	(2.38)	(2.20)	(0.92)	(2.01)	(5.38)	(2.53)	(2.78)	(4.95)
Turnover	-3.2141**	-3.0032**	-3.3828**	-2.9570**	-2.8645**	-2.4600**	-2.4869**	-2.3192**	-3.4981*	-3.4445**	-4.1107**	-3.4751**
	(-3.76)	(-4.21)	(-4.84)	(-4.07)	(-4.17)	(-3.36)	(-3.26)	(-3.32)	(-2.39)	(-2.96)	(-3.69)	(-2.89)
Price	0.1898	0.2574*	0.1372	0.2334	0.4635*	0.5384*	0.2172	0.5301*	-0.0325	0.0290	0.0723	-0.0076
	(1.56)	(2.02)	(1.77)	(1.83)	(2.11)	(2.27)	(1.51)	(2.30)	(-0.29)	(0.27)	(1.02)	(-0.07)
DY	0.1247*	0.1349**	0.1158*	0.1102*	0.1067	0.0352	0.0869	0.1032	0.1392	0.2159**	0.1394	0.1158
	(2.22)	(2.72)	(2.11)	(2.06)	(1.23)	(0.45)	(1.03)	(1.25)	(1.90)	(3.43)	(1.91)	(1.61)
RET2-6	-0.6100	-0.4572	-0.7696*	-0.8654*	-0.9236*	-0.9649	-1.2320*	-0.8392	-0.3553	-0.0447	-0.3938	-0.8866
	(-1.93)	(-1.28)	(-2.13)	(-2.58)	(-2.24)	(-1.80)	(-2.28)	(-1.88)	(-0.75)	(-0.09)	(-0.82)	(-1.77)
RET7-12	0.3256	0.3336	-0.1412	0.3254	0.3315	0.5403	-0.1898	0.5487	0.3209	0.1656	-0.1017	0.1439
	(1.35)	(0.91)	(-0.41)	(1.13)	(0.98)	(0.86)	(-0.33)	(1.29)	(0.95)	(0.43)	(-0.26)	(0.38)
RET13-24	-0.2288	-0.7394**	-0.9608**	-0.3261	-0.3781	-1.3315**	-1.6197**	-0.5765	-0.1074	-0.2584	-0.4255	-0.1226
	(-1.45)	(-2.69)	(-3.48)	(-1.59)	(-1.62)	(-2.68)	(-3.76)	(-1.70)	(-0.51)	(-0.98)	(-1.32)	(-0.51)

Table 8
BCS Regression Results of Conditional Tests Based on Combined Models

Coefficient estimates are time-series average of cross-sectional OLS regressions after trimming 1 percent extreme observations each month. The dependent variable is the risk-adjusted return of FF+Liu model in the first column, the risk-adjusted return of FF+MOM model in the second column, the risk-adjusted return of FS+Liu model in the third column, and the risk-adjusted return of FS+MOM model in the fourth column. The independent variables are defined as follows. SIZE is the natural logarithm of the market value of the equity of the firm as of the end of the second to the last month. BM is the natural logarithm of the ratio of BE and ME at the end of the second to the last month. The values of BM greater than the 0.995 fractile are set equal to 0.995 fractile and those less than the 0.005 fractile are set equal to 0.005 fractile. TURNOVER is the trading volume divided by shares outstanding in the second to last month. PRICE is the natural logarithm of the reciprocal of the share price as reported at the end of the second to the last month. DY is the dividend yield as reported at the end of the second to the last month. R2-6, R7-12, R13-24 equal the logarithms of the cumulative returns over the second through the sixth , the seventh through the 12th, and the 13th through the 24th months prior to the current month, respectively. All coefficients are multiplied by 100. The *t*-statistics are in parentheses. * denotes statistical significance at 5% level, and ** denotes statistical significance at 1% level.

	1978-2006				1978-1990				1991-2006			
	FF+Liu	FF+MOM	FS+Liu	FS+MOM	FF+Liu	FF+MOM	FS+Liu	FS+MOM	FF+Liu	FF+MOM	FS+Liu	FS+MOM
Intercept	2.3496**	2.5611**	0.6279	1.0314	5.0368**	5.4377**	2.6271*	3.4084*	0.1662	0.2238	-0.9964	-0.8998
	(2.84)	(3.13)	(0.80)	(1.28)	(3.56)	(4.10)	(1.99)	(2.49)	(0.21)	(0.26)	(-1.14)	(-1.04)
Size	-0.0735	-0.0584	-0.0109	0.0160	-0.0673	-0.0702	-0.0751	-0.0686	-0.0786	-0.0488	0.0411	0.0847
	(-1.42)	(-1.14)	(-0.16)	(0.24)	(-0.89)	(-0.96)	(-0.64)	(-0.59)	(-1.15)	(-0.72)	(0.52)	(1.19)
BM	0.1349	0.1119	0.1506	0.1342	0.0077	0.0376	-0.0639	-0.0766	0.2383	0.1722	0.3249*	0.3054*
	(1.63)	(1.20)	(1.54)	(1.34)	(0.07)	(0.28)	(-0.52)	(-0.61)	(1.95)	(1.30)	(2.30)	(2.13)
Turnover	-1.8272*	-1.6240*	-2.2239**	-1.9678**	-1.7034*	-1.5748*	-1.7218*	-1.4282	-1.9278	-1.6639	-2.6318*	-2.4062*
	(-2.30)	(-2.20)	(-2.82)	(-2.59)	(-2.18)	(-2.01)	(-2.17)	(-1.63)	(-1.45)	(-1.36)	(-2.01)	(-1.98)
Price	0.2288	0.2731	0.0714	0.1765*	0.5981*	0.6363*	0.2059	0.3393*	-0.0713	-0.0221	-0.0378	0.0443
	(1.57)	(1.91)	(0.83)	(2.05)	(2.33)	(2.56)	(1.31)	(2.18)	(-0.51)	(-0.16)	(-0.47)	(0.56)
DY	0.0178	-0.0163	0.0130	0.0048	0.0356	-0.0443	0.0837	0.0292	0.0034	0.0064	-0.0446	-0.0150
	(0.30)	(-0.26)	(0.20)	(0.08)	(0.42)	(-0.46)	(0.90)	(0.32)	(0.04)	(0.08)	(-0.50)	(-0.17)
RET2-6	-0.4448	-0.3815	-0.7364	-0.5223	-0.4164	-0.4895	-0.6909	-0.6846	-0.4678	-0.2937	-0.7733	-0.3905
	(-1.18)	(-1.06)	(-1.94)	(-1.37)	(-0.69)	(-0.87)	(-1.18)	(-1.18)	(-0.97)	(-0.62)	(-1.53)	(-0.77)
RET7-12	0.1562	0.2283	-0.4574	-0.2285	0.6372	0.7673	-0.3242	-0.0813	-0.2347	-0.2097	-0.5656	-0.3481
	(0.41)	(0.60)	(-1.39)	(-0.61)	(1.00)	(1.28)	(-0.65)	(-0.13)	(-0.54)	(-0.45)	(-1.27)	(-0.85)
RET13-24	-0.8356**	-0.5437	-1.0942**	-1.0597**	-1.4723**	-1.1343*	-1.7587**	-1.5452**	-0.3183	-0.0639	-0.5543	-0.6653*
	(-2.60)	(-1.62)	(-3.77)	(-3.79)	(-2.74)	(-2.13)	(-3.84)	(-3.50)	(-0.91)	(-0.15)	(-1.67)	(-1.98)