O-SCORE FINANCIAL DISTRESS RISK ASSET PRICING

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ABSTRACT

We examine explicitly priced financial distress risk in post-1990 equity markets. We add a financial distress risk factor to Fama and French's (1993) three-factor model, based on Griffin and Lemmon's (2002) findings that financial distress is not fully captured by the book-to-market factor. We test three-factor and four-factor capital asset pricing models using both annual buy-and-hold analysis and monthly time series analysis across portfolios adjusted for common book-to-market, size, and financial distress factors. We find empirical support for an Ohlson (1980) O-score-based financial distress risk four-factor asset pricing model in the U.S. and Japanese markets.

Fama and French (1993) propose a three-factor – a market factor, a firm size factor, and a book-to-market equity (BE/ME) factor – capital asset pricing model to explain monthly stock returns for portfolios of stocks noted in Fama and French (1992). Later literature extends the three-factor model to incorporate additional pricing factors, such as Carhart (1997) adding momentum as a fourth factor. Several authors investigate financial distress as a systematic risk affecting asset returns

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(Campbell, Hilscher, & Szilagyi, 2008; Daniel & Titman, 1997; Dichev, 1998; Ferguson & Shockley, 2003; Griffin & Lemmon, 2002). We add country-specific O-score financial distress as an explicit fourth factor to the three-factor Fama and French model and test the model in two national equity markets. Our financial distress O-score four-factor model outperforms the three-factor model and the Carhart four-factor model in pricing the U.S. and Japanese equity market returns.

In our view, a large strand of the Fama and French three-factor model literature seeks to explain cross sectional stock market factors in studies using natural groupings such as skilled or unskilled mutual fund managers (Carhart, 1997), risk of bankruptcy distress (Dichev, 1998), analyst coverage (Griffin & Lemmon, 2002), and return reversals around earnings announcements (Griffin and Lemmon). A second strand seeks to investigate the underlying factors explaining value and growth stock returns or to test the three-factor model in different samples such as international markets (Arshanapalli, Coggin, & Doukas, 1998a; Arshanapalli, Coggin, Doukas, & David, 1998b; Campbell et al., 2008; Chen & Zhang, 1998; Daniel & Titman, 1997; Fama & French, 1998; Griffin & Lemmon, 2002; Lakonishok, Shleifer, & Vishny, 1994; Lau, Lee, & McInish, 2002). A third strand of research extends the capital asset pricing model beyond Fama and French's (1993) three-factor model (Carhart, 1997; Chen & Zhang, 1998, 2008; Vassalou & Xing, 2004; Von Kalckreuth, 2005). We incorporate financial distress risk into the three-factor model, following this third strand of research, after noting that authors have not explicitly incorporated financial distress risk as a systematic risk factor.

We develop a four-factor model that builds on Fama and French's three-factor model to incorporate Griffin and Lemmon's findings that Ohlson's (1980) O-score measure captures financial distress risk beyond Fama and French's three factors in the 1965–1996 time period for U.S. data. Our four-factor capital asset pricing model adds Ohlson's financial distress O-score as an economy-wide factor to Fama and French's three factors – a financial distress risk four-factor model with country-specific parameter estimates for the United States and Japan. We test the fit of the return generating process for our four-factor model against Fama and French's (1993) three-factor model and Carhart's (1997) momentum-based four-factor model in portfolios of value stocks and growth stocks in the U.S. and the Japanese equity markets. In our 1991–2006 U.S. and Japan Datastream samples, our financial-distress-risk-based four-factor model has stronger explanatory power than either the Fama and French three-factor model or the Carhart (1997) momentum-based four-factor model. In addition, the

country-specific four-factor models explain the returns of both value and growth stocks in Japan and the United States when partitioned into large and small stocks.

1. LITERATURE REVIEW

1.1. Fama and French Three-Factor Stock Return Model Theory and International Tests

Fama and French (1993, 1996a, 1996b, 2008) propose the following three-factor asset pricing model to explain asset returns in period t:

$$r_{i,t} = \alpha_{i,t} + m_{i,t}MTB_t + s_{i,t}SMB_t + h_{i,t}HML_t + \varepsilon_{i,t} \quad (1)$$

where $r_{i,t}$ = asset or portfolio i's return minus the risk-free rate $(r_{i,t} - r_{f,t})$; $\alpha_{i,t}$ = intercept; MTB_t = market excess return $(r_{m,t} - r_{f,t})$; SMB_t = the difference between the returns on portfolios of small and big stocks (Small Minus Big); HML_t = the difference between the returns on portfolios of high and low book value to market value stocks (High Minus Low); $\varepsilon_{i,t}$ = an error term; and m_i, s_i, h_i = asset or portfolio i's regression coefficients for MTB_t, SMB_t, and HML_t.

As pointed out by Fama and French (2004), one important implication of the asset pricing test is that the intercept, α_i, in the time series regression is zero, following the logic of Jensen's alpha for portfolio returns. They indicate that, using this criterion, the Fama and French model captures much of the variation in average returns for portfolios formed on size, BE/ME and other price ratios that cause problems for the capital asset pricing model (CAPM), in U.S. stock markets. Fama and French (1998) find empirical support for their model compared to an international CAPM.

Arshanapalli et al. (1998a, 1998b), Chen and Zhang (1998), Halliwell, Heaney, and Sawicki (1999) and Gaunt (2004) use intercept analysis and adjusted R-square analysis to examine the fit of the Fama and French three-factor model in many international stock markets finding strong empirical support for the three-factor model over domestic single-factor CAPM models.

1.2. Momentum Four-Factor Model Theory and Tests

Jegadeesh and Titman (1993) find that abnormal returns derived from momentum strategies are not fully priced by the three-factor Fama and

French model. However, part of the abnormal returns generated in the first year after portfolio formation dissipates during the following two years. Carhart (1997) builds on Jegadeesh and Titman (1993) to study persistence in mutual fund performance during 1962–1993.

Carhart adds a one year momentum factor – calculated as the difference between portfolio returns for the highest 30% and lowest 30% momentum stocks – to the Fama and French three-factor model and forms a momentum-based four-factor model to explain mutual fund returns.

$$r_{i,t} = \alpha_{i,t} + m_{i,t}MTB_t + s_{i,t}SMB_t + h_{i,t}HML_t + p_{i,t}PR1YR_{t-1} + \varepsilon_{i,t} \quad (2)$$

where $PR1YR_{t-1}$ is the difference between the returns on portfolios of highest 30% and lowest 30% momentum stocks for the prior year and $p_{i,t}$ = asset or portfolio i's regression coefficients for $PR1YR_{t-1}$ and the rest of the variables are the same as the three-factor model in Eq. (1).

Carhart sorts firms into deciles based on high to low portfolio returns to create a return-based factor. Carhart compares the performance of the CAPM to both the Fama and French three-factor model and the momentum four-factor model. Carhart (1997) finds that incorporating momentum as a fourth factor is important for explaining equity mutual funds average returns and risk-adjusted returns: "In tests not reported, I find that the four-factor model substantially improves on the average pricing errors of the CAPM and the three-factor model," (Carhart, 1997, p. 62). Carhart finds that his momentum four-factor model provides additional explanatory power for up to one year after portfolio formation.

1.3. Financial Distress Theory and Tests

Dichev (1998, p. 1146) notes that several authors (Chan, Chen, & Hsieh, 1985; Fama & French, 1992) suggest that the size and book to market effects might be proxying for a firm distress risk factor.[1] Consequently, Dichev explicitly studies bankruptcy risk in NYSE, AMEX, and NASDAQ stocks from 1981 to 1995, comparing Altman's (1968) Z-score and Ohlson's (1980) O-score measures. Dichev (1998, p. 2317) finds "bankruptcy risk is not rewarded by higher returns. Thus a distress factor is unlikely to account for the size and book-to-market effects." Dichev finds that firms with high bankruptcy risk earn substantially lower than average returns since 1980 with either measure and that Ohlson's model displays a stronger negative association between bankruptcy risk and subsequent returns.

Griffin and Lemmon (2002) test portfolio pricing of financial distress with a three-factor Fama and French model using the same samples and time period as Fama and French (1998). Griffin and Lemmon examine the U.S. stock market based on five quintiles of financial distress risk using Ohlson's (1980) measure of distress risk, termed O-score. Using buy-and-hold returns, Griffin and Lemmon find that value portfolios outperform growth portfolios and that high O-scores are positively related to stock returns. The difference in stock returns for firms with the highest risk of distress is twice as large for high BE/ME securities relative to low BE/ME securities compared to other groups (Griffin and Lemmon, 2002, p. 2334).

In summary, Griffin and Lemmon (2002) find that the Fama and French three-factor model explains the returns more completely if the financial distress of the firms is further classified.[2] Griffin and Lemmon (2002, p. 2317) find that "Among firms with the highest distress risk as proxied by Ohlson's (1980) O-score, the difference in returns between high and low book-to-market securities is more than twice as large as that in other firms. This large return differential cannot be explained by the three-factor model or by differences in economic fundamentals." These findings suggest that the market does not fully impound available financial distress information into market prices.[3]

Campbell et al. (2008) examine financial distress risk in the U.S. stock market as a predictor of asset prices. They construct an empirical monthly index for each company with accounting and market-pricing variables. Alphas for three-factor Fama and French and four-factor Carhart regressions indicate that distressed stocks have very low returns, particularly after correcting for risk using the Fama and French three-factor model. They investigate many explanations for apparent underperformance of distressed stocks or "the distress anomaly" (p. 2923).

2. RESEARCH METHODOLOGY

We investigate using Griffin and Lemmon's (2002) financial distress results by proposing a fourth empirical systematic risk factor in the Fama and French (1993) model in place of the prior-one-year momentum factor suggested by Carhart (1997) who incorporated the Jegadeesh and Titman (1993) momentum findings into the Fama and French (1993) empirical asset pricing model. Griffin and Lemmon (2002) suggest that the financial distress risk of a firm has a significant impact on the rate of return so we add a fourth aggregate factor, the financial distress risk factor, OLMH, to the

Fama and French three-factor model to test the structure of factors influencing small and large value and growth stock returns in Japan and the United States. Our model is

$$r_{i,t} = \alpha_{i,t} + m_{i,t}MTB_t + s_{i,t}SMB_t + h_{i,t}HML_t + o_{i,t}OLMH_t + \varepsilon_{i,t} \quad (3)$$

where all variables are the same as the Fama and French variables presented in Eq. (1) plus an additional variable. We add a financial distress risk premium, $OLMH_t$ which equals the value-weighted average rate of return difference between the portfolio containing the lowest 20% O-score firms and the portfolio containing the highest 20% O-score firms. The coefficient $o_{i,t}$is the coefficient for asset i in period t.

2.1. Data and Period of Study

To get independent results from Griffin and Lemmon (2002), we include only recent (1991–2006) data for the two largest developed country stock markets: the United States and Japan. Our data overlaps Griffin and Lemmon's 1965–1995 U.S. Compustat and Center for Research in Securities Prices (CRSP) data and includes a separate nation.

Financial distress risk pricing in another developed nation with similar laws, accounting data and reliance on capitalism but with different patterns of trade and industry should reveal the robustness of the financial distress risk factor asset pricing model. Both countries have similar attitudes in using stock markets and debt markets as sources of capital and also toward using capitalism as a mechanism for allocating resources in their economies. Both countries have substantial differences as well. Their national cultures, social structures, political structures and corporate cultures should be reflected in the factors underlying stock market returns. In particular, corporate management philosophies, workers' attitudes toward their companies and national tax structures differ enough that size, book-to-market, market risk and financial distress factors should be different between the United States and Japan. Our two nation tests of competing three-factor and four-factor models should have enough similarities and differences in the common risk factors to reveal differences in asset pricing for these two markets.

2.1.1. Stock Returns

Our daily returns sample is drawn from non-financial public Datastream firms in the United States and Japan for both currently trading and defunct

securities.[4] We follow Fama and French (1996a, 1996b) and Liew and Vassalou (2000) and exclude financial stocks, insurance stocks, holding companies for securities such as unit trusts and depository receipts, preferred shares, cross listings, warrants, and duplicates. We use July 1991 to June 2006 for the United States Russell 1000 Datastream firms and May 1995 to April 2005 for the Japan Datastream firms. Japanese firms are those listed on the Tokyo or Osaka Stock Exchanges or the Over-the-Counter Securities Exchange for Japan listed in Thomson Financial Datastream (JASDAQ). Closing quotations and the value of each stock are from the Thomson Financial Datastream database. Daily and monthly returns are calculated from the closing quotation adjusted for cash dividends and bonus shares. Additional details are in Table 1.

2.1.2. Accounting Variables

On the basis of Griffin and Lemmon's (2002) tests, we use the Ohlson (1980) O-score as a proxy for the risk of financial distress. Because O-score is calculated using accounting variables from annual financial statements, we allow up to a six-month lag for firms to publish the statements, following the approach taken in Fama and French (1992) and subsequent literature. We gather Thomson Financial accounting statement data from July 1991 to June 2006 for the United States and from May 1995 to April 2005 for Japan, respectively. We eliminate firms with a negative BE/ME when we use BE/ME as a factor to classify stocks.

2.2. Financial Distress Factor

We classify stocks into value stocks and growth stocks assuming that BE/ME is an adequate proxy, following Chan and Chen (1991), Chan, Hamao, and Lakonishok (1991), Chan, Jegadeesh, and Lakonishok (1995), Lakonishok et al. (1994) and Chan and Lakonishok (2004) who suggest that the explanatory ability of BE/ME for the rate of return is very robust. Following Griffin and Lemmon (2002), we sort stocks into three BE/ME groups: the lowest 30% (growth stocks), the middle 40% (blended), and the highest 30% (value stocks). If the ratio of the book value of equity to the market value of equity is low, the firm's future is favorable relative to its historical cost and so is defined as a "growth stock."[5] On the contrary, if the ratio is high, it is a "value stock."

Table 1. Portfolio Classifications and Variable Definitions.

Portfolio Classifications

Annually, all firms are grouped into 15 portfolios in the United States and 15 portfolios in Japan. The top row represents three groupings of individual firm book-to-market-equity (BE/ME) ratios. Group L is the lowest 30% and represents the growth firms. Group M is the middle 40% and represents blended firms (mixture of growth and value). Group H is the highest 30% and represents value firms. The columns partition the probability of financial distress factor, O-score, into five quintile groupings. O-score group LO (low O-score) is the portfolio grouping that contains firms with the lowest 20% of O-score values. O-score group LO represents the firms with the lowest financial distress risk. O-score groups 2, 3, and 4 are portfolios that contain the firms with the second lowest, third lowest, and fourth lowest O-score values. O-score group HO (high O-score) is the portfolio grouping that contains firms with the highest quintile O-score values for that year, or the group with the highest financial distress risk. To read the table, the O-score quintiles are broken down into the HML grouping that is appropriate. For example, the cell labeled LLO is a portfolio that has firms with the lowest 30% of BE/ME ratios and lowest O-score quintile for that year. Likewise, the cell labeled L2 represents a portfolio containing the firms with the lowest 30% of BE/ME ratios for the year and the second lowest O-score quintile. The cell labeled M4 represents a portfolio containing the firms with the middle 40% BE/ME ratio and the fourth lowest O-score quintile grouping. Finally, the cell labeled HHO represents a portfolio containing the firms with the highest BE/ME ratio and the highest O-scale quintile.

O-Score	BE/ME	HML Portfolios		
		L	M	H
O-score portfolios	LO	LLO	MLO	HLO
	2	L2	M2	H2
	3	L3	M3	H3
	4	L4	M4	H4
	HO	LHO	MHO	HHO

Notes: To create size groupings, we sort the firms within each of the fifteen 15 U.S. portfolios and within the fifteen 15 Japanese portfolios by size. We create 30 portfolios for each country by grouping the firms that are greater than the median size (large firms) within a portfolio. The remaining firms are the small firms in each portfolio, respectively.
We measure each variable as follows:

1. Rate of return. Stock rights and dividends are adjusted on ex-rights days and ex-dividend days to create daily multipliers and daily returns, but we do not reinvest cash dividends. We calculate the monthly and annual rates of return with each respective accumulated multiplier from the daily rates of return.
2. Risk-free rate. For the U.S. risk-free rate, we use the treasury bill rate. For the Japanese risk-free rate, we use the commercial paper rate.
3. Market portfolio return. We follow Fama and French's (1992, 1993) methodology of excluding financial and security companies in market portfolio return calculations. We use either the rate of return for firms included in the United States Russell 1000 index (United States sample) or the rate of return for all firms traded in Japan (Japan sample).
4. Book-to-market equity (BE/ME). Book equity of common stock equals total shareholder's equity of the firm minus the amount of preferred stock. Market value of the common stock equals the closing quotation multiplied by the number of outstanding common shares. BE/ME is calculated by dividing the book equity by the market value.
5. Size. Size, or the market value of the stock, is calculated by multiplying the closing quotation of the stock on the last transaction day of the year by the number of outstanding shares.

2.2.1. Financial Distress in the United States

Ohlson (1980) uses a logit model to construct a financial alarm model that we use as our proxy for the likelihood of financial distress. To develop the model, Ohlson chooses 105 bankrupt company stocks and 2,058 non-bankrupt stocks from both NYSE/AMEX and OTC firms. All sample firms are in the manufacturing industry and are selected from 1970 to 1976. He applies nine financial variables to estimate a logit model to predict the probability of financial distress.

Ohlson's logistic regression model is shown as follows (Ohlson, 1980, pp. 118, 121):

$$O-score_t = \begin{cases} -1.32 - 0.407SIZE_t + 6.03TLTA_t - 1.43WCTA_t \\ +0.0757CLCA_t - 2.37NITA_t - 1.83FUTL_t \\ +0.285INTWO_t - 1.72OENEG_t - 0.521CHIN_t \end{cases} \quad (4)$$

where $SIZE_t = \ln$ (total assets/GNP price-level index); $TLTA_t =$ total liabilities/total assets; $WCTA_t =$ working capital/total assets; $CLCA_t =$ current liabilities/current assets; $NITA_t =$ net income/total assets; $FUTL_t =$ funds provided by operations/total liabilities; $INTWO_t = 1$, if net income is negative for the last two years, zero if otherwise; $OENEG_t = 1$, if total liabilities exceeds total assets, zero if otherwise; and $CHIN_t = (NI_t - NI_{t-1})/(|NI_t| + |NI_{t-1}|)$, where $\mathrm{NI_t}$ is net income for the most recent period.

For the U.S. stock markets, we calculate annual O-score values using Ohlson's original parameter estimates.[6] A higher probability of bankruptcy represents a lower quality firm, implying that the probability of bankruptcy for stocks with high financial distress risk (high O-score) is higher. For stocks with low financial distress risk (low O-score), the probability of bankruptcy is low.

2.2.2. Financial Distress in Japan

To obtain the economy-wide estimates for the probability of financial distress risk in Japan, we estimate Japanese parameters for the logistic model with the same explanatory variables and approach taken by Ohlson (1980), but with our 1995 to 2005 Japanese accounting data. We use annual data for all financially distressed Japanese firms and for all normal Japanese firms listed in the Datastream database to estimate the Japanese equivalent logistic regression parameters.

Our estimates for the Ohlson logistic model's parameters for Japan are:

$$O-score(Japan)_t = \begin{cases} 0.022 - 0.053SIZE_t - 2.653TLTA_t - 1.707WCTA_t \\ -2.738CLCA_t + 4.369NITA_t + 2.102FUTL_t \\ +0.065INTWO_t - 0.211OENEG_t + 0.712CHIN_t \end{cases} \quad (5)$$

where the accounting variables have the same definitions as those in Eq. (4).

Our O-score (Japan) financial distress model's estimated parameters are different from the U.S. O-score model parameters, demonstrating the differences in the U.S. economy and Japanese economy. However, the Japanese model's parameter estimates are similar in size to U.S. parameters, demonstrating the similarities in pricing financial distress with accounting variables in the two economies. When we constrain the Japanese O-score logistic model estimates to be the same as the U.S. O-score estimates (results not presented), we reject the null hypothesis of similarity at the 0.001 level.

We use the O-score (Japan) model's estimates to calculate an annual Japanese O-score for each Japanese firm in our sample for each year. The yearly Japanese O-score financial distress probability uses each Japanese firm's accounting data, similar to the procedure used for the U.S. firms. For all the Japanese tests conducted in the rest of the chapter, we use the firm-specific Japanese O-scores calculated using our estimated O-score (Japan) parameters.[7]

2.3. O-Score and HML Portfolio Groupings

We investigate the fit of three competing stock market return generating processes for both the U.S. sample and the Japanese sample using a similar firm portfolios approach used in Fama and French (1993, 1998) and Griffin and Lemmon (2002). We form 15 portfolios of firms (in each country) that are similar in (a) their magnitude of financial distress and (b) BE/ME.

First, we sort all non-financial firms by their previous year's O-scores into five quintile groups from the smallest to the largest in each of our samples.[8] The five quintile O-score groupings are labeled LO (low O-score), 2, 3, 4, and HO (high O-score). The high O-score (HO) group has the high probability for a firm to suffer financial distress compared to any of the other groups and the low O-score (LO) group indicates the low probability for a firm to suffer financial distress relative to the other groups.

Second, we further partition each of the five O-score quintile's sample according to their previous year's BE/ME ratio. We assign the firms into one of three HML portfolios: the highest 30% of values are assigned to a portfolio termed H (value), the middle 40% of values to a portfolio labeled M (blended), and the lowest 30% of values to a portfolio labeled L (growth). Combining our annual O-score groupings with our annual HML (BE/ME) groupings, we classify all firms into one of fifteen portfolios as listed in Table 1 for each of the two countries for each year.

For our initial buy-and-hold analysis, we buy and hold each of the 15 portfolios for a year and calculate the annual return on investment for each equally weighted portfolio. We resort and reclassify portfolios annually. We compare the rates of return between high and low HML groups for each O-score group and between high and low O-score groups for each HML group. Because of the unknown characteristics of the middle HML group (usually termed blended stocks, denoted by M in our tables), we do not overemphasize this group but report all test results for completeness of the analysis.

2.4. Regression Model Analysis of Fama and French-Type Three- and Four-Factor Models

In each country, we employ ordinary least squares (OLS) monthly time-series regressions to test the explanatory power of the three asset pricing models. First, we use the parameter estimates for the Fama and French model (Eq. 1) variables – MTB, SMB, and HML – to estimate the goodness of fit. Second, we use Carhart's (1997) momentum four-factor model (Eq. 2) that adds momentum, in the form of a factor labeled PR1YR, to the three-factor model. We compare its explanatory power relative to the Fama and French three-factor model. Third, we use our financial distress four-factor model (Eq. 3) that adds O-score, in the form of a factor labeled OLMH, to the three-factor model. We compare its explanatory power beyond the Fama and French three-factor model to explain monthly stock returns.

3. EMPIRICAL RESULTS AND ANALYSIS

3.1. O-Score, Book-to-Market Equity, and Returns

To separately examine the relationship between BE/ME and O-scores, we classify portfolios into three groups based on BE/ME, in each of the five

O-score quintiles as described earlier and summarized in Table 1. Tables 2 and 3 present summary statistics for the stocks in each portfolio in the United States and Japan, respectively.[9] Within the quintiles of O-score in the United States and in Japan, the probabilities of bankruptcy for the portfolios with low, medium and high BE/ME exhibit a similar pattern from low to high as expected. For the highest quintile of O-score in the United States, however, low BE/ME firms have the highest probability of bankruptcy at 0.51, whereas high BE/ME firms have the lowest probabilities of bankruptcy at 0.49, which are statistically identical. Similarly, for the highest quintile of O-score in Japan, low BE/ME firms have the highest probability of bankruptcy at 0.68 and high BE/ME firms have lowest probabilities of bankruptcy at 0.62, but again the difference is not statistically significant.

The finding of low BE/ME ratios in firms in the highest O-score group in both the United States and Japan is puzzling. Table 2 shows that when U.S. firms in the highest O-score quintile are partitioned into low, middle, and high BE/ME values, the market value of the lowest BE/ME grouping is much larger than the market value of the firms in the highest BE/ME grouping ($31.5 million market value compared to $6.5 million market value, respectively).

However, the puzzle of low BE/ME firms in the highest quintile is explained when further analyzed. For all O-score quintiles, Table 2 reveals a finding of a pattern of much higher market values for all low BE/ME firms relative to high BE/ME firms. In addition, within the low, middle, and high BE/ME groupings, the average market value of firms increases with the level of financial distress indicated by its O-score quintile. Table 3 reveals very similar patterns for Japan.

Among all low BE/ME stocks in the United States, the second to highest O-score firms have smaller 12-month prior returns and the smallest 36-month prior returns. For both the United States and Japan, high BE/ME firms have monotonically decreasing prior 12-month average returns across increasing O-score quintile, but the prior 36-month average returns share this pattern only for the lowest four O-score quintiles. Comparing the lowest O-score quintile to the highest O-score quintile for each country reveals higher 12-month and 36-month returns for LO firms than for HO firms for all three BE/ME categories.

Table 2 reveals that return on assets is negative for the highest O-score quintile across BE/ME categories in the United States, resulting in a decline in retained earnings growth for that quintile. This is consistent with high financial distress as proxied by the O-score quintile. Table 3 reveals

Table 2. Summary Statistics of Firm Characteristics for United States Portfolios: Sorted by BE/ME and the Probability of Financial Distress.

O-Score Portfolios	Book-to-Market-Equity Portfolios: L (Growth); M (Blended); H (Value)								
	O-score average (probability)			BE/ME average (ratio)			Number of firms per year		
	L	M	H	L	M	H	L	M	H
LO	0.16	0.16	0.16	0.1531	0.3637	0.8033	49	51	50
2	0.20	0.21	0.21	0.1677	0.3610	0.8881	49	51	50
3	0.23	0.23	0.25	0.1715	0.3606	0.8827	49	51	50
4	0.27	0.28	0.31	0.1736	0.3567	1.1193	50	51	50
HO	0.51	0.47	0.49	0.1487	0.3562	0.8543	52	51	50
	Prior 12-month average return (%)			Prior 36-month average return (%)			Retained earnings growth (%)		
	L	M	H	L	M	H	L	M	H
LO	66.00	37.00	30.00	159.00	198.00	177.00	0.3649	0.0271	0.2367
2	31.00	22.00	21.00	130.00	106.00	118.00	0.3541	1.6463	0.4335
3	24.00	21.00	13.00	73.00	89.00	83.00	0.2614	0.1626	0.1203
4	15.00	15.00	9.00	59.00	71.00	69.00	0.1879	0.0756	0.0446
HO	30.00	17.00	5.00	112.00	103.00	94.00	−0.0884	−1.2142	−0.9035
	Market value average ($ millions)			Market leverage average (ratio)			Return on assets average (%)		
	L	M	H	L	M	H	L	M	H
LO	6,092.54	3,380.51	2,106.22	1.6295	1.5323	1.8075	11.18	7.13	5.09
2	7,601.46	3,391.64	2,352.19	1.4383	1.2232	1.5408	11.85	7.91	5.50
3	13,887.48	5,778.58	3,758.85	1.9428	1.3033	1.7447	11.65	7.60	4.57
4	40,472.71	12,480.44	6,595.52	2.0414	1.6772	1.9849	10.34	5.50	2.53
HO	31,507.00	18,665.96	6,517.33	8.1212	1.9450	2.0328	−6.40	−1.60	−5.14

Notes: Firms included in the Russell 1000 index from July 1991 to June 2006 are ranked independently based on their values of financial distress (O-score) calculated using Ohlson's (1980) model and book-to-market-equity (BE/ME) as described in Table 1. Prior 12-month stock returns are percentages of equal-weighted buy-and-hold returns from July to June in the year prior to ranking. The 36-month prior stock returns are equal-weighted buy-and-hold returns from July three years ago to June in the year of ranking. Growth in retained earnings is the percentage change in retained earnings on the balance sheet over the year before ranking. Market capitalization is the market value of firm. Leverage is the ratio of total book assets less book equity to-market equity. Return on assets is the ratio of income before extraordinary items to total book assets.

Table 3. Summary Statistics of Firm Characteristics for Japan Portfolios: Sorted by BE/ME and the Probability of Financial Distress.

O-Score Portfolios	Book-to-Market-Equity Portfolios: L (Growth); M (Blended); H (Value)								
	O-score average (probability)			BE/ME average (ratio)			Number of firms per year		
	L	M	H	L	M	H	L	M	H
LO	0.26	0.28	0.29	0.237	0.848	3.532	218	292	221
2	0.37	0.36	0.37	0.233	0.878	3.153	223	298	223
3	0.45	0.41	0.43	0.169	0.877	8.298	223	298	223
4	0.53	0.47	0.50	0.144	0.908	28.044	223	298	223
HO	0.68	0.59	0.62	0.064	0.904	35.665	224	298	223
	Prior 12-month return average (%)			Prior 36-month average (%)			Retained earnings growth (%)		
	L	M	H	L	M	H	L	M	H
LO	24.0	11.4	12.0	31.2	25.2	23.6	0.51	0.15	−0.10
2	18.5	07.7	7.8	8.0	13.7	19.0	0.20	0.00	−0.84
3	15.0	14.6	6.9	6.9	21.3	31.8	0.11	−0.07	0.09
4	16.0	9.8	5.8	11.2	22.5	30.6	0.12	0.39	0.67
HO	5.2	5.9	−2.8	12.5	14.4	15.4	0.48	−0.28	0.36
	Market value average ($ millions)			Market leverage average ratio			Return on assets average %		
	L	M	H	L	M	H	L	M	H
LO	13,687.00	225.00	21.00	0.17	0.75	1.68	1.4	1.7	00.0
2	32,820.00	224.00	32.00	0.43	0.84	2.19	2.5	2.4	−0.5
3	46,021.00	149.00	31.00	0.57	1.42	10.71	2.6	2.3	−0.3
4	65,963.00	111.00	32.00	1.78	2.34	37.46	0.2	1.3	0.6
HO	65,471.00	132.00	30.00	1.34	4.83	30.50	6.6	0.2	−2.7

Notes: Firms in Japan from May 1995 to April 2005 are ranked independently based on their values of financial distress (O-score) calculated using our Japanese parameter estimates for Ohlson's (1980) model and book-to-market-equity (BE/ME) as discussed in Table 1. Prior 12-month stock returns are percentages of equal-weighted buy-and-hold returns from May to April in the year prior to ranking. The 36-month prior stock returns are equal-weighted buy-and-hold returns from May three years ago to April in the year of ranking. Growth in retained earnings is the percentage change in retained earnings on the balance sheet over the year prior to ranking. Market capitalization is the market value of firm. Leverage is the ratio of total book assets less book equity to market equity. Return on assets is the ratio of income before extraordinary items to total book assets.

a different pattern in Japan, showing that all high BE/ME firms have low return on assets, with three quintiles showing negative return on assets. Interestingly, the average percentage growth in retained earnings patterns does not match the average percentage return on assets patterns across O-score quintiles and BE/ME portfolio types for Japan, indicating potential differences in accounting practices in the two countries.

Within the low BE/ME quintile in the United States, retained earnings growth in the year before ranking is the smallest for the highest O-score firms. For the United States, the prior 12-month return and the return on assets are consistent indicators of firm financial performance across O-score quintiles in high BE/ME firms. The higher a firm's financial distress quintiles, the lower are the return on assets, growth in retained earnings, and prior 12-month return. Interestingly, the prior 36-month stock market return average displays a similar pattern. Taken together, these findings indicate that the negative shocks to book equity may explain the low BE/ME ratios of these firms in the United States.

To further examine whether O-score and BE/ME are both related to distress risk, we report summary market leverage statistics in Tables 2 and 3. Market leverage, measured as the ratio of the book value of liabilities to the market value of equity, is positively related to both O-score and BE/ME for Japan but is positively related to O-score only for the United States. Both O-score and BE/ME are negatively related to return on assets, and positively related to leverage, which is consistent with the view that both O-score and BE/ME are related to distress risk.

When we compute the Spearman rank correlations between O-score and BE/ME, we find a value of 0.054 and 0.0046 in the United States and in the Japanese stock markets, respectively. These results suggest that O-score contains information related to distress risk that the BE/ME ratio does not capture. If the BE/ME ratio and O-score both capture unique information related to the financial distress risk factor, both O-score and BE/ME should be considered in pricing stock returns.

3.2. Summary Statistics for Sales and Investment Ratios for Portfolios

Tables 4 and 5 show the percentage of growth in sales of the low BE/ME portfolios is larger than that of high BE/ME portfolios in the United States and Japan, respectively. The sales-to-book assets ratio of the low BE/ME portfolios is higher than that of the high BE/ME portfolio. The median market value of equity to sales ratio of the low BE/ME portfolios is higher

Table 4. Sales and Investments Ratio Medians For United States Portfolios: Sorted by BE/ME and the Probability of Financial Distress.

O-Score Portfolios	Book-to-Market-Equity Portfolios: L (Growth); M (Blended); H (Value)					
	Median growth in sales (percentage)			Median sales/book assets (ratio)		
	L	M	H	L	M	H
LO	39.40	24.89	22.97	1.2800	1.1718	1.2069
2	25.00	17.78	13.40	1.3543	1.3208	1.1480
3	16.86	11.70	12.14	1.2016	1.1983	1.0460
4	12.00	9.90	6.94	1.1037	1.0890	0.7960
HO	61.19	92.16	29.34	0.8030	0.8183	0.7830
	Median capital expenditure/book assets (ratio)			Median market value/sales (ratio)		
	L	M	H	L	M	H
LO	0.0358	1.6020	0.7497	6.5890	1.6020	0.7497
2	0.0399	1.4245	0.8290	4.2200	1.4245	0.8290
3	0.0312	1.5315	0.8449	3.9680	1.5315	0.8449
4	0.0276	1.8406	1.0950	4.0880	1.8406	1.0950
HO	0.0289	5.3841	1.1530	7.0014	5.3841	1.1530

Notes: Firms included in the Russell 1000 index from July 1991 to June 2006 are ranked independently based on their values of financial distress (O-score) calculated using Ohlson's (1980) model and book-to-market-equity (BE/ME) as described in Table 1. We report the median of growth in sales, sales to book asset, market value of equity to sales, and capital expenditures to book assets.

than that of high BE/ME portfolios in the United States and Japan, which is consistent with Griffin and Lemmon's (2002) evidence that investors favor the firms with high market equity to sales ratios than those with lower market equity to sales levels. The capital expenditure-to-asset ratio in the portfolio with low BE/ME (growth firms) is lower than portfolio with higher BE/ME (either blended or value firms).

We conclude that these data show low BE/ME portfolios perform well relative to high BE/ME portfolios. Griffin and Lemmon (2002) point out that investors may overreact to the information about the future growth potential of firms with low BE/ME. Their findings suggest that investors are anticipating improving sales growth and profitability of those future sales for firms with low BE/ME relative to firms with high BE/ME.

Table 5. Sales and Investments Ratio Medians For Japan Portfolios: Sorted by BE/ME and the Probability of Financial Distress.

O-Score Portfolios	Book-to-Market-Equity Portfolios: L (Growth); M (Blended); H (Value)					
	Median growth in sales (percentage)			Median sales/book assets (ratio)		
	L	M	H	L	M	H
LO	25.0	4.2	1.0	0.830	0.907	0.900
2	52.6	4.8	−1.2	0.868	1.053	1.057
3	5.9	8.9	−0.1	0.850	1.125	1.102
4	−3.6	7.7	−1.1	0.759	1.135	1.138
HO	−9.4	2.1	−4.3	0.584	1.160	1.903
	Median capital expenditure/book assets (ratio)			Median market value/sales (ratio)		
	L	M	H	L	M	H
LO	0.001	−0.005	−0.007	1.069	0.837	0.316
2	0.002	0.002	−0.001	2.198	0.710	0.266
3	0.002	0.004	0.003	4.976	0.621	0.225
4	0.011	0.004	0.002	5.857	0.480	0.177
HO	0.020	0.007	0.003	8.379	0.379	0.145

Notes: Japanese firms from 1995 to 2006 are ranked independently based on their values of the probability of financial distress (O-score) calculated using Ohlson's (1980) model and book-to-market-equity (BE/ME). We report the median of growth in sales, sales to book assets, market value of equity to sales and capital expenditures to book assets.

3.3. Buy-and-Hold Returns for the Portfolios Sorted on BE/ME and O-Score

To investigate whether return differences captured by partitioning firms into the three BE/ME portfolios and the five O-score quintiles are significant, Tables 6 and 7 display the annual buy-and-hold returns and the return differences for all firms in the United States and Japan, respectively. Furthermore, we report the return differences captured by high versus low BE/ME portfolios and high versus low O-score deciles for small and large firms, respectively[10]. We partition stocks in the United States and Japan into 15 portfolios. These portfolios are the three sizes of BE/ME (lowest 30%, middle 40%, and highest 30%) within each of the five O-score quintiles calculated for the respective countries. Furthermore, we partition each of the 15 portfolios of all firms into two sub-portfolios based on their market

Table 6. Average Annual Buy-and-Hold Returns for Size Portfolios in the United States: Sorted by BE/ME and the Probability of Financial Distress.

O-Score Portfolios	L	M	H	Ret(H)−(L)	*p*-value
All firms BE/ME portfolios					
LO	26.76%	28.59%	26.88%	0.12%	0.213
2	18.57%	18.21%	21.48%	2.91%	0.112
3	15.56%	15.66%	20.75%	5.19%	0.032*
4	15.36%	14.59%	17.69%	2.33%	0.143
HO	22.18%	23.06%	34.25%	12.07%	0.035*
Ret(HO)−(LO)	−4.59%	−5.53%	7.36%		
p-value	0.0010*	0.0410*	0.0920		
Small-firm BE/ME portfolios					
LO	27.19%	26.92%	22.54%	−4.64%	0.34
2	25.31%	15.78%	28.38%	3.07%	0.08
3	13.45%	14.31%	21.88%	8.42%	0.02*
4	16.85%	15.16%	21.14%	4.29%	0.07
HO	18.15%	28.22%	27.80%	9.65%	0.02*
Ret(HO)−(LO)	−9.03%	1.30%	5.26%		
p-value	0.02*	0.15	0.09		
Large-firm BE/ME portfolios					
LO	25.79%	30.11%	31.88%	6.09%	0.06
2	15.87%	19.69%	18.62%	2.75%	0.11
3	16.65%	16.36%	18.44%	1.79%	0.14
4	13.31%	13.45%	14.80%	1.49%	0.12
HO	21.07%	15.12%	35.68%	14.61%	0.06
Ret(HO)−(LO)	−4.72%	−14.99%	3.81%		
p-value	0.00*	0.00*	0.13		

Notes: Percentage value-weighted annual buy-and-hold returns for firms in the United States from July 1991 to June 2006 are displayed for portfolios formed by ranking with probabilities of financial distress (O-score) calculated using Ohlson's (1980) model and book-to-market-equity (BE/ME). Stocks are ranked into three groups by size (all stocks, small stocks, and large stocks). Size-adjusted groupings are a simple average of the large and small time series. The tests for statistical differences between groups are based on the time series of monthly returns from July 1991 to June 2006. The high minus low BE/ME portfolio differences are calculated within the same distress groups by forming a portfolio that is long in the high BE/ME portfolio and short in the low BE/ME portfolio. Differences in financial distress portfolio returns are calculated from high distress portfolios minus low distress portfolios within each BE/ME grouping.

*Statistical significance at the 0.05 level separately.

Table 7. Average Annual Buy-and-Hold Returns for Size Portfolios in Japan: Sorted by BE/ME and the Probability of Financial Distress.

O-Score Portfolios	L	M	H	Ret(H)−(L)	*p*-value
All firms BE/ME portfolios					
LO	−0.72%	6.62%	12.42%	13.14%	0.084
2	−2.19%	0.91%	14.68%	16.87%	0.072
3	−1.44%	1.13%	26.49%	27.93%	0.067
4	0.78%	6.07%	14.60%	13.81%	0.044*
HO	−12.28%	3.82%	12.32%	24.60%	0.004*
Ret(HO)−(LO)	−11.57%	−2.80%	−0.10%		
p-value	0.067	0.311	0.494		
Small firms					
LO	1.41%	3.34%	15.84%	14.43%	0.090
2	−6.90%	−1.58%	19.51%	26.40%	0.043*
3	5.81%	3.51%	45.27%	39.47%	0.103
4	8.92%	9.16%	15.03%	6.11%	0.231
HO	−9.41%	3.54%	12.54%	21.95%	0.098
Ret(HO)−(LO)	−10.82%	0.19%	−3.30%		
p-value	0.069	0.488	0.285		
Large firms					
LO	−2.84%	9.89%	9.00%	11.85%	0.259
2	2.51%	3.39%	9.85%	7.33%	0.249
3	−8.69%	−1.25%	7.71%	16.40%	0.031*
4	−7.35%	2.98%	14.17%	21.52%	0.020*
HO	−15.16%	4.09%	12.10%	27.25%	0.003*
Ret(HO)−(LO)	−12.31%	−5.79%	3.09%		
p-value	0.157	0.269	0.395		

Notes: Percentage value-weighted annual buy-and-hold returns for firms in Japan from May 1995 to April 2005 are displayed for portfolios formed by ranking with probabilities of financial distress (O-score) calculated using Ohlson's (1980) model and book-to-market-equity (BE/ME). Stocks are ranked into three groups by size (all stocks, small stocks, and large stocks). The size-adjusted groupings are from a simple average of the large and small time series. The tests for statistical differences between groups are based on the time series of monthly returns from May 1995 to April 2005. The high minus low BE/ME portfolio differences are calculated within the same distress groups by forming a portfolio that is long in the high BE/ME portfolio and short in the low BE/ME portfolio. Similarly, differences in financial distress portfolio returns are calculated using returns from high-distress portfolios minus low-distress portfolios within each BE/ME grouping.

*Statistical significance at the 0.05 level separately.

capitalization (small and large) given the importance of the size factor in the Fama and French three-factor model and in our results in Tables 2 and 3.

We find that a book-to-market effect exists for buy-and-hold portfolios across O-score quintiles in the U.S. and Japanese stock markets. Table 6 shows differences at the 5% significance level in annual buy-and-hold returns for high BE/ME portfolios versus low BE/ME portfolios and within two of the five O-score quintiles for all the U.S. firms. Table 7 shows differences within two of the five O-score quintiles for all Japanese firms. Table 6 displays the average annual size-adjusted percentage returns differentials for all firms between the U.S. portfolios with high BE/ME ratios versus firms with low BE/ME ratios. The returns of the high BE/ME minus the low BE/ME portfolios are significantly different for O-score quintile portfolio 3, at 5.19%, and the O-score quintile HO at 12.07%, but not for the other three quintiles.

The all-firms portfolio tests are further partitioned into the small and larger firms within each of the 15 portfolios. For the United States, the returns differences are clearly due to the small firms, which have an 8.42% difference for O-score quintile 3 and a 9.65% difference for O-score quintile HO. All other small-firm U.S. O-score quintile differences between high BE/ME portfolios and low BE/ME portfolios are not statistically significantly different from zero. No large-firm O-score quintile differences are statistically significantly different from zero for the U.S. firms.

Table 7 displays that the returns differential due to the book-to-market effect is significant in the all-Japanese firms' portfolios in O-score quintile 4 at 13.81% and in O-score quintile HO at 24.60%. When partitioned into small and large Japanese firms, we find that the small-firm O-score quintile 2 high BE/ME versus low BE/ME return difference is statistically significantly at 26.4% and that the large-firm O-score quintiles have high BE/ME return differences of 16.4%, 21.52% and 27.25% in O-score quintiles 3, 4, and HO, respectively.

An O-score effect, or financial distress effect, is noticeable in the United States buy and hold evidence but not in the Japanese evidence. Table 6 shows the returns of the high O-score quintile portfolio, HO, minus the returns of the low O-score quintile portfolio, LO, for the all-firms portfolio grouping shows a statistically significant difference of −4.59% and −5.53% in the low BE/ME portfolios (growth) and the middle BE/ME portfolios (blended firms), but no statistical difference in the high BE/ME (value) portfolios, for the United States. For U.S. small firms, the high financial distress O-score quintile, HO, earns 9.03% less for the low BE/ME portfolio but the high-minus-low O-score differences are not significant for the

blended or the value portfolios. For U.S. large firms, the high financial distress O-score quintile, HO, earns 4.72% less for the low BE/ME portfolios (growth) and 14.99% less for the middle (blended) portfolio but is not significant for the value portfolio. For Japan, Table 7 shows that although we observe the same patterns of lower returns for high financial distress portfolios, HO, compared to low financial distress portfolios, LO, especially for low BE/ME portfolios, the differences are not statistically significant at the 5% level.

Our findings for the U.S. market are consistent with Dichev's (1998) evidence that the firms with low distress risk can earn higher average stock returns than firms with higher financial distress risk. However, the high stock returns occur for the portfolio with high BE/ME (value stocks) in the highest O-score quintile (high financial distress, HO) for large firms, consistent with the firms having higher financial distress risk. Similarly, for Japan, higher stock returns are observed for the Japanese portfolios with high BE/ME ratios (value stocks) compared to portfolios with low BE/ME ratios (growth stocks) across O-score quintiles for all firms, small firms, and large firms.

3.4. *Fama-and-French (1993) Three-Factor Model – Monthly Data Tests*

Although the buy-and-hold return data for average portfolio returns is interesting, an important question investigated in the literature that explores Fama and French's (1993) asset pricing model is whether individual stock returns depend on common factors. We wish to test the goodness of fit of the three alternative asset pricing models in Eqs. (1)–(3). For each country, we would like to test the fit of the three models inside each of the 30 portfolios formed based on a firm's financial distress O-score, relative BE/ME, and relative size.

As discussed previously, each U.S. firm is classified into one of fifteen portfolios: five relative O-score quintiles, ranging from low financial distress to high financial distress, and three relative BE/ME classifications, ranging from low BE/ME (growth) to middle BE/ME (blended) to high BE/ME (value). These 15 portfolios are examined in Tables 2 and 4. Next, we partition each of the 15 all-firms portfolios into small firms (smallest half) and large firms (largest half) for a total of 30 portfolios. These are the same 30 sub-portfolios used in Table 6 and discussed in the previous section.

Similarly for Japanese firms, we partition them into 15 similar portfolios: five relative O-score quintiles and three relative BE/ME classifications, using the same methods discussed earlier. These 15 portfolios are examined in

Tables 3 and 5. We then partition each of the 15 Japanese all-firms portfolios into small firms and large firms for a total of 30 portfolios. These are the same 30 sub-portfolios used in Table 7, discussed earlier.

First, we investigate how the three-factor model of Fama and French (1993) performs in its ability to explain the 30 portfolio returns in the United States and the 30 portfolio returns in Japan. In Table 8 through Table 11, we exhibit estimated regression coefficients and regression statistics for the portfolios in each BE/ME, O-score, and size group in the United States and Japan.[11]

For the United States, Tables 8 and 9 show that the coefficients of the market factor, MTB, are positive for all 15 small-firm portfolios and all 15 large-firm portfolios. The coefficients of the small-minus-big factor, SMB, for twelve of the small-firm portfolios and nine of the large-firm portfolios are significantly different from zero at a 5% significance level. The coefficients of the book-to-market factor, HML, for 12 of the small-firm portfolios and eight of the large-firm portfolios are significantly different from zero. One of the small-firm portfolios and four of the large-firm portfolios have significantly negative HML coefficients. Furthermore, we find most coefficients of the book-to-market factor, HML, increase monotonically as firms move from low to high book-to-market ratio, with the exception of high O-score small firms, which is reversed.

In Tables 8 and 9, the adjusted *R*-square in the United States is higher than 40% for most of the portfolios and greater than 50% for 14 of the large-firm portfolios. For 10 of the 15 small-firm portfolios and 11 of the 15 large-firm portfolios, the intercepts are significantly different from zero, indicating that the Fama and French three-factor model does not price stock returns completely in the United States. The Gibbons, Ross, and Shanken (GRS) (1989) test of the alpha are both significant, indicating rejection of the null hypothesis that all of the alpha coefficients are equal to zero for U.S. small firms (Table 8) and U.S. large firms (Table 9), allowing some room for improvement.

Tables 10 and 11 show that 16 of the 30 coefficients of the market-to-book factor (MTB), 15 of the 30 coefficients of the size factor (SMB), and 8 of the 30 coefficients of the BE/ME factor (HML) are significantly different from zero for small and large firms in the Japanese stock market.

In addition, for Japanese firms, 11 of the 15 small-firm portfolio intercepts and 10 of the 15 large-firm portfolio intercepts are *not* significantly different from zero indicating a very good fit for the Fama and French three-factor model. Likewise, the GRS test is not significant for both groups of portfolios (failing to reject the Fama and French model's fit). In addition,

Table 8. Three-Factor Monthly Regressions: U.S. Small-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.024	0.022	0.113	3.550	4.120	1.900	0.001*	0.000*	0.059
2	0.168	0.015	0.023	2.760	3.270	4.580	0.006*	0.001*	0.000*
3	0.002	0.002	0.019	0.320	1.960	3.660	0.751	0.052	0.000*
4	0.009	0.008	0.175	1.680	1.510	3.970	0.095	0.132	0.000*
HO	0.024	0.020	0.013	3.750	4.150	2.400	0.000*	0.000*	0.017*
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	1.247	0.229	0.437	13.900	14.740	14.550	0.000*	0.000*	0.000*
2	0.852	0.387	0.229	14.200	14.480	15.270	0.000*	0.000*	0.000*
3	2.222	0.863	0.063	13.000	13.740	15.070	0.000*	0.000*	0.000*
4	1.021	0.250	0.778	13.880	14.700	16.060	0.000*	0.000*	0.000*
HO	0.324	0.053	0.276	15.330	14.930	14.680	0.000*	0.000*	0.000*
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	0.528	−0.002	0.583	2.350	4.010	7.000	0.020*	0.000*	0.000*
2	0.076	0.017	0.421	0.380	6.120	8.540	0.705	0.000*	0.000*
3	0.091	0.269	0.539	0.420	8.980	8.240	0.678	0.000*	0.000*
4	0.059	0.509	0.568	0.330	6.070	8.930	0.746	0.000*	0.000*
HO	−0.430	0.309	0.911	2.190	6.970	5.340	0.030*	0.000*	0.000*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.434	0.218	0.366	−2.850	0.180	2.780	0.005*	0.000*	0.000*
2	0.144	0.024	0.260	1.060	0.240	2.320	0.289	0.000*	0.000*
3	0.012	0.135	0.330	0.080	1.460	2.930	0.936	0.000*	0.000*
4	0.010	0.341	0.371	0.080	3.040	3.790	0.934	0.000*	0.000*
HO	0.343	0.185	0.061	2.580	1.730	5.250	0.011*	0.000*	0.000*
				Adjusted R^2 (%)					
LO				43.63	49.00	43.42			
2				30.90	45.10	50.19			
3				30.99	49.07	50.46			
4				20.74	60.70	42.84		GRS F($\hat{\alpha}$)	P(F)
HO				42.39	50.05	55.80		7.0079	0.0002

Notes: U.S. small-firm estimates of the Fama and French 3-factor model Eq. (1) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 9. Three-Factor Monthly Regressions: U.S. Large-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.021	0.034	0.025	3.390	4.980	3.350	0.001*	0.000*	0.001*
2	0.008	0.017	0.024	1.300	3.450	3.490	0.196	0.001*	0.001*
3	0.016	0.007	0.017	3.870	1.380	3.600	0.000*	0.169	0.000*
4	0.019	0.014	0.003	4.010	3.220	0.690	0.000*	0.002*	0.489
HO	0.009	0.021	−0.004	1.990	3.600	0.240	0.048*	0.000*	0.809
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	0.455	1.064	0.436	16.610	15.020	16.650	0.000*	0.000*	0.000*
2	0.241	0.290	0.309	18.700	16.550	23.490	0.000*	0.000*	0.000*
3	0.264	0.032	0.002	23.870	21.380	23.600	0.000*	0.000*	0.000*
4	0.607	0.388	0.232	15.990	23.220	19.310	0.000*	0.000*	0.000*
HO	0.478	0.514	0.553	21.990	23.600	19.760	0.000*	0.000*	0.000*
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−0.797	−1.064	0.118	−3.890	−0.144	2.130	0.000*	0.889	0.035*
2	−0.512	−0.341	−0.414	−2.550	−0.490	−1.820	0.012*	0.628	0.071
3	−0.565	0.199	−0.022	−4.100	5.610	−4.700	0.000*	0.000*	0.000*
4	−0.860	−0.095	0.498	−1.210	−2.650	3.280	0.229	0.009*	0.001*
HO	−0.382	−0.318	−7.202	−0.690	−1.660	−12.170	0.494	0.098	0.000*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.549	−0.767	0.047	−3.950	−0.290	5.000	0.000*	0.775	0.000*
2	−0.354	−0.206	−0.265	−2.610	−0.230	−1.720	0.010*	0.818	0.088
3	−0.394	0.132	−0.024	−4.220	1.190	−1.900	0.000*	0.237	0.059
4	−0.616	−0.088	0.343	−5.940	2.720	3.340	0.000*	0.007*	0.001*
HO	−0.266	−0.231	4.888	−0.940	−1.780	12.190	0.347	0.076	0.000*
				Adjusted R^2 (%)					
LO				66.73	50.95	28.63			
2				62.13	50.94	50.24			
3				67.92	73.15	54.35			
4				55.34	72.24	58.59		GRS F($\hat{\alpha}$)	P(F)
HO				52.82	52.63	96.44		5.5598	0.0011

Notes: U.S. large-firm estimates of the Fama and French three-factor model Eq. (1) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 10. Three-Factor Monthly Regressions: Japan Small-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.021	−0.051	−0.034	2.066	−1.456	−0.609	0.041*	0.148	0.544
2	0.079	−0.046	−0.078	0.633	−1.737	−0.776	0.528	0.085	0.439
3	0.033	−0.028	0.211	1.790	−0.342	2.860	0.076	0.733	0.005*
4	0.050	0.007	−0.022	0.472	0.078	−0.289	0.638	0.938	0.773
HO	−0.014	−0.029	−0.100	−2.358	−1.668	−2.254	0.020*	0.098	0.026*
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	1.481	1.012	1.326	2.744	1.980	3.373	0.007*	0.000*	0.001*
2	1.089	0.691	1.194	1.989	2.655	2.468	0.049*	0.009*	0.015*
3	1.541	0.498	0.071	2.026	1.463	0.048	0.000*	0.146	0.962
4	1.710	0.754	0.586	2.935	1.914	1.796	0.004*	0.058	0.075
HO	1.836	0.601	0.610	2.655	1.869	2.224	0.009*	0.064	0.028*
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	0.153	0.065	−0.497	1.699	2.399	−1.467	0.092	0.018*	0.145
2	0.464	−0.331	−0.806	2.583	−1.809	−1.778	0.011*	0.073	0.078
3	−0.081	−0.157	1.102	−2.935	−2.098	2.183	0.004*	0.038*	0.031*
4	−0.876	0.822	0.098	−1.822	1.486	2.399	0.072	0.140	0.018*
HO	−0.083	0.368	−0.243	−2.521	1.704	−1.815	0.013*	0.091	0.072
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.058	0.081	0.081	−2.444	2.098	1.754	0.016*	0.038*	0.082
2	−0.338	0.150	0.212	−2.583	1.737	1.726	0.011*	0.085	0.087
3	−0.717	0.339	0.566	−1.963	1.938	1.688	0.052	0.055	0.094
4	0.229	0.325	0.364	1.742	2.798	1.748	0.084	0.006*	0.083
HO	0.001	0.330	0.092	1.663	2.420	1.835	0.099	0.017*	0.069
				Adjusted R^2 (%)					
LO				76.0	94.1	85.9			
2				58.3	61.7	50.9			
3				90.8	18.3	5.00			
4				70.2	71.0	53.1		GRS F($\hat{\alpha}$)	P(F)
HO				70.6	57.5	45.7		0.2338	0.8688

Notes: Japan small-firm estimates of the Fama and French three-factor model Eq. (1) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 11. Three-Factor Monthly Regressions: Japan Large-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	−0.055	0.060	−0.059	−2.224	1.946	−0.411	0.028*	0.054	0.682
2	0.073	0.042	−0.021	1.309	0.658	−2.399	0.193	0.512	0.018*
3	0.014	0.027	−0.011	1.726	0.540	−0.113	0.087	0.590	0.910
4	−0.092	0.091	0.049	−1.579	0.868	0.845	0.117	0.387	0.400
HO	0.057	0.099	−0.273	3.373	2.551	−2.744	0.001*	0.012*	0.007*
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	0.883	0.479	1.291	1.178	0.751	1.328	0.241	0.454	0.187
2	0.838	0.739	0.329	2.116	1.679	0.889	0.036*	0.096	0.376
3	2.312	1.111	1.107	3.715	2.623	1.577	0.000*	0.010*	0.118
4	0.390	0.363	2.875	1.130	0.564	3.932	0.261	0.574	0.000*
HO	0.751	0.551	0.980	2.772	2.374	1.877	0.006*	0.019*	0.063
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	0.748	0.577	0.078	1.673	1.971	2.617	0.097	0.051	0.010*
2	−0.941	0.629	−0.012	−2.744	1.835	−1.855	0.007*	0.069	0.067
3	−0.381	0.345	0.041	−1.906	1.772	2.157	0.059	0.079	0.033*
4	−0.030	0.811	−1.033	−2.935	2.183	−2.744	0.004*	0.031*	0.007*
HO	−0.510	−0.222	−0.100	−2.583	−2.045	−1.828	0.011*	0.043*	0.0700
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.844	0.477	0.830	−1.778	1.855	1.742	0.078	0.06	0.0840
2	0.524	0.443	0.358	1.737	1.678	1.989	0.085	0.096	0.049*
3	−0.816	0.238	0.289	−2.399	1.855	1.766	0.018*	0.066	0.0800
4	0.079	0.633	0.486	1.835	1.971	1.537	0.069	0.051	0.1270
HO	0.297	0.300	0.866	1.683	1.778	1.998	0.095	0.078	0.048*
				Adjusted R^2 (%)					
LO				31.6	10.9	32.6			
2				60.6	60.7	15.1			
3				87.2	74.6	14.1			
4				0.60	22.4	89.4		GRS F($\hat{\alpha}$)	P(F)
HO				67.9	59.8	63.9		0.6602	0.6182

Notes: Japan large-firm estimates of the Fama and French three-factor model Eq. (1) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

according to the adjusted *R*-squares for the 30 Japanese stock market regressions, the explanatory power of the Fama and French three-factor model is greater than 50% for 20 of the 30 portfolios. This supports the contention that the three-factor model of Fama and French prices stock returns well in the Japanese stock market but there is room for improvement.

3.5. *Carhart (1997) Momentum Four-Factor Model – Monthly Data Tests*

Jegadeesh and Titman (1993) find that past winners realize consistently higher returns than past losers. Carhart (1997) adopts the prior-one-year momentum anomaly proposed by Jegadeesh and Titman to build a four-factor model which consists of a market factor (MTB), a firm size factor (SMB), a BE/ME factor (HML), and the prior-one-year return momentum factor (PR1YR). This model, labeled Eq. (2) earlier, is the Fama and French three-factor model plus a momentum factor.

We use Carhart's (1997) four-factor model to examine the factors underlying stock returns for our 30 U.S. stock portfolios and our 30 Japanese stock portfolios. When adding an additional factor to an existing well-fitting model (the Fama and French three-factor model), we need to consider the problem of multicollinearity. For each of the overall stock market portfolios, we calculate the variance inflationary factor (VIF) of the PR1YR factor. We obtain a VIF for PR1YR in Carhart's four-factor model of 2.196 for the United States and 1.070 for the Japanese stock market. Because these two VIFs are much smaller than 10, we conclude that the problem of multicollinearity for Carhart's four-factor model is relatively unimportant (Lee, 1993).

Tables 12 and 13 present the estimated regression coefficients and regression statistics for each of the 30 U.S. portfolios based on Carhart's four-factor model in the United States. Similarly, Tables 14 and 15 present the estimated regression coefficients and regression statistics for each of the 30 Japanese stock market portfolios.

For the United States, Table 12 shows that although the estimated coefficients of intercept terms are not significantly different from zero in 14 of the 15 for small-firm portfolios and the GRS test is insignificant, the adjusted *R*-square coefficients are very low, with two being negative. In addition, for small firms 14 of the 15 market factor coefficients and all 15 PR1YR factor coefficients are not significantly differently from zero, indicating Carhart's four-factor model is not suitable for pricing small-firm

Table 12. Four-Factor Carhart Monthly Regressions: U.S. Small-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.009	0.012	0.000	0.750	1.220	0.040	0.455	0.226	0.968
2	0.009	0.004	0.019	0.840	0.530	2.040	0.400	0.595	0.043*
3	0.003	0.001	0.005	0.280	0.130	0.560	0.781	0.895	0.578
4	0.003	−0.004	0.010	0.330	−0.470	1.280	0.741	0.639	0.202
HO	0.016	0.007	0.002	1.460	0.790	0.230	0.145	0.429	0.818
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	−0.923	−0.006	−0.201	−0.800	−0.010	−0.200	0.426	0.995	0.841
2	−0.645	−0.166	0.338	−0.620	−0.220	0.400	0.533	0.825	0.692
3	-2.255	−0.709	0.345	−1.990	−1.010	0.400	0.048*	0.314	0.687
4	−0.892	0.005	0.938	−0.950	0.010	1.260	0.342	0.996	0.210
HO	0.471	0.227	−0.051	0.460	0.280	−0.060	0.643	0.779	0.954
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−0.564	−0.026	0.559	−2.500	−0.150	2.850	0.014*	0.883	0.005*
2	−0.095	−0.008	0.416	−0.470	−0.060	2.500	0.640	0.955	0.013*
3	0.091	0.252	0.502	0.222	1.840	3.000	0.682	0.0680	0.003*
4	0.045	0.480	0.551	0.250	2.880	3.780	0.806	0.005*	0.000*
HO	−0.443	0.277	0.887	−2.230	1.750	5.170	0.027*	0.0820	0.000*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.454	−0.035	0.353	−2.970	−0.290	2.670	0.003*	0.770	0.008*
2	−0.154	−0.037	0.259	−1.130	−0.380	2.300	0.260	0.707	0.023*
3	0.011	0.126	0.310	0.070	1.350	2.740	0.941	0.177	0.007*
4	0.003	0.325	0.362	0.020	2.880	3.670	0.982	0.004*	0.000*
HO	−0.350	0.167	0.594	−2.610	1.560	5.120	0.010*	0.120	0.000*
	$\hat{p}$			$t(\hat{p})$			p-value ($\hat{p}$)		
LO	0.164	0.112	0.117	1.450	1.270	1.200	0.148	0.206	0.233
2	0.082	0.113	0.045	0.820	1.540	0.550	0.415	0.126	0.586
3	−0.011	0.077	0.150	−0.100	1.130	1.800	0.921	0.261	0.073
4	0.064	0.130	0.079	0.700	1.570	1.090	0.483	0.119	0.278
HO	0.070	0.143	0.111	0.710	1.820	1.300	0.479	0.071	0.195
				Adjusted R^2 (%)					
LO				4.18	−1.19	3.70			
2				0.72	−0.24	1.67			
3				0.45	2.22	5.25			
4				−1.05	4.50	7.06		GRS F($\hat{\alpha}$)	P(F)
HO				2.06	1.84	13.27		0.3320	0.8023

Notes: U.S. small-firm estimates of the Carhart four-factor model Eq. (2) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 13. Four-Factor Carhart Monthly Regressions: U.S. Large-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.020	0.035	0.024	3.120	4.830	3.100	0.002*	0.000*	0.002*
2	0.006	0.016	0.024	1.020	3.220	3.270	0.309	0.002*	0.001*
3	0.016	0.007	0.017	3.700	1.270	3.500	0.000*	0.204	0.001*
4	0.019	0.014	0.002	4.010	3.090	0.410	0.000*	0.002*	0.681
HO	0.007	0.019	−0.005	1.610	3.230	−0.240	0.108	0.002*	0.809
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	−0.403	−0.621	−0.370	−0.380	−0.540	−0.300	0.701	0.592	0.766
2	−0.151	−0.261	0.342	−0.150	−0.320	0.290	0.883	0.750	0.770
3	0.265	0.048	−0.011	0.380	0.060	−0.010	0.707	0.954	0.989
4	−0.655	0.387	−0.154	−0.840	0.550	−0.200	0.404	0.584	0.842
HO	0.565	0.607	−5.526	0.770	0.620	−1.830	0.442	0.534	0.070
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−0.794	−1.063	0.115	−3.860	−4.670	0.470	0.000*	0.0001*	0.636
2	−0.507	−0.339	−0.412	−2.530	−2.110	−1.800	0.013*	0.037*	0.074
3	−0.563	0.200	−0.023	−4.070	1.210	−0.150	0.0001*	0.229	0.883
4	−0.860	−0.093	0.502	−5.590	−0.670	3.300	0.0001*	0.503	0.001*
HO	−0.378	−0.314	−7.198	−2.620	−1.640	−12.090	0.010*	0.103	0.0001*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.546	−0.766	0.046	−3.910	−4.970	0.280	0.000*	0.0001*	0.782
2	−0.349	−0.204	−0.264	−2.570	−1.870	−1.700	0.011*	0.063	0.092
3	−0.393	0.133	−0.025	−4.190	1.190	−0.240	0.0001*	0.237	0.810
4	−0.617	−0.087	0.347	−5.920	−0.930	3.370	0.0001*	0.356	0.001*
HO	−0.262	−0.227	4.891	−2.680	−1.750	12.130	0.008*	0.082	0.0001*
	$\hat{p}$			$t(\hat{p})$			p-value ($\hat{p}$)		
LO	0.006	−0.004	0.011	0.380	−0.270	0.610	0.706	0.791	0.540
2	0.010	0.003	0.004	0.710	0.220	0.220	0.479	0.825	0.823
3	−0.001	0.002	−0.001	−0.070	0.140	−0.090	0.943	0.888	0.927
4	−0.006	−0.001	0.009	−0.570	−0.100	0.820	0.572	0.919	0.414
HO	0.010	0.011	−0.001	0.970	0.810	−0.030	0.333	0.420	0.979
				Adjusted R^2 (%)					
LO				6.22	10.43	−0.33			
2				1.80	0.36	−0.33			
3				7.35	−1.43	−2.23			
4				15.00	−1.35	4.48		GRS F($\hat{\alpha}$)	P(F)
HO				28.00	0.12	16.41		5.0046	0.0024

Notes: U.S. large-firm estimates of the Carhart four-factor model Eq. (2) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 14. Four-Factor Carhart Monthly Regressions: Japan Small-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.247	−0.141	−0.422	1.321	−1.125	−1.126	0.244	0.312	0.311
2	0.458	0.113	−0.863	1.430	0.574	−3.274	0.212	0.591	0.022*
3	−0.277	0.458	1.611	−1.447	1.772	1.045	0.208	0.137	0.344
4	−0.033	−0.768	0.350	−0.105	−3.653	1.046	0.920	0.015*	0.344
HO	−0.033	0.324	−1.023	−0.139	1.253	−3.332	0.895	0.266	0.021*
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	1.750	0.875	0.812	5.368	4.000	1.241	0.003*	0.010*	0.270
2	2.002	0.931	−0.333	3.587	2.710	−0.725	0.016*	0.042*	0.501
3	1.072	1.233	2.185	3.207	2.733	0.812	0.024*	0.041*	0.453
4	0.570	0.475	1.273	1.045	1.296	2.179	0.344	0.251	0.081
HO	0.710	1.134	0.311	1.694	2.517	0.581	0.151	0.053*	0.587
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−0.529	0.076	0.204	−1.975	0.421	0.380	0.105	0.691	0.719
2	−0.867	−0.349	0.572	−1.890	−1.237	1.516	0.117	0.271	0.190
3	−0.045	−0.213	0.941	−0.164	−0.575	0.426	0.876	0.590	0.688
4	0.100	−0.782	0.783	0.222	−2.595	1.630	0.833	0.049*	0.164
HO	−0.250	0.328	0.033	−0.726	0.885	0.075	0.500	0.417	0.943
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	0.071	−0.078	−0.043	0.282	−0.458	−0.084	0.789	0.666	0.937
2	0.193	0.144	−0.305	0.444	0.540	−0.853	0.675	0.612	0.433
3	−0.706	0.321	0.516	−2.718	0.917	0.247	0.042*	0.401	0.815
4	0.365	0.258	−0.337	0.860	0.904	−0.741	0.429	0.407	0.492
HO	−0.095	−0.342	0.036	−0.290	−0.977	0.087	0.783	0.373	0.934
	$\hat{p}$			$t(\hat{p})$			p-value ($\hat{p}$)		
LO	−0.398	0.128	0.628	−1.553	0.744	1.221	0.181	0.490	0.276
2	−0.759	−0.225	1.335	−1.729	−0.833	3.695	0.144	0.443	0.014*
3	0.440	−0.690	−1.984	1.672	−1.946	−0.938	0.155	0.109	0.391
4	0.016	1.159	−0.487	0.036	4.020	−1.059	0.972	0.010*	0.338
HO	−0.094	−0.500	1.431	−0.285	−1.411	3.399	0.787	0.217	0.019*
				Adjusted R^2 (%)					
LO				88.6	93.6	77.8			
2				63.1	59.6	86.6			
3				92.9	44.2	28.8			
4				43.7	91.6	71.6		GRS F($\hat{\alpha}$)	P(F)
HO				35.9	63.6	89.4		5.6315	0.0949

Notes: Japan small-firm estimates of the Carhart four-factor model Eq. (2) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 15. Four-Factor Carhart Monthly Regressions: Japan Large-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	−0.409	0.145	0.528	−1.174	0.429	1.296	0.293	0.686	0.252
2	0.140	−0.123	−0.043	0.799	−0.617	−0.223	0.460	0.564	0.833
3	0.119	0.042	−0.419	0.698	0.247	−1.461	0.517	0.815	0.204
4	−0.054	0.276	0.195	−0.302	0.819	1.092	0.775	0.450	0.325
HO	−0.054	0.118	−0.462	−0.595	1.203	−2.025	0.578	0.283	0.099
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	0.128	0.660	2.546	0.131	0.698	2.231	0.901	0.516	0.076
2	0.981	0.389	0.281	2.002	0.700	0.513	0.102	0.515	0.630
3	2.536	1.142	0.237	5.314	2.405	0.296	0.003*	0.061	0.779
4	0.472	0.758	3.188	0.947	0.804	6.373	0.387	0.458	0.001*
HO	0.515	0.593	0.576	2.027	2.153	0.903	0.098	0.084	0.408
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	0.554	0.624	0.400	1.023	1.189	0.631	0.353	0.288	0.556
2	−0.904	0.539	−0.024	−3.327	1.748	−0.080	0.021*	0.141	0.940
3	−0.324	0.353	−0.183	−1.223	1.341	−0.410	0.276	0.238	0.698
4	−0.009	0.912	−0.952	−0.033	1.744	−3.431	0.975	0.142	0.019*
HO	−0.571	−0.212	−0.203	−4.053	−1.385	−0.575	0.010*	0.225	0.590
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.643	−0.525	0.495	−1.110	−0.936	0.732	0.317	0.392	0.497
2	0.486	−0.350	0.371	1.673	−1.062	1.143	0.155	0.337	0.305
3	−0.876	−0.246	−0.057	−3.094	−0.874	−0.119	0.027*	0.422	0.910
4	0.057	−0.739	0.403	0.193	−1.321	1.358	0.855	0.244	0.233
HO	0.360	0.289	0.974	2.392	1.771	2.573	0.062	0.137	0.050*
	$\hat{p}$			$t(\hat{p})$			p-value ($\hat{p}$)		
LO	0.482	−0.116	−0.801	1.067	−0.264	−1.515	0.335	0.802	0.190
2	−0.091	0.224	0.031	−0.401	0.869	0.122	0.705	0.425	0.908
3	−0.143	−0.020	0.555	−0.646	−0.091	1.494	0.547	0.931	0.196
4	−0.052	−0.252	−0.200	−0.225	−0.577	−0.862	0.831	0.589	0.428
HO	0.151	−0.026	0.258	1.282	−0.206	0.871	0.256	0.845	0.423
				Adjusted R^2 (%)					
LO				33.2	5.4	44.6			
2				54.2	59.0	1.6			
3				85.8	69.5	28.7			
4				27.8	12.6	88.9		GRS F($\hat{\alpha}$)	P(F)
HO				71.0	52.1	62.4		0.1926	0.8953

Notes: Japan large-firm estimates of the Carhart four-factor model Eq. (2) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

stock returns in the U.S. stock market. For U.S. large firms, in Table 13, five of the 15 intercepts are not significantly different from zero and the GRS test is significant indicating that the intercept coefficients are not jointly zero. But adjusted *R*-square coefficients are much lower than with the three-factor model, with five being negative and none being greater than 28%. Matching the U.S. small-firm results, all 15 U.S. large-firm market factor, MTB, coefficients and all 15 PR1YR factor coefficients are not significant, indicating that Carhart's four-factor model does not price U.S. large-firm or small-firm returns very well in our post-1990 sample.

Compared to the Fama and French three-factor model, although the Carhart four-factor model has higher explanatory power of portfolio returns in the U.S. stock market for small firms, if measured solely by examining the lowered number of significant intercept coefficients, *all* coefficients of the prior-one-year return factor, PR1YR, are *not* significantly different from zero for both small and large portfolios of U.S. firms that are sorted into similar financial distress and BE/ME levels, indicating a limitation of the Carhart four-factor model to explain asset pricing in U.S. portfolios containing assets with similar levels of financial distress and BE/ME levels.

For the Japanese stock market, Table 14 shows that only one coefficient of the size factor (SMB) and one coefficient of the book-to-market-equity factor (HML) for small firms are significantly different from zero. For large firms, Table 15 shows three of the Japanese size factor coefficients are significantly negative and two of the 15 book-to-market-equity factor coefficients are different from zero, one positive and one negative. For Japanese small firms, Table 14 shows that seven of the 15 market factor (MTB) coefficients are significantly different from zero and are positive. For Japanese large firms, Table 15 illustrates that two of the 15 market factor coefficients are significant and are positive.

For large firms in Japan, none of the coefficients of the momentum factor, PR1YR, are significantly different from zero. In contrast to the large firms, three of the coefficients of the momentum factor, PR1YR, are significantly different from zero for the small firms. Like the U.S. evidence, this indicates a limitation of the Carhart four-factor model to explain asset pricing in Japanese portfolios containing assets with similar levels of financial distress and BE/ME levels.

For the Carhart model, only three of the Japanese small-firm portfolios have significant intercept coefficients compared to four in the three-factor model, indicating a better fit. None of the Japanese larger firm portfolios have significant intercept coefficients compared to five significant intercepts

in the three-factor model, also indicating a better fit. Further evidence that both models fit according to the GRS test is that none of the GRS tests are significant for either the three-factor model or the four-factor Carhart model. Finally, the adjusted *R*-square statistic increases for 10 of the 15 small Japanese firms but is lower for 12 of the 15 large Japanese firm portfolios in the Carhart model compared to the three-factor model.

Overall, although Carhart's four-factor model has higher explanatory power of portfolio returns compared to the three-factor model in the Japanese stock market, as measured by the lowered number of significant intercept terms, the PR1YR factor is not significantly different from zero in 27 of 30 regressions, indicating that Carhart's four-factor momentum model is not a suitable model for pricing stock returns in the Japanese stock market when stocks have similar levels of financial distress and BE/ME.

3.6. Financial Distress Four-Factor Model – Monthly Data Tests

Some previous studies, such as Dichev (1998), suggest that O-score can be a very good proxy for financial distress. Griffin and Lemmon (2002) argue that O-score captures some relevant information that the BE/ME factor (HML) does not capture about stock returns. Vassalou and Xing (2004) find that the size and BE/ME factors do not significantly capture default risk of firms.

We add an O-score-based financial distress factor into Fama and French's three-factor model as the fourth factor in a four-factor financial asset pricing model. This O-score financial distress four-factor model is labeled Eq. (3). Our model consists of a market factor (MTB), a firm size factor (SMB), a BE/ME factor (HML), and the financial distress proxy factor, denoted by OLMH, which is the difference between portfolio average returns of the top financial distress quintile and the bottom financial distress quintile.

To consider the problem of multicollinearity caused by the introduction of an additional factor into a previously well-specified model, we calculate the VIF of the O-score factor in our U.S. sample and in our Japanese sample. We find an O-score factor VIF of 1.906 in the U.S. stock market and 1.375 in the Japanese stock market, respectively. Because the two VIF factors are much smaller than 10, we conclude that the problem of multicollinearity for the regressions run for our O-score financial distress four-factor model is relatively unimportant (Lee, 1993).

In Tables 16–19, we show the estimated regression coefficients and regression statistics for the portfolios in each of our 30 United States and 30 Japanese BE/ME, O-score, and size groups for the four-factor model. Tables 16 and 17 show that most estimated coefficients, for the market-to-book factor (MTB), the size factor (SMB), the BE/ME factor (HML) and the O-score factor (OLMH) for large and small firms in the United States, are significantly different from zero. Specifically, 44 of the 60 U.S. small firms' factor coefficients, and 44 of the 60 U.S. large firms' factor coefficients are statistically significantly different from zero at the 5% significance level.

Furthermore, we find that for both large and small high-BE/ME firms (value stocks) and for small low-BE/ME stocks (small, growth stocks), the coefficient of the O-score factor (OLMH) decreases with the O-score from low to high in the United States, confirming the distress risk puzzle. This evidence is consistent with the U.S. buy-and-hold returns evidence presented in Table 6.

Compared to the Fama and French three-factor model's results (Table 8 and Table 9), the adjusted *R*-square statistics increase for small and large firms, especially for small firms (all adjusted *R*-squares rise for small firms), after the O-score factor is added in the U.S. stock market. The improvement in adjusted *R*-squares is noticeable for all five O-score quintile portfolios for value stocks (high BE/ME), improving up to 29% for small firms (all value stocks had increased adjusted *R*-squares) and by up to 33% for large firms (two portfolios had slight decreases in adjusted *R*-squares). Although the O-score factor coefficients are significantly different from zero for 20 of 30 U.S. portfolios, 20 of the 30 U.S. intercept coefficients are still significantly different from zero, which is the same number of significant intercept coefficients as the Fama and French three-factor model. Furthermore, the GRS tests for both small firms and large firms continue to be significant for the O-score four-factor model formulation compared to the three-factor model results, indicating rejection of the null hypothesis of the joint test that each intercept for the 15 portfolios of small firms equals zero. This implies that the financial distress four-factor risk model can be further improved to price stock returns in the U.S. stock market, in future research.

Overall, we conclude that our O-score financial distress four-factor model has higher explanatory power than the Fama and French three-factor model in the U.S. stock market to explain stock market portfolio returns. Taken together, we find that our O-score financial distress four-factor model might be more adequate than the three-factor model in explaining the cross-sectional structure of U.S. stock returns.

Table 16. Four-Factor Financial Distress Monthly Regressions: U.S. Small-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.020	0.018	0.005	3.000	3.450	0.860	0.003*	0.001*	0.389
2	0.016	0.014	0.020	2.580	3.040	3.960	0.011*	0.000*	0.000*
3	0.000	0.007	0.016	−0.040	1.690	3.140	0.968	0.092*	0.002*
4	0.009	0.005	0.016	1.660	1.020	3.480	0.099	0.310	0.001*
HO	0.024	0.020	0.010	4.020	4.040	1.930	0.000*	0.000*	0.056
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	1.323	0.311	0.568	10.810	11.630	11.360	0.000*	0.000*	0.000*
2	0.821	0.403	0.160	11.190	11.450	12.200	0.000*	0.000*	0.000*
3	2.270	0.882	0.010	9.940	10.720	12.010	0.000*	0.000*	0.000*
4	1.020	0.300	0.015	10.890	11.640	13.020	0.000*	0.000*	0.000*
HO	0.363	0.055	0.324	12.370	11.930	11.620	0.000*	0.000*	0.000*
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−0.889	0.387	0.035	−0.450	4.980	4.830	0.692	0.000*	0.000*
2	0.149	0.057	0.096	0.650	4.660	4.530	0.514	0.000*	0.000*
3	0.133	0.177	0.293	0.540	5.150	5.570	0.592	0.000*	0.000*
4	0.067	0.276	0.736	0.330	5.490	6.270	0.745	0.000*	0.000*
HO	0.246	0.302	0.683	1.110	5.680	7.570	0.270	0.000*	0.000*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	0.021	0.419	1.073	0.110	4.710	6.660	0.917	0.000*	0.000*
2	−0.060	0.061	0.632	−0.330	4.450	4.300	0.745	0.000*	0.000*
3	0.268	0.240	0.367	1.340	5.920	4.070	0.182	0.000*	0.000*
4	0.001	0.607	0.601	0.000	4.050	4.590	0.998	0.000*	0.000*
HO	−0.552	0.195	0.867	−3.070	4.340	5.600	0.003*	0.000*	0.000*
	$\hat{o}$			$t(\hat{o})$			p-value ($\hat{o}$)		
LO	0.400	0.427	0.684	3.020	4.210	6.480	0.003*	0.000*	0.000*
2	0.081	0.082	0.360	0.670	0.930	3.740	0.502	0.087	0.000*
3	0.248	0.102	0.273	1.890	1.240	2.770	0.060	0.215	0.006*
4	−0.009	0.258	0.222	−0.080	2.620	2.590	0.932	0.010*	0.010*
HO	−0.203	0.009	0.252	−1.720	0.100	2.490	0.087	0.923	0.014*
				Adjusted R^2 (%)					
LO				47.88	57.30	72.17			
2				40.62	61.08	68.67			
3				70.24	62.37	70.76			
4				31.31	66.82	59.84		GRS F($\hat{\alpha}$)	P(F)
HO				53.47	50.02	61.53		3.0882	0.0286

Notes: U.S. small-firm estimates of the O-score four-factor model Eq. (3) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 17. Four-Factor Financial Distress Monthly Regressions: U.S. Large-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.016	0.028	0.012	2.660	4.270	2.190	0.009*	0.000*	0.030*
2	0.003	0.013	0.020	0.450	2.700	2.870	0.654	0.008*	0.005*
3	0.015	0.003	0.014	3.620	0.660	2.950	0.000*	0.511	0.004*
4	0.018	0.012	0.000	3.890	2.780	0.080	0.000*	0.006*	0.935
HO	0.007	0.021	0.018	1.510	3.540	1.090	0.134	0.001*	0.278
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	0.556	0.721	0.682	14.430	11.330	14.260	0.000*	0.000*	0.000*
2	0.346	0.373	0.217	10.640	14.510	12.200	0.000*	0.000*	0.000*
3	0.248	0.041	0.064	11.360	14.950	14.910	0.000*	0.000*	0.000*
4	0.611	0.353	0.288	14.210	13.510	9.610	0.000*	0.000*	0.000*
HO	0.436	0.515	−5.097	15.610	15.530	13.060	0.000*	0.000*	0.000*
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−1.277	−1.662	−1.046	−5.770	−6.910	−5.050	0.000*	0.000*	0.000*
2	−1.008	−0.733	−0.846	−4.690	−4.260	−3.370	0.000*	0.000*	0.001*
3	−0.640	−0.148	−0.332	−4.080	−0.820	−1.960	0.000*	0.411	0.051
4	−0.879	−0.260	0.232	−5.030	−1.670	1.380	0.000*	0.096	0.169
HO	−0.578	−0.312	−5.144	−3.580	−1.430	−8.680	0.000*	0.154	0.000*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	0.000	−0.083	1.378	0.000	−0.420	8.230	1.000	0.672	0.000*
2	−0.214	0.242	0.229	−1.230	1.740	1.130	0.219	0.084	0.260
3	−0.309	0.529	0.330	−2.430	3.640	2.420	0.016*	0.000*	0.017*
4	−0.594	0.101	0.647	−4.200	0.800	4.770	0.000*	0.424	0.000*
HO	−0.041	−0.237	2.535	−0.320	−1.350	5.300	0.752	0.180	0.000*
	$\hat{o}$			$t(\hat{o})$			p-value ($\hat{o}$)		
LO	0.531	0.662	1.288	4.530	5.200	11.740	0.000*	0.000*	0.000*
2	0.550	0.433	0.479	4.830	4.760	3.600	0.000*	0.000*	0.000*
3	0.083	0.384	0.343	1.000	4.030	3.840	0.320	0.000*	0.000*
4	0.021	0.183	0.294	0.230	2.220	3.310	0.818	0.028*	0.001*
HO	0.217	−0.006	−2.277	2.540	−0.050	−7.260	0.012*	0.957	0.000*
				Adjusted R^2 (%)					
LO				56.04	52.43	42.98			
2				73.17	59.80	45.90			
3				47.92	60.72	47.72			
4				54.88	51.45	92.10		GRS F($\hat{\alpha}$)	P(F)
HO				60.57	50.22	96.90		6.2963	0.0004

Notes: U.S. large-firm estimates of the O-score four-factor model Eq. (3) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 18. Four-Factor Financial Distress Monthly Regressions: Japan Small-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.013	−0.064	−0.063	0.112	−1.728	−1.226	0.911	0.087	0.223
2	0.063	−0.057	−0.082	0.445	−0.956	−0.703	0.657	0.341	0.484
3	0.041	−0.033	0.449	0.615	0.344	1.318	0.539	0.731	0.190
4	0.040	−0.043	−0.044	0.327	−0.576	−0.527	0.744	0.566	0.599
HO	−0.032	−0.055	−0.134	−0.210	−0.709	−2.222	0.834	0.480	0.028*
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	1.499	1.045	1.399	2.458	3.816	3.663	0.015*	0.000*	0.000*
2	1.128	0.720	1.204	1.829	2.475	2.219	0.070	0.015*	0.028*
3	1.519	0.510	0.526	3.322	1.327	−0.459	0.001*	0.187	0.647
4	1.735	0.880	0.641	2.655	2.395	1.805	0.009*	0.018*	0.074
HO	1.883	0.668	0.695	2.417	1.954	2.729	0.017*	0.053	0.007*
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	0.238	0.216	−0.166	1.906	2.444	−1.693	0.059	0.016*	0.093
2	0.641	−0.204	−0.759	1.693	−1.742	−2.254	0.093	0.084	0.026*
3	−0.179	−0.101	−1.611	−1.784	−1.828	−2.098	0.077	0.070	0.038*
4	−0.762	1.392	0.347	−1.971	2.239	2.358	0.051	0.027*	0.020*
HO	0.132	0.672	0.145	1.683	2.583	2.196	0.095	0.011*	0.030*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	−0.143	0.233	0.251	−1.989	1.828	2.494	0.049*	0.070	0.014*
2	−0.516	0.022	0.165	−1.862	1.971	2.444	0.065	0.051	0.016*
3	−0.619	0.283	3.289	−1.796	1.482	2.133	0.075	0.141	0.035*
4	−0.114	0.097	0.114	−1.772	1.688	2.303	0.079	0.094	0.023*
HO	−0.215	0.635	0.481	−2.286	2.358	2.098	0.024*	0.020*	0.038*
	$\hat{o}$			$t(\hat{o})$			p-value ($\hat{o}$)		
LO	0.094	−0.168	0.369	2.016	−2.286	1.663	0.046*	0.024*	0.099
2	−0.197	−0.142	−0.051	−2.183	−2.045	−2.583	0.031*	0.043*	0.011*
3	−0.109	−0.062	−3.024	−1.742	−1.809	−1.963	0.084	0.073	0.052
4	−0.127	0.635	−0.278	−1.683	1.802	−0.814	0.095	0.074	0.417
HO	−0.240	0.339	−0.432	−3.030	2.087	−1.914	0.003*	0.000*	0.058
				Adjusted R^2 (%)					
LO				71.5	94.9	90.7			
2				51.3	57.7	41.2			
3				89.4	2.50	33.6			
4				64.8	82.8	64.3		GRS F($\hat{\alpha}$)	P(F)
HO				65.9	59.8	70.4		0.2894	0.8322

Notes: Japan small-firm estimates of the O-score four-factor model Eq. (3) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

Table 19. Four-Factor Financial Distress Monthly Regressions: Japan Large-Firm Estimates.

O-Score Portfolios	BE/ME Portfolios								
	L	M	H	L	M	H	L	M	H
	$\hat{\alpha}$			$t(\hat{\alpha})$			p-value ($\hat{\alpha}$)		
LO	0.024	0.097	−0.157	0.367	0.894	−1.478	0.714	0.373	0.142
2	0.065	0.070	−0.005	1.032	1.073	0.074	0.304	0.285	0.941
3	−0.013	0.029	−0.050	−0.290	0.499	0.478	0.773	0.619	0.633
4	−0.091	0.097	0.026	−1.353	0.794	0.455	0.179	0.429	0.650
HO	0.051	0.102	−0.245	1.330	2.284	−2.412	0.186	0.024*	0.017*
	$\hat{m}$			$t(\hat{m})$			p-value ($\hat{m}$)		
LO	0.963	0.515	1.193	1.982	0.811	1.792	0.050*	0.419	0.076
2	0.830	0.767	0.345	1.923	1.788	0.891	0.057	0.076	0.374
3	2.285	1.113	1.068	3.705	2.374	1.532	0.000*	0.019*	0.128
4	0.391	0.369	2.853	1.024	0.519	3.720	0.308	0.605	0.000*
HO	0.745	0.554	1.008	2.537	2.163	1.904	0.012*	0.033*	0.059
	$\hat{s}$			$t(\hat{s})$			p-value ($\hat{s}$)		
LO	−0.303	0.093	1.360	−1.790	1.731	1.899	0.076	0.086	0.060
2	−0.835	0.263	−0.224	−1.862	1.668	−1.802	0.065	0.000*	0.074
3	−0.019	0.317	0.551	−2.016	1.663	2.551	0.046*	0.099	0.012*
4	−0.040	0.731	−0.737	−2.444	2.007	−1.754	0.016*	0.047*	0.082
HO	−0.428	−0.261	−0.467	−1.699	−2.007	−2.157	0.092	0.047*	0.033*
	$\hat{h}$			$t(\hat{h})$			p-value ($\hat{h}$)		
LO	0.062	0.060	0.275	1.778	2.270	2.098	0.078	0.025*	0.038*
2	0.433	0.128	0.541	1.855	2.157	1.294	0.066	0.033*	0.198
3	−1.128	0.214	0.729	−2.697	1.954	1.760	0.008*	0.053	0.081
4	0.088	0.564	0.231	2.468	1.989	2.444	0.015*	0.049*	0.016*
HO	0.226	0.334	1.183	2.583	1.460	2.087	0.011*	0.147	0.039*
	$\hat{o}$			$t(\hat{o})$			p-value ($\hat{o}$)		
LO	0.939	−0.032	−1.145	2.551	−2.655	−2.321	0.012*	0.009*	0.022*
2	0.094	−0.327	−0.190	1.737	−2.860	−1.989	0.085	0.005*	0.049*
3	−0.323	−0.025	0.456	−2.468	−2.551	1.731	0.015*	0.012*	0.086
4	−0.009	−0.071	0.264	−1.842	−1.790	1.877	0.068	0.076	0.063
HO	−0.073	−0.735	−0.328	−1.709	−1.709	−1.772	0.090	0.090	0.079
				Adjusted R^2 (%)					
LO				79.3	14.9	74.5			
2				54.5	66.9	10.2			
3				91.1	69.5	19.8			
4				1.30	67.3	90.3		GRS F($\hat{\alpha}$)	P(F)
HO				63.9	52.5	66.6		0.4528	0.7340

Notes: Japan large-firm estimates of the O-score four-factor model Eq. (3) for portfolios stratified by financial distress level (O-score) and book-to-market-equity (BE/ME). Portfolios and variables are described in Table 1.

*Statistical significance at the 0.05 level separately.

In Japan, Tables 18 and 19 also tell us that the O-score factor plays a key role in explaining the returns of each of the 30 portfolios in the Japanese stock market since the O-score coefficients for 14 of 30 portfolios are significantly different from zero. Relative to the Fama and French three-factor model, the adjusted *R*-square statistics results are mixed, with increases for seven of the 15 small firms and nine of the 15 large firms. The increase effect is noticeable for value stocks, increasing for eight of the 10 value portfolios by up to 42% (decreases are 4.9% for large firms and 9.7% for small firms, both in the second lowest O-score quintile). Three of 30 intercept coefficients for the O-score financial distress four-factor model are significantly different from zero and neither GRS test is significant, indicating a good fit of the four-factor model for both small and large Japanese firms. This compares to 9 significant intercept terms of the 30 intercept terms in the Fama and French three-factor model which also had GRS tests that are not significant. Taken together, the increased *R*-squares (weak evidence), the significant O-score coefficients (stronger evidence), and the decreased number of significant intercept terms (stronger evidence) lead us to believe that the O-score financial distress four-factor model adds value to the Fama and French three-factor model in pricing stock returns in the Japanese stock market.

4. CONCLUSIONS

We use a direct proxy of the likelihood of financial distress, developed by Ohlson (1980) and denoted by "O-score" to examine the relationships among BE/ME, distress risk, and stock returns in the U.S. and Japanese stock markets using 1991–2006 Datastream data. We build a four-factor pricing model using the Fama and French (1993) three-factor model plus a financial distress factor (O-score). We compare the fit of our O-score financial distress four-factor model with the Fama and French three-factor model and with Carhart's (1997) momentum-based four-factor model with monthly data.

Buy-and-hold empirical results show that, in the United States, stocks with high BE/ME (value stocks) have higher returns than the stocks with low BE/ME (growth stocks) within the same O-score quintile for all firms. For the United States, we also find stocks in the lowest O-score quintile have higher returns than the stocks in the highest O-score quintile for both growth stocks and blended stocks, which is consistent with the findings of

Dichev (1998). This finding is consistent with Griffin and Lemmon (2002) and Vassalou and Xing (2004).

Because the Japanese corporate finance market has many similarities and differences compared to the U.S. market and prior research has not applied the Ohlson (1980) financial distress risk measure to Japanese firms, our analysis of Japanese buy-and-hold returns for financial distress quintiles presents new evidence. For Japan, our buy-and-hold results show higher returns for value stocks than for growth stocks. When we compare our Japanese findings to our U.S. findings, we find that value stocks outperform growth stocks for several quintiles in both countries. A major difference is that high financial distress firm quintile in Japan has a large negative return, whereas the high financial distress quintile for the United States has a large positive return. Another major difference is that stock returns for U.S. firms are all higher than Japanese firms, regardless of whether it is a value or growth firm or high or low financial distress. A third major difference is that for the value stocks, most portfolios of Japanese firms exhibit negative average returns while U.S. firms exhibit positive average returns.

According to our long–short buy-and-hold findings in the United States and Japan, we conclude that value stocks could bring investors a higher return than growth stocks and, furthermore, that going long in value stocks and going short in growth stocks, within the highest O-score quintile, would make the highest returns. Additionally, those return differentials increase even more with small firms in the United States (Table 6) and large firms in Japan (Table 7).

To investigate further, we examine monthly time series regressions for the Fama and French three-factor model and two competing four-factor models. We find that the Carhart momentum factor model does not fit well when compared to the Fama and French three-factor model in our 30 portfolios that hold financial distress risk and BE/ME constant, in either the U.S. stock market or the Japanese stock market. We find that our O-score financial distress four-factor model explains portfolio stock returns more completely than Fama and French's (1993) three-factor model in both the U.S. and Japanese stock markets in our 30 portfolios that hold constant financial distress risk and BE/ME. We find (1) fewer intercept coefficients that are significantly different from zero, (2) the adjusted R-square becomes higher, and (3) significant O-score factor coefficients. These three findings imply that a firm's O-score captures relevant pricing information that the three original Fama and French factors do not incorporate.

We attribute the differences in our results across the two nations to differences in U.S. and Japanese corporate governance and financial

practices, political and cultural differences and economic performance. Higher Japanese financial leverage for value firms and lower Japanese financial leverage for growth firms shown by comparing Table 3 (Japan) to Table 2 (U.S.) has an impact on the Japanese-specific parameter estimates of the Ohlson (1980) financial distress metric that are constructed from financial accounting data. U.S. firms also have higher average returns on assets than Japanese firms except in the highest financial distress quintile. We believe that the country-specific parameter estimates for the Ohlson (1980) financial distress measure captures most cultural, social, and economic firm pricing differences for these two countries, allowing a better set of estimates of the factors generating stock prices beyond existing models.

NOTES

1. Daniel and Titman (1997) model the return generating process with three models arguing for a characteristic-based model.

2. Von Kalckreuth (2005) presents a potential explanation for Griffin and Lemmon (2002)'s findings as a "wreckers theory" of financial distress. By contrast, Chen and Zhang (2008) take a different approach than the literature reviewed here. They offer an explanation for three-factor models and both momentum and financial distress anomalies with a neoclassical approach. This alternative approach explains stock returns as outcomes of economic processes rather than explaining the stock return generation process as being the result of the market, book to market, and size factors found in the Fama and French (1993) literature strand. Ferguson and Shockley (2003) examine financial distress risk's role in pricing equity securities by creating portfolios based on relative leverage and relative financial distress, testing them in the U.S. equity market. They use debt to equity to measure relative financial leverage and Altman's (1968) Z to measure relative financial distress. They find that debt to equity and Altman's Z are important time series variables when added to the Fama and French factors and the single-factor CAPM model.

3. Griffin and Lemmon (2002) examine high BE/ME constructed portfolios (value) versus low BE/ME constructed portfolios (growth) by using Fama and French's three-factor model within sorted deciles of Ohlson's (1980) bankruptcy risk proxy for firm distress (O-score), building on Dichev's (1998) work contrasting the ability of Ohlson's (1980) measure and Altman's (1968) measure to predict financial distress.

4. Firms that cease trading or are merged are not excluded. If a firm ceases trading, its stock price on the date that it resumes trading on the same exchange or another exchange or over the counter will be used. But if a firm is permanently delisted or removed from the counter, the final stock price will be taken as zero. A merged company will be excluded if the merger's details are not verifiable. We follow the same rules for our Datastream data as Fama and French (1993) and Griffin and Lemmon (2002) who use CRSP data from 1965 to 1996. Of course, Japanese data are not extensive for years before our data sample.

5. Theoretically, the book value of equity of a firm is primarily based on historical costs and thus does not reflect the future value of the firm. In contrast, the market value of equity does reflect the firm's future.

6. Griffin and Lemmon (2002) do not modify the O-score parameter estimates, even though they use July 1965 to June 1996 data which overlaps Ohlson's 1970–1976 data period.

7. Where appropriate in our later tests, we compare our test results for O-scores calculated for Japanese firms using the U.S. parameters to O-scores calculated using the logistic model parameters estimated in this section for Japan. In our tests, factor models for Japanese data conducted with O-scores calculated with U.S. O-score parameters do not fit as well as factor models for Japanese data conducted with the O-score (Japan) parameters.

8. Griffin and Lemmon (2002) follow the approach taken in Fama and French (1993, 1998). Because Griffin and Lemmon's data sample covers U.S. data from 1965 to 1996 and our sample of 1991 to 2006 includes 10 years of data after that time period, we present our U.S. information that is similar to Griffin and Lemmon's Table II and Table III.

9. Similar to Griffin and Lemmon's Table I.

10. Similar to Griffin and Lemmon's Table II.

11. Similar to Griffin and Lemmon's Table III.

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