E C O N O M I C S   B U L L E T I N

Constructing Fama-French Factors from style indexes: Japanese evidence

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Abstract

One feature that potentially makes the Fama-French (FF) three-factor model less appealing than the Capital Asset Pricing Model (CAPM) is the complexity of the FF model versus simplicity of the CAPM. This motivates us to construct simple benchmarks for FF factors in Japanese market by using four commercially available Daiwa style indexes. The performance of benchmark choice is evaluated through a direct and simple generalized method of moments (GMM) test. Our simply constructed FF factors can explain returns on 33 industry indexes of all common stocks listed on the first section of Tokyo Stock Exchange. Taken FF risk premiums into consideration, finding on a reversal of size effect during post-bubble period confirms similar findings from previous literature.

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1. Introduction

The one-factor capital asset pricing model (CAPM) of Sharpe (1964), Lintner (1965), and Black (1972) shows that expected stock return is positively and linearly related to its market beta or factor loading i.e. the slope in the regression of a stock's excess return on the market portfolio's excess return. It means high (low) value of expected stock return tends to be associated with high (low) value of its beta. Fama and French (1992) find that such relation disappears during the 1963-1990 period in the U.S. They also find negative relation between average stock return and size or market equity (ME) i.e. a stock's price multiplies shares outstanding; and positive relation between average stock return and book-to-market equity (BM). In other words, stock with small size i.e. low ME, or stock with high BM tends to have high average return and vice versa. Therefore, they argue that size and BM should proxy for common risks if asset pricing is rational. Based on these findings, in 1993 they develop a three-factor model to explain the common variation in stock returns (Fama and French, 1993). The model shows that expected stock return is linearly related to the factor loadings on returns of three portfolios constructed to replicate underlying risk factors - market factor, size factor and BM factor. These portfolios are excess return on market portfolio, "small minus big" (SMB) size portfolio, and "high minus low" (HML) BM portfolio.

For the past ten years, since the time of the original publication of Fama and French landmark paper in 1992, intense debate has emerged in the academic literature over the empirical performance of CAPM and FF model. One feature that potentially makes the Fama – French (FF) model less appealing than the CAPM is the complexity of the FF model versus simplicity of the CAPM. There is no doubt that a wide range of alternative proxies for market portfolio is available. In contrast, there is a lack of analogous FF factor benchmarks due mainly to the difficulty in constructing size and BM factors. As the results, it seems more problematic to apply the FF model, particularly for naïve investors. Towards this ends, Faff (2003, 2004) has created simple proxies for FF factors with four relevant "off-the-shelf" or commercially available style indexes produced by the Frank Russell Company and verified their efficacy utilizing sample sizes of U.S. and Australian industry indexes. These indexes are "styled" with mixed characteristics of size and BM, namely small – value index, small-growth index, large-value index, and large-growth index.[1]

Accordingly, the motivation of this paper is to construct simple benchmarks for FF factors in Japanese market by using available style indexes. Four Daiwa style indexes produced by Daiwa Securities Company are utilized to create the SMB and HML factors. These indexes are Daiwa Small Value Index (DSVI), Daiwa Small Growth Index (DSGI), Daiwa Large Value Index (DLVI), and Daiwa Large Growth Index. The construction is ensured to be similar with the nature from the original Fama-French (1993) constructs in that SMB proxy is largely independent from BM effects, and HML proxy is largely independent from size effects. The significance of FF risk premiums is ascertained through the overall test across sections instead of individual tests for each respective industry or group as in Faff (2003, 2004).

Furthermore, the performance of benchmark choice is evaluated through a direct and simple generalized method of moments (GMM) test. Japanese market is appropriate one to choose for the reasons: (a) Japanese stock market is among the largest in the world, therefore, the performance of Japanese market does matter significantly to the world; (b) a reliable source of style index data for Japan is available commercially from the Daiwa Securities

[1] As in Brealey and Myers (2003), value stock is defined as stock with high BM, and growth stock is stock with low BM.

Company; (c) to this author's knowledge, no other Japanese work on simple FF benchmarks has been published. Daniel *et al.* (2001) and Chiao and Hueng (2004) constructed book-to-market and size factor from all Tokyo Stock Exchange (TSE)'s common stocks by following sophisticated procedures as in Fama – French (1993) and evaluated their performance through OLS test. Our choice of GMM over common ordinary least squares (OLS) test is also reasonable since (a) GMM modeling has the advantage of providing a general estimator which encompasses many standard econometric estimators including OLS, instrumental variables (IVs), and maximum likelihood; (b) GMM is valid under weaker assumptions about the normality of data distribution; (c) GMM provides consistent variance estimation that gains in efficiency and helps to avoid biasness in computing the test statistics.

Utilizing a sample size of 33 industry indexes of all common stocks listed on the first section of Tokyo Stock Exchange, our results based on formal asset pricing test suggest that the three-factor model cannot be rejected over the full sample period (1984 - 2004) and three sub-periods. However, when FF risk premiums are taken into consideration, the support for FF model is less persuasive. Particularly, finding on a reversal of size effect during post-bubble period confirms similar findings by a number of researchers.

The contributions of our study are (i) creating new and simple proxies for FF factors in Japanese market, (ii) modifying Faff (2003, 2004)'s method of testing the significance of FF risk premiums i.e. provide the overall test across sections, and (iii) confirming the reversal of size effect.

The remainder of this paper is organized as follows. Section 2 presents the empirical framework of testing the FF three-factor model. Section 3 describes the dataset of variables, explains the construction of proxies for FF factors, and provides some descriptive statistics of the distribution of returns on FF factors. In Section 4, the empirical results are presented. Section 5 provides the robust check, and Section 6 concludes the paper.

2. Empirical Framework

Fama and French (1993, 1996) develop the three-factor model:

$$E\left(\tilde{R}_i\right) - R_f = b_i\left[E\left(\tilde{R}_M\right) - R_f\right] + s_i E\left(\tilde{R}_{SMB}\right) + h_i E(\tilde{R}_{HML}) \tag{1}$$

where $E\left(\tilde{R}_i\right) - R_f$, $E\left(\tilde{R}_M\right) - R_f$, $E\left(\tilde{R}_{SMB}\right)$, $E(\tilde{R}_{HML})$ represent the expected excess return on asset i, the expected excess return on market portfolio, the expected return on proxy portfolio for the "small minus big" size factor, the expected return on proxy portfolio for "high minus low" book-to-market factor, respectively. The factor loadings b_i, s_i and h_i are obtained as the slopes of the empirical counterpart of the model:

$$\tilde{R}_{it} - R_f = \alpha_i + b_i\left(\tilde{R}_{Mt} - R_f\right) + s_i \tilde{R}_{SMBt} + h_i \tilde{R}_{HMLt} + \tilde{\varepsilon}_{it} \tag{2}$$

where $\tilde{R}_{it} - R_f$, $\tilde{R}_{Mt} - R_f$, $\tilde{R}_{SMBt}$, $\tilde{R}_{HMLt}$ denote the realized excess return on asset i, the realized excess return on market portfolio, the realized return on proxy portfolio for size factor and the realized return on proxy portfolio for the book-to-market factor at time t, respectively. The beta coefficients b_i, s_i, h_i represent the sensitivity of the excess return on asset i to changes in returns on common risk factors.

By taking the expectation of equation (2) and comparing it to equation (1), the intercept α_i is expected to be zero for all i. Thus the true FF model imposing zero intercept restriction can be tested directly. Several remarkable papers have utilized direct test, namely MacKinlay and Richardson (1991), and Faff (2003, 2004). As in Faff (2003, 2004), this study introduces the GMM methodology to test the FF model in system of equations:

$$\begin{cases} \tilde{R}_{it} - R_f = b_i\left(\tilde{R}_{Mt} - R_f\right) + s_i \tilde{R}_{SMBt} + h_i \tilde{R}_{HMLt} + \tilde{\varepsilon}_{it} & (3) \\ \tilde{R}_{Mt} - R_{ft} = \mu_M + \tilde{\xi}_t & (4) \\ \tilde{R}_{SMBt} = \mu_{SMB} + \tilde{\psi}_t & (5) \\ \tilde{R}_{HMLt} = \mu_{HML} + \tilde{\omega}_t & (6) \end{cases} \quad i = 1,2,\ldots,N$$

where μ_M , μ_{SMB} , μ_{HML} are the estimated market premium, SMB premium, and HML premium, respectively.

In this system of regression equations, there are seven sample moments ($1/T\sum_{t=1}^{T}\tilde{\varepsilon}_{it}$, $1/T\sum_{t=1}^{T}\tilde{\varepsilon}_{it}(\tilde{R}_{Mt} - R_f)$, $1/T\sum_{t=1}^{T}\tilde{\varepsilon}_{it}\tilde{R}_{SMBt}$, $1/T\sum_{t=1}^{T}\tilde{\varepsilon}_{it}\tilde{R}_{HMLt}$, $1/T\sum_{t=1}^{T}\tilde{\xi}_{it}$, $1/T\sum_{t=1}^{T}\tilde{\psi}_{it}$, $1/T\sum_{t=1}^{T}\tilde{\omega}_{it}$) and six parameters ($b_i, s_i, h_i, \mu_M, \mu_{SMB}, \mu_{HML}$) to be estimated for each asset. Therefore, the system is over-identified. The test of over-identifying restrictions is used to examine whether the moment restrictions are valid or not. Under the null hypothesis, the moment restrictions are valid, implying the choice of FF model is appropriate. The GMM test statistic is asymptotically distributed as chi-squared statistic.

Also, this study tests other null hypotheses:

$H_0 : b_i = 0, H_0 : s_i = 0, H_0 : h_i = 0, H_0 : \bar{\mu}_M = 0, H_0 : \bar{\mu}_{SMB} = 0, H_0 : \bar{\mu}_{HML} = 0$

to examine the significance of the factor loadings and the average FF premiums across industries, where $\bar{\mu}_M$, $\bar{\mu}_{SMB}$, $\bar{\mu}_{HML}$ denote the cross-sectional mean value of $\mu_M, \mu_{SMB}, \mu_{HML}$, respectively.

Thus, our method distinguishes itself from Faff (2003, 2004) in that in testing the null hypotheses of zero risk premiums, we provide the cross-sectional or overall tests instead of individual tests for each asset. The overall cross-sectional t-statistic is computed as in Bremer and Sweeney (1991):

$$\bar{t} = N^{-1/2}\sum_{i=1}^{N} t_i \qquad (7)$$

where $\bar{t}$ denotes the cross-sectional t-statistic, t_i is the individual test statistic for asset *i,* and N is the number of asset.

3. Data Description

3.1 Basic Data

The basic data comprise of monthly returns (including dividends) on (a) 33 value weighted industry portfolio indexes of all stock listed on the first section of the Tokyo Stock Exchange (TSE) constructed by the Daiwa Securities Co., Limited, Tokyo, (b) four Daiwa value weighted style indexes, (c) market index (Tokyo Stock Exchange Stock Price Index - TOPIX) sourced from the Nikkei Economic Electronic Databank System (NEEDS). Since there is no risk-free rate in Japan comparable to the US Treasury bill rates, following Daniel *et al.* (2001), and Chiao and Hueng (2004), 30-day Gensaki rate (sourced from Nihon Keizai Shimbun, Inc., Tokyo) is used as proxy for risk-free rate in order to make our results comparable to them. Gensaki rate is also used in Nowman (2002) as a proxy for the Japanese short-term interest rate. The full sample period extends from January 1984 to December 2004, resulting 252 observations. The additional robust check is conducted by arbitrarily splitting this 21-year period into three non-overlapping sub-periods and dividing industries into ten groups according to the classification of the Tokyo Stock Exchange. [2]

3.2 Constructing Fama-French Three Factors

Four Daiwa style indexes are utilized to create the SMB and HML factors. These indexes are Daiwa Small Value Index (DSVI), Daiwa Small Growth Index (DSGI), Daiwa Large Value Index (DLVI), and Daiwa Large Growth Index (DLGI). They are subsets of four major indexes: Daiwa Large Index (DLI), Daiwa Small Index (DSI), Daiwa Value Index (DVI) and Daiwa Growth Index (DGI). These major indexes themselves are in turn the subsets of Daiwa Total Index (DTI), which is also a benchmark for market index similarly with the TOPIX. Figure 1 depicts the detail relationship between those Daiwa indexes.

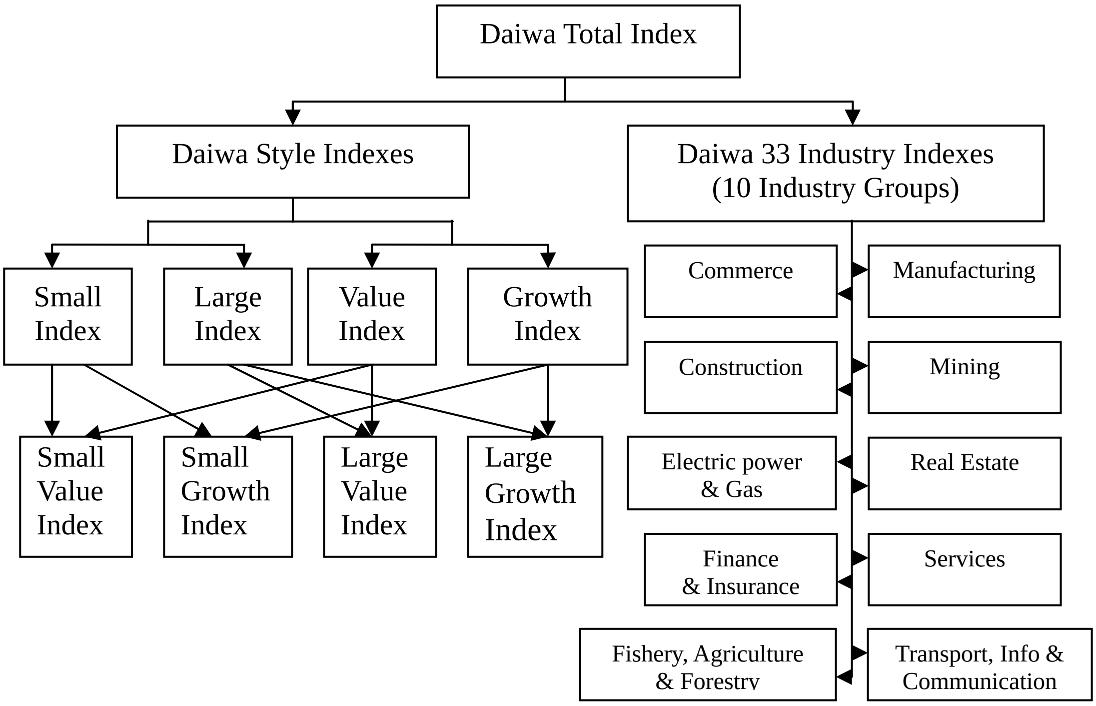

Figure 1: Relationship between Daiwa style indexes and Daiwa industry indexes

Daiwa Large Index (DLI) evaluates the performance of 500 larger companies in the first section of the TSE. Daiwa Small Index (DSI) measures the performance of all other companies in the first section of TSE. Classification of Daiwa Value Index (DVI) and Daiwa Growth Index (DGI) is basically based on the calculation of Value - Growth Score (VGS), which is a composition of four value and growth factors: actual book to market capitalization, actual earnings to market capitalization, estimated return on equity, and estimated growth rate. In the calculation of the VGS, the consolidated accounting data have been used since the end of June, 1989. The indexes are rebalanced twice a year at the end of June and December.[3]

The proxies for three factors in FF model are constructed as follows. The excess market return is simply the excess of the return on TOPIX over the return on 30-day Gensaki rate.

The returns on SMB portfolio is the difference between simple average returns on two

[2] Description of this classification can be found on the Tokyo Stock Exchange website located at http://www.tse.or.jp/EREALIDX/index.html

[3] This description is based on the information published on the website of Daiwa Institute of Research Ltd (http://www.dir.co.jp/dsi2/about/e100about.html).

small stock portfolios (DSVI, DSGI) and the simple average returns on two large stock portfolios (DLVI, DLGI) with approximately same weighted book-to-market equity.

$$\tilde{R}_{SMB} = \frac{\tilde{R}_{SV} + \tilde{R}_{SG}}{2} - \frac{\tilde{R}_{LV} + \tilde{R}_{LG}}{2} \quad (8)$$

where $\tilde{R}_{SV}$, $\tilde{R}_{SG}$, $\tilde{R}_{LV}$, $\tilde{R}_{LG}$ represent the returns on DSVI, DSGI, DLVI, and DLGI, respectively.

Similarly defined, the returns on HML portfolio is the difference between simple average returns on two high book-to-market equity portfolios (DSVI, DSGI) and the simple average returns on two low book-to-market equity portfolios (DLVI, DLGI) with approximately same weighted size.

$$\tilde{R}_{HML} = \frac{\tilde{R}_{SV} + \tilde{R}_{LV}}{2} - \frac{\tilde{R}_{SG} + \tilde{R}_{LG}}{2} \quad (9)$$

These two definitions ensure SMB and HML proxies to be similar with the nature from the original Fama-French (1993) constructs in that SMB proxy is largely independent from BM effects, and HML proxy is largely independent from size effects.

3.3 Descriptive Statistics

Panel A of Table 1 provides basic descriptive statistics of the proxies for FF factors. Three points are worthy noted. First, the average market, SMB and HML premiums are all positive and equivalent to 1.6 percent, 2.9 percent, and 4.4 precent per annual, respectively. This is consistent with Fama and Frech (1993) finding of positive FF premiums in the US market. Second, the market factor offers lowest average return (0.13 percent per month), however with highest standard deviation (5.73 percent per month). This is also consistent with Fama and French (1993). Third, the annual return of 4.4 percent on HML is considerably large from investment perspective.

Table 1: Basic descriptive statistics and correlations between FF factors

PANEL A: Basic descriptive statistics			
	$\tilde{R}_{Mt} - R_f$ (%)	$\tilde{R}_{SMBt}$ (%)	$\tilde{R}_{HMLt}$ (%)
Mean	0.1312	0.2443	0.3581
Median	0.0531	0.4845	0.3426
Maximum	17.5548	17.3043	7.5872
Minimum	-21.0109	-13.9778	-7.5657
Standard deviation	5.7320	4.4507	2.1192
PANEL B: Correlations			
$\tilde{R}_{Mt} - R_f$	1		
$\tilde{R}_{SMBt}$	-0.0615	1	
$\tilde{R}_{HMLt}$	-0.2481	0.2527	1

Notes: Monthly data: January 1984 to December 2004.

Panel B of Table 1 shows that the FF three factors are largely independent. Market factor and SMB are almost uncorrelated (-0.06). There exists low correlations between HML and market factor (-0.24), and between HML and SMB factor (0.25). Also, it is observed that similar degrees of correlations between proxies for FF factors are evident in Fama and French (1993) and Faff (2003).

4. Results

Across the industries in Table 2, using the system of equation (3), (4), (5) and (6), the calculation of factor loadings and GMM test statistic for each respective industry, and average FF risk premiums is shown.

There is evidence that the market betas are all positive and statistically significant. The average value of market beta is close to one, therefore consistent with Fama and French (1993). With respect to size-factor betas, 26 out of 33 size-factor betas are statistically significant at 10 percent level; with two betas (for Electronic Power & Gas; and Securities & Commodities Futures) are negative and significant. There is a lack of statistical significance of the BM-factor beta. Only 14 out of 33 BM-factor betas are statistically significant at 10 percent level; with three betas (for Other Products; Information & Communication; and Services) are found to be significantly negative.

Taking for sample cases of extreme high and low betas, market beta for Securities & Commodity Futures (Pharmaceutical) is highest (lowest) at 1.69 (0.64). This implies that Securities & Commodity Futures is most risky, whereas Pharmaceutical is least risky in term of sharing common market risk. The highest positive exposure to size factor is Mining (0.78). Electronic Power & Gas has highest negative (positive) exposure to size factor (BM factor) at -0.35 (0.78). The highest negative exposure to BM factor is Information & Communication (-0.77). This is consistent with the phenomenon that IT stocks are often overvalued, with high market-to-book value, and subsequently negative factor loading on BM factor.

Applying the hypothesis testing the validity of moment restrictions, the outcome of the GMM statistics supports the FF model across all 33 industries. The lowest associated p-value of 0.114 occurs in Services is still greater than 10 percent level. Glass & Ceramics Products (having the highest associated p-value of 0.989) give greatest support to the FF model.

Compared with previous studies on the FF model using Japanese data, our findings are more supportive of the FF model. Chiao and Hueng (2004) have supported the overall performance of the FF model during period 1980-1994 based on GRS test of the joint hypothesis of zero intercepts for a set of ten TSE prior-return-based portfolios.[4] However, they also found that the explanatory power of FF model is weaken across extreme cases where intercepts in the winner portfolio and the loser portfolio are statistically different from zero. As in Chiao and Hueng (2004), this study also does not attempt to dispute Daniel et al. (2001)'s rejection of the FF factor model in favor of the characteristic model, using a Japanese sample size of nine BM-balanced portfolios and a period from 1975 to 1997. In stead, our analysis based on industry classification is largely independent from the characteristic-based analysis.

A further examination on the significance of FF risk premiums in Panel C of Table 2 reveals that the average FF risk premiums across industries are all significant and positive. This provides additional evidence in the favor of the FF model. Also, the implied economic significance from evidence of lower average market risk premium (0.13 percent per month) than SMB premium (0.25 percent per month) and HML premium (0.36 percent per month) is that size and book-to-market factors were able to outperform the market over the 1984-2004 period.

[4] GRS test developed by Gibbons *et al.* (1989)

Table 2: Fama and French three-factor model tests based on GMM estimations

PANEL A: Betas and GMM statistics

No.	Industry	b_i	s_i	h_i	GMM
1	Fishery, Agriculture & Forestry	0.860 (17.50***)	0.706 (9.42***)	0.104 (0.72)	0.946 [0.331]
2	Mining	1.023 (18.65***)	0.785 (11.41***)	0.058 (0.36)	1.578 [0.209]
3	Construction	1.039 (18.21***)	0.579 (7.50***)	0.579 (2.82***)	0.721 [0.396]
4	Foods	0.759 (19.17***)	0.393 (7.16***)	0.036 (0.31)	0.026 [0.872]
5	Textiles & Apparels	0.947 (29.12***)	0.505 (9.26***)	0.337 (3.07***)	2.186 [0.139]
6	Pulp & Paper	0.805 (11.97***)	0.451 (5.56***)	0.452 (2.91***)	0.729 [0.393]
7	Chemicals	0.950 (30.25***)	0.406 (7.96***)	0.012 (0.11)	0.133 [0.715]
8	Pharmaceutical	0.642 (11.81***)	0.209 (2.64***)	0.017 (0.10)	1.096 [0.295]
9	Oil & Coal Products	0.956 (13.32***)	0.527 (4.95***)	0.503 (2.65***)	0.310 [0.577]
10	Rubber Products	0.886 (18.14***)	0.429 (4.68***)	0.099 (0.47)	1.011 [0.314]
11	Glass & Ceramics Products	0.989 (24.34***)	0.423 (6.55***)	-0.019 (-0.13)	0.000 [0.989]
12	Iron & Steel	1.159 (19.83***)	0.280 (3.26***)	0.695 (3.37***)	0.182 [0.669]
13	Nonferrous Metals	1.122 (23.45***)	0.316 (4.32***)	0.031 (0.17)	0.149 [0.699]
14	Metal Products	0.864 (20.53***)	0.753 (11.73***)	0.196 (1.41)	0.016 [0.898]
15	Machinery	0.980 (29.24***)	0.572 (11.51***)	-0.050 (-0.50)	0.231 [0.631]
16	Electric Appliances	0.909 (14.57***)	-0.060 (-0.54)	0.009 (0.03)	0.057 [0.811]
17	Transportation Equipments	0.835 (19.58***)	-0.107 (-1.38)	0.732 (4.31***)	0.169 [0.680]
18	Precision Instruments	0.789 (13.38***)	0.341 (4.19***)	-0.248 (-1.13)	0.830 [0.362]
19	Other Products	0.742 (15.58***)	0.276 (3.55***)	-0.290 (-1.98**)	0.975 [0.323]
20	Electric Power & Gas	0.720 (10.08***)	-0.350 (3.04***)	0.785 (3.29***)	0.441 [0.506]
21	Land Transportation	0.858 (13.41***)	0.107 (1.21)	0.291 (1.50)	0.574 [0.448]
22	Marine Transportation	1.175 (14.44***)	0.590 (4.71***)	0.569 (2.70***)	0.023 [0.880]
23	Air Transportation	0.917 (11.13***)	0.361 (3.46***)	0.648 (2.81***)	0.159 [0.690]
24	Warehousing & Transport. Serve.	1.033 (19.06***)	0.635 (7.58***)	0.589 (3.42***)	0.010 [0.919]
25	Information & Communication	1.058 (10.88***)	-0.084 (-0.75)	-0.774 (3.22***)	0.523 [0.469]
26	Wholesale Trade	1.138 (22.81***)	0.166 (1.81*)	-0.227 (-1.19)	0.651 [0.420]
27	Retail Trade	0.820 (18.99***)	0.283 (3.54***)	-0.214 (-1.08)	0.828 [0.363]
28	Banks	1.189 (17.57***)	-0.149 (-1.43)	0.423 (1.80*)	0.172 [0.678]
29	Securities & Commodity Futures	1.693 (17.78***)	-0.214 (-2.01**)	0.312 (1.74*)	1.039 [0.308]
30	Insurance	1.089 (16.56***)	-0.169 (-1.46)	0.450 (2.31**)	1.455 [0.228]
31	Other Financing Business	0.979 (19.44***)	0.319 (3.63***)	-0.124 (-0.83)	0.402 [0.526]
32	Real Estate	1.238 (13.41***)	0.070 (0.50)	0.662 (2.96***)	0.116 [0.732]
33	Services	0.896 (18.36***)	0.212 (2.31**)	-0.724 (-4.03***)	2.498 [0.114]

PANEL B: Summary of Market, SMB and HML betas

	Mean	Max	Min	Sig. positive	Sig. negative
b_i	0.9715	1.693	0.642	33	0
s_i	0.2897	0.785	-0.35	24	2
h_i	0.1794	0.785	-0.774	14	3

PANEL C: Market, SMB and HML risk premiums

$\overline{\mu}_M$ (%)	$\overline{\mu}_{SMB}$ (%)	$\overline{\mu}_{HML}$ (%)
0.1289 (2.05**)	0.2483 (5.1***)	0.3613 (15.59***)

Notes: This table presents the results of testing the FF model in the system of regressions (3), (4), (5), and (6) The sample is monthly return data extending from January 1984 to December 2004. GMM is Sargan or J test statistic of overidentifying restrictions. Standard Errors computed from heteroscedastic-consistent matrix (Robust-White). The associated t-statistic is in parentheses ( ). The associated p-value is in square brackets [ ]. ***, **, * indicate significant at 1% level, 5% level, and 10% level, respectively.

5. Robust Check

To access the consistency of results, data are arbitrarily split into three sub-periods (1984-

1989, 1990-1998, and 1999-2004). In this way, the effect of each period, i.e. stock market bubble period, the post-bubble period, and the recent period of zero interest rate policy on the results is separately considered. In addition, 33 industries are allocated into ten groups or categories. Suppose our results are consistent, though the size of factor loadings and FF risk premiums may vary, their level of significance and sign should be insensitive to change in sample periods.

Table 3: Fama and French three-factor model tests based on GMM estimations for ten groups of industry portfolios in sub-periods

PANEL A: Betas and GMM statistics

Group	Period	b_i	s_i	h_i	GMM
Commerce	84-89	1.044 (19.01***)	0.442 (6.83***)	0.292 (2.01**)	1.008 [0.315]
	90-98	0.938 (30.44***)	0.242 (5.50***)	-0.210 (-1.76*)	0.466 [0.494]
	99-04	1.181 (16.13***)	0.062 (0.44)	-0.427 (-1.97**)	1.978 [0.160]
Construction	84-89	0.940 (7.63***)	0.127 (0.99)	0.538 (1.25)	0.547 [0.459]
	90-98	1.028 (13.69***)	0.773 (8.13***)	0.536 (1.96**)	0.235 [0.627]
	99-04	0.895 (9.22***)	0.834 (7.87***)	0.418 (2.10**)	2.128 [0.145]
Electric Power & Gas	84-89	0.956 (5.26***)	-0.579 (-2.66***)	1.036 (2.16**)	0.891 [0.345]
	90-98	0.814 (9.84***)	-0.415 (-4.38***)	0.165 (0.67)	0.000 [0.989]
	99-04	0.066 (0.72)	0.292 (2.87***)	0.245 (1.11)	0.068 [0.793]
Finance & Insurance	84-89	1.468 (19.56***)	-0.134 (-1.79*)	-0.109 (-0.79)	0.416 [0.519]
	90-98	1.174 (29.98***)	-0.174 (-2.78***)	0.433 (3.12***)	0.002 [0.968]
	99-04	1.268 (13.93***)	0.413 (2.97***)	0.398 (1.82*)	0.000 [0.990]
Fish. Agriculture. & Forest.	84-89	1.052 (7.48***)	0.866 (5.14***)	0.090 (0.35)	0.066 [0.797]
	90-98	0.906 (14.02***)	0.614 (5.65***)	0.090 (0.44)	3.243 [0.072]
	99-04	0.519 (6.18***)	0.780 (7.91***)	-0.165 (-0.80)	0.807 [0.369]
Manufacturing	84-89	0.869 (12.81***)	0.403 (6.79***)	0.087 (0.60)	0.509 [0.475]
	90-98	0.929 (46.77***)	0.242 (6.41***)	-0.150 (-1.83*)	4.197 [0.040]
	99-04	0.915 (24.89***)	0.416 (7.03***)	0.317 (2.85**)	0.149 [0.699]
Mining	84-89	0.828 (5.45***)	0.596 (3.31***)	-0.259 (-1.19)	0.028 [0.866]
	90-98	1.091 (16.14***)	0.803 (9.22***)	0.092 (0.45)	1.089 [0.297]
	99-04	0.875 (5.11***)	0.729 (4.03***)	0.257 (0.65)	0.365 [0.545]
Real Estate	84-89	1.422 (5.60***)	-0.207 (-0.89)	0.504 (1.21)	0.001 [0.972]
	90-98	1.253 (14.76***)	-0.114 (-1.20)	0.160 (0.47)	0.039 [0.843]
	99-04	1.040 (7.84***)	0.787 (4.16***)	0.777 (2.24**)	0.081 [0.775]
Services	84-89	1.041 (9.44***)	0.763 (5.11***)	-0.037 (-0.18)	0.045 [0.831]
	90-98	0.835 (16.90***)	0.190 (2.86***)	-0.747 (-4.23***)	1.333 [0.248]
	99-04	1.262 (12.16***)	-0.365 (-4.05***)	-1.078 (-5.10***)	2.352 [0.125]
Transport, Info. & Comm.	84-89	1.087 (10.10***)	0.334 (3.46***)	0.124 (0.67)	0.651 [0.419]
	90-98	1.055 (22.16***)	0.261 (4.18***)	0.021 (0.12)	0.009 [0.926]
	99-04	0.928 (12.70***)	0.381 (3.97***)	0.481 (2.98***)	0.048 [0.825]

PANEL B: Mean Market, SMB and HML betas

Period	$\bar{b}_i$	$\bar{s}_i$	$\bar{h}_i$
84-89	1.0707	0.2611	0.2266
90-98	1.0023	0.2422	0.0390
99-04	0.8949	0.4329	0.1223

PANEL C: Market, SMB and HML risk premiums

Period	$\bar{\mu}_M$ (%)	$\bar{\mu}_{SMB}$ (%)	$\bar{\mu}_{HML}$ (%)
84-89	1.6579 (9.07***)	0.4813 (2.67**)	0.4507 (4.86***)
90-98	-0.9273 (-4.68***)	-0.2309 (-1.78*)	0.2463 (5.13***)
99-04	0.1775 (0.99)	0.7636 (4.95***)	0.4836 (5.52***)

Notes: See table 2

The analysis across groups is given in Table 3, and its key findings are as follows. Basic results from GMM test are fairly consistent. In only one (two) case (s), the FF model can be rejected at 5 (10) percent level of significance. The single rejection at 5 percent level occurs in Manufacturing over the post-bubble period (1990-1998). In addition, the significance of factor loadings are essentially unchanged i.e. out of a total number of 30 betas loading on each respective factor over the three sub-periods, 29 market betas, 26 size-factor betas, and 14 BM-factor betas are found to be significant. However, average FF risk premiums are rather sensitive across sample periods. For example, market risk premium is not significant during the most recent period (1999-2004). Further, market risk premium and SMB premium are significantly negative during the post-bubble period. As such, support for the FF model is less persuasive. Also, finding on a reversal of size effect confirms similar findings by a number of researchers (see Gompers and Metrick, 1998, Dimson and Marsh, 1999, Gustafson and Miller, 1999, and Faff, 2004).

6. Conclusions

Daniel *et al.* (2001) and Chiao and Hueng (2004) construct book-to-market and size factor from all Tokyo Stock Exchange (TSE)'s common stocks by following sophisticated procedures as in Fama – French (1993). Faff (2003, 2004) has successfully created the simple proxies for FF factors with relevant "off-the-shelf" style indexes and verified their efficacy utilizing sample sizes of U.S and Australian industry indexes. Based on formal asset pricing test, his findings are quite favorable to the FF model. This motivates us to further investigate whether simple proxies for FF factors can also explain returns on industry indexes in Japanese market.

Four Daiwa value weighted style indexes have been utilized to construct the proxies for FF factors. Our analysis based on industry-classification suggests that the three-factor model cannot be rejected over the full sample period (1984-2004). A further examination on the significance of FF risk premiums reveals that size and book-to-market factors were able to outperform the market over this period.

In an attempt to ascertain the robustness of our results, the full period is arbitrarily split into three sub-periods. Basic results from GMM test are fairly consistent across periods and therefore remain support to the FF model. However, when FF risk premiums are taken into consideration, the support for FF model is less persuasive. Particularly, finding on a reversal of size effect during post-bubble period confirms similar findings from previous literature.

To conclude, the contributions of our study are creating new and simple proxies for FF factors in Japanese market and modifying Faff (2003, 2004)'s method of testing the significance of FF risk premiums i.e. provide the overall test across sections. Our simply constructed FF factors can explain returns on 33 industry indexes of all common stocks listed on the first section of Tokyo Stock Exchange. This study confirms the findings by a number of researchers on a reversal of size premium. Thus, the issue on which model is better in explaining common variation of stock returns – CAPM, FF model, or another asset pricing model, remains a puzzle.

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