Effects of the Fat-Tail Distribution on the Relationship between Prospect Theory Value and Expected Return

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ABSTRACT:

This study investigates the negative relationship between prospect theory value and expected return considering the fat-tail property of the return distribution. The results of both decile portfolio and cross-sectional regression show evidence supporting the hypothesis related to prospect theory value. However, these results are very sensitive to whether the model includes a short-term reversal factor. In the empirical design combining the hypothesis with the degree of fat-tail of the return distribution, stock groups with the fat-tail return distribution definitely show that prospect theory value has a significant information value for explaining expected return, regardless of whether the short-term reversal and other factors are included in the models. These results suggest that both the fat-tail property in the stock return distribution and the property of the skewed return distribution must be considered in examining the relationship between prospect theory value and expected return. Furthermore, our findings on the effects of the fat-tail property of the return distribution are verified through robustness testing while considering changes in empirical design and using out-of-sample stock markets of the U.S., Japan, and China, as well as the in-sample Korean stock market.

Keywords: Prospect theory value, Decision weight, Skewed distribution, Fat-tail distribution, Out-of-sample test.

JEL classification: G11; G40

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1. Introduction

Investors encounter the problem of decision-making under information constraints because all information necessary for an investment cannot realistically be known (Simon, 1979). Hence, investors cannot make investment decisions under perfect rationality as assumed in the expected utility theory. However, investment behavior under this limited rationality is predictable in part due to the specific tendency of investor psychology (Ariely, 2008). Unlike traditional expected utility theory, Kahneman and Tversky (1979, KT) propose a prospect theory which takes a new perspective on the risk perception of investors under constrained information. In addition, the subsequent revised prospect theory proposed by Tversky and Kahneman (1992, TK) extends this theory's applicability into practice. These studies have contributed greatly to quantitative research on how prospect theory can be applied in financial markets where investor psychology plays an important role. From the perspective of behavioral finance, Barberis, Mukherjee and Wang (2016, BMW) utilize the stock return distribution in the past period in order to prove that trading activities that investors determine based on prospect theory have a significant impact on expected return. This study, based on BMW (2016), tests the hypothesis that the prospect theory value from the past period has a significant negative relationship with expected return. Moreover, as an attempt to extend the existing research, we examine the relationship between prospect theory value and expected return considering the fat-tail property of the return distribution, which is deeply related to the prospect theory value derived from the decision weight of the investor attention.

Regarding the research spanning the 30 years since the introduction of KT's prospect theory (1979), Barberis (2013) summarizes the representative characteristics of prospect theory as reference dependence, loss aversion, diminishing sensitivity, and probability weighting.[1] These four factors are reflected in both the value function and decision weight which are key components to compute the prospect theory value in TK (1992). Among these four factors, the first three factors are more closely related to the value function and the final factor is related to the decision weight. The decision weight in prospect theory value is not a weight of the objective probability but a weight of investor attention on the transaction activities. Compared to the probability weight of the traditional expected utility function, TK (1992) report the tendency to have a higher decision weight in extreme events with smaller frequency and a lower weight in normal events with larger frequency in the distribution. This means that the normal events located in the central part of distribution tend to be allocated with the lower weight, while extreme events located in the tail parts of distribution tend to be allocated with the higher weight. Similar to the tendency in which investors prefer stocks with properties of potentially large gains (Bali, Cakici and Whitelaw, 2011), the decision weight may have a high relevance with extreme values located in the tail of the return distribution.

Using stock market data of the United States and 46 countries, BMW (2016) suggest that investors evaluate stocks based on the past return distribution from the perspective of prospect theory value. In this case,

[1] Investor utility of prospect theory from the perspective of individual stocks is derived from the gains and losses measured by the reference price rather than the absolute price. That is, the gains and losses rely on the reference price. The value function features a graph with a rising S-shaped curve, showing the change in magnitude of value according to changes to losses and gains. As mentioned in Barberis (2013), the value function with an S-shaped curve is longer and deeper in the negative area of losses than in the positive area of gains. This implies that investors are more sensitive to losses than gains of the same magnitude. The loss area in the value function has a shape of a convex curve, but the gain area in the value function features the shape of a concave curve; that is, the characteristic of diminishing sensitivity. The loss area with convexity represents the risk-taking tendency of investors; the gain area with concavity indicates the risk-aversion tendency of investors. As a result, investors have different risk attitude concerning gains and losses.

prospect theory value is calculated by using TK's revised prospect theory (1992). As in the study of DeBondt and Thaler (1985), a stock with a higher prospect theory value computed from the past return distribution seems to be over-evaluated as a desirable investment, while a stock with lower prospect theory value appears to be under-evaluated. Due to the trading activities based on investor beliefs from the past return distribution, BMW (2016) assume that stocks with a higher prospect theory value tend to have a lower expected return in the future, while stocks with a lower prospect theory value tend to have a higher expected return. Subsequently, they proved the significant negative relationship between prospect theory value and expected return. In particular, they also present evidence that this negative relationship is more evident in markets which are strongly dependent on the transaction activities of individual investors, such as the Nasdaq. Accordingly, following BMW (2016), this study measures prospect theory value using the past stock return distribution, and examines the relationship between prospect theory value and expected return.

On the other hand, the prospect theory value computed from the past return distribution is affected by the magnitude of extreme values and decision weights allocated to them; that is, as the degree of positive skewness of the return distribution is larger, stocks have much larger extreme performance located in the tail parts of the return distribution. Therefore, the decision weight exerts a high value for these stocks due to the characteristic of probability weighting based on TK's prospect theory (1992). BMW (2016) show that prospect theory value tends to have a positive relationship with the degree of positive skewness in the return distribution. Previous studies report that investors tend to prefer stocks with lottery attributes (Bali et al., 2011) and with high idiosyncratic risk (Han and Kumer, 2013). These investor preferences may also result in a high weight in the tail of the return distribution. Therefore, to extend previous studies, the second research goal of this study is to empirically investigate the effect of the fat-tail property in the return distribution regarding prospect theory value. Along with the positive relationship of prospect theory value on the degree of skewness in the return distribution, this study considers the degree of fatness in the tail of the stock return distribution. Statistically, the degree of skewed distribution is affected by a maximum or minimum extreme value in the tail parts of the return distribution, while the fatness of the tail parts deviated from the central part in the distribution is depended on the number of extreme values compared to the normal distribution. That is, a surprising extreme event leads to investor attention, and also, many extreme events may strongly attract investor attention. Accordingly, after categorizing stock groups by the degree of fatness in the tail parts of the return distribution, this study re-examines the first research goal within each of two stock groups with fat- and thin-tail return distributions.

The empirical distribution of stock returns is widely known to have characteristics of a leptokurtic distribution (Fama, 1965) with a higher central part and fatter tails compared to the normal distribution.

BMW (2016) mention the positive relationship between prospect theory value and the skewness in the return distribution. However, the skewness is not a measure to directly quantify the fatness of the tail of the return distribution. We employ the statistical probability as a measurement for the degree of fatness in the tail, which deviates from the 99% confidence interval of the stock return distribution. In addition, since the empirical distribution of stock returns does not have a symmetrical structure like the normal distribution, the fatness of the positive tail part differs from the fatness of the negative tail part; however, it is rare for only one side of the tails in the distribution to have a fat-tail. Therefore, when categorizing the degree of fatness in the tail parts, we consider separately the positive and negative tail parts in the empirical design. For the second research goal, we combine the hypothesis of BMW (2016) with the fat-tail property of the stock return distribution. The rationale is as follows. Investors tend to believe that stocks that realized extreme gains (losses) in the past period will continue to have the extreme gains (losses) in the future period, e.g., representativeness heuristic and overconfidence bias suggested by Barberis, Shleifer and Vishny (1998) and Daniel, Hirshleifer and Subrahmanyam (1998). Prospect theory value is determined by gains (losses) and decision weights based on investor attention. First, prospect theory value may be high (low) depending on a very larger extreme gain (loss). As verified in BMW (2016), the degree of skewness in the return distribution has a positive relationship with the magnitude of prospect theory value. Stocks with a longer-skewed return distribution due to much larger extreme gain (loss) have a high likelihood of having very high (low) prospect theory value. We expect this tendency from stocks with the return distribution having a longer-skewed thin-tail characteristic. Second, prospect theory value is also dependent on the many extreme gains (losses) and high decision weights applied to them. Stocks with the fat-tail return distribution due to many extreme gains (losses) may have a high (low) prospect theory value, although this prospect theory value is not very high (low) compared to stocks with a longer-skewed thin-tail return distribution mentioned before. We expect this tendency from stocks with the return distribution having the fat-tail property.

Based on the fat-tail property in the return distribution, this study assumes that the frequent extreme values observed in stocks with the fat-tail return distribution can be attractive enough to gain high investor attention, along with stocks with the thin-tail return distribution due to a surprising extreme value. We may prove it by empirically investigating whether the fat-tail property in the return distribution has a significant influence on the results supporting the hypothesis related to prospect theory. The combined hypothesis with the fat-tail property of the return distribution is as follows: First, from the viewpoint of the positive tail in the stock return distribution, stocks with many positive extreme values may relatively receive high attention from investors, compared to stocks with a few positive extreme values. Investors tend to give a higher decision weight to extreme events located in the positive tail part of the return distribution (TK, 1992; Barberis, 2013). Therefore, these stocks have higher prospect theory values in the past period, tend to be over-evaluated and have a high likelihood of achieving a lower expected return in the future period. That is, the past prospect theory value may have a negative relationship with expected return in the aspect of the positive tail return distribution. In addition, such a tendency may be observed more in stocks with the fat-tail return distribution compared to stocks with the thin-tail return distribution. Second, from the perspective of the negative tail part of the stock return distribution, stocks with many negative extreme values may relatively receive high attention from investors, compared to stocks with a few negative extreme values. Investors tend to give a higher decision weight to extreme events located in the negative tail part of the distribution. Therefore, these stocks have lower prospect theory values in the past period, tend to be under-evaluated and have a high likelihood of achieving a higher expected return in the future period. That is, the past prospect theory value may have a negative relationship with expected return in the aspect of the negative tail return distribution. Such a tendency may be observed more in stocks with the fat-tail return distribution compared to stocks with the thin-tail return distribution. As a result, evidence supporting the hypothesis of the second research goal may be substantially more evident in the return distribution with fatter tails than in the return distribution with thinner tails, regardless of the positive and negative tail parts in the distribution. Accordingly, this study empirically examines the hypothesis using two stock groups with fat- and thin-tail return distributions. In order to obtain reliable results supporting the combined hypotheses, we verify the robustness of the observed results according to the change of empirical design (seasonality, length of estimation period, and length of investment period) using both out-of-sample (the U.S, Japanese, and Chinese), and in-sample (Korean) stock markets.

The main results are summarized as follows: The results using decile portfolio based on the Korean stock market show evidence supporting the negative relationship between past prospect theory value and expected return. These results are consistent with BMW (2016). The expected returns of the L-H zero-cost portfolio, which is the difference between a portfolio (L) constructed by stocks with the lowest prospect theory values and a portfolio (H) formed by stocks with the highest prospect theory values in the past, show significant positive values. Also, Fama and MacBeth (1973)'s cross-sectional regression shows that the past prospect theory value of stocks has a significant negative coefficient against expected return. These results are more evident in the KOSDAQ market, in which most stocks feature small market capitalization and individual investors play a crucial role in transactions, compared to the KOSPI market, in which most stocks feature large or middle market capitalization and institutional and foreign investors play a central role in stock transactions. However, when reversal factors, especially the short-term reversal factor, are included in the cross-sectional regression models as an additive independent variable, the significant negative relationship supporting the hypothesis is not observed. Unlike the results of BMW (2016) for the United States stock market, this result implies that expected returns explained by the past prospect theory value are significantly related with the short-term reversal factor. Next, when combining the fat-tail property of the return distribution and the hypothesis related to prospect theory value, the L-H zero-cost portfolio within stock groups with the fat-tail return distribution has a statistically significant positive value supporting the hypothesis, regardless of the positive and negative tail parts. However, the L-H zero-cost portfolio from stock groups with the thin-tail return distribution does not show significantly consistent evidence. Also, within the stock groups with the fat-tail return distribution, the past prospect theory value significantly explains the expected returns in all models, irrespective of whether short-term reversal or other independent variables are included or not. Our findings suggest that the fat-tail property in the return distribution plays an important role in determining the relationship between prospect theory value and expected return, along with the longer-skewed property. Therefore, the prospect theory value from previous studies which do not consider the fat-tail property of the return distribution might have a high likelihood of failing to sufficiently reflect the trading behavior caused by investor attention in the empirical design. In the robustness test, the change of empirical design, such as seasonality and the length of estimation and investment periods, does not affect the main results. In addition, when using the U.S., Japanese, and Chinese stock markets as out-of-sample data, the results show statistically significant evidence supporting the hypothesis within stock groups with the fat-tail return distribution. However, stock groups with the thin-tail return distribution do not show consistent results of the hypothesis related to prospect theory and, furthermore, statistically have insignificant or weakly significant effect on the results. As a result, this study robustly determines the significant impact of the fat-tail property in the return distribution on the negative relationship between prospect theory value and expected return through both in-sample and out-of-sample stock markets.

Following the introduction, we present the data, period, and methods for empirically testing our hypotheses. Section 3 shows the results of the hypothesis of the negative relationship between prospect theory value and expected return according to the fat-tail property of the return distribution. In addition, we present the robustness of our findings through the changes in empirical design and using out-of-sample stock markets. The final section concludes.

2. Empirical Design

2.1. Data and Period

This study utilizes data of 2,906 stocks both listed and delisted on the Korean stock market (from FnGuide), as in-sample. The test period is from July 1992 to June 2017 (300 months), and covers the period from July 1987 to June 2017 given the period of 5 years required to estimate all independent variables for the Fama and MacBeth (1973) cross-sectional regression approach.[2] For the robust test, we utilize the listed and delisted stocks traded on each market collected from CRSP and Compustat Global. This includes the U.S. (NYSE, AMEX, Nasdaq, 26,313 stocks), Japanese (TOPIX, Jasdaq, 5,440 stocks), and Chinese (Shanghai, Shenzhen, 3,076 stocks) stock markets. The test period is from January 2000 to December 2016 for the U.S. and Japanese stock markets and from January 2011 to December 2016 for the Chinese stock market, excluding the past 5 years required for estimating all independent variables.

The types of data used in the test procedure are summarized as follows: First, price data (P_t) of all stocks except stocks belonging in the financial industry and their accounting data.[3] Second, the stock returns (R_t) calculated by $R_t = P_t/P_{t-1} - 1$. Third, the market return (R_m) calculated using all stocks that are included in test procedure. Fourth, three factors of market, size and value premiums based on Fama and French (1993). Fifth, the risk-free rate from monetary stabilization securities (364 days) for the Korean stock market and short-term bond data of the U.S, Japan, and China from the Federal Reserve Bank.[4] Finally, the independent variables for the Fama and MacBeth cross-sectional regression included TK's prospect theory value (1992), the market beta, the firm size and the book-to-market equity ratio of Fama and French (1992), the momentum of Jegadeesh and Titman (1993), the short-term reversal of Jegadeesh (1990), the long-term reversal of DeBondt and Thaler (1985), the illiquidity of Amihud (2002), the idiosyncratic volatility of Ang, Hodrick, Xing and Zhang (2006), and the maximum and (-1) minimum of Bali et al. (2011). Under the aforementioned data types above, we utilize daily and monthly data according to the research design.[5]

2.2. Methodology

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[2] Stocks traded on the KOSPI and KOSDAQ markets have different test periods. Data from the KOSPI cover the period from July 1987 to June 2017, while data from the KOSDAQ span the period from July 1997 to June 2017.

[3] For the Korean stock market, we exclude stocks belonging in the financial industry according to the industry category classified by the Korea Exchange. For the U.S., Japan, and China, we exclude stocks with a code number of the financial industry (6000~67000) according to the standard industrial classification (SIC).

[4] The source of risk-free rate for the U.S., Japan, and China is obtained from the Federal Reserve Bank's economic research resources website (fred.stlouisfed.org). We utilize 3-month T-Bill for the U.S., and interest rates & discount rate for Japan and China.

[5] BMW (2016) include three additional independent variables in the cross-sectional regression, which represent the degree of skewness in the return distribution; that is, skewness as a statistical measure, the co-skewness of Harvey and Siddique (2000), and the expected idiosyncratic skewness of Boyer, Mitton and Vorkink (2010). However, this study excludes these three independent variables with redundant attributes because we directly calculate the degree of fatness in the tail parts of the return distribution. On the other hand, we conduct the test procedure including these three independent variables in the cross-sectional regression, and verify that these variables do not have significant explanatory power in the models and furthermore, cannot change the results reported in this paper. Therefore, we do not report these results in this paper.

This section presents the method to calculate prospect theory value through two components of the value function and the decision weight using the stock return distribution in the past period. For the stock return distribution, it is necessary to first rank gains and losses against the reference price in the ascending ordered distribution. The representative reference prices are usually selected among zero-values, purchase price and market price. When assessing the price decline of stocks, investors tend to have a neutral attitude if the poor performance is due to a fall in the market. Accordingly, we employ the market return as the reference price, as in BMW (2016). From the stock return distribution of the past 5 years, we calculate the gains and losses ($x_t = R_{j,t} - R_{m,t}$) by subtracting monthly market returns from monthly stock return, and arrange the gains and losses in by ascending order.

$$(x_{-m}p_{-m} \; ; \; x_{-m+1}p_{-m+1}; \ldots ; \; x_{-1}p_{-1}; \; x_0p_0 \; ; \; x_1p_1; \ldots ; \; x_np_n) \tag{1}$$

Here, m indicates the loss area ($x_i < 0$) with negative values within the range of $x_{-m}\sim x_{-1}$, and n indicates the gain area ($x_i \geq 0$) with positive values within the range of $x_0{\sim}x_n$; that is, performance is differentiated into gains and losses according to the sign. The condition of the objective probability is $\sum_{i=-m}^{n} p_i = 1$. In addition, prospect theory value (PTV) is calculated, as follows:

$$\text{PTV} = \sum_{i=-m}^{n} v(x_i)\pi_i \tag{2}$$

In Eq. (2), $v(\cdot)$ is the value function with an S-shaped curve of the ascending form (in the case of zero performance, $v(0) = 0$), and π_i is the decision weight reflecting the investor attention. Prospect theory value is calculated using the gains and losses for the stock return distribution of the past 60 months, as follows:

$$\text{PTV} = \sum_{i=-m}^{-1} v(x_i)[w^-\left(\frac{i+m+1}{60}\right) - w^-(\frac{i+m}{60})] + \sum_{i=1}^{n} v(x_i)[w^+\left(\frac{n-i+1}{60}\right) - w^+(\frac{n-i}{60})] \tag{3}$$

In Eq. (3), the first right-term indicates the loss area and the second right-term indicates the gain area. The probability of the gains and losses that are determined using the data of the past 60 months is divided into denominator and numerator components. The denominator is equally established; that is, $p_i = 1/60 = p_j$. Because the distribution of gains and losses does not have time sequence, it is difficult to provide a different probability for each performance according to the time series. The numerator may have different values according to the degree of deviation from zero; that is, a position farther away from the value of zero has a higher value, compared to a position closer to zero. Therefore, the more extreme gains and losses have a higher value due to the numerator for the probability. Now, we separately explain the value function and the decision weight. First, the value function is explained. As mentioned prior, the value function has the characteristics of reference dependence, loss aversion, and diminishing sensitivity, and the S-sharped curve that consist of the losses in the convex curve part and the gains in the concave curve part. The value functions for the gain area ($x_i \geq 0$) and the loss area ($x_i < 0$) are as follows:

$$v(x_i) = \begin{cases} x_i{}^{\alpha}, & \text{for } x_i \geq 0 \\ -\lambda(-x_i)^{\alpha}, & \text{for } x_i < 0 \end{cases} \tag{4}$$

In Eq. (4), $\lambda(> 1)$ is a parameter that affects the determination of the ascending S-shaped curve. Larger values of λ result in the S-shaped curve having greater loss area against zero; that is, much higher sensitivity on losses. We employ λ=2.2 as in TK (1992) and BMW (2016). The parameter α∈(0, 1) determines the degree of smoothness in the S-shaped curve. We employ α=0.88 based on TK (1992) and BMW (2016).

Second, the decision weight on the investor attention is explained. The decision weight is a function that converts the objective probability into the weight of the investor attention on normal and extreme events as follows:

$$\pi_i = \begin{cases} w^+(p_i + \cdots + p_n) - w^+(p_{i+1} + \cdots + p_n), & \text{for } 0 \leq i \leq n \\ w^-(p_{-m} + \cdots + p_i) - w^-(p_{-m} + \cdots + p_{i-1}), & \text{for } -m \leq i < 0 \end{cases} \tag{5}$$

$$w^+(P) = \frac{P^{\gamma}}{(P^{\gamma}+(1-P)^{\gamma})^{1/\gamma}}, \quad w^-(P) = \frac{P^{\delta}}{(P^{\delta}+(1-P)^{\delta})^{1/\delta}} \tag{6}$$

Where, $w^+(\cdot)$ and $w^-(\cdot)$ are the function of decision weight in the gain area and the loss area, respectively. In the loss area, $w^-(\cdot)$ is the difference that is obtained by subtracting the probability ($p_{-m} + \cdots + p_{i-1}$) of much worse than performance from the probability ($p_{-m} + \cdots + p_i$) of equal to or worse than performance, and the case of $i = -m$ is $\pi_{-m} = w^-(p_{-m})$. On the other hand, in the gain area, $w^+(\cdot)$ is the difference that is obtained by subtracting the probability ($p_{i+1} + \cdots + p_n$) of equal to or better than performance from the probability ($p_i + \cdots + p_n$) of much better than performance, and the case of $i = n$ is $\pi_n = w^+(p_n)$. In the function of decision weight, parameters of γ, δ(∈(0, 1)) are related to the degree of over-weights given into the tail parts; that is, the lower value leads to give over-weights into the tail parts. For these parameters, this study employs γ =0.61 and δ =0.69 as applied in both TK (1992) and BMW (2016).

3. Results

This section presents the results for each research goal. First, the results of the hypothesis of the negative relationship between prospect theory value and expected return are presented. Second, we present results of reexamining the hypothesis of the first research goal after considering the fat-tail property of the stock return distribution. In order to confirm the robustness of the observed results, this study presents results regarding the change in empirical design (seasonality, length of periods in estimation and investment) and out-of-sample stock markets (the U.S., Japan, and China).

3.1. Testing hypothesis related to prospect theory value

This section presents the results for the first research goal regarding whether the prospect theory value using the stock return distribution in the past period has a significant negative relationship with the expected return in the future period. According to BMW (2016), stocks with higher prospect theory values in the past period tend to have lower expected returns, and in contrast, stocks with lower prospect theory values in the past period tend to have higher expected returns. Supporting evidence for the hypothesis is that the L-H zero-cost portfolio has significant positive performance determined by subtracting the expected return of a portfolio (H) constructed by stocks with the highest prospect theory values from the expected return of a portfolio (L) constructed by stocks with the lowest prospect theory values. The results are presented in **Tables 1** and **2** for the decile portfolio and **Tables 3** and **4** for the Fama and MacBeth cross-sectional regression.

First, **Fig. 1** shows the distribution of the prospect theory values from the perspectives of individual stocks and decile portfolio for the Korean stock market. The decile portfolio is constructed based on the prospect theory values calculated using the stock return distribution of the past 60 months. In the first sub-period, the estimation period used to calculate the prospect theory value of each stock is 60 months, over the period from July 1987 to June 1992, and the investment period as a test month is July 1992. According to the roll-sampling method using a moving period of one month, we repeatedly test for each sub-period until the last sub-period ends at June 2017. Therefore, the total number of sub-periods is 300. For each sub-period, the number of stocks considered ranges from 239 to 1,484. **Fig. 1(a)** shows the relationship between prospect theory value and statistical skewness for individual stocks using a scatter plot, and **Fig. 1(b)** regarding the decile portfolio presents the distribution of prospect theory values of each portfolio using the box-plot method.

[Insert Figure 1 here]

Fig. 1(a) shows a significant positive correlation of 62.6% in the relationship between prospect theory values and the skewness in the stock return distribution, as in BMW (2016). That is, a larger degree of positive skewness in the stock return distribution results in higher prospect theory values. **Fig. 1(b),** concerning the decile portfolio, shows a monotonic decreasing pattern from the highest portfolio (H, P1) to the lowest portfolio (L, P10). The portfolio with the highest prospect theory values differs from the remaining portfolios, especially the portfolio with the lowest prospect theory values. **Table 1** presents the results of examining the hypothesis based on the decile portfolio. The results are displayed according to the weighting schemes of the equal weighting method (Panel A) and the value weighting method (Panel B). In addition, the results presented in each panel are separated as the past period and the future period. The past period consists of the prospect theory value (PTV) and risk-free excess return (Ex.return). The future period consists of three types of performance in each portfolio; that is, risk-free excess return (Ex.return), risk-adjusted return by the capital asset pricing model (CAPM alpha), and risk-adjusted return by the Fama and French three-factor model (FF3 alpha).[6] On the rightmost side of the table, the results of the L-H zero-cost portfolio are presented. In addition, t-statistics in parentheses are reported for statistical significance on the results.[7]

[Insert Table 1 here]

Table 1 shows the significant positive performance of the L-H zero-cost portfolio in the future period; that is, evidence supporting the hypothesis for the negative relationship between prospect theory value and expected return. In the weighting scheme, the results using equal-weighted returns show strong evidence compared to those using value-weighted return. The detailed results on the past period and on the future period are as follows: In the past period, the prospect theory value of the decile portfolio shows a monotonic decreasing pattern from the highest portfolio (H, P1) to the lowest portfolio (L, H10). In addition, the portfolio with the highest prospect theory value has a higher excess return compared to the portfolio with the lowest prospect theory value. This observation, in which stocks with the higher (lower) prospect theory value have higher (lower) excess return, empirically supports the suggestion that investor attention results in over-evaluation (under-evaluation) of stocks based on the prospect theory value in the past period. In the future period, most of the L-H zero-cost portfolio has statistically significant positive values. In Panel A

[6] This study employs the Fama and French three-factor model, unlike BMW (2016), which used the four-factor model consisting of momentum and the three factors. As reported by Chae and Eom (2009) and Chui, Titman and Wei (2010), significant negative momentum is reported in the Korean and Japanese stock markets. Therefore, it is difficult to employ the four-factor model in the Korean stock market, unlike in the U.S. stock markets that feature the significant positive momentum effect.

[7] On the basis of Newey and West (1987), this study reports t-statistics for risk-adjusted returns (alphas) estimated by regression through CAPM and Fama and French three-factor model to adjust for the influence of serial correlation and heteroscedasticity of residuals caused by use of overlapping information on the results. We employ 12 lags to calculate the t-statistic based on the previous studies, e.g., Ang, Chen and Xing (2006). All t-statistics for the risk-adjusted returns reported in all tables in the paper are calculated using Newey and West (1987)'s standard error.

regarding the equal weighting method, excess return has a significant value of 0.0295 (t:3.60), and the alphas of CAPM and FF3 feature significant values of 0.0320 (t:3.25) and 0.0172 (t:1.86), respectively. The significant performance in Panel B of the value weighting method is the excess return of 0.0320 (t:1.96) and CAPM alpha of 0.0309 (t:2.21). From the perspectives of the statistical significance of decile portfolio performance, the results using the equal-weighted return show strong evidence supporting the hypothesis compared to the results using the value-weighted return. These results may possibly be explained based on BMW (2016), suggesting that supportive evidence to the hypothesis is found in small-firm stocks in which individual investors play a central role. In order to investigate the effect of individual investor's transactions on the hypothesis, we present results of the same testing procedure after dividing all stocks into the KOSPI and KOSDAQ markets, as shown in **Table 2**. Using data from the Korea Exchange Securities and Derivatives Market Statistics (2017), the ratio of the market capitalization in the Korean stock market consists of 86.32% of the KOSPI and 13.38% of the KOSDAQ in 2016. The ratio of the number of stocks listed in the KOSPI and the KOSDAQ is 39.20% and 60.80% of all listed stocks in the Korean stock market, respectively. These statistics suggest that most stocks traded in the KOSDAQ are much smaller firms than those in the KOSPI. In addition, when comparing the percentage of market capitalization by the type of representative investors in the stock market, institutional, foreign and individual investors in the KOSPI market are 41.49%, 35.23%, and 19.69%, respectively, compared to 27.04%, 9.85%, and 62.90%, respectively, in the KOSDAQ market. This implies that the transaction activities of individual investors play a greater central role in the KOSDAQ market compared to the KOSPI market. **Table 2** presents the results divided into the KOSPI (Panel A) and KOSDAQ (Panel B) markets, and for each market, shows the investment performance of the highest portfolio (H), the lowest portfolio (L), and the L-H zero-cost portfolio.

[Insert Table 2 here]

Regardless of the weighting scheme, **Table 2** shows that results for the KOSDAQ market represent more significant evidence supporting the hypothesis compared to the KOSPI market. In particular, the investment performance using equal-weighted returns in the KOSDAQ market shows more significant and higher values compared to the KOSPI market. Also, the results using equal-weighted returns are more significant than those using value-weighted returns, regardless of the KOSPI and the KOSDAQ. On the other hand, in the case of using value-weighted return, statistical significance on the investment performance is weaker in the KOSPI market than in the KOSDAQ market, but the magnitude of investment performance is slightly a little larger. A possible explanation is as follows. From a comparative perspective of the magnitude of investment performance, stocks with the thin-tail return distribution in the KOSPI market tend to have relatively higher performance when using value-weighted returns, not equal-weighted return, based on **Table 6,** which presents results according to stock groups categorized by the degree of tail fatness in the return distribution. However, these results for the KOSPI market using the value-weighted returns are not supported by criteria based on statistical significance, compared to the significant results for the KOSDAQ market. As a result, this study verifies the evidence in BMW (2016), suggesting that the transaction activities of individual investors have a significant influence on generating the negative relationship between prospect theory value and expected return.

Next, utilizing the Fama and MacBeth cross-sectional regression on individual stocks, this study investigates the negative relationship between prospect theory value and expected return. The results are presented in **Tables 3** and **4**. Compared to the portfolio approach, the cross-sectional regression for individual stocks may have the advantage of providing a complementary explanation for observations among stocks with heterogeneous properties. In addition, we may investigate the unique information value of the past prospect theory value on expected return by considering influential factors known to significantly affect expected return. Accordingly, this study examines whether past prospect theory value has a significant negative effect on the expected return of individual stocks, and whether the significant negative coefficient of the effect of prospect theory value on expected return is consistently observed when the other influential factors are included in the regression models. We establish a six-type cross-sectional model. The dependent variable of all models is the expected return measured by the risk-free excess return of stocks in the future investment period. Independent variables in each model are as follows: Model 1 is a model with a single factor of the past prospect theory value, and the other models additively include the other independent variables. That is, Model 2 additively includes the four independent variables of market beta, firm size and book-to-market equity ratio (Fama and French, 1992) and momentum (Jegadeesh and Titman, 1993). Models 3 and 4 include the independent variables of short-term reversal (Jegadeesh, 1991), long-term reversal (DeBondt and Thaler, 1985) and illiquidity (Amihud, 2002). Models 5 and 6 include the independent variables of idiosyncratic volatility (Ang et al., 2006) and extreme value (maximum and minimum values, Bail et al., 2011). **Table 3** presents the average values of the regression coefficients estimated from the six-type model for each sub-period in the whole period.

[Insert Table 3 here]

From **Table 3**, we verify that the past prospect theory values of stocks definitely explain expected return with a significant negative coefficient of –0.1178 (t:-2.48) in Model 1. This significant negative coefficient of prospect theory value is also verified in Model 2, which includes the four known independent variables of market beta, firm size, book-to-market equity ratio and momentum. However, Model 3, which additively includes the two independent variables of reversal factors, features the evident decreasing magnitude of the coefficient for the past prospect theory value and the change from significant coefficient to insignificant coefficient. The short-term and long-term reversal factors have significant negative coefficients in the models.

When other independent variables are included in the models, the effect of the reversal factors on the coefficient of prospect theory value is still confirmed. This is not consistent with BMW (2016), who presented the results of a significant negative relationship between prospect theory and expected return, regardless of whether reversal factors in the models were included. These results suggest that the negative relationship between the prospect theory value and the expected return in the Korean stock market is related to the effect of the reversal factors on expected return. As in the previous testing procedure, this study also presents the results of cross-sectional regression for the KOSPI and KOSDAQ markets in **Table 4**. The table presents the results for Models 2, 3 and 6.

[Insert Table 4 here]

Table 4 shows that the results of the cross-sectional regression are more supportive evidence for the KOSDAQ compared to the KOSPI market. Also, as shown in **Table 3**, the reversal factors lead to an insignificant negative coefficient of the prospect theory value on expected return. In addition, the short-term reversal factor has a significant negative coefficient in both the KOSPI and the KOSDAQ markets, unlike the long-term reversal factor. That is, the short-term reversal factor seems to have relatively more influential power in the results. Consequently, these results suggest that the past prospect theory value significantly accounts for the changes in expected return, but has a high relevance with the negative effect of the short-term reversal on expected return.

3.2. Testing hypothesis under the fat-tail property of the return distribution

This section presents results for the hypothesis related to prospect theory value when considering the fat-tail property of the stock return distribution. The results are presented in **Tables 5** and **6** for the decile portfolio and **Tables 7** and **8** concerning the Fama and MacBeth cross-sectional regression. As suggested in TK (1992) and BMW (2016), decision weight being a component of prospect theory value has a high relevance with investor attention. When calculating prospect theory value, the decision weight allocates a low weight for normal events in the central part of distribution, while extreme values in the tail parts of distribution are allocated a high weight. From a perspective focusing on the tail parts in the return distribution, stocks with many extreme values (fat-tail distribution) may attract relatively high attention of investors compared to stocks with a few extreme values (thin-tail distribution). In addition, prospect theory value is determined by the magnitude of the extreme value along with decision weight. In two cases of the distribution with a few large extreme values (like, longer-skewed thin-tail distribution) and that with many extreme values (like, fatter-tail distribution), it is difficult to predetermine which case must have a higher prospect theory value. However, it is certain that the magnitude of the extreme value has a significant impact on the magnitude of prospect theory value. This is confirmed in **Fig. 2**. The key point of this study is that stocks with many extreme values in the return distribution may attract high attention of investors, and hence, we consider the degree of tail fatness in the return distribution in the empirical design. Accordingly, this study establishes the hypothesis of the second research goal in which stock groups with the fat-tail return distribution that includes many extreme values show significant supportive evidence regarding the negative relationship between prospect theory value and expected return compared to the stock groups with a thin-tail return distribution that includes a few extremes.

First, the distribution of prospect theory values for the decile portfolio constructed within each stock group classified by the degree of fatness in the tail of the return distribution is presented in **Fig. 2**. As the measure of fatness on the tail of the return distribution, we use the statistical probability deviated from the 99% confidence interval of the distribution (e.g., Eom, Kaizoji and Scalas, 2019). That is, using the standardized return (z_j) calculated by subtracting the average value and dividing by the standard deviation of return, we determine the total frequency (f_T), the frequency ($z_j \leq -2.57,\ f_N^{(-)}$) included in the negative tail part of 0.5% area deviated from the 99% confidence interval of the distribution, and the frequency ($z_j \geq +2.57,\ f_N^{(+)}$) included in the positive tail part of 0.5% area deviated from the 99% confidence interval of the distribution. Then, we calculate the statistical probabilities ($f_N^{(-)}/f_T,\ f_N^{(+)}/f_T$) for each of the positive and negative tails of the return distribution. To enhance the reliability for categorizing two stock groups by tail fatness, we utilize the data of daily returns during the same period with the previous results using monthly returns. Based on the fatness in each case of the negative and positive tails in the return distribution, the decile portfolio is constructed as follows: In each sub-period, the fatness calculated for the negative tail of the return distribution for all stocks is sorted according to the descending order. Subsequently, the top 40% of stocks having the fatter tail among all stocks is categorized into the stock group (G1) with the negative fat-tail. Furthermore, the bottom 40% of stocks having the thinner tail among all stocks is categorized into stock group (G2) with the negative thin-tail. We exclude the middle 20% of stocks in order to clearly classify the two groups. The decile portfolio within each of the two stock groups is constructed based on the prospect theory value of stocks. In the case of the positive tail in the return distribution, the decile portfolio is also constructed using the same method with the case of the negative tail. Using the descending sorted fatness for the positive tail of the return distribution for all stocks, stock group (G3) is constructed using the top 40% of stocks having the positive fat-tail return distribution. Stock group (G4) is constructed by including the bottom 40% of stocks having the positive thin-tail return distribution. The decile portfolio within each stock group is constructed based on the prospect theory value of stocks. **Fig. 2** shows the distribution of prospect theory value for the decile portfolio in each of the stock groups through the box-plot method. In the figure, the four distributions on the left side are the result of two stock groups (G1, G2) on the negative tail part, and the four distributions on the right side are the result of two stock groups (G3, G4) on the positive tail part.[8] Among the decile portfolios constructed for each of the stock groups, the figure focuses on the two-type portfolio; that is, a portfolio (H) with the highest prospect theory value and a portfolio (L) with the lowest prospect theory value.

[Insert Figure 2 here]

Fig. 2 shows that stocks with the highest prospect theory value within stock groups (G2, G4) having the thin-tail return distribution have much higher value compared to stock groups (G1, G3) with the fat-tail return distribution. This may be caused by stocks having the longer-skewed return distribution due to a very large extreme value within the stock groups with the thin-tail distribution. This is because the magnitude of the extreme value has a significant influence on prospect theory value. Thus, this observation that stocks with the highest prospect theory value within stock groups with the fat-tail return distribution have relatively small prospect theory value may be due to these extreme values in the fat-tail distribution having a smaller magnitude than the extreme values in the thin-tail return distribution, despite the numerous extreme values in the fat-tail return distribution. Stock groups with the lowest prospect theory value do not show any evident difference according to tail fatness in the return distribution. In addition, in the positive and negative tail parts in the return distribution, each stock group has a similar magnitude of prospect theory value. This is caused by the tendency of distributional property that the positive and negative tail parts of the return distribution do not have very different fatness. On the other hand, although the magnitude of prospect theory value is smaller in stock groups with the fat-tail return distribution, stocks with the fat-tail distributional property due to highly frequent extreme values may be attractive investments that can attract investor attention. We establish the second hypothesis that the fat-tail property of the return distribution has a significant influence the on results of the hypothesis related to prospect theory along with the longer-skewed property. Therefore, this study separately investigates the hypothesis in each of the stock groups with the fat- and thin-tail return distributions. **Table 5** presents the results using the decile portfolio constructed within each stock group categorized by the fatness on the positive and negative tail parts of the return distribution. The table presents the results using the equal-weighted (Panel A) and value-weighted (Panel B) returns. In each panel, the results are divided into the two cases of negative and positive tails, and are presented for the four stock groups (G1, G2, G3, G4) in each tail. The table reports the performance of the highest portfolio (H), the lowest portfolio (L), and the L-H zero-cost portfolio.

[Insert Table 5 here]

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[8] In the figure, results between the negative (left-side) and positive (right-side) tails are similar, probably because the existence of a fat-tail is observed for the two-side tails of the return distribution, although the negative and positive tails are separately tested in this study.

Table 5 reports that the fat-tail property of the return distribution has a significant influence on the results of the hypothesis of the negative relationship between prospect theory value and expected return. Regardless of the positive and negative tails in the return distribution, from a perspective of statistical significance, the stock groups with the fat-tail return distribution have substantially significant results in the L-H zero-cost portfolio compared to the stock groups with the thin-tail return distribution. In particular, improved statistical significance is confirmed in the results using the value-weighted returns that showed weaker evidence in **Table 1**. The detail results are as follows: In the past period, comparing portfolios with the highest prospect theory, the stock groups with the thin-tail return distribution have much higher prospect theory values (EW(VW); G2:0.3640 (0.3573), G4:0.3633 (0.3565)), compared to the prospect theory values (EW(VW); G1:-0.0346 (-0.0391), G3:-0.0267 (-0.0313)) of the stock groups with the fat-tail return distribution. Portfolios with the lowest prospect theory value do not show any evident difference in the magnitude of the prospect theory value among the stock groups. This is the same with results confirmed in **Fig. 2**. On the other hand, comparison from the viewpoint of the excess return is highly contrasted with the comparison in the magnitude of the prospect theory value in the past period. The excess return (EW (VW); G1:0.0077 (0.0157), G3:0.0090 (0.0177)) of portfolios with the highest prospect theory value within the stock groups with the fat-tail return distribution has definitely higher values compared to the excess return (EW (VW); G2:0.0009 (0.0094), G4:0.0000 (-0.0006)) of the stock groups with the thin-tail return distribution. Portfolios with the lowest prospect theory value do not show any evident difference in the magnitude of the excess returns among stock groups. As a result, in the past period, portfolios with the highest prospect theory value within stock groups with the fat-tail return distribution show characteristics of a higher excess return than stock groups in the thin-tail return distribution, although these portfolios have a lower prospect theory value than those in the thin-tail return distribution. As in Barberis et al. (1998) and Daniel et al. (1998), investors tend to believe that stocks with high excess returns in the past period will continue to have high excess return in the future period. Stocks with the fat-tail return distribution within stock groups (G1, G3) are a more appropriate investment to observe the hypothesis related to prospect theory because high excess return and high prospect theory value are crucial factors for investor attention based on BMW (2016). Next, in the future period, regardless of the weighting scheme, the L-H zero-cost portfolios within stock groups with the fat-tail return distribution have statistically significant results supporting the hypothesis, compared to stock groups with the thin-tail return distribution. In the case of the L-H zero-cost portfolio within stock groups with the negative fat-tail return distribution, when using the equal-weighted return, the excess return features a significant value of 0.0735 (t:6.98), and the alphas of CAPM and FF3 also feature significant values of 0.0763 (t:5.45) and 0.0602 (t:4.71), respectively. Regarding the value-weighted return, the excess return and CAPM alpha result in significant values of 0.0196 (t:2.45) and 0.0190 (t:2.72), respectively. In the case of the positive fat-tail return distribution, the three-type performance of the L-H zero-cost portfolio using the equal-weighted return features significant values of 0.0735 (t:6.73) for excess return, 0.0762 (t:5.33) for CAPM alpha, and 0.0626 (t:4.39) for FF3 alpha. The performance using the value-weighted return also features the significant values of 0.0267 (t:3.01) for the excess return, 0.0252 (t:3.99) for CAPM alpha, and 0.0120 (t:2.52) for FF3 alpha. In contrast, most performance outcomes of the L-H zero-cost portfolio within the stock groups with the thin-tail return distribution are statistically insignificant. When using only the equal-weighted return, significant results for stock groups with the thin-tail distribution are only found in cases of the excess return (G2:0.0198 (t:1.86), G4:0.0197 (t:1.86)) and CAPM alpha (G2:0.0225 (t:2.03), G4:0.0228 (t:1.94)). As a consequence, the fat-tail property of the return distribution must be considered in the empirical design for examining the hypothesis related to prospect theory.

In **Table 5**, further comparison between the investment performance of the L-H zero-cost portfolio according to the weighting schemes is as follows: The first is comparison from the perspective of the investment performance's magnitude according to the fatness in the tail parts of the return distribution. In the case of equal weighting method, stock groups (G1, G3) with the fat-tail distribution definitely have a higher performance of the L-H zero-cost portfolio compared to stock groups (G2, G4) with the thin-tail distribution, regardless of the positive and negative tail parts of the return distribution. However, results using the value-weighted return are the opposite, i.e., stock groups (G2, G4) with the thin-tail distribution have a higher performance of the L-H zero-cost portfolio than those (G1, G3) with the fat-tail distribution. This observation may possibly be explained by examining whether the hypothesis of the negative relationship between prospect theory value (past excess returns) and expected return is realized. In the case of portfolios with the highest prospect theory value in the past period when using equal-weighted returns, stock groups (G1, G3) with the fat-tail distribution show a negative relationship between past excess return and expected return (future excess return), but stock groups (G2, G4) with the thin-tail distribution show a positive relationship in which excess returns in the future period increase against past excess return. Portfolios with the lowest prospect theory values in the past period show a negative relationship between past and future excess returns, regardless of stock groups. Also, all results using value-weighted returns show a negative relationship supporting the hypothesis related to prospect theory. As a result, the difference of investment performance's magnitude according to the weighting schemes may be explained by this observation that stocks with the fat-tail distribution and a high prospect theory value in the past period show changes from the past to the future performance, which is consistent with the expectation based on the hypothesis, but stocks with the thin-tail distribution and high prospect theory value fail to show the expected changes of performance for supporting the hypothesis. The second is the comparison from a perspective of investment performance's magnitude according to the negative and positive tail parts. Within stock groups categorized according to the positive and negative fat-tail parts, the performance of L-H zero-cost portfolio using equal-weighted return does not show significant difference in magnitude, but when using value-weighted returns, the performance of stock groups (G3) with a positive fat-tail distribution is higher compared to stock groups (G1) with a negative fat-tail distribution. Stock groups with the thin-tail distribution do not show any evident difference in the magnitude of performance from both equal and value weighting schemes. This observation may possibly be explained as follows: Generally, an extreme increase (decrease) in the price tends to decrease (increase) through correction in the market, and hence it is more common that the two sides of the negative and positive tail parts have a similar degree of fatness in the distribution. Therefore, a possible observation is that stock groups with the fat-tail distribution in the negative and positive tail parts have a similar magnitude of performance when using equal-weighted returns. In addition, the difference of performance magnitude between the negative and positive tails when using the value-weighted return is caused by investment weights based on the market capitalization of stocks. To explore further evidence to support our findings, **Table 6** presents the results of the same testing procedure for each of the KOSPI and KOSDAQ markets. In other words, the KOSDAQ market that is strongly affected by small stocks shows significant evidence supporting the hypothesis, compared to the KOSPI market that is weakly affected by small stocks. The table shows the three-type performance of the L-H zero-cost portfolio in the future period.

[Insert Table 6 here]

Table 6 shows that the results of the hypothesis may be affected according to the KOSPI and KOSDAQ markets. In the KOSDAQ of Panel B, regardless of the weighting schemes, stock groups (G1, G3) with the fat-tail return distribution have a more significant and higher performance of the L-H zero-cost portfolio, compared to stock groups (G2, G4) with the thin-tail return distribution. That is strong evidence supporting the hypothesis. On the other hand, results for the KOSPI of Panel A are affected by the weighting schemes. When using the equal-weighted return, the performance of the L-H zero-cost portfolio within the stock groups (G1, G3) having the fat-tail return distribution is more supportive evidence for the hypothesis. That is stocks with the fat-tail distribution have more significant and higher performance than stocks with the thin-tail distribution. In the case of using value-weighted return, although the performance of stocks with the fat-tail distribution are more significant, the magnitude of performance is lower compared to stocks with thin-tail. These are the same results with those of Panel B in **Table 5**, which shows higher performance in the stock groups with the thin-tail return distribution. Consequently, these results suggest evidence consistent with both the hypothesis related to prospect theory based on BMW (2016) and the results observed in **Table 5**. That is, the negative relationship between prospect theory value and expected return may be better observed in the KOSDAQ market that strongly relies on the transaction activities of individual investors, and moreover, this finding is significantly and strongly verified in stock groups with the fat-tail return distribution.

Next, the results of the Fama and MacBeth cross-sectional regression considering the fat-tail property in the stock return distribution are presented in **Tables 7** and **8**. The hypothesis seeks to verify whether the past prospect theory value of stocks within stock groups having the fat-tail return distribution has a strongly evident negative relationship with expected return compared to the stock groups having the thin-tail return distribution. In addition, we also verify whether the same evidence is observed, regardless of inclusion of influential factors, especially, the short-term reversal that significantly affected the expected return in the models shown in **Table 3**. **Table 7** presents the average values of regression coefficients on the independent variables estimated from the six regression models in each sub-period over the whole period according to the stock groups categorized from the fatness in the tail parts of the return distribution.

[Insert Table 7 here]

From **Table 7**, we verify that stock groups with the fat-tail return distribution have a statistically significant negative coefficient of the past prospect theory value for explaining the expected return in all models, regardless of the inclusion of other independent variables. This means that the prospect theory value from the fat-tail return distribution in the past period has information value to explain changes in the expected return in the future period. In the case of stock groups with the thin-tail return distribution, consistent with the previous results in **Table 3**, Model 1 with the single factor of the past prospect theory value shows a significant negative coefficient on expected return, but when the reversal factors are included, especially, the short-term reversal factor, prospect theory value does not have a significant coefficient on expected return. In addition, **Table 8** presents the results of cross-sectional regression in the KOSPI and KOSPI markets. The table reports only the results of Model 6.

[Insert Table 8 here]

In **Table 8**, for both the KOSPI and KOSDAQ markets, stock groups with the fat-tail return distribution have significant negative coefficients of the past prospect theory value on expected return, while stock groups with the thin-tail return distribution have insignificant regression coefficients. In addition, regression coefficients observed from the KOSDAQ market have higher significant values compared to the KOSPI market. This is evidence that the hypothesis related to prospect theory value is affected by the transaction activities of individual investors. Accordingly, the supportive evidence for the negative relationship between prospect theory value and expected return is more significantly verified when considering the stock groups with the fat-tail return distribution. Consequently, our findings through both decile portfolio and cross-sectional regression for individual stocks determine that the fat-tail property of the return distribution is a significant influential factor that must be considered in the empirical design for testing the negative relationship between prospect theory value and expected return.

3.3. Robustness test

This section presents the results on the robustness of the previous observation considering the fat-tail property in the return distribution according to the change in empirical design and using out-of-sample data. The results are presented in **Table 9** for the change in empirical design and **Table 10** for using out-of-sample data. First, the results on the robustness according to the change of empirical design are presented in **Table 9**. We employ three changes in the empirical design: seasonality (January effect), the change of period length for estimating the stock return distribution, and the change of investment period length. The seasonality consists of two types: including January and the non-January months. The period length for estimating the return distribution consists of two types: 36 months and 48 months. The length for future investment period consists of four types: 2 months, 3 months, 6 months, and 12 months. The results are divided according to the weighting schemes and the four stock groups categorized by the fatness on the positive and negative tails of the return distribution. The results are presented in Panel A for seasonality, Panel B for period length to estimate the return distribution, and Panel C for length of future investment period. The table reports the excess return and FF3 alpha of the L-H zero-cost portfolio.

[Insert Table 9 here]

Despite the change of empirical design, **Table 9** shows that the results on the negative relationship between prospect theory value and expected return are not qualitatively different with the previous results observed under the fat-tail property of the stock return distribution. The detailed results are as follows: First, concerning the results on the seasonality of Panel A, regardless of the weighting schemes, January shows significant positive performance within stock groups with the fat-tail return distribution. However, stock groups with the thin-tail return distribution all show negative performance in January. In the case of non-January, the stock groups with the fat-tail return distribution show significantly strong positive performance for the equal weighting method and weak positive performance for the value weighting method. In addition, the magnitude of performance is higher in January than in non-January. Overall, stock groups with the fat-tail return distribution show significant evidence supporting our hypothesis after controlling for the seasonality. Second, in Panel B, the stock groups with the fat-tail return distribution are not affected by changes of period length in estimating the return distribution. That is, when using the stock return distribution of both the past 36 and 48 months, stock groups with the fat-tail return distribution show statistically significant positive performance, regardless of the weighting schemes, except a result in the case of 36 months using value-weighted returns. In contrast, stock groups with the thin-tail distribution show nearly insignificant evidence. As a consequence, these results on the effect of period length to estimate the return distribution within stock groups having the fat-tail return distribution are sufficiently robust to be consistent with previous results. Third, in Panel C on the change of future investment period length, the significant evidence supporting the hypothesis becomes weaker with lengthening investment period. In the case of stock groups with the fat-tail return distribution, results using the equal-weighted return show significantly strong positive performance until the investment period of 6 months, and weak positive performance after this investment period, while the performance from the value-weighted return is significantly positive until 3 months. On the other hand, stock groups with the thin-tail return distribution mostly do not show significant results. Accordingly, stock groups with the fat-tail return distribution definitely show the persistence of supportive evidence for the hypothesis related to prospect theory compared to stock groups with the thin-tail return distribution.

Next, results using the out-of-sample stock markets in the U.S., Japan, and China are presented in **Table 10**. This study utilizes daily and monthly data over the period from January 1995 to December 2016 in the U.S. stock market, consisting of the NYSE (6,907 stocks), AMEX (2,698 stocks), and Nasdaq (16,708 stocks). The total number of sub-periods is 204 for NYSE and AMEX (2000.01~2016.12) and 192 for Nasdaq (2001.01~2016.12). Regarding the Japanese stock market, daily and monthly returns of individual stocks use data over the period from January 1995 to December 2016 for the Tokyo (3,878 stocks) and Jasdaq (1,563 stocks) exchanges. The total number of sub-periods is 204 for Tokyo (2000.01~2016.12) and 84 for Jasdaq (2010.01~2016.12). In the case of the Chinese stock market, daily and monthly returns of individual stocks utilize data over the period from January 2006 to December 2016 for Shanghai (1,175 stocks) and Shenzhen (1,091 stocks) stock exchanges. The total number of sub-periods is 72 for both Shanghai and Shenzhen exchanges (2011.01~2016.12). Through out-of-sample data stock markets, we expect to observe the results on the influence from both transaction activities of individual investors and the level of development of stock markets. Specifically, we investigate the Nasdaq and Jasdaq markets, which rely on the transaction activities of individual investors, and the Chinese stock market as an emerging market compared to the U.S. and Japanese stock markets. We apply the same test procedure of the previous results for out-of-sample data. In **Table 10**, the results are presented in Panel A for the U.S., Panel B for Japan, and Panel C for China. In each panel, the table presents the results according to the weighting scheme and the four stock groups categorized by the fatness in the positive and negative tail of the return distribution. The table shows the performance of the excess return and risk-adjusted return (CAPM alpha) for the L-H zero-cost portfolios.

[Insert Table 10 here]

Table 10 reports the significant results focusing on the stock groups with the fat-tail return distribution, like the Korean stock market as in-sample data. That is, results using out-of-sample data of the U.S., Japan, and China show significantly stronger evidence to support the hypothesis within stock groups with the fat-tail return distribution compared to stock groups with the thin-tail return distribution, in particular, when using equal-weighted returns. In addition, the significant performance outcomes of Nasdaq for the U.S. and Jasdaq for Japanese stock markets are higher values compared to NYSE and AMEX for the U.S. and TOPIX for Japanese stock markets. Also, China as the emerging stock market presents significant performance supporting the hypothesis, regardless of the weighting schemes. The results for each country are summarized as follows: First, stock groups with fat-tail return distribution in the U.S. stock market have statistically significant performance of excess returns and risk-adjusted returns (CAPM alpha), except a result of the risk-adjusted return in the negative tail using value-weighted returns. In other words, stock groups with the fat-tail return distribution have significantly stronger evidence supporting the hypothesis related to prospect theory. Among significant investment performance outcomes, Nasdaq has higher values than NYSE and AMEX, and stock groups with the fat-tail distribution have higher values than those with the thin-tail distribution. Consequently, in the U.S. stock market, stock groups with the fat-tail return distribution, rather than stock groups with the thin-tail return distribution, have significantly supportive evidence for the hypothesis, like the results for the Korean stock market. Second, in the Japanese stock market, stock groups with the fat-tail return distribution have more significant evidence to support the hypothesis than stock groups with the thin-tail return distribution. Also, significant performance outcomes from Jasdaq are higher than those from TOPIX. The difference with the results for the U.S. and Chinese stock markets is that stock groups with the thin-tail return distribution have higher values compared to stock groups with the fat-tail return distribution from a perspective of performance magnitude, although the difference is not significant. That is, from the viewpoint of statistical significance on the results for the Japanese stock market, stock groups with the fat-tail return distribution also show more significant evidence for the hypothesis related to prospect theory compared to stock groups with the thin-tail return distribution. Third, the Chinese stock market shows statistically significant performance of excess returns and risk-adjusted return within the stock groups with the fat-tail return distribution. The magnitude of performance from the stock groups with the fat-tail return distribution is mostly greater than the stock groups with the thin-tail return distribution, except the case of comparison in the negative tail using equal-weighted returns. The difference with the results for the U.S. and Japanese stock markets is that stock groups with the thin-tail return distribution also have significant performance, except a result of risk-adjusted return in the positive tail using the value-weighted return. Certainly, consistent with results for other stock markets, the Chinese stock market shows significantly more supportive evidence for the hypothesis in the case of stock groups with the fat-tail return distribution as well. As a consequence, from results using out-of-sample stock markets of the U.S., Japan and China, this study determine that stock groups with the fat-tail return distribution have significantly stronger evidence supporting the hypothesis of the negative relationship between prospect theory value and expected return, and the difference among countries is mostly verified in the results within stock groups with the thin-tail return distribution. Finally, our findings extending the previous studies have robustness from both in-sample and out-of-sample data stock markets.

4. Conclusions

This study investigates the first research goal regarding the significant negative relationship between prospect theory value and expected return. Furthermore, in an attempt to extend the previous studies, we examine the second research goal on the same testing hypothesis under the fat-tail property of the return distribution using stock trading data in markets of the U.S., Japan, China and Korea. To ensure the reliability of the observed results, we employ the approaches of decile portfolio and the Fama and MacBeth cross-sectional regression, and consider the influence according to the change in empirical design. The results are summarized as follows. The prospect theory value in the past period has a significant negative relationship with the expected return in the future period in both the decile portfolio and the cross-sectional regression for the Korean stock market. This relationship is much more evident in the KOSDAQ market, which is reliant on the transaction activities of individual investors. On the other hand, the results using equal-weighted returns show strong evidence supporting our hypothesis compared to those using value-weighted returns. In the empirical design considering the degree of fatness in the tails of the stock return distribution, stock groups with the fat-tail return distribution show significantly consistent evidence for the hypothesis of the negative relationship between prospect theory value and expected return, irrespective of the weighting schemes, or of changes of empirical design and data among other countries. However, the stock groups with the thin-tail return distribution do not consistently show evidence supporting the hypothesis in both in-sample and out-of-sample stock markets.

From the above results, this study suggests that stock groups with the fat-tail property of the return distribution significantly and consistently support the hypothesis of the negative relationship between prospect theory and expected return in the empirical design using both in-sample and out-of-sample data. This emphasizes that the fat-tail property in the stock return distribution must be considered in the empirical design when investigating the hypothesis related to prospect theory, along with the property of the skewed return distribution. Also, this suggests that an empirical design that does not consider the fat-tail property in the return distribution has a high likelihood of failing to sufficiently reflect investor attention from the past return distribution based on prospect theory. Therefore, our findings may be complementary evidence for extending the results in BMW (2016). In addition, we expect future research to combine prospect theory value with the asymmetry of arbitrage trading in market microstructure based on Stambaugh, Yu and Yuan

(2015). The investor tendency to over- and under-evaluate stocks by observed from the prospect theory value in the past period can be influenced by the asymmetry of the arbitrage trading due to the market microstructure. From the previous results presented in this study, when changing from past excess returns to future excess returns, the increasing performance magnitude of stock groups with the lowest prospect theory value as under-evaluated stocks is clearly higher than the decreasing performance magnitude of stock groups with the highest prospect theory value as over-evaluated stocks. This difference may be caused by the market microstructure bias related to the asymmetry of arbitrage trading. Hence, this finding will be valuable to consider in future research.

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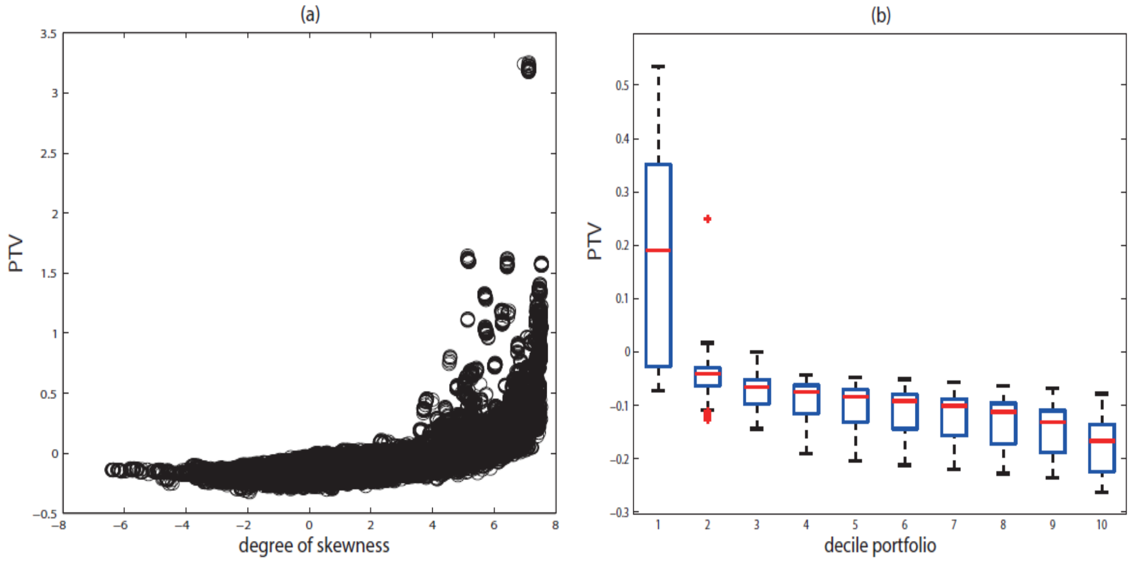

Fig. 1. Prospect theory value of stocks and decile portfolio. The figure shows the distribution of the prospect theory value (PTV) of stocks and decile portfolio for the Korean stock market over period from July 1992 to June 2017. The prospect theory value is calculated using the stock return distribution of the past 60 months. Figure (a) shows the scatter plot between the prospect theory value and the statistical skewness. Figure (b) presents the distribution of the prospect theory value for decile portfolio through the box-plot method. In the figure, the leftmost position on the x-axis indicates the portfolio (P1) with the highest prospect theory value and the portfolio (P10) with the lowest prospect theory value is located at the rightmost position.

Table 1.

Decile portfolio by the prospect theory value

	highest	P2	P3	P4	P5	P6	P7	P8	P9	lowest	L-H
Panel A: equal weighting method											
past	0.1892[a]	-0.0391[a]	-0.0692[a]	-0.0828[a]	-0.0925[a]	-0.1016[a]	-0.1110[a]	-0.1220[a]	-0.1381[a]	-0.1700[a]	-0.3592[a]
PTV	(19.11)	(-32.92)	(-76.23)	(-63.76)	(-62.97)	(-63.46)	(-64.09)	(-64.76)	(-65.38)	(-67.38)	(-29.89)
past	0.0011	0.0026[a]	0.0006	-0.0023[a]	-0.0055[a]	-0.0088[a]	-0.0125[a]	-0.0168[a]	-0.0237[a]	-0.0355[a]	-0.0367[a]
Ex.return	(1.56)	(3.47)	(0.76)	(-3.33)	(-8.23)	(-13.52)	(-19.34)	(-25.79)	(-32.90)	(-47.06)	(-75.80)
Ex.return	0.0178[a]	0.0065	0.0065	0.0099[c]	0.0136[a]	0.0121[b]	0.0168[a]	0.0165[a]	0.0229[a]	0.0474[a]	0.0295[a]
	(2.78)	(1.13)	(1.25)	(1.89)	(2.60)	(2.31)	(2.84)	(2.78)	(3.56)	(4.95)	(3.60)
CAPM α	0.0221[a]	0.0110[b]	0.0106[b]	0.0141[a]	0.0180[a]	0.0166[a]	0.0215[a]	0.0215[a]	0.0282[a]	0.0541[a]	0.0320[a]
	(2.73)	(2.27)	(2.22)	(3.34)	(5.03)	(4.64)	(4.11)	(4.62)	(6.54)	(6.01)	(3.25)
FF3 α	0.0266[a]	0.0152[a]	0.0151[a]	0.0178[a]	0.0213[a]	0.0193[a]	0.0231[a]	0.0226[a]	0.0272[a]	0.0438[a]	0.0172[c]
	(4.05)	(4.35)	(5.38)	(5.33)	(7.20)	(5.96)	(5.18)	(5.89)	(6.66)	(4.82)	(1.86)
Panel B: value weighting method											
Past	0.1831[a]	-0.0456[a]	-0.0760[a]	-0.0897[a]	-0.0995[a]	-0.1086[a]	-0.1181[a]	-0.1294[a]	-0.1449[a]	-0.1755[a]	-0.3586[a]
PTV	(17.36)	(-23.65)	(-45.22)	(-47.76)	(-49.17)	(-50.63)	(-52.43)	(-54.68)	(-58.25)	(-63.81)	(-30.16)
Past	0.0132a	0.0116[a]	0.0054[a]	-0.0002	-0.0039[a]	-0.0076[a]	-0.0119[a]	-0.0162[a]	-0.0225[a]	-0.0337[a]	-0.0470[a]
Ex.return	(13.65)	(11.70)	(5.68)	(-0.19)	(-5.12)	(-10.29)	(-17.19)	(-22.82)	(-28.81)	(-50.33)	(-55.93)
Ex.return	-0.0025	0.0036	0.0029	0.0018	0.0027	0.0036	0.0048	0.0058	0.0073	0.0295[c]	0.0320[b]
	(-0.42)	(0.61)	(0.53)	(0.36)	(0.53)	(0.71)	(0.91)	(1.03)	(1.11)	(1.78)	(1.96)
CAPM α	-0.0075[c]	-0.0015	-0.0021	-0.0029	-0.0017	-0.0010	0.0004	0.0013	0.0027	0.0233[c]	0.0309[a]
	(-1.65)	(-0.33)	(-0.47)	(-0.67)	(-0.41)	(-0.26)	(0.07)	(0.25)	(0.43)	(1.65)	(2.21)
FF3 α	-0.0069	-0.0019	-0.0049	-0.0064	-0.0054	-0.0061[c]	-0.0052	-0.0069	-0.0062	0.0139	0.0208
	(-1.37)	(-0.37)	(-1.10)	(-1.46)	(-1.39)	(-1.81)	(-1.26)	(-1.44)	(-1.14)	(0.86)	(1.30)

Notes: The table presents the investment performances of the decile portfolio constructed based on the prospect theory value of stocks in the Korean stock market. The prospect theory value is calculated from the stock return distribution of the past 60 months. Results are divided into Panel A concerning the equal weighting method and Panel B for the value weighting method. For each panel, the investment performances in the past and future period are presented. The past period shows the average values of the risk-free excess return (Ex.return) and the prospect theory value (PTV) of the decile portfolio, and the future period shows the average values of the excess return, risk-adjusted returns of the capital asset pricing model (CAPM α) and the Fama and French three-factor model (FF3 α) of the decile portfolio. The table shows the results by descending order from the highest portfolio (H, P1) to the lowest portfolio (L, P10). The last column displays the results of the L-H zero-cost portfolio. The t-values in parentheses are presented by 'a', 'b', and 'c' representing the significance levels of '1%', '5%', and '10%', respectively.

Table 2.

Decile portfolio by the prospect theory value in the KOSPI and KOSDAQ markets

	equal weighting method			value weighting method		
	Highest	lowest	L-H	highest	lowest	L-H
Panel A: the KOSPI market, 1992.07~2017.06						
Ex.return	0.0135[b]	0.0370[a]	0.0235[a]	0.0019	0.0297[c]	0.0279
	(2.10)	(3.92)	(2.71)	(0.31)	(1.65)	(1.57)
CAPM α	0.0132[c]	0.0364[a]	0.0233[b]	-0.0030	0.0239	0.0269[c]
	(1.93)	(6.33)	(2.51)	(-0.61)	(1.56)	(1.77)
FF3 α	0.0172[a]	0.0228[a]	0.0056	-0.0023	0.0173	0.0196
	(2.59)	(3.48)	(0.64)	(-0.41)	(0.95)	(1.07)
Panel B: the KOSDAQ, 2002.07~2017.06						
Ex.return	0.0319[a]	0.0678[a]	0.0359[a]	0.0018	0.0276[a]	0.0258[a]
	(3.26)	(5.92)	(3.36)	(0.18)	(3.91)	(2.76)
CAPM α	0.0442[a]	0.0837[a]	0.0395[a]	-0.0026	0.0232[a]	0.0258[a]
	(5.30)	(5.52)	(2.99)	(-0.40)	(4.89)	(3.74)
FF3 α	0.0371[a]	0.0767[a]	0.0397[b]	-0.0042	0.0168[a]	0.0210[c]
	(4.55)	(4.60)	(2.27)	(-0.44)	(3.03)	(1.91)

Notes: The table presents the investment performance of the decile portfolio constructed by the prospect theory value using stocks traded on KOSPI (Panel A) and KOSDAQ (Panel B) markets. The prospect theory value is calculated from the stock return distribution of the past 60 months. Investment performance is the average values of the excess return (Ex.return), the risk-adjusted returns of capital asset pricing model (CAPM α) and the Fama and French three-factor model (FF3 α) of the decile portfolio. Results are divided into equal weighting and value weighting methods, and for each weighting method, the highest portfolio (H), the lowest portfolio (L), and L-H zero-cost portfolio are presented. The t-values in parentheses are presented by 'a', 'b', and 'c' representing the significance levels of '1%', '5%', and '10%', respectively.

Table 3.

Fama and MacBeth cross-sectional regression results

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
PTV	-0.1178[b]	-0.0896[b]	-0.0497	-0.0521	-0.0552	-0.0638
	(-2.48)	(-2.19)	(-1.26)	(-1.30)	(-1.38)	(-1.58)
BETA		0.0105[a]	0.0078[b]	0.0081[b]	0.0085[b]	0.0090[b]
		(2.62)	(2.03)	(2.10)	(2.19)	(2.22)
SIZE		-0.0123[a]	-0.0117[a]	-0.0118[a]	-0.0120[a]	-0.0123[a]
		(-8.53)	(-8.06)	(-8.26)	(-8.23)	(-8.46)
BEME		-0.0040[b]	-0.0031[c]	-0.0032[c]	-0.0031[c]	-0.0036[b]
		(-2.27)	(-1.72)	(-1.79)	(-1.78)	(-2.07)
MOM		-0.0065[a]	-0.0088a[a]	-0.0085[a]	-0.0084[a]	-0.0077[a]
		(-3.44)	(-4.78)	(-4.63)	(-4.56)	(-4.25)
SREV			-0.0514[a]	-0.0514[a]	-0.0515[a]	-0.0518[a]
			(-6.45)	(-6.45)	(-6.49)	(-6.55)
LREV			-0.0127[b]	-0.0124[b]	-0.0127[b]	-0.0127[b]
			(-2.23)	(-2.17)	(-2.16)	(-2.17)
iLIQ				0.0004	-0.0014	-0.0017
				(0.07)	(-0.21)	(-0.25)
IVOL					0.0108	0.0080
					(1.63)	(1.24)
MAX						0.0054
						(0.92)
MIN						-0.0062
						(-0.94)

Notes: The table presents the results of the cross-sectional regression investigating whether the prospect theory value and other independent variables in the past period explain the expected return in the Korean stock market. Results of the six-type models are presented. The dependent variable is the excess return measured by the risk-free excess return of one month in the future period. The independent variables estimated in the past period are the prospect theory value (PTV), market beta (BETA), logarithmic size (SIZE), logarithmic book-to-market equity ratio (BEME), momentum (MOM), short-term reversal (SREV), long-term reversal (LREV), illiquidity (iLIQ), idiosyncratic volatility (IVOL), maximum (MAX) and (-1) minimum (MIN). The results are average values of the regression coefficients estimated for each sub-period in the whole period and their statistic values. The t-values in parentheses are presented by ‘a’, ‘b’, and ‘c’ based on the significance levels of ‘1%’, ‘5%’, and ‘10%’, respectively.

Table 4.

Fama and MacBeth cross-sectional regression in the KOSPI and KOSDAQ markets

	KOSPI market			KOSDAQ market		
	Model 2	Model 3	Model 6	Model 2	Model 3	Model 6
PTV	-0.0763[c]	-0.0395	-0.0554	-0.0279[b]	-0.0237[c]	-0.0162
	(-1.65)	(-0.88)	(-1.20)	(-2.10)	(-1.77)	(-1.26)
BETA	0.0107[b]	0.0081	0.0096[c]	0.0035	0.0027	0.0020
	(1.91)	(1.46)	(1.68)	(0.89)	(0.66)	(0.47)
SIZE	-0.0097[a]	-0.0091[a]	-0.0098[a]	-0.0378[a]	-0.0372[a]	-0.0376[a]
	(-6.42)	(-5.93)	(-6.46)	(-9.69)	(-9.67)	(-9.61)
BEME	-0.0046[c]	-0.0032	-0.0041[c]	-0.0207[a]	-0.0203[a]	-0.0195[a]
	(-1.89)	(-1.34)	(-1.76)	(-4.96)	(-4.88)	(-4.87)
MOM	-0.0068[a]	-0.0087[a]	-0.0075[a]	-0.0094[a]	-0.0101[a]	-0.0106[a]
	(-2.94)	(-3.81)	(-3.41)	(-4.49)	(-4.87)	(-4.80)
SREV		-0.0628[a]	-0.0625[a]		-0.0311[a]	-0.0310[a]
		(-5.86)	(-6.06)		(-2.73)	(-2.67)
LREV		-0.0070	-0.0052		-0.0062	-0.0067
		(-0.54)	(-0.38)		(-1.13)	(-1.16)
iLIQ			-0.0026			-0.0059
			(-0.34)			(-0.93)
IVOL			0.0058			-0.0001
			(0.67)			(-0.01)
MAX			0.0006			0.0008
			(0.09)			(0.08)
MIN			-0.0044			-0.0124[c]
			(-0.56)			(-1.89)

Notes: The table presents results of the cross-sectional regression investigating whether the prospect theory value and other independent variables in the past period explain the expected return in the KOSPI and KOSDAQ markets. Results of Models 2, 3, and 6 are presented. The dependent variable is the excess return measured by the risk-free excess return of one month in the future period. The independent variables estimated in the past period are the prospect theory value (PTV), market beta (BETA), logarithmic size (SIZE), logarithmic book-to-market equity ratio (BEME), momentum (MOM), short-term reversal (SREV), long-term reversal (LREV), illiquidity (iLIQ), idiosyncratic volatility (IVOL), maximum (MAX) and (-1) minimum (MIN). The results are the average values of the regression coefficients estimated for each sub-period in the whole period and their statistic values. The t-values in parentheses are presented by 'a', 'b', and 'c' based on the significance levels of '1%', '5%', and '10%', respectively.

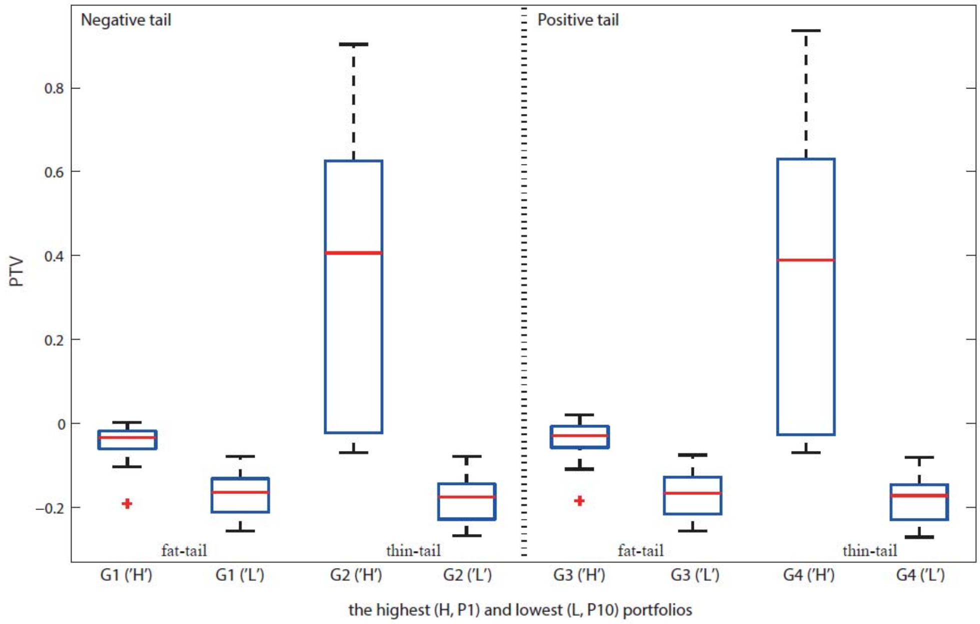

Fig. 2. Prospect theory value under considering the fat-tail property of the return distribution. The figure shows the distribution of the prospect theory value of the decile portfolio constructed within each of the stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized according to the degree of fatness in the tail of the stock return distribution for the Korean stock market. The distribution is divided into the negative tail part on the left-side and the positive tail part on the right-side of the figure. The fatness in the tail of the return distribution is measured using the statistical probability of data deviated from the 99% confidential interval of the distribution. The prospect theory value is calculated from the stock return distribution of the past 60 months. Using the box-plot method, the portfolio (H) with the highest prospect theory value and the portfolio (L) with the lowest prospect theory value is reported within each of the stock groups with fat-tail and thin-tail return distributions.

Table 5.
Decile portfolio by the prospect theory value under considering the fat-tail property of the return distribution

	negative tail part						positive tail part					
	group 1: fat-tail			group 2: thin-tail			group 3: fat-tail			group 4: thin-tail		
	highest	lowest	L-H	highest	lowest	L-H	highest	lowest	L-H	highest	lowest	L-H
Panel A: equal weighting method												
past	-0.0346[a]	-0.1629[a]	-0.1283[a]	0.3640[a]	-0.1733[a]	-0.5373[a]	-0.0267[a]	-0.1636[a]	-0.1369[a]	0.3633[a]	-0.1742[a]	-0.5375[a]
PTV	(-32.43)	(-72.41)	(-70.70)	(21.22)	(-65.87)	(-27.74)	(-21.13)	(-68.42)	(-67.76)	(20.73)	(-67.84)	(-27.45)
past	0.0077[a]	-0.0319[a]	-0.0396[a]	0.0009	-0.0381[a]	-0.0389[a]	0.0090[a]	-0.0332[a]	-0.0422[a]	0.0000	-0.0378[a]	-0.0379[a]
Ex.return	(11.31)	(-48.16)	(-67.48)	(1.13)	(-47.66)	(-64.40)	(13.13)	(-45.85)	(-69.32)	(0.04)	(-46.42)	(-55.65)
Ex.return	-0.0053	0.0682[a]	0.0735[a]	0.0208[b]	0.0406[a]	0.0198[c]	-0.0038	0.0697[a]	0.0735[a]	0.0199[b]	0.0397[a]	0.0197[c]
	(-0.94)	(5.64)	(6.98)	(2.55)	(4.06)	(1.86)	(-0.66)	(5.64)	(6.73)	(2.47)	(3.90)	(1.86)
CAPM α	-0.0010	0.0753[a]	0.0763[a]	0.0247[a]	0.0472[a]	0.0225[b]	0.0006	0.0768[a]	0.0762[a]	0.0236[b]	0.0464[a]	0.0228[c]
	(-0.16)	(5.42)	(5.45)	(2.67)	(5.62)	(2.03)	(0.11)	(5.55)	(5.33)	(2.53)	(4.86)	(1.94)
FF3 α	0.0069	0.0671[a]	0.0602[a]	0.0253[a]	0.0393[a]	0.0139	0.0070	0.0696[a]	0.0626[a]	0.0255[a]	0.0382[a]	0.0128
	(1.60)	(5.30)	(4.71)	(3.20)	(4.23)	(1.21)	(1.48)	(5.17)	(4.39)	(3.29)	(3.92)	(1.15)
Panel B: value weighting method												
Past	-0.0391[a]	-0.1689[a]	-0.1298[a]	0.3573[a]	-0.1789[a]	-0.5361[a]	-0.0313[a]	-0.1692[a]	-0.1379[a]	0.3565[a]	-0.1791[a]	-0.5357[a]
PTV	(-23.64)	(-65.83)	(-72.97)	(19.91)	(-64.01)	(-27.79)	(-17.00)	(-62.77)	(-67.91)	(19.45)	(-64.76)	(-27.44)
Past	0.0157[a]	-0.0301[a]	-0.0459[a]	0.0094[a]	-0.0365[a]	-0.0459[a]	0.0177[a]	-0.0314[a]	-0.0491[a]	0.0092[a]	-0.0363[a]	-0.0455[a]
Ex.return	(19.41)	(-44.89)	(-56.93)	(8.21)	(-47.95)	(-44.62)	(20.92)	(-43.61)	(-53.00)	(8.15)	(-47.75)	(-47.90)
Ex.return	0.0006	0.0202[b]	0.0196[b]	-0.0004	0.0550	0.0554	0.0030	0.0297[a]	0.0267[a]	-0.0006	0.0538	0.0544
	(0.10)	(2.36)	(2.45)	(-0.05)	(1.32)	(1.33)	(0.48)	(3.01)	(3.01)	(-0.08)	(1.17)	(1.20)
CAPM α	-0.0045	0.0145[b]	0.0190[a]	-0.0053	0.0467	0.0519	-0.0018	0.0234[a]	0.0252[a]	-0.0046	0.0449	0.0495
	(-0.71)	(2.25)	(2.72)	(-0.75)	(1.30)	(1.48)	(-0.32)	(3.35)	(3.99)	(-0.73)	(1.15)	(1.28)
FF3 α	-0.0041	0.0020	0.0062	-0.0069	0.0393	0.0463	-0.0013	0.0108[c]	0.0120[b]	-0.0091	0.0393	0.0483
	(-0.60)	(0.41)	(1.01)	(-0.98)	(0.97)	(1.19)	(-0.20)	(1.86)	(2.52)	(-1.41)	(0.89)	(1.13)

Notes: The table presents the investment performances of the decile portfolio constructed using the prospect theory value of stocks within each of the stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized by the fatness in the tail of the stock return distribution for the Korean stock market. The fatness of the tail parts is measured using the statistical probability of data deviated from the 99% confidence interval of the distribution. The tail in the distribution is divided into positive and negative parts. Results are divided into Panel A for the equal weighting method and Panel B for the value weighting method, and for each panel, the performances in the past and future period are presented. The past period shows the average values of the risk-free excess return (Ex.return) and the prospect theory value (PTV) of the decile portfolio, and the future period shows the average values of excess return, the risk-adjusted returns of capital asset pricing model (CAPM α) and the Fama and French three-factor model (FF3 α) of the decile portfolio. Results are presented for the highest portfolio (H), the lowest portfolio (L), and the L-H zero-cost portfolio. The t-values in parentheses are presented by 'a', 'b', and 'c' based on the significance levels of '1%', '5%', and '10%', respectively.

Table 6.

Decile portfolio by the prospect theory value under considering the fat-tail property of the return distribution in the KOSPI and KOSDAQ markets

`	equal weighting method				value weighting method			
	negative tail		positive tail		negative tail		positive tail	
	group 1	group 2	group 3	group 4	group 1	group 2	group 3	group 4
Panel A: the KOSPI market, 1992.07~2017.06								
Ex.return	0.0573[a]	0.0109	0.0590[a]	0.0068	0.0139[c]	0.0408	0.0279[b]	0.0327
	(5.28)	(0.87)	(5.23)	(0.54)	(1.71)	(1.27)	(2.37)	(1.20)
CAPM α	0.0570[a]	0.0107	0.0587[a]	0.0066	0.0133[c]	0.0390	0.0266[a]	0.0305
	(4.58)	(0.98)	(4.37)	(0.55)	(1.91)	(1.43)	(2.63)	(1.38)
FF3 α	0.0385[a]	-0.0007	0.0429[a]	-0.0061	0.0042	0.0354	0.0152[c]	0.0294
	(3.31)	(-0.06)	(3.12)	(-0.55)	(0.66)	(1.12)	(1.75)	(1.15)
Panel B: the KOSDAQ, 2002.07~2017.06								
Ex.return	0.0874[a]	0.0330[c]	0.0934[a]	0.0209	0.0526[a]	0.0256[c]	0.0541[a]	0.0219
	(6.31)	(1.74)	(5.91)	(1.29)	(5.46)	(1.83)	(5.43)	(1.50)
CAPM α	0.0884[a]	0.0367	0.0957[a]	0.0248	0.0526[a]	0.0251b	0.0539[a]	0.0215[b]
	(4.32)	(1.42)	(4.16)	(1.38)	(4.93)	(2.38)	(7.85)	(2.07)
FF3 α	0.0744[a]	0.0302	0.0833[a]	0.0383[b]	0.0370[a]	0.0253[b]	0.0405[a]	0.0317[a]
	(3.59)	(1.59)	(3.30)	(1.98)	(4.40)	(2.37)	(5.63)	(2.87)

Notes: The table presents the investment performances of the decile portfolio constructed using the prospect theory value of stocks within each of the stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized by the degree of fatness in the tail of the stock return distribution for the KOSPI and KOSDAQ markets. The fatness of the tail in the return distribution is measured using the statistical probability of data deviated from the 99% confidence interval of the distribution. The tail in the distribution is divided into positive and negative parts. Results are divided into equal weighting and value weighting methods, and for each weighting scheme, the performance of the L-H zero-cost portfolio is the average values of the risk-free excess return (Ex.return), the risk-adjusted returns of the capital asset pricing model (CAPM α) and Fama and the French three-factor model (FF3 α). The t-values in parentheses are presented by 'a', 'b', and 'c' based on the significance levels of '1%', '5%', and '10%', respectively.

Table 7.

Fama and MacBeth cross-sectional regression under considering the fat-tail property of the return distribution

	group 1: negative fat-tail part						group 2: negative thin-tail part					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
PTV	-0.4137[a]	-0.3648[a]	-0.3062[a]	-0.3081[a]	-0.3103[a]	-0.3202[a]	-0.1125[b]	-0.0681	-0.0277	-0.0277[c]	-0.0286	-0.0371
	(-6.70)	(-5.79)	(-5.01)	(-5.12)	(-5.16)	(-5.12)	(-2.35)	(-1.63)	(-0.66)	(-0.65)	(-0.67)	(-0.85)
BETA		0.0202[a]	0.0169[b]	0.0156[b]	0.0157[b]	0.0164[b]		0.0081[b]	0.0062	0.0074[c]	0.0081[c]	0.0084[c]
		(2.84)	(2.31)	(2.21)	(2.17)	(2.15)		(1.96)	(1.51)	(1.69)	(1.83)	(1.76)
SIZE		-0.0088[a]	-0.0085[a]	-0.0087[a]	-0.0088[a]	-0.0089[a]		-0.0177[a]	-0.0168[a]	-0.0170[a]	-0.0172[a]	-0.0174[a]
		(-5.96)	(-5.48)	(-5.51)	(-5.65)	(-5.69)		(-7.42)	(-6.84)	(-7.03)	(-6.96)	(-6.97)
BEME		-0.0039[c]	-0.0034	-0.0037	-0.0035	-0.0036		-0.0053[b]	-0.0042	-0.0042	-0.0043	-0.0049[c]
		(-1.66)	(-1.43)	(-1.51)	(-1.50)	(-1.57)		(-2.03)	(-1.57)	(-1.60)	(-1.61)	(-1.81)
MOM		-0.0003	-0.0027	-0.0028	-0.0026	-0.0018		-0.0080[a]	-0.0104[a]	-0.0097[a]	-0.0096[a]	-0.0088[a]
		(-0.12)	(-1.04)	(-1.07)	(-0.97)	(-0.67)		(-3.48)	(-4.51)	(-4.22)	(-4.20)	(-3.83)
SREV			-0.0438[a]	-0.0437[a]	-0.0446[a]	-0.0444[a]			-0.0553[a]	-0.0559[a]	-0.0569[a]	-0.0572[a]
			(-2.63)	(-2.62)	(-2.70)	(-2.70)			(-5.20)	(-5.25)	(-5.31)	(-5.38)
LREV			-0.0146	-0.0130	-0.0131	-0.0138			-0.0134[c]	-0.0122	-0.0140[c]	-0.0125
			(-1.59)	(-1.30)	(-1.22)	(-1.30)			(-1.65)	(-1.49)	(-1.73)	(-1.55)
iLIQ				-0.0107	-0.0113	-0.0105				0.0096	0.0050	0.0057
				(-1.06)	(-1.05)	(-0.98)				(1.01)	(0.50)	(0.58)
IVOL					0.0197[c]	0.0167					0.0133	0.0090
					(1.72)	(1.47)					(1.42)	(0.96)
MAX						0.0094						0.0002
						(0.96)						(0.02)
MIN						-0.0014						-0.0138
						(-0.14)						(-1.55)

	group 3: positive fat-tail part						group 4: positive thin-tail part					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
PTV	-0.4105[a]	-0.3076[a]	-0.2506[a]	-0.2510[a]	-0.2512[a]	-0.2484[a]	-0.1166[b]	-0.0787[c]	-0.0450	-0.0432	-0.0414	-0.0571
	(-7.01)	(-5.31)	(-4.50)	(-4.56)	(-4.47)	(-4.13)	(-2.43)	(-1.95)	(-1.11)	(-1.04)	(-0.98)	(-1.29)
BETA		0.0180[a]	0.0155[b]	0.0150[b]	0.0151[b]	0.0145[b]		0.0101[b]	0.0086[b]	0.0080[c]	0.0085[b]	0.0094[b]
		(2.72)	(2.32)	(2.28)	(2.27)	(1.96)		(2.30)	(1.98)	(1.81)	(1.93)	(2.10)
SIZE		-0.0127[a]	-0.0123[a]	-0.0124[a]	-0.0124[a]	-0.0125[a]		-0.0175[a]	-0.0166[a]	-0.0169[a]	-0.0172[a]	-0.0175[a]
		(-7.04)	(-6.54)	(-6.56)	(-6.61)	(-6.52)		(-7.58)	(-6.97)	(-7.16)	(-7.17)	(-7.19)
BEME		-0.0038	-0.0033	-0.0035	-0.0033	-0.0032		-0.0065[b]	-0.0054[c]	-0.0054[c]	-0.0054[c]	-0.0059[b]
		(-1.52)	(-1.27)	(-1.35)	(-1.31)	(-1.30)		(-2.37)	(-1.91)	(-1.94)	(-1.89)	(-2.06)
MOM		-0.0014	-0.0034	-0.0033	-0.0034	-0.0033		-0.0084[a]	-0.0106[a]	-0.0103[a]	-0.0100[a]	-0.0095[a]
		(-0.51)	(-1.26)	(-1.22)	(-1.21)	(-1.16)		(-2.89)	(-3.50)	(-3.36)	(-3.33)	(-3.18)
SREV			-0.0512[a]	-0.0514[a]	-0.0532[a]	-0.0537[a]			-0.0497[a]	-0.0500[a]	-0.0508[a]	-0.0503[a]
			(-3.90)	(-3.87)	(-4.01)	(-4.04)			(-4.41)	(-4.43)	(-4.46)	(-4.47)
LREV			-0.0214[b]	-0.0193[b]	-0.0200[b]	-0.0206[b]			-0.0084	-0.0086	-0.0099	-0.0091
			(-2.53)	(-2.11)	(-2.02)	(-2.07)			(-1.03)	(-1.08)	(-1.21)	(-1.11)
iLIQ				-0.0090	-0.0102	-0.0125				0.0016	-0.0009	0.0002
				(-0.91)	(-0.92)	(-1.10)				(0.17)	(-0.10)	(0.02)
IVOL					0.0205[c]	0.0169					0.0158[c]	0.0124
					(1.70)	(1.38)					(1.66)	(1.27)
MAX						0.0125						-0.0006
						(1.21)						(-0.07)
MIN						-0.0037						-0.0156[c]
						(-0.31)						(-1.66)

Notes: The table presents results of the cross-sectional regression investigating whether the prospect theory value and other independent variables in the past period explain the expected return using stocks within each of the stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized by the degree of fatness in the tail of the stock return distribution for the Korean stock market. The fatness of the tail in the return distribution is measured using the statistical probability of data deviated from the 99% confidence interval of the distribution. The tail in the distribution is divided into positive and negative parts. Results of the six-type models are presented. The dependent variable is the excess return measured by the risk-free excess return of one month in the future period. The independent variables estimated in the past period are the prospect theory value (PTV), market beta (BETA), logarithmic size (SIZE), logarithmic book-to-market equity ratio (BEME), momentum (MOM), short-term reversal (SREV), long-term reversal (LREV), illiquidity (iLIQ), idiosyncratic volatility (IVOL), maximum (MAX) and (-1) minimum (MIN). The results are the average values of regression coefficients estimated for each sub-period in the whole period and their statistic values. The t-values in parentheses are presented by 'a', 'b', and 'c' based on the significance levels of '1%', '5%', and '10%', respectively.

Table 8.

Fama and MacBeth cross-sectional regression under considering the fat-tail property of the return distribution in KOSPI and KOSDAQ markets

	KOSPI market				KOSDAQ market			
	negative tail		positive tail		negative tail		positive tail	
	group 1	group 2	group 3	group 4	group 1	group 2	group 3	group 4
PTV	-0.2897[a]	-0.0262	-0.2058[a]	-0.0477	-0.4139[a]	-0.0213	-0.2988[a]	-0.0712[c]
	(-4.19)	(-0.52)	(-3.29)	(-0.91)	(-5.28)	(-1.30)	(-4.40)	(-1.92)
BETA	0.0171[c]	0.0085	0.0169[b]	0.0091	0.0236[c]	-0.0004	0.0083	0.0172
	(1.88)	(1.24)	(2.12)	(1.35)	(1.84)	(-0.09)	(1.13)	(1.36)
SIZE	-0.0067[a]	-0.0134[a]	-0.0079[a]	-0.0142[a]	-0.0248[a]	-0.0472[a]	-0.0275[a]	-0.0494[a]
	(-4.13)	(-5.35)	(-4.35)	(-5.87)	(-7.11)	(-7.07)	(-6.80)	(-7.36)
BEME	-0.0049[c]	-0.0069[c]	-0.0036	-0.0071	-0.0156[a]	-0.0211[a]	-0.0144[a]	-0.0197[a]
	(-1.74)	(-1.70)	(-1.28)	(-1.63)	(-2.71)	(-3.12)	(-3.35)	(-2.64)
MOM	0.0005	-0.0093[a]	-0.0030	-0.0079[a]	-0.0161[b]	-0.0105[a]	-0.0110[a]	-0.0153[a]
	(0.16)	(-3.27)	(-0.99)	(-2.60)	(-2.45)	(-3.49)	(-2.57)	(-3.16)
SREV	-0.0458[b]	-0.0711[a]	-0.0556[a]	-0.0668[a]	-0.0292	-0.0358[b]	-0.0285[c]	-0.0264
	(-2.39)	(-4.55)	(-2.99)	(-4.31)	(-1.38)	(-2.23)	(-1.66)	(-1.34)
LREV	-0.0155	-0.0069	-0.0207[c]	-0.0024	-0.0105	0.0035	0.0019	0.0018
	(-1.20)	(-0.34)	(-1.72)	(-0.12)	(-0.95)	(0.42)	(0.15)	(0.17)
iLIQ	-0.0210[c]	0.0027	-0.0165	-0.0027	0.0114	-0.0127	-0.0038	-0.0044
	(-1.80)	(0.20)	(-1.41)	(-0.22)	(0.88)	(-1.24)	(-0.30)	(-0.46)
IVOL	0.0152	0.0030	0.0183	0.0092	0.0032	-0.0022	0.0033	-0.0003
	(1.27)	(0.22)	(1.38)	(0.63)	(0.26)	(-0.21)	(0.33)	(-0.02)
MAX	-0.0011	-0.0047	0.0032	-0.0081	0.0129	-0.0053	-0.0014	0.0035
	(-0.11)	(-0.40)	(0.31)	(-0.66)	(0.78)	(-0.52)	(-0.12)	(0.29)
MIN	-0.0012	-0.0191	-0.0021	-0.0117	-0.0083	-0.0096	-0.0140	-0.0064
	(-0.11)	(-1.60)	(-0.18)	(-0.87)	(-0.72)	(-0.78)	(-0.93)	(-0.51)

Notes: The table presents results of the cross-sectional regression investigating whether the prospect theory value and other independent variables in the past period explain the expected return using stocks within each of the stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized by the fatness in the tail of the stock return distribution for the KOSPI and KOSDAQ markets. The fatness of the tail parts is measured by the statistical probability of data deviated from the 99% confidence interval of the distribution. The tail in the distribution is divided into positive and negative parts. Results are for Model 6. The dependent variable is the excess return measured by the risk-free excess return of one month in the future period. The independent variables estimated in the past period are the prospect theory value (PTV), market beta (BETA), logarithmic size (SIZE), logarithmic book-to-market equity ratio (BEME), momentum (MOM), short-term reversal (SREV), long-term reversal (LREV), illiquidity (iLIQ), idiosyncratic volatility (IVOL), maximum (MAX) and (-1) minimum (MIN). The results are the average values of the regression coefficients estimated for each sub-period in the whole period and their statistic values. The t-values in parentheses are presented by 'a', 'b', and 'c' based on the significance levels of '1%', '5%', and '10%', respectively.

Table 9.

Robustness test by the change of empirical design

		equal weighting method				value weighting method			
		negative tail		positive tail		negative tail		Positive tail	
		group1	group 2	group 3	group 4	group 1	group 2	group 3	group 4
Panel A: Seasonality									
January	Ex.return	0.1158^{a}	-0.0198	0.0705^{b}	-0.0165	0.0728^{a}	-0.0443	0.0774^{a}	-0.0435
		(3.12)	(-0.51)	(2.39)	(-0.42)	(2.90)	(-1.56)	(2.94)	(-1.51)
	FF3 α	0.0964^{b}	-0.0589	0.0673^{b}	-0.0597^{c}	0.0441^{b}	-0.0659^{a}	0.0432^{b}	-0.0705^{a}
		(2.36)	(-1.64)	(2.08)	(-1.65)	(2.06)	(-3.32)	(2.24)	(-5.68)
Non-January	Ex.return	0.0696^{a}	0.0234^{b}	0.0738^{a}	0.0230^{b}	0.0148^{c}	0.0644	0.0220^{b}	0.0633
		(6.34)	(2.11)	(6.35)	(2.09)	(1.77)	(1.42)	(2.37)	(1.28)
	FF3 α	0.0497^{a}	0.0214	0.0603^{a}	0.0187	0.0025	0.0562	0.0086	0.0583
		(3.33)	(1.57)	(3.58)	(1.46)	(0.40)	(1.29)	(1.62)	(1.23)
Panel B: Changes of period length for estimating the past return distribution									
36M	Ex.return	0.0471^{a}	0.0624^{a}	0.0584^{a}	0.0553^{a}	0.0229^{a}	0.0826	0.0273^{a}	0.0270^{a}
		(5.93)	(4.83)	(6.97)	(4.59)	(3.02)	(1.62)	(3.41)	(2.81)
	FF3 α	0.0474^{a}	0.0523^{a}	0.0566^{a}	0.0469^{a}	0.0119	0.0699	0.0147^{b}	0.0141
		(4.48)	(2.72)	(4.70)	(2.70)	(1.63)	(1.53)	(2.13)	(1.45)
48M	Ex.return	0.0628^{a}	0.0393^{a}	0.0657^{a}	0.0318^{a}	0.0333^{a}	0.0555	0.0374^{a}	0.0567
		(7.43)	(3.27)	(6.76)	(2.79)	(4.01)	(1.34)	(3.45)	(1.33)
	FF3 α	0.0528^{a}	0.0258	0.0572^{a}	0.0185	0.0199^{a}	0.0477	0.0240^{a}	0.0513
		(5.29)	(1.62)	(4.96)	(1.24)	(3.17)	(1.24)	(2.88)	(1.33)
Panel C: Changes of length for future investment period									
2M	Ex.return	0.1135^{a}	0.0043	0.1049^{a}	0.0093	0.0617^{a}	0.0944	0.0573^{a}	0.0935
		(5.77)	(0.16)	(5.44)	(0.34)	(3.02)	(1.47)	(2.84)	(1.37)
	FF3 α	0.0995^{a}	0.0072	0.0940^{a}	0.0152	0.0297^{c}	0.0801	0.0275	0.0861
		(3.23)	(0.25)	(2.93)	(0.51)	(1.68)	(1.19)	(1.59)	(1.25)
3M	Ex.return	0.2202^{a}	0.0072	0.1562^{a}	0.0204	0.1176^{a}	0.0726^{b}	0.0965^{a}	0.0825^{a}
		(3.03)	(0.17)	(4.55)	(0.47)	(3.16)	(2.44)	(2.84)	(2.66)
	FF3 α	0.1907^{b}	-0.0197	0.1298^{a}	-0.0019	0.0782^{b}	0.0227	0.0657^{b}	0.0295
		(2.15)	(-0.48)	(3.39)	(-0.04)	(2.18)	(0.85)	(2.24)	(0.97)
6M	Ex.return	0.3431^{a}	-0.0765	0.3198^{a}	-0.0301	0.2038^{b}	0.1232	0.1516^{b}	0.1636^{b}
		(2.91)	(-0.60)	(2.57)	(-0.21)	(2.41)	(1.60)	(2.15)	(1.98)
	FF3 α	0.2797^{b}	-0.1561	0.2915^{b}	-0.0994	0.0667	0.0034	0.0852	0.0272
		(2.41)	(-1.12)	(2.10)	(-0.69)	(1.22)	(0.08)	(1.47)	(0.59)
12M	Ex.return	0.7147^{b}	0.1651	0.6076^{b}	1.2777	0.3833^{b}	0.3493	0.3425^{b}	0.4098
		(2.19)	(0.75)	(2.24)	(0.36)	(2.27)	(1.52)	(1.99)	(1.59)
	FF3 α	0.4537	0.0973	0.5363	0.0443	0.1504	0.1838	0.0400	0.1996^{c}
		(1.48)	(0.95)	(1.40)	(0.29)	(1.56)	(1.29)	(0.55)	(1.89)

Notes: The table presents the results on the performance of the decile portfolio according to the change in empirical design. Seasonality (Panel A) is divided into January and non-January months, and the period length for estimating the past return distribution (Panel B) is divided into two types of the past 36 months and 48 months. The length of future investment period (Panel C) is divided into four types of 2 months, 3 months, 6 months and 12 months. Stocks within the four stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized by the fatness in the tail of the stock return distribution in the Korean stock market are utilized. The fatness of the tail parts is measured using the statistical probability of data deviated from the 99% confidence interval of the distribution. The tail in the distribution is divided into positive and negative parts. Results are divided into equal weighting and value weighting methods, and for each weighting scheme, the performance of the L-H zero-cost portfolio is the excess return and the risk-adjusted returns (FF3 α). The t-values in parentheses are presented by ‘a’, ‘b’, and ‘c’ based on the significance levels of ‘1%’, ‘5%’, and ‘10%’, respectively.

Table 10.

Robustness test by using out-of-sample of the U.S., Japan, and China stock markets

	equal weighting method				value weighting method			
	negative tail		positive tail		negative tail		positive tail	
	group 1	group 2	group 3	group 4	group 1	group 2	group 3	group 4
Panel A: the U.S. stock market								
(a) NYSE and AMEX exchanges, 2000.01~2016.12								
Ex.return	0.0438[a]	0.0469[a]	0.0807[a]	0.0181	0.0160[c]	0.0057	0.0416[a]	0.0079
	(5.56)	(2.61)	(9.28)	(1.03)	(1.93)	(1.10)	(4.37)	(1.59)
CAPM α	0.0292[a]	0.0476[a]	0.0716[a]	0.0158	0.0062	0.0054	0.0348[a]	0.0046
	(2.94)	(4.13)	(5.87)	(1.63)	(1.00)	(1.47)	(3.68)	(1.22)
(b) Nasdaq exchange, 2001.01~2016.12								
Ex.return	0.0613[a]	0.0511	0.0998[a]	0.0095	0.0318[a]	0.0046	0.0435[a]	0.0042
	(6.63)	(1.53)	(8.80)	(0.30)	(4.15)	(0.32)	(4.98)	(0.31)
CAPM α	0.0483[a]	0.0593[a]	0.0926[a]	0.0189[a]	0.0281[a]	0.0077	0.0418[a]	0.0052
	(4.34)	(5.64)	(5.35)	(2.79)	(3.10)	(0.57)	(4.50)	(0.40)
Panel B: Japan stock market								
(a) TOPIX exchange, 2000.01~2016.12								
Ex.return	0.0103[b]	0.0155[a]	0.0179[a]	0.0100[a]	0.0097	0.0097[b]	0.0143[a]	0.0051
	(1.98)	(4.46)	(3.15)	(3.36)	(1.64)	(2.00)	(2.62)	(0.76)
CAPM α	0.0076	0.0138[a]	0.0142[b]	0.0082[a]	0.0074	0.0099[c]	0.0124[b]	0.0047
	(1.39)	(3.56)	(2.09)	(2.90)	(1.11)	(1.79)	(2.14)	(0.93)
(b) Jasdaq exchange, 2010.01~2016.12								
Ex.return	0.0203[b]	0.0581[b]	0.0761[c]	0.0196	0.0287[b]	0.0173	0.0302[b]	0.0100
	(2.11)	(2.33)	(1.84)	(1.46)	(2.27)	(1.52)	(2.03)	(0.56)
CAPM α	0.0179[b]	0.0371[a]	0.0354[b]	0.0200	0.0234	0.0116	0.0249[c]	0.0184
	(2.03)	(3.11)	(2.56)	(1.53)	(1.32)	(1.47)	(1.77)	(0.89)
Panel C: China stock market, 2011.01~2016.12								
Ex.return	0.0146[a]	0.0156[a]	0.0119[a]	0.0079[b]	0.0234[a]	0.0140[b]	0.0218[a]	0.0081[c]
	(4.62)	(3.97)	(3.17)	(2.41)	(6.21)	(2.56)	(4.31)	(1.81)
CAPM α	0.0149[a]	0.0154[b]	0.0121[b]	0.0080[c]	0.0236[a]	0.0135[b]	0.0217[a]	0.0083
	(4.16)	(2.38)	(2.44)	(1.75)	(5.41)	(2.19)	(5.32)	(1.45)

Notes: The table presents the results using out-of-sample stock markets in the U.S., Japan, and China. The U.S. market consists of the NYSE, AMEX and Nasdaq. The Japan market consists of the TOPIX and Jasdaq. The China market consists of Shanghai and Shenzhen. For each country, stocks within the four stock groups (fat-tail: G1, G3, thin-tail: G2, G4) categorized by the fatness in the tail of the stock return distribution are utilized. The fatness of the tail parts is measured using the statistical probability of data deviated from the 99% confidence interval of the distribution. The tail in the distribution is divided into positive and negative parts. Results are divided into equal weighting and value weighting methods, and for each weighting scheme, performances of the L-H zero-cost portfolio are the average values of excess return (Ex.return), and the risk-adjusted returns of capital asset pricing model (CAPM α). The t-values in parentheses are presented by 'a', 'b', and 'c' based on the significance levels of '1%', '5%', and '10%', respectively.