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Capital investment decision, corporate governance, and prospect theory

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Abstract

This paper investigates whether the effects of prospect theory exist in the decision making of corporate capital investment via the value function of cumulative prospect theory proposed by Tversky and Kahneman (1992). With a reference point of firm performance, the change in annual capital investment ratio is taken as the proxy variable for value which reflects the utility obtained from gains or losses. By adopting the value function as the empirical model, irrational behavior of risk aversion, risk seeking, and loss aversion is observed. Besides, the evidences show that financial constraints cannot change the behavior of risk aversion when firms are facing gains, but the irrational behavior cannot be observed when variables of corporate governance structure are included, i.e. the corporate governance mechanism is functioning. On the other hand, no behavior of risk seeking is observed when firms are facing losses with the consideration of financial constraints or corporate governance.

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1. Introduction

A critique of expected utility theory is presented as a descriptive model of decision making under risk, which they call prospect theory. Instead of the absolute level of consumption or wealth, Kahneman and Tversky (1979) propose a value function defined on the gains or losses relative to a reference point. Under prospect theory, value is assigned to gains and losses rather than to final assets. The value function is normally concave for gains, commonly convex for losses, and is generally steeper for losses than for gains. Prospect theory has been successfully employed to explain the behavior of financial market investors. But it is not clear whether the individual-level theory is applicable to organization-level decision making. Only few papers apply prospect theory to the decision making of organizations.

Among the policies of corporate finance, the decision of capital investment is an analogy to the behavior of individual investors. According to prospect theory, people are risk-averse when involving sure gains and become risk-seeking when facing sure losses. By taking firm performance as the reference point, this paper argues that the decision making of capital investment might have tendency towards risk aversion or risk seeking. Though the
management of a firm is a coalition of individuals, this paper deems that the behavior on capital investment is somehow different from the one of financial market investors. When the management is likely to make irrational decisions on capital investment for the purpose of increasing firm value or expropriating wealth, the irrational behavior might be abated by the mechanism of corporate governance including ownership structure and board composition. Besides the mechanism of corporate governance, the behavior on capital investment is constrained by the resource availability, i.e., the financial constraints, within a firm as well, such as cash flow, dividend payout, firm size, capital density, and previous investment.

The first purpose of this paper is to investigate whether the irrational behavior of prospect theory exists in the decision making of corporate capital investment. Secondly, this paper tries to find other explanatory factors of corporate capital investment under prospect theory. By considering financial constraints and corporate governance structure of a firm, multiple regression models are fitted according to the conditions of value function.

2. Literature review

2.1. Prospect theory

Kahneman and Tversky (1979) propose prospect theory as an alternative to expected utility theory (also called Morgenstern–von Neumann utility theory) and provide robust evidences that people’s actual decision making does not follow rational calculation. The value function is defined on deviations from a reference point, which is concave for gains with the implication of risk aversion and convex for losses, implying risk seeking. As shown in figure 1, the value function is an S-shaped curve, concave for gains and convex for losses, suggesting tendencies toward risk aversion when facing gains and toward risk seeking when facing losses. In addition, the curve is generally steeper for losses than for gains, the tendency of loss aversion. Under prospect theory, people underweight the outcome that are merely probable in comparison with the outcome that are obtained with certainty. This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses. Behavior in the losses domain opposite to the behavior in gains domain is called reflection effect.

\[
\text{Value} = \begin{cases} 
0 & (x \geq 0), \\
(1-x)/\lambda & (x < 0)
\end{cases}
\]

For \( \alpha < 1 \), the value function exhibits risk aversion over gains; the function exhibits risk seeking over losses for \( \beta < 1 \). When \( \alpha \) is smaller, the risk aversion of the individual is more in the gains domain. Similarly, when \( \beta \) is smaller, the risk seeking is more in the losses domain. Furthermore, if the loss-aversion coefficient \( \lambda \) is greater than 1, individuals are more sensitive to losses than gains. Tversky and Kahneman have estimated \( \alpha \) and \( \beta \) to be 0.88 and \( \lambda \) to be 2.25. Besides, al-Nowaihi, Bradley, and Dhami (2008) give a proof which shows that loss aversion implies the value of \( \alpha \) must be equal to the one of \( \beta \), not only \( \lambda > 1 \).
Prospect theory has already been applied fruitfully to a range of areas including economics, finance, and management (Bernasconi, 1998; Bromiley 1991; Dhami and al-Nowaihi, 2007; Kyle et al., 2006; Odean, 1998; Rieger and Wang, 2006; Shimizu, 2007). The existing literature on prospect theory has focused on behavior of individuals and non-corporate financial issues. Few papers apply prospect theory to the decision making of organizations, but the empirical literature on corporate finance is insufficient. Kyle et al. (2006) solve a liquidation problem for an agent with preferences consistent with prospect theory. They find that the agent may liquidate a project with a relatively superior Sharpe ratio if its current profits rise or drop to the break-even point. Conversely, the agent is willing to hold a risky project with a relatively inferior Sharpe ratio if the project is currently making losses, and intends to liquidate it when it breaks even. By complementing prospect theory with organization-level behavioral theory and the threat-rigidity thesis, Shimizu (2007) examines the risk-seeking behavior of organizations in the context of the divestiture of formerly acquired units. The evidence shows that divestiture decisions are influenced by both individual and organizational factors that cannot be explained solely by one theory.

2.2. Financial constraints to capital investment

In literature, financial constraints to investment include cash flow, dividend payout, firm size, capital intensity, and lagged investment etc. Previous studies find evidences that investment is highly correlated with cash flow, and a firm with a large cash flow ratio would be able to increase investment more easily (Fazzari, Hubbard, and Petersen, 1988; Gilchrist and Himmelberg, 1995; Black, Legoria, and sellers, 2000). For the interpretation of cash flow being evidence of a constraint to investment, some firms cannot obtain external funds so that an increase in current cash flow directly increases funds available for current investment and signals an increase in net worth of a firm.

As to the dividend payout, Fazzari et al. (1988) use low dividend payout to identify financially constrained firms. Because dividends and investment are competing uses of funds, firms facing severe financing constraints should choose lower dividend-to-income ratios. In addition, size of a firm also affects its ability to finance additional investment. Gilchrist and Himmelberg (1995) suggest that small firms are more likely to face financing constraints. Black et al. (2000) argue that the decision to invest in fixed assets is dependent on capital intensity and prior capital investment of a firm. They expect that capital investment by firms with high capital intensity is more affected by tax reforms than those with relatively lower capital intensity. Since investment opportunity is sensitive to the capital structure of the firm, Black et al. (2000) also include each firm’s debt-to-equity ratio to control for the effects of financial leverage. In addition, capital investment for a firm in any year should be correlated with investment in the succeeding year because firms in various life stages may be experiencing relatively higher or lower levels of capital investment.

2.3. Corporate governance structure

Many papers suggest that firms’ ownership structure is a primary determinant of the extent of agency problems between controlling insiders and outside investors. La Porta et al. (1999) argue that when large shareholders effectively control corporations, they might try to expropriate wealth by seeking personal benefits at the expense of minority shareholders. The findings suggest that ownership and control can be separated to the benefit of the large shareholders. Both cash flow rights and voting rights are critical to corporate governance of a firm. Since incentives to expropriate vary with cash flow rights, controlling shareholders and managers with less than full ownership of the cash flow rights of the firms who control corporate assets can potentially expropriate outside investors. Claessens et al. (2002) find that firm value increases with the cash flow ownership of the largest shareholder, indicating a
positive incentive effect. But firm value falls when the control rights of the largest shareholder exceed its cash flow ownership, consistent with an entrenchment effect.

According to the literature, board composition is another factor that affects firm performance and corporate decisions. A corporate board could play an important role in limiting the power of a controlling shareholder to expropriate the interests of minority shareholders, which implies that directors make decisions rationally. But board composition is likely to be influenced by controlling shareholders, Chaessens et al. (2000) argue that a controlling family is able to elect board directors and appoint management. In addition, Balatbat et al. (2004) suggest that independent directors and supervisors can increase efficiency and operating performance of a firm, which implies that independent directors make decisions rationally and reduce the probability of irrational capital investment. Yeh and Woidtke (2005) examine firm valuation as a function of board composition in Taiwan and find that firm value is negatively related to board affiliation in family-controlled firms. Thus, this paper argues that the variables of ownership of board, percentage of board seats held by non-controlling group, and independent director are positively associated with capital investment for gains and are negatively correlated with investment for losses.

3. Research design

3.1. Data and hypotheses

By examining pooled cross-section firm-year data, the sample includes Taiwanese listed companies between 2001 and 2006, with the exception of financial companies. After deleting observations due to lack of data, the sample consists of 685 Taiwanese companies, resulting in a sample of 4,110 observations. All data regarding ownership structure, board composition, and other company information are from the databank of Taiwan Economic Journal (TEJ). This paper tests hypotheses by fitting regression models under value function of cumulative prospect theory. According to Bowman (1982), Kyle et al. (2006), and Shimizu (2007), the investing behavior of firms is risk-averse when performing well and is risk-seeking when performing badly. First, this paper examines the hypothesis that behavior of firms’ capital investment is risk-averse when facing gains, as shown in H1. On the other hand, the hypothesis that behavior of firms’ capital investment is risk-seeking when facing losses is presented as H2.

**H1:** Behavior of firms’ capital investment is risk-averse when facing gains.

**H2:** Behavior of firms’ capital investment is risk-seeking when facing losses.

Furthermore, many evidences prove that corporate capital investment is constrained by financial factors, such as cash flow, dividend payout ratio, firm size, leverage ratio, and capital intensity (Fazzari et al., 1988; Gilchrist and Himmelberg, 1995; black et al., 2000). To test the robustness of value function, this paper considers financial constraints as control variables in empirical models. According to the literature, capital investment is constrained by financial ratios when firms decide to increase the ratio of capital investment. But this paper argues that when firms are risk-averse when facing gains, financial constraints cannot influence the decision, i.e., as H1a shows that the risk-averse behavior of firms is not affected when considering financial constraints. For instance, it is not necessary or urgent to increase the investment ratio when firms perform well and own sufficient cash flow. Conversely, if firms plan to increase the investment ratio when facing losses, the decision is constrained by financial factors. The hypothesis is described as H2a below, i.e., the risk-seeking behavior of firms is diminished when considering financial constraints.

**H1a:** The risk-averse behavior of firms is not affected when considering financial constraints.

**H2a:** The risk-seeking behavior of firms is diminished when considering financial constraints.

Besides the financial constraints, this paper suggests that capital investment decision is correlated with corporate governance since corporate governance affects firm performance and firm value is associated with capital investment. No matter the irrational behavior of risk-averse or risk-seeking, the behavior is abated when the
mechanism of corporate governance is existent and functioning. The hypotheses are as follows.

**H1b:** The risk-averse behavior of firms is diminished when corporate governance mechanism is existent.

**H2b:** The risk-seeking behavior of firms is diminished when corporate governance mechanism is existent.

### 3.2. Analytical approach

According to the value function of prospect theory, the independent variable is gains or losses relative to a reference point. Hence, this paper takes firm performance as the reference point which determines gains or losses for firms. This paper defines gains for whose firm performance is superior to 75% of firms in the same industry and losses for whose firm performance falls below the 25th percentile in the same industry. Regarding the dependent variable, this paper takes the change in annual capital investment ratio \( \Delta INV \) as the proxy variable for value (utility) which reflects the utility obtained from gains or losses. Since capital investment of a firm provides useful information about future earnings, it reflects the value or utility of a firm according to its performance. This paper argues that a firm is risk-averse or risk-seeking about its capital investment according to the domain of gains or losses.

In addition, under prospect theory, this paper also tries to find explanatory factors that influence the decision of capital investment. Following the value function of Kahneman and Tversky (1992), this paper assigns the reference point a value of zero by fitting regression models without intercept, i.e., the coordinate axis is shifted. To test the hypotheses H1 and H2, the empirical regression models are displayed as follows. The equation (2), the value function when facing gains, tests the risk-averse behavior, and the equation (3) representing the value function when facing losses tests the risk-seeking behavior, respectively. When H1 and H2 are supported, coefficients of \( \alpha \) and \( \beta \) are equal and coefficient \( \gamma \) is not significantly different from 1.

\[
\Delta INV_i = \gamma(Performance_i)^\alpha + \epsilon_i \quad (2)
\]

\[
\Delta INV_i = -\lambda(\text{Performance}_i)^\beta + \epsilon_i \quad (3)
\]

Besides the simple regression models, this paper also fits multiple regression models with control variables such as financial constraints or corporate governance to test the remaining hypotheses. Regarding the variables of financial constraints and corporate governance, this paper takes cash flow ratio, dividend payout ratio, capital intensity etc. as financial constraints; variables of corporate governance include cash flow rights, separation of ownership and control, ownership of board members, percentage of board seats of non-controlling group, and existence of independent director. When multiple regression models are applied, this paper adopts the values of variance inflation factor (VIF) to test collinearity. If all the values of VIF in a regression model are smaller than 10, the collinearity problem can be ignored.

### 3.3. Variable selection and measurement

Following the approach of Black, Legoria and Sellers (2000), this paper measures the annual capital investment as the change in gross property, plant, and equipment for each year plus the annual R&D expenditures. The measure of investment captures both a firm’s investment in fixed assets and R&D that accurately reflects a company’s investment decision. To control for inflation and growth, the annual investment is scaled by total sales, i.e., the measure of investment is the change in fixed assets plus R&D divided by sales, which this paper calls capital investment ratio. In addition, Black et al. (2000) suggest that capital investment for a firm in any year should be correlated with investment in the succeeding year. To reflect the utility obtained from gains and losses, this paper uses the change in annual capital investment ratio \( \Delta INV \) as the dependent variable. Firm performance includes market performance and operating performance. The former refers to the market value (equity market value or Tobin’s Q); the latter refers to financial performance (ROA, ROE or EPS). This paper argues that operating performance is more correlated with capital investment decision than market performance. Since EPS is an absolute
measure which is influenced by inflation, this paper measures firm operating performance using both ROA and ROE as independent variables. ROA is defined as after-tax earnings divided by total assets, and ROE is measured as after-tax earnings divided by total equity.

Besides, this paper considers control variables such as cash flow ratio (CFR, operating cash flow divided by net sales), dividend payout ratio (DPR, cash dividends declared divided by net earnings), capital intensity (CI, the ratio of fixed assets to total assets), industry (IND, set equal to 1 when a company is classified as an electron industry, and zero otherwise), cash flow rights (CASH, the percentage of share holding), control rights (CONTROL, voting rights), separation of ownership and control (SEPR, the difference between control rights and cash flow rights), interaction of cash flow rights and separation (INTER, the interaction item of cash flow rights and separation), ownership of board members (OBM, percentage of shares held by the board members), percentage of board seats held by non-controlling group (NON_C, percentage of board seats held by non-controlling group), independent director (INDP, set equal to 1 when independent director exists, and zero otherwise). According to Gilchrist and Himmelberg (1995) and Black et al. (2000), firm size and debt ratio are also influential factors of capital investment. Following the literature, this paper defines firm size as the natural log of total assets and debt ratio as debt-to-equity ratio. However, the variables of firm size and debt-to-equity ratio are highly correlated with other variables, so the variables are excluded from the control variables. In addition, the VIF values of cash flow rights (CASH) and control rights (CONTROL) are greater than 10, so that the variables are excluded as well.

4. Results

4.1. Descriptive statistics

After eliminating companies whose primary business is financial services, the sample consists of 685 Taiwanese companies that are listed on Taiwan Stock Exchange Corporation (TSEC), and results in a total data of 4,110 during the period between 2001 and 2006. This paper classifies companies whose operating performance is the lower 25% and the upper 25% in the same industry into losses (n=1,028) and gains (n=1,027) domains respectively. Table 1 shows the statistics of dependent variable, independent variable and control variables according to subgroups of losses and gains. Panel A of Table 1 displays the values of mean, median and standard deviation when ROE is the proxy for operating performance which is the independent variable. Besides, Panel B presents the statistics of variables while operating performance is represented by ROA.

4.2. The behavior of risk aversion, risk seeking, and loss aversion

According to the value function of cumulative prospect theory, this paper fits the data in gains domain with the equation of $u(x) = x^\alpha$ where $x$ represents the variable of operating performance and $u(x)$ is substituted by the variable of change in capital investment ratio. Conversely, the data in losses domain is fitted with the equation of $u(x) = -\lambda(x-x)^\beta$ where the value of $\beta$ must be equal to the one of $\alpha$ and $\lambda>1$ for testing the effect of loss aversion. Due to the no-intercept regression model, the data range in gains domain is restricted to $x \geq 0$; conversely, the data range in losses domain is limited to $x < 0$. If the equations of gains and losses are supported, the S-shaped value function is verified that the function is concave for gains, convex for losses, and steeper for losses than for gains, which this paper calls the irrational behavior on capital investment. To estimate the values of $\alpha$ and $\beta$ ($\alpha < 1$, $\beta < 1$), this paper takes iterations of putting values, ranging from 0.1 to 0.9, into the equations of value function. The iteration will be stopped when the values concurrently reach the conditions including $\alpha = \beta$ and $\lambda > 1$. In addition, the coefficient of $x^\alpha$ in the value function for gains is equal to 1. In the value function, $u(x)$ is represented by the variable of change in capital investment ratio (INV) and $x$ is replaced by operating performance (ROE or ROA).

Table 2 presents the iterative process of estimation in which the value of $\gamma$ in the function for gains should be tested to be 1, i.e., the null hypothesis of $\gamma = 1$ cannot be rejected; the coefficient $\lambda$ in the function for losses should
be tested to be greater than 1, i.e., the null hypothesis of $\lambda \leq 1$ should be rejected. Since the results of iterations are similar when ROA and ROE are proxies for operating performance, this paper merely displays the iterative process of ROE here and reports the results of ROA later. Briefly, in Table 2, the dependent variable and independent variable of the equations are $\text{INV}$ and ROE respectively. During the iterative process, this paper finds that the null hypothesis of $\gamma = 1$ in the function for gains cannot be rejected ($t=1.49$) when $\alpha = 0.45$, and that the hypothesis is rejected at the other values. Conversely, in the function for losses, the null hypothesis of $\lambda \leq 1$ is rejected when $\beta$ is ranging from 0.45 to 0.9. To meet the conditions of the value function at the same time, i.e., $\alpha = \beta$, $\gamma = 1$ and $\lambda > 1$, the estimates of equations yield $\alpha = \beta = 0.45$ and $\lambda = 1.1882$. When ROA is the proxy for operating performance, the estimates of equations also yield $\alpha = \beta = 0.45$. For the function of gains, the value of $\gamma$ is 0.93 and the null hypothesis of $\gamma = 1$ cannot be rejected. For the function of losses, the value of $\lambda$ is 1.6875 and that the null hypothesis of $\lambda \leq 1$ is rejected at the 5% level.

4.3. Explanatory factors of capital investment

To test the robustness of the value function, this paper tests the hypotheses of H1a, H2a, H1b and H2b. By taking ROE as the proxy for operating performance, under the value function with $\alpha = 0.45$, the results of multiple regression models in gains and losses domain with values of adjusted $R^2$ and VIF (variance inflation factor) are displayed in Table 3 and Table 4, respectively. Since all the VIF values are less than 10, there is no collinearity problem. For comparison purpose, the results of Model 1 in Table 3 and Table 4 are identical to the results of Table 2, in which the risk-averse, risk-seeking, and loss-averse behavior of capital investment is observed with the conditions of $\gamma = 1$ and $\lambda > 1$, respectively.

| Table 1. Summary statistics of losses group (n=1,028) and gains group (n=1,027) |
|-----------------|-----------------|----------------|-----------------|-------------------|-----------------|
| Variable       | Losses Mean     | Losses Median | Losses Std.     | Gains Mean       | Gains Median    | Gains Std.      |
| Change in capital investment ratio (INV) |                  |                 |                  |                  |                 |                 |
| Return on equity (ROE)                  | -9.09%           | 7.15%           | -1.19%           | 2.16%            | 41.26%          | 14.23%          |
| Cash Flow Ratio (CFR)                   | -32.85%          | 22.58%          | -14.61%          | 22.28%           | 56.32%          | 8.84%           |
| Dividend Payout Ratio (DPR)              | -22.25%          | 12.82%          | 4.77%            | 12.88%           | 5.45%           | 22.24%          |
| Capital Intensity (CI)                   | -2.65%           | 42.84%          | 0                | 40.77%           | 20.71%          | 26.13%          |
| Industry (IND)                           | 32.57%           | 19.25%          | 31.43%           | 14.69%           | 22.21%          | 15.40%          |
| Cash flow rights (CASH)                  | 0.45             | 0.54            | 0                | 1                | 0.49            | 0.49            |
| Control rights (CONTORL)                 | 21.05%           | 26.60%          | 18.15%           | 23.06%           | 16.30%          | 19.21%          |
| Separation of ownership and control (SEPR) | 26.19%           | 34.09%          | 24.17%           | 31.41%           | 17.81%          | 17.96%          |
| Ownership of board members (OBM)         | 5.14%            | 7.49%           | 0.66%            | 1.66%            | 9.39%           | 12.12%          |
| Percentage of board seats held by non-controlling group (NON_C) | 19.87%           | 28.83%          | 17.93%           | 25.55%           | 12.62%          | 14.96%          |
| Independent director (INDP)              | 29.32%           | 40.07%          | 28.57%           | 41.67%           | 23.29%          | 19.59%          |
| Change in capital investment ratio (INV) |                  |                 |                  |                  |                 |                 |
| Return on assets (ROA)                   | -8.39%           | 16.61%          | -0.78%           | 14.92%           | 9.55%           | 8.55%           |
| Cash Flow Ratio (CFR)                    | -23.69%          | 17.03%          | 6.16%            | 14.22%           | 5.32%           | 16.76%          |
| Dividend Payout Ratio (DPR)               | 2.84%            | 47.48%          | 0                | 46.58%           | 12.42%          | 28.24%          |
| Capital Intensity (CI)                   | 32.96%           | 16.87%          | 30.40%           | 12.10%           | 22.81%          | 13.87%          |
| Industry (IND)                           | 0.30             | 0.72            | 0                | 1                | 0.46            | 0.45            |
| Cash flow rights (CASH)                  | -7.21%           | 8.29%           | -0.94%           | 2.66%            | 36.89%          | 17.89%          |
| Control rights (CONTORL)                 | -8.39%           | 16.61%          | -0.78%           | 14.92%           | 9.55%           | 8.55%           |
| Separation of ownership and control (SEPR) | 5.12%            | 6.48%           | 0.49%            | 1.8%             | 9.26%           | 10.79%          |
| Ownership of board members (OBM)         | 19.47%           | 26.76%          | 15.53%           | 23.69%           | 12.60%          | 14.86%          |
| Percentage of board seats held by non-controlling group (NON_C) | 26.76%           | 42.20%          | 25.00%           | 41.67%           | 21.71%          | 18.25%          |
| Independent director (INDP)              | 0.19             | 0.38            | 0                | 0                | 0.39            | 0.49            |
Table 2. Process of estimating parameters while ROE as operating performance

| Function of gains (n=1,027) | Function of losses (n=1,028) |
|-----------------------------|-----------------------------|
| \( \Delta \text{INV} = \gamma(\text{ROE})^{\alpha} \) | \( \Delta \text{INV} = -\lambda(-\text{ROE})^{\beta} \) |
| \( \gamma \) | t test for Ho: \( \gamma = 1 \) | \( \lambda \) | t test for Ho: \( \lambda \leq 1 \) |
| 0.10 | 0.1340 | -70.69** | 0.1779 | -16.58 |
| 0.20 | 0.2495 | -33.27** | 0.3281 | -7.40 |
| 0.30 | 0.4618 | -13.00** | 0.5713 | -2.67 |
| 0.40 | 0.8505 | -1.97* | 0.9427 | -0.21 |
| 0.45 | 1.1521 | 1.49 | 1.1882 | 1.96* |
| 0.50 | 1.5589 | 4.04** | 1.4799 | 3.46** |
| 0.60 | 2.8456 | 7.33** | 2.2199 | 4.81** |
| 0.70 | 5.1734 | 9.12** | 3.1975 | 7.33** |
| 0.80 | 9.3700 | 10.08** | 4.4466 | 8.27** |
| 0.90 | 16.9098 | 10.59** | 6.0034 | 8.89** |

Notes: 1. + p < 0.10; *p < 0.05; **p < 0.01.

Table 3. Results of regression analysis in gains domain (n=1,027)

| Variables | Description | Coefficient | VIF | Coefficient | VIF | Coefficient | VIF | Coefficient | VIF |
|-----------|-------------|-------------|-----|-------------|-----|-------------|-----|-------------|-----|
| (ROE)0.45 | Return on equity | 1.1521** (11.25) | 0 | 1.0915** (3.88) | 7.88 | 0.2848 (0.99) | 7.36 | 0.2619 (0.72) | 9.51 |
| CFR | Cash flow ratio | 0.0345 (1.12) | 1.51 | 0.0362 (1.21) | 3.82 |
| DPR | Dividend payout ratio | -0.0847** (-3.48) | 3.59 | -0.1184** (-4.93) | 2.75 |
| CI | Capital intensity | 0.0797+ (1.92) | 2.53 | 0.0748+ (1.80) | 1.56 |
| IND | Industry | 0.0347** (2.21) | 3.21 | 0.0220 (1.37) | 3.67 |
| INTER | Interaction of Ownership and Separation | -0.0107* (-2.16) | 2.35 | -0.0122* (-2.54) | 2.37 |
| SEPR | Separation of ownership and control | 0.2557** (3.60) | 2.52 | 0.2933** (4.20) | 2.60 |
| OBM | Ownership of board members | 0.1034* (2.30) | 5.26 | 0.1274** (2.81) | 5.70 |
| NON_C | Percentage of board seats held by non-controlling group | 0.0537 (1.52) | 6.12 | 0.0698* (1.97) | 6.57 |
| INDP | Existence of independent director | 0.0413** (2.81) | 2.06 | 0.0391** (2.61) | 2.26 |
| Adjusted R-square | | 0.12 | 0.25 | 0.26 | 0.31 |

Notes: The t-statistics are in parentheses below estimated coefficients. + p < 0.10; *p < 0.05; **p < 0.01
Table 4. Results of regression analysis in losses domain (n=1,028)

| Variables                  | Description                               | Model 1       | VIF  | Model 2       | VIF  | Model 3       | VIF  | Model 4       | VIF  |
|----------------------------|-------------------------------------------|---------------|------|---------------|------|---------------|------|---------------|------|
| (-ROE)⁻⁰·⁴⁵                 | Return on equity                          | -1.1882**     | (-11.05) | 0             | 1.39 | -0.5390       | (-0.61) | -0.3718       | (-0.14) |
| CFR                       | Cash flow ratio                           | 0.0375        | (0.33) | 1.01          |      | 0.0101        | (0.09) |               |      |
| DPR                       | Dividend payout ratio                     | -0.0224**     | (-4.18) | 1.00          |      | -0.0233**     | (-4.34) | 1.02          |      |
| CI                        | Capital intensity                         | 0.0954        | (1.38) | 1.88          |      | 0.0977        | (1.19) | 2.67          |      |
| IND                       | Industry                                  | 0.0504        | (1.44) | 1.56          |      | 0.0584        | (1.38) | 2.32          |      |
| INTER                     | Interaction of Ownership and Separation   | -2.2946+      | (-1.77) | 2.19          |      | -2.0212+      | (-1.73) | 2.24          |      |
| SEPR                      | Separation of ownership and control       | 0.7680*       | (2.55) | 2.78          |      | 0.7332*       | (2.43) | 2.88          |      |
| OBM                       | Ownership of board members                | 0.1508        | (0.99) | 3.39          |      | 0.0380        | (0.24) | 3.92          |      |
| NON_C                     | Percentage of board seats held by non-controlling group | -0.0767       | (-0.87) | 2.87          |      | -0.1645       | (-1.70) | 3.58          |      |
| INDP                      | Existence of independent director         | 0.0087        | (0.16) | 1.47          |      | 0.0122        | (0.23) | 1.52          |      |
| Adjusted R-square         |                                           | 0.11          |      | 0.11          |      | 0.12          |      | 0.13          |      |

Notes: The t-statistics are in parentheses below estimated coefficients.
+ p < 0.10; *p < 0.05; **p < 0.01.
In Table 3 and Table 4, Model 2 shows the results of multiple regression models by considering variables of financial constraints including cash flow ratio (CFR), dividend payout ratio (DPR), capital intensity (CI) and industry (IND). As to the Model 2 in Table 3 (gains domain), the coefficient value of independent variable \((ROE)^{0.45} = 1.0915\), is significantly different from zero at the 0.01 level \((t=3.88)\) and the null hypothesis of \(\gamma = 1\) is not rejected \((t=0.3253)\), implying that the risk-averse behavior still exists. In addition to the independent variable, coefficients of all variables are significant except CFR. The signs of significant coefficients are as the literature predicts. For example, variable DPR (dividend payout ratio) is negatively correlated with capital investment; variable IND (dummy variable of industry) is positively correlated with capital investment that means the change in annual capital investment ratio of electron firms is greater than non-electron firms when facing gains. The result of Model 2 in Table 3 implies that the financial constraints cannot influence the risk-averse behavior of capital investment under the value function, then the hypothesis H1a is supported, i.e., the risk-averse behavior of firms is not affected when considering financial constraints.

The results of Model 2 in Table 4 (losses domain), the variable DPR is significantly negative with a coefficient value of -0.0224 at the 0.01 level. The coefficient value of independent variable \((-ROE)^{0.45} = -0.5160 \ (\lambda = 0.5160)\) which is not significantly different from zero \((t=-0.40)\) and the null hypothesis of \(\lambda \leq 1\) is not rejected \((t=0.3752)\), i.e., the risk-seeking behavior is not observed any more. In this case, the hypothesis H2a is supported that the risk-seeking behavior of firms is diminished when considering financial constraints. Regarding Model 3 in Table 3 and 4, the control variables include interaction of ownership and separation (INTER), separation of ownership and control (SEPR), ownership of board members (OBM), percentage of board sets held by non-controlling group (NON_C), and existence of independent director (INDP). As mentioned, variables of cash flow rights (CASH) and control rights (CONTROLL) are excluded due to high value of VIF that may cause collinearity problem. As to the Model 3 in Table 3, the coefficient value of independent variable \((ROE)^{0.45} = 0.2848\), not significantly different from zero \((t=0.99)\) and the null hypothesis of \(\gamma = 1\) is rejected \((t=-2.49)\). The results mean that the risk-averse behavior no longer exists. Among the significant coefficients of Model 3, the coefficient of SEPR (separation of ownership and control) is significantly positive at the 0.01 level and the coefficient of INTER (interaction of ownership and separation) is significantly negative at the 0.05 level. The results show that the capital investment ratio is decreasing when the ownership (cash flow rights) is high, implying the tendency of risk aversion; SEPR, OBM (ownership of board members) and INDP (existence of independent director) are positively correlated with the change of capital investment ratio so that the risk-averse behavior is diminished. In this case, the hypothesis H2b is supported.

For the losses domain, the results of Model 3 in Table 4 also show that the risk-seeking behavior is not observed either where the coefficient value of independent variable \((-ROE)^{0.45} = -0.5390 \ (\lambda = 0.5390)\) which is not significantly different from zero \((t=-0.61)\) and the null hypothesis of \(\lambda \leq 1\) is not rejected \((t=-0.52)\). Since the coefficient value of INTER \(-2.2946\) is significantly negative at the 0.10 level, the one of SEPR \(0.7680\) significantly positive at the 0.05 level implies the entrenchment effect and tendency of risk seeking. The result shows that controlling shareholders with high ownership might dilute the entrenchment effect and the risk-seeking behavior. Hence, the hypothesis H2b is supported that the risk-seeking behavior of firms is diminished when corporate governance mechanism is existent.

Furthermore, this paper fits model 4 to test the stability of Model 2 and Model 3. By comparing Model 4 with Model 2 and Model 3 in Table 3, the directions of coefficients remain the same. The coefficient value of independent variable \((ROE)^{0.45} = 0.2619\) with \(t=0.72\) which is not significantly different from zero and the null hypothesis of \(\gamma = 1\) is rejected \((t=-2.03)\), implying that the risk-averse behavior is not observed. In Model 4, the significance of some coefficients is different. For example, the significance of variable IND (industry dummy) changes from the 0.01 level to be insignificant; variable NON_C (percentage of board seats held by non-controlling group) turns to be significant at the 0.05 level. However, most of the coefficients are stable and the hypothesis H1b is not violated. Similarly, the coefficients of Model 4 in Table 4 remain the same signs and the values are close to the ones of Model 2 and Model 3. The risk-seeking behavior in losses domain is not observed where the coefficient value of independent variable \((-ROE)^{0.45} = -0.3718 \ (\lambda = 0.3718)\) which is not significantly different from zero \((t=-0.52)\) and the null hypothesis of \(\lambda \leq 1\) is not rejected \((t=-0.40)\). Hence, the hypotheses H2a and H2b are still supported.
As to the results of regression models with ROA as the proxy for operating performance (not reported in tables), the coefficient of independent variable is 0.93 for gains and significantly different from zero at the level of 0.01 under the value function. In addition, the null hypothesis of $\gamma = 1$ cannot be rejected at the 0.05 level. For losses domain, the coefficient of independent variable is -1.6875, i.e., the loss-aversion coefficient $\lambda$ is 1.6875 which is significantly different from zero and that the null hypothesis of $\lambda \leq 1$ is rejected at the 0.05 level. Hence, the irrational behavior on capital investment is still supported. Regarding the rest of the models, the results are similar to the ones in Table 3 and Table 4.

5. Conclusion

This paper finds that the behavior of risk aversion, risk seeking, and loss aversion on corporate capital investment is identified. But the risk-averse behavior of firms when facing gains is not affected when only financial constraints are considered. However, the irrational behavior of firms is not observed when variables of corporate governance are included. For the losses domain, the risk-seeking behavior of firms is diminished when considering financial constraints or corporate governance mechanism. Although the corporate behavior of risk aversion and risk seeking on capital investment is identified under value function, the irrational behavior is no longer observed when corporate governance mechanism is considered. The results show the importance of the corporate governance mechanism. In order to reduce the problem of irrational behavior on capital investment decision, it is important to enhance the corporate governance mechanism and high cash flow rights of controlling groups, high percentage of board seats held by non-controlling group, high ownership of board members, and independent directors are suggested. Conversely, it might imply that the value function is not applicable to the organization-level decisions.

This paper makes two contributions. First, this paper verifies the corporate behavior of risk aversion, risk seeking, and loss aversion on capital investment which has not been discussed before. Second, under prospect theory, this paper finds that corporate governance mechanism is crucial to the decision of capital investment.

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