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我國銀行短期投資之賭資效應與損益兩平效應

The House-Money and Break-Even Effects on Banks' Short-Term Investments: Evidence from Taiwan's Banks

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摘要：本文檢定本國銀行短期投資行為有無 Thaler and Johnson (1990) 提出的賭資效應和損益兩效應所述的行為偏誤現象。實證結果支持前述兩效應：銀行於前期有投資利得時，後期的投資風險明顯增加；因銀行可能對損益兩平機會過度樂觀或過度自信，前期投資損失亦會導致銀行於後期偏好風險，即使前期損失很大時亦然。前期利得或損失愈大，後期投資風險也愈大；但後期風險對前期小損失的敏感度大於對前期大損失的敏感度。上述行為偏誤在民營銀行更明顯。因此，即使如銀行此般具有投資專業者，仍有行為偏誤現象。

關鍵詞：賭資效應、損益兩平效應、行為財務、損失趨避、風險值

Abstract: To test the house-money and break-even effects of Thaler and Johnson (1990), this paper samples Taiwanese banks to examine whether prior short-run investment performance affects subsequent investment behaviors. The finding is that the afore-mentioned effects are empirically supported: past investment gains manifestly correlate with subsequent risk-taking; prior losses elicit increased subsequent risk, because banks are likely over-optimistic and overconfident of the break-even opportunity, even if their losses are large. Moreover, investment risks rise as prior gains increase; larger the preceding losses beget higher subsequent risks, yet the sensitivity of risks to small

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prior losses is greater than when prior losses are large. The aforementioned biased behavior is more pronounced for privately-owned banks. Consequently, banks still possibly demonstrate behavioral biases, even though they possess investment proficiency.

Keywords: House Money Effect, Break-Even Effect, Behavioral Finance, Loss Aversion, Value at Risk

1. Introduction

Over the past two decades, both experimental economics and behavioral finance studies demonstrate that individual decision-makers typically exhibit irrational behaviors that stem from both psychology and emotions. For this reason, both the rational expectation in economics and the efficient market hypothesis in financial theory face a number of challenges. Behavioral finance, as initiated by Kahneman and Tversky (1979) prospect theory, can ingeniously explain a number of anomalies in financial markets and corporate irrational financial decisions via dissecting decision-makers' psychological and behavioral biases. Therefore, there is a dramatic rise in research in this field.[1]

Kahneman and Tversky (1979) prospect theory explains individual irrational behaviors that exhibit loss aversion as facing losses and risk aversion as facing gains, but this theory is one-shot outcome and belongs to static analysis. Using dynamic analysis, numerous studies propose that prior performance causes subsequent risk-seeking behaviors. Several previous studies have addressed the effect prior outcome on subsequent decisions. For example, Thaler (1980) and Arkes and Blumer (1985) claim that sunk costs influence present decisions; Battalio *et al.* (1990) suggest that past performance could affect current decisions. Thaler and Johnson (1990) argue that the house-money and break-even effects hold for individual decisions; prior gains or losses will be integrated into the decisions that follow. Accordingly, the former asserts that the prior gains from decisions will cause subsequent behaviors to be risk-seeking; the latter asserts that in the presence of prior losses outcomes that provide an opportunity to break even are especially attractive due to loss aversion intentions.

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[1] Anomalies include stock price overreaction (De Bondt and Thaler, 1985) and underreaction (see, e.g., Abarbanell and Bernard, 1992; Jegadeesh and Titman, 1993), calendar effect (Keim, 1983; Mills and Coutts, 1995, among others), size and value effects (Fama and French, 1992), return predictability and excessive volatility (Barberis *et al*., 2001), and so on. Irrational corporation decisions, for example, consist of investment distortions (Malmendier and Tate, 2005) and unfavorable diversification strategies due to managers' overconfidence and overoptimism (Kaplan and Ruback, 1995; Montier, 2002, pp.145-148).

There are mixed results about whether the house-money effect is tenable. Gertner (1993) finds that individual decision-making behaviors are consistent with the expectation of the house money effect. Ackert *et al*. (2003) use experimental approaches and argue that the house money effect stands; however, experiments by Weber and Camerer (1998) and Clark (2002) find opposing results. Weber and Zuchel (2005) point out that the presence of the house-money effect depends on the type of decisions. In the financial markets, Grinblatt and Keloharju (2001) point out that individuals and institutional investors are relatively loss-averse and their trading behaviors are significantly influenced by past stock returns and price patterns. Recently, Coval and Shumway (2005) and Liu *et al*. (2006) find that future market makers' subsequent trading behaviors are greatly affected by prior performance. However the former concludes that investors are risk-seeking following losses, which supports the loss-averse argument; while the latter finds that investors are risk-seeking after trading gains, which agrees with the house-money effect. These mixed results warrant additional investigation.

It is worth noting that the break-even effect is seldom explicitly examined in previous studies. This effect highlights the risk taking that follows prior losses, while the house-money effect focuses on the impact of prior gains, according to the logic of these two effects. Yet, these two effects really are not mutually exclusive; numerous studies compare the choice of subsequent risks between prior gains and prior losses to test only the house-money effect, but have nothing to do for the break-even effect. In essence, when the subsequent risks that follow prior gains exceed those that follow prior losses, it is not necessarily true that the break-even effect fails to hold, because if the subsequent risks that follow prior losses are greater than those that follow extremely low prior returns (near zero outcome) or break even, then the break-even effect should be supported. Likewise, the contrary case relative to the above statement does not necessarily indicate the absence of the house-money effect. Briefly, the subsequent risks that follow prior gains (losses) ought to be compared with those that follow prior break-even conditions when testing the house-money (break-even) effect. In other words, the two effects can be tested independently, rather than considered as mutually exclusive. This paper will explicitly test the break-even effect in additional to the house-money effect based on the aforementioned concept.[2] According to this notion, the sample banks are separated into three groups, which are based on positive, negative, and near-zero prior returns.

Moreover, the studies above suggest that persons who are not professed typically exhibit behavioral biases. Do specialists have this bias? Grinblatt and Keloharju (2001) argue that institutional investors are loss-averse. O'Connell and Teo (2004) find that the mutual fund managers' decisions

[2] The finding of Coval and Shumway (2005) is somewhat consistent with the gist of the break-even effect. They find that futures traders regularly assume "above-average" afternoon risk to recover from morning losses. However, the authors do not mention the break-even effect.

are affected by their prior performance and argue that this phenomenon can be explained by loss aversion and overconfidence. Coval and Shumway (2005) and Liu *et al*. (2006) research the trading behaviors of market makers in the futures market and find that they have behavioral biases, where Liu *et al*. (2006) portend that the behavioral biases derived from both the frame effect and the mental accounting are present not only for individual investors, but also for professional ones. Since professional and institutional traders have profound influences on asset prices, further understanding as to whether in other areas they also present irrational and biased trading behaviors is meaningful and important.

This paper aims to examine whether Taiwan's banks, the institutional investors, have behavioral biases that are expected by the house-money and break-even effects as investing in securities in the short term. Also, this paper investigates whether there is a positive (or negative) relationship between prior outcomes and subsequent investment risks. This paper uses actual investment data of banks rather than experimental procedures, which may lack learning opportunities and fail to feedback trading tracks (Weber and Zuchel, 2005). The advantage of focus on Taiwan's banks is that these might typically have behavioral biases, because they face a less-developed and highly restricted financial system, an increasingly competitive operational environment due to deregulation of the past fifteen years, smaller firm size relative to that of developed countries, and decision making largely by the rule of man.

The study can fill empirical evidence gaps of behavioral finance and give insights into the degree of rationality in banks' decision-making behaviors. If banks' prior performances influence their subsequent risk attitudes toward investment, then the decision-makers will fail to rationally assess the trade-off between risks and returns, such that the behaviors will likely be excessively risk-taking or conservative, and thus unfavorable to the bank's value.

This paper employs three measures in attempt to capture banks' short-term investment risks, which are: equity investment ratio, outcome volatility, and value at risk. The empirical result is that banks' short-term investment decisions are substantially influenced by their prior investment outcomes, even when other potential factors are controlled. As numerous previous studies demonstrate, the house-money effect is empirically supported. Moreover, this paper indicates that the break-even effect also holds and that banks display a dynamic loss-averse behavior; prior losses invoke banks to be more risk-seeking than both prior gains and zero returns do, because banks might be over-optimistic and overconfident of the chance to break even, regardless of the size of prior losses. Moreover, the higher the prior gains, the greater the subsequent risk taking; the higher the preceding losses, the greater the following risks, yet the sensitivity of the risk taking to the prior losses is greater if the losses are at small levels than when losses are at large levels. Further, the above-mentioned result is more applicable to privately-owned banks (denoted as POB) but not to state-owned ones (denoted as SOBs). There are distinctive risk-taking behaviors following prior investment gains and losses between POBs and SOBs.

The remainder of the paper is organized as follows. Section 2 reviews literature concerning the house-money and break-even effects. Section 3 develops the hypotheses of this study. The data description and the measures of investment risk are presented in Section 4. Section 5 addresses empirical methods and results, including univariate and multiple-regression analyses, and results' explanations. Section 6 concludes the paper.

2. Literature Review

The argument from the prospect theory is based on a one-shot condition (Tversky and Kahneman, 1981). That is, the prospect theory describes one-period behavior with focus on the unrealized outcome relative to the reference point. Under condition of more than one period, prior performance could affect the reference point and thus the subsequent degree of risk taking. Thaler and Johnson (1990) design an experiment to observe whether and how prior gains and losses affect risk-taking. Based on experimental results, the authors propose the house-money and break-even effects. The former suggests that prior outcomes induce subsequent decisions to be more risk-inclined because decision-makers intuitively perceive that subsequent failures that result from risk-taking decrease gains, which are monies of other persons and thus injures no his own money, and therefore attenuates the tendency toward loss aversion. The latter argues that in the presence of prior losses, decision-makers especially prefer outcomes that provide a break-even opportunity. Thaler and Johnson believe that the reason behind these two effects is that losses following losses (gains) are not equivalent to single-period and independent losses; the pain of the former is more substantial.

Thaler and Johnson (1990) further suggest that the house-money effect could be applied to explain the hubris hypothesis, which concerns company acquisition issues, as referred to by Roll (1986).[3] They also state that the break-even effect can account for the behavior that, when experiencing losses due to security price declines, investors tend to maintain holdings in order to avert losses. Several studies document this behavioral bias, such as Shefrin and Statman (1985), and Ferris *et al*. (1988), who find that stocks with price declines have lower trading volumes than those with rising prices.

A number of studies support the house-money effect. Battalio *et al*. (1990) studies the effect of prior gains and losses on decision-making behaviors to find that the house-money effect is supported,

[3] Roll (1986) uses the hubris hypothesis to explain why bidding firms acquire a firm at a high price.

but alleviates as potential losses approach prior gains. Gertner (1993) also finds that individual decision-making behaviors coincide with the expectation of the house-money effect.

Weber and Zuchel (2005) point out that Bange's (2000) finding, where the change in small-size investors' portfolios is consistent with positive feedback rules and able to reflect the conditions of stock market, is in agreement with the house-money effect. Barberis *et al*. (2001) study investors' behaviors and the effects of behaviors on stock prices and market conditions. They incorporate both the house-money effect and loss aversion into their model to show the anomaly of high stock return volatilities and argue that when the following prices initially ascend and investors are profitable, investors are relatively risk-inclined, and therefore a lower discount rate is used to evaluate stock value. This induces subsequent prices to rise further, and investment costs augment for following investors; consequently, stock return volatilities rise dramatically.

Liao (2003) studies the relation between loss aversion, house-money effect and crack of stock price bubbles. He finds that the stock price bubbles are resulted from the interaction between traders with loss aversion and rational arbitragers; when there are the facts that prices successively drop and trading losses likely erode cumulative gains with time from the past, both the house-money effect and loss aversion will invoke stock prices to more seriously crack, and the effect from the former is more significant. Liao thus argues that both the house-money effect and loss aversion can explain the crack of stock market in 1987 in the U.S. and other similar steep falls in financial asset prices.

O'Connell and Teo (2004) find that mutual fund managers take on more risk following an increase in net gains and losses; however, responses to gains and losses are highly asymmetric. Fund managers actively reduce risk in the wake of losses, but merely mildly increase risk in the wake of gains. The authors relate these findings to behavioral theories of narrow framing, dynamic loss aversion, and overconfidence. The present paper recognizes that O'Connell-Teo (2004) finding is in line with the house-money effect and partially in line with the break-even effect as well. Nicolosi *et al*. (2005) find that less-experienced investors tend to be more risk-seeking following profitable trading, consistent with the house-money effect. Liu *et al*. (2006) examine the trading behaviors of market makers in the futures market in Taiwan and document that following investment gains (losses) in the morning, trading is more (less) risk-inclined (averse) and both trading volume and magnitude increase (downsize), revealing that the house-money effect matters. The authors suggest that behavioral biases of the framing effect and mental accounting not only happen to individual investors, but also to professional ones, who have particularly substantial impacts on asset prices.

Several studies conclude different findings from the above-mentioned literature. Clark's (2002) experiment, which concerns public goods, finds that individual decisions to willingly contribute public goods are not identical to the house-money effect.[4] Weber and Zuchel (2005) also execute an experiment and find that a person's attitude toward risks is associated with the present form of questions; when the question belongs to two-shot gambles, the house-money effect holds, but does not when facing a portfolio investment decision. The authors also find that in this case, prior losses lead to subsequently more risk-seeking behaviors than prior gains do. Finally, Coval and Shumway (2005) investigate the trading behaviors of market makers in the futures market in the USA and find that traders are considerably loss-averse. American traders take on more risks (i.e., buying at higher prices and selling at lower ones) following morning losses, but takes on less risk following morning gains, inconsistent with the house-money effect. This behavioral bias merely influences prices temporarily in the afternoon; prices that are determined by loss-averse traders reverse earlier than those that are determined by traders who have fewer behavioral biases.

The literature mentioned above documents that professionals such as institution investors may also have behavioral biases; e.g., market makers in the future market (Coval and Shumway, 2005; Liu *et al*., 2006), corporate managers (Malmendier and Tate, 2005), and mutual funds' managers (O'Connell and Teo, 2004). There are several articles in Taiwan support that the professionals likely exhibit behavioral biases. For example, in the stock market in Taiwan, Huang (2000) finds that foreign institution investors and securities investment trust corporation tend to buy winner stocks and sell loser ones, while dealers perform the opposite trading strategy; Huang (2005) suggestions that although, overall, the disposition effect is not be found for dealers' investing behaviors, but seemingly exists for investment on electronic firm stocks, and more obvious for up market condition and around Chinese New Year; Liu and Hung (2006) find that analysts of securities companies are overconfident of their abilities to forecasting short-run market index trends. Based on this behavioral bias argument, this paper conjectures that institutional investors, like banks, are also likely to display biased-trading behaviors. Since institutional investors have influence on asset prices and a bank's risk management and attitudes are very important for its operating performance, as well as company value, this research is relatively meaningful and critical.

3. Hypothesis Formulation

According to prior studies, specialists possibly exhibit behavioral biases. Thaler and Johnson

[4] However, Harrison (2007) argues that though Clark's (2002) experiment design is sound, its nonparametric tests are controvertible; econometric methodology involving panel data should be employed to consider correlation both across individual-level responses and over time. Using correct methods, the result is favorable to the house-money effect as based on the same experiment with Clark's (2002).

(1990) propose the house-money and break-even effects to describe the impact of prior performance on subsequent risk attitude for decision-making. This paper focuses on the aforementioned two effects on banks' short-term investment behaviors. Banks' security investments generally comprise financial instruments, such as equity securities (stocks, mutual funds, and depositary receipts), bonds, notes and bills, of which equity securities involve relatively higher market/price risks than other instruments in the short term.

Since the house-money effect highlights the influence of prior gains, whereas the break-even effect emphasizes risk-taking following prior losses, the two effects are not mutually exclusive. This paper argues that risks following the prior break-even, or near-zero returns, should serve as a benchmark for those risks following prior gains and losses, respectively. Even if the house-money (break-even) effect holds, the risks following prior gains (losses) are not necessarily larger than those following prior losses (gains), because of a difference in causes, which provokes distinctive subsequent risks between gains and losses, i.e., the effect of prior losses largely results from loss aversion, while the effect of prior gains is due primarily to less pain from losses after gains (Coval and Shumway, 2005; Thaler and Johnson, 1990). However, although a comparison between the risks that follow prior gains and prior losses is not relevant to tests of the two effects, it is helpful to understand the extent of influence of the prior outcomes. For these reasons, this paper classifies the sample into three groups -- prior realized gains, prior realized losses, and prior break even. Note that I do not consider unrealized gains and losses, mainly because the time they affect risk attitudes is at the same period, rather than the following period, and also because this data is unavailable.

According to the house-money effect, this paper hypothesizes as follows:

H1: Following prior realized gains from investments, banks' subsequent investment risks will be higher than those following prior break even, all else being equal.

H2: The larger the investment gains a bank yields, the higher risks are loaded subsequently.

In addition, according to the break-even effect, prior losses can lead to risk-averse decision attitudes, unless the current potential gains can provide a break-even opportunity. Also, the spirit of this effect predicts that the lower the prior losses (i.e., bigger "negative returns"), the higher the risks taken and that the risks should be higher than those under preceding break-even situations, due to greater chance of break-even, but they do not necessarily exceed those under conditions with positive prior performance. Thus, this paper hypothesizes that:

H3: For banks prior losses can cause risk-seeking decision behaviors when prior loss is small, relative to prior near-zero-performance situations.

H4: There is a positive relation between small-level prior negative returns and subsequent risk takings for banks.

As to the condition with larger prior losses, less risk-taking might be followed by lower investment risks, because of the lesser chance of break even, or followed by greater risks if the investor subjectively perceives that the opportunity to break even is also high and therefore is loss-averse. Thus, whether this case, along with the situation with overall prior losses, has higher risks than the prior break-even condition is an empirical issue. This paper sets one of the possible results as a hypothesis:

H5: For banks prior large losses can cause subsequent risk-seeking decisions, relative to prior near-zero-returns conditions; the larger the losses, the higher risks taken.

Though a comparison of subsequent risks between large (or overall) prior losses and prior break-even can not directly test the break-even effect, it can provide insight into the influence of prior investment outcomes on the following behaviors. These hypotheses are those that this study attempts to test.

4. Data and Measures of Investment Risks

4.1 Data Description

The sample includes 36 banks in Taiwan, including commercial and business banks. The decision for the starting time of the sample period, which is from 1994 to 2006, is based on the fact that there is the least missing data after 1993, and the fact that most new banks in Taiwan are found after 1991. This paper employs quarterly financial data, containing assets, debts, short-term investments, long-term equity securities investments, profitability (returns on equity (ROE) and spreads between loans and deposits), liquidity ratio, and the net gains of short-run investments. Since bank investments may be associated with market interest rate and the conditions of stock market, this paper also collects data on the inter-bank offer interest rate and returns on Taiwan stock exchange market index. These raw data is used to further compute variables' observations by their operational definitions, described in detail in later sub-sections. All these data are collected from the Taiwan Economic Journal Data Bank. The data is a panel type, but unbalanced because of missing values.

4.2 Investment Risk Measures

This study uses three approaches to measure investment risks for banks. The first measure is the ratio for investing in equity securities to total investments in the short term. This measure is typically used to determine mutual funds' risks for practitioners and is also logical. For example, equity funds are required to maintain stock weights of no less than 70% according to regulations concerning mutual funds management in Taiwan. An equity fund is recognized to be riskier than a bond fund simply due to its higher proportion of stock investments. Since equity securities have a greater possibility of generating capital gains or losses (i.e., price risks) than other securities (e.g., bills and bonds) have in the short term, increases in equity investment ratios are substantially consistent with increases in risks, based on the definition that investment performance is only composed of capital gains and losses. Therefore, this ratio measure can be used as a proxy variable for securities investment risks.

The second risk measure is the volatility of investment performance. The following GARCH(1, 1) model is employed to estimate the performance volatility (h_t).

$$R_t = C + \varepsilon_t \quad (1)$$

$$\varepsilon_t \mid \Omega_{t-1} \sim N(0, h_t)$$
$$h_t = d_0 + d_1\varepsilon_{t-1}^2 + d_2 h_{t-1} \quad (2)$$

where Eq. (1) is a mean equation that consists of investment returns (R_t), equal to net investment gains, divided by total investments, regressed on a constant *C*. In Eq. (2), ε_t is an error term that is supposed to possess autoregressive conditional variances with heteroscedasticity. Ω_{t-1} denotes a set of information available up to period *t*-1. *N* represents a normal distribution with a mean of zero and conditional variance h_t. d_0, d_1 and d_2 all are parameters, $d_0 > 0$, $d_1 \geqq 0$ and $d_2 \geqq 0$. This paper separately estimates h_t for each sample bank, such that we are able to obtain estimates of return volatility for each quarter.

Since only capital gains and losses are considered in investment returns, this paper excludes dividends, interest income, unrealized returns, and trading costs as components of returns. Dividends and interest income are not incorporated because they are typical investment yields and there is no likelihood of loss, but gain, and thus may not cause decision-makers to have psychological or behavioral biases, such as loss aversion or overconfidence. Additionally, dividends and interest are generally obtained semi-annually, or annually, which conflicts with quarterly data and may distort empirical results.

The last measure is value at risk (*VaR*), which is employed to estimate downside risk of the investment position. *VaR* has been widely used now by financial institutions to measure the risk related to the uncertainty of earnings on trading portfolio for periods as short as one day. The *VaR* concept can be expressed as:

$$\text{Prob}\,(X_T < -VaR) = \alpha\% \quad (3)$$

where X_T is a random variable that denotes the gain or loss amounts of a portfolio in the future *T* days; 1-α% represents the confidence probability level. *VaR* (positive value) describes the probability that the investment loss is greater than *VaR* is α% during a certain period.

This study uses the Monte Carlo simulation approach to compute *VaR*. This paper views the overall short-run investments of a bank as a portfolio, yet individual securities in the portfolio are not distinguished because there is only data available on overall investment performance. The value of a short-term investment portfolio is supposed to follow a geometric Brownian motion, such that investment returns, R_t, can be expressed as the following equation, under the assumption that mean return (μ) is a constant for each bank.

$$R_t = \mu \Delta t + \sigma_t \varepsilon \sqrt{\Delta t} \tag{4}$$

where μ is the mean return throughout sample period in this study for individual banks; Δt is one quarter; σ_t denotes quarterly variance (volatility) of returns, substituted by estimate of $h_t^{0.5}$ as estimated by the Equations (1) and (2). $\varepsilon \sim^{iid} N(0, 1)$ and $\varepsilon\sqrt{\Delta t} \sim^{iid} N(0, \Delta t)$.

The ε in Eq. (4) is randomly generated, following $N(0, 1)$, for each quarter of a sample bank, such that quarterly R_t can be simulated. This process is performed 10,000 times and the same numbers of R_t are obtained for each quarter. Then, for one quarter, we simulate return distribution and the value of five percentile is taken, based on sorting the 10,000 simulated values increasingly. Let the resulting value is r_t, then *VaR* is calculated using the following equation.

$$VaR = |r_t| \times (INV_{t-1} + INV_t) \times 0.5 \tag{5}$$

where *INV* represents short-term investment amounts (in thousands of Taiwanese dollars) that are derived from banks' balance sheets.[5]

The three risk measures separately are dependent variables in later regression analyses in this paper. Note that the natural logarithm of the last two measures is used, but not for the first one because several of the equity investment ratios are zero. The correlation coefficients for [equity investment ratio, log(volatility)], [equity investment ratio, log(*VaR*)], and [log(volatility), log(*VaR*)] are equal to 0.37, 0.17, and 0.83, respectively. This information provides additional recognition that the nature of the equity ratio might be different from that of the two alternative risk measures. Logically, the first measure is based on an ex ante concept, while the last two measures belong to be ex post one.

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5 This paper also adopts a delta-normal approach to compute *VaR*, equaling $-z\sigma(INV_{t-1} + INV_t) \times 0.5$, where z is -1.645 under 95% confidence interval and the estimate of $h_t^{0.5}$ is substituted for σ. The correlation coefficient between delta-normal *VaR* and Monte-Carlo simulation one equals 0.78, significant at the 1% level. The results from regression analyses below are qualitatively the same as the dependent variable being *VaR* in Eq. (5).

5. Empirical Methods and Results

5.1 Summary Statistics and Univariate Analysis

This study is interested in whether banks' subsequent attitudes on investment risks are diverse following prior gains or losses. Thus, the concerning variables are prior investment performance, denoted by $ROI_{t\text{-}1}$ (the same variable as R in Eq.(1)), and subsequent risks. These variables' descriptive statistics are reported in Table 1. Since this study uses three risk measures (dependent variables) and distinctive control variables are considered in later regression analyses, the numbers of missing data are not identical and thereby different numbers of observations are present across risk variables. Hence, I report their descriptive statistics separately. That is, there are 1,385, 1,508 and 1,508 observations for equity investment ratio, performance volatility and *VaR*, respectively.

For the research's purpose, descriptive statistics of three groups, based on positive and negative $ROI_{t\text{-}1}$, are separately shown in Panel A of Table 1, where the zero $ROI_{t\text{-}1}$ (denoted as G_0) group is formed by the criterion that for each bank, the returns are larger than the .95 quantile of negative $ROI_{i,t\text{-}1}$ and less than the .05 quantile of positive $ROI_{i,t\text{-}1}$. These returns in the group G_0 are tiny and near zero; therefore, it is believed that this criterion is radically reasonable. In Panel B, the negative $ROI_{i,t\text{-}1}$ are further partitioned into two sub-groups, symbolized by G_{NL} and G_{NH}, according to the individual bank's returns median. Namely, if the $ROI_{i,\,t\text{-}1}$ is less than $ROI_{t\text{-}1}$ median of bank i, then the observation in period t is classified as G_{NL}; or G_{NH} otherwise. Additionally, the group of positive $ROI_{t\text{-}1}$ is symbolized by G_P.

In Table 1, for both the overall means and medians of three risk measures, the group G_N is the largest, in particular for G_{NL}, and the G_0 is the smallest. To consider the deviations' impacts, I further conduct *t*- and nonparametric tests for risk equality among the four groups. The result is reported in Table 2. The differences in three risk measures between any two groups out of G_P, G_N and G_0 are statistically significant. The result is the same as that in Table 1, which is clear by the naked eye. This result supports the house money effect (Hypothesis 1) due to $G_P > G_0$, and the break-even effect (hypothesis 3) because of $G_{NS} > G_0$. Also, the evidence that $G_N > G_P$ and $G_{NL} > G_0$ implies that sample banks might perceive that the opportunity to break even from prior losses is high, and therefore exhibit risk-taking behaviors. However, these tests are done merely for overall means and medians across sample banks and this result could thus not offer a final conclusion because the effects of cross-sectional and other potential factors are not yet considered. As a result, further examination is necessary. To incorporate cross-sectional effects, regression analyses with panel data are later performed taking fixed or random effects into account.

Table 1 Summary Statistics of Variables in Hypotheses

	$ROI_{t\text{-}1}$ (%)		Equity investment ratio (%)			log(volatility) (%)			log(VaR) (in thousands of Taiwan dollars)		
Panel A: Negative $ROI_{t\text{-}1}$ are not partitioned.											
	G_P	G_N	G_P	G_N	G_0	G_P	G_N	G_0	G_P	G_N	G_0
Mean	4.96	−2.88	15.42	23.61	11.68	1.87	3.68	0.37	15.09	15.61	13.50
	(4.81)	(−6.23)									
Median	2.62	−0.69	8.74	11.70	6.85	1.61	3.94	0.99	15.02	15.73	14.47
	(2.59)	(−1.08)									
Max.	262.56	−0.00	99.94	88.03	72.54	11.03	10.37	7.48	22.08	19.94	20.26
	(262.56)	(−0.00)									
Min.	0.00	−24.48	0.00	0.93	0.00	−5.81	−4.55	−15.97	6.97	8.26	−5.88
	(0.00)	(−72.96)									
Std. Dev.	12.17	4.94	18.71	25.02	12.40	2.27	3.20	3.40	1.84	2.09	3.95
	(11.76)	(19.44)									
Obs.	1209	80	1209	80	96	1302	90	116	1302	90	116
	(1302)	(90)									
Panel B: Negative $ROI_{t\text{-}1}$ are partitioned.											
	G_{NH}	G_{NL}	G_{NH}	G_{NL}		G_{NH}	G_{NL}		G_{NH}	G_{NL}	
Mean	−0.73	−5.80	16.57	33.13		3.02	4.43		15.18	16.15	
	(−0.70)	(−12.55)									
Median	−0.31	−3.80	7.02	31.97		2.95	4.99		15.24	16.40	
	(−0.29)	(−4.77)									
Max.	−0.00	−0.23	88.03	84.22		7.48	10.37		19.40	19.94	
	(−0.00)	(−0.23)									
Min.	−3.92	−24.48	0.93	3.36		−4.55	−1.13		8.26	12.39	
	(−3.92)	(−72.96)									
Std. Dev.	0.93	6.49	23.11	24.65		3.34	2.90		2.32	1.69	
	(0.92)	(27.25)									
Obs.	46	34	46	34		48	42		48	42	
	(48)	(42)									

Notes. The sample is sorted by the sign of prior investment returns, $ROI_{t\text{-}1}$. Positive (negative) $ROI_{t\text{-}1}$ belongs to G_P (G_N) and near-zero $ROI_{t\text{-}1}$ belongs to G_0. The G_N is further partitioned into two sub-groups, G_{NL} and G_{NH}, based on individual bank's $ROI_{t\text{-}1}$ median . If the $ROI_{i,t\text{-}1}$ is less than $ROI_{t\text{-}1}$ median of bank i, the observation in period t is sorted as G_{NL}; G_{NH} otherwise. Since there are different control variables across later regression analyses for three risk variables and the numbers of missing data on control variables are dissimilar, there are distinct observation numbers among groups. The figures in parentheses in the two sub-columns of $ROI_{t\text{-}1}$ are descriptive statistics corresponding to both log(volatility) and log(VaR) columns. The equity investment ratio, investment return volatility, and value at risk (VaR) are three risk measures, of which the return volatility is calculated by Eq. (1) and (2), while the VaR is estimated by Eq. (5).

Table 2 Tests of Equality for Investment Risks across Sample Groups

groups	Equity investment ratio (%)		log(volatility) (%)		log(*VaR*)	
	mean	median	mean	median	mean	median
$G_N - G_P$	8.19	2.96	1.81	2.33	0.52	0.71
	(2.87)***	(1.77)*	(5.26)***	(4.62)***	(2.32)**	(2.52)**
$G_P - G_0$	3.74	1.89	1.50	0.62	1.59	0.55
	(2.72)***	(2.09)**	(4.68)***	(5.28)***	(4.29)***	(3.80)***
$G_{NH} - G_0$	4.89	0.17	2.65	1.96	1.68	0.77
	(1.34)	(0.31)	(4.61)***	(3.95)***	(3.15)***	(2.66)***
$G_{NL} - G_0$	21.45	25.12	4.06	4.00	2.65	1.93
	(4.86)***	(5.31)***	(7.43)***	(6.12)***	(5.80)***	(4.82)***

Notes. The sample is classified by the sign of prior returns, ROI_{t-1}. Positive (negative) ROI_{t-1} belongs to G_P (G_N) and near zero ROI_{t-1} belongs to G_0. The G_N is further partitioned into two sub-groups, G_{NL} and G_{NH}, based on individual bank's ROI_{t-1} median. If the $ROI_{i,t-1}$ is less than ROI_{t-1} median of bank *i*, the observation in period *t* is classified as G_{NL}; G_{NH} otherwise. The first (second) column of each risk measure presents means (medians) of between-groups differences with *t*-value (*z*-value) in parentheses, where the *z*-value is the statistic of the Mann-Whitney test. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

5.2 Regression Model and Hypothesis Test

To consider cross-sectional effects and the impacts of other potential factors, this study adopts regression analyses with fixed or random effects for the panel data to examine the effect of prior investment performance on subsequent risk taking.[6] The empirical model is:

$$\begin{aligned} Y_{i,t} = {} & \beta_{0,i} + \beta_1 DP_{i,t} + \beta_2 DNH_{i,t} + \beta_3 DNL_{i,t} + \beta_4 DP_{i,t} \times ROI_{i,t-1} \\ & + \beta_5 DNH_{i,t} \times ROI_{i,t-1} + \beta_6 DNL_{i,t} \times ROI_{i,t-1} + \sum_{j=1}^{J} \theta_j Xj_{i,t} + e_{i,t} \end{aligned} \quad (6)$$

where the subscript *i* and *t* represent bank and time (quarter), respectively. *Y* is a risk measure. *DP*, *DNH* and *DNL* are dummy variables, where *DP* (*DNH*, *DNL*) equals 1 if the observations belong to group G_P (G_{NH}, G_{NL}), and 0 otherwise (explicitly, $DP = DNH = DNL = 0$ as $ROI_{i,t-1}$ is zero). X_j are control variables and θ_j denote their coefficients. $\beta_{0,i}$ represents the intercept of bank *i*. β_1-β_6 are coefficients. $e_{i,t}$ is the error term.

We can exploit β_1-β_6 to test this paper's hypotheses. β_1, β_2 and β_3 reveal the incremental intercepts, respectively, due to different risk takings across G_P, G_{NH} and G_{NL}, as compared with G_0. β_4, β_5 and β_6 indicate the sensitivity of risks (*Y*) to the conditions with positive ROI_{t-1}, high and

[6] Fixed effects consist of two types: periodical and cross-sectional. Here, the former does not work smoothly because the matrix of independent variables is near singular, owing to incorporating market interest rate and returns on stock market index. Hence, this paper only considers cross-sectional effects.

low negative $ROI_{t\text{-}1}$, respectively. According to expectation of the 2nd, 4th and 5th hypotheses, both β_4 and β_5 should be positive, as well as β_6 should not be negative. Namely, it is expected that the higher the prior gains, or the smaller (larger) the prior losses (i.e., the higher (lower) of negative returns), the more active risk seeking the subsequent behaviors.

Moreover, since the interact terms ($DP \times ROI_{i,t\text{-}1}$, $DNH \times ROI_{i,t\text{-}1}$ and $DNL \times ROI_{i,t\text{-}1}$) are considered, three terms: 1) $\beta_1 + \beta_4 \times ROI_{i,t\text{-}1}$, 2) $\beta_2 + \beta_5 \times ROI_{i,t\text{-}1}$, and 3) $\beta_3 + \beta_6 \times ROI_{i,t\text{-}1}$, are the incremental effects of positive, high negative, and low negative $ROI_{t\text{-}1}$ on risks, respectively, relative to zero $ROI_{t\text{-}1}$. The Wald test is utilized to test whether these three effects are different from zero and to investigate the differences among these terms. All the house-money and break-even effects as well as the loss-averse hypothesis expect that the three terms should be positive. Additionally, one can predict a positive sum of the second and third terms according to the break-even effect and loss-averse. Here, $ROI_{i,t\text{-}1}$ is substituted by $\overline{ROI}_{t-1}^{+}$ for the first term, by $\overline{ROI}_{t-1}^{H-}$ for the second one, and by $\overline{ROI}_{t-1}^{L-}$ for the last one, where $\overline{ROI}_{t-1}^{+}$, $\overline{ROI}_{t-1}^{H-}$ and $\overline{ROI}_{t-1}^{L-}$ denote the means of the $ROI_{t\text{-}1}$ of G_P, G_{NH} and G_{NL}, respectively.

As general panel data analyses, F and Hausman (1978) tests are used to test fixed and random effects, respectively. The null hypothesis for the former is that there are identical intercepts across sample banks, and for the latter is that the random effect model should be adopted because its parameter estimators are consistent and efficient, but not for those of the fixed effect model. The F test is first performed and if its null hypothesis is rejected, then the Hausman test (with statistics being χ^2 distribution) is conducted.

5.3 Control Variables

The following variables are incorporated as control variables X_j, because they are likely to influence equity investment ratio and risk:

The upper limit of short-term equity investments (*ULI*): According to requirement of Taiwan's financial regulatory agencies, the amounts of short-run equity investments must not go beyond 25% of the bank's total equity minus long-term equity investments. Thus, the gap between bank equity and long-term equity investments is employed as a control variable. Also, this variable has the attribute of company size, for which it may be necessary to control. This variable is taken as the natural logarithm to reduce its magnitude and to induce it to tend to follow a normal distribution.

The additional amounts of other securities in short-term investments (ΔAOS): There is likely a trade-off relationship between equity securities and other short-term investments, such that the change in amounts of other securities might negatively influence equity investments in the same period. The natural logarithm of this variable is used. Note that this variable is merely used in the equity ratio regression equation.

Liquidity (*LIQ*): According to Taiwan's regulatory agency requirements, the current asset-to-deposit ratio must be greater than seven percent. These short-term securities investments belong to current assets, so that investment risks and equity ratios are possibly correlated with the liquidity ratio.

Profitability: The proxies consist of the difference between loan and deposit rates (i.e., spread) (*LMD*) and the ordinary income after taxes on equity (*ROE*). The loan rate is interest revenues over average loans, while the deposit rate equals interest costs over the sum of average deposits and average funds borrowed. Profitability may be the motive for banks that make use of short-term funds. A bank's low overall profitability could invoke risk-taking behaviors to enhance expected returns, while high operating performance might also bring about riskier behaviors because high performance can be a forceful backing. The effect of profitability on investment risk is an empirical issue.

Market interest rate (*INT*): The inter-bank offered interest rate is used as the proxy. This variable is likely to affect stock market conditions and thus equity securities investments and risks, because it is the opportunity cost of capital and is associated with capital flows in financial markets.

Stock market conditions (*SMC*): The return on the issuance volume-weighted average index of the Taiwan Stock Exchange is the proxy. This paper uses continuously compounding returns and the following equation to transfer a monthly return into a quarterly one.

$$\text{Monthly return, } R_m = \ln(I_m / I_{m-1})$$

$$\text{Quarterly return, } QR_t = \left[\prod_{m=t1}^{t3} (1 + R_m)\right] - 1$$

where R_m denotes the return on the mth month; $t1$-$t3$ is the first to the third months in quarter t.

The last control variable is the dummy variable, representing whether the sample bank has been subordinated to a financial holding company (*DFH*). The *DFH* equals 1 if the sample bank was subordinated to a holding company, 0 otherwise. A bank under command of a holding company may enjoy more abundant capital and human resources than one not subordinated to a holding company, and thus conduct dissimilar risk-taking behaviors.

Other, Taiwan's banks can be categorized as state-owned (SOB) or privately-owned (POB). The SOBs are often not independent investors because they are strongly controlled by the government and substantially influenced by the government policies. Thus, it is worthy of further examining whether banks with different ownership attributes present distinct risk-taking behaviors in investment decisions.[7] However, when using panel data and considering the fixed or random effect, it does not

[7] The author expresses his appreciation for this helpful comment from an anonymous referee.

allow of incorporating the dummy variable indicating bank ownership attribute due to multicollinearity. Hence, this paper examines the effect of bank attribute on risk-taking behavior by separately performing regression analyses with two subsamples of SOB and POB.

5.4 Empirical Results

First, whether there is serious collinearity between control variables (excluded dummy variables) in Eq. (6) is examined using both correlation coefficient matrix and variance inflation factor (VIF). The correlation coefficients in Table 3 indicate that these control variables have no collinearities. Also, since the VIFs in Panel B of Table 3 are all greatly less than ten (the critical value exhibiting collinearity), the collinearities between control variables do not exist clearly.

The estimation results of Eq. (6) are displayed in Table 4. All three regression analyses incorporate cross-sectional fixed effects because both the *F*- and Hausman tests (using χ^2 statistics) significantly reject their null hypotheses. In these three models, most of the coefficients of the three dummy variables that represent four groups that rely on ROI_{t-1} are significantly positive except for the last two models' DNH_t. From these, however, we can only determine intercept differences, rather than the risk magnitude discrepancies between G_0 and other groups, because the slopes across groups might diverge.

The coefficients of $DP_t{\times}ROI_{t-1}$ are significantly positive (0.01) in both the return volatility and *VaR* models, but not in the equity ratio model. This reveals that the return volatility risks and downside (loss) risks will rise when the preceding investment returns boost, consistent with the expectation of hypothesis 2 , whereas the equity investment ratio changes insignificantly with increasing prior returns. The coefficients of $DNH_t \times ROI_{t-1}$ are significantly negative in both the return volatility and *VaR*

Table 3 Collinearity Examination

Panel A: Correlation Coefficients	$\log(ULI)_t$	ΔAOS_t	LIQ_t	LMD_t	ROE_t	INT_t	SMC_t
ΔAOS_t	0.08						
LIQ_t	−0.31	0.00					
LMD_t	0.03	0.00	−0.01				
ROE_t	−0.04	0.05	0.09	−0.02			
INT_t	−0.21	−0.08	−0.02	−0.06	0.12		
SMC_t	−0.02	0.06	0.01	0.01	0.02	−0.09	1.00
Panel B: Variance Inflation Factor							
Y_1: Equity investment ratio	1.17	1.02	1.12	1.00	0.03	1.09	1.02
Y_2: log(Volatility)	1.22	--	1.14	1.01	1.07	1.10	1.01

Note: In panel B, VIFs under Y_3 (log(*VaR*)) are missed because they are the same as those under Y_2.

models (-0.38 and -0.21, respectively), but insignificantly positive in the equity ratio model, which is not consistent with the expectation of hypothesis 4. That is, when prior losses are small (belonging to sub-group G_{NH}), subsequent investment risks decline with decreasing losses (revealing a loss-averse behavior), while the equity ratio does not alter significantly. As for $DNL_t \times ROI_{t-1}$, the coefficients are very significant with negative value in the three risk models, which coincides with the prediction of hypothesis 5. The coefficient is -0.85 (-0.02; -0.01) in the equity ratio (the return volatility; *VaR*) model, indicating that if prior losses are large (belonging to G_{NL}) and rise 1% (1%; NT$1), then the equity investment ratio (the volatility; *VaR*) will increases 0.85% ($e^{0.02}$ %, or about 1.02%; $e^{0.01}$, or about NT$1,010).

According to the analyses above and the lower correlation coefficients between the equity ratio and the other two measures (see the last paragraph in section 5), and since return volatility and value at risk are typically and widely employed as risk measures, the equity ratio seems not to be an adequate measure for investment risks. Thus, the equity ratio could be only used as a rudimentary and ex ante criterion in risk management mechanism for banks. Thus, it is necessary for financial institutions to incorporate other dimensions for risk management, such as risk diversification, conflict avoiding or delivery of interest, and so on.

In turn, the house-money and break-even effect hypotheses are tested. The results are reported in Panel B of Table 4 and qualitatively the same across three risk models. $\beta_1 + \beta_4 \times \overline{ROI}_{t-1}^{+}$ is positive significantly at the 1% level and conforms to the prediction of the house-money effect (hypothesis 1); that is, prior high performance triggers risk-seeking behaviors to follow, relative to the behaviors of the zero-return group. This is consistent with the findings of the most past literature, such as Malmendier and Tate (2005) and Liu *et al.* (2006), focusing on specialists' behaviors, as well as Battalio *et al.* (1990), Gertner (1993), and Ackert *et al.* (2003), focusing on behaviors of general people, though they all do not use firms (banks) as a sample.

Moreover, $\beta_2 + \beta_5 \times \overline{ROI}_{t-1}^{H-}$ is significantly positive, in line with the break-even effect expectation (hypothesis 3), revealing that prior relatively small losses cause subsequent greater risk-taking behaviors, as compared with the behavior of the zero-return group. This is similar to the findings of Coval and Shumway (2005), and Weber and Zuchel (2005). The $\beta_3 + \beta_6 \times \overline{ROI}_{t-1}^{L-}$ is also considerably positive and larger than $\beta_1 + \beta_4 \times \overline{ROI}_{t-1}^{+}$ and $\beta_2 + \beta_5 \times \overline{ROI}_{t-1}^{H-}$, as well as ($\beta_2 + \beta_5 \times \overline{ROI}_{t-1}^{H-}$)+($\beta_3 + \beta_6 \times \overline{ROI}_{t-1}^{L-}$) is significantly positive and larger than $\beta_1 + \beta_4 \times \overline{ROI}_{t-1}^{+}$, which points out that the combined negative-return group takes greater risks than that of the zero-return and positive-return groups, and that the sample banks are much more risk-seeking as prior losses increase. These results imply that there is a dynamic loss-averse behavior for sample banks

Table 4 Regression Analysis of Risk Measures

	Equity investment ratio (%)	log(Volatility) (%)	log(VaR) (in thousands of Taiwan dollars)
Panel A: Parameter estimations			
Overall average intercept	−5.22	−0.66	1.28
	(−0.32)	(−0.51)	(1.11)
β_1: DP_t	6.07	0.48	0.33
	(4.87)***	(4.52)***	(3.45)***
β_2: DNH_t	7.02	0.27	0.17
	(2.84)***	(1.25)	(0.89)
β_3: DNL_t	7.39	1.09	0.83
	(2.52)**	(5.10)***	(4.44)***
β_4: $DP_t \times ROI_{t-1}$ (%)	−0.01	0.01	0.01
	(−0.33)	(4.03)***	(2.46)**
β_5: $DNH_t \times ROI_{t-1}$ (%)	0.75	−0.38	−0.21
	(0.41)	(−2.25)**	(−1.65)*
β_6: $DNL_t \times ROI_{t-1}$ (%)	−0.85	−0.02	−0.01
	(−2.72)**	(−2.90)***	(−2.32)**
log(ULI)$_t$	0.58	0.03	0.11
	(0.60)	(0.38)	(1.56)
ΔAOS_t	$<$ −0.01		
	(−12.30)***		
LIQ_t (%)	$<$ −0.01	$<$ −0.01	$<$ 0.01
	(−2.56)**	(−0.49)	(0.48)
LMD_t (%)	$<$ −0.01	$<$ −0.01	$<$ −0.01
	(−0.41)	(−0.29)	(−0.53)
ROE_t (%)	−0.11	$<$ 0.01	$<$ 0.01
	(−3.51)***	(0.52)	(0.86)
INT_t (%)	−0.63	0.02	0.02
	(−3.50)***	(1.26)	(1.52)
SMC_t (%)	−0.03	$<$ 0.01	$<$ 0.01
	(−1.50)	(0.02)	(0.46)
DFH_t	−0.73	0.12	0.28
	(−0.57)	(1.05)	(2.83)***
Panel B: Wald test – Both effect hypotheses' tests			
(1) $\beta_1+\beta_4\times \overline{ROI}^{+}_{t-1}$	6.02	0.54	0.38
	(23.63)***	(25.32)***	(14.05)***
(2) $\beta_2+\beta_5\times \overline{ROI}^{H-}_{t-1}$	6.47	0.54	0.32
	(9.09)***	(8.07)***	(3.63)*
(3) $\beta_3+\beta_6\times \overline{ROI}^{L-}_{t-1}$	12.30	1.31	0.96
	(26.56)***	(41.56)***	(30.37)***
(2)+(3)	18.77	1.85	1.27
	(25.43)***	(32.81)***	(20.99)***
(1)−(2)−(3)	−12.75	−1.31	−0.89
	(16.63)***	(22.97)***	(15.49)***
Bank-fixed effect test: F value	3.49***	2.91***	3.11***
Bank-random effect test: χ^2	112.88***	96.24***	100.32***
Model type	Fixed	Fixed	Fixed
Number of bank	36	36	36
Observations	1385	1508	1508
Adjusted R^2	0.65	0.83	0.81

Notes. All variable symbols and their definitions can be found in Eq. (6) and Subsection 7.2. β_1, β_2, β_3, β_4, β_5, and β_6 are the coefficients of DP, DNH, DNL, $DP_t \times ROI_{t-1}$, $DNH_t \times ROI_{t-1}$, and $DNL_t \times ROI_{t-1}$, respectively. The figures in parentheses in *Panel A* are t-values and those in *Panel B* are χ^2 values, the statistics for the Wald test. The bank-random effect is tested by the Hausman test and its statistic follows a χ^2 distribution. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

because they intend to pursue break even though realized losses are increasingly large and investment risks are high, as a result. This coincides with the fifth hypothesis and the suggestions from Grinblatt and Keloharju (2001), O'Connell and Teo (2004) and Coval and Shumway (2005) that investors are loss-averse. To explore the cause of this risk-seeking behavior, this study conjectures that the sample banks' decision-makers tend to be over-optimistic and overconfident and, therefore, overestimate the likelihood of break even, even if their preceding losses are relatively large. To test this, I further investigate the structure of the prior losses. The finding is that there are quarterly successive losses of 22 phases (evidently, 22 quarterly losses are followed by gains) across 15 banks out of 24 banks that experience losses during the sample period, where 49 quarters with losses are continuous in time. This means that these 49 quarters are followed by losses instead of break-even conditions. In addition, 19 quarters with losses occur singly, i.e., they are not in the shape of consecutive quarters. Consequently, for more than half of the observations of losses, or about 54% (49 over (22+19+49)), it is the cases that subsequent investments are lost, for more than half of the sample banks. The conjecture concerning bank over-optimism and overconfidence can thus be supported by the replenishing empirical examination.

Although several past studies, such as Coval and Shumway (2005), and Weber and Zuchel (2005), do not explicitly analyze the break-even effect, their results are somewhat similar to this paper's finding. Both Coval and Shumway (2005) and Weber and Zuchel (2005) claim that decision-makers are more risk-inclined following prior losses than following prior gains. This paper roughly recognizes that extant findings seemingly support the break-even effect because risk-seeking behaviors are likely derived from decision-makers' cognizance that the opportunity to break even is high enough. Yet, if it is assured that risk-seeking following prior losses is greater than that following prior near-zero returns in prior studies, then the break-even effect can be more reliably supported, as this paper contends.

Furthermore, investment risks have greater sensitivity to $DNH_t \times ROI_{t-1}$ (see β_5) than to $DNL_t \times ROI_{t-1}$ (see β_6), implying a nonlinear relationship exists between risks and prior losses. That is, as prior losses are relatively small, the greater the losses are, the riskier investments banks make; but as prior losses are relatively large, increases in risks gradually drop as losses boost. This also reveals that the sample banks' overconfidence biases expand first, and then shrink gradually with increases in prior losses.

As to the control variable effects, the upper limit of short-term equity investments (log(ULI)) has no significant impact on investment risks. A potential explanation is that, for most sample banks, there is a relatively large gap between short-term equity investments and their upper limit amounts. For example, the ratio of short-term equity investments to the amounts of equity book values, minus long-term equity investments, has a mean of 9.3%, standard deviation of 7.9%, and range of 0-23.6%.

The coefficient of quarterly change in amounts of other short-term securities investments (ΔAOS) is negative, significant at the 1% level, and identical to the expectation. Its size is tiny because the magnitude of ΔAOS (1,264.02, expressed in thousands of Taiwanese dollars) is considerably large relative to the dependent variable -- the equity investment ratio. Liquidity (*LIQ*) is significantly different from zero only in the equity ratio model, but the negative coefficient is extremely small (-0.0019) and, therefore, there is no economic significance.

With regard to profitability, both the net yields between loans and deposits (*LMD*) and *ROE* are insignificant in the three models, except that there exists a significantly negative relation between *ROE* and equity investment ratio (with coefficient -0.11 and *t*-value -3.51). This signifies that equity investments increase when *ROE* is low, which implies that sample banks implement short-term equity investments in order to augment profits.

The coefficient of the market interest rate is significant only in the equity ratio model, -0.63 with *t*-value -3.50, indicating that sample banks' stock investment decisions are reasonable, considering the effects of the interest rate on the cost of capital and stock market conditions. Stock market conditions (*SMC*) have just a slightly negative effect (coefficient -0.03) on equity ratio because of the *t*-value -1.50 (*p*-value 0.13), which points to the fact that banks appear to increase equity investments when downward conditions of the stock market occur, which thus is a correct investment decision.

The last control variable, the dummy variable that represents whether the sample bank has been subordinated to a financial holding company (*DFH*), is significant (at the 1% level) only in the *VaR* model. This result suggests that the sample banks that are subordinated to a holding company have, on average, downside risks of 1.32 (or $e^{0.28}$) thousand dollars higher than those not subordinated to a holding company, but this amount of risk at value is tiny for banks, and thus, meaningless. In addition, there is no significant difference in both return volatility and equity ratio between the two categories of banks.

As to the difference in risk-taking between banks with distinct ownership natures, Table 5 shows results of regressions using sample sorted into privately- and state-owned banks. To perform the Wald test for testing both effect hypotheses, the respective mean $ROI_{t\text{-}1}$ of banks with different ownerships must be calculated. The results are that for the equity investment ratio model, the mean $\overline{ROI}^{+}_{t-1}$, $\overline{ROI}^{H-}_{t-1}$ and $\overline{ROI}^{H+}_{t-1}$ are 5.57%, -0.77% and -NT$6.87 thousands (2.79%, -0.12% and -NT$0.82 thousands) separately, while for the other two models those are 5.56%, -0.77% and -NT$14.51 thousands (2.82%, -0.12% and -NT$0.82 thousands) separately, for POBs (SOBs). From this we can see that POBs have larger both average investment gains and losses than SOBs do.

Table 5 Regression Analysis of Risk Measures

	Equity investment ratio (%)		log(Volatility) (%)		log(*VaR*) (in thousands of Taiwan dollars)	
	Privately-owned	State-owned	Privately-owned	State-owned	Privately-owned	State-owned
Panel A: Parameter estimations						
Average intercept	−7.20	−9.94	−1.64	0.67	0.45	0.35
	(−0.42)	(−0.20)	(−1.04)	(0.57)	(1.33)	(0.29)
β_1: DP_t	3.87	9.09	0.60	0.05	0.38	0.10
	(2.84)***	(2.97)***	(4.43)***	(0.36)	(3.19)***	(0.68)
β_2: DNH_t	6.53	10.98	0.44	−0.81	0.26	−0.48
	(2.58)**	(0.77)	(1.65)*	(−1.24)	(1.15)	(−0.73)
β_3: DNL_t	4.75	5.80	1.26	−0.37	0.91	−0.34
	(1.44)	(0.61)	(4.86)***	(−0.70)	(4.10)***	(−0.64)
β_4: $DP_t \times ROI_{t-1}$ (%)	−0.02	0.62	0.01	0.06	0.01	0.04
	(−0.80)	(1.60)	(4.03)***	(3.08)***	(2.71)***	(2.33)**
β_5: $DNH_t \times ROI_{t-1}$ (%)	1.29	101.60	−0.37	−5.27	−0.19	−3.36
	(0.73)	(1.05)	(−1.96)**	(−1.10)	(−1.21)*	(−0.70)
β_6: $DNL_t \times ROI_{t-1}$ (%)	−0.85	−6.38	−0.02	−1.16	−0.01	−1.18
	(−2.66)***	(−0.73)	(−2.51)**	(−2.35)**	(−2.01)**	(−2.34)**
log(ULI)$_t$	0.74	0.18	0.10	−0.06	0.19	0.42
	(0.73)	(0.06)	(1.04)	(−0.80)	(2.27)**	(0.56)
ΔAOS_t	< −0.01	< −0.01				
	(−5.51)***	(−8.88)***				
LIQ_t (%)	< −0.01	0.01	< −0.01	< 0.01	< 0.01	< 0.01
	(−2.61)**	(0.83)	(−0.64)	(1.06)	(0.17)	(1.23)
LMD_t (%)	< −0.01	3.67	< −0.01	−0.05	< −0.01	−0.05
	(−0.39)	(2.32)**	(−0.47)	(−0.94)	(−0.68)	(−0.97)
ROE_t (%)	−0.08	−0.15	< −0.01	< 0.01	< 0.01	< 0.01
	(−2.25)**	(−1.86)*	(−0.12)	(0.38)	(0.08)	(0.84)
INT_t (%)	−0.43	−2.17	< −0.01	0.03	< 0.01	0.03
	(−2.25)**	(−3.66)***	(−0.03)	(1.21)	(0.13)	(1.14)
SMC_t (%)	−0.02	−0.07	< −0.01	< −0.01	< 0.01	< 0.01
	(−1.14)	(−1.41)	(−0.22)	(−0.16)	(0.25)	(0.06)
DFH_t	−0.88	−2.61	−0.03	0.21	0.13	0.28
	(−0.63)	(−0.85)	(−0.18)	(1.70)*	(1.09)	(2.14)**
Panel B: Wald test –Both effect hypotheses' tests						
(1) $\beta_1+\beta_4\times \overline{ROI}^{+}_{t-1}$	3.75	10.81	0.67	0.22	0.42	0.23
	(7.62)***	(13.08)***	(24.37)***	(2.63)*	(12.40)***	(2.64)*
(2) $\beta_2+\beta_5\times \overline{ROI}^{H-}_{t-1}$	5.53	−1.21	0.72	−0.23	0.41	−0.11
	(6.40)**	(0.02)	(10.06)***	(0.41)	(4.44)**	(0.10)
(3) $\beta_3+\beta_6\times \overline{ROI}^{L-}_{t-1}$	10.55	11.03	1.50	0.58	1.08	0.62
	(17.01)***	(3.32)*	(37.69)***	(3.16)*	(26.32)***	(3.51)*
(2) + (3)	16.09	9.82	2.22	0.36	1.49	0.51
	(16.69)***	(0.78)	(32.03)***	(0.46)	(19.43)***	(0.92)
(1)−(2)−(3)	−12.34	0.99	−1.55	−0.13	−0.44	−0.29
	(14.39)***	(0.01)	(22.68)***	(0.08)	(12.57)**	(0.35)
Bank-fixed effect test: *F* value	3.41***	4.65***	3.60***	0.64	3.90***	0.75
Bank-random effect test: χ^2 value	85.77***	--	92.19***	--	98.34***	--
Model type	Fixed	No effect	Fixed	No effect	Fixed	No effect
Number of bank	27	9	27	9	27	9
Observations	1087	298	1110	398	1110	398
Adjusted R^2	0.67	0.61	0.82	0.81	0.81	0.81

Notes. All variable symbols and their definitions can be found in Eq. (6) and Subsection 7.2. β_1, β_2, β_3, β_4, β_5, and β_6 are the coefficients of *DP*, *DNH*, *DNL*, $DP_t \times ROI_{t-1}$, $DNH_t \times ROI_{t-1}$, and $DNL_t \times ROI_{t-1}$, respectively. The figures in parentheses in *Panel A* are *t*-values and those in *Panel B* are χ^2 values, the statistics for the Wald test. Bank-random effect is tested by the Hausman test and its statistic follows a χ^2 distribution. When the bank number is less than the independent variable number, the Hausman statistic can not been computed. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively.

The regression results indicate that risk-taking behaviors the two effect hypotheses describe which are found in Table 4 tend to be POBs' behaviors. According to the Wald test results, the SOBs are not significantly risk-taking when their prior losses are small, but they are still risk-seeking with prior both gains and large losses, and the degree of risk taking is weaker than that of the POBs. Further, relying on the estimates of β_4 through β_6, for SOBs, risk taking is immunized to changes in prior small losses, while the sensitivity of risk taking to changes in prior gains and large losses is higher than that of POBs. This seems to imply that though SOBs' short-run total investment risks are smaller, their behavioral bias is more significant or specialty is more deficient than POBs.

6. Conclusions

This paper investigates the behaviors of short-term securities investments of Taiwanese banks to test the house-money and break-even effects as mentioned by Thaler and Johnson (1990). Data for the present study is collected from financial statements of 36 banks, for each quarter from 1994 to 2006. This paper uses three separate measures to assess investment risks: volatility of returns, value at risk, and ratio of equity securities investments. Although the last one seems not to be a suitable measure for investment risks and there are dissimilar drivers relative to the first two measures, the test results for the hypotheses are qualitatively the same across the three measures. Empirical evidence indicates that prior investment gains and losses have considerable influence on the sample banks' subsequent investment behaviors and risks, which are mainly correlated with returns on equity, market interest rates, and stock market conditions. Even though banks possess unique financial and investment expertise, they may still exhibit behavioral biases: prior gains cause banks to undertake risk-seeking short-term investments, which supports the house-money effect hypothesis, coinciding with most previous studies' findings. Prior losses invoke banks to be more risk-inclined than both prior gains and zero returns do, because banks might be over-optimistic and overconfident of the chance to break even, even though their losses are large-consistent with the spirit of the break-even effect. Moreover, as losses take place in the prior quarter, banks' subsequent risk-taking investments imply that they display dynamic loss-averse behavior. Also, the larger the preceding gains, the greater the return volatility risks and downside (loss) risks. The larger the prior losses, the greater the subsequent risks and equity investment ratio, but the sensitivity of the risks to the prior small losses is higher than that of prior larger losses. Other, this paper finds that the aforementioned conclusion is more applicable to privately-owned banks than to state-owned ones. SOBs tend to be risk-averse in facing prior small losses and take lower risks than POBs do in condition of prior gains and large losses, but SOBs have higher sensitivity of risk taking to changes in prior gains and large losses than POBs have.

Numerous prior papers find that individual investors' attitudes toward risk are affected by their prior performance, and professional managers and investors also present irrational behavioral biases. Also, corporate decision-makers are individuals after all, and thus, may behave irrationally. This paper demonstrates that banks' short-run investments emerge behavioral biases, i.e., investment decisions are influenced by prior performance. This means decision-makers fail to rationally evaluate the trade-off between risks and returns, so the behaviors will likely be excessively risk-taking or conservative, and thus unfavorable to the bank's value. Therefore, it is important for banks to enhance risk assessment and management techniques, set up and feasibly perform internal control systems, and avoid making decisions by a single person, in order to safeguard the rights and interests of its depositors, creditors, and shareholders.[8]

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[8] The author expresses his appreciation for this helpful comment from an anonymous referee.

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