On the Concentration of Mutual Fund Portfolio Holdings - Skills or Overconfidence?

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Abstract

This paper tests the alternative hypotheses of investment selection skills versus overconfidence of fund managers among equity mutual funds in Taiwan. We find a positive relation between fund holdings' concentration level and risk-adjusted fund performance in the bull market, but a negative relation in the bear markets. The time varying concentration-performance relation is not driven by the fund size. The finding implies that fund managers have superior investment selection skills when the market is less volatile, but they exhibit overconfidence when the market is in turmoil. Investment advice that follows from these findings are that mutual fund investors should choose concentrated funds in bull markets, and shift their investment to more broadly diversified funds in bear markets.

Keywords: Mutual fund holdings concentration; Risk-adjusted fund performance; Information ability; Overconfidence; Taiwan market

EMF classifications: 380; 530; 720

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1 Introduction

The principles of modern portfolio theory suggests that investors should widely diversify their holdings to reduce idiosyncratic risks. In the last two decades, a large body of empirical evidence has shown that investors diversify their portfolio holdings much less than is recommended by normative models of portfolio choice (Barberis and Thaler, 2003). One of the phenomena of under-diversification is that mutual fund managers concentrate their fund holdings in a relatively small number of stocks. In this paper, we investigate the relation between the concentration of fund holdings and risk-adjusted performance of Taiwan equity mutual funds, and test the causes of this concentrated investment strategy - investment selection skills and overconfidence hypotheses. The investment selection skills hypothesis implies a positive relation between the concentration level of fund holdings and the risk-adjusted fund performance, that fund managers' competent investment ability leads to good stock selection and hence high risk-adjusted returns. A negative relation between the concentration level of fund holdings and risk-adjusted fund performance supports the overconfidence hypothesis. As fund managers exhibit overconfidence in stock-picking, they underestimate the risk of their favorite stocks and take big bets on them, leading to low risk-adjusted returns.

Markowitz (1952), the founder of modern portfolio theory, argues that "diversification is both observed and sensible; a rule of behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim." A large body of research supports Markowitz's argument that, on average, actively managed mutual funds do not outperform passive benchmarks[1]. However, more recently studies shed light on those mutual funds that do display outperformance. For instance, several studies have found positive performance for those funds that have local positions or industries concentration. Coval and Moskowitz (1999, 2001) show that U.S. mutual fund managers tend to hold stocks whose company headquarters are located close to their funds' headquarters. The subsequent outperformance of these funds implies that fund managers have superior information about local stocks. Kacperczyk et al. (2005) find that U.S. mutual fund managers concentrate their holdings in particular industries and subsequently perform better than diversified funds. This finding suggests that these managers might have informational advantages in those specific industries in which they invest. Baks et al. (2006) have similar findings in the concentrated mu-

[1]See Jensen (1968), Malkiel (1995), Daniel et al. (1997). For a summarized literature, see Kacperczyk et al. (2005).

tual funds in the U.S. market where overconfidence bias does not play a role in managers' investment behavior. Cohen et al. (2009) examine the performance of stocks that represent managers' "Best Ideas" - stocks, that active managers display the most conviction towards ex-ante, are overweighted the most relative to some benchmark weighting scheme. The authors find that these best-convicted stocks strongly outperform the market economically and statistically.

There are competing theoretical research models to explain why investors are willing to hold concentrated portfolios rather than broadly diversified ones. One stream of research is developed in the classical Markowitz mean-variance framework. For example, Brennan (1975) models optimal number of securities to include in a risky asset portfolio when there are fixed transaction costs in individual securities. Levy and Livingston (1995) argues that fund managers with superior information should hold a relatively concentrated portfolio. Van Nieuwerburgh and Veldkamp (2010) shows that optimal underdiversification arises due to increasing return to scale from specializing in one asset. Boyle et al (2012) argue that ambiguity aversion is ubiquitous among investors and there is a trade-off between familiarity (modeled via ambiguity aversion) and diversification. Optimal concentrated portfolios (i.e. underdiversification) occurs when investor's ambiguity aversion is high and assets are volatile, and vice versa. The common argument in these papers is that under-diversification in portfolio choice exists when investors acquire superior information as well as investment skills (i.e. confidence or competence) to process information correctly[2].

Interestingly, Keynes (1983) advocates a portfolio selection principle against Markowitz's diversification argument. He says that "The right method in investment is to put fairly large sums into enterprises which one thinks one knows something about...it is a mistake to think that one limits one's risk by spreading too much between enterprises about which one knows little and has no reason for special confidence. ...One's knowledge and experience are definitely limited and there are seldom more than two or three enterprises at any given time in which I personally feel myself entitled to put full confidence." Keynes' view suggests that investors might tilt portfolios toward their favorite stocks in which they have superior information and they can assess these pieces of information correctly. In this case, there should be a positive relation between portfolio holdings concentration and performance. This is the investment selection skills hypothesis we proposed that is consistent with

[2]Boyle et al (2012) quantify ambiguity aversion, or say confidence in asset evaluation, as the size of the confidence interval for the estimate of an asset's expected return is small relative to other assets.

the theoretical research on under-diversification described above.

However, an alternative perspective is that investors might fail to assess their stocks correctly if they are overconfident about the information and skills they possess, and therefore tilting portfolios towards their favorite stocks will lead to a poor investment return. Behavioral finance suggests an alternative hypothesis to explain a concentrated investment strategy. Traditional research in finance and economics has been based on the assumption that agents are fully-rational, self-interested, emotionless maximizers of expected utility. Behavioral finance recognizes that, in the real world, humans may have limited rationality, may not be totally self-interested or emotionless, and may suffer from psychological flaws and biases. This stream of research tends to understand the effect of these factors on financial and economic decision-making.

Overconfidence is one of the most widely documented and stable biases in humans' beliefs (Svenson, 1981). Overconfident individuals tend to overestimate their abilities (Frank, 1935) and the precision of their own knowledge (Fischhoff et al. 1977). In a financial context, this can cause investors to overestimate their own trading skills and the precision of their private information regarding security values (Puetz and Ruenzi, 2011). Experts may even be more prone to overconfidence than the general population in security markets where predictability is very low (Griffin and Tversky 1992). There are consequences of overconfidence in investment, such as investors underestimate risk or overestimate their abilities to beat the market (De Bondt et al. 2012); investors attribute success to their own skills but blame failure on bad luck (Miller and Ross, 1975, Daniel et al. 1998, 2001, Den Steen, 2002); investors trade too much based on their false beliefs about their trading skills and information precision, especially a high trading activity after previous out-performance (Odean 1999, Puetz and Ruenzi 2011).

The behavioral finance literature suggests there may be a negative relation between portfolio holdings concentration (i.e. portfolio underdiversification) and performance. If fund managers are overconfident in their acquired information and stock-picking skills, they are more willing to concentrate investment in a relatively small number of stocks that, in fact, associated with underestimated risk and/or overestimated expected returns. Hence, the risk-adjusted returns will be low. This is the overconfidence hypothesis we propose.

Existing studies on "concentrated funds" have not fully tested the investment selection skills hypothesis and the overconfidence hypothesis in different aspects of risk-return tradeoff relationship, in particular, Sharpe ratio, Jensen's alpha and appraisal ratio. These three ratios, defined in the following Section 2.2, measure different aspects of reward to portfolio risk. In

this paper, we test the two proposed alternative hypotheses in the Taiwan equity mutual fund market. We shed light on one of the consequences of overconfidence bias - mutual fund managers underestimate risk or overestimate their abilities to beat the market. Whilst "investment selection skills" based on a concentration strategy increases funds' risk-adjusted returns, an "overconfidence" based concentration strategy jeopardizes the funds' risk-adjusted returns and long-term performance. Following Baks et al. (2006), this paper employs three statistics to measure the concentration level of the funds - the Herfindahl index, normalized Herfindahl index and coefficient of variation[3].

Taiwan is an open economy where its mutual fund market was established in 1982. By the end of January 2011, the managed assets of equity mutual funds in Taiwan had reached TWD685.96 billions[4]. As an emerging market, the Taiwan equity mutual fund market has great potential for growth and is playing an important role in the global financial markets. Research on the Taiwan mutual fund market can assist domestic and international investors to form a better understanding of the market and therefore investment decisions. Our sample contains 173 Taiwan-based mutual funds with returns data on a quarterly time series basis spanning 2001 to 2012.

The panel data analyses show a positive relation between funds' concentration level and risk-adjusted performance during the bull market of 2003Q1 - 2007Q2, but a negative relation during the bear markets of 2001Q2 - 2002Q4 and 2007Q3 - 2012Q2. Furthermore, the risk-adjusted performance of the portfolios sorted by size and concentration level of the funds confirms that the time varying concentration-performance relation is not driven by fund size. This finding implies that fund managers have competent investment abilities in acquiring and assessing superior information when the market is growing, but they exhibit overconfidence when the market is falling. The investment advice that follows from our results is that mutual fund investors should choose more concentrated equity mutual funds in bull markets, and shift their investment to more broadly diversified equity mutual funds (e.g. index funds) in bear markets.

Our paper relates to the literature on information advantage in portfolio selection. Information advantage has been offered as a potential explanation for portfolio concentration in the recent literature: Van Nieuwerburgh and Veldkamp's (2010), and Van Nieuwerburgh and Veldkamp (2006, 2009) studies on the bias toward investing in own-company stock and the "home-bias" puzzle. Empirical evidence on the information advantage explanation

[3]See Section 2.1 for definitions.

[4]TWD is the abbreviation of the local currency of Taiwan.

is mixed. For instance, whereas Ivkovic and Weisbenner (2005) and Massa and Simonov (2006) find some support for this explanation, Calvet et al. (2007) and Goetzman and Kumar (2008) do not.

This paper also relates to the literature on determinants and consequences of overconfidence in security trading. Existing studies use a variety of different proxies to measure investors' overconfidence bias. Odean (1999) manifests overconfidence among individual investors through excessive trading and under-diversified portfolios. Puetz and Ruenzi (2011) find that equity fund managers trade more after good past performance. Menkhoff et al. (2006) indicate that unsophisticated fund managers tend to take higher risk which may be explained by a higher level of overconfidence. Ekholm and Pasternack (2008) find that overconfidence decreases with investor size. O'Connell and Teo (2009) examine the trading behavior of institutional currency traders and find that they increase risk-taking following gains. They show that this can also be explained by overconfidence. In a corporate finance context, overconfident CEOs tend to overestimate future cash flow of investment projects, or pay more for mergers and acquisitions, resulting in negative revenues of the firms (Malmendier and Tate 2006, Bruner 2004).

The remainder of this paper is organized as follows. In Section 2 we define the concentration indices and fund performance measures, and specify the panel data regression models that allow us to examine the concentration-performance relation of equity mutual funds. Section 3 presents the data and summary statistics. Section 4 reports whole and sub-period sample regression results, and the construction of the size portfolios and their risk-adjusted performance in the three sub-period samples. Section 5 concludes the paper, briefly summarising our findings and providing investment recommendations.

2 Methods

2.1 Concentration Indices

Our paper assesses the extent to which mutual fund managers in Taiwan hold under-diversified or concentrated portfolios. Following Bakes et al. (2006), we use three statistics to measure funds' concentration level - the Herfindahl index, normalized Herfindahl index and coefficient of variation. These statistics have been used in other contexts to measure the extent to which a sample's constitution diverges from an equal weighting.

The Herfindahl index (also known as Herfindahl–Hirschman Index) is a measure of the size of firms in relation to the industry and, is widely applied in competition law, antitrust and technology management. For a given fund,

the Herfindahl index is the sum of the squared portfolio weights:

$$H_p = \sum_{i=1}^{N_p} w_{pi}^2 \tag{1}$$

where fund p has N equity holdings each of weight w_i, with $\sum w_i = 1$. The weight, w_i, is the ratio of the total market value of the holding i to the total market value of the fund p. The Herfindahl index ranges from $1/N$ to 1. It's obvious that the value of the index varies with N, the number of stock holdings of the fund.

The normalized Herfindahl index is defined as

$$H_p^* = \frac{H_p - \frac{1}{N_p}}{1 - \frac{1}{N_p}} \tag{2}$$

where the normalized Herfindahl index, H_p^*, is invariant to the number of stock holdings and ranges from 0 to 1.

The coefficient of variation (CV) is defined as

$$CV_p = \frac{\sigma(w_{pi})}{\mu(w_{pi})} \tag{3}$$

where $\sigma(w_{pi})$ is the standard deviation of the portfolio weights across all stock holdings; $\mu(w_{pi})$ is the mean of the portfolio weights across all stock holdings. This index is widely used in investment to determine the volatility (risk) in comparison to the amount of return.

In a portfolio selection context, these three statistics measure the concentration level of the fund holdings - a greater value of the statistic reflects that fund holdings are more concentrated in a relatively small number of stocks. There are differences among the three statistics: the Herfindahl index accounts for a fund's total number of stock holdings and hence produces higher values or ranking for funds with fewer holding relative to the normalized Herfindahl index; the coefficient of variation is mathematically related to the normalized Herfindahl index according to $H_p^* = CV_p^2/(N_p - 1)$. The extent to which the different statistics produce similar inference provides some indication of the robustness of the results.

2.2 Fund Performance Measures

To test the performance of concentrated mutual funds, we examine the relation between funds' concentration indices and risk-adjusted performance.

In this section, we define excess return, Sharpe ratio, Jensen's alpha and appraisal ratio that are used to evaluate fund performance.

Fund p's excess return is fund p's quarterly return subtracted by Taiwan 3-month fixed deposit interest rate:

$$\text{Excess return} = R_p - R_f \tag{4}$$

where R_p is fund's quarterly return and R_f is the Taiwan 3-month fixed deposit interest rate. This measure does not take into account the risk embedded in the fund because fund managers can simply pick risky stocks and receive high returns in the short term by luck (or low returns or losses if unlucky).

Sharpe ratio, SR, is a widely used risk-adjusted return measure and is defined as

$$SR_p = \frac{R_p - R_f}{\sigma_p} \tag{5}$$

where σ_p is the standard deviation of the fund p's quarterly excess return. This measure indicates the percentage excess return rewarded for bearing 1% unit of risk embedded in the fund. In other words, a fund has riskier stock holdings will have low Sharpe ratio even it yields relatively high excess return in the short term.

Jensen's alpha is used to determine the abnormal return of portfolio over the theoretical expected return, such as the Capital Asset Pricing Model (CAPM) return:

$$alpha_p = (R_p - R_f) - \widehat{\beta}_p(R_m - R_f) \tag{6}$$

where R_m is the market portfolio return and $\widehat{\beta}$ is the estimated market beta of the fund. In our sample, the time series used to estimate funds' market betas have a number of quarterly observations from 6 to 46. The majority of the funds have more than 40 quarterly observations in the sample. Jensen's alpha was first used by Michael Jensen in 1968 to evaluate mutual fund manager performance. The expected returns generated by CAPM is supposed to be "risk-adjusted" because it accounts for the relative riskiness of the asset. Riskier assets have higher expected returns than less risky assets. A portfolio that has "positive alpha" (abnormal return) over the long-term means the portfolio outperforms the market with a return higher than the "risk-adjusted" return and, its success is not due to temporary luck. Investors constantly seek investments that have higher alpha.

The appraisal ratio is defined as

$$APP_P = alpha_p/\sigma_{\epsilon_p} \tag{7}$$

where σ_{ϵ_p} is the standard deviation of the residuals from the same regression estimating market beta, $\widehat{\beta}$, in equation (6). The appraisal ratio was proposed by Treynor and Black (1973) to account for possible differences in idiosyncratic risk exposure. Fund managers attempt to hedge against a portfolio's idiosyncratic risk by picking a basket of stocks. A high appraisal ratio means that the managers did a good job at picking which stocks to hold.

By and large, a fund manager who achieves a high return may have simply taken a risk and been lucky. The same fund manager may just as likely crash and burn in the future. To tackle this problem, Sharpe ratio, Jensen's alpha and appraisal ratio put returns in the context of how risky the investments have been. The three fund performance measures differ in the aspects of portfolio risk they account for. Modern portfolio theory decomposes portfolio risk into market risk and idiosyncratic risk. Sharpe ratio measures the reward per unit of the portfolio risk, including market risk and idiosyncratic risk; appraisal ratio measures the reward per unit of idiosyncratic risk of the portfolio; Jensen's alpha calculates the reward of the total idiosyncratic risk by controlling the market volatility. Whereas skillful fund managers will achieve high values of the three risk-adjusted returns, overconfident managers will be punished by low or negative values.

2.3 Panel Data Regression Models

We use panel data regression models to examine the relation between fund concentration level and performance, and subsequently test the information ability and overconfidence hypotheses. Since the Sharpe ratio measures the risk premium per unit of portfolio risk, a negative relation between funds' concentration level and the Sharpe ratio implies that fund managers exhibit an overconfidence bias. The interpretation is that fund managers are over-optimistic on their own information and investment skills. They systematically underestimate the risk and pick, in fact, high risk stocks, resulting in lower risk-adjusted returns of the funds. In contrast, a positive relation between funds' concentration level and the Sharpe ratio tells us that the big bets in stock-picking are due to fund managers' investment abilities (i.e. abilities in acquiring and assessing superior information of favorite stocks) instead of overconfidence. Since the big bets are rational, the risk-adjusted returns increase with the concentration level of the funds.

Similar inference can be drawn on Jensen's alpha. A negative relation between funds' concentration level and Jensen's alpha over the long-term

means that fund managers are overconfident in their investment abilities and, hence, weaken fund performance relative to the market portfolio. A positive relation between funds' Jensen's alpha and concentration level over the long-term implies that fund managers conduct savvy investment strategies. Funds' risk-adjusted performance is improved with the concentration level relative to the benchmark market portfolio. By taking into account idiosyncratic risk exposure, a negative relation between funds' concentration level and appraisal ratio implies that fund managers overestimate expected returns of favorite stocks and/or underestimate idiosyncratic risk of the fund, and vice versa. In summary, a positive relation between funds' concentration level and the three risk-adjusted performance supports the investment selection skills hypothesis, and a negative relation supports the overconfidence hypothesis.

Existing researches indicate that there are three factors influencing mutual fund returns - fund size, fund's total costs and fees, and market risk premium. Grinblatt and Titman (1989) show that funds with smaller net asset values have a better performance. Chen et al. (2004) suggest that larger fund size reduces fund performance. Carhart (1997) argues that fund net returns are negatively correlated with expense levels, especially in actively managed funds. Wermers (2000) also documents that after considering expense and transaction costs, funds underperformed by 1.6% during 1975 to 1994 in the U.S. market. The market risk premium is widely considered as a risk factor in individual security or portfolio returns, as shown in the CAPM. By controlling for these three factors, we have the following panel data regression models:

$$\begin{aligned}(R_{pt} - R_{ft}) &= \boldsymbol{\beta}_0 + [H_{pt}, H^*_{pt}, CV_{pt}]\boldsymbol{\beta}_1 + \boldsymbol{\beta}_2(R_{mt} - R_{ft}) + \boldsymbol{\beta}_3 SIZE_{pt} \\ &\quad + \boldsymbol{\beta}_4 COST_{pt} + \mu_{pt} \end{aligned} \tag{8}$$

$$\begin{aligned}SR_{pt} &= \lambda_0 + [H_{pt}, H^*_{pt}, CV_{pt}]\lambda_1 + \lambda_2(R_{mt} - R_{ft}) + \lambda_3 SIZE_{pt} \\ &\quad + \lambda_4 COST_{pt} + \varepsilon_{pt} \end{aligned} \tag{9}$$

$$alpha_{pt} = \phi_0 + [H_{pt}, H^*_{pt}, CV_{pt}]\phi_1 + \phi_2 SIZE_{pt} + \phi_3 COST_{pt} + e_{pt} \tag{10}$$

$$APP_{pt} = \theta_0 + [H_{pt}, H^*_{pt}, CV_{pt}]\theta_1 + \theta_2 SIZE_{pt} + \theta_3 COST_{pt} + \eta_{pt} \tag{11}$$

where $SIZE_{pt}$ is the natural logarithm of fund p's net assets at quarter t, $COST_{pt}$ is the fraction of a fund's total costs and fees over its net assets. Other variables are defined in equations (1-7). The three concentration indices are included in each regression model separately.

3 Data

We extract the sample data from Taiwan Economic Journal database. Equity mutual funds that have an international focus are excluded so that the Taiwan stock market index return, TSEC, can be used as a proxy of the market risk premium. The sample includes 173 Taiwan-based equity mutual funds with between 6 to 46 quarterly observations over the period 2001:Q2 to 2012:Q2. The panel data is unbalanced, since not all mutual funds exist over the whole sample period. The average number of quarterly time serious observations of each fund is 38. Table 1 presents the summary statistics of the variables in equations (8-11). In the table, the average Jensen's alpha across funds during the sample period is 1.37, showing that the mutual funds in general outperformed the benchmark market index in the last 12 years. The average H is 0.35, slightly greater than the average H^* of 0.33. The values of H range between 0.06 and 0.92; the values of H^* range between 0.03 and 0.92. Both concentration indices are bounded between 0 and 1, consistent with their definitions.

Table 1. Summary Statistics

This table reports the summary statistics of the variables in equations (1-11).

	Obs	Mean	Std. Dev.	Min	Max
$Rp\text{-}R_f$ (%)	6577	1.88	15.09	-36.00	79.44
SR (%)	6577	0.12	0.99	-2.42	4.90
alpha	6577	1.37	6.86	-19.06	49.97
APP	6577	0.20	0.98	-2.65	5.32
H	6580	0.35	0.14	0.06	0.92
*H**	6580	0.33	0.15	0.03	0.92
CV	6580	1.88	0.48	0.54	5.17
$R_m\text{-}R_f$ (%)	6583	0.52	13.23	-30.62	42.52
SIZE	6583	13.90	0.98	9.25	16.92
COST	6583	0.30	0.14	0.01	2.76

Table 2 presents the coefficient correlation between the independent variables in equations (8-11). The correlation between H and H^*, H and CV, H^* and CV is 1, 0.64 and 0.66, respectively. The three concentration indices are all highly correlated to each other and, negatively correlated to funds' expense level, $COST$, at a low level. Higher compensation seemingly induces fund managers to undertake a more passive investment strategy.

Table 2. Correlation Structure

This table reports the correlation coefficients between the independent variables in equations (8-11).

Variables	H	H^*	CV	R_m-R_f (%)	$SIZE$
H^*	1.00				
CV	0.64	0.66			
R_m-R_f (%)	0.14	0.14	0.00		
$SIZE$	0.08	0.09	0.24	0.05	
$COST$	-0.02	-0.02	-0.12	-0.31	0.11

4 Empirical Results

In this section, we first present the panel data regression results for the whole sample period, then present the results for the sub-period samples of the bull and bear markets using the same regression models. We expect that the dot-com bubble financial crisis and the recent global financial crisis might have an impact on fund managers' investment behavior. Finally, we analyze whether the concentration-performance relation depends on the size of the funds.

4.1 Panel Data Regression Results: Whole Sample Period

The equations (8-11) are estimated by OLS with panel-correlated standard errors (PCSE). The PCSE specification adjusts for the contemporaneous correlation and heteroskedasticity among fund returns (Kacperczyk et al. 2005, Beck and Katz 1995). Table 3 reports the estimation results. The first three columns (8.a), (8.b) and (8.c) show the coefficients from the panel regression of equation (8) where the three concentration indices (H, H^* and CV) included in the regression separately. For funds' excess returns, the coefficients of the three concentration indices are positive and highly significant, where the great magnitude of the coefficients also demonstrate that the impact is strong. For instance, the coefficient of the concentration index H is 8.74, implying that an increase in H by 1 unit increases the quarterly excess return of the fund by 8.74%, or by approximately 35% on an annual basis. The coefficients of the market index return, $(R_{mt} - R_{ft})$ are at unity and highly significant in (8.a), (8.b) and (8.c). Regardless of the concentration level of

the funds, on average, all funds choose to balance the portfolios with equivalent market risk to the market index. Though the coefficients of the other two control variables, $SIZE$ and $COST$ are insignificant in the three regressions, the negative sign of these coefficients are consistent with the literature.

As we know, excess return is not a measure of risk-adjusted return. Whilst the positive relation between funds' concentration level and excess return does not tell us whether the risk is underestimated hence overconfidence bias exists among fund managers, the estimation results of equations (9-11) on risk-adjusted returns can. The columns of (9.a), (9.b) and (9.c) in Table 3 show that for the Sharpe ratio, the coefficients of the three concentration indices are positive and highly significant. For instance, the coefficient of the concentration index H is 0.54 at 1% significance level, implying that an increase of 1 unit in H increases the Sharpe ratio by 0.54% per quarter, or by approximately 2.16% on an annual basis. The coefficients of market index return are significant and the coefficients of size and cost factors are insignificant in the regressions on the Sharpe ratio. The results of the regressions on Jensen's alpha and appraisal ratio are similar to those on Sharpe ratio as showed in the columns of (10.a), (10.b), (10.c), (11.a), (11.b) and (11.c) in Table 3.

The positive relation between funds' concentration level and risk-adjusted returns indicates that fund managers exhibit good stock-picking skills. They are able to select stocks with high expected returns, in the meantime, they donot underestimate the risk (market risk and idiosyncratic risk) of the stocks. As consequences, the risk-adjusted performance - the Sharpe ratio and the appraisal ratio of the funds is high with the concentration level of portfolio holdings; the long-term performance of the funds surpassing the market index performance - Jensen's alpha also increases with concentration level. Therefore, we can say that the adoption of concentrated investment strategy by fund managers is due to fund managers' excellent investment skills but not overconfidence bias.

Table 3. Estimates of equation (8-11).

This table reports the estimates of equations (8-11) with panel-corrected standard errors (PCSE). The panel data sample includes 173 mutual fund funds and spans the period of 2001 to 2012. The dependent variables are excess return (*Rp-Rf*), Sharpe ratio (*SR*), Jensen's alpha (*alpha*) and Appraisal ratio (*APP*). Estimation results of (.a), (.b) and (.c) refer to the three concentration indices, *H*, *H** and *CV*, included in the regression models, respectively. Panel-corrected standard errors are reported in parentheses.

Dependent Variable: Quarterly Performance												
	Excess return (*Rm-Rf* %)			Sharpe ratio (*SR* %)			Jensen's alpha (*alpha*)			Appraisal ratio (*APP*)		
	(8.a)	(8.b)	(8.c)	(9.a)	(9.b)	(9.c)	(10.a)	(10.b)	(10.c)	(11.a)	(11.b)	(11.c)
Cons.	-1.22	-0.87	-0.16	-0.01	0.01	0.05	-0.61	-0.27	0.15	-0.03	0.02	0.07
	(2.86)	(2.85)	(2.9)	(0.2)	(0.2)	(0.2)	(3.02)	(3)	(3.03)	(0.45)	(0.44)	(0.44)
H	8.74	-	-	0.54	-	-	8.52	-	-	1.13	-	-
	(2.36)***	-	-	(0.15)***	-	-	(2.38)***	-	-	(0.34)***	-	-
*H**	-	8.53	-	-	0.53	-	-	8.33	-	-	1.11	-
	-	(2.31)***	-	-	(0.15)***	-	-	(2.33)***	-	-	(0.33)***	-
CV	-	-	1.57	-	-	0.1	-	-	1.59	-	-	0.21
	-	-	(0.56)***	-	-	(0.03)***	-	-	(0.56)***	-	-	(0.08)***
R_m-$R_{f\ (\%)}$	1	1	1.01	0.07	0.07	0.07	-	-	-	-	-	-
	(0.05)***	(0.05)***	(0.05)***	(0)***	(0)***	(0)***	-	-	-	-	-	-
SIZE	0	-0.01	-0.07	0	0	-0.01	-0.04	-0.05	-0.1	-0.01	-0.01	-0.02
	(0.19)	(0.19)	(0.2)	(0.01)	(0.01)	(0.01)	(0.2)	(0.2)	(0.21)	(0.03)	(0.03)	(0.03)
COST	-1.31	-1.26	-1.09	-0.11	-0.11	-0.1	-1.46	-1.41	-1.06	-0.27	-0.26	-0.22
	(1.8)	(1.8)	(1.85)	(0.12)	(0.12)	(0.12)	(1.88)	(1.88)	(1.93)	(0.26)	(0.26)	(0.27)
R-squared	0.79	0.79	0.79	0.79	0.79	0.79	0.03	0.03	0.01	0.03	0.03	0.01

***,** and * denote 1%, 5% and 10% significance level.

4.2 Panel Data Regression Results: Sub-period Samples

Taiwan is an open economy that heavily depends on exports; hence it has a high probability of being influenced by developed countries. During our sample period, there are two global financial crises affect Taiwanese economy and the stock market. One is the US stock market crash of 2000–2002 due to the dot-com bubble bursts. The other is the global financial crisis started in the middle of 2007 and is lasting till recently, involving the credit crunch, the sub-prime crisis, housing bubble issues and the collapse of Lehman Broters in the US and, the Euro debt crisis.

We investigate the relation between mutual funds' concentration level and risk-adjusted performance in bear and bull stock markets during the sample period: the bear market is the two global financial crisis periods of 2001Q2 - 2002Q4 and 2007Q3 - 2012Q2; the bull market is the period of 2003Q1 - 2007Q2. The bear and bull markets differ in the mutual fund and the overall stock market performance, where the bull market has higher and less volatile returns of the funds and stock market index than those of the bear markets. For instance, the average excess return and the Sharpe ratio in the bull market period of 2003Q1 - 2007Q2 is 5.42% and 0.36%, with volatility of 9.19% and 0.61%, respectively. These measures of fund performance are much lower and even negative in the bear market periods, where the average excess return and the Sharpe ratio in the first bear market period of 2001Q2 - 2002Q4 is 2.22% and 0.13%, with volatility of 26.52% and 9.19%, respectively; and is -0.95% and -0.06%, with volatility of 13.39% and 0.91% in the second bear market period of 2007Q3 - 2012Q2. The overall stock market performance - the market index excess return in the bull market period of 2003Q1 - 2007Q2 is 3.52% with volatility of 6.46%, but in the first and second bear market periods is -1.45% and -1.22% with volatility of 23.20% and 12.58%, respectively. Figure 1 shows that the Taiwan stock market index excess return is more volatile during the two bear market periods relative to the bull market period. Thus, it is very likely that mutual funds' concentration-performance relation may differ across different market climates.

Tables 4, 5 and 6 report the estimates of panel data regressions of equations (8-11) for the three sub-periods of bull and bear markets. Table 5 shows that during the bull market period of 2003Q1 - 2007Q2, the coefficients of the three concentration indices are positive at 1% significance level. However, Tables 4 and 6 shows that the coefficients of the three concentration indices are insignificant in the two bear market periods of 2001Q2 - 2002Q4 and

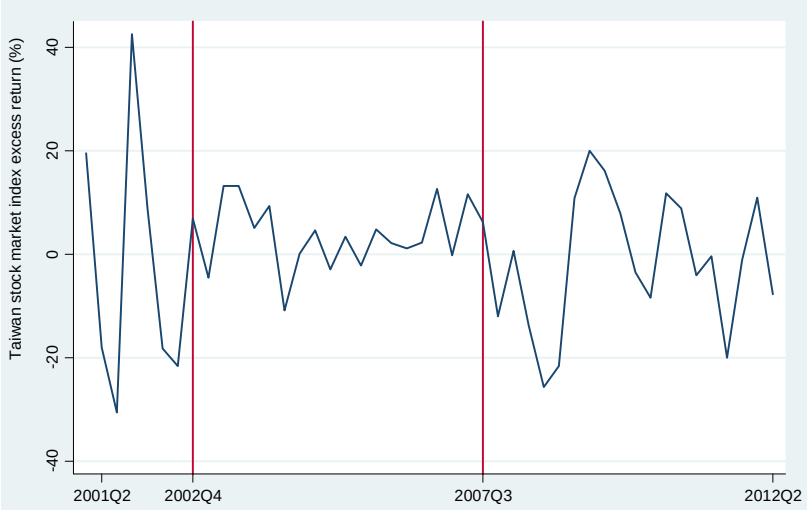

Figure 1. Taiwan stock market index excess returns over time. The two vertical lines show the end of the dot-com bubble crisis in 2002Q4 and the start of the global financial crisis in 2007Q3.

2007Q3 - 2012Q2. In the second bear market period, i.e. the global financial crisis period, the coefficients of the three concentration indices, H, $H^*$and CV, are even negative. Although the average concentration levels of the three sub-period samples are very much the same, the concentrated investment strategy in mutual fund holdings does not work during market turmoil - higher concentration level does not significantly increase risk-adjusted returns of the fund; it even reduces risk-adjusted returns of the fund in a more series global financial crisis. A possible explanation is that fund managers' judgement in stock selection is correct and savvy when market condition is good, but they are overconfident when market condition is poor with higher uncertainty. We can reject the overconfidence hypothesis in the bull market condition but cannot reject it in the bear market condition.

Table 4. Estimates of equations (8-11) for the sub-period sample from 2001Q2 to 2002Q4, i.e. the period of the dot-com bubble crisis.

This table reports the estimates of equations (8-11) with panel-corrected standard errors (PCSE). The panel data sample includes 173 mutual fund and spans the period of 2001Q2 to 2002Q4, i.e. the period of the dom.com bubble crisis. The dependent variables are excess return (*Rp-Rf*), Sharpe ratio (*SR*), Jensen's alpha (*alpha*) and Appraisal ratio (*APP*). Estimation results of (.a), (.b) and (.c) refer to the three concentration indices, *H*, *H** and *CV*, included in the regression models, respectively. Panel-corrected standard errors are reported in parentheses.

Dependent Variable: Quarterly Performance												
	Excess return (*Rm-Rf* %)			Sharpe ratio (*SR* %)			Jensen's alpha (*alpha*)			Appraisal ratio (*APP*)		
	(8.a)	(8.b)	(8.c)	(9.a)	(9.b)	(9.c)	(10.a)	(10.b)	(10.c)	(11.a)	(11.b)	(11.c)
Cons.	-3.26	-2.70	-0.57	-0.08	-0.04	0.07	-5.83	-5.28	-5.05	-0.48	-0.41	-0.39
	(9.79)	*(9.61)*	*(9.36)*	*(0.56)*	*(0.55)*	*(0.53)*	*(12.73)*	*(12.56)*	*(12.44)*	*(1.76)*	*(1.73)*	*(1.71)*
H	10.81	-	-	0.62	-	-	12.09	-	-	1.48	-	-
	(8.21)	-	-	*(0.50)*	-	-	*(8.30)*	-	-	*(1.17)*	-	-
*H**	-	10.46	-	-	0.61	-	-	11.73	-	-	1.44	-
	-	*(8.00)*	-	-	*(0.49)*	-	-	*(8.09)*	-	-	*(1.14)*	-
CV	-	-	2.18	-	-	0.15	-	-	2.29	-	-	0.29
	-	-	*(1.93)*	-	-	*(0.12)*	-	-	*(1.89)*	-	-	*(0.27)*
R_m-$R_{f\ (\%)}$	1.05	1.05	1.07	0.07	0.07	0.07	-	-	-	-	-	-
	*(0.10)****	*(0.10)****	*(0.10)****	*(0.01)****	*(0.01)****	*(0.01)****	-	-	-	-	-	-
SIZE	0.23	0.22	0.05	0.01	0.01	0.00	0.35	0.34	0.30	0.04	0.03	0.03
	(0.59)	*(0.59)*	*(0.61)*	*(0.03)*	*(0.03)*	*(0.04)*	*(0.71)*	*(0.71)*	*(0.82)*	*(0.10)*	*(0.10)*	*(0.11)*
COST	-0.88	-0.91	-1.50	-0.13	-0.13	-0.16	0.14	0.15	0.52	-0.18	-0.18	-0.13
	(3.51)	*(3.52)*	*(3.54)*	*(0.22)*	*(0.22)*	*(0.22)*	*(5.66)*	*(5.67)*	*(5.77)*	*(0.77)*	*(0.77)*	*(0.78)*
R-squared	0.88	0.88	0.88	0.89	0.89	0.88	0.04	0.04	0.02	0.03	0.03	0.01

***,** and * denote 1%, 5% and 10% significance level.

Table 5. Estimates of equations (8-11) for the sub-period sample from 2003Q1 to 2007Q2.

This table reports the estimates of equations (8-11) with panel-corrected standard errors (PCSE). The panel data sample includes 173 mutual fund and spans the period of 2003Q1 to 2007Q2, i.e. the period of the dot.com bubble crisis. The dependent variables are excess return (*Rp-Rf*), Sharpe ratio (*SR*), Jensen's alpha (*alpha*) and Appraisal ratio (*APP*). Estimation results of (.a), (.b) and (.c) refer to the three concentration indices, *H*, *H** and *CV*, included in the regression models, respectively. Panel-corrected standard errors are reported in parentheses.

Dependent Variable: Quarterly Performance												
	Excess return (*Rm-Rf* %)			Sharpe ratio (*SR* %)			Jensen's alpha (*alpha*)			Appraisal ratio (*APP*)		
	(8.a)	(8.b)	(8.c)	(9.a)	(9.b)	(9.c)	(10.a)	(10.b)	(10.c)	(11.a)	(11.b)	(11.c)
Cons.	-4.50	-3.89	-2.92	-0.10	-0.06	0.00	-2.25	-1.67	-0.85	-0.24	-0.16	-0.04
	(3.76)	*(3.72)*	*(3.71)*	*(0.27)*	*(0.27)*	*(0.27)*	*(4.33)*	*(4.28)*	*(4.31)*	*(0.60)*	*(0.59)*	*(0.59)*
H	14.01	-	-	0.89	-	-	13.14	-	-	1.83	-	-
	*(3.89)****	-	-	*(0.26)****	-	-	*(3.99)****	-	-	*(0.57)****	-	-
*H**	-	13.77	-	-	0.87	-	-	12.90	-	-	1.80	-
	-	*(3.83)****	-	-	*(0.26)****	-	-	*(3.92)****	-	-	*(0.56)****	-
CV	-	-	3.21	-	-	0.20	-	-	2.94	-	-	0.42
	-	-	*(1.10)****	-	-	*(0.07)****	-	-	*(1.14)****	-	-	*(0.16)****
R_m-$R_{f\ (\%)}$	0.90	0.90	0.91	0.06	0.06	0.06	-	-	-	-	-	-
	*(0.17)****	*(0.17)****	*(0.18)****	*(0.01)****	*(0.01)****	*(0.01)****	-	-	-	-	-	-
SIZE	0.12	0.10	-0.04	0.00	-0.01	-0.01	-0.02	-0.04	-0.15	-0.01	-0.01	-0.03
	(0.21)	*(0.21)*	*(0.24)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.24)*	*(0.25)*	*(0.26)*	*(0.03)*	*(0.03)*	*(0.04)*
COST	-1.03	-0.96	-1.22	-0.10	-0.09	-0.11	-2.00	-1.93	-2.12	-0.33	-0.32	-0.34
	(3.01)	*(3.01)*	*(3.13)*	*(0.20)*	*(0.20)*	*(0.20)*	*(3.25)*	*(3.25)*	*(3.38)*	*(0.48)*	*(0.45)*	*(0.46)*
R-squared	0.48	0.48	0.46	0.47	0.47	0.45	0.08	0.08	0.04	0.08	0.08	0.04

***,** and * denote 1%, 5% and 10% significance level.

Table 6. Estimates of equations (8-11) for the sub-period sample from 2007Q3 to 2012Q2, i.e. the period of the global financial crisis.

This table reports the estimates of equations (8-11) with panel-corrected standard errors (PCSE). The panel data sample includes 173 mutual fund and spans the period of 2007Q3 to 2012Q2, i.e. the period of the global financial crisis. The dependent variables are excess return (*Rp-Rf*), Sharpe ratio (*SR*), Jensen's alpha (*alpha*) and Appraisal ratio (*APP*). Estimation results of (.a), (.b) and (.c) refer to the three concentration indices, *H*, *H** and *CV*, included in the regression models, respectively. Panel-corrected standard errors are reported in parentheses.

Dependent Variable: Quarterly Performance												
	Excess return (*Rm-Rf* %)			Sharpe ratio (*SR* %)			Jensen's alpha (*alpha*)			Appraisal ratio (*APP*)		
	(8.a)	(8.b)	(8.c)	(9.a)	(9.b)	(9.c)	(10.a)	(10.b)	(10.c)	(11.a)	(11.b)	(11.c)
Cons.	3.58	3.57	3.29	0.18	0.18	0.16	3.69	3.68	3.38	0.49	0.49	0.45
	(3.42)	*(3.41)*	*(3.34)*	*(0.27)*	*(0.26)*	*(0.26)*	*(3.55)*	*(3.54)*	*(3.45)*	*(0.57)*	*(0.57)*	*(0.56)*
H	-0.37	-	-	-0.01	-	-	-0.34	-	-	-0.08	-	-
	(2.51)	-	-	*(0.16)*	-	-	*(2.51)*	-	-	*(0.36)*	-	-
*H**	-	-0.37	-	-	-0.01	-	-	-0.35	-	-	-0.08	-
	-	*(2.47)*	-	-	*(0.16)*	-	-	*(2.48)*	-	-	*(0.36)*	-
CV	-	-	0.38	-	-	0.03	-	-	0.41	-	-	0.05
	-	-	*(0.63)*	-	-	*(0.04)*	-	-	*(0.63)*	-	-	*(0.09)*
R_m-$R_{f\ (\%)}$	0.96	0.96	0.96	0.07	0.07	0.07	-	-	-	-	-	-
	*(0.07)****	*(0.07)****	*(0.07)****	*(0.00)****	*(0.00)****	*(0.00)****	-	-	-	-	-	-
SIZE	-0.14	-0.13	-0.17	-0.01	-0.01	-0.01	-0.14	-0.14	-0.19	-0.02	-0.02	-0.02
	(0.22)	*(0.22)*	*(0.23)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.23)*	*(0.23)*	*(0.24)*	*(0.04)*	*(0.04)*	*(0.04)*
COST	-4.78	-4.78	-4.70	-0.29	-0.29	-0.29	-4.67	-4.67	-4.58	-0.67	-0.67	-0.66
	*(1.77)****	*(1.77)****	*(1.76)****	*(0.12)****	*(0.12)****	*(0.12)****	*(1.80)****	*(1.79)****	*(1.78)****	*(0.26)****	*(0.26)****	*(0.26)****
R-squared	0.82	0.82	0.82	0.81	0.81	0.81	0.01	0.01	0.01	0.01	0.01	0.01

***,** and * denote 1%, 5% and 10% significance level.

4.3 Size Portfolios

To further analyze whether the relation of mutual funds' concentration level and risk-adjusted performance depends on fund size, we segregate the mutual funds into different size portfolios and compare the risk-adjusted returns between high and low concentrated portfolios within each size portfolios. Similar to Section 4.2, we analyze the three sub-periods of bull and bear markets to account for the financial crisis effect. We first sort the mutual funds into five equally sized portfolios according to the lagged net assets of the mutual funds. The mutual funds in each of these five portfolios are further divided into two groups according to the three concentration indices of H, H* and CV, respectively. The portfolios are rebalanced quarterly and, their risk-adjusted returns - Sharpe Ratio, Jensen's alpha and appraisal ratio are expressed at a quarterly frequency.

Table 8 presents the risk-adjusted returns of the size portfolios in the bull market in 2003Q1 - 2007Q2. Tables 7 and 9 present the risk-adjusted returns of the size portfolios in the bear markets in 2001Q2 - 2002Q4 and 2007Q3 - 2012Q2. In all the three sub-periods, we observe that mutual fund risk-adjusted returns measured by the Sharpe ratio, the Jensen's alpha and the appraisal ratio generally decrease as portfolio size increases, regardless of different concentration measures. This is consistent with Grinblatt and Titman (1989) and Chen et al. (2004) that small size funds outperform large funds. We also observe that, in most of the cases, the differences in risk-adjusted returns between high and low concentrated portfolios within the size quintiles is positive in Table 8 where a bull market presents, but it is negative in Tables 7 and 9 where a bear market presents. Specifically, in the bull market of 2003Q1 - 2007Q2 (Table 8), the Sharpe ratio, Jensens' alpha and appraisal ratio of mutual funds in the largest size quintile associated with high concentration index H exceed those in the same size quintile associated with low H index by 0.08, 1.03 and 0.12, respectively. However, the values of the risk-adjusted returns in the first bear market of 2001Q2 - 2002Q4 (Table 7) are -0.06, -1.34 and -0.20, respectively; and is 0.01, 0.10 and 0.03 in the second bear market of 2007Q3 - 2012Q2 (Table 9). Although mutual fund risk-adjusted returns have a pattern of going down against the size quintiles in both bull and bear markets, the concentration-performance relation varies: high concentration level leads to high risk-adjusted performance during bull markets but low risk-adjusted performance during bear markets. This confirms that our finding in Section 4.2 is not driven by size effect.

Table 7. Size Portfolios for the sub-period sample from 2001Q2 to 2002Q4, i.e. the period of the dot-com bubble crisis.

This table reports the risk-adjusted performance of portfolios sorted by mutual funds' size and concentration indices from the period of 2001Q2 to 2002Q4. Mutual funds are sorted into five equally sized portfolios according to the lagged net assets of the mutual funds, where Quintile 1 and 5 refer to the smallest and largest size portfolio, respectively. The mutual funds in each of these five portfolios are further divided into two groups according to their associated concentration indices of H,
H* and CV, respectively. The portfolios are rebalanced quarterly and, their risk-adjusted return - Sharpe ratio (SR), Jensen's alpha (alpha) and appraisal ratio (APP) are expressed at a quarterly frequency. The t-statistics of the difference in risk-adjusted returns between the high and low concentration index portfolios are given in parentheses.

	Concentration Index:	*H*			*H**			*CV*		
Size Quintiles		Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*	Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*	Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*
Quintile 1	Low	-0.03	3.84	0.49	-0.02	3.88	0.49	-0.02	3.91	0.52
	High	-0.03	3.82	0.44	-0.03	3.73	0.43	-0.04	3.38	0.36
	High-Low	*-0.01*	*-0.03*	*-0.05*	*-0.01*	*-0.15*	*-0.06*	*-0.02*	*-0.53*	*-0.16*
			(-0.01)			*(-0.09)*			*(-0.30)*	
Quintile 2	Low	-0.07	2.44	0.34	-0.07	2.44	0.34	-0.05	3.03	0.41
	High	-0.09	1.86	0.22	-0.09	1.86	0.22	-0.11	1.31	0.15
	High-Low	*-0.03*	*-0.58*	*-0.13*	*-0.03*	*-0.58*	*-0.13*	*-0.07*	*-1.72*	*-0.26*
			(-0.36)			*(-0.36)*			*(-1.06)*	
Quintile 3	Low	-0.05	3.04	-0.54	-0.05	3.04	-0.54	-0.05	2.99	0.38
	High	-0.04	3.64	0.36	-0.04	3.64	0.36	-0.02	4.25	0.44
	High-Low	*0.01*	*0.60*	*0.90*	*0.01*	*0.60*	*0.90*	*0.03*	*1.26*	*0.06*
			(0.34)			*(0.34)*			*(0.70)*	
Quintile 4	Low	-0.03	3.62	0.56	-0.03	3.62	0.56	0.00	4.33	0.60
	High	-0.03	3.95	0.41	-0.03	3.95	0.41	-0.05	3.20	0.36
	High-Low	*0.00*	*0.34*	*-0.15*	*0.00*	*0.34*	*-0.15*	*-0.05*	*-1.12*	*-0.24*
			(0.20)			*(0.20)*			*(-0.67)*	
Quintile 5	Low	-0.04	3.33	0.45	-0.04	3.33	0.45	-0.10	1.80	0.29
	High	-0.10	1.99	0.24	-0.10	1.99	0.24	-0.07	2.72	0.32
	High-Low	*-0.06*	*-1.34*	*-0.20*	*-0.06*	*-1.34*	*-0.20*	*0.03*	*0.92*	*0.02*
			(-0.83)			*(-0.83)*			*(-1.11)*	

***, ** and * refer to 1%, 5% and 10% significance level.

Table 8. Size Portfolios for the sub-period sample from 2003Q1 to 2007Q2.

This table reports the risk-adjusted performance of portfolios sorted by mutual funds' size and concentration indices from the period of 2003Q1 to 2007Q2. Mutual funds are sorted into five equally sized portfolios according to the lagged net assets of the mutual funds, where Quintile 1 and 5 refer to the smallest and largest size portfolio, respectively. The mutual funds in each of these five portfolios are further divided into two groups according to their associated concentration indices of H,
H* and CV, respectively. The portfolios are rebalanced quarterly and, their risk-adjusted return - Sharpe ratio (SR), Jensen's alpha (alpha) and appraisal ratio (APP) are expressed at a quarterly frequency. The t-statistics of the difference in risk-adjusted returns between the high and low concentration index portfolios are given in parentheses.

	Concentration Index:	*H*			*H**			*CV*		
Size Quintiles		Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*	Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*	Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*
Quintile 1	Low	0.70	2.61	0.45	0.69	2.52	0.43	0.67	2.22	0.40
	High	0.68	2.59	0.42	0.69	2.70	0.44	0.72	3.18	0.49
	High-Low	*-0.02*	*-0.02*	*-0.03*	*0.00*	*0.18*	*0.00*	*0.06*	*0.97*	*0.09*
			(-0.03)			*(0.33)*			*(1.79)***	
Quintile 2	Low	0.61	1.24	0.30	0.60	1.19	0.29	0.60	1.40	0.30
	High	0.63	2.39	0.37	0.64	2.44	0.37	0.65	2.41	0.39
	High-Low	*0.03*	*1.16*	*0.06*	*0.04*	*1.24*	*0.08*	*0.05*	*1.01*	*0.09*
			*(2.37)***			*(2.55***)*			*(2.06)***	
Quintile 3	Low	0.63	1.73	0.35	0.62	1.58	0.33	0.64	1.96	0.37
	High	0.65	2.35	0.37	0.65	2.43	0.38	0.64	2.15	0.37
	High-Low	*0.01*	*0.62*	*0.03*	*0.03*	*0.85*	*0.05*	*0.00*	*0.20*	*0.00*
			(1.23)			*(1.69)**			*(0.39)*	
Quintile 4	Low	0.59	1.37	0.28	0.59	1.42	0.29	0.57	1.32	0.25
	High	0.67	2.65	0.41	0.67	2.63	0.41	0.69	2.48	0.44
	High-Low	*0.08*	*1.28*	*0.13*	*0.08*	*1.22*	*0.12*	*0.12*	*1.16*	*0.18*
			*(2.52)****			*(2.40)***			*(2.36)***	
Quintile 5	Low	0.57	1.36	0.26	0.57	1.37	0.26	0.64	2.25	0.37
	High	0.65	2.39	0.38	0.66	2.40	0.39	0.62	2.04	0.35
	High-Low	*0.08*	*1.03*	*0.12*	*0.09*	*1.03*	*0.13*	*-0.02*	*-0.21*	*-0.02*
			*(2.01)***			*(2.02)***			*(-0.40)*	

***, ** and * refer to 1%, 5% and 10% significance level.

Table 9. Size Portfolios for the sub-period sample from 2007Q3 to 2012Q2, i.e. the period of global financial crisis.

This table reports the risk-adjusted performance of portfolios sorted by mutual funds' size and concentration indices from the period of 2007Q3 to 202Q2. Mutual funds are sorted into five equally sized portfolios according to the lagged net assets of the mutual funds, where Quintile 1 and 5 refer to the smallest and largest size portfolio, respectively. The mutual funds in each of these five portfolios are further divided into two groups according to their associated concentration indices of H,

H* and CV, respectively. The portfolios are rebalanced quarterly and, their risk-adjusted return - Sharpe ratio (SR), Jensen's alpha (alpha) and appraisal ratio (APP) are expressed at a quarterly frequency. The t-statistics of the difference in risk-adjusted returns between the high and low concentration index portfolios are given in parentheses.

	Concentration Index:	*H*			*H**			*CV*		
Size Quintiles		Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*	Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*	Sharpe ratio *(SR)*	Jensen's alpha *(alpha)*	Appraisal ratio *(APP)*
Quintile 1	Low	-0.05	0.49	0.13	-0.05	0.50	0.13	-0.06	0.37	0.10
	High	-0.07	0.27	0.06	-0.07	0.25	0.05	-0.07	0.26	0.06
	High-Low	*-0.02*	*-0.23*	*-0.07*	*-0.02*	*-0.24*	*-0.08*	*-0.01*	*-0.11*	*-0.04*
			(-0.72)			*(-0.76)*			*(-0.36)*	
Quintile 2	Low	-0.04	0.68	0.19	-0.04	0.68	0.19	-0.06	0.48	0.12
	High	-0.09	-0.03	-0.01	-0.10	-0.08	-0.02	-0.09	-0.02	0.00
	High-Low	*-0.05*	*-0.71*	*-0.19*	*-0.06*	*-0.76*	*-0.20*	*-0.04*	*-0.49*	*-0.12*
			*(-2.20)***			*(-2.37)***			*(-1.56)8*	
Quintile 3	Low	-0.07	0.28	0.07	-0.07	0.25	0.06	-0.06	0.42	0.09
	High	-0.08	0.20	0.04	-0.07	0.26	0.05	-0.08	0.13	0.03
	High-Low	*-0.01*	*-0.08*	*-0.03*	*0.00*	*0.01*	*-0.01*	*-0.02*	*-0.29*	*-0.06*
			(-0.23)			*(0.02)*			*(-0.82)*	
Quintile 4	Low	-0.03	0.78	0.21	-0.03	0.77	0.20	0.00	1.18	0.30
	High	-0.10	-0.15	-0.03	-0.10	-0.13	-0.03	-0.12	-0.43	-0.09
	High-Low	*-0.07*	*-0.93*	*-0.24*	*-0.07*	*-0.90*	*-0.23*	*-0.12*	*-1.61*	*-0.40*
			*(-2.82)****			*(-2.74)****			*(-5.07)****	
Quintile 5	Low	-0.11	-0.20	-0.05	-0.10	-0.16	-0.04	-0.11	-0.20	-0.04
	High	-0.10	-0.10	-0.02	-0.10	-0.12	-0.03	-0.11	-0.23	-0.05
	High-Low	*0.01*	*0.10*	*0.03*	*0.00*	*0.03*	*0.01*	*0.00*	*-0.03*	*-0.01*
			(0.32)			*(0.10)*			*(-0.09)*	

***, ** and * refer to 1%, 5% and 10% significance level.

5 Conclusion

The theoretical arguments in the literature of portfolio underdiversification and behavioral finance suggest the investment selection skills hypothesis and the overconfidence hypothesis on actively managed mutual funds, where fund managers concentrate fund holdings in a relatively small number of stocks. The concentrated investment strategy adopted by fund managers who have good investment abilities in acquiring and assessing superior information leads to a positive relation between the concentration level of fund holdings and risk-adjusted fund performance, suggesting the investment selection skills hypothesis. If fund managers are overconfident, the concentrated investment strategy will result in a negative relation between the concentration level of fund holdings and risk-adjusted performance, suggesting the overconfidence hypothesis.

In this paper, we test these two hypotheses in Taiwan equity mutual fund market. We employ the Herfindahl index, the normalized Herfindahl index and the coefficient of variation to measure the concentration level of mutual fund holdings, and employ the Sharpe ratio, the Jensen's alpha and the appraisal ratio to measure the risk-adjusted fund performance. Using a panel data of 173 Taiwan-based equity mutual funds spanning from 2001 to 2012, we show that high concentrated funds have high risk-adjusted performance relative to low concentrated funds in the bull market of 2003Q1-2007Q2, but this is not true in the bear markets of 2001Q2-2002Q4 (i.e. the dot-com bubble financial crisis) and 2007Q3-20012Q2 (i.e. the global financial crisis).

Further, we compare the risk-adjusted performance of high and low concentrated portfolios sorted by fund size, and confirm that the time varying concentration-performance relation is not driven by the size effect. This implies that fund managers demonstrate good investment abilities when the market is less volatile, but they exhibit overconfidence when the market is in turmoil. Mutual fund investors should choose more concentrated funds in bull markets, and shift their investment to more broadly diversified funds in bear markets. Our findings, hence, lend evidence to the actively managed mutual funds literature.

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