THE EFFECTS OF PORTFOLIO CONCENTRATION ON INVESTMENT PERFORMANCE OF ACTIVELY MANAGED DOMESTIC EQUITY MUTUAL FUNDS, 1990 TO 2010

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ABSTRACT

The purpose of this study is to investigate the relation between the investment performance and portfolio concentration of domestic equity mutual funds from 1990 to 2010. Although previous studies had considered several measures of portfolio concentration, and reported mixed results, not a single study had considered the percentage of the fund's portfolio invested in its top-ten holdings (TOPTEN), which is provided by the Morningstar, Inc., as an intuitive measure of portfolio concentration. The present study attempts to fill this gap. We have focused on both the TOPTEN and the number of portfolio holdings as alternative measures of portfolio concentration. When we sorted our data on the TOPTEN, we found that the less concentrated (i.e., the more diversified) the fund was, the larger its net assets and its number of holdings, and the better the fund's investment performance--suggestive of economies of scale in mutual fund operations. That is, portfolio concentration had a negative effect on investment performance. However, when we re-sorted the data on the number of portfolio holdings, instead, we found the opposite results. That is, portfolio concentration had a positive effect on investment performance. Therefore, we investigated the joint effect of the TOPTEN and holdings on investment performance and found that the less concentrated portfolios (those with larger holdings) outperformed those portfolios that were more concentrated (those with smaller number of holdings). We concluded that portfolio concentration is in fact not beneficial, but that this is apparent only when the TOPTEN is used in combination with the number of securities held, as recommended by the Morningstar, Inc.

Key Words: Mutual Funds, Performance Evaluation, portfolio Concentration
JEL Codes: C02, C12, G10, G11, G20, G23

I. INTRODUCTION

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Zakri Bello & Jerry J. DeRidder

A. Literature Review

Although several studies had investigated the impacts of portfolio concentration on the investment performance of equity mutual funds, their definitions of "portfolio concentration" had not always been the same. Some of the previous studies had focused on the number of securities held by the mutual fund (i.e. portfolio holdings) as a measure of portfolio concentration, while others had focused on the number of industries the portfolio manager had focused on. Still others had focused on the manager's investment strategies, styles, sectors, et cetera, as indicators of portfolio concentration. Huij and Derwall (2011), for example, investigated the performance of global equity mutual funds by "focusing on the extent to which mutual fund managers had allocated funds across multiple investment strategies and concentrated their investments in multiple market segments, simultaneously." Thus the portfolio concentration investigated by Huij and Derwall specifically concerned the investment strategies used by the manager, that is, the allocation of funds across asset classes, industries, and countries. Huij and Derwall found that mutual funds that concentrated on investment styles, sectors, and countries tended to have larger tracking errors and that they tended to outperform the less concentrated mutual funds. According to Huij and Derwal, investment performance was mostly driven by the number of the market segments the fund manager focused on.

Ivkovich, Sialm, and Weisbenner (2004), on the other hand, investigated the investment behavior of individual investors and found that those investors that held fewer number of stocks outperformed those investors that held diversified portfolios. Smith (2011) however opined that an investor ought to be concerned about concentration risk which arises when one has too few stocks or is concentrated in only one sector, or when individual stocks make up more than 10% of the value of the portfolio. Smith recalled that Benjamin Graham, generally recognized as "the architect of modern investing," recommended about 10 to 30 stocks in order to achieve a reasonably diversified portfolio. In line with Ivkovich, et al. (2004), Brands, Brown, and Gallagher (2005) found a positive relation between the performance of actively managed portfolios and portfolio concentration. Brands, et al. defined portfolio concentration as "the extent to which the portfolio deviated from the market portfolio (i.e. the Australian Stock Exchange's S&P/ASX 300).

Further, Bogle (1994) argued that it was not sufficient to know how many stocks a fund owned, since many of the individual stocks might only represent a small percentage of the fund's net assets and thus had little relative impact on the fund's investment performance. Bogle argued that the better test of portfolio diversification, versus portfolio concentration, was the proportion of the total assets the fund held in its largest positions. According to Bogle, the greater the concentration (i.e. the less the diversification), the greater the investment opportunity. This line of reasoning was supported by Kacperczyk, Sialm, and Sheng (2005) who investigated the industry concentration of equity mutual funds and found that investment ability was more

evident among fund managers who held portfolios concentrated in a few industries. According to Kacperczyk et al., concentrated funds outperformed diversified funds.

Several other studies that investigated the relation between investment performance and portfolio concentration also found some positive benefits of portfolio concentration and reported that the benefits of concentration outweighed those of diversification. Mauboussin (2006) for example found that "on average, the more focused the portfolio, the better the investment performance." He argued that this finding was in line with Warren Buffett's thinking and the opinion of those money management groups that had launched "focus" or "benchmark unconstrained" funds.

The earliest study of the impact of portfolio concentration was by Ulrich and Olson (1976) who, based on a sample of eight mutual funds and a sample period of four years, observed that over-diversification reduced returns to shareholders and deprived them of the benefits of professional management. Accordingly, they recommended greater portfolio concentration "as a strategy for improving portfolio performance." Moreover, Nofsinger (2008) mentioned that John Maynard Keynes was an advocate of portfolio concentration and that he, Keynes, had opined that he "preferred one investment about which he had sufficient information to form a judgment to ten securities about which he knew little or nothing." Nofsinger argued that people prefer those things that are familiar to them. Moreover, some very successful investors such as Warren Buffet and Peter Lynch had advocated portfolio concentration, notwithstanding the well-known theories of both random diversification and efficient diversification. Warren Buffett (2009) in particular argued that portfolio concentration "may in fact be unrisky." And, according to Wolinsky (2011), Peter Lynch coined the term "deworsification" regarding excessive diversification by "stock investors who invested much capital outside their most favored stocks."

Further, Brewster (2004) argued that successful investors have proved that concentrating on a handful of stocks could "work well" and that although diversification did provide a hedge, "it was also an opportunity cost." Wolinsky (2011), on the other hand, argued that even though most mutual funds tended to over-diversify, causing their investment performance to suffer, under-diversification (i.e. portfolio concentration) was even more dangerous. Finally, Shawky and Smith (2005) discussed the tradeoff that normally existed between the benefits of diversification and both the costs of monitoring and the costs of transactions that increased with diversification. Moreover, Statman (1987) found that a reasonably diversified portfolio must include 30 to 40 stocks, and argued that marginal costs tended to increase faster than marginal benefits as the number of stocks included in the portfolio increased. Statman recommended a "limited diversification."

Although, generally, investors relate diversification to the number of stocks held in the portfolio (i.e. random diversification), academics tend to think in terms of efficient diversification, which considers other variables such as return correlations among the stocks held, the variances of the stocks, and the percentage of the portfolio funds invested in each stock. As observed by Statman (1987), the number of securities held is not the sole determinant of diversification.

increased significantly but the other measures such as the expense ratio, portfolio turnover, the percentage of the portfolio invested in the top ten securities held by the fund, and portfolio holdings are not significantly affected.

Table 1. Sample Profile of Domestic Equity Mutual Funds (February 1990 – January 2010)

Variable	N	Mean	Std. Dev.
Net Assets ($mm)	940	1076.850	3035.190
U. S. Stocks %	940	91.500	6.672
Non-US Stocks %	940	4.777	4.007
Bonds %	940	0.170	0.953
Cash %	940	3.180	4.692
Holdings	940	138.656	219.230
TOPTEN	940	28.633	12.218
Expense Ratio	940	1.204	0.583
Portfolio Turnover	939	95.525	88.731

Note: N is the number of mutual funds with non-missing data; "std. dev." is short for standard deviation; and TOPTEN is the percentage of the mutual fund's portfolio invested in the top-ten securities held by the average mutual fund in the sample. Net assets are in millions of dollars. Other investments are less than 1% of the fund's portfolio and are not shown in the Table.

As shown in Table 1, the sample's average net assets is $1077 million, with a standard deviation of $3035, suggesting that the mutual funds vary substantially in terms of their sizes. On average, 92% of the portfolio was invested in domestic stocks and less than 5% of the portfolio was invested in bonds, foreign stocks, or other assets. And as is indicated by the portfolio turnover of 96%, the average portfolio manager bought and replaced his or her entire holdings approximately every 12.5 months, suggesting that our sample consists of actively managed mutual funds. Moreover, as shown in Table 1, the average equity mutual fund held 139 securities (Holdings), invested approximately 29% of its portfolio funds in the top 10% securities it held (TOPTEN), and had an expense ratio of 1.2%.

Finally, we obtained the monthly mutual fund returns, for the February 1990 to January 2010 sample period, from the Principia database. The corresponding returns on the market portfolio, represented by the S&P 500 index, and the monthly yields on the three-month Treasury bills were also extracted from the same database.

III. THE METHODOLOGY

We used the following regression equation to measure the risk-adjusted performance of the mutual fund portfolio:

$$r_{it} = \alpha_i + \beta_i r_{mt} + e_{it}, \qquad\qquad [1]$$

where, r_{it} is the excess return on fund i, in month t, i.e. the fund's return in excess of the 91-day Treasury bill rate; r_{mt} is the excess return on the S&P 500 index in month t; and e_{it} is the residual return on fund i, in month t. Fund i's risk-adjusted performance is measured by Jensen's alpha, α_i

Moreover, because there might remain some idiosyncratic risk in the mutual fund portfolio, we measured the fund's risk-adjusted performance again using the Sharpe Information Ratio, S_p, as suggested by Reilly and Norton (2006) and Goodwin (1998). If "D_t" is the tracking error, that is, the difference between the returns on the portfolio and the benchmark in period t (R_{pt}–R_{mt}), then:

$$S_p = \frac{\bar{D}}{\sigma_D}, \qquad\qquad [2]$$

where, $\bar{D}$ is the average value of the monthly differences (D) in return between the portfolio and the benchmark. That is, $\bar{D} = \frac{1}{n}\sum_{t=1}^{n} D_t$; σ_D is the standard deviation of the differential returns, and n is the number of monthly returns. The t-statistic for the test of the null hypothesis that the excess returns over the market portfolio are zero, on average, is:

$$t = \frac{\bar{D}}{\sigma_D / \sqrt{n}}, \qquad\qquad [3]$$

The t statistic has a t distribution with n-1 degrees of freedom.

As with Jensen's alpha, this performance measure indicates portfolio performance relative to the benchmark portfolio and lends itself to statistical tests of significance. However, unlike the Jensen's alpha, the Sharpe Information Ratio adjusts for total risk, rather than just systematic risk, and this is crucial to performance measurement because previous studies have shown that mutual fund portfolios, on average, contain significant idiosyncratic risks. Reilly and Norton (2006) and Goodwin (1998) argued that the Sharpe Information Ratio was a more general measure of portfolio performance than the traditional Sharpe measure.

IV. THE RESULTS

We began our analyses with cross-sectional regressions of fund returns on the market portfolio. As shown in Table 2, the fund's investment performance, as measured by the Jensen's alpha, α_i, was significant for all of the investment objective categories during the study period, with the exception of the Aggressive Growth (AG) category. The AG group's alpha was not significantly different from zero at the 5% level. Thus this group had tracked the market as represented by the S&P 500 index during the 1990 to 2010 sample period. The other categories as well as the overall sample had outperformed the market during that period. For the overall sample, the Jensen's alpha was 0.113 and was statistically significant. Thus, as a group, mutual funds had outperformed the market from 1990 to 2010.

Table 2. Cross-sectional Regression of Excess Fund Returns on the Market Portfolio
(February 1990 – January 2010)

Objective	α_i	t-value	β_i	Sp	t-value	Net Assets
AG	0.076	1.27	1.172	0.034	1.042	1046.74
G	0.116*	11.93	1.008	0.042	1.287	934.37
GI	0.048*	4.04	0.911	0.016	0.490	1923.37
EI	0.085*	3.44	0.799	0.120*	3.677	1791.40
SC	0.252*	10.20	0.993	0.076*	2.329	678.59
Sample	0.113*	26.13	0.976	0.042	1.287	1076.85

Note: "Objective" refers to the funds' investment objective; α_i, β_i, and S_p are the Jensen's alpha, portfolio beta, and Sharpe Information Ratio estimated using equations (1),

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} ,$$

and Equation (2),

$$S_p = \frac{\bar{D}}{\sigma_D}$$

The variables and estimated parameters are described under "The Methodology." All of the estimated portfolio betas, β_i, are significant at the 5% level.

*Significant at the 5% level.

Further, the Small Company category, the smallest investment objective category as judged by their average net assets, had the largest alpha, while the Growth and Income category which is the largest in terms of average net assets had the smallest alpha—suggestive of diseconomies of scale in mutual fund operations. However, when investment performance was measured using the Sharpe's Information Ratio, Sp, only

two investment objective categories—the Equity Income and the Small Company groups—outperformed the S&P 500 benchmark. Moreover, using the Information Ratio as a measure of performance, instead of the Jensen's alpha, the overall sample just tracked the benchmark portfolio as judged by the Information Ratio of 0.042, which was not statistically different from zero.

In view of the fact that previous evidence had indicated that the average mutual-fund portfolio was not fully diversified, our results as indicated by the Information Ratio are the more convincing results. Therefore, our overall conclusion is that our sample of mutual funds neither outperformed nor underperformed the market portfolio during the 1990 to 2010 period. And, as expected, the mutual fund category that assumed the most aggressive stance in connection with its investment style, the AG group, had the largest portfolio beta of 1.172, even though the Jensen's alpha for this category was not statistically different from zero. Both the Aggressive Growth and the Growth categories were aggressive portfolios on average, while the Growth and Income and Equity Income groups were defensive portfolios, as indicated by their portfolio betas. The Small Company group was about as volatile as the market.

Next, we sorted our data by the percentage of the fund's portfolio invested in its top ten holdings (TOPTEN) and then divided the sample into five portfolios (quintiles) based on the fund's TOPTEN. Quintile #1 had the lowest TOPTEN and Quintile #5 had the highest TOPTEN. We then repeated the cross-sectional regressions for each quintile and, additionally, we calculated the average holdings for each quintile. The results are contained in Table 3.

Table 3. Cross-sectional Regression of Excess Fund Returns on the market Portfolio: Quintiles Are Based on the TopTen

Quintile	α_i	t-value	β_i	TopTen	Holdings	Nassets	Exret
1	0.212*	10.78	1.013	14.371	328.656	1102.36	0.488
2	0.108*	6.41	1.003	22.051	141.954	1861.73	0.396
3	0.093*	5.98	0.983	26.938	107.832	1387.02	0.379
4	0.086*	5.75	0.973	32.331	84.317	1796.52	0.350
5	0.112*	6.00	0.959	46.823	49.203	641.40	0.340
Sample	0.113*	26.13	0.976	28.633	138.656	1076.85	0.391

Note: The parameters, α_i and β_i, were estimated using Equation (1),

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

as described in "The Methodology" section. "TopTen" is the percentage of the fund's portfolio invested in the top ten companies the fund held; "Holdings" is the number of securities held by the fund; "Nassets" is the fund's net assets (in millions of dollars); and Exret is the fund's monthly return in excess of the monthly yield on three-month Treasury bills.

*Significant at the 5% level.

As shown in Table 3, the smallest TOPTEN quintiles had the largest Jensen's alphas and the largest excess returns (Exret), suggesting that the less concentrated mutual fund portfolios (those with lower TOPTENs) had the better investment performance during the 1990 to 2010 period. In other words, as a mutual fund became more concentrated its investment performance suffered. These findings are not supportive of Iskovich et al. (2004), Brands, et al. (2005), Kacperczyk, et al. (2005), Mauboussin (2006), Ulrich and Olsen (1976), and Warren Buffet (2009), who extolled the benefits of portfolio concentration. The findings are more in line with Wolinsky (2011) and Smith (2011), who argued that portfolio concentration (i.e. under diversification) can be even more "dangerous" than excessive diversification as far as investment performance was concerned. Moreover, as shown in Table 3, the lower TOPTEN quintiles also had the largest portfolio holdings and the largest net assets. Thus the less concentrated the mutual fund was (lower TOPTEN), the more diversified it was (larger holdings), and the better its investment performance was. Our results do not show any monotonic relation between a mutual fund's size, as measured by its net assets, and either the fund's TOPTEN or its portfolio holdings when the data were sorted on the TOPTEN. Further, each TOPTEN quintile as well as the overall sample outperformed the S&P 500 benchmark during the 1990 to 2010 study period.

We repeated the analyses by sorting the data on portfolio holdings and then divided the sample into quintiles (based on the fund's holdings). Quintile #1 had the smallest holdings, and Quintile #5 had the largest holdings, on average. Additionally, we calculated the average TOPTEN for each quintile, and then performed cross-sectional regressions for each quintile and for the entire sample. The results are contained in Table 4.

Table 4. Cross-sectional Regression of Excess Fund Returns on the Market Portfolio: Quintiles Are Based on Portfolio Holdings

Quintile	α_i	t-value	β_i	TopTen	Holdings	Nassets	Exret
1	0.147*	7.91	0.971	31.333	58.192	413.658	0.378
2	0.131*	7.43	1.005	29.356	73.400	625.723	0.391
3	0.123*	6.48	0.998	27.998	93.409	1085.630	0.380
4	0.116*	7.09	0.978	27.164	141.615	1639.960	0.416
5	0.095*	6.70	0.978	26.644	343.806	3028.330	0.389

Note: The parameters, α_i and β_i, were estimated using Equation (1),

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it},$$

as described in "The Methodology" section. "TopTen" is the percentage of the fund's portfolio invested in the top ten companies the fund held; "Holding" is the number of securities held by the fund; "Nassets" is the fund's net assets (in millions of dollars); and Exret is the fund's monthly return in excess of the monthly yield on three-month Treasury bills. All of the estimated portfolio betas, β_i, are significant at the 5% level.

*Significant at the 5% level.

Zakri Bello & Jerry J. DeRidder

As shown in Table 4, Jensen's alpha tended to get worse as the mutual fund's portfolio holdings became larger, and as the portfolio became less concentrated (lower TOPTEN). That is, portfolio concentration was beneficial and that diversification was detrimental to investment performance. These results are contradictory to those presented in Table 3. Thus, sorting the data by portfolio holdings had produced results that did not conform to those obtained when the data were sorted by TOPTEN. These results, contained in Table 4, are consistent with Iskovich et al. (2004), Brands, et al. (2005), Kacperczyk, et al. (2005), Mauboussin (2006), Ulrich and Olsen (1976), and Warren Buffet (2009), who argued that portfolio concentration was beneficial. Moreover, as shown in Table 4, portfolio performance tended to get worse as the net assets under management increased—suggestive of diseconomies of scale in mutual fund operations as observed by Perold and Salomon (1991), Beckers and Vaughan (2001), and Chen et al. (2004). We concluded that sorting the data by the mutual fund's TOPTEN would produce results that were contradictory to those obtained when the sample were sorted by portfolio holdings.

To investigate the joint effects of TOPTEN and holdings, we first sorted our data by the TOPTEN and formed TOPTEN quintiles, and then we divided each of the TOPTEN quintiles into sub-quintiles based on portfolio holdings. The highest TOPTEN quintile is quintile #1 and the largest holdings sub-quintile is quintile #5. Thus quintile 1/5 is the first TOPTEN quintile and the fifth holdings sub-quintile (within the first TOPTEN quintile). Quintile 5/1 is the fifth TOPTEN quintile and the first holdings sub-quintile (within the fifth TOPTEN quintile). Finally, we performed cross-sectional regressions for each of the 25 sub-quintiles, and then calculated the average TOPTEN and the average holdings for each sub-quintile. The results are contained in Table 5.

Table 5. Cross-sectional Regression of Excess Fund Returns on the Market Portfolio: Quintiles Are Based on TopTen and Then on Portfolio Holdings

Quintile: (TopTen/Holdings)	α_i	t-value	β_i	TopTen	Holdings	Nassets	Exret
Panel A:							
1/1	0.213*	4.92	0.992	17.070	95.785	420.478	0.449
1/2	0.232*	4.95	1.018	16.771	120.960	959.904	0.588
1/3	0.253*	5.31	1.034	14.886	160.090	1159.990	0.474
1/4	0.171*	4.05	1.010	12.232	316.756	1306.450	0.457
1/5	0.192*	4.85	1.011	10.925	941.782	1658.250	0.473
Panel B:							
2/1	0.146*	3.48	1.014	22.877	67.173	251.592	0.375
2/2	0.156*	3.79	1.034	22.407	89.726	718.547	0.386
2/3	0.102*	2.23	1.020	21.212	109.662	855.265	0.418
2/4	0.103*	3.50	0.959	22.025	140.882	2053.000	0.452
2/5	0.040	1.50	0.988	21.690	300.947	5389.050	0.351
Panel C:							
3/1	0.143*	3.82	0.939	27.058	56.404	499.353	0.335

3/2	0.096*	2.63	1.007	27.080	70.592	446.030	0.387
3/3	0.101*	2.83	0.967	26.898	86.415	1759.050	0.349
3/4	0.128*	3.45	0.983	26.896	109.176	1179.210	0.452
3/5	-0.011	-0.44	1.020	26.759	215.328	3045.260	0.369
Panel D:							
4/1	0.067*	1.98	0.949	32.642	44.731	408.096	0.348
4/2	0.113*	3.25	0.962	32.304	56.725	693.040	0.334
4/3	0.061	1.70	1.009	32.820	68.515	1234.420	0.352
4/4	0.067*	2.15	0.978	32.169	89.730	2666.860	0.343
4/5	0.118*	3.97	0.966	31.712	162.521	4028.620	0.371
Panel E:							
5/1	0.171*	3.41	0.959	57.950	25.766	501.390	0.380
5/2	0.064	1.74	1.003	46.268	34.094	346.107	0.273
5/3	0.093*	2.06	0.959	44.474	40.797	406.276	0.305
5/4	0.114*	2.70	0.960	43.324	49.626	990.989	0.374
5/5	0.129*	3.80	0.907	42.239	96.017	999.917	0.379

Note: The parameters, α_i and β_i, were estimated using Equation (1): $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$,

as described in "The Methodology" section. "TopTen" is the percentage of the fund's portfolio invested in the top ten companies the fund held; "Holding" is the number of securities held by the fund; "Nassets" is the fund's net assets (in millions of dollars); and Exret is the fund's monthly return in excess of the monthly yield on three-month Treasury bills. All of the estimated portfolio betas, β_i, are significant at the 5% level.
*Significant at the 5% level.

As shown in Table 5, investment performance as measured by Jensen's alpha was not monotonically related either to TOPTEN, portfolio holdings, or the fund's net assets when the data were sorted on holdings. That is, neither portfolio concentration nor portfolio diversification appeared to be linearly related to investment performance. However, portfolio holdings were positively related to net assets, contrary to Brewster (2004), and negatively related to TOPTEN. As expected, portfolio holdings tended to increase as net assets increased. It also appeared that the TOPTEN's effects on investment performance, indicated in both Table 3 and Table 4, had been cancelled out by those of holdings. Thus when both variables are taken together, mutual fund performance may not appear to be related to either portfolio concentration or to portfolio diversification. These results are consistent throughout the 25 sub-quintiles presented in Table 5.

Finally, we tested for differences in performance between the sub-quintiles in Panel A and Panel E of Table 5, by performing a paired test using the Wilcoxon Signed-Rank test. The null hypothesis that there was no difference in investment performance measured by alpha was rejected. The calculated probabilities were 0.0625 and 0.0227 for the Wilcoxon test and the t test, respectively. Thus the difference in investment performance between the two sets of sub-quintiles was significant at the 10% for the Wilcoxon test and at 5% for the t test. We repeated the paired test on the excess returns (Exret) and the results were the same. Thus those portfolios that were less concentrated

with larger holdings outperformed those portfolios that were more concentrated with smaller holdings.

The Morningstar, Inc. has suggested that if the TOPTEN variable were used in combination with the total number of holdings, it could indicate how concentrated a fund was. We find that taken together, the two variables can also help to predict the level of concentration and holdings that would enhance investment performance.

V. SUMMARY AND CONCLUSIONS

We investigated the relation between the investment performance and portfolio concentration of actively managed domestic equity mutual funds over the 1990 to 2010 period. The average mutual fund in our sample invested approximately 29% of its portfolio in the top ten securities that it held, and it purchased and completely replaced all of its holdings within approximately 12.5 months, as indicated by an average portfolio turnover of 96%. We used both portfolio holdings and the percentage of funds invested in the top securities held by the fund as alternative measures of portfolio concentration.

Overall, on the basis of their Jensen's alpha, the average mutual fund in our sample had outperformed the market, represented by the S&P index, during the study period. However, when we used an alternative measure of investment performance, the Sharpe's information ratio, the average mutual fund neither outperformed nor underperformed the S&P 500 benchmark during that period. Since previous studies had determined that the average domestic equity mutual fund contained a significant level of idiosyncratic risk, we considered the information ratio as the more appropriate measure of investment performance. Therefore, we concluded that the average mutual fund had tracked the market over the study period.

Further, we sorted our data on the percentage of the portfolio invested in the top ten securities held by the mutual fund (TOPTEN) and found that lower TOPTEN quintiles were associated with better investment performance. That is, the less concentrated (i.e., the more diversified) the fund was, the larger its net assets and number of holdings, and the better the investment performance--suggestive of economies of scale in mutual fund operations. In other words, portfolio concentration had a negative effect on investment performance. However, when we re-sorted the data on the number of portfolio holdings instead, we found the opposite results. That is, less concentrated (or more diversified) mutual funds—those with larger portfolio holdings and larger net assets—were associated with poorer investment performance, suggestive of diseconomies of scale in mutual fund operations. In other words, portfolio concentration had a positive effect on investment performance. Most of the previous studies of portfolio concentration and portfolio diversification had used portfolio holdings and net assets to estimate the level of portfolio concentration.

Finally, we investigated the joint effects of the TOPTEN and holdings on investment performance by first sorting the data on the TOPTEN and then re-sorting the data on holdings (within the TOPTEN quintiles), resulting in 25 holdings sub-

45

quintiles. We then tested for the difference in investment performance among the largest versus the smallest holdings sub-quintiles. We found that those portfolios that were less concentrated and had the largest holdings out performed those portfolios that were more concentrated with smaller holdings.

The Morningstar, Inc., had speculated that if the TOPTEN were used in combination with the number of portfolio holdings, it could indicate how concentrated a mutual fund was. We have observed that the two variables, when combined, can help to predict the level of concentration and holdings that can enhance investment performance.

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