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To Catch a Thief Part II:

BROADENING THE EVIDENCE

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In this paper the author extends previous research of the capture ratio. This new study broadens the previous study of only growth and income funds. It encompasses five major style categories among institutional money managers for a fifteen-year period. This study reinforces the capture ratio's value with findings that it is an even better predictor of future risk-adjusted performance for most style categories than the widely used selection ratio. The author also further examines this ratio's relationship to beta.

Manager selection and monitoring is a critical component of investment management. Indeed, this is an area where most consultants promise to add value for their clients. In doing so we become detectives on the hunt for investment-manager thieves: those who take more via return than they pay for via risk. In other words, we strive to hire managers with future excess risk-adjusted return and fire managers without excess risk-adjusted return. Many qualitative and quantitative tools assist along the way.

"To Catch a Thief," published in the *Journal of Investment Consulting* (December 2001) examined the efficacy of one of these tools: the capture ratio. The research showed the ratio's promise for selecting managers with superior performance, explaining the origin of past returns, and identifying consistently conservative managers. This work had its limitations, however. First, it addressed only growth and income funds, so the results could have been style specific. Second, many consultants use separately managed accounts, which might not be as highly correlated to mutual funds. Third, the results could have been period specific. To address these issues, this new research extensively studies the fifteen-year period ending June of 2001 and incorporates five major style categories of separately managed accounts.

Capture Ratio 101

The capture ratio reports a money manager's success or failure in capturing the upside of the benchmark, as well as success or failure in not capturing the downside of the benchmark. Each manager has two capture ratios: the upside capture ratio and the downside capture ratio. These ratios are created using the following calculations:

$C_u = M_u \div B_u$

$C_d = M_d \div B_d$

where

C_u = manager's upside capture ratio

C_d = manager's downside capture ratio

M_u = manager's annualized return during all up or positive benchmark return quarters

M_d = manager's annualized return during all down or negative benchmark return quarters

B_u = annualized return of the benchmark during all up benchmark return quarters

B_d = annualized return of the benchmark during all down benchmark return quarters

Returns are annualized as:

$R_a = (1+R_t)^{1/(N/4)} - 1$

where

R_a = annualized return for the given up or down periods

R_t = total return for the given period (for example, if calculating the upside capture, it would be the manager's cumulative return during all positive benchmark return quarters)

N = number of up, down or total quarters

A manager's returns are divided into two categories: all returns during the index's positive quarters, and all returns during the index's negative quarters. Next, negative quarterly returns are linked and annualized, and so are positive returns. The index's annualized down and up returns respectively becomes the denominator in each ratio's calculation. For the numerator, the manager's return series during all the index's positive quarters are annualized, and so are all the returns for the index's negative quarters.

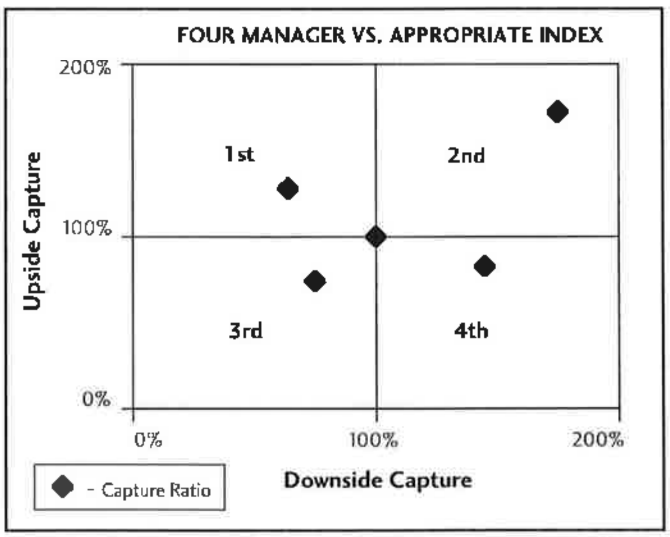
The following example derives a hypothetical large-cap value-balanced manager's capture ratio:

INVESTMENT	7-YEAR ANNUALIZED RETURN
Large value balanced index	8.7%
Index return for positive quarters	20.8%
Index return for negative quarters	-15.1%
Manager X large value balanced	9.0%
Manager X for up index quarters	16.8%
Manager X for down index quarters	-7.3%

Upside capture = 16.8% ÷ 20.8% = 80.7%
Downside capture = -7.3% ÷ -15.1% = 48.4%

The capture ratio in this example tells us that we are looking at a thief, because this manager "paid" only 48.4 percent of the losses while "receiving" 80.7 percent of the gains.

The capture ratio can be used alone to help describe the character of a manager. But the ratio is most commonly used to compare managers within a style category. A selection of competing managers' capture ratios are calculated and plotted on a quadrant chart like the one that follows.



The dot in the middle indicates a 100-percent upside and 100-percent downside capture, or the benchmark return.

The first-quadrant manager captures more than the upside and less than the downside and therefore is the most sought after. The second-or third-quadrant managers are equivalent on a risk-adjusted basis; the only difference is that the second-quadrant manager carries above-average market risk and the third-quadrant manager carries below-average market risk. Meanwhile, the unfortunate fourth-quadrant manager is to be shunned for capturing more of the benchmark's downside and less of its upside.

It is theoretically possible to have a negative capture ratio, where a manager has a cumulative negative return over the benchmark's up quarters or a cumulative positive return over the benchmark's down quarters. This does not happen very often happen when using more than three years of data.

Research Methodology

In analyzing the efficacy of the capture ratio or any performance measure, three areas demand examination:

- We need to know how the ratio predicts and explains past performance.
- We need to determine if the ratio persists in the future; if it doesn't persist from period to period, its value diminishes greatly.
- We need to know if the ratio can help predict superior future performance.

These areas lead to three hypotheses for testing the capture ratio:

- The ex-post capture ratio highly correlates with superior past performance (that is, in sample analysis).
- The capture ratio persists (that is, a manager tends to maintain the same capture ratio ranking from period to period).
- The capture ratio predicts future superior performance on a statistically significant basis (that is, out-of-sample analysis).

For the test of the first hypothesis, I divided separately managed account managers into five different style categories, as defined by Effron's PSN database: large growth, large value, small growth, small value, and intermediate fixed income. The indexes used for these style categories were Frank Russell (FRC) 1000 Growth, FRC 1000 Value, FRC 2000 Growth, FRC 2000 Value, and the Lehman Brothers Intermediate Government/Corporate Bond Index, respectively.[2] Table 1 reports the returns of these benchmarks over the entire fifteen-year period studied.

After each manager was assigned to a respective style category, the fifteen-year return series for each style category of managers was decomposed as a group into multiple subperiods of seven-, five-, and three-year periods. For example, for three-year periods, the first period begins in June 1986 and ends in June 1989. The second period begins in June 1989 and ends in June 1992, and so on. The result is a total of ten periods per style category and fifty periods total. Next, for each of these fifty style category subperiods, the managers were grouped into capture-ratio quadrants. Then each quadrant's return was studied using the Sharpe ratio, the Sortino ratio, and the selection ratio to determine if any of the four capture-ratio quadrants exhibited superior or inferior risk-adjusted performance when compared with the average of all managers in their respective style categories. Doing so adjusts for any style effects by studying only capture-ratio quadrants within each respective style category.

The same procedure was used to test the second hypothesis. The second period of each subperiod, however, became the first comparison period for out-of-sample testing. For example, for large-growth managers, I constructed capture-ratio quadrants from the return series of the three-year period from June 1986 through June 1989. Next, each capture-ratio quadrant group of managers was tracked to see how many remained in their original quadrants for the following period, June 1989 through June 1992. A chi-square test measured the statistical significance of capture-ratio persistence, either negative or positive. I again calculated the capture-ratio quadrants of large-growth managers available from June 1989 through June 1992 and then followed these groupings into the next period. This process for each style category for the seven-, five-, and three-year periods, creating seven test periods (one seven-year, two five-year, and four three-year test period) for each style category, for a total of 35 test periods.

The third hypothesis was tested with similar methodology by testing the future *risk-adjusted return* of each previous capture-ratio quadrant grouping instead of the future *capture-ratio quadrant ranking* of this same group. That is, I determined the future performance of each style-specific capture-ratio quadrant group for the subsequent test period, then tested the *future* returns of each style-category quadrant grouping for statistically significant differences from the average of all the funds within the given style category.

In addition to the above hypotheses, I also tested the correlation of beta to standard deviation and to upside and downside capture ratios. Beta's relationship to the capture ratio is of interest because the capture ratio may simply be a proxy for beta and therefore an unnecessary additional datum. Indeed, the capture ratio is analogous to beta in that it measures how much a manager tends to go up and down in line with the benchmark. The capture ratio does not assume a linear relationship, however, and it divides the benchmark sensitivity into up and down markets, akin to an upside and a downside beta measurement. I also examined how well historical betas correlate to beta, standard deviation, and upside and downside capture in the *future* (out-of-sample).

Past Performance Prediction

Tables 2 and 3 report the in-sample performance of large-growth managers.[3] With the exception of the Sharpe ratio, the relative performance is ranked sequentially from the first to the fourth quadrant. That is, for the selection ratio and the Sortino ratio, the first quadrant continually provides the greatest risk-adjusted return, the second quadrant the second-greatest risk adjusted return and so on, and the fourth quadrant provides the poorest risk adjusted performance. The Sharpe ratio ranks similarly, except that it often reverses the order of the second and third quadrants (that is, it shows the third quadrant with a higher risk-adjusted return than the second).

As hypothesized in the previous research, the Sharpe ratio may not be the best risk-adjusted measure of performance. The Sortino ratio is analogous to the Sharpe ratio with the risk-free rate of return as the benchmark, but the denominator in the ratio is the semi-standard deviation,[4] which only measures deviation on the downside of the benchmark. The Sharpe ratio, on the other hand, uses the regular standard deviation, which treats up- and downside deviations equally.[5] That is, a 10-percent deviation above the average has the same additive magnitude and direction to total risk as a 10-percent deviation below the average. The latter deviation is intuitively more risky; most investors are concerned with a shortfall in return, not an excess. Because of the Sharpe ratio's equal treatment of upside and downside deviations, it relegates otherwise superior managers to inferior rankings due to their implicitly greater upside deviations. For example, the Sharpe ratio shows second-quadrant managers inferior to third-quadrant managers for the three-year period June 1986 to June 1989. Using the Sortino ratio, however, the second-quadrant managers are superior to the third-quadrant managers. Because the Sharpe and Sortino ratios use the same numerator, one can deduce the ranking reversal is caused by a change in the denominator alone. Therefore, the second-quadrant managers have more total risk per regular standard deviation but less downside risk per semi-standard deviation. This phenomenon of positive Sortino and Sharpe ratios resulting in opposite rankings of second- and third- quadrant managers occurs in seven of the recorded periods in tables 2 and 3.

Meanwhile, the selection ratio ranks identically to the Sortino ratio. Note that six of the periods show the third-quadrant managers with a positive Sharpe ratio but a negative Sortino ratio. All the while, second-quadrant managers maintain a positive Sortino ratio; therefore, the

TABLE 1

Benchmark Data 6/1986 through 6/2002

INDEX	SHARPE RATIO	ANNUALIZED RATE OF RETURN	STANDARD DEVIATION	UPSIDE CAP
Russell 1000 Growth	0.11	12.95	19.63	100
Russell 1000 Value	0.16	13.94	13.74	100
Russell 2000 Growth	0.05	7.65	25.19	100
Russell 2000 Value	0.11	12.12	18.50	

Source: PSN/Effron

TABLE 2

Sample Performance of Large Growth Managers

7-YEAR PERIOD 6/1987 – 6/1994

CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	30	0.1087	0.4817	0.0747	0.0406	0.2280	0.0935
2	18	0.0750	0.2233	0.0350	0.0198	0.2144	0.0285
3	56	0.0766	0.0280	0.0067	0.0223	0.2318	0.0330
4	2	0.0550	(0.1000)	(0.0100)	0.0071	0.0283	0.0000
Total	106	0.0850	0.1872	0.0292	0.0318	0.3001	0.0629
	Median	0.0800	0.1650	0.0200			
RUS 1000 GROWTH		0.0600					

7-YEAR PERIOD 6/1994 - 6/2001

CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	17	0.1924	0.5141	0.0629	0.0309	0.3026	0.0322
2	10	0.1510	0.2800	0.0520	0.0281	0.3291	0.0527
3	71	0.1876	(0.0748)	(0.0038)	0.0341	0.2047	0.0424
4	8	0.1163	(0.4388)	(0.0288)	0.0130	0.3140	0.0189
Total	106	0.1795	0.0257	0.0104	0.0381	0.3547	0.0493
	Median	0.1800	0.0200	0.0100			
RUS 1000 GROWTH		0.1500					

5-YEAR PERIOD 6/1986 - 6/1991

CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	29	0.1166	0.5379	0.0648	0.0398	0.2151	0.0810
2	17	0.0871	0.2765	0.0306	0.0140	0.2143	0.0222
3	79	0.0842	(0.0922)	(0.0050)	0.0277	0.2956	0.0378
4	4	0.0450	(0.3325)	(0.0300)	0.0238	0.1737	0.0216
Total	129	0.0906	0.0906	0.0147	0.0331	0.3820	0.0570
	Median	0.0900	0.1000	0.0100			
RUS 1000 GROWTH		0.0800					

5-YEAR PERIOD 6/1991 - 6/1996

CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	19	0.3211	0.5374	0.1426	0.0488	0.3264	0.1178
2	29	0.2366	0.1014	0.0438	0.0380	0.3422	0.0859
3	64	0.3048	(0.1853)	(0.0289)	0.0577	0.3508	0.0789
4	17	0.1976	(0.6400)	(0.0653)	0.0297	0.4850	0.0394
Total	129	0.2778	(0.0743)	0.0096	0.0654	0.4917	0.1078
	Median	0.2700	(0.0400)	(0.0100)			
RUS 1000 GROWTH		0.2900					

5-YEAR PERIOD 6/1996 - 6/2001

CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	40	0.1490	0.6375	0.0865	0.0343	0.3426	0.0689
2	31	0.1100	0.2755	0.0497	0.0257	0.2967	0.0489
3	108	0.1371	0.0573	0.0231	0.0314	0.2156	0.0486
4	9	0.0622	(0.5700)	(0.0425)	0.0172	0.3408	0.0167
Total	188	0.1316	0.1867	0.0368	0.0363	0.3901	0.0601
	Median	0.1300	0.1400	0.0300			
RUS 1000 GROWTH		0.1000					

TABLE 3

Sample Performance of Large Growth Managers

3-YEAR PERIOD 6/1986 - 6/1989							
CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	45	0.1124	0.8060	0.1300	0.0535	0.3817	0.1291
2	18	0.0650	0.3906	0.0329	0.0158	0.3703	0.0226
3	67	0.0667	0.0234	0.0237	0.0377	0.3083	0.0742
4	5	0.0120	(0.8080)	(0.0440)	0.0179	0.2305	0.0207
Total	135	0.0797	0.3024	0.0564	0.0482	0.5336	0.1044
	Median	0.0700	0.2700	0.0300			
RUS 1000 GROWTH		0.0500					

3-YEAR PERIOD 6/1989 - 6/1992							
CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	15	0.1740	0.6660	0.0700	0.0297	0.4508	0.0497
2	36	0.1406	0.3439	0.0481	0.0278	0.3638	0.0578
3	67	0.1216	(0.3857)	(0.0502)	0.0495	0.4824	0.0790
4	17	0.0812	(0.7194)	(0.0641)	0.0257	0.3963	0.0330
Total	135	0.1274	(0.1163)	(0.0113)	0.0464	0.6301	0.0834
	Median	0.1300	(0.1100)	(0.0100)			
RUS 1000 GROWTH		0.1300					

3-YEAR 6/1992 - 6/1995							
CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	38	0.3242	0.7871	0.3139	0.0675	0.4256	0.4297
2	25	0.2132	0.2584	0.0744	0.0466	0.4567	0.0905
3	104	0.2617	(0.0813)	0.0028	0.0618	0.3737	0.0813
4	30	0.1430	(0.6983)	(0.0823)	0.0377	0.4155	0.0391
Total	197	0.2495	0.0354	0.0588	0.0801	0.6035	0.2382
Median		0.2400	0.0200	0.0100			
RUS 1000 GROWTH		0.2400					

3-YEAR 5/1995 - 6/1998							
CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	36	0.6725	0.6000	0.1164	0.0935	0.3859	0.0710
2	18	0.5222	0.4678	0.1018	0.1059	0.4242	0.0794
3	37	0.6081	(0.4638)	(0.0665)	0.0928	0.4263	0.0687
4	14	0.4929	(0.5350)	(0.0779)	0.1254	0.4416	0.0495
Total	105	0.6001	0.0511	0.0226	0.1190	0.6646	0.1134
	Median	0.6200	0.0700	0.0200			
RUS 1000 GROWTH		0.6200					

3-YEAR 6/1998 - 6/2001							
CAPTURE QUADRANT	TOTAL NUMBER	SHARPE AVERAGE	SELECTION AVERAGE	SORTINO AVERAGE	SHARPE SD	SELECTION SD	SORTINO SD
1	34	0.0659	0.8015	0.1235	0.0380	0.3763	0.0940
2	13	0.0446	0.3292	0.0769	0.0407	0.4012	0.0697
3	79	0.0243	0.1439	0.0516	0.0431	0.3243	0.0805
4	10	(0.0280)	(0.6110)	(0.0350)	0.0204	0.2999	0.0255
Total	136	0.0328	0.2705	0.0638	0.0470	0.5039	0.0895
	Median	0.0300	0.2550	0.0500			
RUS 1000 GROWTH		0.0000					

positive Sortino ratio alone guarantees a higher ranking over the third-quadrant funds with negative Sortino ratios. Due to the selection ratio's identical ranking relative to the Sortino ratio, its greater familiarity, and its ability to more succinctly test returns, I've chosen to focus on the selection ratio alone for future-return prediction tests.

It is interesting to note that there are noticeably fewer fourth-quadrant large-growth and small-growth managers during this study period[6] compared with other quadrants. Large-value and—to a lesser extent—small-value managers, however, had more fourth-quadrant managers than the other style groupings. I attribute this to the fact that this fifteen-year period was particularly favorable to value. It seems active managers were able to more easily add relative performance when their styles were out of favor.

It is no surprise that the first-quadrant managers rank the best and the fourth-quadrant fare the worst; going up more than one's benchmark and down less is a sure recipe for superior returns, and going up less than one's benchmark and down more is a sure recipe for inferior returns. It was uncertain, however, whether the second or third quadrants would rank higher. One might intuitively favor third-quadrant managers over second-quadrant managers because negative returns have more impact than positive returns. For example, it takes a 100-percent positive return to recover from a 50-percent negative return. So one might hypothesize that a 90-percent upside and 90-percent downside capture ratio (the third-quadrant manager) would have more return than a 110-percent upside and 110-percent downside capture ratio (the second-quadrant manager). The outcomes also depend, however, on the frequency and magnitude of the upside and downside returns, which are usually quite different. For this fifteen-year period, almost 75 percent of most style categories' quarterly returns were positive. Meanwhile, the total upside return for the large-value index ending in June 2001 was a staggering 1,532 percent, or an annualized return of 26.2 percent. The cumulative downside return was a negative 57 percent, or an annualized return of –24.3 percent.

Figure 1 reports the annualized return for six different capture-ratio scenarios on the large-value index during the entire fifteen-year period. For example, a second-quadrant manager maintaining both 110-percent upside and downside capture earned a return of 15.07 percent for the fifteen-year period ending June 2001, whereas a third-quadrant manager maintaining both 90-percent upside and downside ratios earned just 12.75 percent for this same period. The third-quadrant manager had roughly 2.25 percent less annualized return (12.75 percent vs. 15.07 percent) than the second-quadrant manager. To further show the importance of the upside over the downside capture ratio for this period, compare the 110-percent upside and 100-percent downside versus the 100-percent upside and the 110-percent downside capture manager. The former added almost 2 percent per annum to the return by capturing an extra 10 percent of the upside, whereas the latter lost only 0.74 percent annualized for capturing an additional 10 percent of the downside. When considering the effects of compounding, the case is only more compelling. The 110 percent/100 percent manager adds more than 200 percent of cumulative return to the benchmark return, whereas the 100 percent/110 percent manager only gives up about 66 percent of cumulative return. Hence it becomes apparent that one is better off capturing more downside if one can in return capture more upside in return. Of course, if the future relative frequency and magnitude of up and down returns changes significantly, the third-quadrant managers could perform better than the second-quadrant managers. The formulas for calculating return and excess return for a given set of capture ratios are given in Appendix B.

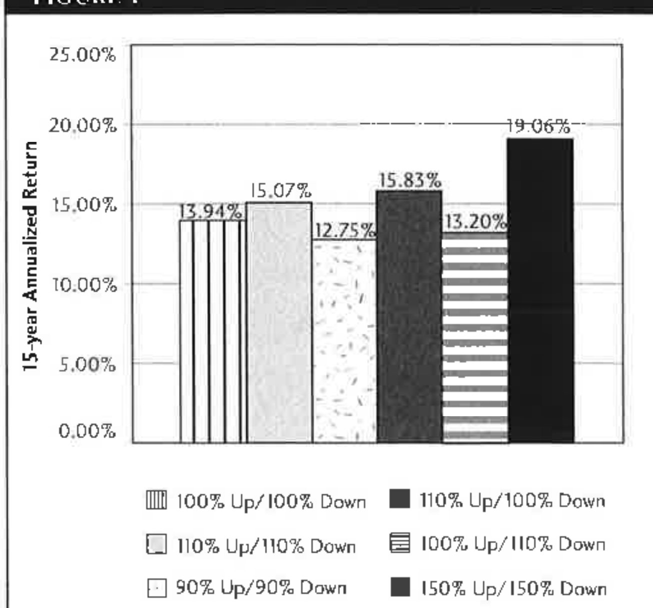
In the end, the real use of analyzing the past capture ratio is to explain the origin of a manager's past return. That is, did the manager add (or take away) return by capturing more (or less) of the benchmark's upside and/or capturing less (or more) of the benchmark's downside? Does the ratio tell us anything about the future?

Capture Ratio Persistence

Table 4 provides the capture-ratio persistence for the style categories.[7] Again, I categorized each manager by style-category group and then divided each group into capture-ratio quadrants for each subperiod. I then followed a style-specific capture-ratio quadrant group from one period to the next to see how many managers in the subsequent period have the same capture ratio they had in the previous period. This created thirty-five tables of tests: five style categories with seven subperiods (one seven-year, two five-year, and four three-year). I determined whether a style-specific quadrant group persisted into the subsequent period with chi square tests for statistical significance using alphas of 5 percent and 10 percent (that is, confidence levels of 95 percent and 90 percent, respectively, that the persistence is not due to chance).

It is important to remember that persistence can be negative or positive. For second- and third-quadrant managers, persisting negatively

FIGURE 1



is defined as obtaining a lesser ranking for the next period (that is, the second-quadrant manager gets ranked subsequently in the third or fourth quadrant and the third-quadrant manager gets ranked subsequently in the fourth quadrant). First-quadrant managers become negatively persistent if they move into any other quadrant. Fourth-quadrant managers persist negatively if they remain in the fourth quadrant. (Although it could be said this is positively persisting, I chose to classify it as negative to be consistent with the other three quadrants. This classification also shows us if the fourth-quadrant managers improve in the future.) If a capture-ratio persisted positively, it was recorded as one period of positive persistence. If, on the other hand, a capture-ratio quadrant persisted negatively, it was reported as one negative period.

Table 4 reduces the resulting thirty-five tables to four for brevity of reporting. The numbers in these condensed tables represent the percentage of periods that had statistically significant persistence. For example, for large-domestic I combined U.S. large-value and growth managers. For the seven-year test period, table 4 shows that the large domestic-equity second-quadrant managers *positively* persisted at alphas[8] of both 5 percent and 10 percent for 50 percent of the periods. This means that for one of the periods (50 percent), the second-quadrant managers persisted on a statistically significant basis and for the other period they did not persist positively or negatively. (If they would have *negatively* persisted one of the two periods, it would have been recorded as –50 percent instead of +50 percent.)

Remember, however, this is a summary of the number of periods for the given style categorization table, which for all but the fixed-income table includes multiple style categories. In the large domestic-equity grouping, for example, the style-category periods of both large-value and large-growth have again been combined. Hence the total of two periods found in the seven-year test period represents the results of one large-value *and* one large-growth style category. In this case, the seven-year-period 50 percent for second-quadrant managers represents large growth persisting for its one and only seven-year test period and the large value not persisting for its one and only seven-year test period (that is, one out of two periods or 50 percent)." Assuming there is no relationship between past and future capture ratio (the null hypothesis), the style-specific manager quadrants should persist 5 percent and 10 percent of the periods at alphas of 5 percent and 10 percent, respectively.

TABLE 4

Capture Ratio Quadrant Persistence

	ALL STYLE CATEGORIES % FUTURE SIGNIFICANT PERIODS				
	TOTAL	QUADRANT			
PERIOD/*a*	PERIODS	1	2	3	4
7-Year/ 10%	5	-20%	33%	20%	0%
7-Year/ 5%	5	-20%	33%	0%	0%
5-Year/ 10%	10	-10%	57%	0%	-20%
5-Year/ 5%	10	-10%	43%	10%	0%
3-Year/ 10%	20	0%	63%	35%	7%
3-Year/ 5%	20	0%	50%	25%	7%
ALL / 10%	35	-6%	58%	23%	0%
ALL / 5%	35	-6%	46%	17%	5%

	LARGE DOMESTIC EQUITY % FUTURE SIGNIFICANT PERIODS				
	TOTAL	QUADRANT			
PERIOD/*a*	PERIODS	1	2	3	4
7-Year/ 10%	2	-50%	50%	50%	0%
7-Year/ 5%	2	-50%	50%	0%	0%
5-Year/ 10%	4	-25%	75%	25%	0%
5-Year/ 5%	4	-25%	75%	25%	0%
3-Year/ 10%	8	0%	63%	50%	13%
3-Year/ 5%	8	0%	63%	50%	13%
ALL / 10%	14	-14%	64%	43%	7%
ALL / 5%	14	-14%	64%	36%	7%

	ALL DOMESTIC EQUITY % FUTURE SIGNIFICANT PERIODS				
	TOTAL	QUADRANT			
PERIOD/*a*	PERIODS	1	2	3	4
7-Year/ 10%	4	-25%	33%	25%	0%
7-Year/ 5%	4	-25%	33%	0%	0%
5-Year/ 10%	8	-13%	38%	13%	0%
5-Year/ 5%	8	-13%	38%	13%	0%
3-Year/ 10%	16	0%	50%	38%	7%
3-Year/ 5%	16	0%	38%	25%	7%
ALL / 10%	28	-7%	44%	29%	4%
ALL / 5%	28	-7%	37%	18%	4%

	FIXED INCOME % FUTURE SIGNIFICANT PERIODS				
	TOTAL	QUADRANT			
PERIOD/*a*	PERIODS	1	2	3	4
7-Year/ 10%	1	0%	0%	0%	0%
7-Year/ 5%	1	0%	0%	0%	0%
5-Year/ 10%	2	0%	50%	-50%	-100%
5-Year/ 5%	2	0%	0%	0%	0%
3-Year/ 10%	4	0%	50%	25%	0%
3-Year/ 5%	4	0%	50%	25%	0%
ALL / 10%	7	0%	43%	0%	-17%
ALL / 5%	7	0%	29%	14%	0%

TABLE 5

Future Performance Prediction Ability

ALL STYLE CATEGORIES — % FUTURE PERIODS WITH SUPERIOR SELECTION RATIOS

PERIOD/a	TOTAL PERIODS	QUADRANT 1	QUADRANT 2	QUADRANT 3	QUADRANT 4	TOP 25% SR	TOP 25% UC
7-Year/ 10%	5	20%	67%	-20%	0%	20%	40%
7-Year/ 5%	5	20%	33%	-20%	0%	20%	40%
5-Year/ 10%	10	30%	57%	-50%	-40%	40%	60%
5-Year/ 5%	10	20%	57%	-30%	-40%	20%	40%
3-Year/ 10%	20	14%	50%	-40%	-13%	20%	40%
3-Year/ 5%	20	16%	25%	-10%	-13%	15%	25%
ALL / 10%	35	21%	54%	-40%	-19%	26%	46%
ALL / 5%	35	18%	35%	-17%	-19%	17%	31%

LARGE DOMESTIC EQUITY — % FUTURE PERIODS WITH SUPERIOR SELECTION RATIOS

PERIOD/a	TOTAL PERIODS	QUADRANT 1	QUADRANT 2	QUADRANT 3	QUADRANT 4	TOP 25% SR	TOP 25% UC	TOP 25% BOTH
7-Year/ 10%	2	0%	100%	-50%	0%	50%	100%	100%
7-Year/ 5%	2	0%	50%	-50%	0%	50%	100%	100%
5-Year/ 10%	4	50%	75%	-75%	-25%	25%	100%	75%
5-Year/ 5%	4	50%	75%	-50%	-25%	25%	50%	25%
3-Year/ 10%	8	25%	75%	-63%	0%	13%	63%	38%
3-Year/ 5%	8	25%	38%	-25%	-13%	0%	63%	38%
ALL / 10%	14	29%	79%	-64%	-7%	21%	79%	57%
ALL / 5%	14	29%	50%	-36%	-14%	14%	64%	43%

ALL DOMESTIC EQUITY — % FUTURE PERIODS WITH SUPERIOR SELECTION RATIOS

PERIOD/a	TOTAL PERIODS	QUADRANT 1	QUADRANT 2	QUADRANT 3	QUADRANT 4	TOP 25% SR	TOP 25% UC
7-Year/ 10%	4	0%	67%	-25%	0%	25%	50%
7-Year/ 5%	4	0%	33%	-25%	0%	25%	50%
5-Year/ 10%	8	25%	50%	-50%	-29%	25%	50%
5-Year/ 5%	8	25%	50%	-38%	-29%	13%	25%
3-Year/ 10%	16	13%	44%	-50%	0%	13%	31%
3-Year/ 5%	16	19%	19%	-19%	-7%	6%	25%
ALL / 10%	28	14%	48%	-46%	-9%	18%	39%
ALL / 5%	28	18%	30%	-25%	-13%	11%	29%

FIXED INCOME — % FUTURE PERIODS WITH SUPERIOR SELECTION RATIOS

PERIOD/a	TOTAL PERIODS	QUADRANT 1	QUADRANT 2	QUADRANT 3	QUADRANT 4	TOP 25% SR	TOP 25% UC	TOP 25% BOTH
7-Year/ 10%	1	100%	0%	0%	0%	0%	0%	0%
7-Year/ 5%	1	100%	0%	0%	0%	0%	0%	0%
5-Year/ 10%	2	50%	0%	-50%	0%	100%	100%	100%
5-Year/ 5%	2	0%	0%	0%	0%	50%	100%	50%
3-Year/ 10%	4	25%	25%	0%	-50%	50%	75%	50%
3-Year/ 5%	4	0%	25%	25%	-25%	50%	25%	25%
ALL / 10%	7	43%	14%	-14%	-33%	57%	71%	57%
ALL / 5%	7	14%	14%	14%	-17%	43%	43%	29%

SR = *selection ratio* UC = *upside capture ratio*

Overall, the large domestic-equity style categories had the strongest persistence, with second-quadrant managers persisting on a statistically significant basis for almost two-thirds of all periods. The third quadrant managers persisted 43 percent of the periods, at an alpha of 10 percent and 36 percent of the periods at an alpha of 5 percent. Meanwhile, the first- and fourth-quadrant managers performed slightly contrarily; the fourth-quadrant managers tended to fair better in the future, and first-quadrant managers tended to fair worse in the future, sometimes on a statistically significant basis. This reverting to the mean of the first-and fourth-quadrant managers confirms the previous research findings. However, unlike the original findings, here the second quadrant persists more strongly than the third quadrant. This is fortuitous, because second-quadrant managers are consistently better performers than third-quadrant managers when it comes to actual returns. Again, in a prolonged period of negative returns the third-quadrant managers could prove the better performers. Nonetheless, this fifteen-year study period did have some subperiods with poor performance.

The previous research found third-quadrant managers to have fairly strong persistence and second-quadrant managers to have only mild persistence. Specifically, the previous research found that third-quadrant managers persisted at an alpha of 5 percent four out of seven periods (57 percent) and the second-quadrant managers persisted a net of one out of seven periods (14 percent). Compare this with large domestic-equity in this study for both value and growth, which persisted 36 percent and 64 percent (vs. 57 percent and 14 percent in the previous study) for third-quadrant and second-quadrant managers, respectively, for all periods at an alpha of 5 percent. Furthermore, here this trend of greater persistence among second-quadrant managers is consistent across every single style category, whereas the previous study only covered growth and income mutual funds (large/mid value domestic equities). One possible reason for the different findings is that the original study did not explicitly neutralize for style differences, and the current study did. In addition, this study's use of institutional-manager return series instead of mutual funds may have changed the results. Needless to say, I consider the results of the current study much more robust.

Predicting the Future Winners

The capture ratio presents a challenge because it consists of only four discrete values. It is unlike the Sharpe or selection ratios, which give as many rankings as there are managers, with enough decimal places so that no two managers have identical risk-adjusted returns. Consequently, with capture-ratio quadrant rankings one can have a second-quadrant manager who may have a 200-percent upside ratio and 101-percent downside ratio. This manager gets the exact same categorization as a manager with a 101-percent upside ratio and 200-percent downside ratio. Obviously, the former manager is the preferred manager. Similarly, a manager with 110-percent upside ratio and 99-percent downside ratio would receive the coveted first-quadrant manager ranking, besting the second-quadrant ranking of the 200-percent upside and 101-percent downside manager. Yet, the latter manager would actually be preferred on a risk-adjusted return basis, or would have been preferred during our fifteen-year time period.

Previous studies such as Blake (1996) and Grinold (1990) have found that the selection ratio is a good predictor of future risk-adjusted performance. This study compares the predicting performances of the upside capture ratio and selection ratio. The upside capture ratio is infinitely scaled like the Sharpe and selection ratios, so they can be more succinctly compared. In addition, the upside capture ratio has more impact on the total return than the downside for this study's fifteen-year period because there was more upside total return and periods than down. Furthermore, for some periods the downside capture had a negative correlation to the future risk-adjusted return of the portfolio, whereas the upside capture virtually always had a positive correlation to future risk-adjusted return. Thus using the upside and downside capture together (via the capture-ratio quadrant ranking), could possibly obscure good information found in the more consistently positively correlated upside capture ratio.

Table 5 reports the future-performance prediction ability of each respective datum. For this test, I again categorized each manager into a style category and then created style-category group returns over each test subperiod. Each style-category group of managers was further divided into capture-ratio quadrants for a given subperiod. Next, a capture-ratio quadrant group's return was tracked into the subsequent period to determine if the particular group's future return was statistically any different from the average of the whole group of managers in its style-specific category (that is, all four capture-ratio quadrants of that style category). For example, I divided large-growth managers into their respective capture-ratio quadrants for the three-year period between June 1986 and June 1989. Next, I tracked each capture-ratio quadrant group of managers and compared each of the four groups' returns during the subsequent three-year period (June 1989 to June 1992) to the return of the entire large-growth group of managers during the same period (that is, the average return of the entire style group for that period). Remember that return is measured as risk-adjusted active return using the selection ratio. Thus the future return of an entire style category is defined as the equally weighted average of all the given style category managers' future selection ratios. A t-test determined if the difference in return from the entire style group was statistically significant for any capture-ratio quadrant.

Future selection ratio differences were tested at alphas of 5 percent and 10 percent. The resulting thirty-five test tables are summarized in table 5.

Among large domestic style categories, the second-quadrant managers have future superior performance at an alpha of 10 percent for a remarkable 79 percent of the periods studied; pure randomness would suggest persistence just 10 percent of the time. At an alpha of 5 percent, the second-quadrant has superior future performance in 50 percent of the periods studied. At least for this study period, the second-quadrant predicts future superior performance of large domestic-equity managers eight to ten times more often than what simple randomness would suggest. For all domestic equity managers the rate falls between five and six times.

Interestingly, in the earlier study, for three-year periods the second-quadrant funds alternated periods of superior and inferior performance. We hypothesized this was due to style effects, as growth and income funds can have different capitalizations and value and growth weights. This study did not encounter this phenomenon because it strictly controlled for style differences. For all domestic-equity style groups, the second-quadrant fund rankings also better predict superior future performers than either the selection ratio or the upside capture ratio. For fixed-income, however, the upside capture ratio provided markedly better prediction ability. Interestingly, for fixed-income the first-quadrant ratio becomes the best predictor of superior performance both ex-post and ex-ante. It would be interesting to see if this relationship holds for fixed-income styles other than the intermediate fixed-income managers studied here.

The upside capture roughly matches the second-quadrant capture ratio at predicting future superior performance. The major exception is with fixed-income, where the upside capture does exceedingly better. Interestingly, Chandler (1999) shows selection ratio and alpha to be very good predictors of future fixed-income manager performance. Here the upside capture is an even stronger predictor than the selection ratio. This supports the hypothesis that most of the good information in the capture ratio is contained in the upside capture ratio, at least for this fifteen-year study period. Before shunning the capture-ratio quadrant-ranking scheme in favor of only using the upside capture ratio, remember that this fifteen-year period was marked with exceptional upside performance in both frequency and magnitude. If in the future, however, downside performance increases in frequency or magnitude, the capture ratio utilizing both upside and downside likely will be more valuable than the upside alone.

Care should be taken when viewing the ALL periods data because, in one sense, it double counts some periods. That is, embedded in a seven-year period of data is one five-year period and two three-year periods. This is why results are also reported for specific periods. None of the periods, however, is completely composed of another subset of periods.

Beta Test

The capture ratio may simply be a proxy for beta and thus an unnecessary additional construct. Table 6 reports the beta relationship among domestic-equity style categories. The top table shows the correlation between beta (market risk for each respective

TABLE 6

Beta Risk Relationship for Domestic Equities

IN-SAMPLE BETA CORRELATIONS

	TOTAL PERIODS	STANDARD DEVIATION	DOWNSIDE CAPTURE	UPSIDE CAPTURE
7-Year Average	8	0.84	0.87	0.64
Standard Deviation	—	0.10	0.06	0.21
Minimum	—	0.66	0.78	0.37
Maximum	—	0.97	0.93	0.88
5-Year Average	12	0.80	0.80	0.64
Standard Deviation	—	0.19	0.13	0.20
Minimum	—	0.35	0.50	0.25
Maximum	—	0.96	0.93	0.90
3-Year Average	20	0.75	0.73	0.61
Standard Deviation	—	0.20	0.13	0.17
Minimum	—	0.35	0.44	0.33
Maximum	—	0.98	0.92	0.91
ALL Average	40	0.79	0.78	0.62
Standard Deviation	—	0.18	0.13	0.18
Minimum	—	0.35	0.44	0.25
Maximum	—	0.98	0.93	0.91

OUT-OF-SAMPLE BETA CORRELATIONS

	TOTAL PERIODS	DOWNSIDE CAPTURE	UPSIDE CAPTURE	FUTURE BETA
7-Year Average	0.25	0.41	0.30	0.42
Total Periods	4	4	4	4
# Sig. Periods	1	2	2	3
% Sig. Periods	25%	50%	50%	75%
5-Year Average	0.27	0.34	0.26	0.39
Total Periods	8	8	8	8
# Sig. Periods	4	5	3	5
% Sig. Periods	50%	63%	38%	63%
3-Year Average	0.38	0.35	0.30	0.46
Total Periods	16	16	16	16
# Sig. Periods	9	9	7	12
% Sig. Periods	56%	56%	44%	75%
ALL Average	0.33	0.35	0.29	0.43
Total Periods	28	28	28	28
# Sig. Periods	14	16	12	20
% Sig. Periods	50%	57%	43%	71%

style category) and standard deviation (total risk), downside capture, and upside capture. Beta was calculated using the appropriate style-category benchmark. Beta was most highly correlated with the standard deviation and downside capture; for all style categories and periods the average correlations were 0.79 and 0.78, respectively. The beta for all time periods, however, carried a lower correlation with the upside capture ratio of 0.62.

Out-of-sample, the overall correlations dropped drastically, as reported in the bottom of table 6. Studying the correlations out-of-sample means calculating the beta for one style specific subperiod, then following the same group of managers into the next style-specific subperiod and calculating the correlation between the two periods. If a group's betas perfectly predict the managers' subsequent period betas, the correlation is 1. If there is no linear relationship between the managers' betas in past and subsequent periods, the correlation is 0. The same examination for beta's correlation to *future* standard deviation, downside capture and upside capture ratios found, for all subperiods, that past beta carried a 0.43 correlation with the future beta. Meanwhile, past beta carried a correlation with the future standard deviation, downside capture, and upside capture of 0.33, 0.35 and 0.29, respectively. Viewing this another way, past beta explained the future variance of upside capture by roughly 8.4 percent ($(0.29)^2$).

Also reported in the bottom of table 6 is the number of periods the future correlation is significant. Here significance is defined as an R^2 of 10 percent or more, indicating that the past beta explained 10 percent or more of the variance of the future variable in question. Using this criterion, the future beta was explained by past beta for 71 percent of all periods. Interestingly, past and future betas of growth managers (small-cap and large-cap) had a significant R^2 for *all* periods, whereas value managers had a significant R^2 for only 43 percent of the periods. This phenomenon is consistent among large and small capitalizations. Hence, at least for this fifteen-year period, past beta as an estimate of future beta was a much more meaningful measure for growth managers than value managers.

Prognostications and Implications

These expanded findings lead to several profitable lessons and the following guidelines:

- This research robustly confirmed previous findings that second-quadrant managers provide the best prospects for future superior risk-adjusted performance among all domestic-equity style categories. First-quadrant managers provide the best future-performance prospects for fixed-income, albeit the study included only intermediate fixed-income managers.
- Unlike the earlier study, which found mild persistence among second quadrant managers and the strongest persistence among third-quadrant managers, this study found the best persistence among second-quadrant managers and milder persistence among

third-quadrant managers. The first study found that second-quadrant managers did not persist as strongly in the same quadrant and yet did persist in having the best future returns. This is explained by the second-quadrant managers in the first study moving to the first-quadrant (which has even better subperiod returns than the second-quadrant). Because the current study strictly controlled for style, the second-quadrant managers remained in their quadrant but still had the best future performance because first-quadrant managers tended to perform worse in the future. Also, similar to the first study, the fourth-and first-quadrant managers tended to rank contrarily in the future. Therefore, the second-quadrant managers, and to a lesser extent the third-quadrant managers, provide us a glimpse of their future upside and downside return patterns simply from their past ratios.

- The upside capture ratio alone provides robust predictions of future superior performers. In fact, for fixed-income the upside capture ratio is a better measure for identifying future performance than second-quadrant membership. However, if future periods sustain a greater number and magnitude of negative quarters, the downside capture ratio may provide more predictive power, and consequently the capture ratio quadrant ranking may be much more valuable than the upside capture alone.

Conclusion

This research significantly broadened the original study of the capture ratio. It addressed only growth and income mutual funds; this study addressed seven major style categories of separately managed account managers covering equity value and growth styles, varying capitalizations, and fixed-income. The capture-ratio quadrants accurately identified past superior performers and explicated a manager's origin of returns. Even more importantly, the capture-ratio quadrants tended to predict future superior risk-adjusted performers when utilizing second-quadrant managers for domestic-equity style categories and first-quadrant managers for fixed-income. While certainly not ideal, the capture-ratio quadrant analysis was significantly more successful than the more widely used selection ratio in predicting future performers in all domestic-equity classes. Lastly, a further examination of the capture ratio's relation to beta showed that, on an in-sample basis, beta was modestly correlated with the capture ratio. In out-of-sample periods, however, the relationship was rather weak. Hence the broadening evidence suggests that the capture ratio should garner more attention than presently afforded it.

Appendix A

The following table is a simplistic example of some of the problems with the standard deviation's equal treatment of deviations, whether they are positive or negative, regardless of the return distribution:

YEAR	BASE CASE	PLUS 5% DEVIATION RETURN	MINUS 5% DEVIATION RETURN	PLUS 40% DEVIATION RETURN
1	12.00%	12.00%	12.00%	12.00%
2	16.00%	16.00%	16.00%	16.00%
3	5.00%	5.00%	5.00%	5.00%
4	N/A	16.00%	6.00%	51.00%
Average	11.00%	12.25%	9.75%	21.00%
Risk	5.57%	5.19%	5.19%	20.51%
Sharpe	1.26	1.59	1.11	0.83
Skewness	-0.78215	-1.31582	0.456508	1.703767

The base case column is three years of contrived return data. Here, the arithmetic averages (rather than geometric averages, for simplicity—the rankings using geometric averages are identical and the two averages are quite similar) are 11 percent. The risk or standard deviation is 5.57 percent. This gives a Sharpe ratio of 1.26, assuming a risk-free rate of 4 percent. Note that the distribution is positively skewed. In fact, none of the distributions is normal.

The "Plus 5% Deviation" column adds a fourth year of return data 5 percent *above* the previous average return of 11 percent (that is, a 16 percent return). The result is more average return and a new lower risk level of 5.19 percent.

The "Minus 5% Deviation" column also adds a fourth year of data 5 percent *below* the previous 11 percent average. The result is obviously less average return, but the ending risk level is the *same 5.19 percent* as when the deviation was 5 percent above the previous average. Hence, the standard deviation changes by precisely the same amount whether or not the risk is good (above-average deviation) or bad (below-average deviation). That is, the deviations are treated equally without regard to direction.

In this instance, when combining the newer lower return, the Sharpe ratio shows the return series with added "good risk" (the plus 5 percent deviation) as better than the "bad risk" return series. To underscore how the Sharpe ratio can still misclassify, the final column "Plus 40% Deviation" has a fourth-year return 40 percent greater than the previous average (51 percent). The result is a much higher average return and a much higher risk level. Solely because of "good risk," this return series Sharpe ratio drops drastically to be relegated to last place, all because of an extraordinary excess return. The Sharpe ratio says this return series *would have been more favorable* if this investment would have lagged its average by 5 percent rather than to have exceeded it by 40 percent. Most rational investors would disagree.

Appendix B

Formula for total annualized return per given capture ratios:

$R_T = ((1+C_u x R_u)^{(U/t)} x(1+C_d x R_d)^{(D/t))^{[illegible]}} -1$

where

R_T = total annualized return garnered for the given upside and downside capture ratios

R_u = annualized return of the benchmark during all up (positive) quarters

R_d = annualized return of the benchmark during all down (negative) quarters

C_u = manager's upside capture ratio

C_d = manager's downside capture ratio

U = number of up (positive) quarters for the benchmark

D = number of down (negative) quarters for the benchmark

[Note: With a C_u of 100 percent and a C_d of 100 percent, the above formula simply reduces to the following formula (which is the benchmark return):

$R_B = ((1+R_u)^{(U/4)} x(1+R_d)^{(D/4)(4/(D+U))} -1]$

Formula for annualized excess return (in excess of annualized benchmark return) per given capture ratios:

Therefore, to solve for the excess return added (or taken away) via a given capture ratio, subtract the benchmark from the above generic formula to arrive at the following:

$R_E=((1+C_u x R_u)^{(U/4)} x(1+C_d x R_d)^{(D/4)(4/(D+U))} - (R_B + 1)$

[Note: $R_B + 1=((1+R_u)^{(U/4)} x (1+R_d)^{(D/4)(4/(D+U))}$

Also, if using monthly rather than quarterly data, replace all 4s in the exponents with 12s.]

ENDNOTES

1. The year ending June 2001 was chosen because it was the most recent quarterly database data available when the research began in the fall of 2001.

2. The study also addressed international value and growth managers, but the sample sizes were too small over many of the test periods, so these results were excluded.

3. Results for large-growth managers only were reported in this paper. Large growth was the first and the largest style category tested; its data was copied for representation.

4. The **Sharpe ratio** is calculated as follows:

$(R_M - R_F)/ \sigma_M$

where

R_M = return of manager

R_F = risk free rate

σ_M = standard deviation of manager return

The **Sortino ratio** is calculated as follows:

$(R_M - R_F)/ \sigma_{SD}$

where

R_M = return of manager

R_F = risk free rate

σ_{SD} = semi-standard deviation of manager return

The **selection ratio** is calculated as follows:

$(R_M - R_B)/ \sigma_A$

where

R_M = return of manager

R_B = return of benchmark

σ_A = standard deviation of active return (i.e., active risk or tracking error)

5. See Appendix A for a more in-depth discussion on this dilemma of equally treating up and down deviations. The reason for the equal treatment is all deviations are squared when calculating variance, which the standard deviation is simply the square root of.

6. Tables for the other four style categories were omitted for the sake of brevity.

7. Style categories were grouped in various ways for ease of reporting. Each test throughout this study, however, was conducted on an individual style category basis (that is, large growth managers only).

8. That is, the period is found in the first part of the first column and the alpha, or *a*, is found in the second part of the first column, separated by a "/."

9. Remember, each style category of managers was tested solely among its own style category; but the results combined groupings of style cateories so as to reduce the thirty-five charts to just four tables.

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This report was written in 200X, and the analysis presented in the report does not include data since that date. Had more recent data been included, some of the conclusions reached in the article may have been different.

Asset allocation/diversification cannot guarantee a profit nor prevent loss in a declining market.

The indices are presented to provide you with an understanding of their historic long-term performance and are not presented to illustrate the performance of any security. Investors cannot directly purchase any index.

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Definition of terms:

Correlated: a broad class of statistical relationships between two or more random variables or observed data values

Ex-post: Latin for "After the fact."

Large Growth: Large-growth funds invest in big companies that are projected to grow faster than other large-cap stocks. Most of these funds focus on companies in rapidly expanding industries.

Large Value: Large-value funds focus on big companies that are less expensive or growing more slowly than other large-cap stocks. These funds often feature investments in energy, financial, or manufacturing sectors.

Small Growth: Small-growth funds focus on faster-growing companies whose shares are at the lower end of the market-capitalization range. These funds tend to favor companies in up-and-coming industries or young firms in their early growth stages. As a result, the category tends to move in sync with the market for initial public offerings. Many of these funds invest in the technology, health-care, and services sectors. Because these businesses are fast-growing and often richly valued, their stocks tend to be volatile.

Small Value: Small value funds invest in small-caps with valuations and growth rates below other small-cap peers. They tend to invest in manufacturing, financial, and energy sectors.

International Fixed Income: International Fixed Income funds invest in debentures outside of the United States.

FRC 1000 Growth: The Russell 1000 Growth Index measures the performance of the large-cap growth segment of the U.S. equity universe. It includes those Russell 1000 companies with higher price-to-book ratios and higher forecasted growth values.

FRC 1000 Value: The Russell 1000 Value Index measures the performance of the large-cap value segment of the U.S. equity universe. It includes those Russell 1000 companies with lower price-to-book ratios and lower expected growth values.

FRC 2000 Growth: The Russell 2000 Growth Index measures the performance of the small-cap growth segment of the U.S. equity universe. It includes those Russell 2000 companies with higher price-to-book ratios and higher forecasted growth values.

FRC 2000 Value: The Russell 2000 Value Index measures the performance of small-cap value segment of the U.S. equity universe. It includes those Russell 2000 companies with lower price-to-book ratios and lower forecasted growth values.

Lehman Brothers Intermediate Government/Corporate Bond Index: A benchmark index made up of the Lehman Brothers® Government and Corporate Bond indexes, including U.S. government Treasury and agency securities as well as corporate and Yankee bonds.

Sharpe Ratio: A risk-adjusted measure developed by William F. Sharpe, calculated using standard deviation and excess return to determine reward per unit of risk. The higher the Sharpe ratio, the better the fund's historical risk-adjusted performance.

Sortino Ratio: A variation of the Sharpe ratio which differentiates harmful volatility from volatility in general by replacing standard deviation with downside deviation in the denominator. Thus the Sortino Ratio is calculated by subtracting the risk free rate from the return of the portfolio and then dividing by the downside deviation. The Sortino ratio measures the return to "bad" volatility. This ratio allows investors to assess risk in a better manner than simply looking at excess returns to total volatility, since such a measure does not consider how often the price of the security rises as opposed to how often it falls. A large Sortino Ratio indicates a low risk of large losses occurring.

Selection Ratio: The number of people hired divided by the number of applicants. *Selection Ratio = Number of Hires / Number of Applicants*

Chi Square: any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-square distribution when the null hypothesis is true, or any in which this is *asymptotically* true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a chi-square distribution as closely as desired by making the sample size large enough.

Beta: A quantitative measure of the volatility of a given stock, mutual fund, or portfolio, relative to the overall market, usually the S&P 500.

Standard Deviation: A statistical measure of the historical volatility of a mutual fund or portfolio, usually computed using 36 monthly returns. More generally, a measure of the extent to which numbers are spread around their average.

Alpha: A coefficient which measures risk-adjusted performance, factoring in the risk due to the specific security, rather than the overall market. A high value for alpha implies that the stock or mutual fund has performed better than would have been expected given its beta (volatility).

Confidence level: The degree of likelihood that a startup will be able to accomplish the goals described in its business plan. More generally, a statistical calculation measuring the degree of certainty about a correlation, result or forecast.

T-test: The t-test assesses whether the means of two groups are *statistically* different from each other.

Ex Ante: Latin for "before the event."

R^2: A measurement of how closely a portfolio's performance correlates with the performance of a benchmark index, such as the S&P 500, and thus a measurement of what portion of its performance can be explained by the performance of the overall market or index. Values for r-squared range from 0 to 1, where 0 indicates no correlation and 1 indicates perfect correlation.