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**HEDGE FUND AND COMMODITY FUND INVESTMENT STYLES
IN BULL AND BEAR MARKETS**

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HEDGE FUND AND COMMODITY FUND INVESTMENT STYLES IN BULL AND BEAR MARKETS

Abstract

This study examines the performance of sixteen different hedge fund and commodity fund investment styles during rising and falling stock prices over the period 1990:01 through 1998:08. Since a primary motivation for investing in hedge funds and commodity funds is to diversify against falling stock prices, it is important to examine the performance of these funds during bear stock markets. The study evaluates hedge funds and commodity funds both as stand-alone assets and as portfolio assets, and in both bull and bear stock markets. In addition, it utilizes the Sharpe ratio as well as alternative safety-first performance criteria to evaluate the funds. We conclude that commodity funds generally provide greater downside protection than do hedge funds. Commodity funds have higher returns in bear markets than do hedge funds, and generally have an inverse correlation with stock returns in bear markets, while hedge funds typically exhibit a higher positive correlation with stock returns in bear markets than in bull markets. However, three hedge fund styles – market-neutral, event-driven, and global macro – provide fairly good downside protection while still providing more attractive returns over all markets than do commodity funds.

Hedge Fund and Commodity Fund Investment Styles in Bull and Bear Markets

A primary motivation for investing in alternative asset classes is to diversify against poor performance in traditional assets classes, particularly equities. It is important, therefore, that investors understand how these asset classes can be expected to perform in bear stock markets. This study examines the performance of two popular alternative asset classes in bear and bull stock markets, hedge funds and commodity funds.

Most studies of hedge fund and commodity fund performance do not distinguish between up and down stock markets (see Ackermann, McEnally, and Ravenscraft, 1999; Agarwal and Naik, 1999; Brown, Goetzmann, and Ibbotson, 1999; Edwards and Caglayan, 2000; Edwards and Liew, 1999a and 1999b; Fung and Hsieh, 1997; and Liang, 1998). Past studies also rely primarily on data from only the past decade, a time during which stock prices experienced a strong upward trend. Thus, the conclusions of these studies are based largely on an environment of rising stock prices. It is not clear how these funds would perform during a period of declining stock prices.

An exception to the foregoing studies is Schneeweis and Spurgin, 1998 and 1999, who find that the simple correlations between the returns on some alternative investments and stock returns are often quite different during extreme up and down movements in stock prices. Our study examines in greater detail the performance of hedge funds and commodity funds in bear versus bull stock markets. Specifically, we analyze the performance of sixteen different investment styles used by hedge funds and commodity funds as both stand-alone assets and portfolio assets. These styles are listed in Table 1, and descriptions of them can be found in Appendix A. In addition, we compute optimal portfolio weights for each of the investment

styles in both bull and bear stock markets, which are computed by including each of the investment styles in an optimum stock and bond portfolio and maximizing the Sharpe ratio of the portfolio. Finally, we evaluate the performance of the different hedge fund and commodity fund investment styles using safety-first performance criteria that emphasize limiting downside risk, and compare these results to those obtained using the more conventional Sharpe ratio performance criterion.

Our data is provided by Managed Accounts Reports (MAR), and consist of the monthly returns of 1665 hedge funds and 2345 commodity funds during the 104-month period 1990:01 through 1998:08. As of mid-1998 these funds together managed about \$175 billion, roughly two-thirds of the estimated total capital managed by all hedge funds and commodity funds. (For a more complete description of these data, see Edwards and Caglayan, 2000.) We construct both equally-weighted (EW) and value-weighted (VW) monthly return indexes for the various investment styles using the returns of individual hedge funds and commodity funds (including non-survivors) during the nine-year period 1990:01 through 1998:08. This differs from Schneeweis and Spurgin (1999), who use the indexes of hedge fund and commodity fund returns that are provided by data vendors, which may not include non-survivors.

I. Performance in Bull Versus Bear Stock Markets

To provide a benchmark against which to compare the performance of hedge funds and commodity funds in bull and bear markets, Tables 1 and 2 rank investment styles in terms of their overall performance during the 1990:01 through 1998:08 period. No distinction is made between bull and bear markets. Table 1 ranks the investment styles according to their respective individual Sharpe ratios, or as *stand-alone assets*. Table 2 ranks the investment styles as *portfolio assets*, based on their respective contribution to the performance of an optimum

diversified domestic stock and bond portfolio. Specifically, their rank is determined by the increase in the Sharpe ratio of the portfolio that results from their inclusion in an optimum stock and bond portfolio.¹ The optimal benchmark portfolio to which hedge funds and commodity funds are added consists of S&P 500 index stocks (23 percent), intermediate-term government bonds (70 percent), U.S. small stock index (3 percent), and long-term government bonds (4 percent). This portfolio produces the highest Sharpe ratio (0.92) during 1990:01 through 1998:08 of all domestic stock and bond index portfolios.

The rankings in Tables 1 and 2 are similar whether the styles are ranked as stand-alone or portfolio assets, or whether an EW or VW measure of returns is used. With respect to hedge funds, market-neutral, event-driven, and global macro are always ranked one, two, and three, no matter which ranking criterion is used or which return measure is used. An exception, not surprisingly, is short selling, which receives a higher ranking as a portfolio asset than as a stand-alone asset. Short-selling funds typically have a significant inverse correlation with stock returns, which makes them an attractive portfolio asset in declining stock markets. Although the rankings of commodity funds differ somewhat, when the same measure of return is used three of the four topped-ranked styles are the same in both Tables 1 and 2. When EW returns are used, financial, agriculture and currency are always in the top four styles. Similarly, when VW returns are used, private pools, financial, diversified, and agriculture are always in the top four styles. Thus, the same styles receive a top ranking whether they are ranked on the basis of individual Sharpe ratios or on the basis of their contribution to a diversified asset portfolio. This conclusion is undoubtedly driven by the fact that all styles have a relatively low correlation with returns on stocks and bonds.

To examine performance separately in bull and bear stock markets, Table 3 and 4 ranks

the respective investment styles separately for bull- and bear-market months, using the same performance criteria used in Table 1 (stand-alone asset) and Table 2 (portfolio asset). Table 3 also provides, for bull- and bear-market months separately, mean annualized returns and Sharpe ratios for each investment style as well as the simple correlations between the monthly returns on each style and the monthly returns on the S&P 500 stock index.² Bull-market months are defined as those in which the S&P 500 index rises by one percent or more (or at an annualized rate of twelve percent or more), and bear-market months are defined as those in which the S&P 500 falls by one percent or more (or at an annualized rate of minus twelve percent or more). Of the 104 months during 1990:01-1998:08, 62 qualify as bull-market months and 25 as bear-market months. The mean annualized return for the S&P 500 index is 43.49 percent in bull-market months and minus 45.80 percent in bear-market months (see Table 3).

With respect to hedge funds, returns in bear markets are generally negative, and almost all styles exhibit significantly higher *positive* correlations with stock returns in bear markets than in bull markets (see Table 3). This is just the opposite from what an investor seeking diversification would hope for. Market-neutral funds and short-selling funds are the exceptions. Market-neutral funds continue to have positive returns even in bear markets, although their correlation with stock returns rises. Short-selling funds produce very high returns in bear markets and have an inverse correlation with stock returns in both bull and bear markets. However, although event-driven, global macro, and funds of funds all have negative returns in bear markets using EW returns (- 4.19 percent, - 4.52 percent, and - 3.61 percent respectively), these negative returns are far less than the 45.80 percent average annualized decline in S&P 500 stocks during those months. This partially explains why market-neutral, event-driven, and global macro funds are generally ranked among the top four styles in *both* bull and bear markets.

Commodity funds provide greater downside protection than hedge funds in bear markets. In general, commodity funds have *higher* returns in bear markets, and have an inverse (or lower positive) correlation with stock returns in bear markets. In addition, when a VW return measure is used (which weights larger funds more heavily), the same styles are ranked in the top three in both bull and bear markets: private pools, financial, and diversified (see Table 3). Similarly, when EW returns are used, financial and diversified rank among the top four styles in both bull and bear markets. Thus, while commodity funds do not produce as high returns in bull markets as do hedge funds (11.77 percent versus 22.06 percent a year), they generally provide better diversification against a declining stock market than do hedge funds.

Table 4 ranks investment styles according to their contribution to a diversified asset portfolio in bull and bear markets (as in Table 2). Once again, market-neutral, event-driven, and global macro funds appear as the top-ranked hedge fund styles in both bull and bear markets, and, when VW return measures are used, private pools again appears as a top-ranked commodity style in both bull and bear markets. Other top-ranked commodity styles in bear markets, when either EW or VW returns are used, are financial, diversified, and currency. The top-ranked hedge funds and commodity funds also receive much higher portfolio allocations in bear markets than in bull markets, which is further evidence of their diversification potential (see Table 4).

Four general conclusions emerge from these findings. First, commodity funds generally provide greater downside protection than do hedge funds. Second, the best performing hedge fund and commodity fund styles when ranked as stand-alone assets (or by individual asset Sharpe ratios) are also the best performing styles when ranked as portfolio assets. Third, the best performing styles in bull stock markets are generally also the best-performing styles in bear stock markets. Thus, the rankings in Table 1 are surprisingly robust, both to how these rankings are

compiled and to bull and bear stock markets. This robustness with respect to bear stock markets is undoubtedly why some hedge fund and commodity fund styles are referred to by practitioners as “absolute return” strategies – the ability to provide a positive return in down-markets as well as in up-markets. Lastly, the optimal portfolio weights given to the top-ranked hedge funds and commodity funds are much greater in bear markets than in bull markets (see Table 4). An investor who anticipates a declining stock market, therefore, would want to increase the proportion of her portfolio devoted to hedge funds and commodity funds.

II. Safety-First Performance Criteria

An alternative way of evaluating the performance of hedge funds and commodity funds in bull and bear markets is to use performance (or selection) criterion that place a heavier weight on avoiding bad outcomes. These criteria typically utilize “safety-first” decision rules, which put more emphasis on limiting the risk of poor performance than does the Sharpe ratio (which is used as the performance criterion in the prior analyses).

Two of the best-known safety-first criteria are those of Roy and Kataoka.³ Roy’s criterion considers the best asset or portfolio as being the one that has the smallest probability of producing a return below some specified lower return level (R_L). For a portfolio, this can be stated as:

$$\text{Minimizing Prob. } (R_p < R_L) \tag{1}$$

where

R_p = return on the portfolio; and

R_L = specified return below which an investor does not want to fall.

Assuming that R_L lies below the mean return of the portfolio $E(R_p)$, this criterion implies that the best portfolio is the one where R_L is the maximum number of standard deviations away

from the mean return on the portfolio (see Elton and Gruber, 1995, ch. 11). Algebraically, this can be represented as:

$$E(R_p) = R_L + k \sigma_p \quad (2)$$

where

σ_p = standard deviation of returns on the portfolio; and

k = the number of standard deviations that R_L lies below the mean return of the portfolio.

The objective function for this criterion reduces to maximizing k :

$$k = \frac{E(R_p) - R_L}{\sigma_p} \quad (2')$$

The larger the k , the more desirable is the portfolio. An investor, therefore, must specify an “absolute return” below which she does not want to fall. This criterion is identical to the Sharpe ratio criterion if R_L is defined to be the riskless rate of return (or the T-Bill rate). If R_L is set higher than the T-bill rate, which seems likely, a different result can occur. In the analysis that follows, we use an annual return of ten percent as the specified lower return (R_L).

The second safety-first criterion, Kataoka’s, considers the best asset or portfolio to be the one that maximizes R_L subject to the constraint that the probability of obtaining a return less than, or equal to, the specified lower return is not greater than some predetermined probability value. This can be represented for a portfolio as:

$$\begin{aligned} &\text{Maximizing } R_L \\ &\text{Subject to Prob. } (R_p < R_L) \leq \chi \end{aligned} \quad (3)$$

where

R_p = return on the portfolio

R_L = lower return limit; and

χ = the predetermined probability value (in this analysis a probability value of 5%).

The likelihood of obtaining a portfolio return below the specified probability value depends on the number of standard deviations that the lower limit lays below the mean return of the portfolio. With $\chi = 5\%$, the lower limit for a portfolio lies 1.645 standard deviations below the mean portfolio return (see Elton and Gruber, 1995, ch. 11). Thus, maximizing the lower limit R_L is equivalent to maximizing:

$$E(R_p) - 1.645 * \sigma_p \quad (4)$$

where

$E(R_p)$ = mean return on the portfolio; and

σ_p = standard deviation of portfolio returns.

Thus, a more desirable portfolio (a higher R_L) results from either a higher mean return or a lower standard deviation.

Tables 5 and 6 provide rankings of the different hedge fund and commodity fund styles according to the Sharpe, Roy, and Kataoka criteria. Table 5 provides these rankings when hedge funds and commodity funds are viewed as stand-alone assets, and Table 6 provides these rankings when hedge funds and commodity funds are viewed as assets in a diversified stock and bond portfolio. Table 6 also provides optimal portfolio weights under the alternative performance criteria when the above objective functions are maximized.

In Tables 5 and 6 both Kataoka's and Roy's criteria produce rankings that are very similar to those produced by the Sharpe ratio. An exception is market-neutral, which no longer ranks highly under Roy's criterion when returns are measured as VW returns. This occurs because market-neutral does not provide a VW return greater than the required ten percent (see

Table 1). When EW returns are used, however, market-neutral is ranked first by Roy's criterion as well as by the other criterion. It is also notable that the portfolio allocations given to the top-ranked hedge funds and commodity funds are generally greater under Roy's criterion, which seeks to minimize the probability of incurring a return less than ten percent. This suggests that hedge funds and commodity funds are useful diversification assets when the objective is limiting downside risk and obtaining a specified minimum absolute return.

III. Conclusions

This study examines the performance of various hedge fund and commodity fund investment styles during periods of both rising and falling stock prices. Since a primary motivation for investing in hedge funds and commodity funds is to diversify against falling stock prices, it is important to understand how the different investment styles perform in bear stock markets. Past studies of both hedge fund and commodity fund performance generally do not examine this issue.

Using data on the monthly returns of 1665 hedge funds and 2345 commodity funds during the period 1990:01 through 1998:08, we conclude that commodity funds provide greater downside protection than do hedge funds. Commodity funds have higher returns in bear markets than do hedge funds, and generally have an inverse correlation with stock returns in bear markets. In contrast, hedge funds' returns are generally negative in bear markets and almost all hedge fund styles exhibit significantly higher positive correlation with stock returns in bear markets than in bull markets. However, four hedge fund styles – market-neutral, event-driven, global macro, and short selling – perform reasonably well in bear markets, depending upon how returns are measured (as either EW or VW returns). Further, except for short selling, these styles also are top-performers in bull stock markets, and over all markets their performance far exceeds

that of all commodity funds. Thus, while commodity funds may offer better downside protection than hedge funds, market-neutral, event-driven, and global macro hedge funds provide fairly good downside protection while providing more attractive returns than commodity funds over all markets.

The conclusions of this study are, of course, based on only eight and a half years of monthly data, a relatively small sample in terms of financial markets and instruments. Further, we are able to observe only twenty-five months in which stock prices declined by twelve percent or more (on an annualized basis), and are not able to observe any periods during which stock prices fell over an extended period of time. Thus, only the future can tell us if our conclusions will be robust to either more severe or sustained periods of declining stock prices.

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ENDNOTES

¹ See Elton, Gruber, and Rentzler (1987), and Frost and Savarino (1988) for a discussion of this methodology and the underlying assumptions.

² Sharpe ratios for bull and bear markets are calculated using the standard deviation of returns for the entire 104 months, and the respective mean returns for bull- and bear-market months.

³ For a discussion of the conditions under which safety-first criteria are consistent with expected utility maximization and with mean-variance analysis, see Elton and Gruber (1995).

Table 1
Stand-alone Analysis of Hedge Fund and Commodity Fund Index Returns by Investment Style
1990:01 – 1998:08

EW and VW are equally-weighted and value-weighted average annualized returns, respectively. The average annual excess return is the annualized average of the monthly returns minus the monthly T-bill rates. The Sharpe ratio is average annual excess return divided by the standard deviation of monthly returns. M² is the absolute excess return in excess of the S&P 500 index return for the same level of returns volatility as the S&P 500 index.

	Rank by Sharpe Ratio	Sharpe Ratio	Average Annual Excess Return (%)	Annual Std. Deviation (%)	M ² (%)
<u>Hedge Funds</u>					
EW Mkt. Neutral Funds	1	3.06	7.67	2.52	30.483
EW Event Driven Funds	2	1.77	11.20	6.36	13.279
EW Global Macro Funds	3	1.69	10.98	6.54	12.181
EW Sector Specific Funds	4	1.42	16.36	11.59	8.581
EW Funds of Funds	5	1.11	5.85	5.31	4.529
EW Long-only Funds	6	1.09	17.05	15.64	4.183
EW Global Funds	7	1.05	9.74	9.38	3.644
EW Short-sell Funds	8	0.13	2.04	16.42	-8.554
<i>EW All Hedge Funds</i>	<i>NA</i>	<i>1.50</i>	<i>8.83</i>	<i>5.93</i>	<i>9.684</i>
VW Mkt. Neutral Funds	1	1.83	3.78	2.10	14.091
VW Event Driven Funds	2	1.64	9.17	5.61	11.613
VW Global Macro Funds	3	1.42	18.95	13.36	8.677
VW Funds of Funds	4	1.22	7.66	6.32	6.001
VW Global Funds	5	1.08	10.41	9.70	4.098
VW Sector Specific Funds	6	0.89	12.26	13.79	1.629
VW Long-only Funds	7	0.84	13.81	16.54	0.923
VW Short-sell Funds	8	0.16	2.12	13.54	-8.110
<i>VW All Hedge Funds</i>	<i>NA</i>	<i>1.55</i>	<i>12.99</i>	<i>8.40</i>	<i>10.400</i>
<u>Commodity Funds</u>					
EW Financial CTAs	1	1.19	10.07	8.53	5.538
EW Stock CTAs	2	0.97	5.94	6.15	2.701
EW Agriculture CTAs	3	0.93	10.03	10.79	2.179
EW Currency CTAs	4	0.79	8.22	10.53	0.191
EW Diversified CTAs	5	0.77	7.94	10.46	0.000
EW Private Pools	6	0.43	4.08	9.63	-4.536
EW Public Funds	7	0.20	1.79	9.31	-7.617
EW Energy CTAs	8	-0.06	-0.77	12.33	-11.015
<i>EW All CTAs</i>	<i>NA</i>	<i>0.74</i>	<i>6.24</i>	<i>8.47</i>	<i>-0.375</i>
VW Private Pools	1	1.21	9.80	8.12	5.901
VW Financial CTAs	2	0.85	10.83	12.82	1.039
VW Diversified CTAs	3	0.83	8.77	10.59	0.831
VW Agriculture CTAs	4	0.71	5.12	7.27	-0.782
VW Public Funds	5	0.56	5.35	9.69	-2.821
VW Currency CTAs	6	0.51	5.27	10.39	-3.440
VW Stock CTAs	7	0.27	2.11	8.08	-6.682
VW Energy CTAs	8	-0.48	-7.56	15.79	-16.572
<i>VW All CTAs</i>	<i>NA</i>	<i>0.79</i>	<i>7.46</i>	<i>9.55</i>	<i>0.218</i>
<u>Standard Assets</u>					
S&P 500 Index	NA	0.77	10.19	13.30	NA
US Small Stock	NA	0.46	7.90	17.24	-4.114
Int.-Term Govt. Bonds	NA	0.73	3.08	4.31	-0.555
Long-Term Govt. Bonds	NA	0.73	5.99	8.25	-0.495
Long-Term Corp. Bonds	NA	0.79	4.90	6.32	0.191

Table 2
Portfolio Analysis of Hedge Funds and Commodity Funds by Investment Style
1990:01 – 1998:08

EW and VW are equally-weighted and value-weighted average returns, respectively. The optimal benchmark portfolio consists of 23% S&P 500 index stocks, 3% US small stock index, 70% intermediate-term government bonds, and 4% long-term government bonds; and has a Sharpe ratio of 0.92. Sharpe ratio changes are the difference between the Sharpe ratio of the optimal benchmark portfolio and the Sharpe ratio of the same portfolio after the respective hedge fund and commodity fund styles are included in the portfolio. Sharpe ratios and the optimal portfolio weights are obtained using a numerical algorithm because the objective function that maximizes the Sharpe ratio of the portfolio is non-linear. The percentage increase in the Sharpe ratio is calculated relative to the Sharpe ratio of the optimal benchmark portfolio.

	Rank by Increase in Sharpe Ratio	Change in the Sharpe Ratio of the Optimal Portfolio	Percentage Increase in the Sharpe Ratio of the Optimal Portfolio	Weight in the Optimal Portfolio
<u>Hedge Funds</u>				
EW Market-Neutral Funds	1	2.16	234.78%	96%
EW Event Driven Funds	2	0.93	101.09%	72%
EW Global Macro Funds	3	0.81	88.04%	74%
EW Sector Specific Funds	4	0.59	64.13%	51%
EW Short-sell Funds	5	0.58	63.04%	35%
EW Long-only Funds	6	0.45	48.91%	36%
EW Funds of Funds	7	0.33	35.87%	64%
EW Global Funds	8	0.30	32.61%	45%
<i>EW All Hedge Funds</i>	<i>NA</i>	<i>0.67</i>	<i>72.83%</i>	<i>68%</i>
VW Market-Neutral Funds	1	1.09	118.48%	83%
VW Event Driven Funds	2	0.87	94.57%	73%
VW Global Macro Funds	3	0.61	66.30%	45%
VW Funds of Funds	4	0.38	41.30%	63%
VW Global Funds	5	0.32	34.78%	44%
VW Short-sell Funds	6	0.24	26.09%	26%
VW Sector Specific Funds	7	0.16	17.39%	28%
VW Long-only Funds	8	0.15	16.30%	29%
<i>VW All Hedge Funds</i>	<i>NA</i>	<i>0.68</i>	<i>73.91%</i>	<i>66%</i>
<u>Commodity Funds</u>				
EW Financial CTAs	1	0.51	55.43%	58%
EW Agriculture CTAs	2	0.47	51.09%	38%
EW Diversified CTAs	3	0.31	33.70%	34%
EW Currency CTAs	4	0.28	30.43%	33%
EW Stock CTAs	5	0.25	27.17%	50%
EW Private Pools	6	0.08	8.70%	22%
EW Public Funds	7	0.02	2.17%	8%
EW Energy CTAs	8	0.01	1.09%	3%
<i>EW All CTAs</i>	<i>NA</i>	<i>0.32</i>	<i>34.78%</i>	<i>38%</i>
VW Private Pools	1	0.67	72.83%	57%
VW Agriculture CTAs	2	0.35	38.04%	37%
VW Diversified CTAs	3	0.33	35.87%	38%
VW Financial CTAs	4	0.28	30.43%	33%
VW Stock CTAs	5	0.16	17.39%	27%
VW Currency CTAs	6	0.14	15.22%	24%
VW Public Funds	7	0.12	13.04%	25%
VW Energy CTAs	8	0.00	0.00%	0%
<i>VW All CTAs</i>	<i>NA</i>	<i>0.29</i>	<i>31.52%</i>	<i>38%</i>

Table 3
Sharpe Ratios, Average Annual Returns and Correlations with S&P 500 Index Returns
in Bull and Bear Markets
1990:01 – 1998:08

EW and VW are equally-weighted and value-weighted average returns, respectively. The order of the hedge fund and commodity fund styles in the table are the same as those in Table 1, and are based on the Sharpe ratios in Table 1. Bull-market months are those in which the returns on the S&P 500 index rise by 1 percent or more, and bear-market months are those in which the returns on the S&P 500 index fall by 1 percent or more. Sharpe ratios for bull and bear markets are calculated using the standard deviation of returns for all months, and the respective mean returns for bull- and bear-market months. The test statistic for the correlation coefficients is $t(n-2) = r / [(1-r^2)/(n-2)]^{0.5}$. ** indicates significance at the 5% level, and * indicates significance at the 10% level.

	BULL MARKETS				BEAR MARKETS			
	Rank by Sharpe Ratio	Sharpe Ratio	Average Annual Return(%)	Correlation with S&P 500	Rank by Sharpe Ratio	Sharpe Ratio	Average Annual Return(%)	Correlation with S&P 500
Hedge Funds								
EW Mkt. Neutral Funds	1	3.71	14.22	0.350**	2	0.61	6.46	0.558**
EW Event Driven Funds	3	3.03	24.18	0.216*	3	-1.43	-4.19	0.792**
EW Global Macro Funds	4	2.88	23.71	0.344**	4	-1.44	-4.52	0.317
EW Sector Specific Funds	2	3.06	40.28	0.361**	7	-2.28	-21.48	0.611**
EW Funds of Funds	7	2.07	15.88	0.223*	5	-1.60	-3.61	0.657**
EW Long-only Funds	6	2.24	40.02	0.419**	6	-1.91	-25.02	0.636**
EW Global Funds	5	2.56	28.88	0.466**	8	-2.73	-20.71	0.834**
EW Short-sell Funds	8	-1.46	-19.13	-0.453**	1	3.44	61.39	-0.698**
EW All Hedge Funds	NA	2.90	22.06	0.406**	NA	-2.11	-7.62	0.792**
VW Mkt. Neutral Funds	1	2.56	9.59	0.113	2	0.27	5.46	0.665**
VW Event Driven Funds	4	2.46	18.66	0.058	4	-0.59	1.62	0.751**
VW Global Macro Funds	7	2.05	32.28	-0.013	3	-0.33	0.44	0.302
VW Funds of Funds	2	2.51	20.71	0.323**	7	-2.17	-8.82	0.651**
VW Global Funds	3	2.49	29.03	0.428**	8	-2.49	-19.22	0.822**
VW Sector Specific Funds	5	2.19	35.04	0.273**	6	-1.97	-22.20	0.311
VW Long-only Funds	6	2.12	39.92	0.487**	5	-1.90	-26.48	0.608**
VW Short-sell Funds	8	-0.92	-7.61	-0.375**	1	2.65	40.79	-0.641**
VW All Hedge Funds	NA	2.48	25.67	0.068	NA	-1.04	-3.85	0.556**
Commodity Funds								
EW Financial CTAs	3	1.18	14.89	0.383**	1	1.45	17.26	-0.435**
EW Stock CTAs	1	1.97	16.97	0.304**	8	-1.17	-2.27	0.266
EW Agriculture CTAs	2	1.32	19.16	-0.137	7	0.42	9.44	-0.333
EW Currency CTAs	6	0.32	8.28	0.227*	2	1.40	19.64	0.183
EW Diversified CTAs	4	0.62	11.30	0.161	3	1.34	18.90	-0.438**
EW Private Pools	5	0.42	8.90	0.188	4	0.75	12.14	-0.514**
EW Public Funds	7	0.13	6.12	0.245*	6	0.51	9.64	-0.446**
EW Energy CTAs	8	-0.65	-3.16	0.173	5	0.55	11.66	-0.261
EW All CTAs	NA	0.54	11.77	0.231*	NA	1.31	17.18	-0.390*
VW Private Pools	1	1.05	13.43	0.194	1	1.88	20.16	-0.521**
VW Financial CTAs	2	0.75	14.47	0.330**	3	1.31	21.64	-0.409**
VW Diversified CTAs	3	0.62	11.41	0.180	2	1.39	19.58	-0.491**
VW Agriculture CTAs	5	0.49	8.41	0.007	7	0.81	10.81	-0.067
VW Public Funds	4	0.52	9.94	0.282**	6	0.83	12.90	-0.318
VW Currency CTAs	6	0.05	5.44	0.189	5	1.00	15.36	0.004
VW Stock CTAs	7	-0.45	1.21	-0.037	4	1.30	15.42	-0.032
VW Energy CTAs	8	-0.67	-5.76	0.066	8	-0.36	-0.77	0.248
VW All CTAs	NA	0.55	10.63	0.227*	NA	1.45	19.66	-0.443**
Standard Assets								
S&P 500 Index	NA	2.90	43.49	1.000**	NA	-3.81	-45.80	1.000**
US Small Stock	NA	2.01	47.12	0.353**	NA	-2.87	-44.62	0.692**
Int.-Term Govt. Bonds	NA	1.57	11.63	0.320**	NA	-1.40	-1.13	-0.166
Long-Term Govt. Bonds	NA	1.68	18.74	0.405**	NA	-1.57	-8.03	-0.107
Long-Term Corp. Bonds	NA	1.88	16.74	0.439**	NA	-1.85	-6.79	0.106

Table 4
Portfolio Analysis of Hedge Funds and Commodity Funds in Bull and Bear Markets
1990:01 – 1998:08

EW and VW are equally-weighted and value-weighted average returns, respectively. The order of the hedge fund and commodity fund styles in the table are the same as those in table 2. Bull-market months are defined as those in which the S&P 500 index return is 1 percent or more, and bear-market months are those in which the S&P 500 index return is negative 1 percent or more.

	BULL MARKETS			BEAR MARKETS		
	Rank by Increase in Sharpe Ratio	Change in the Sharpe Ratio of the Optimal Portfolio*	Weight in the Optimal Portfolio	Rank by Increase in Sharpe Ratio	Change in the Sharpe Ratio of the Optimal Portfolio**	Weight in the Optimal Portfolio
Hedge Funds						
EW Market-Neutral Funds	2	0.35	58%	2	1.75	100%
EW Event Driven Funds	1	0.96	55%	3	1.50	100%
EW Global Macro Funds	4	0.17	24%	NA	0.00	0%
EW Sector Specific Funds	3	0.33	34%	NA	0.00	0%
EW Short-sell Funds	5	0.16	12%	1	4.70	76%
EW Long-only Funds	8	0.03	8%	NA	0.00	0%
EW Funds of Funds	6	0.08	18%	NA	0.00	0%
EW Global Funds	7	0.07	22%	NA	0.00	0%
<i>EW All Hedge Funds</i>	<i>NA</i>	<i>0.24</i>	<i>43%</i>	<i>NA</i>	<i>0.00</i>	<i>0%</i>
Commodity Funds						
VW Market Neutral Funds	3	0.18	42%	NA	0.00	0%
VW Event Driven Funds	1	0.89	49%	3	0.81	100%
VW Global Macro Funds	2	0.48	16%	2	0.86	100%
VW Funds of Funds	4	0.15	25%	NA	0.00	0%
VW Global Funds	6	0.06	14%	NA	0.00	0%
VW Short-sell Funds	5	0.11	12%	1	4.12	100%
VW Sector Specific Funds	NA	0.00	0%	NA	0.00	0%
VW Long-only Funds	NA	0.00	0%	NA	0.00	0%
<i>VW All Hedge Funds</i>	<i>NA</i>	<i>0.43</i>	<i>25%</i>	<i>NA</i>	<i>0.00</i>	<i>0%</i>

Table 4 continued

	BULL MARKETS			BEAR MARKETS		
	Rank by Increase in Sharpe Ratio	Change in the Sharpe Ratio of the Optimal Portfolio*	Weight in the Optimal Portfolio	Rank by Increase in Sharpe Ratio	Change in the Sharpe Ratio of the Optimal Portfolio**	Weight in the Optimal Portfolio
Commodity Funds						
EW Financial CTAs	NA	0.00	0%	2	2.52	100%
EW Agriculture CTAs	1	0.42	14%	5	1.86	100%
EW Diversified CTAs	NA	0.00	0%	3	2.42	100%
EW Currency CTAs	NA	0.00	0%	1	2.71	100%
EW Stock CTAs	2	0.11	19%	8	0.21	100%
EW Private Pools	NA	0.00	0%	4	1.90	100%
EW Public Funds	NA	0.00	0%	6	1.67	100%
EW Energy CTAs	NA	0.00	0%	7	1.63	100%
<i>EW All CTAs</i>	NA	0.00	0%	NA	2.38	100%
VW Private Pools	2	0.01	3%	1	2.95	100%
VW Agriculture CTAs	1	0.04	9%	6	2.20	100%
VW Diversified CTAs	NA	0.00	0%	3	2.48	100%
VW Financial CTAs	NA	0.00	0%	2	2.51	100%
VW Stock CTAs	NA	0.00	0%	5	2.22	100%
VW Currency CTAs	NA	0.00	0%	4	2.29	100%
VW Public Funds	NA	0.00	0%	7	2.00	100%
VW Energy CTAs	NA	0.00	0%	8	0.92	100%
<i>VW All CTAs</i>	NA	0.00	0%	NA	2.62	100%

* Change in the Sharpe ratio of the optimal portfolio is calculated as the difference between the Sharpe ratio of the optimal benchmark portfolio and the Sharpe ratio calculated after the EW and VW portfolios of hedge funds and commodity funds are added into the optimal benchmark portfolio. The optimal benchmark portfolio in the bull markets consists of 56% S&P 500 index, 17% US small stock index, and 27% intermediate-term government bonds; and has a Sharpe ratio of 5.31.

** Change in the Sharpe ratio of the optimal portfolio is calculated in the same way: it is the difference between the Sharpe ratios before and after the EW and VW portfolios of hedge funds and commodity funds are added to the optimal benchmark portfolio. The optimal benchmark portfolio in the bear markets consists of 100% allocated in intermediate-term government bonds. It has a Sharpe ratio of -1.21.

Table 5
Stand-alone Analysis of Hedge Funds and Commodity Funds using Alternative Selection Criteria
1990:01 – 1998:08

EW and VW are equally-weighted and value-weighted average returns, respectively. The order of the hedge fund and commodity fund styles in the table are the same as those in Table 1.

	Sharpe Ratio	Roy's Criterion with 10% Minimum Annual Return*	Kataoka's Criterion with $\chi=5\%$ ** (%)	Ranking by Sharpe Ratio	Ranking by Roy's Criterion	Ranking by Kataoka's Criterion
Hedge Funds						
EW Market-Neutral Funds	3.06	1.03	8.44	1	1	1
EW Event Driven Funds	1.77	0.96	5.66	2	3	2
EW Global Macro Funds	1.69	0.90	5.14	3	4	3
EW Sector Specific Funds	1.42	0.97	2.21	4	2	4
EW Funds of Funds	1.11	0.14	2.03	5	7	5
EW Long-only Funds	1.09	0.77	-3.76	6	5	7
EW Global Funds	1.05	0.50	-0.76	7	6	6
EW Short-sell Funds	0.13	NA	-20.05	8	NA	8
VW Market Neutral Funds	1.83	NA	5.25	1	NA	1
VW Event Driven Funds	1.64	0.73	4.86	2	2	2
VW Global Macro Funds	1.42	1.04	1.91	3	1	4
VW Funds of Funds	1.22	0.41	2.19	4	6	3
VW Global Funds	1.08	0.55	-0.63	5	3	5
VW Sector Specific Funds	0.89	0.52	-5.50	6	5	6
VW Long-only Funds	0.84	0.53	-8.48	7	4	7
VW Short-sell Funds	0.16	NA	-15.23	8	NA	8
Commodity Funds						
EW Financial CTAs	1.19	0.58	0.96	1	1	1
EW Stock CTAs	0.97	0.14	0.74	2	5	2
EW Agriculture CTAs	0.93	0.46	-2.80	3	2	3
EW Currency CTAs	0.79	0.30	-4.18	4	3	4
EW Diversified CTAs	0.77	0.27	-4.35	5	4	5
EW Private Pools	0.43	NA	-6.84	6	NA	6
EW Public Funds	0.20	NA	-8.60	7	NA	7
EW Energy CTAs	-0.06	NA	-16.13	8	NA	8
VW Private Pools	1.21	0.58	1.36	1	1	1
VW Financial CTAs	0.85	0.45	-5.34	2	2	4
VW Diversified CTAs	0.83	0.35	-3.73	3	3	3
VW Agriculture CTAs	0.71	0.01	-1.92	4	6	2
VW Public Funds	0.56	0.03	-5.67	5	4	5
VW Currency CTAs	0.51	0.02	-6.90	6	5	7
VW Stock CTAs	0.27	NA	-6.26	7	NA	6
VW Energy CTAs	-0.48	NA	-28.61	8	NA	8

* Roy's criterion values are computed for a 10% annual return. That is, 10% annual return is assumed to be the level of return below which the investors do not want to fall. To compute the Roy's criterion, the minimum return should lie below the mean return of the portfolio. Any hedge fund portfolio that has an annual return below 10% is omitted from the analysis.

** Kataoka's criterion values are derived according to the predetermined probability value of $\chi=5\%$.

Table 6
Portfolio Analysis of Hedge Funds and Commodity Funds using Alternative Selection Criteria
 1990:01 – 1998:08

EW and VW are equally-weighted and value-weighted average returns, respectively. The order of the hedge fund and commodity fund styles in the table are the same as those in Table 2.

	SHARPE RATIO				ROY'S CRITERION				KATAOKA'S CRITERION			
	Rank by Sharpe Ratio of the Optimal Portfolio	Sharpe Ratio of the Optimal Portfolio*	Weight in the Optimal Portfolio	Rank by Roy's Criterion of the Optimal Portfolio	Roy's Criterion of the Optimal Portfolio**	Weight in the Optimal Portfolio	Rank by Kataoka's Criterion of the Optimal Portfolio	Kataoka's Criterion of the Optimal Portfolio***	Weight in the Optimal Portfolio	Rank by Kataoka's Criterion of the Optimal Portfolio	Kataoka's Criterion of the Optimal Portfolio****	Weight in the Optimal Portfolio
Hedge Funds												
EW Mkt. Neutral Funds	1	3.08	96%	1	1.03	100%	1	8.45	98%			
EW Event Driven Funds	2	1.85	72%	3	0.96	100%	2	5.96	83%			
EW Global Macro Funds	3	1.73	74%	4	0.90	100%	3	5.30	78%			
EW Sector Funds	4	1.51	51%	2	0.97	100%	5	3.98	42%			
EW Short-sell Funds	5	1.50	35%	7	0.41	24%	4	4.33	33%			
EW Long-only Funds	6	1.37	36%	5	0.74	88%	8	2.76	23%			
EW Funds of Funds	7	1.25	64%	NA	0.38	0%	6	3.35	54%			
EW Global Funds	8	1.22	45%	6	0.50	90%	7	2.89	33%			
Commodity Funds												
VW Mkt. Neutral Funds	1	2.01	83%	NA	0.38	0%	1	5.57	89%			
VW Event Driven Funds	2	1.79	73%	2	0.73	92%	2	5.53	78%			
VW Global Macro Funds	3	1.53	45%	1	1.04	90%	3	4.08	37%			
VW Funds of Funds	4	1.30	63%	6	0.44	74%	4	3.32	53%			
VW Global Funds	5	1.24	44%	3	0.55	95%	5	2.92	33%			
VW Short-sell Funds	6	1.16	26%	NA	0.38	0%	6	2.91	23%			
VW Sector Funds	7	1.08	28%	4	0.53	75%	8	1.97	17%			
VW Long-only Funds	8	1.07	29%	5	0.52	76%	7	2.01	16%			

Table 6 continued

	SHARPE RATIO				ROY'S CRITERION				KATAOKA'S CRITERION			
	Rank by Sharpe Ratio of the Optimal Portfolio	Sharpe Ratio of the Optimal Portfolio*	Weight in the Optimal Portfolio	Rank by Roy's Criterion of the Optimal Portfolio	Roy's Criterion of the Optimal Portfolio**	Weight in the Optimal Portfolio	Rank by Kataoka's Criterion of the Optimal Portfolio	Kataoka's Criterion of the Optimal Portfolio*** (%)	Weight in the Optimal Portfolio			
Commodity Funds												
EW Financial CTAs	1	1.43	58%	1	0.69	71%	1	3.71	47%			
EW Agriculture CTAs	2	1.39	38%	2	0.60	56%	2	3.64	29%			
EW Diversified CTAs	3	1.23	34%	3	0.50	49%	3	2.97	27%			
EW Currency CTAs	4	1.20	33%	4	0.49	50%	5	2.83	24%			
EW Stock CTAs	5	1.17	50%	NA	0.38	0%	4	2.96	40%			
EW Private Pools	6	1.00	22%	NA	0.38	0%	6	2.06	18%			
EW Public Funds	7	0.94	8%	NA	0.38	0%	7	1.71	11%			
EW Energy CTAs	8	0.93	3%	NA	0.38	0%	8	1.70	7%			
VW Private Pools												
VW Agriculture CTAs	1	1.59	57%	1	0.74	70%	1	4.61	55%			
VW Diversified CTAs	2	1.27	37%	4	0.39	12%	2	3.49	34%			
VW Financial CTAs	3	1.25	38%	3	0.55	54%	3	2.91	28%			
VW Stock CTAs	4	1.20	33%	2	0.59	55%	5	2.53	21%			
VW Currency CTAs	5	1.08	27%	NA	0.38	0%	4	2.83	25%			
VW Public Funds	6	1.06	24%	4	0.39	11%	6	2.33	19%			
VW Energy CTAs	7	1.04	25%	4	0.39	16%	7	2.12	18%			
	NA	0.92	0%	NA	0.38	0%	NA	1.51	0%			

*The optimal benchmark portfolio consists of 23% S&P 500 index, 3% US small stock index, 70% intermediate-term government bonds, and 4% long-term government bonds; and has a Sharpe ratio of 0.92. Portfolios of hedge funds and commodity funds that do not enter the optimal portfolio and hence are not able to enhance the portfolio's Sharpe ratio are indicated by "NA".

** The optimal benchmark portfolio consists of 100% allocated to S&P 500 index and has a Roy's criterion measure of 0.38. Portfolios of hedge funds and commodity funds that do not enter the optimal portfolio and hence are not able to enhance the portfolio's Roy's criterion measure are indicated by "NA". Roy's criterion values are computed for a 10% annual return. That is, 10% annual return is assumed to be the level of return below which the investors do not want to fall. To compute the Roy's criterion, the minimum return should lie below the mean return of the portfolio.

*** The optimal benchmark portfolio consists of 3% S&P 500 index, 8% US small stock index, and 89% intermediate-term government bonds. It has a Kataoka's criterion measure of 1.51. Portfolios of hedge funds and commodity funds that do not enter the optimal portfolio and hence are not able to enhance the portfolio's Kataoka's criterion measure are indicated by "NA". Kataoka's criterion values are derived according to the predetermined probability value of $\chi=5\%$.

Appendix A
MAR Hedge Fund Investment Style Classifications and Definitions

Investment Style	Definition
Funds of Funds	Capital is allocated among a number of hedge funds, providing investors with access to managers they might not be able to invest on their own. <i>Diversified</i> – Allocate capital to a variety of fund types. <i>Niche</i> – Allocate capital to a specific type of fund.
Event-Driven	Investment theme is dominated by events that are seen as special situations or opportunities to capitalize from price fluctuations. <i>Distressed Securities</i> – Focus on securities of companies in reorganization and/or bankruptcy. <i>Risk Arbitrage</i> – Simultaneously buys stock in a company being acquired and sells stock in its acquirers.
Global Macro	Opportunistic funds that invest anywhere they see a value opportunity; attempt to take advantage of macro changes in global economies, particularly major interest rate shifts; and use leverage and derivatives to enhance positions.
Global	<i>International</i> – Focus on economic macro changes around the world (mostly outside of the US); tend to be stock-pickers in equity markets; use index derivatives, but to a lesser extent than macro managers. <i>Emerging</i> – Invest in less mature financial markets; because shorting is not permitted in many emerging markets, managers go to cash or other markets when valuations make being long equity unattractive. <i>Regional</i> – Focus on specific regions of the world, e.g. Asia, Europe, Latin America.
Long-only	Traditional equity funds, but structured as hedge funds, permitting extensive use of leverage and incentive fees.
Market-Neutral	Attempt to lock-out or neutralize market risk by being both long and short. Thus, with greatly reduced market risk, the emphasis is asset selection. <i>Long/short stock</i> – take long and short stock positions to eliminate or reduce exposure to market risk. <i>Convertible arbitrage</i> – Go long convertible securities and short underlying equities, profiting from mispricing in the relationship between the two. <i>Stock arbitrage</i> – Buy a basket of stocks and short stock index futures, or the reverse. <i>Fixed income arbitrage</i> – Buy bonds – often T-bonds – and short other instruments that replicate the purchased bonds, in terms of rate and maturity.
Sector	Stock funds that follow specific economic sectors and/or industries.
Short-sell	Short overvalued stocks in the hopes buying them back at a lower price.

MAR Commodity Fund Investment Style Classifications and Definitions

Investment Style	Definition
Public Funds	Similar to conventional stock or bond mutual funds, except that public fund managers buy and sell commodity futures, forward, and option contracts rather than stocks and bonds. Have low minimum-investment requirements, which make them accessible even to small (retail) investors.
Private Pools	Private investment partnerships organized and operated by a commodity pool operator (CPO). The CPO pools investors' funds into a common portfolio and employs one or more professional traders or Commodity Trading Advisors (CTAs) to manage the pooled funds. Usually have high minimum-investment requirements, and are therefore generally available only to high-net worth individuals and institutional investors.
Currency CTAs	Trade futures, forward, and options on currencies. Investors choose a particular CTA with an investment strategy that suits their risk preferences and have their funds managed by that CTA on an individual basis. Investments with CTAs are typically available only to investors with substantial net worth.
Agriculture CTAs	Trade futures, forward, and options on agricultural commodities.
Financial CTAs	Trade futures, forward, and options on fixed-income instruments.
Stock CTAs	Trade futures, forward, and options on equity indices.
Energy CTAs	Trade futures, forward, and options on energy commodities.
Diversified CTAs	May trade futures, forward, and options on all types of commodities and financial instruments.