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MANAGED FUTURES AS AN ASSET CLASS

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ABSTRACT

This paper examines the performance of managed futures investments during the years 1982 through 1996, both as stand-alone investments and as assets in diversified stock and bond portfolios. The "managed futures" industry encompasses Commodity Trading Advisors (CTAs), private commodity (futures) pools, and public commodity (futures) funds. A major finding is that diversified investments in either CTAs or commodity pools make both attractive stand-alone investments and portfolio assets. Including such investments in stock and bond portfolios increases the Sharpe ratios of those portfolios by from 22.7 to 45.4 percent. In contrast, a diversified investment in public commodity funds is always a poor stand-alone investment and a poor portfolio asset. Finally, while CTA and pool returns have been significantly lower in the 1990's than in the 1980's, those investments continued to provide attractive risk-adjusted returns because of lower returns volatility and low correlation with other financial assets. In particular, in the sub-period 1989-96, CTA and pool investments received portfolio allocations of from 39 to 48 percent in unconstrained optimal portfolios.

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By year-end 1996 almost $30 billion was invested in the managed futures industry, a nearly 60-fold increase since 1980 (see Chart 1).[1] This paper evaluates the performance of managed futures investments, both as "stand-alone" assets and portfolio assets in diversified stock and bond portfolios during the period 1982 through 1996, virtually the entire life of the managed futures industry. A general conclusion of the paper is that some types of diversified managed futures investments have consistently provided higher risk-adjusted returns than have diversified stock and bond portfolios, and that including managed futures investments in diversified asset portfolios can significantly enhance the performance of such portfolios.

The term "managed futures" refers to the various institutional (or legal) investment vehicles that provide professional money management to investors who wish to participate in "commodity" markets, which includes the trading of futures, forward, and option contracts on both physical commodities and financial instruments. Three managed futures investment vehicles are currently available.[2] First, investors can purchase the shares of public commodity (futures) funds, which is similar to buying shares in a stock or bond mutual fund, except that the fund buys and sells commodity futures and forward contracts rather than stocks and bonds.[3] Public futures funds commonly have the lowest minimum-investment requirement of all managed futures vehicles, making them accessible

to small (retail) investors. Second, investors can place funds with a private Commodity Pool Operator (CPO), who pools investors' funds together and employs one or more professional traders (or Commodity Traders Advisors (CTAs)), to manage (or trade) the pooled funds.[4] Generally, CPOs do not trade themselves, or act as CTAs. Private futures pools typically have higher minimum-investment requirements than do public funds, and therefore are available only to high-net worth individuals or institutional investors. Third, investors themselves can retain a CTA to manage their money on an individual basis. This avenue is open only to investors with substantial net worth, since CTAs typically set a very high minimum-investment requirement.

All managed futures vehicles are subject to government regulation and oversight, some more than others. Public commodity (or futures) funds must register with the Commodity Futures Trading Commission (CFTC) and the Securities and Exchange Commission (SEC). CPO's, if they accept "public funds," also are required to register with the CFTC and the SEC. A CPO is not considered to have accepted "public funds" if it does not have more than 499 investors in the pool and does not have more than 35 "unaccredited" investors. "Unaccredited" investors are those who do not qualify as an "accredited" investor. An "accredited" investor must have a net worth of at least $1 million or an annual income of more than $200,000 for at least two consecutive years. Finally, CTA's must register with the CFTC and are subject to regulation by the CFTC.

In placing money directly with a CTA, investors are in effect "buying" the trading skills of CTAs. Investors themselves must select which CTAs to employ and are responsible for evaluating the performance of the CTAs . The advantage of investing directly with a CTA are that the fees charged by funds and pools can be avoided. Pools and public funds provide investors with two additional investment services: the benefits of holding a diversified portfolio of CTAs, and the ability of fund or pool managers to hire

better CTAs. In particular, some CTAs may be better able to select profitable commodities to trade, and may possess greater skill in trading those commodities. Large pools and funds commonly employ four to six CTAs. However, investors must pay additional fees for the services rendered by pool and fund managers. Further, because of the high minimum-investment requirements of pools and CTAs, small investors generally have no choice but to use public futures funds.

The fee structure of the different managed future investment vehicles varies significantly. CTAs commonly impose both a management fee (of about three percent of principal) and a profit-based incentive fee (typically about twenty percent of net profits) on investors. Together, over a year those fees can amount to as much as twenty percent or more of an investor's principal at the beginning of the year. Pool and fund operators also charge management fees (typically two or three percent) and incentive fees, in addition to passing on the CTA fees to investors. Investors must decide whether pools and funds generate sufficient additional risk-adjusted returns to justify the fees associated with retaining them. There may also be one-time front-load and back-load fees of up to 8 percent of principal, and brokerage commissions and trading expenses can amount to as much as 10 percent of principal during a year. Thus, for investors to receive a positive return on a managed futures investment, CTAs, pools and funds must have sizeable gross (or before fees and expenses) returns -- typically thirty percent or more a year on invested capital.

This article analyzes the performance of the three stylized managed futures investments during the seventeen-year period l980 through l996. The organization of the paper is as follows. Section I describes the managed futures data examined. Section II examines two potential biases that may exist in our data and the statistical procedures used to correct for these biases. Section III discusses the measures used to evaluate the

performance of managed futures investments. Sections IV and V evaluate the performance of managed futures investments, first, as "stand-alone" investment assets, and, second, as "portfolio" assets, or assets in diversified stock and bond portfolios. Section VI provides the optimal allocations that managed futures would receive in both constrained and unconstrained stock and bond portfolios. Section VII analyzes whether managed futures investments provide a hedge against general price inflation. Finally, section VIII summarizes the conclusions of the paper.

I. DATA

This study examines the monthly performance of CTAs, private pools, and public funds over the period 1980 through 1996, virtually the entire history of the managed futures industry. The data encompass 1,150 CTAs, 439 private commodity pools, and 619 public futures funds, for a total of 119,481 months of performance data: 60,054 for CTA's, 24,523 for commodity pools, and 34,904 for public funds. The data are provided by Managed Account Reports (MAR), which receives monthly performance information from participating CTAs, pools, and funds. While the data base is quite large, it may nevertheless not capture all CTAs, pools, or funds, since MAR relies on voluntary reporting.[5] However, CTAs, pools, and fund managers have an incentive to report their performance because of the marketing benefits associated with the greater public exposure they receive when providing performance information.

CTAs, pools and funds are included in the data sample if they began trading at any time subsequent to year-end 1979 and prior to year-end 1996. The reported performance histories of pools and funds consist of monthly returns net of all fees after registration with the CFTC (Commodity Futures Trading Commission).[6] The reported performance histories of CTAs, however, may contain net monthly returns <u>prior</u> to registering with the

CFTC as well as after registering with the CFTC.[7] Pre-registration CTA returns are included in the CTA performance data reported by MAR.

Separately-reported information about fees for most CTAs, pool, and funds are available only for the current period (April, 1997). These data indicate that the administrative fees of most CTA's range from 0.1 to twelve percent of principal, with a median fee of about three percent, and the CTA incentive fees range from ten to forty percent of net new profits, with a median fee of twenty percent. (See Charts 2 and 3, and Appendix 1). Pools and funds typically also levy management fees of about three percent of an investor's principal and incentive fees of about twenty percent of net new profits.

Finally, the performance of managed futures investments are compared to a broad range of non-futures investments. These include buy-and-hold portfolios of both large and small-cap common stocks, U.S. Treasury-bills, intermediate and long-term government bonds, and long-term corporate bonds. Monthly returns for those hypothetical investments are shown in Table 1.[8]

II. DATA BIASES

There are two potential biases in the MAR data: a "self-selection" bias, and a "survivorship" bias. A "self-selection" bias may exist because the MAR data may include performance histories prior to the date that performance is first reported to MAR. In particular, the reported performance histories of CTAs commonly include performance prior to their accepting investors' (or "public") funds and registering with the CFTC. Such pre-registration performance history, which may be as long as three years of monthly returns, commonly exhibits unusually high returns (Edwards and Ma, 1998). Thus, because only successful traders "self-select" to report to MAR, the exclusion of

unsuccessful (or poor-performing) traders from the data may cause an upward bias in the early trading histories of CTAs.

There may also be a "self-selection" bias in the MAR data because of the voluntary nature of the reporting relied on by MAR. In particular, because successful CTAs, pools, and funds may be more likely than unsuccessful CTAs, pools, and funds to begin reporting their performance histories to MAR, the early "reported" performance histories of all managed futures investments may exhibit an upward self-selection bias. [9]

This article employs three procedures to eliminate whatever self-selection bias exists. The first is to omit the first twenty-eight months of CTA reported returns but no performance history for funds and pools. The "28-month" CTA rule is used by Edwards and Park (l996), who find that returns in the first twenty-eight months of a CTA's performance history are commonly significantly higher than are later returns. Omitting the first twenty-eight months of CTA data, therefore, eliminates most of the upward bias the might derive from self-selection reporting problems.

A problem with this procedure, however, is that it also eliminates from the data many small CTA observations, which may impart a downward bias to observed CTA returns because small CTA's generally have higher returns than large CTAs.[10] **(This occurs because most newly-reporting CTAs have small amounts of money under management.) In particular, if no observations are excluded from the data, the smallest CTAs (or smallest quintile of CTAs) has an average return significantly greater than the average return of the largest (or largest quintile of) CTAs. (See Appendix 2, column 1). Further, this difference persists even after the first twenty-eight months of performance data are excluded from the data. (See Appendix 2, column 3). Thus, in attempting to correct for a possible self-selection bias by omitting from the data a CTA's early**

performance history we may unwitting cause a downward bias in CTA returns by eliminating small, high-return, CTAs.

The second procedure is to use the "first-reporting" dates in the MAR database to determine a decision rule for omitting CTA, pool, and fund returns prior to their first reporting to MAR. More specifically, for about seventy to ninety percent of the CTAs, pools, and funds in the MAR database, MAR reports the dates on which performance was first reported to MAR. Thus, by using MAR's first-reporting dates we can determine the median number of months of pre-reporting performance data that is included in the MAR data base for CTAs, pools, and funds.

Specifically, because MAR did not begin to collect comprehensive data on CTAs, pools, and funds until 1991, only data for CTAs, pools, and funds that started operations subsequent to January, 1991, are used to estimate the median number of months of pre-reporting performance data included in the MAR performance histories of CTAs, pool, and funds.[11] The median number of pre-reporting monthly observations for CTAs, pools and funds are, respectively, twelve, five, and six months.[12] Thus, for the full sample of CTAs, pools, and funds (or for all years), we omit the first twelve months of CTA performance history, the first five months of pool performance history, and the first six months of fund performance history. This procedure is referred to as the FR (first-reporting) rule. This procedure obviously does not eliminate from the data as many small-CTA observations.

The third, and most conservative, procedure, is to eliminate the first twenty-eight months of CTA performance and the first twelve months of both pool and fund performance. Results using this conservative rule can then be compared to the results using the first two procedures. This procedure, while minimizing the possibility of a self-

selection bias, also eliminates the greatest number of small CTAs, pools, and funds, and therefore may understate the true performance of managed futures investments.

The data may also have a "survivorship" bias because if it may not contain all non-surviving funds. In particular, if non-surviving funds have lower returns than surviving funds (which is likely), omitting non-surviving (or lower-return) funds from the data will result in upwardly-biased observed returns. Our data does contain both surviving and non-surviving funds, and therefore should be free of survivorship bias. Specifically, the data base contains about the same number of fund-month observations for surviving and non-surviving CTAs, pools, and funds (59,328 vs. 60,153), so that the performance of non-survivors is well represented.[13]

However, there is still some reason to believe that prior to 1991 the data may not include all non-survivors.[14] A year-by-year analysis of the "attrition rates" of managed futures funds shows that reported annual attrition rates were generally much lower in the years 1980 through 1988 than in 1989 through 1996: about nine percent versus sixteen percent for CTAs, one percent versus fifteen percent for pools, and less than one percent versus twelve percent for public funds.[15] (See Appendix 3) Although it is possible that the enormous difference in attrition rates pre- and post- 1989 are due to particularly turbulent commodity markets during the 1990's, or to greatly enhanced competition in commodity markets in the 1990's, those explanations seem incapable of explaining such large disparities in the attrition rates.[16] The most likely explanation, therefore, is that the data do not include all non-survivors during the 1980-88 period, which, if true, would result in a survivorship bias during this period. Based on an analysis of the difference in returns of survivors versus non-survivors during the 1989-96 period, we estimate that annual survivorship biases during the 1980-88 period may be in the range of about 5.17 percentage points for CTAs, 6.74 percentage points for pools, and 3.05 percentage points for public

funds (see Appendix 3a).[17] Thus, to the extent that non-survivors are omitted from the data prior to 1989, reported returns during those years may be upward biased.[18]

The foregoing analysis has two implications. First, the returns reported for the 1980-88 period are likely to be higher than the "true" returns for those years. Second, because subsequent to 1989 most non-survivors are included in the data, reported returns for the 1989-1996 period should more accurately represent the returns an investor could expect on managed futures investments.

III. PERFORMANCE MEASURES

Monthly and annual returns for CTAs, CPOs and public commodity funds are examined over the seventeen year period l980 through l996. Monthly returns are measured as the change in unit value over a month plus cash distributions per unit made during the month divided by the unit value at the end of the preceding month. This formula assumes that all cash distributions are reinvested during the month in which they are received.

To evaluate the performance of alternative managed futures investments, three stylized managed futures portfolios are formed for CTAs, pools, and funds: (1) one-CTA, pool, or fund portfolios, where a single CTA, pool or fund is randomly-selected each month; (2) Equally-Weighted Market Portfolios (EWMP) of all CTAs, pools, or funds in existence in a particular month, where an identical amount is invested in each CTA, pool, or fund; and, (3) Value-Weighted Portfolios (VWMP) of all CTAs, pools, or funds in existence in a particular month, where the weights reflect the proportion of total invested dollars managed by particular CTAs, pools, or funds in the month. Monthly and annual returns are calculated for each of these stylized portfolios.

For EWMP's, monthly returns are calculated as the simple arithmetic average of the monthly returns of all CTAs, pools or funds in the portfolio. For VWMP's, monthly

returns are the weighted average of the monthly returns of CTAs, pools, or funds in the portfolio. Both EWMP and VWMP investments, therefore, implicitly assume a one-month investment horizon and that investors re-balance their portfolios at the end of every month to maintain the assumed weights in the portfolio: equal for the EWMP, and dollar-weighted for the VWMP.[19] For randomly-selected, single CTA, pool, and fund portfolios, expected monthly returns are calculated as the simple average of the monthly returns of all CTAs, pools, or funds in existence in the month. Thus, expected returns on single-CTA, pool, and fund investments are identical to the returns on an EWMP of CTAs, pools, or funds.

Another method for measuring returns was considered but not used: Net-Asset-Value-Weighted Market Portfolios (NWMP). In an NWMP each CTA, pool or fund is allocated an equal investment at the start of a given investment period (such as at the beginning of a year) and this investment is maintained for the entire investment period. Unlike the EWMP and VWMP returns, NWMP returns do not assume a rebalancing of assets each month. Thus, NWMP returns incorporate the compounding effect that flows naturally from a CTA's , pool's, or fund's performance during the specified investment period. With a time horizon of only a month, the NWMP and EWMP methodologies are identical because portfolio weights are reset each month. For longer time horizons, however, these methodologies can yield quite different returns because NWMP returns are dependent both on the specific investment horizon selected and the starting date of that horizon. Thus, we chose not be evaluate managed futures investments in terms of NWMP returns because of the arbitrariness associated with selecting both starting dates and time horizons for analysis.

In addition to examining monthly and annual returns for alternative investments, we also examined returns volatility for these investments as well as risk-adjusted returns.

In particular, returns volatility is measured as the standard deviation (SD) of monthly returns for a specific time period. For example, the annual returns volatility for an EWMP (or a VWMP) of CTAs is the standard deviation of the twelve monthly returns during the year on an EWMP (or a VWMP) of CTAs. The returns volatility for a randomly-selected, single CTA, pool, or fund portfolio is more complicated: it is a function of both the time variation in returns and the cross-sectional variation in returns that occurs because a different CTA, pool, or fund is selected every month from the population of CTAs, pools, and funds. For example, the expected annual returns volatility for a one-CTA portfolio is the standard deviation of all individual CTA returns in every month of the year.

Sharpe ratios (SR) for the alternative managed futures investments are used as a measure of risk-adjusted returns.[20] Sharpe ratios for an investment are calculated as

(1) $$\frac{R_i - R_f}{\sigma_i}$$

where:

R_i = the average monthly rate of return on the ith investment during a specified investment period;

R_f = the average monthly risk-free rate of return (or T-Bill return) during the investment period; and

σ_i = the standard deviation of monthly rates of return on the ith investment during the investment period.

□

Finally, average returns, returns volatility, and Sharpe ratios for the alternative managed futures investments are compared to similar performance measures for non-futures investments during the same time periods. Table 1 provides monthly and annual

returns, as well as returns volatility, for investments in the S&P 500 (large-cap) common stock index, the Russell 2000 (small-cap) common stock index, U.S. Treasury bills, intermediate-term government bonds, long-term government bonds, and long-term corporate bonds. Sharpe ratios for the alternative investments are shown in Table 5.

IV. MANAGED FUTURES AS STAND-ALONE INVESTMENTS

A. Commodity Trading Advisors

Table 2 provides performance figures for randomly-selected, single-CTA portfolios, for an EWMP of CTAs, and for a VWMP of CTAs. Following our procedure for correcting for a possible self-selection bias, the analysis in Table 2 excludes the first twelve months of all reported CTA returns. (Appendix 4 provides comparable performance figures when the first twenty-eight months of all reported CTA returns are omitted.)

The figures in Table 2 and Appendix 4 suggest the following five conclusions:

First, although the mean returns for randomly-selected, single-CTA portfolios are identical to the returns for an EWMP of CTAs, the returns volatility for single-CTA portfolios is more than twice as high as it is for either an EWMP or a VWMP of CTAs.[21] This occurs because single-CTA portfolios are not diversified across CTAs. Thus, the higher returns volatility of single-CTA portfolios makes them an inferior investment to either an EWMP or a VWMP of CTAs.

Second, as expected, excluding the first twenty-eight months of all CTA returns data results in lower CTA returns than when only the first twelve months of CTA returns data are excluded. The higher returns when only the first twelve months are excluded may occur because either (1) the CTA returns data still contain an upward self-selection bias when only the first twelve months of data are omitted or (2) the exclusion of twenty-eight months of returns data excludes a greater number of small, high-return, CTAs from the

data, imparting a downward bias to CTA returns. when twenty-months of data are excluded. Because it is impossible to distinguish the effects of these competing explanations, in subsequent sections of the paper we report only the results for the twelve-month exclusion rule, relegating the results using the twenty-eight month exclusion rule to the appendices. In any case, a VWMP of CTA returns in not affected by which exclusion rule is used because small CTAs receive a much lesser weight in a VWMP than in an EWMP. (Compare the results for VWMP's in Table 2 with those in Appendix 4.)

Third, returns for both an EWMP and a VWMP of CTAs have been falling over time. For example, annual returns are much higher in the 1982-88 period (34.3 percent) than in the 1989-1996 period (13.3 percent) for an EWMP of CTAs.

Fourth, returns on an EWMP of CTAs are generally much higher than on a VWMP of CTAs. For example, in the 1982-96 period an EWMP of CTAs had an annual return of almost 23.2 percent, while a VWMP of CTAs had an annual return of 13.8 percent . This occurs because small CTAs have higher returns than large CTA's but receive a lessor weight in a VWMP.

Fifth, returns volatility, which is similar for both EWMP and VWMP returns, is considerably lower in the 1993-96 period than in earlier years. It is also largely unaffected by whether a twelve or twenty-eight month exclusion rule is used to correct for the self-selection bias.

B. Private Pools

Table 3 provides performance figures for randomly-selected, single-pool portfolios, for an EWMP of pools, and a VWMP of pools. In Table 3 the first five months of pool returns are excluded. (Appendix 5 provides comparable performance figures when the first twelve months of pool returns are excluded.)

The performance statistics are similar to those for CTAs in the following respects:

-- the returns volatility for single-pool portfolios is much higher than for either an EWMP or a VWMP of pools;[22]

-- mean returns for both an EWMP and a VWMP of pools have been falling over time, and are much lower in the 1989-96 period than in earlier years (for example, an EWMP of pools had an annual return of 28.7 percent in 1982-88 versus an annual return of 9.4 percent in 1989-96); and

-- the returns volatility of both an EWMP and a VWMP of pools is much lower in 1989-96 than in earlier years.

In contrast to the CTA findings, the mean return for a VWMP of pools is 13.9, which is considerably higher than the mean return for an EWMP of pools in 1989-1996 (9.4 percent), although the reverse in true for 1982-88. This suggests that in recent years pools, unlike CTAs, have been subject to economies of scale. This may occur because pools can employ whatever size CTA they believe will deliver the best performance. In addition, the choice of exclusion rule does not affect average returns: they are much the same whether the first five or twelve months of returns data are excluded.[23]

C. Public Futures Funds

Table 4 provides performance figures for randomly-selected, single-fund, portfolios, for an EWMP of public funds, and for a VWMP of public funds. In Table 4 the first six months of returns are excluded. (Appendix 6 provides comparable performance figures for funds when the first twelve months of returns are excluded.) As for pools, fund returns are largely unaffected by which data exclusion rule is used. The pattern of fund returns is also very similar to those for pools, with one major exception: the level of public fund returns is much lower than for either pools or CTAs. For example, in 1989-96 the mean annual returns for an EWMP of CTAs, pools, and funds are, respectively, 13.3 percent, 9.4 percent, and 6.3 percent, the latter just barely above the mean Treasury Bill

return during this period (5.16 percent). As such, public funds have the lowest returns of all managed futures investments.

D. Comparative Risk-Adjusted Returns

Sharpe ratios are used as measures of risk-adjusted returns and to rank the alternative managed futures investments against each other as well as against the non-futures investments provided in Table 1. Table 5 shows these results over various time periods. The returns in Table 5 are based on our "MAR first-reporting" exclusion rule: excluding the first twelve, five, and six months of returns data for CTAs, pools, and funds respectively. Although pool and fund returns are largely insensitive to which exclusion rule is used, CTA returns are quite sensitive to which exclusion rule is used. Thus, for the sake of completeness, Appendix 7 reproduces the results for CTAs in Table 5 when the first twenty-eight months of returns data are excluded.

The use of Sharpe ratios as a measure of risk-adjusted returns can be justified by the low correlation between the returns on managed futures investments and the returns on non-futures investments, such as common stocks and bonds. Table 6 shows the correlation coefficients between the various managed futures investments and alternative non-futures investments, such as common stocks and bonds, for the 1982-96 period and for two sub-periods. In the 1982-96 the correlation coefficients are generally below 0.10 and are not statistically different from zero. In the 1989-96 period, however, the correlation coefficients between managed futures returns and bond returns are in the range of 0.20 and are generally statistically different from zero, although there continuous to be no relationship between managed futures returns and stock returns.

Table 5 shows that an EWMP of CTAs ranks first among all investments in the 1982-96 period, first during 1982-88, and second during 1989-96. CTA returns during the 1982-88 period, however, are probably upward biased because of a survivorship bias. Even

during 1989-96, however, when there is no survivorship bias, an EWMP of CTAs continues to be a good stand-alone investment, ranking below only common stocks. Given the sensational (and historically abnormally high) returns generated by common stocks during this period, an investment in an EWMP of CTAs appears to provide very attractive returns.[24] In addition, while an EWMP of pools ranks first during 1982-88, its ranking falls to a dismal seventh during 1989-1996, making it a poorer stand-alone investment than common stocks and bonds over the entire time period. Public funds also perform poorly, probably because of the higher fees associated with those funds and self-imposed restrictions in retaining only "seasoned" CTAs.[25] Finally, as expected, randomly-selected, single-CTA, pool, or fund portfolios never receive a high ranking because higher returns volatility lowers their Sharpe ratios significantly.

Table 5 also shows the same performance statistics for a VWMP of pools. A VWMP of pools ranks third for the entire 1982-96 period, behind corporate and government bonds and ahead of common stocks, third in 1982-1989, and first in 1992-96. It is notable that a VWMP of CTAs never ranks highly, reflecting the poorer performance of large CTAs. Thus, in the 1989-96 period, a VWMP of pools provides attractive returns, greater than even the "high-flying" S&P 500 stock index. Further, in the 1989-96 (a period free of survivorship bias), the Sharpe ratio for a VWMP of pools is considerably higher than for an EWMP of CTAs (0.955 versus 0.796).[26]

E. Summary

The performance statistics in Tables 5 suggest four major conclusions. First, a VWMP of pools stands out as an attractive stand-alone investment, with respect to both alternative non-futures investments and other managed futures investments, especially during the 1989-96 period. Although a VWMP of pools earned a somewhat lower average

annual return than common stocks during this period (13.9 percent versus 16.0 percent), the lower volatility of pool returns resulted in a higher Sharpe ratio for the VWMP of pools. This performance is especially impressive given the extraordinary high common stock returns during the 1989-96 period. A clear implication is that private pool managers add value: they generate higher returns and higher Sharpe ratios than most non-futures investments do, and they outperform other managed futures returns.

Second, neither single-CTA, pool, or fund portfolios nor any type of public fund investment make attractive stand-alone investments. Single-CTA, pool or fund portfolios all have high returns volatility, and public funds have low returns.

Third, the strong performance of an EWMP of CTAs during the 1982-1988 period should probably be given less credibility for two reasons. This period is subject to the greatest survivorship bias, and CTA reported CTA returns are highly sensitive to the exclusion rule used to control for self-selection bias.

Fourth, returns on all types of managed futures investments fell substantially in 1989-1996, compared to 1982-88, for reasons that remain unclear. A possible "data" explanation is that returns in the 1982-88 period may have been artificially inflated because of an upward survivorship bias, so that the elimination of this bias in the 1989-96 period makes in appear that returns fell in 1989-96. Another possibility is that market conditions in 1989-96 may not have been favorable to commodity traders. In particular, most commodity traders are to a greater or lesser degree "trend followers," and in 1989-96 commodity prices appear to have exhibited less trending behavior (or more choppiness) than in earlier years, making it difficult for traders to identify price trends and to capitalize on such trends.[27] Finally, during 1989-1996 there was undoubtedly greater competition. With a greater number of traders and more capital competing for trading profits, commodity markets may have become more efficient, resulting in lower returns.

Fifth, despite the decline in the level of returns in 1989-96, Sharpe ratios for a VWMP of pools rose significantly from 1982-88 to 1989-96 (from 0.694 to 0.955) -- lower returns were more than offset by a lower volatility of returns. However, this was not true for an EWMP of pools or for either an EWMP or a VWMP of CTAs. Thus, large pools appear to have been more successful in managing risk than were either small pools or individual CTAs.

V. MANAGED FUTURES AS PORTFOLIO ASSETS

An alternative way to view managed futures investments is as a separate asset class in a diversified portfolio of assets, and then examine the question of whether the performance of such a portfolio would be enhanced by inclusion of managed futures investments. Some institutional investors, such as pension funds, have recently begun to experiment with including managed futures investments in their portfolios in an effort to enhance performance.[28] A major reason to think that portfolio performance would be enhanced is that managed futures investments typically have high returns and a very low correlation with the returns on most other financial assets.

Table 6 shows the simple correlation coefficients between the alternative managed futures investments and other common financial assets. In general, the correlations between the alternative managed futures investments and other financial assets are close to zero. Some correlations are even negative. For example, the returns on a VWMP of pools are negatively correlated with S&P 500 common stock returns in all time periods, although they are never significantly different from zero. The highest correlation observed for the 1982-96 period is 0.15, between a VWMP of funds and long-term government bonds. Thus, including managed futures in a diversified asset portfolio may provide additional diversification benefits. [29]

Adding a new asset class to the portfolio can be shown to enhance portfolio performance (or to increase the portfolio's Sharpe ratio) if the asset in question satisfies the following condition:

$$(2) \qquad [\text{Sharpe Ratio of Candidate Asset}] \geq [\text{Correlation Coefficient}] \times [\text{Sharpe Ratio of Portfolio}]$$

where the correlation coefficient reflects the correlation between the returns on the new asset and the returns on the existing portfolio.[30] If this correlation is zero (as appears to be the case for most managed futures investments), the above equation reduces to the simple condition:

$$[\text{Sharpe Ratio of Candidate Asset}] \geq 0$$

An asset will satisfy this condition so long as its return is greater than the risk-free rate of return.[31]

Table 7 provides a "break-even" analysis for the alternative managed futures investments. Specifically, the minimum (or "break-even") rate of return that a managed futures investment must earn in order to be included in a diversified portfolio can be determined by rewriting equation (1) as follows and solving for the R_c , the required rate of return:

$$(3) \qquad [\frac{R_c - R_f}{\sigma_c}] \geq \rho_{pc} [\frac{R_p - R_f}{\sigma_p}]$$

(4) $$R_c \geq \rho_{cp} (\sigma_c / \sigma_p) (R_p - R_f) + R_f$$

where:

R_c = the average monthly rate of return on managed futures investment c,

R_f = the average monthly riskless rate of return,

σ_c = the standard deviation of monthly rates of return on the managed futures investment c,

R_p = the average monthly rate of return on portfolio p,

σ_p = the standard deviation of the monthly rates of return on portfolio p,

ρ_{cp} = the simple correlation between monthly returns on the managed futures investment c and monthly returns on portfolio p.

For given σ_c, ρ_{cp}, σ_p, R_p, and R_f, therefore, the required rate of return on a managed futures investment is R_c.

Table 7 does not include a break-even analysis for randomly-selected, one-CTA, pool, and fund portfolios because there is no obviously correct way to compute the relevant correlations between the returns on those investments and the other financial assets.[32] However, since the correlations between returns on EWMPs of CTAs, pools, and funds and other financial assets are close to zero, we might also expect the correlations between the returns on one-CTA, pool, and fund portfolio to be close to zero.[33]

To utilize the break-even methodology an assumption must be made about the characteristics of the hypothetical (or benchmark) portfolios to which futures investments are added. Two hypothetical portfolios are used: one that is 100 percent invested in the

S&P 500 common stock index, and one that consists of 60 percent S&P 500 stocks and 40 percent long-term corporate bonds.

Table 7 provides both the computed break-even returns for the managed futures investments examined as well as the actual returns on those investments. If the actual return is greater than the break-even return for an investment, including that investment in the benchmark diversified portfolio will increase that portfolio's Sharpe ratio. Over the entire 1982-96 period, as well as for the sub-period 1982-88, all managed futures investments satisfy the criterion for inclusion in both benchmark portfolios. The only exception to this general conclusion occurs in the 1989-96 period, when an EWMP funds fails to satisfy the criterion for inclusion in either benchmark portfolio. (A VWMP of funds barely satisfies it).[34] Thus, the break-even analysis indicates that including investments in a diversified portfolio of CTAs or pools in diversified stock and bond portfolios will clearly enhance the performance (or increase the Sharpe ratios) of those portfolios.[35]

VI. OPTIMAL PORTFOLIO ALLOCATIONS

While the previous analysis suggests that portfolio performance can be improved by including managed futures investments in the portfolio, it does not tell us anything about what the optimal portfolio allocations should be to managed futures investments. This section provides estimates of those allocations.

Elton and Gruber (1987) show that, when the objective is to maximize a portfolio's Sharpe-ratio, optimal portfolio allocations can be obtained by solving the following constrained optimization:[36]

$$\text{Maximize}\ \gamma_p = \frac{R_p - R_f}{\sigma_p} \tag{5}$$

subject to

$$R_p = \sum_{i=1}^{N} R_i X_i, \quad \sum_{i=1}^{N} X_i = 1, X_i \geq 0 \text{ for all } i$$

where

$\tilde{a}_p$ **= Sharpe ratio of portfolio p,**

R_p **= the expected rate of return on portfolio p,**

σ_p **= the standard deviation of the monthly rates of return on portfolio p,**

R_f **= the risk-free rate of return,**

X_i **= the proportion of asset I in portfolio p, and**

□

R_i **= the expected rate of return on asset I.**

□

Because the objective function represented by equation (5) is non-linear, the optimization solution must be obtained by using a numerical algorithm. In addition, optimal portfolio allocations are estimated under both unconstrained and constrained conditions. Irwin, Krukemeyer and Zulauf (1992) argue that constraining the portfolio allocations reduces the estimation error when solving an optimal portfolio problem.[37] In the constrained-estimation procedure, the minimum and maximum portfolio allocations for stocks and bonds are set equal to the minimum and maximum U.S. capital-market-value-weights over the 1970-84 period.[38]

Table 8 shows the optimum portfolio allocations for diversified portfolios of CTAs, pools, and funds for 1982-96 and for two sub-periods, 1982-88 and 1989-92.[39] These allocations are generated by assuming that a particular managed futures investment (or set

of investments) is included in a diversified portfolio consisting of S&P 500 stocks, small-cap stocks, intermediate-term government bonds, long-term government bonds, and long-term corporate bonds. Optimal allocations for portfolios which do not include any managed futures investment are shown in the column labeled w/o. In general, unconstrained portfolios tend to have from 15 to 47 percent in S&P 500 stocks and the remainder of the portfolio in long-term corporate bonds and intermediate-term government bonds, depending on the time period analyzed. Neither small-cap stocks nor long-term government bonds enter the unconstrained optimal portfolios. In 1982-1996 an unconstrained portfolio consisting of 74 percent bonds and 26 percent stock has an average annual return of 12.9 percent, a standard deviation of monthly returns of 7.1 percent, and a Sharpe ratio of 0.922. This portfolio is used as a benchmark against which to evaluate the benefits of incorporating managed futures investments into the portfolio.

Columns one through six in Table 8 show for both constrained and unconstrained portfolios the optimal allocations when each of the alternative managed futures is separately included in the portfolio. For unconstrained portfolios in 1982-96, an EWMP of CTAs and a VWMP of pools receive the highest allocations (twenty-nine and twenty-eight percent respectively). For constrained portfolios during this period these two managed futures investments as well as an EWMP of pools all receive the same high portfolio allocation (twenty-seven percent). Further, the allocations for an EWMP of CTAs and a VWMP of pools rise sharply in the unconstrained portfolios in the 1989-96 period (to thirty-nine and forty-eight percent respectively). Taking only 1989-96, a period for which we have the most confidence in the data, inclusion of an investment in a VWMP of pools increases the Sharpe ratio of the benchmark unconstrained portfolio by a surprising 45.4 percent (from 0.979 to 1.423), and increases the Sharpe ratio of the benchmark constrained portfolio by 30.3 percent (from 0.954 to 1.256). (See column 5 in Table 8) The increases in

portfolio Sharpe ratios occur largely because of a reduction in portfolio returns volatility, although there is a small increase in average portfolio returns as well.

When all managed futures investments are available for inclusion in the benchmark portfolios, the results are strikingly dichotomous. In both the 1982-1996 and the sub-period 1982-88 an EWMP of CTAs is the only investment to enter the portfolio, receiving a portfolio allocation of between twenty-six to twenty-nine percent in the constrained and unconstrained portfolios (see column 9 in Table 8). The results for 1989-1996 are quite different: only an investment in a VWMP of pools enters the portfolio, receiving an allocation of forty-eight and twenty-seven percent in the unconstrained and constrained portfolios respectively.

This result occurs because the returns on an EWMP of CTAs fall sharply from 1982-88 to 1989-96, from an average annual return of 34.3 percent to an annual return of 13.4 percent (see Table 5). Although returns on a VWMP of pools also fall over this period, they fall by considerably less, and this decline is coupled with an even greater decline in returns volatility which results in a rise in the Sharpe ratio for a VWMP of pools from 1982-88 to 1989-96. (See Table 3)

Further, the high returns in 1982-88 on an EWMP of CTAs are probably upward biased because of a survivorship bias in the CTA data during those years. For this reason the most credence should be given to our findings for the 1989-96 period. In that period a VWMP of pools is the best managed futures investment to include in a diversified asset portfolio. If this investment is given the optimal allocation of forty-eight percent in an unconstrained portfolio, or twenty-seven percent in a constrained portfolio, portfolio Sharpe ratios would increase by 45.4 percent and 30.3 percent respectively. (See column 9 in Table 8) The specific optimal allocations for a constrained portfolio would be twenty-seven percent in a VWMP of pools, forty-five percent in large-cap stocks, four percent in

small-cap stocks, nine percent in long-term corporate bonds, seven percent in long-term government bonds, and eight percent in intermediate-term government bonds.

Alternatively, if investors were not able to construct an investment that replicated the returns on a VWMP of pools, the next best alternative would be to invest in an EWMP of CTAs. In the 1989-96 period an EWMP of CTAs receives a portfolio allocation of thirty-nine percent in an unconstrained portfolio and twenty-seven percent in an unconstrained portfolio. Including those allocations in the benchmark unconstrained and constrained portfolios would increase portfolio Sharpe ratios by 27.6 and 22.7 percent respectively.

Finally, if neither of those managed futures investments were available, it would still beneficial to include one of several other types of managed futures investments in a diversified portfolio. For example, over all time periods an EWMP of pools receives a portfolio allocation of between eighteen and twenty-seven percent. Indeed, of all the managed futures investments examined, only public funds receive a zero allocation in some time periods and for some portfolios. In 1989-96, an EWMP of funds receives a zero allocation in both unconstrained and constrained portfolios, and a VWMP of funds receives a zero allocation in the unconstrained portfolio and only a three percent allocation in a constrained portfolio. In contrast to other managed futures investments, therefore, including public funds in a diversified asset portfolio does not appear to increase portfolio Sharpe ratios appreciably.[40]

VII. ARE MANAGED FUTURES A HEDGE AGAINST INFLATION?

Some investors believe that managed futures investments provide a hedge against general price inflation, or that there is a strong positive correlation between commodity prices in general and price inflation. Holding long positions in commodity futures contracts, therefore, should earn higher returns when there is greater inflation.

The returns on a managed futures investment, however, need not reflect a long position in commodities. They depend, rather, on the trading strategies and skills of CTAs. CTAs may hold both short and long positions, depending on which commodities they are trading and on their ability to time-the-market. They may even hold short positions during periods of high inflation, incurring losses rather than gains. Further, CTAs trade financial futures, such as currencies and stock index futures, as well as commodity futures, and the expected correlation between the returns on financial futures and inflation rates is less obvious. Thus, a priori, it is not clear that returns on managed futures investments should be positively related to price inflation.

The findings of prior research studies are mixed. Irwin and Brorsen (l985), in their study of 84 public futures funds, find a high correlation between the returns of pubic funds and inflation: 0.606 over the 1975-83 period. Irwin and Landa (1987), using essentially the same data plus one year, find a correlation of 0.55 between returns on public funds and inflation. In contrast, Elton, Gruber and Rentzler (1987, 1990) find no evidence of a positive correlation between the returns of public funds and inflation, and conclude that funds do not provide a hedge against inflation. Irwin, Krukemyer and Zulauf (1992) support EGR's findings. They examine over 100 public funds from 1979 through 1989 and find a negative relationship between fund returns and inflation: the average correlation for the eleven-year period is -0.01. On a yearly basis, EGR (1990) find that the highest correlation between fund returns and inflation is 0.18, and in four of the eleven years there is a negative correlation between fund returns and inflation. (In 1986, for example, this correlation is -0.38.)

Our results offer some support for the view that managed futures investments provide a hedge against inflation: returns are significantly and positively correlated with price inflation. Table 9 provides the correlation coefficients between monthly and annual

returns on the different managed futures investments and monthly and annual inflation rates. Two results stand-out: yearly correlation coefficients are much higher than monthly correlation coefficients, and the correlation between managed futures returns and inflation rates is much higher in 1989-1996 than in 1982-88.

These findings should be interpreted cautiously. Our data period is relatively short for drawing conclusions about the effects of price inflation. Further, the positive correlation between managed futures returns and inflation rates is largely driven by the strong relationship which exists during 1989-96, when inflation rates were low and falling and managed futures returns were also relatively low. This leaves unclear whether such a strong positive relationship would exist when inflation rates were high and rising. Further, it is possible that the strong correlation between managed futures returns and inflation rates during 1989-96 may be due to a third economic factor that affected both inflation and managed futures returns during this period but which may be absent in future time periods.

To provide "period-free" estimates of the relationship between managed futures returns and inflation rates, Table 10 sorts all monthly observations during 1982-96 into three distinct inflation categories -- high, medium, and low inflation -- and calculates the mean annual returns on the alternative managed futures investments for each of these inflation categories. In general, higher inflation rates are associated with higher managed futures returns in all periods, and the difference between returns in high- and low-inflation periods in the 1989-96 period is much greater than in the 1982-88 period. Thus, based on our limited time period, returns on managed futures investments do appear to be higher when inflation rates are higher, and therefore to provide a hedge against inflation.

VIII. CONCLUSION

This study examines the performance of managed futures investments during the years l982 through 96, both as stand-alone investments and as assets in diversified stock and bond portfolios. The performance of nine stylized managed futures investments are examined: randomly-selected, single-CTAs, pool and fund portfolios; equally-weighted market portfolios (EWMPs) of CTAs, pools and funds; and, value-weighted (VWMP) of CTAs, pools, and funds. In addition, two subperiods are examined: l982-88 and l989-96.

The key finding is that several types of managed futures investments make both good stand-alone investments and good portfolio assets.[41] Based on a Sharpe ratio analysis, in all time periods studied either an EWMP of CTAs or a VWMP of pools receives the highest ranking among the alternative asset classes examined. In particular, one of those two investments outperforms even large-cap common stocks in all periods, despite the sensational returns on common stock in the 1980's and 1990's. In addition, a portfolio analysis shows that, with the exception of public funds, including managed futures investments in a diversified stock and bond portfolio significantly increases portfolio Sharpe ratios. For example, for the 1989-96 period (a period for which we have the greatest confidence in the data), including an investment in either a VWMP of pools or an EWMP of CTAs increases the Sharpe ratio of a diversified stock and bond portfolio by from 22.7 to 45.4 percent. The only managed futures that do not make either attractive stand-alone investments or portfolio assets are investments in public funds.

These findings raise a number of important issues. First, since it unrealistic to believe that investors would assemble a portfolio consisting of all CTAs or pools in existence, and re-balance this portfolio every month to achieve the designated weighting scheme, there remains the practical question of exactly what kind of managed futures investments investors should hold. In particular, how many randomly-selected CTAs or pools would investors need to acquire in order to approximate the results for our stylized

portfolios of CTAs and pools? A study by Billingsley and Chance (1996) suggests that for a diversified asset portfolio with a substantial commitment to managed futures investments (similar to our optimal portfolios) probably fewer than ten CTAs or pools would be needed to achieve most of the benefits that would be attained by including a diversified investment of all CTAs or pools in existence. Further, including even two or three CTAs or pools in such a portfolio could result in substantial portfolio benefits.[42] Thus, managed futures are clearly feasible investments for high net worth investors and institutional fund managers.[43]

Second, the high net (and therefore very high gross) returns produced by a diversified portfolio of CTAs or pools raises a question about the efficiency of futures markets. How could such high speculative returns be earned in an efficient market? Given the general lack of a positive correlation between either CTA or pool returns and other financial assets, these high returns do not appear to be explained by an associated high risk premium, at least as commonly measured (such as by "betas"). We are, therefore, left with the question of whether the high returns earned by CTAs and pools can be sustained in the future -- or, stated in another way, whether the reasons for those returns (or "market inefficiencies") will continue to exist in the future.

Finally, the results of this study are based on diversified portfolios of all CTAs and pools. No effort was made to identify and select superior-performing CTAs and pools. If, in fact, some CTAs or pools possess greater trading skill than others, and one were able to identify those CTAs or pools, it is obvious that a portfolio consisting of only superior-performing CTAs or pools would provide even greater risk-adjusted returns than observed. An important issue, therefore, is whether some CTAs and pool managers do possess superior trading skill, and, if they do, can this skill be identified.

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Chart 1
Managed Futures Assets Under Management
January 1980 - December 1996

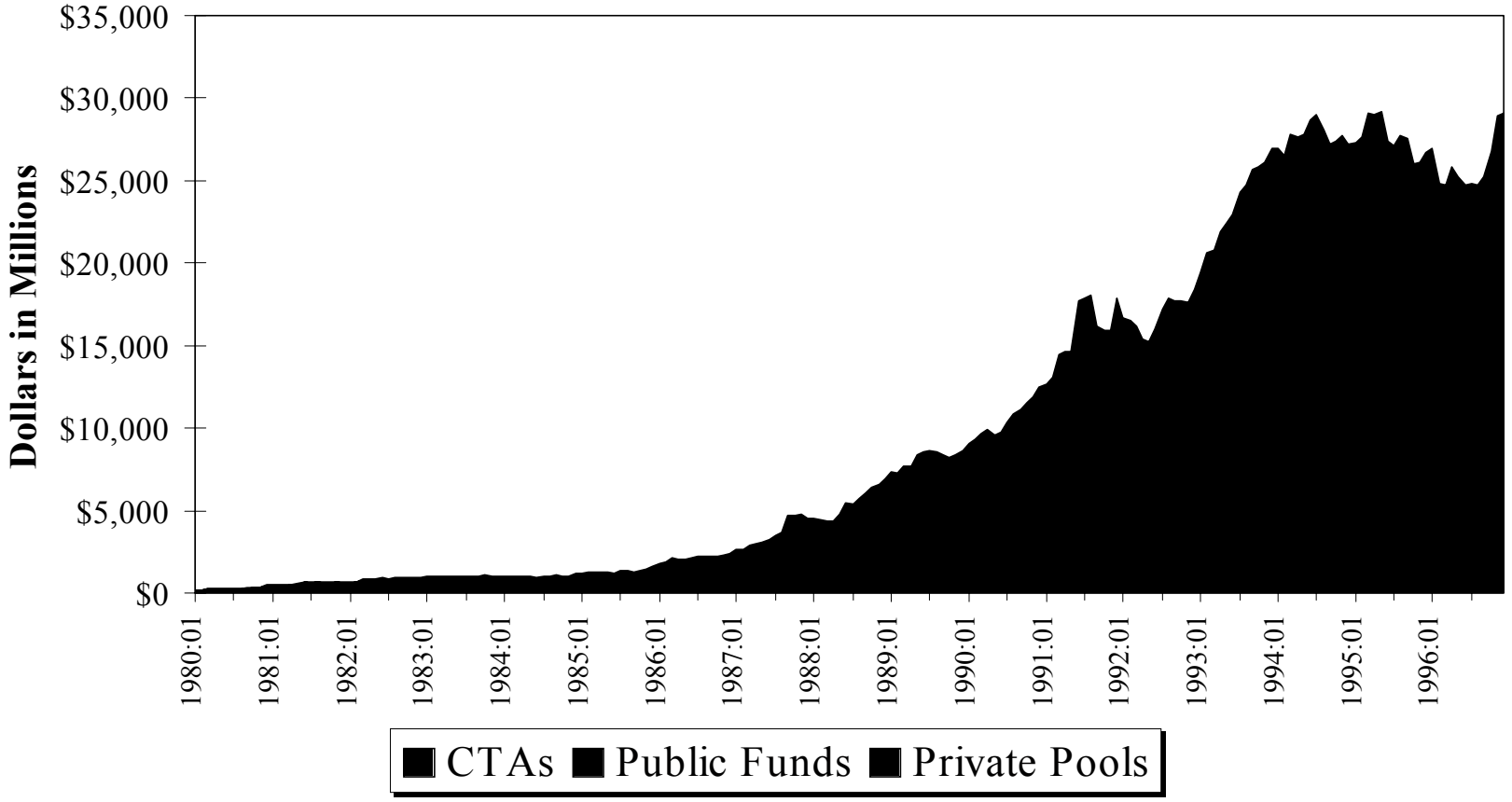


Chart 2
Historgram of Administrative Fees

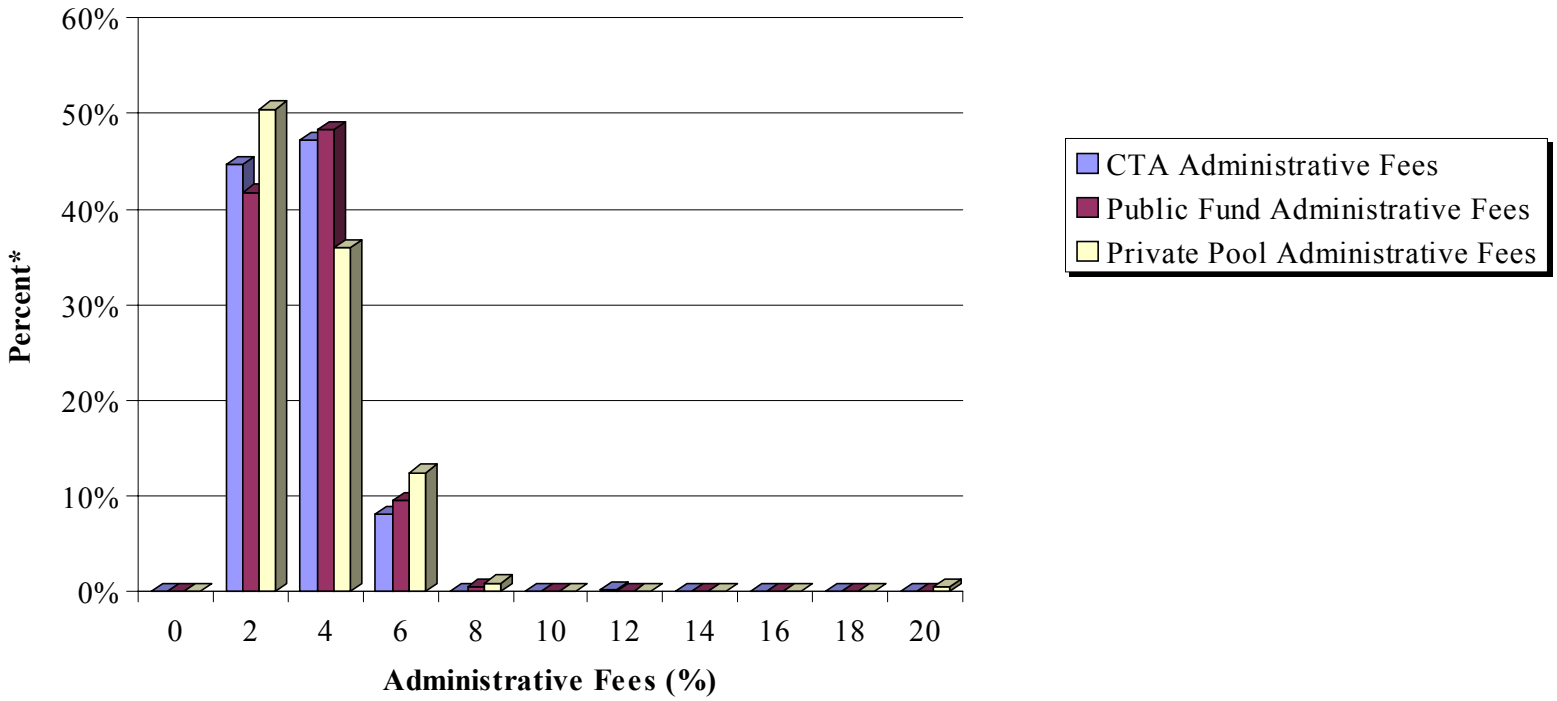
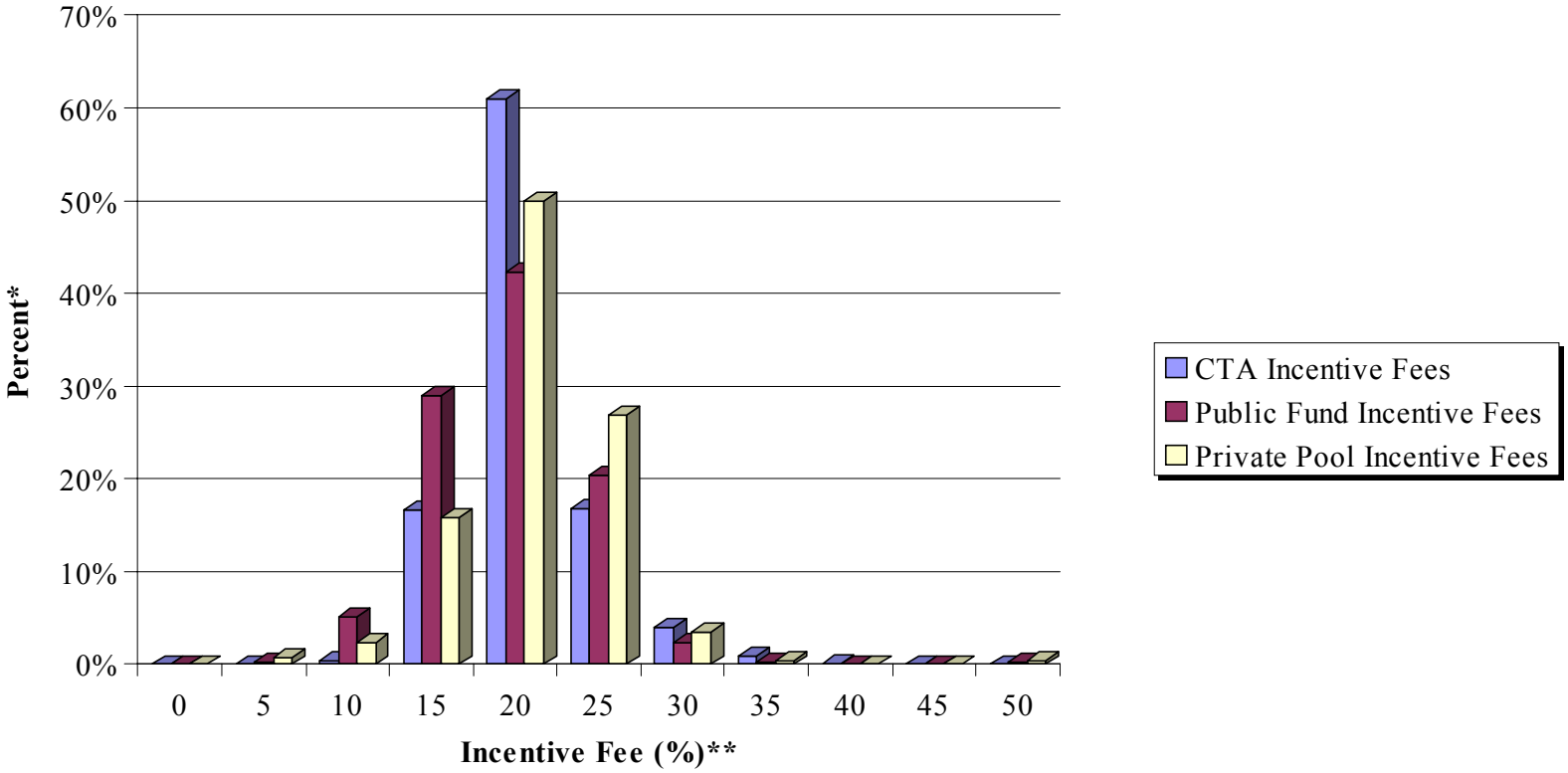


Chart 3
Historgram of Incentive Fees



* Percentage of the total number of CTAs, pools, and funds.
** Percent of net profits.

TABLE 1
Returns and Standard Deviations for Alternative Futures and Nonfutures Investments

	S&P500 (Large-cap)			Russell 2000 (Small-cap)			Intermediate-Term Government Bonds			Long-Term Government Bonds			Long-Term Corporate Bonds			Treasury Bills		
Year	Monthly Return	Standard Deviation	Annual Return	Monthly Return	Standard Deviation	Annual Return	Monthly Return	Standard Deviation	Annual Return	Monthly Return	Standard Deviation	Annual Return	Monthly Return	Standard Deviation	Annual Return	Monthly Return	Standard Deviation	Annual Return
1980	2.50	5.29	29.95	3.06	7.88	36.72	0.41	4.60	4.96	-0.17	6.16	-2.02	-0.08	5.81	-1.00	0.89	0.26	10.70
1981	-0.36	3.72	-4.26	0.30	5.29	3.55	0.80	3.12	9.59	0.33	6.40	3.96	0.04	5.75	0.53	1.15	0.13	13.80
1982	1.76	5.52	21.16	2.04	6.11	24.44	2.17	2.03	26.03	2.91	3.03	34.87	3.06	3.68	36.72	0.84	0.21	10.06
1983	1.74	2.86	20.92	2.27	4.98	27.19	0.61	1.54	7.30	0.10	3.25	1.20	0.55	2.94	6.55	0.71	0.05	8.46
1984	0.58	4.05	6.96	-0.53	4.70	-6.38	1.11	1.83	13.32	1.26	3.35	15.08	1.35	3.22	16.20	0.79	0.09	9.42
1985	2.41	3.51	28.86	2.39	4.92	28.62	1.57	1.63	18.79	2.33	3.52	27.95	2.26	2.99	27.07	0.62	0.05	7.45
1986	1.55	5.18	18.54	0.57	4.75	6.79	1.19	1.65	14.28	1.96	5.00	23.47	1.55	2.36	18.54	0.50	0.05	5.99
1987	0.81	8.80	9.72	-0.13	10.79	-1.60	0.25	1.39	2.96	-0.19	2.97	-2.26	0.01	2.78	0.16	0.44	0.06	5.28
1988	1.34	2.91	16.09	1.94	4.07	23.28	0.50	1.36	6.04	0.81	2.91	9.72	0.88	2.38	10.51	0.51	0.10	6.17
1989	2.36	3.57	28.32	1.31	3.09	15.67	1.06	1.56	12.67	1.42	2.35	17.04	1.28	1.79	15.30	0.67	0.06	8.06
1990	-0.14	5.31	-1.67	-1.57	6.88	-18.83	0.78	1.26	9.36	0.53	2.69	6.36	0.57	2.04	6.80	0.63	0.05	7.54
1991	2.34	4.56	28.07	3.33	5.21	39.94	1.21	0.88	14.50	1.50	1.79	17.94	1.53	1.24	18.36	0.45	0.05	5.45
1992	0.64	2.13	7.66	1.50	4.27	18.00	0.59	1.58	7.09	0.67	2.04	8.00	0.76	1.53	9.12	0.29	0.04	3.44
1993	0.81	1.77	9.73	1.49	2.79	17.87	0.90	1.16	10.76	1.43	2.07	17.10	1.05	1.42	12.55	0.24	0.01	2.86
1994	0.15	3.04	1.81	-0.11	3.13	-1.30	-0.43	1.36	-5.16	-0.64	2.51	-7.70	-0.47	2.04	-5.69	0.32	0.07	3.83
1995	2.70	1.50	32.34	2.14	2.81	25.72	1.31	0.98	15.67	2.34	2.17	28.07	1.99	1.81	23.82	0.45	0.04	5.45
1996	1.79	3.15	21.48	1.37	4.31	16.40	0.18	1.52	2.14	-0.04	2.70	-0.53	0.14	2.16	1.65	0.42	0.02	5.08
1982-96	1.39	4.17	16.68	1.20	5.02	14.40	0.87	1.52	10.44	1.09	2.98	13.08	1.10	2.46	13.20	0.53	0.19	6.36
1982-88	1.46	4.92	17.52	1.22	6.02	14.64	1.06	1.71	12.72	1.31	3.54	15.72	1.38	2.99	16.56	0.63	0.17	7.56
1989-96	1.33	3.40	15.96	1.18	4.34	14.16	0.70	1.33	8.40	0.90	2.40	10.80	0.85	1.87	10.20	0.43	0.15	5.16
1989-92	1.30	4.09	15.60	1.11	5.20	13.37	0.91	1.33	10.92	1.03	2.22	12.36	1.03	1.67	12.36	0.51	0.16	6.12
1993-96	1.36	2.59	16.32	1.22	3.32	14.64	0.49	1.31	5.88	0.77	2.59	9.24	0.67	2.05	8.04	0.36	0.10	4.32

Monthly Return: Arithmetic average of monthly returns durring the year.
Standard Deviation: Standard deviation of monthly returns during the year.
Annual Return: Monthly return multiplied by 12.

TABLE 2
CTAs: Returns and Standard Deviations
Exclude First 12 Months

		One-CTA Portfolio*	Equal-Weighted Market Portfolio of CTAs			Value-Weighted Market Portfolio of CTAs			
Year	Number of CTAs	Standard Deviation	Monthly Return	Standard Deviation	Annual Return	Number of CTAs	Monthly Return	Standard Deviation	Annual Return
1980	35**	14.50	NA	NA	NA	32**	NA	NA	NA
1981	46	13.88	2.51	7.18	30.12	43	1.52	6.48	18.20
1982	60	14.63	2.70	5.65	32.35	55	1.27	7.16	15.23
1983	65	13.30	2.10	6.45	25.22	59	0.11	6.36	1.28
1984	74	13.71	2.10	7.06	25.16	68	1.89	8.59	22.68
1985	115	16.65	3.19	5.59	38.29	112	2.06	6.17	24.76
1986	145	16.67	2.39	6.74	28.73	140	0.13	5.95	1.50
1987	179	27.44	4.94	6.52	59.23	171	3.77	5.38	45.18
1988	212	16.67	2.61	8.13	31.32	204	1.28	6.22	15.34
1989	237	11.44	1.40	4.51	16.74	229	0.38	5.08	4.56
1990	291	9.69	2.38	3.02	28.55	283	1.97	3.44	23.64
1991	336	9.21	1.09	3.66	13.08	329	1.17	4.73	14.04
1992	410	7.09	0.61	2.88	7.26	403	0.27	3.97	3.24
1993	472	8.29	1.08	2.19	13.00	460	1.09	2.45	13.08
1994	483	8.54	0.36	1.94	4.30	471	-0.24	2.27	-2.83
1995	462	7.90	1.08	2.08	13.00	453	1.01	2.67	12.16
1996	424	7.72	0.90	2.88	10.86	421	1.07	3.26	12.88
1982-96		11.55	1.93	4.97	23.16		1.15	5.12	13.80
1982-88		18.97	2.86	6.46	34.32		1.50	6.48	18.00
1989-96		8.58	1.11	2.95	13.32		0.84	3.54	10.08
1989-92		9.23	1.37	3.52	16.44		0.95	4.27	11.40
1993-96		8.13	0.86	2.25	10.32		0.74	2.66	8.88

Monthly Return: Arithmetic average of monthly returns during the year.

Standard Deviation: Standard deviation of monthly returns during the year.

Annual Return: Monthly Return multiplied by 12.

* The return on a one-CTA randomly-selected portfolio is identical to the return on an equally-weighted portfolio of CTAs. The standard deviation of one-CTA portfolio returns is the standard deviation of all possible one-CTA portfolio returns.

** Monthly returns start from 1980:4.

TABLE 3
Private Pools: Returns and Standard Deviations
Exclude First 5 Months

		One-Pool Portfolio*	Equal-Weighted Market Portfolio of Private Pools			Value-Weighted Market Portfolio of Private Pools			
Year	Number of Pools	Standard Deviation	Monthly Return	Standard Deviation	Annual Return	Number of Pools	Monthly Return	Standard Deviation	Annual Return
1980	10	11.30	5.20	8.86	62.45	5	3.37	5.86	40.40
1981	11	12.53	2.11	7.73	25.34	6	2.63	6.65	31.58
1982	15	10.11	1.64	6.89	19.64	11	1.84	5.79	22.14
1983	24	13.02	2.56	8.14	30.67	20	0.60	4.27	7.18
1984	31	14.82	1.92	10.16	23.05	27	1.52	5.72	18.22
1985	42	14.58	2.04	5.86	24.52	37	1.92	6.19	23.04
1986	65	16.18	2.54	5.10	30.49	57	0.58	5.41	6.98
1987	94	13.84	4.59	5.27	55.02	83	4.04	4.59	48.50
1988	122	20.38	1.47	6.29	17.64	105	1.04	3.63	12.51
1989	157	10.24	0.67	4.27	8.05	128	1.28	3.25	15.36
1990	175	7.91	1.95	2.42	23.45	159	2.84	3.00	34.07
1991	196	8.64	0.41	4.30	4.89	191	0.74	3.07	8.90
1992	203	7.19	0.01	2.72	0.12	201	0.59	2.23	7.02
1993	222	6.91	1.01	2.62	12.14	219	1.24	1.84	14.92
1994	202	6.81	-0.04	2.24	-0.50	199	0.48	2.19	5.71
1995	191	6.77	1.01	2.45	12.06	191	0.90	2.08	10.76
1996	169	7.63	1.18	3.99	14.20	168	1.18	2.87	14.14
1982-96		10.04	1.53	5.26	18.36		1.39	3.96	16.68
1982-88		15.06	2.39	6.83	28.68		1.65	5.09	19.80
1989-96		7.74	0.78	3.18	9.36		1.16	2.61	13.92
1989-92		8.47	0.76	3.50	9.12		1.36	2.96	16.32
1993-96		7.04	0.79	2.86	9.48		0.95	2.23	11.40

Monthly Return: Arithmetic average of monthly returns during the year.

Standard Deviation: Standard deviation of monthly returns during the year.

Annual Return: Monthly return multiplied by 12.

* The return on a one-pool randomly-selected portfolio is identical to the return on an equally-weighted portfolio of pools. The standard deviation of one-pool portfolio returns is the standard deviation of all possible one-pool portfolio returns.

TABLE 4
Public Funds: Returns and Standard Deviations
Exclude First 6 Months

		One-Fund Portfolio*	Equal-Weighted Market Portfolio of Public Funds			Value-Weighted Market Portfolio of Public Funds			
Year	Number of Funds	Standard Deviation	Monthly Return	Standard Deviation	Annual Return	Number of Funds	Monthly Return	Standard Deviation	Annual Return
1980	13	11.27	2.59	6.24	31.07	5	3.19	7.98	38.31
1981	22	8.77	0.91	5.87	10.94	19	1.87	6.05	22.49
1982	33	8.79	0.93	5.47	11.12	30	1.09	5.40	13.05
1983	48	10.90	-0.13	7.29	-1.58	45	-0.60	6.11	-7.21
1984	61	10.40	1.55	7.30	18.55	59	1.21	7.68	14.56
1985	74	8.11	1.85	5.13	22.16	74	1.67	5.80	20.04
1986	93	10.41	-0.40	6.06	-4.79	92	-1.05	6.97	-12.60
1987	113	18.21	3.52	5.64	42.24	112	3.05	5.68	36.54
1988	138	10.21	0.90	6.95	10.82	135	0.48	5.70	5.79
1989	180	22.11	0.39	5.48	4.74	171	0.55	4.89	6.62
1990	209	6.05	1.58	3.03	18.96	198	1.22	2.78	14.64
1991	233	7.47	0.53	4.64	6.36	230	0.80	5.10	9.58
1992	257	6.63	-0.10	3.46	-1.23	256	-0.05	3.53	-0.64
1993	309	5.33	0.84	2.30	10.05	306	1.26	2.14	15.16
1994	315	5.20	-0.60	1.90	-7.19	312	-0.47	1.70	-5.58
1995	324	5.50	0.83	2.07	9.98	322	0.71	2.34	8.57
1996	296	6.03	0.69	3.08	8.30	293	0.98	2.61	11.78
1982-96		9.27	0.82	4.90	9.84		0.72	4.82	8.64
1982-88		12.15	1.17	6.21	14.04		0.84	6.15	10.08
1989-96		8.41	0.52	3.38	6.24		0.63	3.27	7.56
1989-92		11.44	0.60	4.17	7.20		0.63	4.08	7.56
1993-96		5.56	0.44	2.38	5.28		0.62	2.25	7.44

Monthly Return: Arithmetic average of monthly returns during the year.

Standard Deviation: Standard deviation of monthly returns during the year.

Annual Return: Monthly return multiplied by 12.

* The return on a one-fund randomly-selected portfolio is identical to the return on an equally-weighted portfolio of funds.
The standard deviation of one-fund portfolio returns is the standard deviation on all possible one-fund portfolio returns.

TABLE 5

Average Annual Sharpe Ratios, Rank by Sharpe Ratio, and Average Annual Returns for Alternative Managed Futures Investments, 1982-1996
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds

	1982:1-1996:12			1982:1-1988:12			1989:1-1996:12		
	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns
Equally-Weighted Market Portfolios									
RS CTAs	0.421	8	23.2%	0.407	7	34.3%	0.274	8	13.3%
RS Private Pools	0.346	9	18.4%	0.406	8	28.7%	0.152	9	9.4%
RS Public Funds	0.112	11	9.8%	0.155	11	14.0%	0.035	11	6.2%
EW CTAs	0.977	1	23.1%	1.196	1	34.3%	0.796	2	13.4%
EW Private Pools	0.662	5	18.4%	0.894	2	28.7%	0.371	7	9.3%
EW Public Funds	0.211	10	9.9%	0.303	10	14.1%	0.088	10	6.2%
S&P 500 (large cap)	0.717	4	16.7%	0.581	6	17.5%	0.912	1	16.0%
Long-term Corporate Bonds	0.806	2	13.2%	0.867	4	16.5%	0.777	3	10.2%
Intermediate-term Government Bonds	0.775	3	10.4%	0.869	3	12.7%	0.689	4	8.4%
Long-term Government Bonds	0.657	6	13.1%	0.667	5	15.7%	0.670	5	10.8%
Russell 2000 (small cap)	0.451	7	14.4%	0.339	9	14.6%	0.597	6	14.2%
Value-Weighted Market Portfolios									
RS CTAs	0.421	8	23.1%	0.407	7	34.3%	0.274	8	13.4%
RS Private Pools	0.346	9	18.4%	0.406	8	28.7%	0.152	10	9.3%
RS Public Funds	0.112	11	9.9%	0.155	10	14.1%	0.035	11	6.2%
VW CTAs	0.422	7	13.8%	0.465	6	18.0%	0.399	7	10.1%
VW Private Pools	0.752	3	16.7%	0.694	3	19.8%	0.955	1	13.9%
VW Public Funds	0.142	10	8.6%	0.116	11	10.1%	0.202	9	7.6%
S&P 500 (large cap)	0.717	4	16.7%	0.581	5	17.5%	0.912	2	16.0%
Long-term Corporate Bonds	0.806	1	13.2%	0.867	2	16.5%	0.777	3	10.2%
Intermediate-term Government Bonds	0.775	2	10.4%	0.869	1	12.7%	0.689	4	8.4%
Long-term Government Bonds	0.657	5	13.1%	0.667	4	15.7%	0.670	5	10.8%
Russell 2000 (small cap)	0.451	6	14.4%	0.339	9	14.6%	0.597	6	14.2%

RS - Randomly-Selected, single-CTA, pool, or fund portfolios.

EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.

Annual Sharpe ratios are computed from monthly observations: multiply the monthly Sharpe ratio by the square root of 12.

Average annual returns are the average monthly returns multiplied by 12.

Table 6
Correlation Coefficients for Asset Classes for 1982-1996 and Sub-Periods 1982-1988 and 1989-1996
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds

1982:1-1996:12	EW CTAs	EW Pools	EW Funds	VW CTAs	VW Pools	VW Funds	Common Stocks	Long Corp. Bonds	Inter. Gov't Bonds	Long Gov't Bonds	T-bills	Small Cap. Stocks
EW CTAs	1.00											
EW Private Pools	0.93**	1.00										
EW Public Funds	0.90**	0.89**	1.00									
VW CTAs	0.91**	0.91*	0.95**	1.00								
VW Private Pools	0.84**	0.86**	0.82**	0.90**	1.00							
VW Public Funds	0.89**	0.86**	0.96**	0.96**	0.87**	1.00						
Common Stock Returns (S&P500)	-0.01	-0.03	0.08	0.02	-0.05	0.08	1.00					
Long-term Corporate Bonds	0.07	0.07	0.06	0.06	0.09	0.09	0.40**	1.00				
Intermediate-term Government Bonds	0.04	0.03	0.05	0.03	0.04	0.08	0.34**	0.92**	1.00			
Long-term Government Bonds	0.11	0.09	0.11	0.10	0.14*	0.15*	0.39**	0.94**	0.92**	1.00		
Treasury Bills	0.09	0.09	0.05	0.04	0.06	0.02	-0.02	0.18**	0.23**	0.14*	1.00	
Russell 2000 (Small Cap. Index)	-0.08	-0.10	-0.02	-0.06	-0.13*	-0.03	0.85**	0.22**	0.15*	0.19**	-0.10	1.00

Sub-period 1982:1-1988:12\1989:1-1996:12	EW CTAs	EW Pools	EW Funds	VW CTAs	VW Pools	VW Funds	Common Stocks	Long Corp. Bonds	Inter. Gov't Bonds	Long Gov't Bonds	T-bills	Small Cap. Stocks
EW CTAs	1.00	0.96**	0.92**	0.96**	0.84**	0.91**	-0.02	0.15	0.14	0.16	0.14	-0.20**
EW Private Pools	0.92**	1.00	0.92**	0.94**	0.90**	0.89**	0.01	0.19*	0.16	0.21**	0.10	-0.16
EW Public Funds	0.91**	0.89**	1.00	0.96**	0.77**	0.97**	0.12	0.21**	0.21**	0.23**	0.08	-0.11
VW CTAs	0.91**	0.90**	0.94**	1.00	0.83**	0.95**	0.01	0.18*	0.17*	0.20**	0.05	-0.16
VW Private Pools	0.85**	0.85**	0.83**	0.92**	1.00	0.76**	-0.11	0.11	0.10	0.15	0.15	-0.26**
VW Public Funds	0.90**	0.86**	0.96**	0.97**	0.91**	1.00	0.14	0.25**	0.25**	0.27**	0.04	-0.10
Common Stock Returns (S&P500)	-0.01	-0.06	0.06	0.03	-0.02	0.06	1.00	0.52**	0.43**	0.49**	0.08	0.77**
Long-term Corporate Bonds	0.03	0.01	0.00	0.01	0.07	0.03	0.34**	1.00	0.92**	0.98**	0.12	0.24**
Intermediate-term Government Bonds	-0.03	-0.05	-0.03	-0.05	0.01	0.00	0.29**	0.93**	1.00	0.92**	0.17*	0.12
Long-term Government Bonds	0.08	0.04	0.06	0.05	0.13	0.10	0.33**	0.92**	0.92**	1.00	0.10	0.19*
Treasury Bills	-0.06	-0.03	-0.02	-0.02	-0.02	0.00	-0.12	0.16	0.22**	0.13	1.00	-0.08
Russell 2000 (Small Cap. Index)	-0.05	-0.08	0.02	-0.01	-0.08	0.00	0.89**	0.22**	0.16	0.19*	-0.14	1.00

Correlations are computed using monthly returns.
EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.

* significant at the 10% level.
** significant at the 5% level.
Test statistic t(n-2) = r / ((1-r^2)/(n-2))^(0.5).
For 1982-1996, the critical values at the 5% and 10% level are 1.9759 and 1.6551, respectively.
For 1982-1988, the critical values at the 5% and 10% level are 1.9886 and 1.6632, respectively.
For 1989-1996, the critical values at the 5% and 10% level are 1.985 and 1.6609, respectively.
*** Buy and Hold Futures Returns are CRB Future Price Index Returns plus the one month T-bill return.

Table 7
Break-Even Analysis for Managed Futures Investments
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds

		1982:1-1996:12		1982:1-1988:12		1989:1-1996:12	
		100% stocks	60% stocks 40% bonds	100% stocks	60% stocks 40% bonds	100% stocks	60% stocks 40% bonds
EW CTAs	Break-Even Return	6.16%	6.51%	7.38%	7.52%	5.03%	5.49%
	Average Return	23.16%	23.16%	34.32%	34.32%	13.32%	13.32%
VW CTAs	Break-Even Return	6.63%	6.92%	7.93%	8.01%	5.37%	5.99%
	Average Return	13.80%	13.80%	18.00%	18.00%	10.08%	10.08%
EW Pool	Break-Even Return	5.86%	6.23%	6.77%	6.76%	5.37%	5.95%
	Average Return	18.36%	18.36%	28.68%	28.72%	9.36%	9.36%
VW Pool	Break-Even Return	5.85%	6.20%	7.34%	7.64%	4.29%	4.71%
	Average Return	16.68%	16.68%	19.80%	19.80%	13.92%	13.92%
EW Funds	Break-Even Return	7.25%	7.53%	8.27%	8.35%	6.51%	7.05%
	Average Return	9.84%	9.84%	14.04%	14.04%	6.24%	6.24%
VW Funds	Break-Even Return	7.27%	7.67%	8.24%	8.48%	6.66%	7.29%
	Average Return	8.64%	8.64%	10.08%	10.08%	7.56%	7.56%

RS - Randomly-Selected, single-CTA, pool, fund, hedge fund, or fund of hedge fund portfolios.
EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.
stocks - S&P500 (large-cap)
bonds - Long-term Corporate Bonds

Table 8
Optimal Portfolio Allocations, 1982-1996
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds

1982:1-1996:12

	Unconstrained										Constrained*									
Managed Futures	w/o	1	2	3	4	5	6	7	8	9	w/o	1	2	3	4	5	6	7	8	9
EW CTAs		0.29						0.29		0.29		0.27						0.27		0.27
EW Private Pools			0.21					0.00		0.00			0.27					0.00		0.00
EW Public Funds				0.06				0.00		0.00				0.06				0.00		0.00
VW CTAs					0.14				0.00	0.00					0.17				0.00	0.00
VW Private Pools						0.28			0.28	0.00						0.27			0.27	0.00
VW Public Funds							0.02		0.00	0.00							0.02		0.00	0.00
Standard Assets																				
S&P500 (large-cap)	0.26	0.19	0.21	0.24	0.22	0.20	0.25	0.19	0.20	0.19	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Long-term Corp. Bonds	0.31	0.05	0.08	0.29	0.20	0.04	0.30	0.05	0.04	0.05	0.17	0.09	0.09	0.17	0.17	0.09	0.17	0.09	0.09	0.09
Inter.-term Gov't Bonds	0.43	0.47	0.51	0.41	0.44	0.48	0.42	0.47	0.48	0.47	0.20	0.08	0.08	0.20	0.10	0.08	0.20	0.08	0.08	0.08
Long-term Gov't Bonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.07	0.07	0.08	0.07	0.07	0.12	0.07	0.07	0.07
Russell 2000 (small-cap)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Average Returns	12.9%	15.4%	13.6%	12.7%	12.8%	13.5%	12.8%	15.4%	13.5%	15.4%	14.2%	17.3%	16.0%	14.0%	14.6%	15.5%	14.2%	17.3%	15.5%	17.3%
Standard Deviations	7.1%	6.9%	6.4%	6.8%	6.5%	6.1%	7.0%	6.9%	6.1%	6.9%	9.3%	9.3%	9.3%	9.0%	9.1%	8.7%	9.2%	9.3%	8.7%	9.3%
Sharpe Ratio	0.922	1.325	1.129	0.932	0.998	1.183	0.923	1.325	1.183	1.325	0.854	1.229	1.084	0.908	0.962	1.102	0.902	1.229	1.102	1.229
Change		43.7%	22.5%	1.1%	8.2%	28.3%	0.1%	43.7%	28.3%	43.7%		43.9%	26.9%	6.3%	12.6%	29.0%	5.6%	43.9%	29.0%	43.9%

Sub-Period 1982:1-1988:12

	Unconstrained										Constrained*									
Managed Futures	w/o	1	2	3	4	5	6	7	8	9	w/o	1	2	3	4	5	6	7	8	9
EW CTAs		0.26						0.26		0.26		0.27						0.27		0.27
EW Private Pools			0.20					0.00		0.00			0.27					0.00		0.00
EW Public Funds				0.09				0.00		0.00				0.09				0.00		0.00
VW CTAs					0.13				0.00	0.00					0.17				0.00	0.00
VW Private Pools						0.21			0.21	0.00						0.27			0.27	0.00
VW Public Funds							0.03		0.00	0.00							0.00		0.00	0.00
Standard Assets																				
S&P500 (large-cap)	0.15	0.10	0.12	0.12	0.11	0.12	0.14	0.10	0.12	0.10	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Long-term Corp. Bonds	0.18	0.00	0.00	0.13	0.05	0.00	0.17	0.00	0.00	0.00	0.17	0.09	0.09	0.17	0.17	0.09	0.17	0.09	0.09	0.09
Inter.-term Gov't Bonds	0.67	0.64	0.68	0.65	0.71	0.67	0.66	0.64	0.67	0.64	0.20	0.08	0.08	0.18	0.10	0.08	0.20	0.08	0.08	0.08
Long-term Gov't Bonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.07	0.07	0.07	0.07	0.07	0.14	0.07	0.07	0.07
Russell 2000 (small-cap)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Average Returns	14.1%	18.8%	16.5%	13.9%	14.1%	14.7%	13.9%	18.8%	14.7%	18.8%	16.0%	21.3%	19.8%	15.9%	16.7%	17.4%	16.0%	21.3%	17.4%	21.3%
Standard Deviations	7.0%	7.3%	6.7%	6.4%	6.2%	6.1%	6.7%	7.3%	6.1%	7.3%	10.8%	11.1%	11.1%	10.4%	10.7%	10.5%	10.8%	11.1%	10.5%	11.1%
Sharpe Ratio	0.940	1.539	1.337	0.987	1.057	1.167	0.945	1.539	1.167	1.539	0.783	1.297	1.166	0.863	0.915	1.000	0.844	1.297	1.000	1.297
Change		63.7%	42.2%	5.0%	12.4%	24.1%	0.5%	63.7%	24.1%	63.7%		65.5%	48.8%	10.2%	16.8%	27.7%	7.7%	65.5%	27.7%	65.5%

Sub-Period 1989:1-1996:12

	Unconstrained										Constrained*									
Managed Futures	w/o	1	2	3	4	5	6	7	8	9	w/o	1	2	3	4	5	6	7	8	9
EW CTAs		0.39						0.39		0.00		0.27						0.27		0.00
EW Private Pools			0.18					0.00		0.00			0.19					0.00		0.00
EW Public Funds				0.00				0.00		0.00				0.00				0.00		0.00
VW CTAs					0.18				0.00	0.00					0.19				0.00	0.00
VW Private Pools						0.48			0.48	0.48						0.27			0.27	0.27
VW Public Funds							0.00		0.00	0.00							0.03		0.00	0.00
Standard Assets																				
S&P500 (large-cap)	0.47	0.25	0.41	0.47	0.41	0.22	0.47	0.25	0.22	0.22	0.50	0.45	0.45	0.50	0.45	0.45	0.48	0.45	0.45	0.45
Long-term Corp. Bonds	0.46	0.10	0.26	0.46	0.31	0.00	0.46	0.10	0.00	0.00	0.17	0.09	0.17	0.17	0.17	0.09	0.17	0.09	0.09	0.09
Inter.-term Gov't Bonds	0.07	0.18	0.14	0.07	0.08	0.21	0.07	0.18	0.21	0.21	0.20	0.08	0.08	0.20	0.08	0.08	0.20	0.08	0.08	0.08
Long-term Gov't Bonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.07	0.07	0.09	0.07	0.07	0.08	0.07	0.07	0.07
Russell 2000 (small-cap)	0.00	0.08	0.01	0.00	0.01	0.09	0.00	0.08	0.09	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Average Returns	12.8%	12.9%	12.2%	12.8%	12.5%	13.2%	12.8%	12.9%	13.2%	13.2%	12.9%	13.7%	12.7%	12.9%	12.8%	13.8%	12.8%	13.7%	13.8%	13.8%
Standard Deviations	7.7%	6.1%	6.8%	7.7%	7.0%	5.6%	7.7%	6.1%	5.6%	5.6%	8.0%	7.2%	7.4%	8.0%	7.5%	6.9%	7.8%	7.2%	6.9%	6.9%
Sharpe Ratio	0.979	1.250	1.021	0.979	1.031	1.423	0.979	1.250	1.423	1.423	0.964	1.182	1.010	0.964	1.021	1.256	0.964	1.182	1.256	1.256
Change		27.6%	4.3%	0.0%	5.2%	45.4%	0.0%	27.6%	45.4%	45.4%		22.7%	4.8%	0.0%	5.9%	30.3%	0.1%	22.7%	30.3%	30.3%

EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.
* Constrained optimizations have the following restrictions on the weights: S&P500 - 45 to 65%, Long-term Corporate Bonds - 9 to 17%, Intermediate-term Government Bonds - 8 to 20%, Long-term Government Bonds - 7 to 19%, and the Russell 2000 - 4 to 8%. See Ibbotson, Siegal, and Love (1985).

Table 9

Correlation of Managed Futures Returns with Inflation Rates

12-month rule for CTAs, 5-month rule for pools, 6-month rule for funds, and all data for hedge funds and funds of hedge funds

	Monthly Correlations			Yearly Correlations		
Investments	1982-1996	1982-1988	1989-1996	1982-1996	1982-1988	1989-1996
EW CTAs	0.09	0.01	0.28**	0.38	0.21	0.86**
VW CTAS	0.12	0.05	0.27**	0.52**	0.60	0.52
EW Private Pools	0.08	0.02	0.24**	0.24	-0.07	0.74**
VW Private Pools	0.12	0.03	0.32**	0.71**	0.53	0.93**
EW Public Funds	0.10	0.03	0.26**	0.56**	0.61	0.61
VW Public Funds	0.09	0.02	0.24**	0.54**	0.70*	0.41
Common Stock Returns	-0.16**	-0.09	-0.27**	-0.33	-0.06	-0.44
Russell 2000 (Small Cap. Index)	-0.23**	-0.12	-0.42**	-0.43	0.11	-0.68*
Intermediate-term Government Bonds	-0.09	-0.19*	0.05	0.00	-0.11	0.07
Long-term Government Bonds	-0.18**	-0.24**	-0.08	-0.16	-0.18	-0.17
Long-term Corporate Bonds	-0.14*	-0.18*	-0.07	-0.08	-0.07	-0.14
Treasury Bills	0.26**	0.21*	0.42**	0.51*	0.29	0.78**

The inflation rate is defined as the contiunously compounded growth rate in the CPI seasonally adjusted.

* significant at the 10% level.

** significant at the 5% level.

Use test statistic t(n-2) = r / ((1-r^2)/(n-2))^(0.5).

For monthly observations from 1982-1996, the critical values at the 5% and 10% level are 1.9759 and 1.6551, respectively.

For monthly observations from 1982-1988, the critical values at the 5% and 10% level are 1.9886 and 1.6632, respectively.

For monthly observations from 1989-1996, the critical values at the 5% and 10% level are 1.985 and 1.6609, respectively.

For yearly observations from 1982-1996, the critical values at the 5% and 10% level are 2.1604 and 1.7709, respectively.

For yearly observations from 1982-1988, the critical values at the 5% and 10% level are 2.5706 and 2.015, respectively.

For yearly observations from 1989-1996, the critical values at the 5% and 10% level are 2.4469 and 1.9432, respectively.

Table 10
Managed Futures Returns Under Low, Medium, and High Inflation Rate States
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds

	Annualized Returns 1982-1996			Annualized Returns 1982-1988			Annualized Returns 1989-1996		
Investments	Low	Medium	High	Low	Medium	High	Low	Medium	High
Average Monthly Inflation Rates	0.39%	1.49%	2.73%	0.15%	1.60%	2.85%	0.59%	1.39%	2.62%
EW CTAs	18.26%	20.25%	33.81%	35.56%	28.71%	44.37%	-2.58%	14.55%	26.88%
VW CTAS	6.31%	11.83%	25.21%	16.67%	13.67%	28.00%	-10.27%	13.92%	22.87%
EW Private Pools	11.21%	18.59%	25.07%	24.36%	28.58%	33.36%	-6.83%	11.88%	19.29%
VW Private Pools	10.92%	15.57%	24.47%	19.24%	17.36%	25.22%	-2.33%	16.64%	24.50%
EW Public Funds	0.97%	9.41%	19.81%	9.06%	13.30%	20.61%	-11.75%	7.56%	21.62%
VW Public Funds	3.50%	5.95%	19.35%	12.17%	4.33%	19.28%	-10.39%	9.57%	21.30%
Common Stock Returns	29.06%	9.81%	18.01%	32.11%	4.93%	27.90%	25.61%	13.25%	11.80%
Russell 2000 (Small Cap. Index)	36.95%	6.16%	8.32%	35.23%	-2.12%	27.54%	39.20%	8.84%	-0.13%
Intermediate-term Government Bonds	12.46%	10.22%	8.68%	20.65%	10.12%	9.89%	3.89%	10.78%	8.11%
Long-term Government Bonds	20.63%	12.95%	5.85%	34.96%	10.40%	7.15%	5.24%	15.97%	6.00%
Long-term Corporate Bonds	19.48%	12.49%	8.30%	31.38%	12.19%	10.44%	6.56%	13.74%	6.95%
Treasury Bills	5.87%	6.04%	7.29%	6.96%	7.75%	7.78%	4.79%	4.74%	6.61%

The inflation rate is defined as the contiunously compounded growth rate in the CPI seasonally adjusted.

Inflation rate classifications:

Low : the lowest 25% of monthly inflation rates.

Medium : the middle 50% of monthly inflation rates.

High : the highest 25% of monthly inflation rates.

Appendix 1

Fee Structure in Managed Futures Industry as of April 1997

	Administrative Fees (%)			Incentive Fees (%)		
	CTAs	Public Funds	Private Pools	CTAs	Public Funds	Private Pools
Mean	2.94%	2.79%	2.92%	20.40%	19.11%	20.38%
Median	3%	3%	2%	20%	20%	20%
Standard Deviation	1.26%	1.48%	1.87%	3.76%	4.69%	4.55%
Minimum	0.10%	0.20%	0.25%	10%	3%	2%
Maximum	12%	8%	20%	40%	50%	50%
Number	987	441	235	1090	413	261

Appendix 2
Relationship of Performance to Size: Alternative Exclusion Rules*

Commodity Trading Advisors		All Data 1980:1-1996:12			12 Rule 1980:4-1996:12			28 Rule 1981:8-1996:12		
		SIZE	Mon. Ret.	Yr. Ret.	MV	Mon. Ret.	Yr. Ret.	MV	Mon. Ret.	Yr. Ret.
Smallest Quintile	1	0.15	4.39%	52.68%	0.23	3.35%	40.16%	0.37	2.10%	25.26%
	2	0.70	2.94%	35.22%	1.05	2.24%	26.88%	1.72	1.74%	20.91%
	3	2.39	2.25%	27.02%	3.62	2.21%	26.55%	6.05	1.43%	17.14%
	4	9.51	1.73%	20.76%	12.94	1.34%	16.03%	19.60	1.10%	13.15%
Largest Quintile	5	70.34	1.18%	14.14%	81.62	0.94%	11.28%	106.50	1.00%	11.98%
S-L			3.21%	38.53%		2.41%	28.89%		1.11%	13.28%
t-stat			(8.07)			(5.95)			(3.04)	

Private Pools		All Data 1983:2-1996:12			5 Rule 1983:6-1996:12			12 Rule 1984:1-1996:12		
		SIZE	Mon. Ret.	Yr. Ret.	MV	Mon. Ret.	Yr. Ret.	MV	Mon. Ret.	Yr. Ret.
Smallest Quintile	1	0.17	1.44%	17.34%	0.17	1.22%	14.60%	0.17	1.07%	12.89%
	2	0.59	1.62%	19.43%	0.61	1.62%	19.43%	0.63	1.62%	19.44%
	3	1.34	1.76%	21.13%	1.40	1.60%	19.22%	1.49	1.48%	17.76%
	4	3.50	1.32%	15.89%	3.70	1.50%	17.95%	3.98	1.43%	17.22%
Largest Quintile	5	31.42	1.35%	16.23%	33.18	1.34%	16.13%	36.96	1.51%	18.15%
S-L			0.09%	1.10%		-0.13%	-1.53%		-0.44%	-5.26%
t-stat			(0.21)			(-0.31)			(-0.99)	

Public Funds		All Data 1981:3-1996:12			6 Rule 1981:8-1996:12			12 Rule 1984:1-1996:12		
		SIZE	Mon. Ret.	Yr. Ret.	MV	Mon. Ret.	Yr. Ret.	MV	Mon. Ret.	Yr. Ret.
Smallest Quintile	1	0.52	0.81%	9.74%	0.51	0.76%	9.11%	0.50	0.81%	9.76%
	2	1.67	0.74%	8.93%	1.62	0.76%	9.07%	1.54	0.67%	8.10%
	3	4.05	0.86%	10.34%	3.97	0.91%	10.90%	3.76	0.93%	11.10%
	4	10.61	0.74%	8.94%	10.59	0.76%	9.13%	10.31	0.86%	10.27%
Largest Quintile	5	49.26	0.79%	9.54%	48.79	0.73%	8.76%	47.71	0.82%	9.85%
S-L			0.02%	0.20%		0.03%	0.35%		-0.01%	-0.09%
t-stat			(0.07)			(0.14)			(-0.04)	

*Alternative rules used to correct for self-selection bias are to exclude the first 5, 6, 12, or 28 months of returns.

SIZE - Average dollars (in millions) under management by funds in quintile, over time.

S-L - Smallest quintile mean return minus largest quintile mean return.

Quintiles are formed on a monthly basis according to the previous month's dollars under management. In addition, quintiles are formed only when there are at least 15 CTAs, pools, or funds in a quintile.

Appendix 3
Attrition Rates of Managed Futures, 1980-1996

	CTAs			Private Pools			Public Funds		
	All Data	Exclude 12	Exclude 28	All Data	Exclude 5	Exclude 12	All Data	Exclude 6	Exclude 12
Averages									
1980-96	11.84%	12.84%	12.85%	7.66%	7.68%	7.97%	5.85%	6.07%	6.39%
1980-88	8.67%	9.30%	8.93%	1.10%	1.13%	1.30%	0.16%	0.18%	0.23%
1989-96	15.41%	16.38%	16.28%	15.04%	15.05%	14.65%	12.25%	12.68%	12.55%
1989-92	11.29%	12.38%	13.11%	11.49%	11.21%	10.82%	8.07%	8.04%	8.04%
1993-96	19.53%	20.37%	19.46%	18.59%	18.90%	18.47%	16.43%	17.33%	17.07%

* Alternative rules used to correct for self-selection bias are to exclude the first 5, 6, 12, or 28 months of returns.

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Appendix 3a
Survivorship Bias for Managed Future Investments
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds

Year	Average Monthly Returns(%)	Number of Monthly Obs.	Average Monthly Returns(%)	Number of Monthly Obs.	Average Monthly Returns(%)	Number of Monthly Obs.
	CTAs		Survived CTAs		Defunct CTAs	
1989	1.40	2,788	1.57	973	1.30	1,815
1990	2.35	3,225	3.09	1,151	1.94	2,074
1991	1.15	3,818	1.64	1,442	0.86	2,376
1992	0.67	4,597	1.12	1,926	0.34	2,671
1993	1.06	5,331	1.53	2,498	0.66	2,833
1994	0.37	5,847	0.71	3,103	-0.01	2,744
1995	1.08	5,629	1.68	3,760	-0.11	1,869
1996	0.89	5,389	1.09	4,731	-0.50	658
Average	1.12		1.55		0.56	
Monthly Bia	0.43					
Annual Bias	5.17					
	Pools		Survived Pools		Defunct Pools	
1989	0.63	1,700	1.39	633	0.17	1,067
1990	1.97	1,999	3.03	739	1.34	1,260
1991	0.48	2,216	0.96	914	0.14	1,302
1992	0.05	2,436	0.70	1,094	-0.48	1,342
1993	0.99	2,547	1.60	1,270	0.39	1,277
1994	-0.06	2,542	0.35	1,477	-0.63	1,065
1995	1.01	2,342	1.33	1,703	0.17	639
1996	1.15	2,180	1.36	1,938	-0.53	242
Average	0.78		1.34		0.07	
Monthly Bia	0.56					
Annual Bias	6.74					
	Funds		Survived Funds		Defunct Funds	
1989	0.34	1,890	0.01	711	0.53	1,179
1990	1.54	2,350	2.14	866	1.19	1,484
1991	0.58	2,711	1.01	1,040	0.31	1,671
1992	-0.07	2,938	0.21	1,309	-0.29	1,629
1993	0.82	3,488	1.26	1,794	0.36	1,694
1994	-0.59	3,747	-0.34	2,245	-0.97	1,502
1995	0.80	3,910	1.04	2,881	0.14	1,029
1996	0.66	3,784	0.79	3,355	-0.30	429
Average	0.51		0.76		0.12	
Monthly Bia	0.25					
Annual Bias	3.05					

Monthly Bias = "Survived" minus "All."

Annual Bias = Monthly Bias multiplied by 12.

□

Appendix 4
CTAs: Returns and Standard Deviations
Exclude First 28 Months

		One-CTA Portfolio*	Equal-Weighted Market Portfolio of CTAs			Value-Weighted Market Portfolio of CTAs			
Year	Number of CTAs	Standard Deviation	Monthly Return	Standard Deviation	Annual Return	Number of CTAs	Monthly Return	Standard Deviation	Annual Return
1980	0	0	NA	NA	NA	0	NA	NA	NA
1981	30**	10.90	NA	NA	NA	28**	NA	NA	NA
1982	40	11.18	1.81	6.31	21.72	38	1.19	7.25	14.24
1983	52	13.24	1.79	7.98	21.46	49	0.00	6.44	0.01
1984	56	13.39	1.59	7.55	19.08	51	1.83	8.94	22.01
1985	68	12.17	2.09	4.91	25.06	66	2.01	6.48	24.12
1986	94	13.29	1.38	4.99	16.52	91	-0.52	6.55	-6.20
1987	126	14.77	3.94	6.16	47.28	122	3.60	5.44	43.20
1988	166	16.24	2.33	8.75	27.96	159	1.25	6.35	14.95
1989	179	11.62	1.12	4.70	13.44	174	0.35	4.92	4.20
1990	205	9.54	2.29	3.29	27.48	201	1.96	3.46	23.54
1991	231	9.26	0.76	4.12	9.17	228	1.24	5.11	14.87
1992	266	6.97	0.36	2.91	4.28	262	0.18	4.14	2.20
1993	331	6.62	0.95	2.33	11.35	324	1.13	2.58	13.55
1994	365	8.15	0.31	2.24	3.74	355	-0.22	2.32	-2.68
1995	352	7.84	1.13	2.34	13.50	343	1.04	2.70	12.43
1996	321	7.87	0.97	2.99	11.60	319	1.10	3.38	13.25
1982-96		9.83	1.52	5.08	18.26		1.08	5.29	12.96
1982-88		14.25	2.13	6.60	25.62		1.34	6.72	16.08
1989-96		8.35	0.99	3.16	11.83		0.85	3.63	10.20
1989-92		9.31	1.13	3.76	13.56		0.93	4.37	11.16
1993-96		7.69	0.84	2.43	10.08		0.76	2.74	9.12

Monthly Return: Arithmetic average of monthly returns during the year.

Standard Deviation: Standard deviation of monthly returns during the year.

Annual Return: Monthly return multiplied by 12.

* The return on a one-CTA randomly-selected portfolio is identical to the return on an equally-weighted portfolio of CTAs. The standard deviation of one-CTA portfolio returns is the standard deviation on all possible one-CTA portfolio returns.

** Monthly returns start from 1981:8.

Appendix 5
Private Pools: Returns and Standard Deviations
Exclude First 12 Months

		One-Pool Portfolio*	Equal-Weighted Market Portfolio of Private Pools			Value-Weighted Market Portfolio of Private Pools			
Year	Number of Pools	Standard Deviation	Monthly Return	Standard Deviation	Annual Return	Number of Pools	Monthly Return	Standard Deviation	Annual Return
1980	10**	8.13	2.41	4.49	NA	5**	1.41	2.92	NA
1981	11	11.37	1.67	6.97	20.02	6	2.62	6.65	31.40
1982	12	10.26	1.76	7.32	21.17	8	1.79	5.90	21.47
1983	18	11.27	2.13	7.67	25.57	14	0.22	4.69	2.68
1984	26	15.25	1.84	10.58	22.13	22	1.51	5.73	18.12
1985	33	10.41	1.73	5.33	20.71	29	2.03	6.20	24.30
1986	52	17.11	2.37	5.42	28.48	47	0.48	5.58	5.72
1987	75	13.98	4.57	5.33	54.90	66	4.08	4.65	49.00
1988	110	21.61	1.42	6.48	17.06	97	1.04	3.67	12.42
1989	134	10.40	0.60	4.23	7.21	115	1.26	3.18	15.13
1990	148	7.86	1.91	2.44	22.96	134	2.85	3.05	34.25
1991	168	8.62	0.34	4.25	4.13	165	0.80	2.99	9.57
1992	180	7.14	-0.06	2.76	-0.66	178	0.55	2.25	6.66
1993	190	7.17	0.97	2.74	11.66	187	1.28	1.90	15.30
1994	185	6.69	0.00	2.33	-0.03	183	0.51	2.19	6.09
1995	174	6.72	0.97	2.43	11.65	174	0.87	2.00	10.40
1996	160	7.67	1.18	3.98	14.19	160	1.18	2.86	14.21
1982-96		10.03	1.45	5.30	17.40		1.36	4.03	16.32
1982-88		17.01	2.26	6.91	27.12		1.59	5.21	19.08
1989-96		7.74	0.74	3.18	8.88		1.16	2.60	13.92
1989-92		8.47	0.70	3.49	8.40		1.37	2.94	16.44
1993-96		7.08	0.78	2.89	9.36		0.96	2.21	11.52

Monthly Return: Arithmetic average of monthly returns during the year.

Standard Deviation: Standard deviation of monthly returns during the year.

Annual Return: Monthly return multiplied by 12.

* The return on a one-pool randomly-selected portfolio is identical to the return on an equally-weighted portfolio of pools. The standard deviation of one-pool portfolio returns is the standard deviation on all possible one-pool portfolio returns.

** First observation 1980:4.

Appendix 6
Public Funds: Returns and Standard Deviations
Exclude First 12 Months

		One-Fund Portfolio*	Equal-Weighted Market Portfolio of Public Funds			Value-Weighted Market Portfolio of Public Funds			
Year	Number of Funds	Standard Deviation	Monthly Return	Standard Deviation	Annual Return	Number of Funds	Monthly Return	Standard Deviation	Annual Return
1980	9**	9.52	1.77	3.65	NA	1***	3.01	4.65	NA
1981	17	8.27	0.70	5.23	8.39	14	1.62	5.80	19.42
1982	29	8.71	0.77	5.48	9.28	26	1.26	5.64	15.09
1983	40	11.19	0.07	7.31	0.78	37	-0.51	6.18	-6.17
1984	55	10.61	1.64	7.41	19.62	53	1.29	7.86	15.44
1985	68	8.14	1.84	5.24	22.02	68	1.59	5.94	19.13
1986	81	10.46	-0.52	6.28	-6.27	81	-0.98	7.22	-11.80
1987	102	18.95	3.62	5.71	43.40	101	3.20	5.57	38.42
1988	127	10.39	0.86	7.25	10.32	125	0.59	6.53	7.14
1989	153	23.50	0.37	5.81	4.40	151	0.78	5.70	9.34
1990	189	6.15	1.58	3.15	19.01	179	1.30	2.84	15.55
1991	208	7.47	0.49	4.69	5.93	205	0.66	5.04	7.90
1992	232	5.96	-0.19	3.61	-2.34	231	0.00	3.63	0.01
1993	269	5.40	0.83	2.39	9.95	268	1.25	2.22	14.99
1994	279	5.07	-0.63	1.91	-7.58	277	-0.45	1.68	-5.43
1995	311	5.37	0.78	2.19	9.35	310	0.71	2.47	8.51
1996	275	6.01	0.67	3.14	8.01	274	0.98	2.61	11.82
1982-96		9.49	0.81	5.02	9.72		0.78	5.01	9.36
1982-88		12.51	1.18	6.33	14.16		0.92	6.36	11.04
1989-96		8.58	0.49	3.51	5.88		0.65	3.45	7.80
1989-92		11.81	0.56	4.34	6.72		0.68	4.33	8.16
1993-96		5.51	0.41	2.45	4.92		0.62	2.30	7.44

Monthly Return: Arithmetic average of monthly returns during the year.

Standard Deviation: Standard deviation of monthly returns during the year.

Annual Return: Monthly return multiplied by 12.

* The return on a one-fund randomly-selected portfolio is identical to the return on an equally-weighted portfolio of funds. The standard deviation of one-fund portfolio returns is the standard deviation on all possible one-fund portfolio returns.

** First observation 1980:4.

Appendix 7

Average Annual Sharpe Ratios, Rank by Sharpe Ratio, and Average Annual Returns for Alternative Managed Futures Investments, 1982-1996
28-month rule for CTAs, 0-month rule for pools, and 0-month rule for funds

	1982:1-1996:12			1982:1-1988:12			1989:1-1996:12		
	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns
Equally-Weighted Market Portfolios									
RS CTAs	0.351	8	18.3%	0.366	8	25.6%	0.229	8	11.8%
RS Private Pools	0.340	9	17.4%	0.373	7	27.1%	0.137	9	8.9%
RS Public Funds	0.101	11	9.7%	0.137	11	14.2%	0.038	11	5.9%
EW CTAs	0.679	4	18.3%	0.790	4	25.6%	0.605	5	11.8%
EW Private Pools	0.673	5	17.4%	0.933	1	27.1%	0.339	7	8.9%
EW Public Funds	0.195	10	9.7%	0.271	10	14.2%	0.096	10	5.9%
S&P 500 (large cap)	0.717	3	16.7%	0.581	6	17.5%	0.912	1	16.0%
Long-term Corporate Bonds	0.806	1	13.2%	0.867	3	16.5%	0.777	2	10.2%
Intermediate-term Government Bonds	0.775	2	10.4%	0.869	2	12.7%	0.689	3	8.4%
Long-term Government Bonds	0.657	6	13.1%	0.667	5	15.7%	0.670	4	10.8%
Russell 2000 (small cap)	0.451	7	14.4%	0.339	9	14.6%	0.597	6	14.2%
Value-Weighted Market Portfolios									
RS CTAs	0.351	8	18.3%	0.366	7	25.6%	0.229	8	11.8%
RS Private Pools	0.340	9	17.4%	0.373	6	27.1%	0.137	10	8.9%
RS Public Funds	0.101	11	9.7%	0.137	10	14.2%	0.038	11	5.9%
VW CTAs	0.360	7	13.0%	0.365	8	16.1%	0.393	7	10.2%
VW Private Pools	0.763	3	16.3%	0.721	3	19.1%	0.937	1	13.9%
VW Public Funds	0.128	10	9.4%	0.092	11	11.0%	0.202	9	7.8%
S&P 500 (large cap)	0.717	4	16.7%	0.581	5	17.5%	0.912	2	16.0%
Long-term Corporate Bonds	0.806	1	13.2%	0.867	2	16.5%	0.777	3	10.2%
Intermediate-term Government Bonds	0.775	2	10.4%	0.869	1	12.7%	0.689	4	8.4%
Long-term Government Bonds	0.657	5	13.1%	0.667	4	15.7%	0.670	5	10.8%
Russell 2000 (small cap)	0.451	6	14.4%	0.339	9	14.6%	0.597	6	14.2%

RS - Randomly Selected, single-CTA, pool, or fund portfolios.

EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.

Annual Sharpe ratios are computed from monthly observation: multiply the monthly Sharpe ratio by the square root of 12.

Average annual returns are the average monthly returns multiplied by 12.

Appendix 8

Average Annual Sharpe Ratios, Rank by Sharpe Ratio, and Average Annual Returns for Alternative Managed Futures Investments, 1982-1996

	1982:1-1996:12			1982:1-1988:12			1989:1-1996:12		
	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns	Sharpe Ratio	Sharpe Ratio Rank	Average Annual Returns
12-month rule for CTAs, 5-month rule for pools, and 6-month rule for funds									
RS CTAs	0.421	5	23.2%	0.407	5	34.3%	0.274	5	13.3%
RS Private Pools	0.346	6	18.4%	0.406	6	28.7%	0.152	7	9.4%
RS Public Funds	0.112	9	9.8%	0.155	8	14.0%	0.035	9	6.2%
EW CTAs	0.977	1	23.2%	1.196	1	34.3%	0.796	2	13.3%
EW Private Pools	0.662	3	18.4%	0.894	2	28.7%	0.371	4	9.4%
EW Public Funds	0.211	7	9.8%	0.303	7	14.0%	0.088	8	6.2%
VW CTAs	0.422	4	13.8%	0.465	4	18.0%	0.399	3	10.1%
VW Private Pools	0.752	2	16.7%	0.694	3	19.8%	0.955	1	13.9%
VW Public Funds	0.142	8	8.6%	0.116	9	10.1%	0.202	6	7.6%
28-month rule for CTAs, 0-month rule for pools, and 0-month rule for funds									
RS CTAs	0.351	5	18.3%	0.366	5	25.6%	0.229	5	11.8%
RS Private Pools	0.340	6	18.0%	0.373	4	28.6%	0.137	7	8.8%
RS Public Funds	0.101	9	9.5%	0.137	8	13.1%	0.038	9	6.3%
EW CTAs	0.679	2	18.3%	0.790	2	25.6%	0.605	2	11.8%
EW Private Pools	0.673	3	18.0%	0.933	1	28.6%	0.339	4	8.8%
EW Public Funds	0.195	7	9.5%	0.271	7	13.1%	0.096	8	6.3%
VW CTAs	0.360	4	13.0%	0.365	6	16.1%	0.393	3	10.2%
VW Private Pools	0.763	1	16.7%	0.721	3	20.2%	0.937	1	13.7%
VW Public Funds	0.128	8	8.4%	0.092	9	9.4%	0.202	6	7.4%

RS - Randomly-Selected, single-CTA, pool, or fund portfolios.

EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.

Annual Sharpe ratios are computed from monthly observations: multiply the monthly Sharpe ratio by the square root of 12.

Average annual returns are the average monthly returns multiplied by 12.

Appendix 9
Correlation Coefficients Between Asset Classes for 1982-1996 and Sub-Periods 1982-1988 and 1989-1996
28-month rule for CTAs, 0-month rule for pools, and 0-month rule for funds

1982:1-1996:12	EW CTAs	EW Pools	EW Funds	VW CTAs	VW Pools	VW Funds	Common Stocks	Long Corp. Bonds	Inter. Gov't Bonds	Long Gov't Bonds	T-bills
EW CTAs	1.00										
EW Private Pools	0.93**	1.00									
EW Public Funds	0.94**	0.89**	1.00								
VW CTAs	0.933**	0.89**	0.95**	1.00							
VW Private Pools	0.83**	0.85**	0.83**	0.90**	1.00						
VW Public Funds	0.91**	0.86**	0.97**	0.97**	0.88**	1.00					
Common Stock Returns (S&P500)	0.03	-0.02	0.07	0.04	-0.04	0.08	1.00				
Long-term Corporate Bonds	0.05	0.10	0.06	0.07	0.09	0.08	0.40**	1.00			
Intermediate-term Government Bond	0.02	0.05	0.05	0.04	0.05	0.07	0.34**	0.92**	1.00		
Long-term Government Bonds	0.07	0.12	0.11	0.11	0.14*	0.14*	0.39**	0.94**	0.92**	1.00	
Treasury Bills	0.06	0.09	0.04	0.03	0.07	0.02	-0.02	0.18**	0.23**	0.14*	1.00
Russell 2000 (small cap)	-0.04	-0.08	-0.03	-0.05	-0.13*	-0.02	0.85**	0.22**	0.15*	0.19**	-0.10

Sub-periods 1982:1-1988:12\1989:1-1996:12	EW CTAs	EW Pools	EW Funds	VW CTAs	VW Pools	VW Funds	Common Stocks	Long Corp. Bonds	Inter. Gov't Bonds	Long Gov't Bonds	T-bills
EW CTAs	1.00	0.96**	0.93**	0.95**	0.84**	0.91	-0.03	0.13	0.11	0.15	0.12
EW Private Pools	0.92**	1.00	0.92**	0.94**	0.90**	0.91	0.02	0.19*	0.16	0.22**	0.09
EW Public Funds	0.94**	0.89**	1.00	0.96**	0.79**	0.97	0.11	0.21**	0.20**	0.23**	0.07
VW CTAs	0.93**	0.88**	0.95**	1.00	0.84**	0.96	0.01	0.18*	0.17*	0.20**	0.05
VW Private Pools	0.83**	0.84**	0.84**	0.92**	1.00	0.78	-0.11	0.12	0.11	0.15	0.15
VW Public Funds	0.92**	0.86**	0.96**	0.97**	0.91**	1.00	0.13	0.25**	0.25**	0.27**	0.04
Common Stock Returns (S&P500)	0.05	-0.04	0.05	0.05	-0.01	0.07	1.00	0.52**	0.43**	0.49**	0.08
Long-term Corporate Bonds	0.00	0.05	-0.01	0.02	0.08	0.02	0.34**	1.00	0.92**	0.98**	0.12
Intermediate-term Government Bond	-0.04	-0.02	-0.04	-0.03	0.01	-0.01	0.29**	0.93**	1.00	0.92**	0.17*
Long-term Government Bonds	0.04	0.07	0.05	0.07	0.13	0.09	0.33**	0.92**	0.92**	1.00	0.10
Treasury Bills	-0.06	-0.04	-0.02	-0.01	-0.02	-0.01	-0.12	0.16	0.22**	0.13	1.00
Russell 2000 (small cap)	0.02	-0.05	0.01	0.00	-0.07	0.02	0.89**	0.22**	0.16	0.19*	-0.14

Correlations are computed using monthly returns.
EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.

* significant at the 10% level.
** significant at the 5% level.
Use test statistic t(n-2) = r / ((1-r^2)/(n-2))^(0.5).
For 1982-1996, the critical values at the 5% and 10% level are 1.9759 and 1.6551, respectively.
For 1982-1988, the critical values at the 5% and 10% level are 1.9886 and 1.6632, respectively.
For 1989-1996, the critical values at the 5% and 10% level are 1.985 and 1.6609, respectively.
*** Buy and Hold Futures Returns are CRB Future Price Index Returns plus the one month T-bill return.

Appendix 10
Break-Even Analysis for Managed Futures Investments
28-month rule for CTAs, 0-month rule for pools, and 0-month rule for funds

		1982:1-1996:12		1982:1-1988:12		1989:1-1996:12	
		100% stock	60% stocks 40% bonds	100% stock	60% stocks 40% bonds	100% stock	60% stocks 40% bonds
EW CTAs	Break-Even Return	6.63%	6.85%	8.17%	8.25%	4.89%	5.35%
	Average Return	18.26%	18.26%	25.62%	25.62%	11.83%	11.83%
VW CTAs	Break-Even Return	6.81%	7.17%	8.23%	8.45%	5.34%	5.99%
	Average Return	12.96%	12.96%	16.08%	16.08%	10.20%	10.20%
EW Pool	Break-Even Return	6.09%	6.58%	7.08%	7.31%	5.42%	5.99%
	Average Return	18.04%	18.04%	28.56%	28.56%	8.84%	8.84%
VW Pool	Break-Even Return	5.92%	6.28%	7.41%	7.75%	4.32%	4.74%
	Average Return	16.68%	16.68%	20.16%	20.16%	13.68%	13.68%
EW Funds	Break-Even Return	7.14%	7.38%	8.18%	8.20%	6.38%	6.90%
	Average Return	9.49%	9.49%	13.15%	13.15%	6.29%	6.29%
VW Funds	Break-Even Return	7.28%	7.64%	8.34%	8.53%	6.52%	7.13%
	Average Return	8.37%	8.37%	9.45%	9.45%	7.43%	7.43%

RS - Randomly-Selected, single-CTA, pool, or fund portfolios.

EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.

stocks - S&P500 (large-cap)

bonds - Long-term Corporate Bonds

Appendix 11
Optimal Portfolio Allocations, 1982-1996
28-month rule for CTAs, 0-month rule for pools, and 0-month rule for funds

1982:1-1996:12

	Unconstrained										Constrained*									
Managed Futures	w/o	1	2	3	4	5	6	7	8	9	w/o	1	2	3	4	5	6	7	8	9
EW CTAs		0.21						0.13		0.02		0.26						0.07		0.00
EW Private Pools			0.21					0.11		0.00			0.27					0.20		0.05
EW Public Funds				0.06				0.00		0.00				0.06				0.00		0.00
VW CTAs					0.11				0.00	0.00					0.13				0.00	0.00
VW Private Pools						0.28			0.31	0.26						0.27			0.27	0.22
VW Public Funds							0.02		0.00	0.00							0.01		0.00	0.00
Standard Assets																				
S&P500 (large-cap)	0.26	0.19	0.21	0.24	0.23	0.20	0.25	0.22	0.23	0.04	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Long-term Corp. Bonds	0.31	0.14	0.06	0.29	0.22	0.03	0.31	0.28	0.24	0.48	0.17	0.10	0.09	0.17	0.17	0.09	0.17	0.09	0.09	0.09
Inter.-term Gov't Bonds	0.43	0.45	0.52	0.41	0.44	0.49	0.42	0.26	0.00	0.00	0.20	0.08	0.08	0.20	0.14	0.08	0.20	0.08	0.08	0.08
Long-term Gov't Bonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.07	0.07	0.08	0.07	0.07	0.13	0.07	0.07	0.07
Russell 2000 (small-cap)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Average Returns	12.9%	13.7%	13.5%	12.7%	12.7%	13.5%	12.8%	14.4%	14.4%	13.6%	14.2%	15.9%	15.9%	14.0%	14.4%	15.5%	14.2%	15.9%	15.5%	15.6%
Standard Deviations	7.1%	6.6%	6.4%	6.8%	6.6%	6.1%	7.0%	7.2%	14.4%	13.6%	9.3%	9.4%	9.3%	9.0%	9.0%	8.7%	9.2%	9.3%	8.7%	8.8%
Sharpe Ratio	0.922	1.127	1.123	0.931	0.972	1.186	0.923	1.129	1.181	1.187	0.854	1.068	1.077	0.907	0.940	1.103	0.901	1.079	1.103	1.104
Change		22.2%	21.8%	1.0%	5.4%	28.6%	0.1%	22.4%	28.1%	28.7%		25.0%	26.1%	6.1%	10.1%	29.1%	5.5%	26.3%	29.1%	29.3%

Sub-Period 1982:1-1988:12

	Unconstrained										Constrained*									
Managed Futures	w/o	1	2	3	4	5	6	7	8	9	w/o	1	2	3	4	5	6	7	8	9
EW CTAs		0.19						0.00		0.00		0.27						0.00		0.00
EW Private Pools			0.22					0.22		0.22			0.27					0.27		0.27
EW Public Funds				0.09				0.00		0.00				0.08				0.00		0.00
VW CTAs					0.10				0.00	0.00					0.12				0.00	0.00
VW Private Pools						0.22			0.22	0.00						0.27			0.27	0.00
VW Public Funds							0.02		0.00	0.00							0.00		0.00	0.00
Standard Assets																				
S&P500 (large-cap)	0.15	0.10	0.12	0.13	0.12	0.12	0.14	0.12	0.12	0.12	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Long-term Corp. Bonds	0.18	0.01	0.00	0.13	0.08	0.00	0.17	0.00	0.00	0.00	0.17	0.09	0.09	0.17	0.17	0.09	0.17	0.09	0.09	0.09
Inter.-term Gov't Bonds	0.67	0.71	0.67	0.65	0.70	0.67	0.66	0.67	0.67	0.67	0.20	0.08	0.08	0.19	0.15	0.08	0.20	0.08	0.08	0.08
Long-term Gov't Bonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.07	0.07	0.07	0.07	0.07	0.14	0.07	0.07	0.07
Russell 2000 (small-cap)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Average Returns	14.1%	15.6%	16.7%	13.8%	13.9%	14.9%	14.0%	16.7%	14.9%	16.7%	16.0%	19.0%	19.8%	15.8%	16.2%	17.5%	16.0%	19.8%	17.5%	19.8%
Standard Deviations	7.0%	6.5%	6.8%	6.4%	6.3%	6.2%	6.8%	6.8%	6.2%	6.8%	10.8%	11.4%	11.0%	10.4%	10.5%	10.5%	10.8%	11.0%	10.5%	11.0%
Sharpe Ratio	0.940	1.237	1.343	0.980	1.007	1.179	0.943	1.343	1.179	1.343	0.783	1.055	1.164	0.858	0.879	1.008	0.844	1.164	1.008	1.164
Change		31.6%	42.8%	4.3%	7.1%	25.4%	0.3%	42.8%	25.4%	42.8%		34.7%	48.6%	9.6%	12.2%	28.7%	7.7%	48.6%	28.7%	48.6%

Sub-Period 1989:1-1996:12

	Unconstrained										Constrained*									
Managed Futures	w/o	1	2	3	4	5	6	7	8	9	w/o	1	2	3	4	5	6	7	8	9
EW CTAs		0.31						0.31		0.00		0.27						0.27		0.00
EW Private Pools			0.17					0.00		0.00			0.18					0.00		0.00
EW Public Funds				0.00				0.00		0.00				0.00				0.00		0.00
VW CTAs					0.18				0.00	0.00					0.19				0.00	0.00
VW Private Pools						0.47			0.47	0.47						0.27			0.27	0.27
VW Public Funds							0.01		0.00	0.00							0.04		0.00	0.00
Standard Assets																				
S&P500 (large-cap)	0.47	0.30	0.42	0.47	0.42	0.22	0.47	0.30	0.22	0.22	0.50	0.45	0.45	0.50	0.45	0.45	0.48	0.45	0.45	0.45
Long-term Corp. Bonds	0.46	0.15	0.29	0.46	0.30	0.00	0.46	0.15	0.00	0.00	0.17	0.09	0.17	0.17	0.17	0.09	0.17	0.09	0.09	0.08
Inter.-term Gov't Bonds	0.07	0.18	0.12	0.07	0.09	0.21	0.07	0.18	0.21	0.21	0.20	0.08	0.09	0.20	0.08	0.08	0.20	0.08	0.08	0.08
Long-term Gov't Bonds	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.07	0.07	0.09	0.07	0.07	0.07	0.07	0.07	0.07
Russell 2000 (small-cap)	0.00	0.06	0.00	0.00	0.01	0.09	0.00	0.06	0.09	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Average Returns	12.8%	12.3%	12.2%	12.8%	12.5%	13.1%	12.8%	12.3%	13.1%	13.1%	12.9%	13.3%	12.6%	12.9%	12.9%	13.8%	12.7%	13.3%	13.8%	13.8%
Standard Deviations	7.7%	6.2%	6.9%	7.7%	7.1%	5.6%	7.7%	6.2%	5.6%	5.6%	8.0%	7.2%	7.4%	8.0%	7.5%	6.9%	7.8%	7.2%	6.9%	6.9%
Sharpe Ratio	0.979	1.144	1.011	0.979	1.029	1.408	0.979	1.144	1.408	1.408	0.964	1.119	1.000	0.964	1.020	1.248	0.965	1.119	1.248	1.248
Change		16.8%	3.3%	0.0%	5.1%	43.7%	0.0%	16.8%	43.7%	43.7%		16.2%	3.8%	0.0%	5.8%	29.5%	0.1%	16.2%	29.5%	29.5%

EW - Equally-Weighted Market Portfolio; VW - Value-Weighted Market Portfolio.
*Constrained optimizations have the following restrictions on the weights: S&P500 - 45 to 65%, Long-term Corporate Bonds - 9 to 17%, Intermediate-term Government Bonds - 8 to 20%, Long-term Government Bonds - 7 to 19%, and the Russell 2000 - 4 to 8%. See Ibbotson, Siegal, and Love (1985).

ENDNOTES

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[1]. The figures in Chart 1 may overstate funds under management because of double-counting: private pools and public funds may sometimes report funds under management which also are reported as funds under management by commodity trading advisors (CTAs).

[2]. Alternatively, some managed futures vehicles, such as CTA funds, can be viewed as a special class of hedge funds that exclusively trade futures and options on futures.

[3]. Public futures funds are registered as "securities" under SEC regulations and are advertised and sold like any other registered security.

[4]. CPOs typically manage more than one private pool and retain at least two CTAs to trade the funds in each pool.

[5]. CTAs and private pool operators have no legal requirement to publicly disclosure their performance records.

[6]. Profit-based incentive fees are typically levied periodically. Thus, in reporting monthly performance net of incentive fees, it is necessary to adopt an accounting convention to account for fees. In some cases, funds themselves accrue the fees over the relevant months, and the data reported to MAR reflect those fee accruals. In other cases, MAR revises the reported fund performance by spreading the reported fees over the relevant performance period of the fund.

[7]. According to the Commodity Pool Operator and Trading Advisor Regulations promulgated by the CFTC under the Commodities Exchange Act as Amended, CTAs are required to report in their disclosure documents at least three years of prior trading performance (five years starting August 25, 1995). The regulations do not require the disclosure of proprietary trading performance. However, if any proprietary trading performance is disclosed, then all such trading must be disclosed. Typically, a newly registered CTA has little or no pre-registration customer trading performance and therefore has little else to show but a proprietary trading history.

[8]. See *Stocks, Bonds, Bills, and Inflation: 1996 Yearbook*, by Ibbotson Associates, Inc.

[9]. The existence of a self-selection bias in CTA data is commonly acknowledged by data vendors. For example, Barclays attempts to correct for this bias by eliminating the first 48 months of CTA performance data.

[10]. There need be no relationship between the size of pools and funds and the average size of CTAs they use to manage their moneys. Large pools and funds can use small CTAs as well as large CTAs to manage their moneys.

[11]. Using data for CTAs, pools, and funds that started operations before 1991 would provide an incorrect assessment of the pre-reporting bias because it would result in the exclusion of too much data. For example, in the case of a CTA that began operations in 1980 and first reported to MAR in 1991 when MAR began its comprehensive data collection, excluding all data prior to its first reporting to MAR would result in excluding the first eleven years of its performance. This is clearly unwarranted.

[12]. The respective mean number of pre-reporting months was sixteen for CTAs, eight for pools, and nine for public funds. Medians were used rather than means because the means were subject to a few large observations.

[13]. Non-survivors are defined as CTAs, pools, or funds which began operations at any time subsequent to March, 1980, but ceased operations at some time prior to year-end 1996. Survivors are defined as CTAs, pools, and fund still operating at year-end 1996.

[14]. Prior to l990 (when MAR changed ownership) the MAR database consisted of only the largest 25 CTAs. Smaller CTAs, and CTAs who went out of business, were not included in the database. MAR used the unpublished performance records maintained by the previous owners, including the performance records of both surviving and non-surviving CTAs not included in the published database, to "backfill" the database for early years. In backfilling the data, however, it is possible that some non-surviving CTAs were inadvertently excluded from the database.

[15]. The annual “attrition rate” is computed as the proportion of funds that existed at the beginning of a year that do not exist (or survive) at the end of the year. CTAs, pools, and funds may cease to exist either because of poor performance or because they voluntarily dissolve or go out business. However, it is probable that most cease to exist because of poor performance.

[16]. While reported attrition rates also are higher in 1989-92 than in 1993-96, the differences are not as great as between the 1980's and 1990's, and are more likely to be the result of greater competition in fund management than of poor data collection by MAR.

[17]. **There is a significant survivorship bias no matter which exclusion rule is used to control for the self-selection bias.**

[18]. **Prior studies, based on fewer observations, also find a survivorship bias. Fung and Hsieh (1997) find that reported annual CTA returns in the 1980's could be inflated by as much as 3.48 percentage points because of the failure to include non-surviving CTAs in the data. Schneeweis, Spurgin, and McCarthy (1996, p. 768) report that for an EWMP's of CTAs "...including nonsurviving CTAs ... would have reduced annual returns by approximately 1.0-2.5%, increased standard deviation by 1.2-1.4%, and reduced the Sharpe ratios from 16 to 27% ..." In the analyses in Appendices 3 and 3a non-surviving funds are defined as any CTAs, pools, or funds that discontinued operations at any time prior to year-end 1996. For mutual funds, Brown and Goetzmann (1995) report an annual survivorship bias of about one percentage point.**

[19]. **That means that for an EWMP each month funds are taken from last month's winners and given to last month's losers to maintain an equally-weighted portfolio. For a VWMP winners get larger and therefore receive a larger allocation.**

[20]. **Sharpe ratios provide a reasonable risk-adjusted measure of returns on managed futures investments because the returns are typically uncorrelated with the returns on most non-futures investments (such as on stocks and corporate bonds). In other words, the "beta" on managed futures investments is near zero.**

[21]. **The monthly standard deviation of randomly-selected, single-CTA portfolio returns for a given sample period is the standard deviations of all monthly returns for all CTAs in existence at any time during the sample period. New entrants and non-surviving CTAs during the sample year are included in calculating the standard deviation. The annual standard deviation for an EWMP of CTA returns is the monthly standard deviation of EWMP monthly returns multiplied by the square root of 12.**

[22]. **The same calculation is done for randomly-selected, single-pool and single-fund portfolios as is done for randomly-selected, single-CTA portfolios. See note 21.**

[23]. **The performance figures when no returns data are excluded also are very similar to those in Table 3. We do not report those results.**

[24]. **Use of the 28-month exclusionary rule would result in a considerably lower ranking for an EWMP of CTAs. See Appendix 7. As discussed earlier, however, there is reason to believe that use of this rule results in downward bias in CTA returns.**

[25]. A finding that public funds do not make good stand-alone investments is consistent with earlier studies. Elton, Gruber and Rentzler (l987, l990) find that public funds perform poorly relative to stocks and bonds during the 1979-88 period. More recently, Irwin, Krukemyer and Zulauf (1992) find that under no scenario does the Sharpe ratio of a public fund investment exceed the Sharpe ratio of a stock or bond investment during the 1979-89 period. Earlier studies by Lintner (1983) and Irwin and Brorsen (1985) find some evidence that funds make good stand-alone investments, but those studies examine a relatively small number of funds for only a few years during the early 1980's.

[26]. The performance of a VWMP of pools is insensitive to the exclusionary rule used: it ranks first among all investments in 1989-96 no matter which rule is used to exclude early performance data. (See Appendices 7 and 8)

[27]. An indication of this is that returns on the Mount Lucas Management Company (MLM) index, a dynamically-constructed, trend-following commodity index, were considerably lower in 1989-96 than in 1982-88. Returns on the MLM index are based on the closing prices of nearby futures contracts of twenty-five actively traded futures markets, and on the use of a trend-following trading strategy that assigns either long or short positions to the various futures contracts, depending on market circumstances. Thus, lower returns on the MLM index in 1989-96 indicates that a simple trend-following trading strategy did not perform as well during this period as it had in earlier years.

[28]. See Burr (1994) and Mattlin (1991).

[29]. See also Appendix 9 for correlations using different exclusion rules.

[30]. It has been shown that every risk-averse investor -- regardless of the degree of his risk-aversion -- will be better off by adding a new asset to his or her portfolio if the inclusion of that asset improves the return-risk tradeoff of that portfolio in the sense of shifting the efficient frontier upward and/or to the left.

[31]. See Elton, Gruber and Rentzler (1987).

[32]. This is because in our randomly-selected, single-CTA, pool, or fund portfolio a different CTA, pool, and fund is selected every month. It is not, therefore, appropriate to use, say, a year of monthly returns for each CTA, pool, or fund to compute one-year correlation coefficients and then use the average of those correlation coefficients to represent the correlation between a randomly-selected, single-CTA, pool, and fund portfolios and other financial assets.

[33]. Selecting a different CTA, pool, or fund every month should simply add to the randomness of the returns on randomly-selected, single-CTA, pool, or fund portfolios.

[34]. Elton, Gruber and Rentzler (l987, l990), and Irwin, Krukemyer and Zulauf (l990) use this methodology to evaluate investments in public futures funds and also find that adding public futures funds to a diversified portfolio does not enhance performance. More limited studies of CTAs are Lintner (l983), Baratz and Eresian (l986, l990), Peters (l989), and Oberuc (l990). Orr (l987) examines a small sample of pools for earlier years.

[35]. For break-even analyses using different exclusion rules, see Appendix 10.

[36]. An objective of maximizing the Sharpe ratio, of course, implicitly assumes a specific investor risk-preference function. Other implicit assumptions are that there can be riskless borrowing and lending at the same rate and that short sales are impossible.

[37]. See also Frost and Savarino (1988).

[38]. See Ibbotson, Siegel and Love (1985). The ranges are:

Common Stocks	45.5 to 64.3 percent
Small Stocks	4.3 to 7.3 percent
Intermediate-term Govt. Bonds	8.9 to 19.8 percent
Long-term Govt. Bonds	7.1 to 19.0 percent
Long-term Corporate Bonds	9.9 to 17.0 percent

These ranges implicitly assume that the market portfolio consists of only the above five asset classes.

[39]. As indicated earlier, we do not include an analysis of randomly-selected, single-CTA, pool, and fund portfolios because there is no obvious way to compute the appropriate correlation coefficients.

[40]. For optimal portfolio allocations using different exclusion rules, see Appendix 11.

[41]. Elton, Gruber and Rentzler (l987, l990), and Irwin, Krukemyer and Zulauf (l990) use this methodology to evaluate investments in public futures funds and find that adding public futures funds to a diversified portfolio does not enhance performance. More limited studies of CTAs are Lintner (l983), Baratz and Eresian (l986, l990), Peters (l989), and Oberuc (l990). Orr (l987) also examines a small sample of pools for earlier years.

[42]. Billingsley and Chance (1996), p. 74.

[43]. If, on the other hand, the designated portfolio allocation to managed futures is arbitrarily restricted to less than five percent of the portfolio, the gains to including managed futures investments are relatively small. See Billingsley and Chance (1996).