Managed Futures and Asset Allocation

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Summary

We study the role of managed futures in long-term asset allocation portfolios. We begin by determining whether managed futures returns can be replicated through investing in broadly diversified stock and bond indices. Next, we investigate whether adding managed futures funds improves the risk-return tradeoff for long-term asset allocation portfolios. The results suggest that managed futures funds offer distinct risk and return characteristics to investors that are not easily replicated through investing in traditional stocks and bonds. Including managed futures also improves the risk-return tradeoff of the long-term asset allocation portfolios we consider, thus benefiting long-term investors. Our scenario analysis on interest rate environments indicates that managed futures exhibit superior performance during periods in which most traditional asset classes underperform. Overall, the results suggest that the managed futures funds benefit long-term investors, particularly in rising interest rate environments.

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Managed Futures and Asset Allocation Portfolios

1. Introduction

Managed futures denotes the sector of the investment industry in which professional money managers actively manage client assets using global futures and other derivative securities as the investment instruments. Managed futures managers are also known as Commodity Trading Advisors (CTAs), and The National Futures Association (NFA) is their self-regulatory organization.[1] The first managed futures fund started in 1948; however, managed futures did not take off as an industry until the 1980s.

In conjunction with the growth of the derivatives market and the proliferation of derivative securities, the managed futures industry has expanded significantly over the past 20 years. Assets under management have grown from $1 billion in the mid-1980s to approximately $100 billion in 2004. The global futures markets were traditionally dominated by agriculture and commodity futures. In 1980, agricultural trading represented about 64% of market activity, metals comprised 16%, and currency and interest rate futures accounted for the remaining 20%. Today, global futures markets are dominated by financial futures—currency, interest rate, and stock index futures—and agriculture represents only 7%. Initially, managed futures professionals traded primarily in the commodities market, but the advent of futures on currency, interest rates, and stock and bond indices since the 1980s has both expanded the investment opportunity set and precipitated an evolution in the instruments of choice for managers.

In general, managed futures managers can be classified along two dimensions: the markets in which they trade, and the trading strategies they employ. Typically, CTAs are fully diversified across markets and trade hundreds of different futures contracts, or are focused either on a specific market or a set of related markets. A non-exhaustive list of markets for which specialized CTAs exist includes currencies, agricultural commodities, precious metals, energy, and stocks. Managers are also classified by trading strategy or style into two broad groups: *trend-*

[1] From a legal standpoint, CTAs must register with the Commodity Futures Trading Commission (CFTC) in accordance with the U.S Commodity Exchange Act (Title 7, Chapter 1, Section 6n). Similar obligations exist for firms located outside of the U.S. (e.g., the Commodity Investment Regulations in Japan). CTAs are typically organized as Limited Partnerships and have offshore structures reminiscent of those created for hedge funds.

following, which attempt to identify and exploit trends in the futures markets; and *discretionary* or *fundamental*, which rely primarily on fundamental analysis of global supply and demand, macroeconomic indicators, and geopolitical forces.

Although the two broad trading strategies discussed above are sufficient to classify the vast majority of the CTA universe, a superset of trend-following strategies known as *systematic* strategies completes the taxonomy. In practice, trend-following approaches rely on quantitative models to perform technical or fundamental analysis and to generate buy and sell signals. While trend-following is by far the most widespread strategy among CTAs, trading systems can be classified as either trend-following or *counter* trend-following.

Trend-following trading systems are often fully automated and tend to be diversified across a range of markets. Most trend-followers refrain from trying to predict trends, and instead take positions that will profit from the persistence of the current market trend. They examine widespread indicators such as moving averages, exponential smoothing, and momentum, in order to eliminate market noise and specify the current direction of a market. CTAs differ from one another with respect to the time horizon used to determine the existence of a trend, and individual managers can focus on short-, intermediate-, or long-term trends, or some combination of horizons. [2] *Counter*-trend systems, on the other hand, look for trend *reversals*. CTAs employing a counter trend-following strategy rely on methods including rate of change indicators, such as oscillators and momentum, or on technical indicators such as head and shoulders patterns.

Discretionary managers may also employ systematic models based on fundamentals and underlying economic factors, but their trading decisions are informed by individual criteria and their beliefs regarding the model results. Because experience and trader-specific skill are critical to the success of discretionary strategies, discretionary CTAs often specialize in a particular sector or market. However, some CTAs diversify across strategies by basing their trading on a

[2] Risk management is a key part of any trading strategy. Trend-following CTAs typically cut losses as soon as they materialize, let profits run, and often add to winning trades. Additionally, trend-followers usually apply filters such as volatility, trading volume, and various risk/reward ratios to trading signals in order to determine the capital allocation.

mix of trend-following and discretionary methods, independent of whether they are also diversified across trading markets.

Investors can access managed futures in three ways. Public commodity or futures funds offer investors the managed futures equivalent of mutual funds. In particular, the reduced volatility offered by diversified portfolios of individual managers is directly analogous to the reduction of the specific risk associated with individual securities in diversified mutual fund portfolios, because the underlying mechanism is the same. A collection of similar but imperfectly correlated assets will tend toward the risk and return characteristics of the market portfolio, with skilled managers identified as those who can consistently improve the risk and return tradeoff relative to the market. High net-worth and institutional investors can also obtain exposure to managed futures through private commodity pools, in which the pooled assets are invested in one or several CTA managers. Private funds offer diversification benefits similar to public funds, but may possess the general characteristics of hedge funds and other private investment vehicles, including liquidity restrictions and limited transparency. Last, the investors can directly hire CTA advisors to manage money. While the advantages of separately managed CTA accounts as part of a customized investment program are obvious, all three methods for exposure to managed futures offer the opportunity for diversification across CTA trading styles and futures markets.

In contrast with traditional long-only money managers, for which the bulk of returns are derived from the long-term systematic risk and return characteristics of the stock and bond markets, managed futures managers add value primarily through their trading skills. Consequently, managed futures are also described as skill-based or absolute return investment strategies. Through their ability to invest in derivatives and to take both long and short positions, CTAs offer investors an effective way to gain exposure to markets, instruments, and strategy-driven investment characteristics otherwise not easily accessed.

In this paper, we study the role of managed futures in long-term diversified asset allocation portfolios. The remainder of this paper is organized as follows. First, we review the literature on managed futures and asset allocation. Next, we analyze the long-term risk and return characteristics of managed futures and other major asset classes. We also study whether the managed futures returns can be replicated through passively investing in traditional stocks and bonds. We then investigate whether adding managed futures funds improves the risk-return tradeoff for long-term asset allocation portfolios. The results suggest that the managed futures funds offer distinct risks and returns to investors that are not easily replicated through investing in stocks and bonds. Including managed futures improves the risk and return characteristics of the long-term portfolios, and thus benefits long-term investors. Our results based on a scenario analysis of interest rate environments also show that managed futures exhibit superior performance during periods in which most other asset classes underperform.

2. Literature Review

The growth in demand for managed futures products reflects appreciation of the potential benefits CTAs offer investors. Numerous studies have been conducted on the subject of managed futures and on the diversification effects they have on portfolios of various types of assets.

Mean-variance optimization demonstrates that adding managed futures to traditional stock and bond portfolios improves the efficient frontier. However, it has been argued that the peculiar nature of CTA return distributions has the potential to offer additional diversification effects that are not fully captured by the mean-variance approach. Cerrahoglu (2004) shows that well-diversified managed futures funds offer risks and returns comparable to diversified equity portfolios. In addition, managed futures tend to have low correlation with traditional stock and bond investments, since returns from managed futures are often derived from a set of factors different from those affecting traditional stocks and bonds. These low correlations are attractive characteristics for long-term investors who seek the benefits of diversification.

For appropriately constructed portfolios, managed futures are shown to offer unique downside risk control along with the simultaneous potential for upside returns. Cerrahoglu (2004) argues that the unique risk and return characteristics of managed futures are primarily attributable to the fact that the financial instruments CTAs trade are not generally available to traditional long-only managers. As a result, it makes sense to include managed futures in portfolios consisting of stocks and bonds. He also shows that correlations between CTAs and stock markets are positive in bull markets and negative in bear markets. While it is not yet fully understood why trends and other profit opportunities tend to develop when stock markets are experiencing turmoil, this feature of managed futures can be used advantageously in the context of portfolio construction as a source of downside protection and capital preservation.

Kat (2004) studied the benefits of combining both CTAs and hedge funds in a diversified portfolio. In his analysis, the positive skew of managed futures was shown to be beneficial in reducing the impact of the negative skew of hedge fund strategies.[3] Managed futures allow investors to significantly reduce overall portfolio risk without suffering the negative skew associated with hedge funds. Kat (2004) also concludes that managed futures are a better diversifier than hedge funds. In another study of CTAs in a portfolio context, Liang (2003) treated managed futures, hedge funds and funds of funds as distinct asset classes. Among other results, CTAs were found to be lesser of the three on a stand-alone performance basis during the study period, but the negative correlations of CTAs with the other two classes made them effective hedging instruments that can significantly improve the risk-return tradeoff for hedge fund and fund of funds investors.

While the futures markets in which CTAs execute their strategies are formally zero-sum games, investigations into the sources of managed futures returns have identified an analogue to the inherent positive market returns of stocks and bonds. The positive trend of stock returns is attributable to long-term capital creation in an expanding global economy, while bond returns derive from the time value of borrowed money. The key foundation for futures returns, some practitioners and academics have posited, is the risk transfer function of the futures market itself (Kritzman (1993), Lightner (2003), and Spurgin (2003), among others). Some commercial market participants, the hedgers, are willing to pay the equivalent of an insurance premium to noncommercial participants, the investors, for the assumption of risk. In the aggregate and over the long term, hedgers are willing to act consistently to transfer risk even if they expect the spot markets to move in their favor, and in doing so pay a net positive insurance premium. As providers of liquidity, investors receive this premium in the form of net trading profits. The

[3] Skew is a statistical measure that quantifies the direction and degree to which large returns tend to be biased. Normally distributed returns exhibit zero skew, while the positive skew of managed futures reflects a greater likelihood of large positive rather than negative returns.

subtlety of this mechanism in explaining managed futures returns lies in the fact that the "asset" investors must own in order to profit, analogous to owning stocks or bonds, is *not* the financial instrument underlying the market. Rather, it is a trading strategy that accommodates the trend hedgers must follow to continuously and effectively transfer risk. In other words, the risk and return characteristics of managed futures as an asset class are hypothetically explained by being "long" a *trend-following strategy*, not the futures contracts themselves.

One empirical validation of these ideas is provided through the Mount Lucas Management Index (MLMI), which is a passive futures index that applies consistent and transparent rules for trading on price trends in an equally weighted, unleveraged portfolio spanning 25 futures markets. First developed in 1988, the MLMI strategy was initially back-tested on historical data through 1961, and the results demonstrated formidable returns at attractive levels of risk. Lightner (2003) notes this result disturbed many market participants at the time, since it challenged the idea that managed futures returns were strictly skill-based by demonstrating futures markets do in fact produce an inherent return, but through a naive trend-following strategy.

More recent research has utilized the MLMI to demonstrate the value of managed futures in a portfolio context. Jensen, Johnson, and Mercer (2003) found that a 10% allocation to MLMI within diversified portfolios significantly increased the Sharpe ratios for a full range of investor risk tolerances, from conservative to aggressive. The study covered the period from 1961 to 2000, during which the enhancement to risk-adjusted returns was primarily attributable to risk reduction rather than return enhancement. The impact of monetary policy on such diversification benefits was also investigated by separately analyzing periods of expansive and restrictive policy. MLMI demonstrated benefits during periods of rising interest rates and inflationary pressure, but not during expansive policy periods.

3. Historical Performance Analysis

Data

Unlike investment vehicles such as mutual funds, which have disclosure requirements mandating that managers regularly report their investment performance and other activities to regulatory authorities, CTAs usually report performance on a voluntary basis to database vendors. This voluntary reporting leads to several data biases that make the accurate measurement of CTA performance difficult. The two most common are known as *survivorship bias* and *back-fill bias*.

Survivorship bias occurs because the most likely reason for a manager to stop reporting is poor investment performance. As a result, the average return of the managers remaining in a peer group is an upward-biased estimate of the actual return of all managers over the reporting period. Several studies of the importance of survivorship bias on CTA returns have been conducted. Fung and Hsieh (2000) find a survivorship bias of 3.6% per year, while Schneeweis, Spurgin, and McCarthy (1996) estimate a 1.4% annual bias. In contrast, back-fill bias occurs when managers choose to start, rather than stop, reporting to database vendors. Typically, a manager begins reporting after having achieved good performance for a certain number of months, and the back-filling of the database with the manager's incubation period returns creates an upward bias from the instant and favorable performance history. In practice, these systematic upward biases in reported performance are tempered somewhat by a countervailing phenomenon known as *termination* or *self-selection bias*: successful managers who have reached the capacity constraints of their investment strategies, or who are no longer actively pursuing new investors, lack the incentive to continue publicly reporting performance and may stop doing so.

Mindful of such data biases, in this study we use the Trading Advisor Qualified Universe Value-Weighted (CTA$) and Equal-Weighted (CTAEQ) indices, created by the Center of International Securities and Derivatives Market (CISDM) at the University of Massachusetts. The Trading Advisor Qualified Universe indices measure the performance of managed derivatives trading advisors and investment products, and include both active and retired advisors and funds in an effort to eliminate selection and survivorship bias. Originally constructed by MAR (Managed Account Reports), the CISDM indices track the performance of individual CTAs, as well as CTA funds and pools that invest in individual CTAs. To be included in a CISDM Trading Advisor index, an advisor must either have $500,000 under management and have been trading client assets for at least 12 months, or manage funds for a public fund listed in MAR.[4] These indices offer monthly data beginning in January 1980.

Historical Performance

Table 1 shows the annualized return and risk characteristics of the two CISDM indices from January 1980 to August 2004, along with several other traditional asset classes that together span U.S. stock and bond markets and international equities. We display risk-adjusted return ratios for monthly return frequency. The results are presented in both nominal and inflation-adjusted formats, with inflation represented by the Consumer Price Index (CPI).

Over the past 25 years, the CISDM Trading Advisor indices have outperformed the U.S. equity market while maintaining a comparable level of risk, as measured by the standard deviation of returns. On an annualized basis, the Value-Weighted CTA index (CTA$) returned 14.58% with a standard deviation of 18.47%, while its Equal-Weighted counterpart (CTAEQ) gained 17.32% at a standard deviation of 20.47%. These returns exceed the S&P 500 performance of 13.27% by 131 and 405 basis points, respectively, at an increased cost of 85 and 285 basis points over the 17.62% standard deviation for the S&P 500 during the same period. Both managed futures and stocks out-performed bonds (9.65%) and cash (6.10%) during the study period

Sharpe ratios provide a more direct measure of the favorable risk-adjusted performance for managed futures; at 0.16 for CTA$ and 0.19 for CTAEQ, they slightly exceed the S&P 500 figure of 0.15. However, the unusual return and risk characteristics of managed futures require a more careful analysis of risk-adjusted return comparisons, and prompt us to examine some of the other statistical measures in Table 1 more closely.

Recall that the positive skew of managed futures returns is a desirable quality and a reflection of aggregate CTA manager skill. While the equity asset classes in Table 1 exhibit negative skews, ranging from approximately –0.2 for international stocks to –0.9 for the S&P 500, the CTA$ and

[4] In addition to the aforementioned benchmarks, CISDM publishes sub-indices for currency, European, stock index, financial and diversified traders. For detailed information, check the CISDM web site: www.cisdm.org. For a thorough analysis of the risk characteristics of the CISDM indices, see Gupta and Chatiras (2003).

CTAEQ skews are relatively large and positive at 1.2 and 1.8, respectively.

Note that bonds and cash also have positive skews in nominal terms, and that cash retains its positive value on an inflation-adjusted basis. Conceptually, we can attribute the positive nominal skew of bonds to the contribution due to inflation, rather than manager skill. For cash and inflation, positive skews should be considered in the context of strong positive serial correlations, which reflect the predictability of the risk-free rate and the consistent upward trend of inflation. Because skew and other statistics are calculated based on the assumption of independent and identically distributed returns, and cash and inflation apparently violate this assumption, the skew results for these asset classes are unreliable.[5] A statistical analysis based on less restrictive assumptions, such as the method developed by Lo (2002), is required to compare the skews of cash and inflation on an equal footing with the other asset classes in Table 1. While the corrected skews for cash and inflation might very well be positive and significant to reflect the potential for upside return surprises (e.g. unanticipated jumps in inflation), we speculate that the results presented here are upwardly biased.

In other words, while skew is a useful metric to infer manager skill because it reflects the bias toward large positive returns, we must be careful to ensure that the assumptions underlying its calculation are respected. The serial correlations in Table 1 indicate that to be the case for all but cash and inflation. In any event, positive skew is an unambiguous indication that returns are not normally distributed.

A second indicator of the unusual nature of managed futures returns is kurtosis, which measures the likelihood of large positive or negative returns relative to small returns. Assets that exhibit positive kurtosis are more likely to experience larger outlier returns than assets with normally distributed returns, which by our conventions have zero kurtosis. The results are “fat tails” and a narrow central peak in the return distribution, since extreme gains or losses are more likely than usual to occur. While all of the asset classes in Table 1 exhibit positive kurtosis, the CTAEQ and CTA$ managed futures indices have the second and third largest, at 5.31 and 3.67, respectively.

[5] Large positive serial correlations also imply that long-term volatility is biased downward (Lo (2002)).

Together with the positive skew, the large positive kurtosis of CTA returns tells a statistical story of upside potential: larger returns are more likely than usual, and they are positively biased. However, these favorable deviations from normal asset returns come with a price: our typical measures to gauge risk and risk-adjusted return—the standard deviation and Sharpe ratio—do not tell the rest of the story regarding downside potential, and we need to consider alternative risk-adjusted return measures that do not rely on the assumption of near-normality, as does the Sharpe ratio.

To address this issue, we utilize two alternative measures: the Sortino ratio, and the Stutzer ratio (Stutzer (2002)). The Sortino ratio is a risk-adjusted return ratio that divides excess return over a designated target return, which is cash return in our analysis, by the risk of not achieving that target return. By using the semi-standard deviation below the target return as the risk level, the Sortino ratio tells us how well we are being compensated for each unit of shortfall risk we incur. To eliminate the bias introduced by the presence of skew and kurtosis, we also calculate the Stutzer ratio, which is a generalization of the Sharpe ratio. In fact, the Stutzer ratio can be interpreted in the same manner as the Sharpe ratio, and reduces to the Sharpe ratio for normally distributed returns, so direct comparison of the two gives a quantitative measure of the impact of skew and kurtosis on risk-adjusted returns.

At 0.76, the CTAEQ Sortino ratio is nearly double the 0.41 figure for the S&P 500, while the 0.59 for the Value-Weighted CISDM Trading Advisor index is nearly 50% higher. Given the use of shortfall risk in the construction of the Sortino ratio, this is unambiguous evidence of both the superior risk adjusted performance of CTAs and the smaller downside risk potential of managed futures returns relative to stocks. On an unbiased risk-adjusted basis, the superiority of the CISDM indices is also clear. The Stutzer ratios for the CISDM indices are larger than their corresponding Sharpe ratios, while the Stutzer ratio for the S&P 500 decreases relative to its Sharpe ratio. At 0.17 for CTA$ and 0.21 for CTAEQ, the unbiased risk-adjusted performance of the CISDM indices appreciably exceeds that of the S&P 500, with a Stutzer ratio of 0.14.

Table 2 shows the annual correlation between managed futures, stocks, bonds, cash, and inflation. The correlation numbers demonstrate that managed futures have relatively low correlation with both stocks and bonds. This indicates that managed futures can potentially reduce the risk and enhance return for portfolios consisting of traditional stock and bond investments. The relatively high correlations with inflation, as well as cash in the case of CTAEQ, can be understood in the context of the preceding discussion of skew. Both bonds and cash reflect the skew and serial correlation of the inflation component of nominal interest rates, and as a positively trending asset class with likelihood of upside surprises, managed futures have much in common with inflation. In other words, the correlation analysis provides evidence of the value of managed futures as a potential inflation hedge as well as a source of diversification within a portfolio of traditional assets.

Regression Analysis

From the historical data, we attempt to determine the proportion of managed futures returns that can be attributed to the systematic market risk of stocks and bonds (betas), and the proportion attributable to the other risk factors that are not correlated with traditional stocks and bonds and to CTA manager value-added (alpha). To investigate the sources of managed futures returns, we conduct a return-based regression analysis using traditional stock, bond, and cash benchmarks. The benchmarks used in the analysis are: the S&P 500, Russell 2000, and MSCI EAFE for large, small and international stocks, respectively; the Lehman Brothers Aggregate Bonds for bonds; and T-bills for cash. Table 3 shows the results.

We run two sets of regressions: one constraining the style weights on the benchmarks to be positive, and the other allowing negative weights in order to reflect short positions in the benchmarks. Even when we allow for the fact that managed futures portfolios often contain both long and short positions, we find that traditional stock, bond, and cash benchmarks do not explain managed futures performance very well. In particular, while the R-squared for each regression allowing negative weights is nearly double the value for the corresponding constrained regression, the largest R-squared is less than 6% but statistically significant at the 1% level—far from a well-fitted model.

As we might expect from our discussion of the correlations in Table 2, the largest style weight for each regression corresponds to cash, with values ranging from 65% to 80%. Despite the magnitude of these style weights and the strong correlations with inflation and cash, the explanatory power of regressions including cash as a factor is poor. In fact, these results indicate that the vast majority of managed futures performance—at least 94%—cannot be explained by the same factors that drive stock, bond, and cash returns. In other words, managed futures returns are driven by factors that are not correlated with traditional assets and/or by the value added by CTA managers.

Scenario Analysis

Previous studies have shown that managed futures perform better during periods of rising interest rates or restrictive monetary policy. The performance of managed futures, stocks, bonds, and cash are examined during periods of expansionary and contractive monetary policies. We follow the methodology of Jensen, Mercer and Johnson (1996); in particular, we exclude months in which the Federal Reserve moved between expansive and restrictive policy, since these months contain the impact of the policy announcement itself as well as days representing both economic states.

Table 4 presents the performance difference during periods of expansionary and contractive monetary policy. It clearly shows that stocks underperform in rising interest rate environments as opposed to declining environments, and that the differences are statistically significant to a high degree in some cases. Managed futures do not exhibit significant out- or underperformance between the two states.

Table 5 presents the inflation-adjusted performance during rising and declining interest rates. The underperformance of stocks in rising interest rate environments is even more severe after adjusting for inflation, and the differences are statistically significant for all three stock indices. Again, the impact of interest rates on managed futures remains negligible, further validating the finding that managed futures fare better than stocks in rising interest rate environments. This is particularly relevant today, as we are potentially heading into an extended period of rising interest rates. As of December 2004, the Federal Reserve has raised rates for the fifth time in the past 18 months.

The analysis of historical returns shows that managed futures returns have low correlations with traditional long-only stock, bond, and cash portfolios. This strengthens the argument that unlike traditional long-only portfolios, which profit only when equity or bond markets are rising (due to generally favorable economic conditions and/or issuer-specific economic results), managed futures investors typically profit when sustainable trends in such markets are identified, whether up or down. Furthermore, futures and forward trading are risk transfer activities that, unlike equities, do not represent a direct investment in any asset. Thus, whether equity markets are rising or declining, managed futures may generate attractive returns.

4. Managed Futures in Asset Allocation Portfolios

In this section, we further investigate the role of managed futures in diversified portfolios. We conduct two analyses: 1) a mean-variance efficiency analysis, in which we perform a mean-variance optimization (MVO) to study the impact of managed futures on the efficient frontier and efficient portfolios; and 2) a portfolio-level analysis, in which we add managed futures to three pre-constructed, asset class-level model portfolios consisting of stocks, bonds, and cash. The three model portfolios represent typical portfolios used by conservative, moderate, and aggressive investors. Our goal is to show the potential benefit of managed futures for investors with portfolios of traditional assets.

Mean-Variance Efficiency Analysis

We use MVO to illustrate the benefit of adding managed futures to the universe of asset classes being considered. Figure 1 shows the mean-variance efficient frontier with and without managed futures over the historical period of January 1980 to August 2004. Two efficient frontiers are shown. The one above includes managed futures, while the frontier below excludes managed futures from consideration.

The figure shows that managed futures significantly improve the mean-variance efficiency of the portfolios. In other words, investors can access higher expected returns at all levels of risk, as gauged by portfolio standard deviation. The expected return difference grows across the efficient frontier as risk level increases, and peaks in the moderate-to-aggressive range at an annual standard deviation of approximately 12%. The difference persists at higher risk levels, but decreases in magnitude as investors are rewarded less for the incremental risk they assume.

Figures 2 and 3 show the detailed efficient portfolio allocations with and without managed futures. For portfolios of traditional asset classes, the allocations shift from approximately 90% cash to 100% large stocks as risk level increases. The combined proportion in cash and bonds shifts to stocks at a roughly steady rate, with the small fraction of the equity allocation devoted to international stocks disappearing in the moderate-to-aggressive range. For portfolios including managed futures, the optimal asset class weights behave very differently, with the managed futures allocation playing a role similar to that of large stocks in traditional portfolios. As risk level increases, the allocation to managed futures ranges from 0% to 100%, and increases at a roughly steady rate. The remainder of the optimal portfolio allocation is dominated in turn by cash, bonds, and large stocks as risk level increases. These MVO results demonstrate that the risk and return characteristics of managed futures make it a more attractive asset class than stocks for investors willing to assume at least a moderate level of risk in a diversified portfolio.

Model Portfolio Analysis

To extend our analysis of the impact of managed futures in a portfolio context, we consider their incremental addition to model portfolios for a range of investor risk tolerances. Model portfolios are often used by financial advisors when offering advice to individual investors. Using the following asset classes and benchmarks, we construct three long-term asset allocation portfolios, with the allocation breakdowns shown in Table 6:

Asset classes	***Benchmarks***
Large-Cap Equity	S&P 500
Small-Cap Equity	Russell 2000
International Equity	MSCI EAFE
Aggregate Bonds	LB Aggregate
Cash	3 month T-bill

Table 6: Model Portfolios Representing Conservative, Moderate, and Aggressive Investors

	Conservative	Moderate	Aggressive
Large Cap Stocks	15%	35%	50%
Small Cap Stocks	0%	9%	17%
International Stocks	5%	16%	28%
Bonds	47%	30%	5%
Cash Equivalents	33%	10%	0%

Many portfolios contain traditional investments such stocks and bonds. In order to maximize profit potential commensurate with risk in all market cycles, suitable portfolios should also include investments that have the potential to perform when these traditional markets experience difficulty. Managed futures have historically performed independently of traditional investments like stocks and bonds. This is manifested through low correlations, which provide the potential for managed futures to perform well even when traditional stock and bond markets experience performance downturns.

Of course, managed futures funds will not automatically be profitable during unfavorable periods for these traditional investments, and vice versa, since a large part of the returns is determined by the skills of the manager and the presence of exploitable trends in the futures markets. The degree of non-correlation of any given managed futures fund will also vary, particularly as a result of market conditions and manager skill, and some funds will have significantly greater correlation with stocks and bonds than others.

To quantify the impact on absolute and risk-adjusted return in portfolio context, we consider adding managed futures to model portfolios for conservative, moderate, and aggressive investors. We add from 2% to 20% of the two CISDM CTA indices separately to each model portfolio in increments of 2%, with half of each increment taken from stocks and half from bonds and cash in an effort to preserve the relative mix of these traditional assets. The results for Conservative, Moderate, and Aggressive Model Portfolios are shown in Tables 7, 8 and 9, respectively.

For the period of study, the addition of CTA$ and CTAEQ consistently increases return for all three sets of model portfolios, with standard deviation consistently decreasing and risk-adjusted return consistently increasing for Moderate and Aggressive portfolios. The Conservative portfolio risk level also decreases, but eventually reaches a minimum near a 10% allocation to managed futures and then increases through the traditional Conservative portfolio risk level near an allocation of 15%. The Sharpe, Sortino, and Stutzer ratios for the Conservative portfolio exhibit a similar pattern, but remain above the values for the Conservative portfolio without managed futures for the range of weights studied. With the exception of the positively-skewed Moderate portfolios for 18% and 20% allocations to CTAEQ, the Stutzer ratios for the Moderate and Aggressive portfolios are slightly less than the Sharpe ratios for each portfolio. This coincides with a progressive reduction in negative skew and positive kurtosis as the allocation to managed futures increases, which indicates both a reduction in the impact of negative skew from the traditional equity asset classes and clear diversification benefits.

We can understand these results by returning again to Figure 3, which shows the optimal allocation to managed futures in efficient portfolios with these same benchmark indices used as asset class proxies. At the risk level for the Conservative portfolio, the optimal allocation to managed futures is approximately 15%, which we find roughly maximizes return at the same level of risk as the Conservative portfolio without managed futures. The optimal allocation to managed futures is greater than 50% for the Moderate and Aggressive portfolios. Conceptually, as the allocation to managed futures is incrementally increased, the three model portfolios move from the lower efficient frontier in Figure 1, upward and to the left toward lower risk, higher return, and the upper efficient frontier with the optimal weighting to managed futures. In all cases, the portfolios remain in between the two frontiers and thus are inefficient; only a new application of MVO will provide the optimal weights and efficient portfolios. However, even at 20% allocation to managed futures for the Moderate and Aggressive portfolios, we have only probed a fraction of the gap between the two frontiers.

These results show the potential for managed futures to increase absolute and risk-adjusted return, while simultaneously decreasing risk as measured by standard deviation, of long-term asset allocation portfolios for a range of investor risk levels. Our analysis demonstrates that a modest allocation to managed futures can enhance long-term returns while reducing portfolio risk, even for conservative investors. While an identical analysis over shorter sub-periods of the

25 years we consider might yield less favorable results, using the longest baseline of data available indicates that managed futures benefit investors when included in diversified portfolios of traditional assets.

5. Conclusions

We study the role of managed futures in long-term asset allocation portfolios. We investigate whether adding managed futures funds improve the risk-return tradeoff for long-term asset allocation portfolios. We also study whether the managed futures returns can be replicated through investing in broadly diversified stocks and bonds indices. Then, we investigate whether adding managed futures funds improve the risk-return tradeoff for long-term asset allocation portfolios. The results suggest that the managed futures funds offer distinct risk and return characteristics to investors that are not easily replicated through investing in traditional stocks and bonds. Including managed futures improves the risk-return tradeoff of the long-term asset allocation portfolios, thus benefiting long-term investors. Our scenario analysis results show that managed futures exhibits superior performance while most other asset classes underperform. Overall, the results demonstrate that the managed futures funds benefit long-term investors, especially in rising interest rate environments.

Table 1: Historical Performance (January 1980 – August 2004)

Nominal	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio[6]	Stutzer Ratio[7]
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	14.58	15.97	18.47	-0.12	1.24	3.67	0.16	0.59	0.17
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	17.32	18.96	20.47	-0.07	1.75	5.31	0.19	0.76	0.21
S&P 500 TR	13.27	14.63	17.62	0.00	-0.58	2.28	0.15	0.41	0.14
Russell 2000 TR	11.82	14.02	22.25	0.15	-0.92	3.53	0.11	0.29	0.11
MSCI EAFE TR	10.89	12.53	19.34	0.04	-0.19	0.33	0.10	0.32	0.10
LB Aggregate Bond TR	9.65	9.85	6.76	0.20	0.77	5.39	0.16	0.94	0.17
U.S. 30 Day TBill TR	6.10	6.10	0.96	0.96	0.84	0.96	NA	NA	NA
U.S. Inflation	3.73	3.74	1.08	0.57	0.85	1.88	-0.63	4.81	NA
Inflation-Adjusted	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR REAL	10.45	11.79	17.73	-0.13	1.18	3.28	0.10	0.41	0.10
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR REAL	13.10	14.67	19.61	-0.09	1.69	5.05	0.13	0.55	0.14
S&P 500 TR REAL	9.19	10.53	17.15	0.01	-0.58	2.15	0.08	0.29	0.08
Russell 2000 TR REAL	7.79	9.95	21.62	0.16	-0.91	3.45	0.05	0.20	0.05
MSCI EAFE TR REAL	6.90	8.52	18.86	0.05	-0.20	0.37	0.04	0.21	0.04
LB Aggregate Bond TR REAL	5.70	5.91	6.71	0.23	0.37	4.18	-0.01	0.46	NA
U.S. 30 Day TBill TR REAL	2.28	2.29	1.02	0.50	-0.10	0.75	-1.06	1.51	NA

[6] The Sortino ratio is a risk-adjusted return ratio that considers excess return over a designated target return and the risk of not achieving that target return. Excess return is defined as the series' return less the target return; risk is considered to be the semi-standard deviation below the target return. The Sortino ratio therefore tells you how well you are being compensated by a series for each unit of shortfall risk you are incurring.

[7] The Stutzer ratio is a risk-adjusted return measure that is a generalization of the Sharpe ratio, but is unbiased in the presence of skew and kurtosis. It equals the Sharpe ratio for normally distributed return series.

Table 2: Correlation between Managed Futures and Other Asset Classes

	CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	S&P 500 TR	Russell 2000 TR	MSCI EAFE TR	LB Aggregate Bond TR	U.S. 30 Day TBill TR	U.S. Inflation
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	100%	81%	17%	6%	11%	9%	18%	49%
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	81%	100%	4%	-4%	16%	23%	52%	56%
S&P 500 TR	17%	4%	100%	77%	57%	23%	11%	1%
Russell 2000 TR	6%	-4%	77%	100%	45%	16%	2%	7%
MSCI EAFE TR	11%	16%	57%	45%	100%	5%	-2%	-9%
LB Aggregate Bond TR	9%	23%	23%	16%	5%	100%	29%	-15%
U.S. 30 Day TBill TR	18%	52%	11%	2%	-2%	29%	100%	73%
U.S. Inflation	49%	56%	1%	7%	-9%	-15%	73%	100%

Table 3: Return-based Regression Analysis of Managed Futures Returns (January 1980 – August 2004)

With Positive Weight Constraints	S&P 500 TR (%)	Russell 2000 TR (%)	MSCI EAFE TR (%)	LB Aggregate Bond TR (%)	U.S. 30 Day TBill TR (%)	**R Squared (%)**
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	0	0	0	25.9	74.1	**1.5**
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	0	0	0	35.1	64.9	**3.3**
Without Positive Weight Constraints						
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	7.7	-8.1	-7.3	27.9	79.8	**2.6**
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	2.3	-10.7	-8.8	42.6	74.6	**5.8**

Table 4: Federal Reserve Monetary Policy (Interest Rate Environment) and Managed Futures Performance (January 1980 – August 2004)

Contractive Monetary Policy / Rising Interest Rate Environment	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	16.97	18.81	21.80	-0.17	1.73	5.08	0.15	0.66	0.16
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	20.14	22.35	24.29	-0.09	1.60	3.96	0.18	0.76	0.19
S&P 500 TR	6.65	8.19	18.20	-0.03	-0.92	3.64	0.00	0.19	0.00
Russell 2000 TR **(*)**	1.43	4.17	23.62	0.01	-1.20	4.77	-0.05	0.07	NA
MSCI EAFE TR **(**)**	-0.82	0.91	18.96	-0.18	-0.09	0.60	-0.10	0.02	NA
LB Aggregate Bond TR	10.53	10.81	7.93	0.01	0.96	6.69	0.11	0.88	0.11
U.S. 30 Day TBill TR **(**)**	7.90	7.91	1.03	0.90	0.96	0.38	0.00	NA	NA
U.S. Inflation	5.16	5.17	1.25	0.69	0.98	0.73	-0.62	21.50	NA
Expansionary Monetary Policy / Declining Interest Rate Environment	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR	13.52	14.69	16.59	-0.02	0.58	0.97	0.17	0.55	0.18
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR	16.41	17.79	18.68	-0.05	1.79	6.27	0.21	0.78	0.22
S&P 500 TR	16.16	17.45	17.53	-0.01	-0.27	0.82	0.22	0.54	0.21
Russell 2000 TR	17.25	19.18	21.49	0.21	-0.52	1.08	0.20	0.46	0.20
MSCI EAFE TR	16.89	18.47	19.48	0.14	-0.22	0.00	0.21	0.52	0.21
LB Aggregate Bond TR	8.74	8.89	5.73	0.23	-0.03	1.13	0.19	0.93	0.20
U.S. 30 Day TBill TR	5.09	5.09	0.79	0.96	0.58	0.41	0.00	NA	NA
U.S. Inflation	2.90	2.90	0.89	0.37	0.26	1.85	-0.70	3.02	NA

(*) – Indicate the performance difference between rising and declining interest rate environments is statistically significant for 10% significance level.
(**) – Indicate the performance difference between rising and declining interest rate environments is statistically significant for 5% significance level.

Table 5: Federal Reserve Monetary policy (Interest Rate Environment) and **Inflation-Adjusted** Managed Futures Performance (January 1980 – August 2004)

Contractive Monetary Policy / Rising Interest Rate Environment	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR REAL	11.22	12.94	20.54	-0.18	1.63	4.64	0.07	0.42	0.07
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR REAL	14.24	16.32	22.95	-0.10	1.57	4.00	0.11	0.51	0.11
S&P 500 TR REAL **(**)**	1.41	2.91	17.46	-0.02	-0.93	3.42	-0.08	0.07	NA
Russell 2000 TR REAL **(**)**	-3.55	-0.91	22.65	0.02	-1.21	4.62	-0.11	-0.01	NA
MSCI EAFE TR REAL **(**)**	-5.69	-4.01	18.23	-0.17	-0.13	0.59	-0.18	-0.08	NA
LB Aggregate Bond TR REAL	5.10	5.39	7.82	0.06	0.37	4.83	-0.09	0.34	NA
U.S. 30 Day TBill TR REAL	2.60	2.61	0.94	0.35	-0.48	1.02	-1.59	1.94	NA
Expansionary Monetary Policy / Declining Interest Rate Environment	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
CISDM Trading Advisor Qualified Universe Index, Value-Weighted (CTA$) TR REAL	10.33	11.46	16.13	-0.03	0.58	0.97	0.12	0.41	0.12
CISDM Trading Advisor Qualified Universe Index, Equal-Weighted (CTAEQ) TR REAL	13.13	14.46	18.05	-0.06	1.71	5.72	0.16	0.60	0.17
S&P 500 TR REAL	12.89	14.17	17.19	0.00	-0.25	0.69	0.16	0.42	0.16
Russell 2000 TR REAL	13.95	15.85	21.03	0.21	-0.49	0.99	0.16	0.37	0.15
MSCI EAFE TR REAL	13.60	15.16	19.10	0.15	-0.19	0.03	0.16	0.41	0.16
LB Aggregate Bond TR REAL	5.68	5.84	5.72	0.26	-0.10	1.09	0.04	0.52	0.04
U.S. 30 Day TBill TR REAL	2.13	2.14	1.04	0.54	0.00	0.95	-0.81	1.34	NA

(*) – Indicate the performance difference between rising and declining interest rate environments is statistically significant for 10% significance level.
(**) – Indicate the performance difference between rising and declining interest rate environments is statistically significant for 5% significance level.

Figure 1: Historical Mean-Variance Analysis with and without Managed Futures (Resampled)

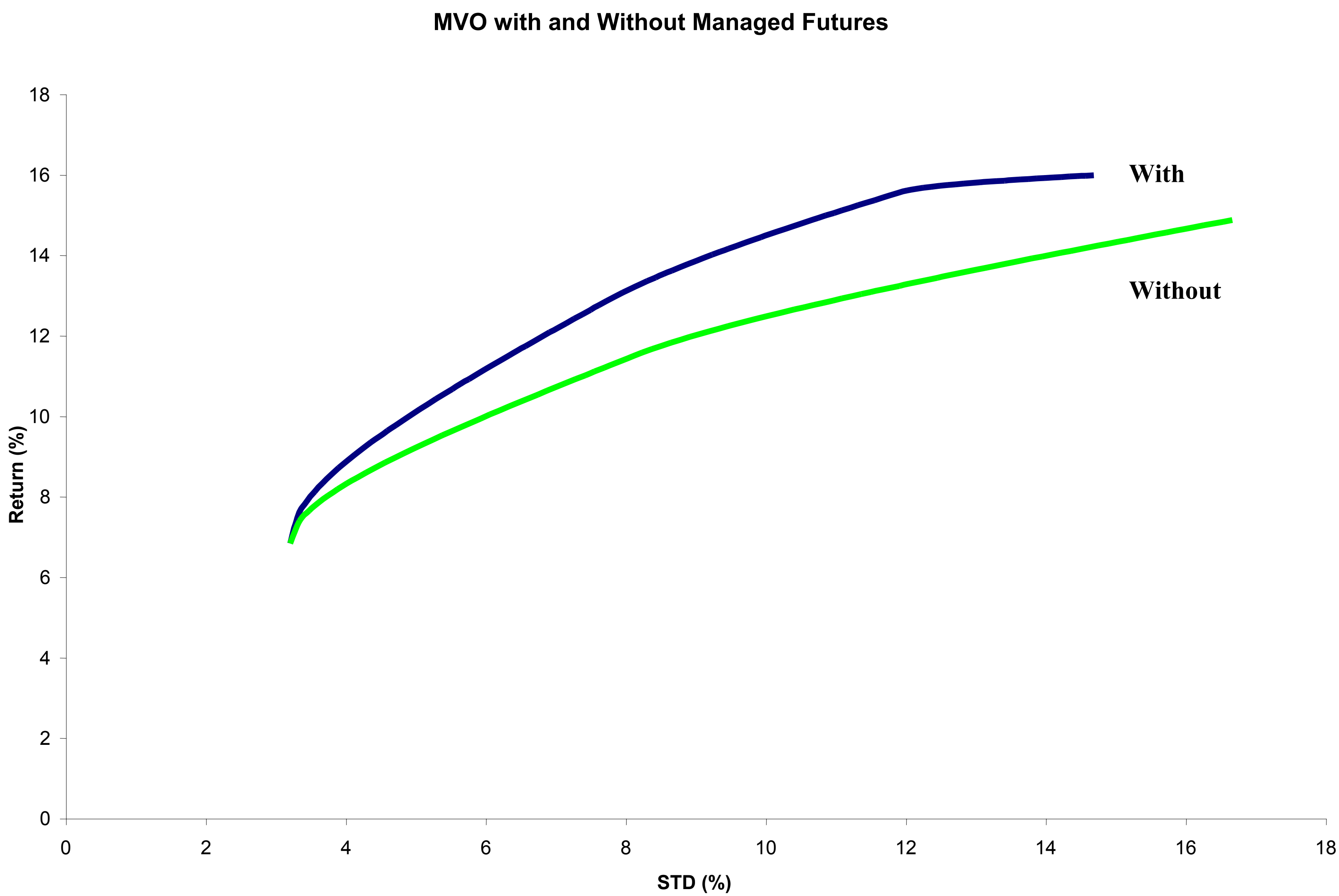

Figure 2.

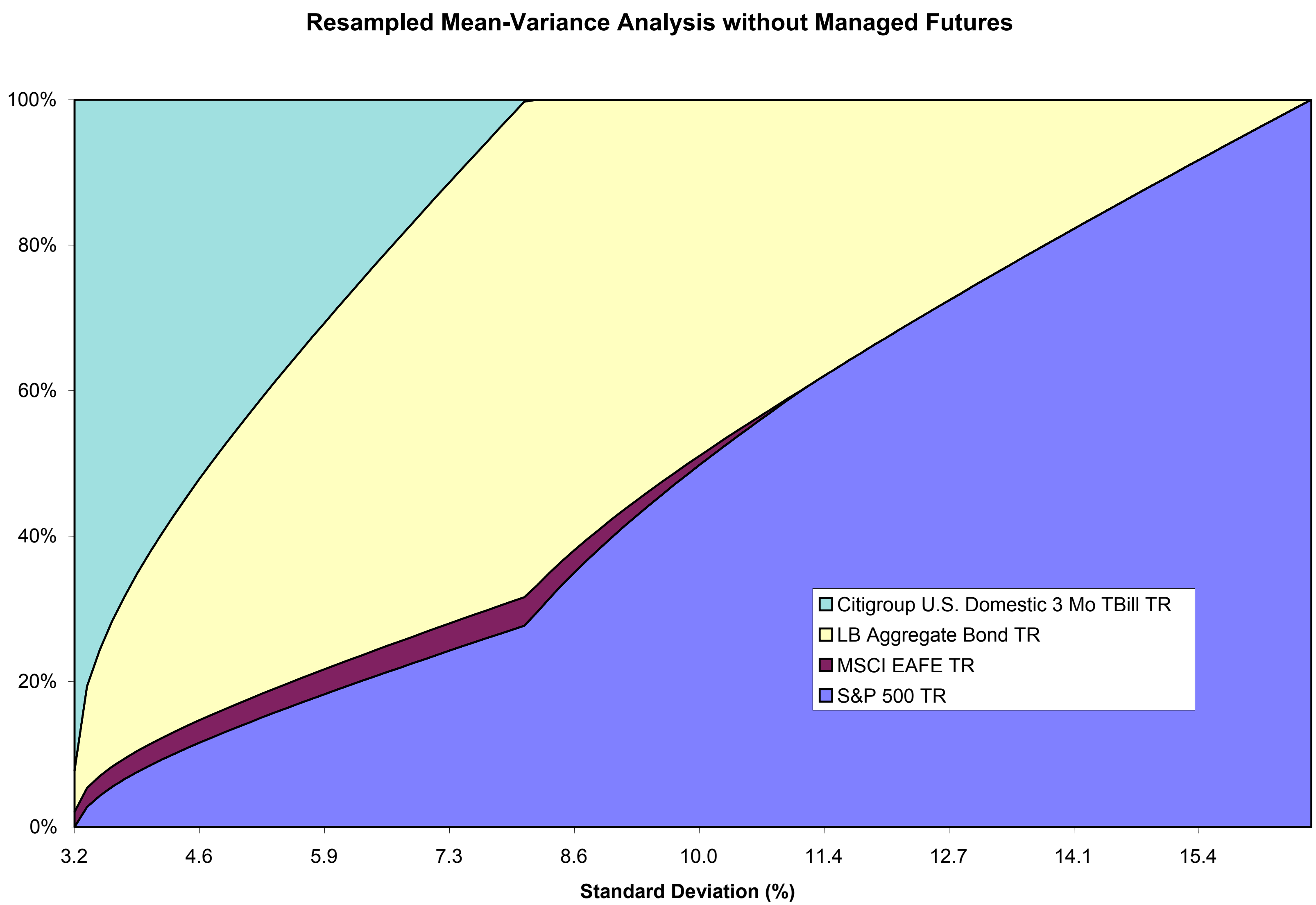
Resampled Mean-Variance Analysis without Managed Futures
100%
80%
60%
40%
20%
0%
3.2
4.6
5.9
7.3
8.6
10.0
11.4
12.7
14.1
15.4
Standard Deviation (%)
Citigroup U.S. Domestic 3 Mo TBill TR
LB Aggregate Bond TR
MSCI EAFE TR
S&P 500 TR

Figure 3.

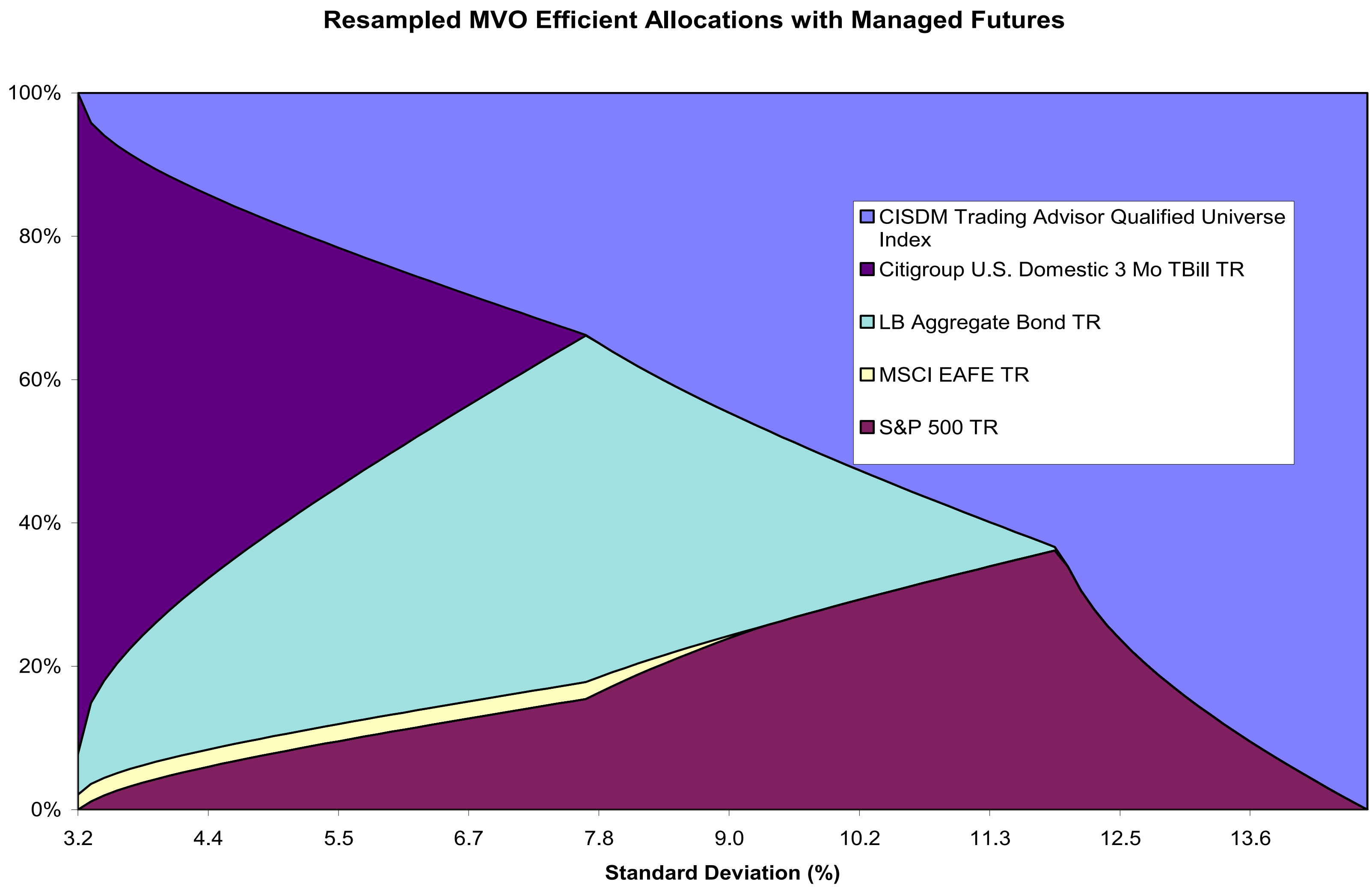
Resampled MVO Efficient Allocations with Managed Futures
100%
80%
60%
40%
20%
0%
3.2
4.4
5.5
6.7
7.8
9.0
10.2
11.3
12.5
13.6
Standard Deviation (%)
CISDM Trading Advisor Qualified Universe Index
Citigroup U.S. Domestic 3 Mo TBill TR
LB Aggregate Bond TR
MSCI EAFE TR
S&P 500 TR

Table 7: Managed Futures and Conservative Model Portfolio Performance (January 1980 – August 2004)

	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
Conservative	9.36	9.48	5.01	0.0975	0.3986	1.5719	0.1974	1.3854	0.1999
Conservative CTA$ 2%	9.47	9.58	4.90	0.1024	0.4438	1.5742	0.2079	1.4770	0.2109
Conservative CTA$ 4%	9.55	9.66	4.79	0.1014	0.4731	1.5053	0.2173	1.5722	0.2214
Conservative CTA$ 6%	9.65	9.76	4.75	0.1015	0.5288	1.5905	0.2257	1.6475	0.2304
Conservative CTA$ 8%	9.74	9.84	4.71	0.0950	0.5728	1.5988	0.2324	1.7199	0.2381
Conservative CTA$ 10%	9.84	9.94	4.74	0.0897	0.6374	1.7672	0.2375	1.7599	0.2441
Conservative CTA$ 12%	9.92	10.02	4.78	0.0782	0.6933	1.8470	0.2407	1.7929	0.2482
Conservative CTA$ 14%	10.02	10.12	4.87	0.0688	0.7590	2.0560	0.2425	1.7934	0.2509
Conservative CTA$ 16%	10.09	10.20	4.98	0.0544	0.8177	2.1671	0.2423	1.7883	0.2514
Conservative CTA$ 18%	10.19	10.31	5.13	0.0432	0.8749	2.3611	0.2412	1.7536	0.2510
Conservative CTA$ 20%	10.27	10.39	5.29	0.0283	0.9268	2.4621	0.2384	1.7163	0.2485
Conservative CTAEQ 2%	9.53	9.64	4.90	0.1027	0.4965	1.6631	0.2114	1.5116	0.2154
Conservative CTAEQ 4%	9.67	9.78	4.81	0.1021	0.5703	1.6705	0.2242	1.6427	0.2300
Conservative CTAEQ 6%	9.83	9.94	4.78	0.1030	0.6571	1.8336	0.2355	1.7471	0.2430
Conservative CTAEQ 8%	9.97	10.08	4.77	0.0969	0.7277	1.8864	0.2447	1.8456	0.2539
Conservative CTAEQ 10%	10.14	10.24	4.83	0.0932	0.8072	2.0970	0.2517	1.8965	0.2628
Conservative CTAEQ 12%	10.27	10.38	4.91	0.0826	0.8797	2.2043	0.2565	1.9412	0.2694
Conservative CTAEQ 14%	10.43	10.54	5.04	0.0757	0.9554	2.4410	0.2592	1.9413	0.2735
Conservative CTAEQ 16%	10.57	10.69	5.20	0.0629	1.0296	2.6011	0.2598	1.9455	0.2755
Conservative CTAEQ 18%	10.72	10.85	5.40	0.0550	1.1002	2.8422	0.2591	1.9152	0.2760
Conservative CTAEQ 20%	10.86	11.00	5.62	0.0424	1.1706	3.0326	0.2569	1.8869	0.2742

Table 8: Managed Futures and Moderate Model Portfolio Performance (January 1980 – August 2004)

	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation (%)	Serial Correlation	Skewness	Kurtosis	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
Moderate	11.46	11.96	10.46	0.0666	-0.6500	2.3679	0.1659	0.5882	0.1623
Moderate CTA$ 2%	11.58	12.05	10.28	0.0678	-0.6237	2.2983	0.1716	0.6094	0.1677
Moderate CTA$ 4%	11.67	12.12	10.11	0.0672	-0.6032	2.2883	0.1767	0.6299	0.1728
Moderate CTA$ 6%	11.79	12.23	9.94	0.0641	-0.5472	2.1603	0.1828	0.6557	0.1790
Moderate CTA$ 8%	11.86	12.29	9.78	0.0637	-0.5081	2.1123	0.1877	0.6780	0.1838
Moderate CTA$ 10%	11.99	12.40	9.69	0.0615	-0.4535	2.0536	0.1931	0.7014	0.1893
Moderate CTA$ 12%	12.07	12.47	9.55	0.0564	-0.3821	1.9621	0.1981	0.7286	0.1946
Moderate CTA$ 14%	12.17	12.57	9.47	0.0543	-0.3087	1.8827	0.2029	0.7538	0.1997
Moderate CTA$ 16%	12.26	12.65	9.40	0.0499	-0.2389	1.8638	0.2069	0.7775	0.2042
Moderate CTA$ 18%	12.38	12.76	9.35	0.0430	-0.1374	1.7674	0.2117	0.8070	0.2095
Moderate CTA$ 20%	12.44	12.82	9.30	0.0389	-0.0510	1.7469	0.2150	0.8320	0.2134
Moderate CTAEQ 2%	11.64	12.11	10.26	0.0664	-0.5953	2.1594	0.1736	0.6167	0.1700
Moderate CTAEQ 4%	11.79	12.25	10.08	0.0645	-0.5472	2.0042	0.1809	0.6449	0.1772
Moderate CTAEQ 6%	11.97	12.41	9.90	0.0600	-0.4662	1.7453	0.1892	0.6792	0.1856
Moderate CTAEQ 8%	12.11	12.53	9.73	0.0583	-0.4036	1.5610	0.1962	0.7105	0.1930
Moderate CTAEQ 10%	12.29	12.71	9.64	0.0547	-0.3261	1.3775	0.2037	0.7437	0.2008
Moderate CTAEQ 12%	12.44	12.84	9.50	0.0483	-0.2369	1.1811	0.2108	0.7815	0.2087
Moderate CTAEQ 14%	12.60	13.00	9.42	0.0452	-0.1468	1.0186	0.2177	0.8175	0.2161
Moderate CTAEQ 16%	12.75	13.14	9.36	0.0396	-0.0602	0.9102	0.2237	0.8530	0.2229
Moderate CTAEQ 18%	12.93	13.31	9.33	0.0319	0.0503	0.7943	0.2302	0.8950	0.2305
Moderate CTAEQ 20%	13.05	13.43	9.29	0.0272	0.1462	0.7444	0.2352	0.9328	0.2366

Table 9: Managed Futures and Aggressive Model Portfolio Performance (January 1980 – August 2004)

	Geome Mean (%)	Arithm Mean (%)	Stand Deviation	Serial Correla	Ske	K	Sharpe Ratio	Sortino Ratio	Stutzer Ratio
Aggressive	12.59	13.69	15.79	0.0770	-0.8354	2.6728	0.1439	0.4145	0.1406
Aggressive CTA$ 2%	12.67	13.75	15.57	0.0781	-0.8262	2.6675	0.1469	0.4239	0.1435
Aggressive CTA$ 4%	12.77	13.82	15.38	0.0781	-0.8149	2.6842	0.1502	0.4339	0.1466
Aggressive CTA$ 6%	12.86	13.88	15.15	0.0764	-0.7892	2.6444	0.1536	0.4454	0.1501
Aggressive CTA$ 8%	12.94	13.93	14.96	0.0768	-0.7681	2.6295	0.1566	0.4555	0.1530
Aggressive CTA$ 10%	13.04	14.00	14.80	0.0760	-0.7443	2.6361	0.1598	0.4661	0.1561
Aggressive CTA$ 12%	13.10	14.02	14.47	0.0738	-0.7020	2.5790	0.1638	0.4825	0.1602
Aggressive CTA$ 14%	13.17	14.06	14.16	0.0703	-0.6551	2.5416	0.1682	0.4999	0.1645
Aggressive CTA$ 16%	13.24	14.09	13.90	0.0688	-0.6114	2.5271	0.1721	0.5162	0.1684
Aggressive CTA$ 18%	13.30	14.11	13.61	0.0653	-0.5492	2.4562	0.1762	0.5351	0.1725
Aggressive CTA$ 20%	13.37	14.15	13.35	0.0603	-0.4819	2.4074	0.1804	0.5550	0.1769
Aggressive CTAEQ 2%	12.73	13.81	15.55	0.0769	-0.8128	2.5779	0.1483	0.4274	0.1448
Aggressive CTAEQ 4%	12.90	13.94	15.34	0.0758	-0.7884	2.5003	0.1530	0.4410	0.1494
Aggressive CTAEQ 6%	13.05	14.06	15.10	0.0730	-0.7509	2.3658	0.1578	0.4562	0.1543
Aggressive CTAEQ 8%	13.19	14.17	14.90	0.0722	-0.7185	2.2530	0.1623	0.4701	0.1588
Aggressive CTAEQ 10%	13.35	14.31	14.73	0.0702	-0.6837	2.1568	0.1670	0.4846	0.1634
Aggressive CTAEQ 12%	13.48	14.38	14.39	0.0669	-0.6306	1.9960	0.1726	0.5055	0.1691
Aggressive CTAEQ 14%	13.62	14.48	14.08	0.0621	-0.5726	1.8501	0.1785	0.5279	0.1751
Aggressive CTAEQ 16%	13.74	14.58	13.81	0.0594	-0.5175	1.7226	0.1841	0.5495	0.1808
Aggressive CTAEQ 18%	13.86	14.66	13.52	0.0548	-0.4461	1.5537	0.1898	0.5742	0.1869
Aggressive CTAEQ 20%	13.99	14.76	13.27	0.0485	-0.3691	1.4067	0.1958	0.6005	0.1931

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