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University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

ASSIGNMENT 3: CTA'S OPTIMAL PORTFOLIO CONSTRUCTION

Course: MSc Finance (Investment & Asset Management

Module: AC6129 Corporate Internship

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Group: 08

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CORK UNIVERSITY BUSINESS SCHOOL

Assignment 3: Optimal Portfolio Construction

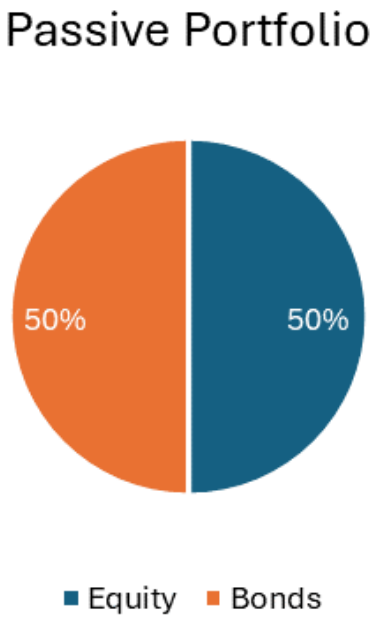

Chart 1: Weights for Passive Portfolio

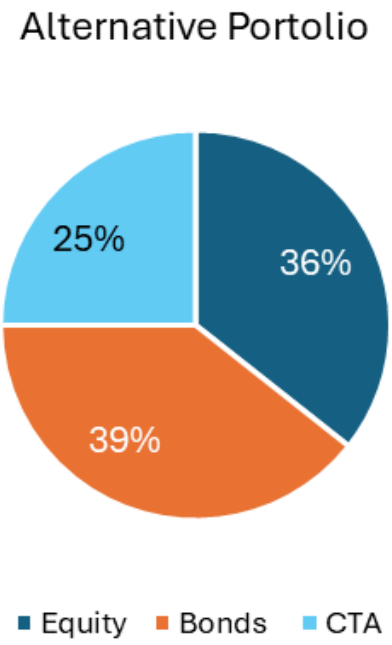

Chart 2: Pie chart for Alternative Portfolio

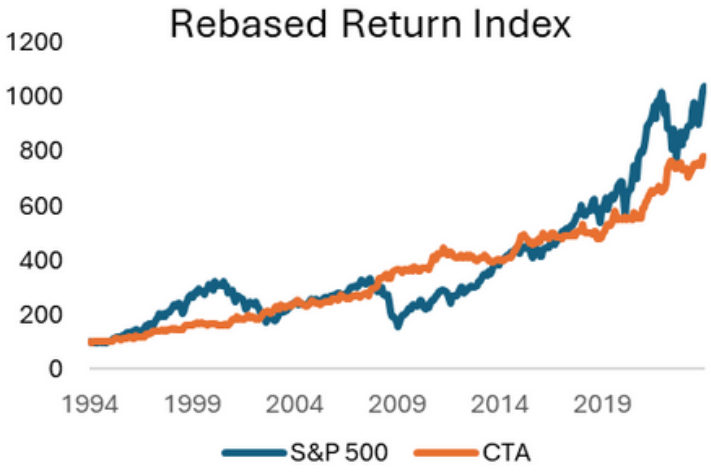

Chart 3: Equity and CTA Historic Performance

Part A: Portfolio Optimisation

Executive Summary: This report explores the formation of an investment fund's portfolio. By following a passive investment strategy allocating a 50/50 split between equities and bonds, the fund is leaving a lot of opportunities on the table. In order to optimize the portfolio, the fund is willing to allocate up to 25% to an alternative investment strategy, CTA's.

CTA Strategy: Commodity trading advisories commonly use a managed futures strategy with a plethora of different trading strategies. CTA's usually count on long-term predictions by taking a long position in markets experiencing upward trends while shorting markets seeing a downturn. CTA's are known to have a negative correlation with traditional asset classes and can be considered as a great way to hedge against the stock market in periods of economic downturn. Due to the trend-following nature of CTA strategies, they tend to perform well in economic downturn as this is when the markets start showing more trends and an increase in volatility. Confirmed by our data (Chart 3), CTA's outperformed the S&P500 only in periods of economic downturn. For example, the 2000's dot-com bubble, the 2008 global financial crises and the series of bad events kicked off by the 2019 pandemic. In the extended periods between such events, CTA returns are relatively flat compared to the benchmark.

Alternative portfolio creation: In order to find the best portfolio allocation, a multitude of strategies was employed using 30 years of data from the hedge fund database CISDM for CTA return, the S&P500 as a benchmark for equity returns, and 10-year US treasuries as bond returns. The alternative portfolio allocated 25% to CTA strategy with the remaining 75% being allocated between equities and bonds. The alternative portfolio is created based on modern portfolio theory and aims to find the portfolio with the highest risk-adjusted returns by maximizing the Sharpe Ratio.

The historical performance of the risk and returns for the alternative portfolio is then compared to the original, passive portfolio to determine the fund's ideal asset class allocation.

Assignment 3: Optimal Portfolio Construction

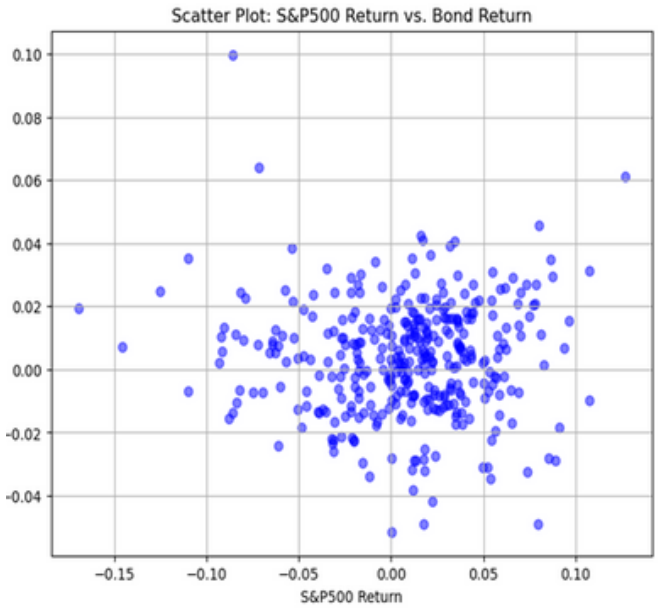

Chart 4: Scatter Plot: S&P Return vs Bond Returns

Assets	Weights	Annual Return	Annual Volatility
S&P 500	0.5	9.39%	15.16%
Bond	0.5	4.41%	6.29%

Table 1: Performance statistics

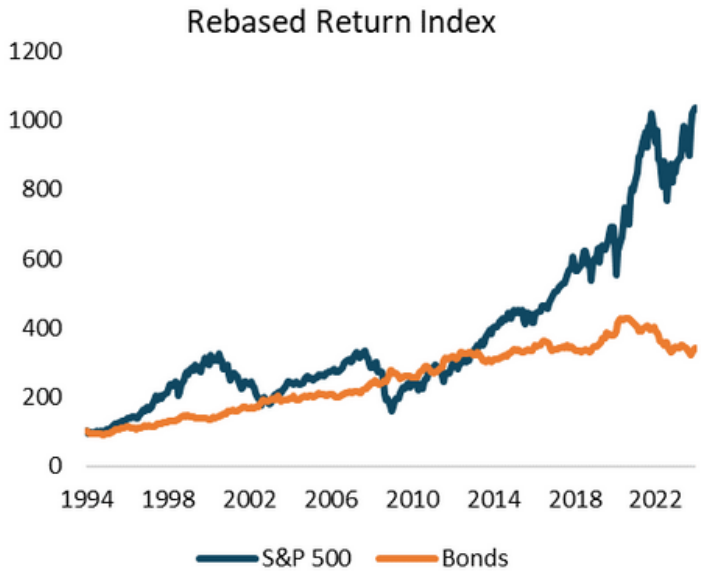

Chart 5: Equity and Bond Historic Performance

Passive Portfolio	
Annual Return	7.13%
Annual Volatility	9.31%
Risk Free Rate	3.84%
Sharpe Ratio	0.354

Table 2: Passive Portfolio Historic performance

Historic performance of Passive Portfolio

Description: The passive portfolio was constructed using two key assets: bonds and equity, each representing 50% of the portfolio's allocation. Examination of monthly returns from the S&P 500 and US Bonds spanning from 1994 to 2023 revealed some notable insights. Chart 4 portrays a scatter plot illustrating the distribution of monthly returns for bonds and the S&P 500 index. Notably, bonds exhibit a concentration of returns within the -4% to 4% range, displaying lower volatility compared to the S&P 500 index, which demonstrates a broader range of returns between -10% and 10%. This observation underscores the higher risk associated with S&P 500 investments.

Historic Performance: Over the 30-year period from 1994 to 2023, the S&P 500 delivered an annualized return of 9.39%, while bonds yielded an annualized return of 4.41%. Furthermore, the standard deviation for equities stood at 15.16%, significantly higher than the 6.29% standard deviation observed for bonds during the same timeframe displaying inherently higher volatility.

Advantages: Despite the S&P 500's impressive performance and higher returns relative to bonds, it comes with heightened risk exposure. Conversely, bonds offer lower returns but entail reduced volatility. The construction of a passive investment portfolio, evenly balanced between the S&P 500 and bonds, resulted in enhanced risk-adjusted returns. This passive portfolio achieved an annual return of 7.13% with an annual volatility of 9.31%, yielding a Sharpe ratio of 0.354. While the passive portfolio's returns surpass those of a bond only portfolio, it falls short of outperforming an equity only portfolio. Therefore, the passive portfolio substantially mitigates risk exposure compared to equity investments alone.

Summary: The inclusion of both bonds and equities in a passive portfolio empower the generation of superior risk-adjusted returns compared to either asset class individually. However, there remains potential for optimization by introducing a third asset, as explored in the alternative portfolio.

Assignment 3: Optimal Portfolio Construction

Assets	Weights	Annual Return	Annual Volatility
S&P 500	0.356	9.39%	15.16%
Bond	0.394	4.41%	6.29%
CTA	0.250	7.48%	8.29%

Table 3: Performance statistics

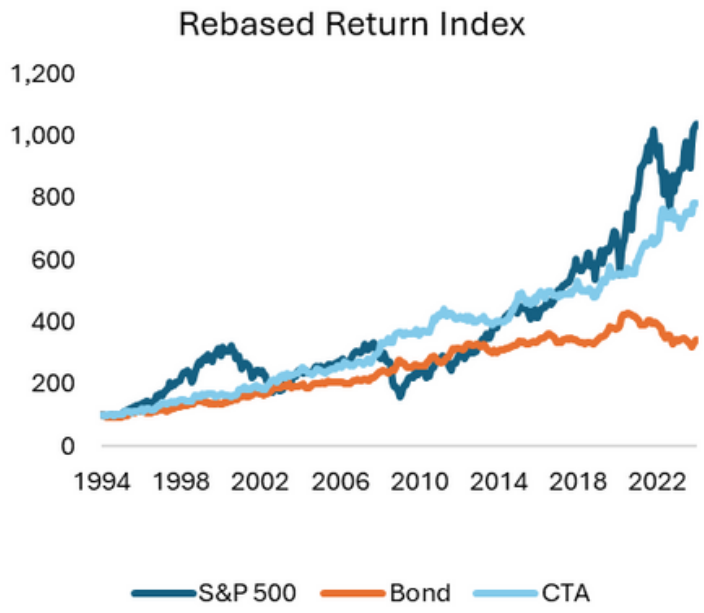

Chart 6: Historic Performance

Alternative Portfolio	
Annual Return	6.95%
Annual Volatility	6.29%
Risk Free Rate	3.84%
Sharpe Ratio	0.495

Table 4: Passive Portfolio Historic performance

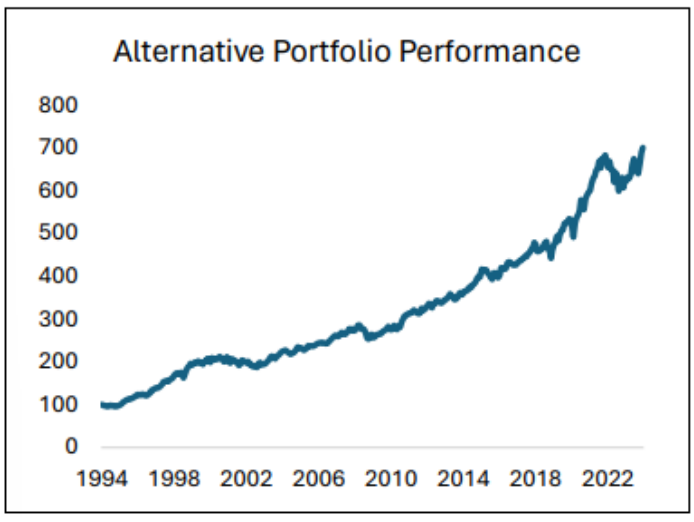

Chart 7: Historic performance of Alternative Portfolio

Historic Performance of Alternative Portfolio

Description: The alternative investment portfolio examined in this comprehensive analysis includes three primary assets: Equity, Bonds, and Commodity Trading Advisor (CTA). Each asset class undergoes meticulous evaluation based on essential performance metrics such as Holding Period Return, Annual Return, as well as key risk indicators including Standard Deviation and Sharpe Ratio. The portfolio allocation is strategically distributed with Equity representing 35.6% Bonds comprising 39.4%, and CTA accounting for 25% of the total allocation.

Historic Performance: In terms of annualized performance, Equity emerges as the top performer, boasting an Average Annual Return of 8.40%. Bonds, recognized for stability, offer a more conservative Average Annual Return of 4.41%. CTA falls in the intermediate with an Average Annual Return of 7.35%

Turning to risk assessment, Equity exhibits the highest volatility, reflected in its Standard Deviation of 15.16%, indicating greater price fluctuations. Conversely, Bonds provide stability, registering the lowest Standard Deviation at 6.29%, thereby presenting a lower-risk alternative. CTA occupies an intermediary position with a Standard Deviation of 8.29%. The overall volatility of the portfolio over the 30-year period stands at 6.29%.

When evaluating risk-adjusted returns, the Sharpe Ratio assumes significance. Despite its higher volatility, Equity maintains a Sharpe Ratio of 0.366, indicating a favorable riskadjusted return. CTA also demonstrates competitive riskadjusted returns with a Sharpe Ratio of 0.439. In contrast, Bonds lag significantly behind with a Sharpe Ratio of 0.091. The portfolio's Sharpe Ratio stands at 0.495, signaling optimal risk-adjusted returns.

Advantages: Moreover, the alternative portfolio outperforms the passive portfolio in terms of generating better riskadjusted returns. The Sharpe ratio for the passive portfolio is 0.354, whereas the Sharpe ratio for the alternative portfolio is 0.495, representing a 40% increase in risk-adjusted returns achieved simply by adding an asset to the portfolio.

Assignment 3: Optimal Portfolio Construction

Portfolio	Annual Return	Annual Volatility	Sharpe Ratio
Passive	7.13%	9.31%	0.354
Alternative	6.95%	6.29%	0.495

Table 5: Passive vs Alternative portfolio

Alternative portfolio	
Bounds	Weights between 0 to 1 CTA weights cannot exceed 0.25
Constraints	$\sum_i Wi=1$

Table 6: Bounds and Constraints

Alternative Portfolio Performance	
Initial investment	10,000,000
Start Date	01/01/1994
End Date	31/12/2023
Term	30 years

Portfolio	Portfolio Value at End	HPR
Passive	69,032,409	590%
Alternative	70,049,171	600%

Table 7: Historic Performance

Optimal Portfolio Construction

Optimal Portfolio Construction: In order to determine the optimal asset weights for the portfolio, initial weights of 0.33 were assigned to each asset class. Subsequently, monthly returns were utilized to construct a covariance matrix, which was then annualized by multiplying it by the square root of 12. The expected returns of the portfolio were computed using the sum product of asset returns and weights, while the expected standard deviation of the portfolio was calculated using the formula for the standard deviation of a three-asset portfolio.

Utilising a Python optimizer, the asset weights were optimized to maximize the Sharpe ratio, with the aim of minimizing the negative Sharpe ratio. A risk-free rate of 3.84% was considered in this analysis. Constraints were applied to ensure that the weights of assets remained nonnegative and summed up to 1. Additionally, an extra constraint was implemented to ensure that the weights assigned to CTA did not exceed 0.25.

Summary: While Equity and CTA's have been the primary drivers of portfolio growth, one must weigh these higher returns against the associated risks. Bonds offer stability but at the expense of lower returns. A balanced approach, considering risk tolerance and return objectives is essential for constructing an optimal investment portfolio.

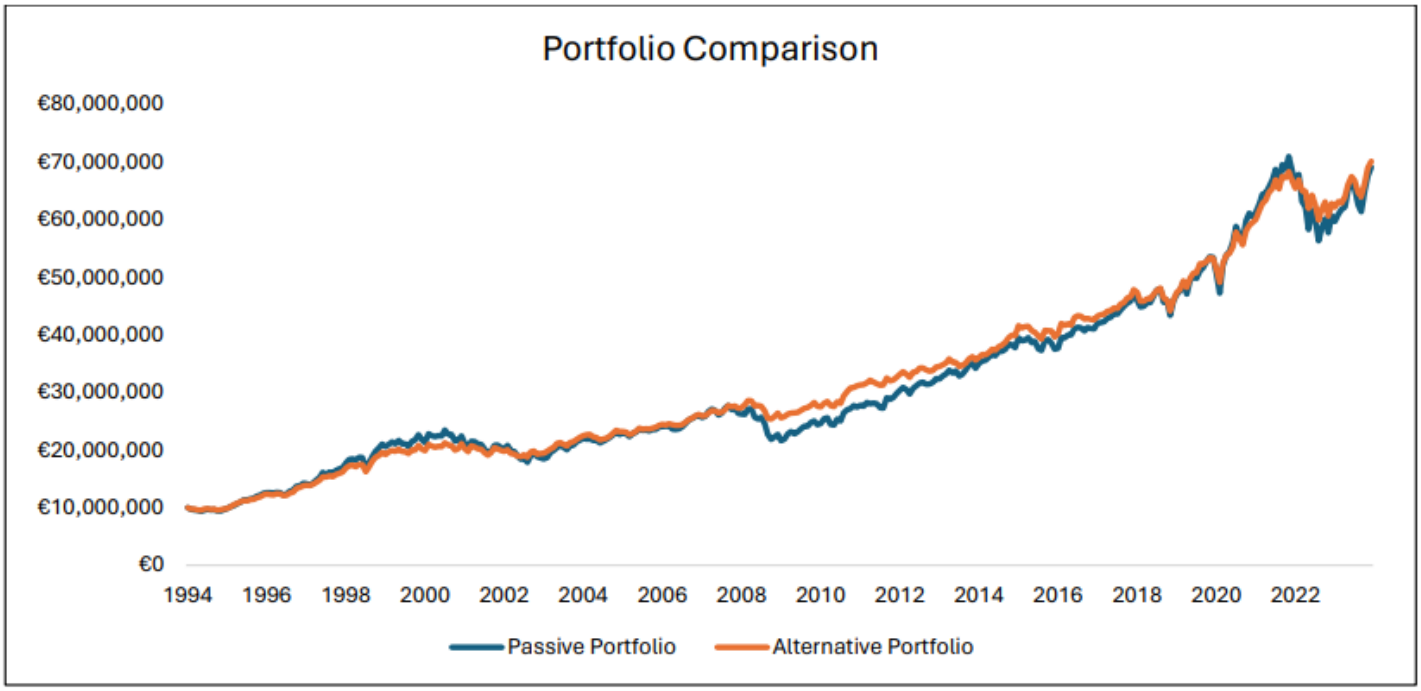

Chart 8: Passive vs Alternative portfolio comparison

Assignment 3: Optimal Portfolio Construction

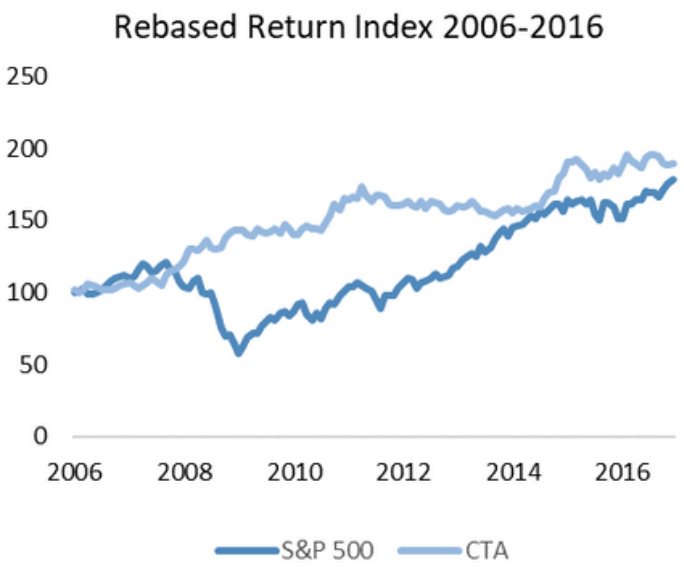

Chart 9: Equity vs CTA's performance (2006-2016)

Date	S&P500	CTA's
Oct-07	-4.40%	3.38%
Dec-07	-6.16%	2.04%
May-08	-8.60%	2.11%
Aug-08	-9.08%	-0.61%
Sep-08	-16.94%	0.28%
Oct-08	-7.49%	5.79%

Table 8: Returns of S&P 500 and CTA's during 2008 financial crisis

Effects of including the asset in the portfolio, historic and future

Including CTA's as an additional asset in the portfolio can have profound benefits, especially in terms of risk reduction, diversification benefits and the potential alterations in the return profiles Analysing the historic performance returns provided a framework to predict the impact of future performance.

Capitalising on Market Trends: During the financial crisis, there were significant swings in the market trends on both the downside (2007-2008) and the upside from (2009 onwards). Trend-following CTA's capitalised on these movements by tactically taking positions that corresponded with the market's movement, consequently generating positive returns in declining markets. (Chart 9)

CTA's characteristics can be observed in October 2007, when the S&P500 dropped -4.4%, meanwhile CTA's generated a positive return of 3.38%. Consequently, the S&P500 experienced several extremely negative months in 2008 during the financial crisis, as shown in (Table 8). Over this same timeframe CTA's performed significantly better under these market conditions than traditional equities, as seen by most months producing positive returns. The S&P500 declined about 57% from its peak to its low point over the period from late 2007 to mid-2009.

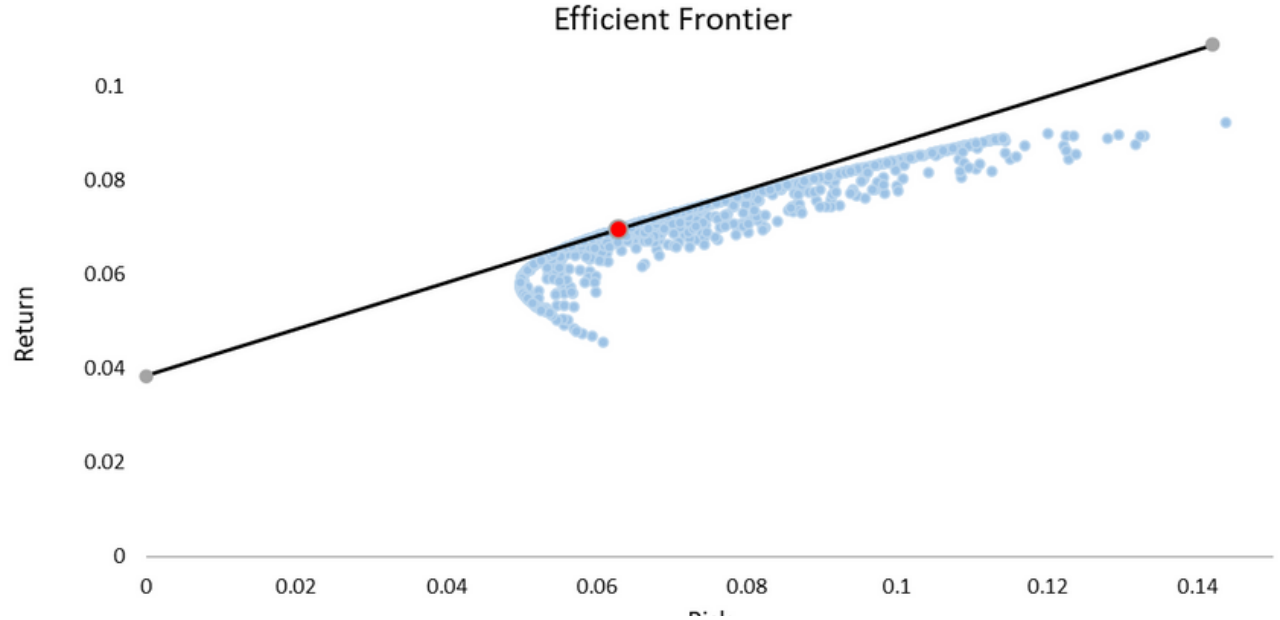

Chart 10: Efficient Frontier and the Capital Allocation Line

Assignment 3: Optimal Portfolio Construction

Liquidity: CTA's trade in extremely liquid futures markets which allow them to adjust positions rapidly in response to dynamically changing market conditions. During the financial crisis, this increased liquidity gave CTA's was an immense edge when liquidity speedily dried up in the majority of the financial markets.

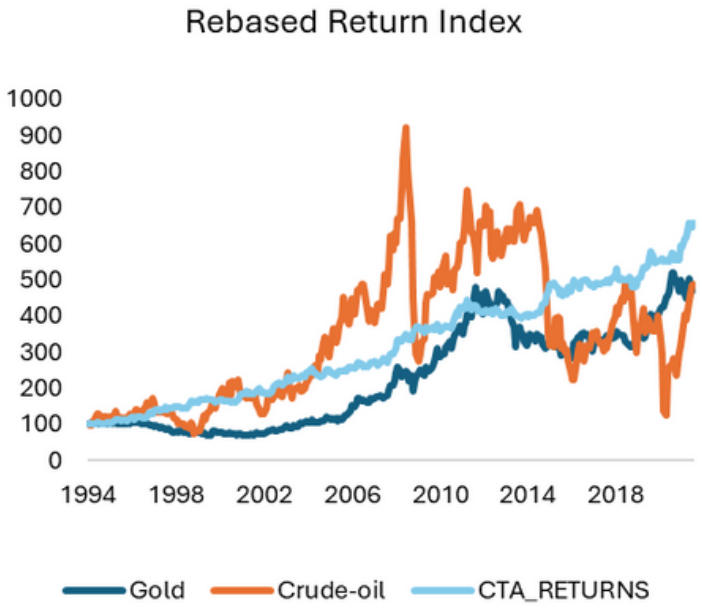

Chart 9: Historic Returns of Alternative Assets

Feature	Value
R-Square	0.070
Adj. R-Square	0.064
Significance F	0.000

Variables	Coeff	P-Value
Gold	0.136	0.000
VIX	-0.004	0.523

Table 9: Regression

Regression: The CTA returns were regressed against the change in factors including Gold, Inflation, Crude Oil and the VIX Index. After conducting multiple regression analysis, the most significant results were found in respect to changes in Gold prices. The regression revealed an R-Squared figure of 0.07007, indicating that the model explained approximately 7% of the total variance of the CTA returns. The adjusted R- Squared figure of 0.06438 implies that in the future how the returns of both assets will be correlated. This regression for Gold was significant at the 99% confidence level. The Coefficient figure of 0.1355 implies a positive relationship between both assets and, ceterius paribus, for every 1% increase in Gold prices, CTA's returns will increase 0.136%.

Effects of including the asset in the portfolio, historic and future

Capitalising on Market Trends: The benefits of CTA's are most clearly identifiable over this period as they were able to generate substantial positive returns due to their unique ability to invest in assets that are inversely correlated with equities and the shorting of equity markets. However, it must be noted that past performance cannot be taken as a guarantee of favorable future performance, especially in a bear market cycle. Investors in CTA's must be aware of the potential of highly variable results, assess their investment risk tolerance and must evaluate their investment goals before employing CTA's in their portfolio strategy. A downside of CTA's that must be factored in when making investment decisions is the fees associated with CTA's. Due to their implementation of intricate strategies and active management they usually command higher fees than traditional investments, which may adversely affect the net returns to investors.

Diversification: CTA's offer unique diversification benefits as their performance is not strictly tied to Bonds or Equities. The various strategies enacted with less correlation with traditional asset categories can lead to an enhancement of the overall portfolio in terms of diversification.

During the financial crisis and times of worsening market conditions, CTA's indulged in strategies that could go both long and short thereby creating a source of uncorrelated returns. This unique instrument assisted investors to diversify some risk away and reduced the impact of enhanced volatility on their overall portfolio.

The tradeoff that must be deciphered for an individual investor is that you will never win as big as you could have by holding a portfolio of 100% of equities, but you will benefit from increased protection by including CTA's, to achieve a more steady, moderate return that may be the ideal scenario for a risk averse investor who seeks to maintain their wealth, not specifically increase wealth dramatically. CTA's may not appeal to a young, ambitious investor seeking the highest returns possible for this reason.

Assignment 3: Optimal Portfolio Construction

Conclusion

This report emcompasses the differences between investment returns in a passive portfolio (50% Equities and 50% Bonds and the returns that can be generated from an alternative strategy, with a maximum allocation of 25% to CTA‘s over the period from 1994-2023. The driving force behind this report is to display the emphasis on the allocation to CTA‘s as a means of capitalising on the missed opportunities of the passive portfoio. CTA‘s diversification is a benefit in bearish markets and provides a hedge against traditional asset classes proven by their negative correlation to these assets. The report encapsulates the need to minimize the standard deviation of returns to provide a balanced portfolio to generate returns without engaging in excessive risk taking.

PART B: Academic Papers Summary

Paper:

Richard B Spurgin. (1999).
A Benchmark for Commodity Trading Advisor Performance. Journal of Alternative Investments.

Summary:

This article introduces a passive index designed to serve as a benchmark for evaluating the performance of commodity trading advisors (CTAs), particularly those utilizing diversified trend-following strategies across various derivatives markets. Diversified CTAs are involved in trading commodities, currencies, interest rates, and equity derivatives. The index mimics the performance of trend-followers by implementing a momentum trading strategy, incorporating hypothetical long and short positions in commodity, currency, and fixed income futures contracts. The study reveals that the passive index exhibits a high correlation with the average CTA's return, indicating its usefulness in performance measurement, attribution, and the construction of multi-manager CTA portfolios.

Paper:

Greg N. Gregorious., Georges., Nicolas Papageorgiou., Fabrice Rouah.(2005). Survival of commodity trading advisors: 1990–2003. Journal of Future Markets

Summary:

The article extends the examination of Commodity Trading Advisors (CTAs) beyond the scope of previous studies, focusing on the period from 1990 to 2003. Employing various statistical techniques, the research conducts a comprehensive survival analysis across different CTA classifications. In contrast to prior findings, this study reveals a divergence in the median lifetime of CTAs, underscoring the substantial influence of the fund's strategy on survivorship. Notably, the results highlight a significant positive size effect on survival, suggesting that larger CTAs tend to endure for a longer duration. Furthermore, the study indicates that poor returns, and to a lesser extent, high-risk exposure, contribute to a hastened demise of CTAs.

Paper:

Commodity Trading Advisors' leverage and reported margin-to-equity ratios Fernando diz, The Journal of Futures Markets, Vol. 23, No. 10, 1003–1017 (2003) © 2003 Wiley Periodicals.

Summary:

The academic paper emphasizes the complex relationship between leverage, risk management, and performance among commodity trading advisors (CTAs). While leverage has the potential to enhance returns, the paper finds that excessive leverage may increase the risk of significant losses, undermining overall performance. Effective risk management strategies, such as diversification and position sizing, are crucial for CTAs to navigate market volatility and preserve capital. Additionally, the analysis of the margin-to-equity ratio suggests that finding a balance between leverage and risk management is essential for achieving sustainable and consistent performance in commodity futures markets.

PART B: Academic Papers Summary

Paper:

Erdős, P., Li, Y., Liu, R. and Mende, A. (2021). Same same but different – Stylized facts of CTA sub strategies. International Review of Financial Analysis, 74, p.101657. doi:https://doi.org/10.1016/j.irfa.2021.101657.

Summary:

This paper investigates the distributional properties of CTA strategies. These included analyses of trend-following, fundamental and contrarian strategies. They analyse 89 Commodity Trading Advisors (CTA's) on a dataset of daily returns. They uncovered characteristics of volatility clustering, fat-tail behaviour and long memory in volatility. They highlighted the fact of analysing daily data instead of monthly data to avoid potential misleading insights for users. They used models like Markov-switching multifactor model, GARCH and EGARCH to assess these features and give a synopsis of the stylised facts of the returns of CTA's and what this means for investors. The contribution of this paper lies in the practical insights it provides for investment strategy and portfolio formulation.

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Paper:

Efficient Use of Commodity Futures in Diversified Portfolios GERALD R. JENSEN* ROBERT R. JOHNSON JEFFREY M. MERCER The Journal of Futures Markets, Vol. 20, No. 5, 489–506 (2000) Q 2000 by John Wiley & Sons

Summary:

The academic paper explores the integration of commodity futures into diversified portfolios to enhance risk-adjusted returns and diversification benefits. It analyzes the risk-return characteristics of commodity futures compared to traditional assets and discusses various portfolio allocation strategies. Empirical analysis supports the conclusion that incorporating commodity futures can improve portfolio performance and diversification. These futures exhibit low correlation with traditional assets, offering valuable diversification opportunities, and serve as effective hedges against inflation and economic uncertainty. Overall, the paper advocates for the strategic inclusion of commodity futures in well-diversified investment strategies.

Paper:

The performance of commodity trading advisors: A mean-variance-ratio test approach

Summary:

The paper compares the Mean-Variance-Ratio (MVR) test and Sharpe Ratio (SR) test for commodity trading advisor (CTA) performance analysis. While the SR test often finds no significant differences, the MVR test detects outperforming funds and short-term performance changes, offering valuable insights for investors. Literature highlights the MVR test's superiority in small sample analysis. Hypothesis testing demonstrates the MVR test's ability to detect significant performance variations among CTAs. Future research may explore utility theory integration and distribution assumptions relaxation. Overall, the MVR test provides superior insights into CTA performance, facilitating more informed investment decisions, despite potential drawbacks in small samples.

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PART B: Academic Papers Summary

Paper:

Commodity trading advisors and their role in managed futures

Summary:

The conclusions drawn from the comparison between systematic and discretionary traders offer valuable insights for constructing a diversified portfolio of CTAs. Despite systematic traders dominating the managed futures industry, there's a compelling case for including discretionary advisors, especially in sectors like agriculture, currency, and finance. Systematic traders remain important in the allocation mix, serving as core CTAs in diversified categories and in sectors such as stock indices, interest rates, and finance or foreign exchange. While the analysis provides valuable information, it's just one of many factors considered in decision-making. Asset allocators must carefully examine both quantitative and qualitative factors before hiring advisors. Nonetheless, the performance statistics between systematic and discretionary CTAs are highly useful when combined with traditional measurements of advisor results, aiding in better decision-making processes.

Paper:

Simple and Cross Efficiency of CTAs Using Data Envelopment Analysis

Summary:

The research assesses Commodity Trading Advisors (CTAs) using Data Envelopment Analysis (DEA), evaluating both simple and cross efficiency. DEA analyzes various financial metrics as inputs and outputs to determine efficiency, revealing significant variability in CTA performance. By identifying key determinants of efficiency, such as trading volume and risk-adjusted returns, the study offers practical insights for investors navigating alternative asset classes. Through its contribution to understanding CTA efficiency and performance drivers, the research enhances investment decision-making processes.

Paper:

Benefits and limitations of diversification among commodity trading advisors

Summary:

The article explores the advantages and drawbacks of diversification among Commodity Trading Advisors (CTAs). It highlights diversification's potential benefits in mitigating risk and enhancing portfolio performance by combining CTAs with uncorrelated strategies. However, it cautions against over-diversification, which may dilute returns and increase complexity. The study underscores the importance of thorough due diligence when selecting CTAs and emphasizes the need for investors to carefully balance the benefits and limitations of diversification in their portfolios. Overall, it offers valuable insights into optimizing CTA allocations to achieve desired risk-return profiles while navigating diversification challenges.

PART B: Academic Papers Summary

Paper:

Jorion, P. and Schwarz, C., 2014. Are hedge fund managers systematically misreporting? Or not?. Journal of Financial Economics, 111(2), pp.311-327.

Summary:

The paper investigates occurrence of gaps in hedge fund return distributions, focusing on a kink at zero. They noted this kink may result from the involuntary effects of incentive fees on net returns rather than fund managers purposefully misreporting. They conducted empirical studies of examinations and simulations of hedge funds with and also without the incentive fees. Combined with equity mutual funds, their study shows how the incentive fees create a kink at zero in net returns distributions. They also investigated whether asset liquidity and bounding yields at zero were potential explanations. They concluded that the discontinuities in hedge fund returns don't automatically infer manipulation. This can be explained by factors inherent in hedge fund fee's and properties of their assets.

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Paper:

Li CaiChris (Cheng)., JiangMarat Molyboga. (2017). The Moral Hazard Problem in Hedge Funds: A Study of Commodity Trading Advisors. Journal of Portfolio Management, 43(2)77-89.

Summary:

The article delves into the moral hazard problem arising from the asymmetric nature of performance-based compensation in hedge funds, wherein investors bear the negative consequences of managers' risk choices. The authors systematically examine the relationship between risk shifting by hedge fund managers, their chosen investment strategy, and survivorship concerns. Through an analysis of gross fund returns spanning the period from 1994 to 2014, the authors uncover that the inclination for risk increases following poor performance is weaker when managerial survivorship concerns are strong and more pronounced when concerns are weak. Notably, risk shifting tends to be less prevalent when managers opt for algorithms over discretion in their investment strategy. To quantify the economic impact of risk shifting, the authors introduce a novel model that suggests fund managers generate an additional 0.25% per annum in fees, consequently exerting a negative influence on investors' risk-adjusted returns.

PART B: Academic Papers Summary

Paper:

Nicolas P.B Bollen.,Mark C. Hutchinson., John O'Brien. (2021). When it pays to follow the crowd: Strategy conformity and CTA performance. Journal of Future Markets

Summary:

Contrary to previous findings in hedge funds and mutual funds, recent research on commodity trading advisors (CTAs) has uncovered a positive relationship between performance and returns that exhibit a stronger correlation with those of peers. Specifically within the realm of CTAs, adherence to strategy conformity, particularly in aligning with a time series momentum factor, is linked to higher performance, indicative of managerial skill. This suggests that a shared trend-following strategy significantly influences CTA returns, providing investors with an opportunity to engage in momentum-based investments. The results underscore a unique dynamic in the relationship between strategy distinctiveness and performance within CTAs, diverging from the patterns observed in hedge funds and mutual funds.

PART B: Academic Papers Summary

Reviewing the 12 ABS approved journal articles provided a comprehensive insight into Commodity Trading Advisors (CTA's). The journals highlighted CTA's risk management strategies, performance metrics and their position within diversified portfolios. Overall, the journals showcased the advantages of incorporating CTA's for their enhanced diversification benefits by applying approaches of momentum and trend-following. Some CTA's that followed the crowd proved to be a beneficial strategy to generate returns. The research also touched on performance analysis methods such as the sharpe ratio and mean variance ratio to access the performance of CTA managers, noting CTA's often command high fees for their expertise in alternative investments. One journal investigated the potential for moral hazard in the context of misreporting returns for higher performance-based compensation.

Papers contrasted systematic and discretionary trading strategies within the managed futures domain paying particular attention to the risk management procedures and diversification inherent in their approaches. The use of leverage required a detailed understanding to balance suitable risk levels with higher leverage for greater returns.

Collectively, all papers appreciate CTA's unique value in an investment portfolio in terms of risk reduction, diversification and their ability to perform well in both bull and bear markets. However, challenges in selecting the right CTA for a portfolio must be noted. CTA's are a stellar low correlation, alternative investment to enhance a portfolio, especially beneficial in times of market uncertainty.