Quantifying CTA Risk Management

Kathryn Kaminski, PhD, CAIA

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The Risks of Managed Futures

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- *Managed Futures are speculative and can be leveraged.*
- *Past results are not indicative of the future performance, and performance of managed futures can be volatile.*
- *You could lose all or a substantial amount of your investment.*
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EXECUTIVE SUMMARY

Risk management is often cited as a key to success for CTA strategies. Despite this claim, the process and tools for validating this statement have remained somewhat elusive for CTA investors. This paper uses a simple factor-based framework to quantify CTA risk management. Mirroring the approach in Greyserman and Kaminski (2014), a baseline equal dollar risk strategy and four risk management factors based on liquidity, correlation, volatility and capacity are constructed. The factors measure the impact of shifting risk allocation among markets in response to a particular aspect of risk management (liquidity, correlation, volatility, and capacity).

Liquidity	• Measures the effect of allocating relatively more risk to liquid markets.
Correlation	• Measures the effect of incorporating inter-market correlation into risk allocation.
Volatility	• Measures the effect of determining position sizes based on slower measurement of volatility.
Capacity	• Measures the effect of re-allocating risk based on capacity constraints.

From 2001 to 2015, the liquidity and correlation factor returns have been positive on average. The correlation factor returns have been relatively positive post 2008 and the liquidity factor post 2011. This suggests that risk management approaches that allocate to more liquid markets and incorporate correlation into portfolio construction have recently outperformed an equal risk approach. Since 2001, the capacity factor has experienced negative returns with a realized Sharpe ratio of -0.30. Despite the overall negative performance, there are periods where a capacity constrained portfolio outperforms the equal risk strategy (or benchmark). This indicates that although capacity constraints may have the potential to reduce performance over longer time periods, adjusting risk in response to capacity constraints may also increase variation in performance relative to a benchmark.

To examine the explanatory power of this approach, the risk management factors are applied to the Newedge Trend Index from March 2001 to May 2015. The index has significant positive exposure to three of the four risk management factors, especially correlation and capacity. For the correlation factor, this is consistent with CTA managers shifting risk in response to correlation across asset classes. For the capacity factor, this is consistent with CTA managers shifting risk in response to capacity constraints based on position limits. The risk management factors are then applied to a set of Managed Futures 40 Act mutual funds with daily returns from January 2014 to May 2015. In this sample set, many individual CTAs also hold significant loadings to the correlation and capacity risk management factors. The analysis in this paper demonstrates that risk management decisions may help quantify both aggregate and individual CTA performance.

INTRODUCTION

Risk management is often cited as a key to success for CTA strategies. Despite this claim, the process and tools for validating this statement have remained somewhat elusive for CTA investors. Investors are often given descriptive statements and must base their decisions on qualitative analysis. This paper uses a simple framework to quantify CTA risk management. The multi-factor model incorporates key aspects of portfolio construction including liquidity considerations, correlation, volatility adjustment, and capacity constraints.

Factor based return analysis is a commonly used technique for performance evaluation. The use of factors to understand return drivers and portfolio construction has a long history in the equity space. Only recently, Greyserman and Kaminski (2014) apply a multi-factor model to examine CTA style factors focusing on three construction styles based on market size, equity bias, and trading speed.[1] Expanding upon their work, this paper develops a modified framework for factor construction which focuses on risk management. The key difference is that each risk management factor focuses primarily on how risk is allocated in a portfolio, not on how momentum signals are constructed.

To provide background, the paper first reviews portfolio construction. This process demonstrates how varying risk allocation can be used to construct risk management factors based on liquidity, correlation, volatility, and capacity. To investigate the impact of risk management factors in aggregate, the Newedge Trend Index is examined for exposure to risk management factors. In a simple analysis, several risk management factors demonstrate significant exposure in the Newedge Trend Index. A similar analysis is then applied to a set of daily Managed Futures 40 Act Mutual Fund strategies. The analysis in this paper suggests that risk management decisions may help to explain CTA performance relative to a baseline (or benchmark).

FUTURES PORTFOLIO CONSTRUCTION

Futures portfolios are built by taking positions (or exposures) in futures contracts across an array of markets. As a result, futures portfolios are defined by the size of a long or short position (or exposure) in each market. One simple way to determine the position size for each market is the following equation:

$$Position\ size\ =\ portfolio\ scaling\ factor\ *\ \frac{market\ conviction * market\ risk\ allocation}{volatility\ of\ market} \qquad (1)$$

Market conviction defines the direction (long or short) and the level of confidence for each market. The market risk allocation is the amount of risk allocated to a particular market. Given the conviction and the risk allocation, each position (in number of contracts) is set by the amount of volatility in each particular market (from eq. (1) volatility of market). For example, if corn is not very volatile and oil is very volatile, the position in oil will be smaller, all other things equal. Each position in a futures portfolio allocates a

[1] Baltas and Kosowski (2013) and Fung and Hsieh (2004) consider factor based analysis of CTA returns. Baltas and Kosowski(2013) examine capacity and are unable to demonstrate statistical significant capacity considerations in the CTA space. Their analysis uses predictive flow regressions and they perform a simple constraint based only on open interest. This paper examines exchange, order, and risk limits. Fung and Hsieh (2001) use lookback straddle options to replicate trend following.

certain amount of risk. At the total portfolio level, the portfolio scaling factor scales positions up or down to achieve a total risk target for the entire portfolio.[2]

For many CTAs, portfolio construction can be simplified into a three-step process: valuation/model conviction, risk adjustment and measurement, and risk allocation (see Figure 1). For trend following portfolios, valuation and model conviction are determined by quantitative models. This is often determined by moving average or channel breakout models. The magnitude is often called the trend strength and the sign determines a short or long trend position.[3] Once the model conviction is determined, in stage two, the position sizes are set based on the volatility of each market.[4] Finally, in stage three, risk is allocated across markets. If no additional considerations are added in stage three, the portfolio equally allocates risk. In practice, there may be other considerations which can shift risk away from equal allocation. For example, considerations such as liquidity, trading costs, inter-market correlations, position and risk limits, capacity considerations and other portfolio constraints may also be relevant. Adding these considerations can incorporate risk management aspects that move portfolio risk away from equal risk allocation.

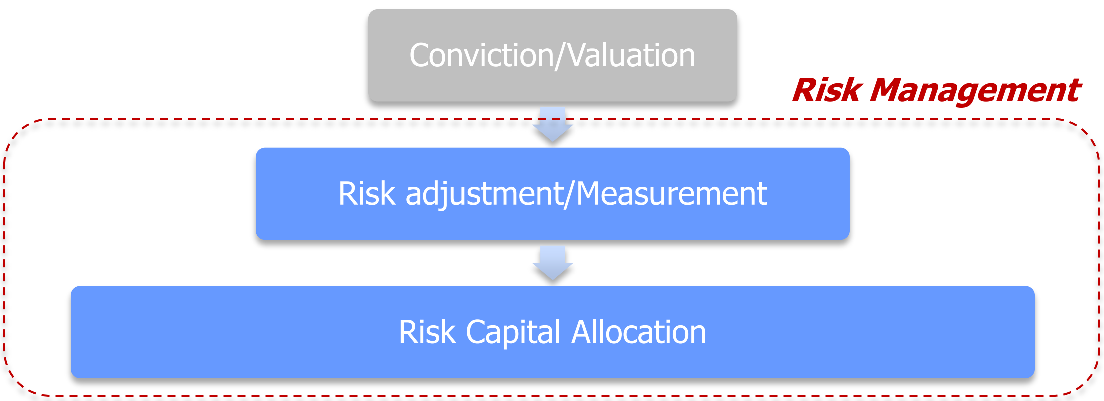

Figure 1: A simple schematic for portfolio construction in futures trading portfolios

If the portfolio construction process is simplified into these three stages, stage one is model conviction, while stages two and three represent risk management. Once stage one is separated from risk management and held constant, risk management decisions can be isolated to create risk management-based factors.[5] This paper will examine four factors which focus on liquidity, correlation, volatility, and capacity.

[2] For example, if the portfolio has 5% risk but the portfolio target is 4%, the scaling factor will bring all futures positions down to 80 percent of their original size to achieve 4% risk.

[3] The models determine the trend strength and sign of the trend for each market. There are many approaches for constructing trend strength. A common approach is to aggregate momentum signals across many different time horizons and parameters to create an aggregate measure of trend strength for each market. For more detail on trend following portfolio construction see Chapter 3 of Greyserman and Kaminski (2014)

[4] Risk (or volatility) can be measured in many different ways including past price volatility, trading ranges, or other measures. The measurement can be slow or fast depending on the horizon used and technique for measuring the volatility of a market.

[5] By assuming risk management and signal generation are separable, this allows for a clean construction of factors. Despite this assumption, it is important to acknowledge that in many cases risk management and signal construction are not separable. Signals do allocate risk and the choice of signal will still impact factors and loadings to factors in certain situations.

DEFINING CTA RISK MANAGEMENT FACTORS

Similar to the Fama French (1993) three factor model, a multi-factor model for returns can be defined by determining a baseline strategy and corresponding style factors. Similar to Greyserman and Kaminski (2014), the baseline strategy used here is a trend following strategy which allocates equal dollar risk to all included markets (82 markets are used including equity indices, currencies, commodities, and fixed income). The baseline strategy is diversified across different time horizons (short term, medium term, and long term) based on simple moving average momentum signals.[6] The baseline strategy is simulated with $5 billion in capital traded with a 4% monthly risk target. Consistent with actual traded portfolios, limits on positions/orders based on liquidity, risk, and exchange requirements are imposed on all portfolios.[7] These limits cut position sizes and risk must be re-allocated to hit monthly risk allocation targets. Once the baseline strategy is determined, risk management factors can be constructed by adjusting one particular aspect of risk management. The corresponding risk management factors are described in Figure 2. All factor returns represent the difference between the modified strategy and the baseline strategy.

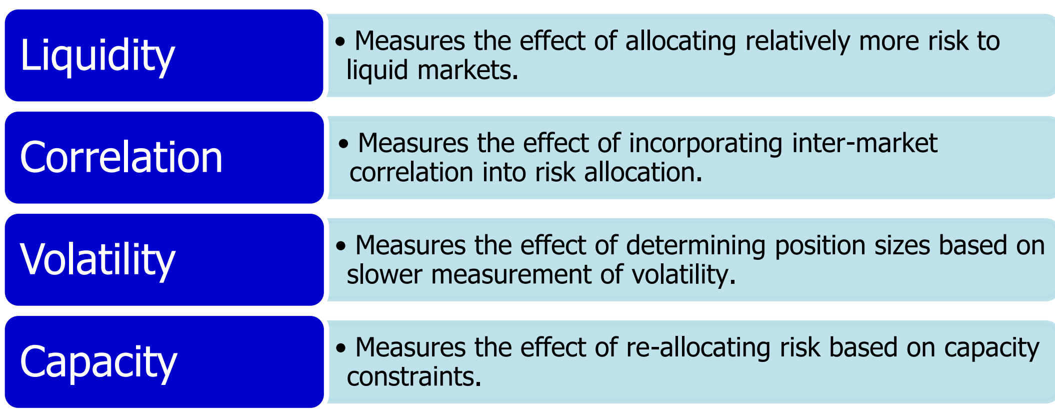

Figure 2: Risk management factors

The ***liquidity factor*** measures the effect of allocating relatively more risk to highly liquid markets. Liquidity is defined by the volume and volatility for each market. From equation (1), for the baseline trend following strategy, equal dollar risk means that each market gets equal risk allocation. For the liquidity factor, the risk allocation across markets will tilt more risk towards the more liquid markets. When the liquidity factor returns are positive, this means that a portfolio that allocates more risk to more liquid markets outperforms the equal dollar risk portfolio.

The ***correlation factor*** measures the effect of incorporating correlation into risk allocation. The allocation is determined by ranking markets based on their "correlation contribution" for each market. When a market is highly correlated with many other markets and that market is not in an offsetting position, less risk will be allocated to it. When the correlation factor returns are positive, this means that a portfolio that incorporates correlation in risk allocation outperforms the equal dollar risk portfolio. The baseline strategy (equal dollar risk) does not consider correlation when it allocates risk across markets.

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6 Moving average signals for fast (1 month), medium (3 months), and slow (12 months) speeds are aggregated to measure the trend strength. The results in this paper are robust to the choice of baseline signal set. Trailing stop signals (as per Greyserman and Kaminski 2014) and variations of moving average models were compared to verify the robustness of the results.

7 Risk adjustment is based on quarterly measurements. Exchange limits are dictated by the exchange. Position (order) limits are based on not exceeding 7.5% historical median volume per contract and risk limits are based on a 3% VaR limit at the 95% level.

The ***volatility factor*** measures the effect of reacting more slowly to changes in market volatility through the "volatility of market" in equation (1). The baseline strategy measures market volatility in equation (1) using a three month lookback. The volatility factor represents the difference between the baseline and an alternate specification that measures volatility with a longer (six month) lookback. A positive return for this factor means that over that time period, the portfolio with the slower volatility adjustment outperforms the baseline.

The ***capacity factor*** measures the effect of re-allocating risk based on capacity constraints. The factor compares the performance of a portfolio that trades at $20 billion in capital with the baseline strategy that trades at 5 billion in capital. The same volatility target, limits and constraints are applied to each of the $5 billion and $20 billion strategies, except some of these limits are more binding for a larger portfolio.[8] In response to these limits, a larger portfolio will re-allocate risk to other positions to reach the total risk target. When the capacity factor returns are positive, this means that the portfolio that re-allocated risk due to capacity constraints outperforms the equal dollar risk portfolio.

For each factor, the impact of each aspect of risk management can be measured across the set of included markets (82 markets across equities, currencies, fixed income, and commodities). Table 1 plots the performance statistics for the baseline strategy (benchmark) and four risk management factors (liquidity, correlation, volatility, capacity). Since 2001, the liquidity and correlation factor returns have been positive on average while the volatility and capacity factors returns have been negative on average. The capacity factor has the most negative realized Sharpe ratio during this period. This suggests that re-allocation of risk due to capacity constraints underperformed the baseline strategy by 0.94 percent per year on average from 2001 to 2015. For a longer term view of the factors, Figure 3 plots the cumulative return for each of the risk management factors from 2001 to 2015. The correlation factor became more positive although somewhat volatile post 2008. This suggests that adjusting risk for correlation would have improved portfolio performance post 2008. The liquidity factor was positive prior to 2005 and it became positive again post 2011. The capacity factor is negative for the entire time period with a large drawdown in 2005-2006. There seem to be certain periods where the capacity constrained portfolio either underperforms or outperforms the baseline strategy (trading at $5 billion). This suggests that exposure to capacity constraints can cause performance to deviate from the baseline strategy.

Table 1: Performance statistics for the baseline trend following strategy (equal dollar risk) and four risk management factors (liquidity, correlation, volatility, capacity) from Jan 2001 to May 2015. Daily data is used and statistics are annualized for this table. Source: Campbell

Risk Management Factors	Mean (%)	Median (%)	Standard Deviation (%)	Sharpe	Skew	Max Drawdown (%)
baseline	10.33	13.01	13.10	0.74	-0.39	27.58
liquidity	0.23	0.18	1.11	0.19	0.12	6.88
correlation	0.23	-0.15	1.45	0.16	0.26	4.85
volatility	-0.08	-0.18	0.94	-0.06	0.40	6.22
capacity	-0.94	-1.01	2.85	-0.30	0.06	26.38

[8] The liquidity factor directly allocates risk based on liquidity per market consistently over time. The capacity factor applies limits to different notional capital amounts based on risk, position, and exchange limits. The correlation between these factors is 0.31.

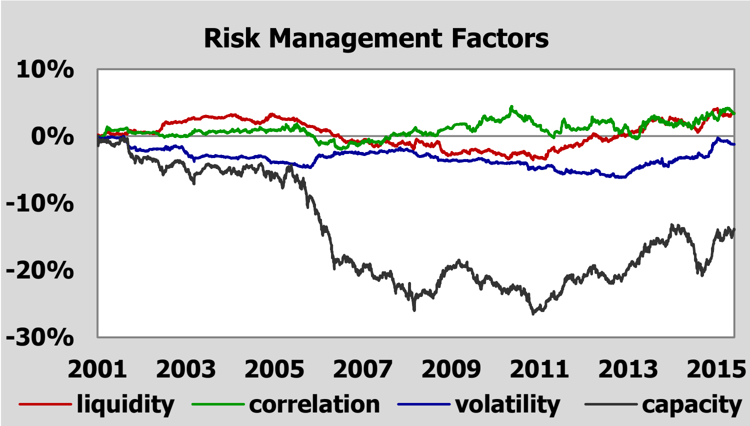
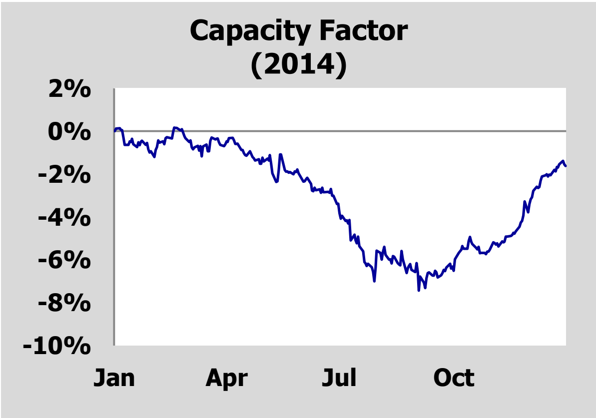


Figure 3: Cumulative factor performance (liquidity, correlation, volatility, capacity) from January 2001 to May 2015. Source: Campbell

For a specific example, Figure 4 plots the cumulative capacity factor returns in 2014. The capacity factor had strong negative performance followed by strong positive performance. For a closer look across markets, Figure 5 plots the capacity factor by sector. From this figure, the capacity factor's negative return was driven by underperformance in the commodity sector with later outperformance in currencies and fixed income. The underperformance in commodities could have been the result of under-allocation to trends in commodities. The outperformance may be due to over-allocation in risk to currencies and fixed income during a year where trends were relatively strong.[9] Figure 4 and Figure 5 demonstrate how risk allocation due to capacity constraints can be both positive and negative over shorter time intervals. If capacity constraints are relevant for a portfolio, it is possible that this could cause either under or outperformance relative to the baseline strategy or benchmark.



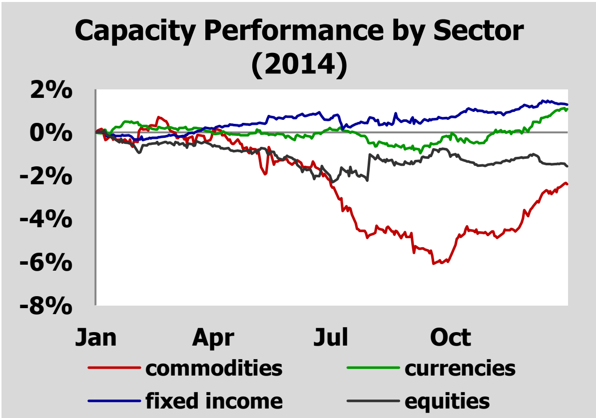


Figure 4: Cumulative performance for the capacity factor in 2014. Source: Campbell

Figure 5: Cumulative performance for capacity by sector (commodity, currency, fixed income, equity) in 2014. Source: Campbell

[9] For a capacity constrained portfolio to hit a realized risk target, the capacity constrained portfolio must target slightly higher risk. For example this means that the capacity constrained portfolio will tend to have more risk in less capacity constrained markets while realizing the same total risk. In this case, currency and fixed income markets trended strongly late 2014, an over allocation (in relative terms) may have improved performance.

QUANTIFYING RISK MANAGEMENT

The previous section examined several potentially relevant aspects of risk management to construct four risk management factors. The next step is to examine how these factors may be incorporated into real CTA portfolios. To examine the aggregate effect of risk management in the CTA industry, the Newedge Trend index is evaluated for its exposure to risk management factors. This index is a set of 10 managers whose predominant trading strategy is trend following.

Using daily data, Figure 6 plots the factor exposures for Newedge Trend Index from March 2001 to May 2015. Newedge Trend Index maintains significant positive loadings (betas) to three of the four risk management factors. This suggests that in aggregate CTA managers in this index allocate more risk to liquid markets, incorporate global correlation effects into their risk allocation, and shift risk in their portfolios in response to capacity constraints. For this sample, the correlation and capacity factor loadings (betas) are highly positive and significant with an adjusted t-statistic of 13.53 and 9.92 respectively. The volatility factor is the least significant factor loading (beta) with an adjusted t-statistic below 2.

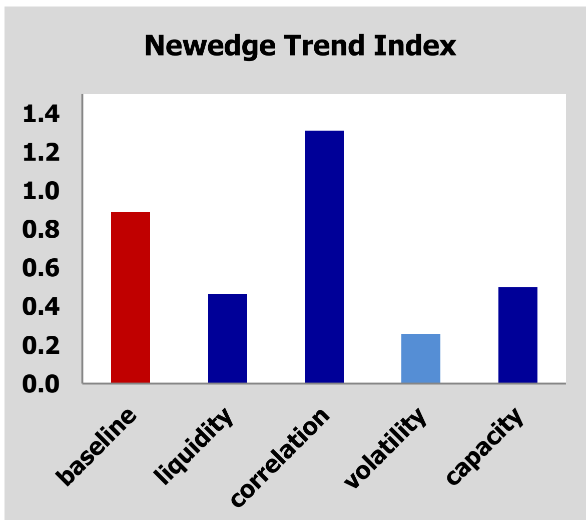


Figure 6: Factor loadings (betas, daily) for Newedge Trend Index to each risk management factor from March 2001 to May 2015. For each factor a two-factor model is estimated with the baseline and each individual factor. Source: Campbell, Newedge

	Liquidity	Correlation	Volatility	Capacity
beta	0.465	1.310	0.259	0.499
tstat	4.92	19.13	2.32	14.03
tstat (adj)	3.48	13.53	1.64	9.92

Table 2: Factor loading estimates (betas, daily), their t-statistics and adjusted t-statistics for Newedge Trend Index to each risk management factor from March 2001 to May 2015. For each factor a two-factor model is estimated with the baseline and each individual factor. Regressions are applied to two day smoothed returns to adjust for the effects of asynchronous global markets. The adjusted t-statistic is the original divided by the square root of 2. Source: Campbell, Newedge

INDIVIDUAL CTA MANAGERS

Since the analysis of the aggregate group of CTA managers demonstrated significant exposure to risk management factors, the next step would be to analyze individual CTA manager data. Unfortunately, daily data are not available for the underlying constituents in the Newedge Trend Index. However, daily performance data can be obtained from Bloomberg for a universe of Managed futures 40 Act mutual funds from January 2014 to May 2015. This universe of funds is filtered down to those with at least a 50% correlation with the baseline trend strategy and at least one year of daily data. This resulted in a set of 28 daily data series. Using the same methodology as the analysis of Newedge Trend Index, these time series are regressed with the baseline and each of the four factors (liquidity, correlation, volatility, and capacity). Figure 7 plots the factor exposures for all managers. For those factor exposures with t-statistics of 2 or greater, their factor exposures are filled in red. The Newedge Trend Index is indicated in orange. During this time period, the Newedge Trend Index has a positive loading on correlation and capacity and a close to zero loading for liquidity and volatility. Consistent with the Newedge Index, there are many managers which seem to have both positive and significant loadings to both correlation and capacity. Even in this short time period, risk management decisions seem to explain individual CTA manager performance. This suggests that CTA risk management factors may be a potentially interesting area for further research for applications in manager assessment and performance evaluation.

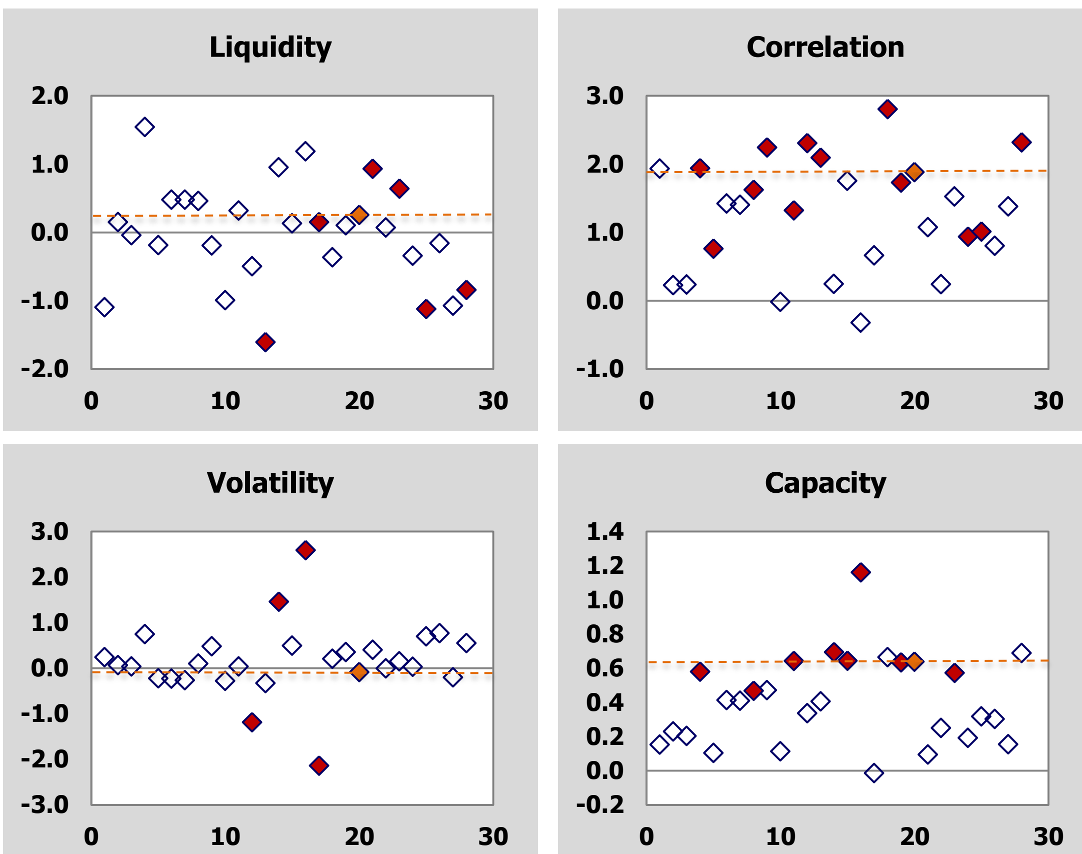


Figure 7: Risk management factor coefficients (betas) for a set of Managed Futures 40 Act mutual fund managers from January 2014 to May 2015. The manager return series are regressed on the baseline trend following strategy (equal dollar risk) and each of the four risk management factors (liquidity, correlation, volatility, and capacity) to estimate coefficients (betas). Coefficients with t-statistics greater than 2 are filled in and labeled in red. For reference Newedge Trend Index is labeled in orange. Source: Campbell, Bloomberg

CONCLUSIONS AND FURTHER CONSIDERATIONS

CTAs often cite risk management as a key to their success. Despite this claim, the process for evaluating CTA risk management has remained somewhat qualitative. This paper attempts to quantify CTA risk management by defining four risk management factors (liquidity, correlation, volatility, and capacity). These risk management factors are examined and subsequently applied to a popular CTA index (Newedge Trend Index) and individual daily return series for Managed Futures 40 Act mutual fund strategies. Many of the CTA returns exhibit positive and significant exposure to the liquidity, correlation, and capacity factors. This suggests that CTA strategies may be shifting risk in response to liquidity, correlation, and capacity relative to the baseline (or benchmark). The analysis in this paper demonstrates that risk management decisions can help quantify CTA performance.

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ABOUT THE AUTHOR

Kathryn Kaminski, PhD, CAIA, currently holds the position of Director, Investment Strategies at Campbell & Company. She recently co-authored the book "Trend Following with Managed Futures: The Search for Crisis Alpha" published by Wiley Trading in 2014. She has extensive experience in hedge funds, asset management, and academia. She has been a senior lecturer at MIT Sloan, affiliated faculty at SSE, and visiting professor at the Swedish Royal Institute of Technology (KTH). Dr. Kaminski's work has been published in a range of industry publications as well as academic journals. She holds a BS in Electrical Engineering from MIT (2001) and a PhD in Operations Research from MIT Sloan (2007). She also holds the CAIA designation as a 100 Women in Hedge Funds PAAMCO CAIA Scholar and she serves on the CAIA Curriculum Committee focusing on Hedge Funds and Managed Futures. In 2015, the Hedge Fund Journal featured Kathryn as one of the top 50 leading women in hedge funds.

For more information please contact:

Richard Johnson
Managing Director, Global Head of Institutional Sales
410.413.2659
richard.johnson@campbell.com

Susan Roberts
Director, Product Specialist
410.413.2616
susan.roberts@campbell.com

Andy Schneider
Vice President, Institutional Marketing
410.413.2672
andy.schneider@campbell.com

Marielle Sexton
Asst. Vice President, Institutional Marketing
410.413.2696
marielle.sexton@campbell.com

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