Alternative Investment Analyst Review™

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Editors' Letter

The Global Financial Crisis has focused renewed attention on risk measurement and risk management. Much of this attention has been directed towards tail risk. This issue of the *Alternative Investment Analysts Review* provides our readers with a selection of papers focused on tail risk and methods of measuring and managing tail risk.

The first paper, "Risk Parity for the Long Run," addresses one tail risk mitigating investment strategy that has garnered significant interest since the initial drawdowns of the global financial crisis – risk parity. Partridge and Croce provide an overview of risk parity and the financial theory underlying the strategy. They also provide an analysis of the performance of an ex-ante risk parity strategy and compare the strategy to a maximum Sharpe ratio portfolio.

In the second section, Altan Pazarbasi provides a review of literature on tail risk.

"Long-Term Investors, Tail Risk Hedging, and the Role of Global Macro in Insituitional Portfolios" was authored by CAIA member Andrew Rozanov. The paper discusses the growing interest in tail risk and the cost associated with tail risk hedging strategies. Rozanov focuses on global macro as an alternative to many costly tail risk strategies and argues that global macro may provide the best of both worlds – tail risk mitigation in bad times without the drag that most tail risk hedging programs provide in good times.

"A Comparison of Tail Risk Protection Strategies in the U.S. Market" provides an analysis of a wide variety of tail risk management strategies. The authors assess the effectiveness of each strategy based on the likelihood that the strategy provides the desired protection as well as the performance drag associated with the strategy. Ultimately, the authors find that the ideal strategy choice will depend on a particular investor's asset allocation preferences.

Authors Sebastian and Karacsony focus on tail risk management through low volatility equity investment and managed futures and global macro investments. While low volatility equity strategies have gained significant attention in recent years, the authors find evidence that questions their appropriateness as a solution for tail risk management. In contrast, the authors argue that managed futures and global macro provide significant tail risk control without over burdening an investor's portfolio.

Tail risk management is not just a hot catch phrase. It is an increasingly important topic for investment managers and analysts. It is particularly relevant to CAIA members and others involved with alternative investments as some of these strategies may expose investors to significant tail risk (e.g., merger arbitrage and convertible arbitrage). While much of the traditional investment world is caught up in a mean-variance framework (which tends to underestimate the magnitude of tail risk), those involved with alternative investments tend to have a better understanding and appreciation of the importance of non-normality and the left-tails of return distributions. Furthermore, as outlined in the research featured in this issue of AIAR, some alternative investment strategies inherently provide tail risk mitigation when added to a traditional portfolio (e.g., managed futures and global macro strategy). We hope that you find this issue informative, and we encourage your feedback and submissions. We hope that the New Year brings you good fortune both personally and professionally.

Sincerely,
Hossein Kazemi and Edward Szado
Editors, AIAR

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ABSTRACT: Financial theory suggests that a risk parity portfolio will be identical to the maximum Sharpe ratio portfolio if all assets have identical Sharpe ratios and equal cross-correlations with one another. This article shows that the first of these conditions may be true, but that the second is most likely not. While this implies that the risk parity portfolio will be slightly different from the maximum Sharpe ratio portfolio, the authors find that this difference was relatively minor in practice, even when considering an implementable Ex-Ante Risk Parity strategy.

No naïve strategy—Ex-Ante Risk Parity included—can rival the performance of portfolios formed with full knowledge of what assets will outperform in the near future. Over the long run, however, because the economic environment is continually in flux, risk parity presents itself as a potential strategy with which to approximate the optimal static portfolio because it provides equal risk exposure to assets that typically perform well in different economic environments.

ABSTRACT: This article provides a brief literature review of the evolution of tail risk measures, as well as research on tail dependency and documents a number of academic studies that assess tail risk and tail dependency of hedge fund returns.

ABSTRACT: This paper focuses on two related topics: The tension between the fundamental premise of long-term investing and the post-crisis pressure to mitigate tail risks; and new approaches to asset allocation and the potential role of global macro strategies in institutional portfolios.

The author argues that the current environment bodes extremely well for the future of hedge funds in general and global macro strategies in particular. If institutional investors begin to think less in terms of asset classes and more

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in terms of risk factors and risk premia, then the age-old distinction between "traditional" and "alternative" investments will increasingly become obsolete. More and more investors who perhaps have shunned hedge funds or were not allowed to invest in them, may well seek out those providers who can construct better growth engines for their portfolios, irrespective of where the underlying components may be sourced. In this context, global macro funds have the added advantage of being in a very small class of strategies that can offer investors "long volatility" and "long convexity" exposure in times of market dislocation and distress. This becomes even more compelling when one compares and contrasts them to dedicated tail-risk hedge funds.

ABSTRACT: Tail-risk protection strategies are those that hedge against loss when the equity markets experience a significant drawdown. This article surveys the historical performance of various tail-risk protection strategies. The analysis targets a specific level of drawdown protection and compares the allocation needed from each hedging strategy. It then analyzes the cost and the consistency of tail-risk protection strategies. It identifies a number of tail risk strategies that perform well along these measures.

ABSTRACT: High market volatility has driven the development of investment strategies advertised to deliver reduced risk without reduced return. The "low-volatility" equity anomaly (low-volatility stocks may have similar or greater returns than high-volatility stocks) is best exploited by investors as part of the toolkit of a broader active strategy. "Tail risk" strategies can provide protection in extreme market events, but their persistent negative carry (ongoing cost) make them unappealing to most investors (e.g., purchasing out-of-money puts). Managed futures and global macro hedge fund strategies have desirable downside risk protection characteristics combined with positive returns and alpha for their investors. Investors can increase their downside protection by allocating part of their hedge fund or opportunistic asset category to managed futures and global macro strategies

Call for Articles

Article submissions for future issues of *Alternative Investment Analyst Review* are actively invited. Articles should be approximately 15 pages, single spaced, and cover a topic of interest to CAIA members. Please **download the submission form** and include it with your article in an email to **AIAR@CAIA.org**.

Chosen pieces will be featured in future issues of AIAR, archived on **CAIA.org**, and promoted throughout the CAIA community.

What a CAIA Member Should Know

Risk Parity for the Long Run:

Building Portfolios Designed to Perform Across Economic Environments

Lee Partridge, CFA, CAIA
Chief Investment Officer, Salient Partners
Roberto Croce, Ph.D.
Director of Quantitative Research for the Investments Group, Salient Partners

1. Introduction

This document extends our earlier study[1] which provides a comparison of ex ante risk parity allocations with the ex post optimal portfolio[2]. Our prior work showed that when the investment opportunity set consists of two assets—stocks and bonds—ex ante risk parity performs on par with the optimal allocation, despite being allocated using less information. This finding has profound implications for asset allocation because it implies that risk parity may offer a proxy for the long-run optimal portfolio and serve as the basis for an implementable version of Modern Portfolio Theory (MPT).

We start with a quick review of MPT, which motivates us to focus on risk-adjusted returns as the proper metric for quality of an asset allocation. We then discuss the conditions under which a risk parity allocation in fact provides the highest possible risk-adjusted return available to market participants. Using a long historical dataset of U.S. Equity, 10-Year U.S. Treasury, and Commodity Futures returns, we show that one of these two conditions likely does not hold and statistically reject the possibility that risk parity generates precisely the maximum Sharpe ratio portfolio (MSRP).[3] However, risk-adjusted returns on the parity allocation are quite similar to the optimal portfolio.[4] Having placed risk parity into its proper theoretical context, we next examine the historical performance of an implementable risk parity strategy, which is allocated historically based on data that would have been available at the time of each rebalance. We find that this implementable version of risk parity also performs on par with the MSRP, confirming findings in our earlier work, which considered a shorter time period and fewer asset classes.

In section 3 we examine the economic intuition for why a risk parity portfolio might be expected to perform on par with the long-run optimal portfolio. We show that the three asset classes we are considering here each perform differently in different macroeconomic environments, making them solid building blocks for a risk parity strategy. Because the macro economy went through phases that favored each asset class during the historical period we study, we find that the average implementable risk parity allocation is very similar to the ex post optimal MSRP.

2. Financial Theory and Risk Parity

MPT, which is due to Markowitz (1952), Sharpe (1964), Lintner (1964), and Merton (1972), shows that there is only one efficient portfolio of risky assets—the maximum Sharpe ratio portfolio (MSRP)—which is unique and offers the highest level of excess return per unit of risk possible given the mix of assets you are considering.[5] Exhibit 1 shows a hypothetical efficient frontier for two assets: stocks and bonds. The Capital Market Line (CML) is a ray drawn from the risk-free rate that achieves tangency with the efficient frontier precisely at the MSRP. Assuming that investors are free to borrow and lend at the risk-free rate, the CML represents the best possible set of risk-return combinations available to them.[6] Every point along the CML represents the

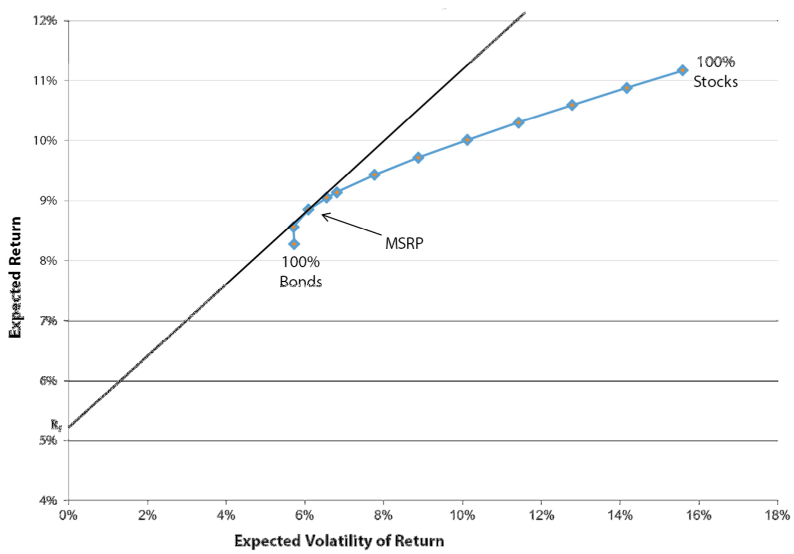


Exhibit 1 The Efficient Frontier and the Capital Market Line
Notes: Exhibit illustrates the concepts of an efficient frontier and CML based on data from 1/1978-10/2011. Please see Patridge, et al. (2011) for further information. Past performance is no guarantee of future results.
Source: Bloomberg, Salient Capital Advisors, LLC as of 10/31/2011.

same level of risk-adjusted return.

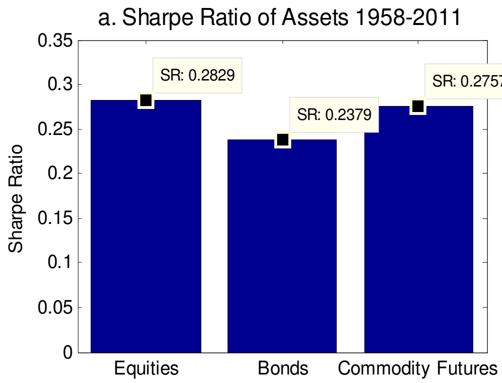
If the CML offers superior risk-return combinations, then why are the vast majority of investors holding equity-dominated portfolios? One obvious reason is that we do not know what will be in the MSRP ahead of time—only after we have observed returns over the investment horizon is the efficient portfolio known. This complicates attempts to invest based on MPT, because it means the seed for the CML is undetermined. Attempts to implement MPT to date have involved subjective estimates on forward returns, which can be influenced by behavioral biases such as over- or under-estimating returns on an asset class due to recent performance or over- or under-estimating risk due to investor familiarity with an asset class. Another approach is to derive expected returns from capitalization weights based on the assumption that asset markets are efficient and in equilibrium. The poor quality of these forecasts makes the prospect of levered exposure to such portfolios somewhat unappealing.

In a prior whitepaper we showed that risk parity offers a potential solution to problems identifying the optimal portfolio. A risk parity portfolio is one in which each asset in the portfolio is designed to contribute an equal amount of the portfolio's risk, where risk is measured by the variance of monthly returns. Portfolios constructed according to risk parity will naturally have a higher allocation to (1) assets with lower volatility and (2) assets with lower correlation to other portfolio constituents. It follows that risk parity portfolios will be diversified relative to their capitalization–weighted and 60% Equity, 40% Treasury (60/40) counterparts.

Maillard, Roncalli, and Teiletche (2010) show that the MSRP exactly coincides with a risk parity portfolio when (1) all assets have the same Sharpe ratio and (2) all assets have the same cross-correlations with one another.

Using return data for U.S. Equities, U.S. 10-year Treasuries, and Commodity Futures from October 1958 to December 2011, we compute the historical Sharpe ratio of each asset and the correlations among the assets.[7] Panel (a) of Exhibit 2 shows the long-run Sharpe ratio for each asset. They are quite similar to one another: Treasuries have a Sharpe ratio of 0.238, Commodities have a Sharpe ratio of 0.276, and Equities have a Sharpe ratio of 0.283. Panel

(b) of Exhibit 2 shows the correlation matrix for monthly returns on the assets. It suggests that the cross-correlations across asset classes are not all equal. Statistically speaking, we reject the hypotheses that: (1) the Equity-Treasury correlation is equal to the Treasury-Commodity Future correlation and (2) that the Equity-Commodity Future



b. Correlation of Asset Returns 1958-2011

	Equity Returns	Commodity Returns	Treasury Returns
Equity Returns	1.00		
Commodity Returns	0.13	1.00	
Treasury Returns	0.16	-0.11	1.00

Exhibit 2 Sharpe Ratios and Correlations
Notes: Panel (a) of this exhibit shows Sharpe ratio of each asset over the period from October 1958 to December 2011. Panel (b) of this exhibit shows a correlation matrix for monthly returns on the assets. U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. Data accumulated December 2011. Past performance is not indicative of future results.
Source: Salient Capital Advisors, LLC, December 2011.

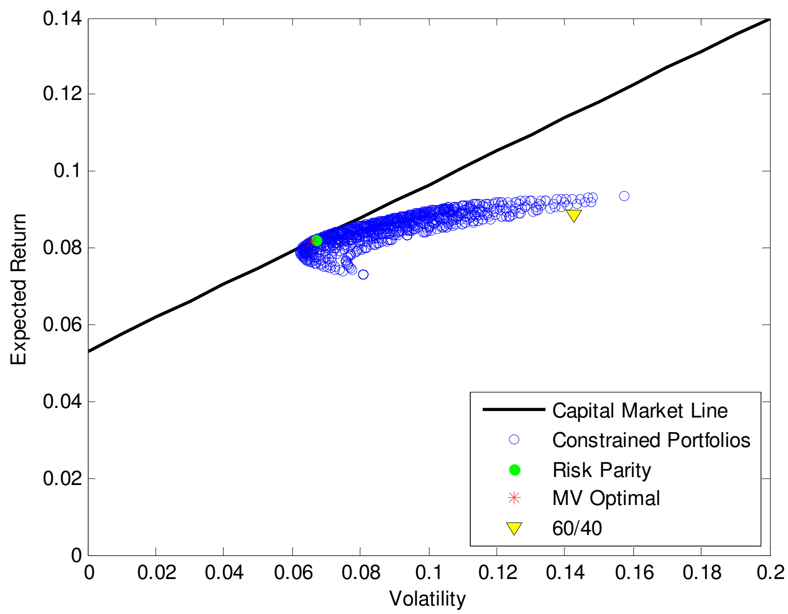


Exhibit 3 Feasible Combinations of Return and Risk
Notes: Exhibit uses a fine grid of allocations to Equities, Treasuries, and Commodity Futures to illustrate the combinations of expected return and volatility available to investors over the period of October 1958 to December 2011. The efficient frontier is the outside edge of the area plotted in blue, while the CML is the black line drawn from the risk free rate on the Y-axis through the mean-variance optimal (or MSRP), which is marked with a red asterisk. The risk parity portfolio is plotted in green immediately adjacent to the mean-variance optimal portfolio. Optimal and risk parity portfolio weights are computed using a nonlinear solver in MATLAB. U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. All data accumulated December 2011.
Source: Salient Capital Advisors, LLC, December 2011.

correlation is equal to the Treasury-Commodity Future correlation.[8] These statistical findings indicate that the MSRP is distinct from the risk parity portfolio, but the similarity of Sharpe ratios and mild differences in cross-correlation suggest that risk-adjusted returns for the two allocations should be similar.

To illustrate the similarity of risk parity to the MSRP, we plot the two portfolios in return/volatility space in Exhibit 3. The risk parity portfolio is immediately adjacent to the MSRP, with expected excess annual return of 2.88% (versus 2.85% for the MSRP) and annual volatility of 6.69% (versus 6.58% for the MSRP). These results match our prior results from the case of two assets. However, this risk parity portfolio is still un-implementable—just like the MSRP—because the allocation that achieves exact parity is only known after the fact, once the full statistical distribution of returns has been realized. Unlike returns, however, we believe historical correlation and volatility are reasonably informative about future correlation and volatility.[9]

The last thing we do in this section is consider an implementable risk parity strategy which we will call Ex Ante Risk Parity, where allocations are made using only information that would have been available at the time each position was initiated. We simulate the strategy by computing the covariance of the assets during the two years prior to the date they will be held. Each of these covariance estimates implies a risk parity allocation, which we solve for using a nonlinear optimizer in MATLAB. By combining these weights with returns in the subsequent month, we arrive at a monthly return for the portfolio. Next, we roll forward one month in time, re-estimate covariance, re-compute weights, and compute returns for the following month. We repeat this process each month.

Exhibit 4 is identical to Exhibit 3 except that the risk parity return/risk pair has been replaced by the implementable Ex Ante Risk Parity strategy. The exhibit shows that Ex Ante Risk Parity slightly outperformed the static MSRP over our long sample period. In the next section, we will try to formulate some economic intuition for these results by studying the relationship between asset returns, optimality, and the macroeconomic environment.

3. Asset Returns and the Economic Environment

In the previous section, we showed that risk parity generated performance similar to the MSRP over the period of October 1958 to December 2011. In this section we will look more carefully at returns in order to supply some intuition for this result. The remainder of section 3 will explain why risk parity leads to an allocation so similar to the MSRP in the long run while deviating significantly from it in the short run.

An investor on October 1, 1958 would have achieved an optimal outcome over the next 53 years (through 2011) if she had held a portfolio of 16.6% Equity, 48% Treasuries, and 35.4% Commodity Futures, generating excess returns of 2.85%/year, volatility of 6.58%/year, implying a Sharpe ratio of 0.43. This result is somewhat surprising in light of institutional investors' equity-heavy allocations. Looking at shorter periods of time may shed some light on why a portfolio of 60% equities and 40% bonds is the starting point for many institutional allocations.

In order to provide some intuition for the finding that the long-run efficient portfolio has such a small allocation to equities (16.6%), we calculate efficient portfolios over every overlapping 5-year period between October 1958 and December 2011. Examining the evolution of the short-run optimal portfolio through time offers insight into why the long-run optimal allocation has so much non-equity exposure. Plotted in blue in Exhibit 5 is the optimal short-run allocation to Equities, plotted in green is the optimal short-run allocation to Treasuries, and plotted in red is the optimal short-run allocation to Commodity Futures. As you can see, the asset allocation weights of the MSRP are highly dependent on the time period you examine.

Equities played a dominant role in short-run optimal portfolios over three time periods: from the late 1960s to the

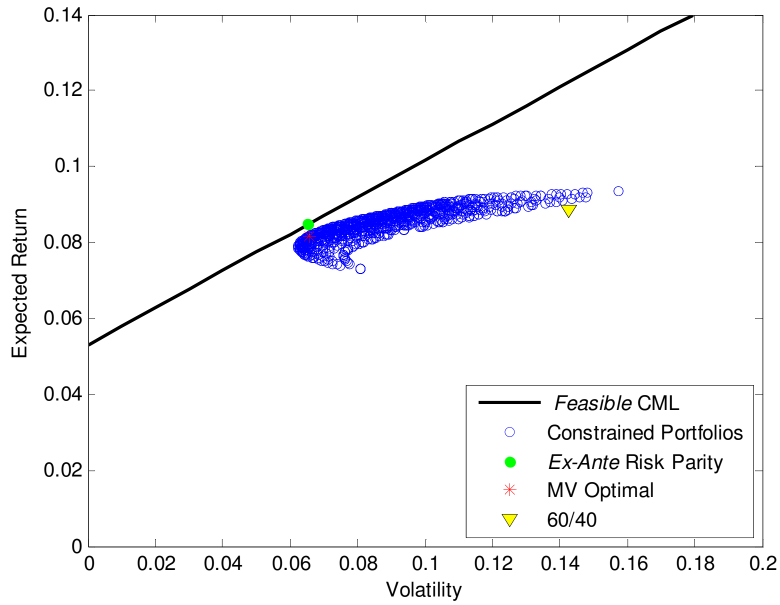


Exhibit 4 Implementable Risk Parity and the Efficient Frontier

Notes: Exhibit uses a fine grid of allocations to Equities, Treasuries, and Commodity Futures to illustrate the combinations of expected return and volatility available to investors over the period of October 1958 to December 2011. The efficient frontier is the outside edge of the area plotted in blue, while the CML is the black line drawn from the risk-free rate on the Y-axis through the E -Ante Risk Parity portfolio, which is shown in green. The Ex Ante Risk Parity is created by calculating historical covariance starting in October 1958 (using data from October 1956-September 1958), solving for portfolio weights that would have led to risk parity during the historical period, holding this portfolio in October 1958, then iterating forward one month at a time. The entire Feasible CML offers risk/return combinations superior to the MSRP. U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. All data accumulated December 2011.
Source: Salient Capital Advisors, LLC, December 2011.

early 1970s, from the early to mid-1980s, and the late 1990s. Treasuries were dominant in short-run optimal portfolios in the late 1950s, briefly in the mid-1970s, from the mid-1980s through the late 1990s, in the early 2000s, and between 2009 and 2011. Commodity Futures were a dominant portion of short-run optimal portfolios throughout the 1970s, the early 1980s, and from the early 2000s through today. In other words, equities produced higher risk-adjusted returns than the other asset classes over a relatively small fraction of the historical period we looked at, and thus make up a small component in the optimal portfolio for the long period we are studying.

Why did these three assets behave so differently over different historical periods? In our view, it is a function of their very different responses to macroeconomic conditions. Exhibit 6 shows correlations between annual returns for each asset and some metrics of macroeconomic conditions over the same time period. The exhibit shows that, on average, Equity returns respond positively to economic growth but negatively to inflation, that Commodity Futures returns respond positively to both inflation and economic growth, and that Treasury returns respond negatively to both inflation and economic growth. Put another way, equities thrive during periods of low inflation and high economic growth, commodities thrive during periods of high growth and high inflation, and Treasuries thrive during periods of low growth and low inflation. Because each of these economic scenarios makes up a substantial portion of the long-run period we are studying, the ex post optimal allocation for the period of October 1958 to December 2011 is spread across all three of these assets. The risk parity portfolio attempts to equalize its risk exposure to each of these asset classes, arriving at a result quite similar to that of the long-run MSRP using only information that was available at the time each allocation was made.

We should state explicitly here that if one could have dynamically allocated to the MSRP through time, that portfolio would have outperformed an allocation to risk parity. But it should also be apparent from Exhibit 5 that it is very unlikely one could have predicted ahead of time what allocation would produce the highest Sharpe ratio based on past returns—the short-run optimal allocation is simply too volatile. We are addressing what is, in

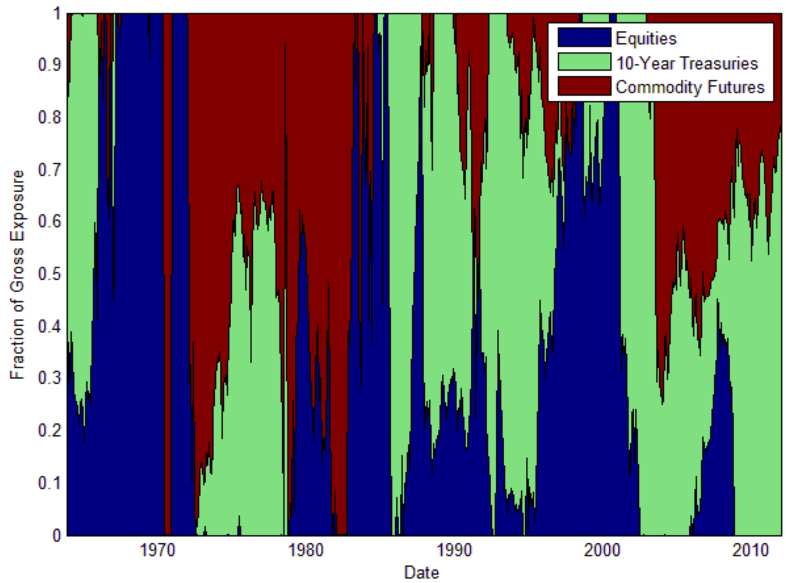


Exhibit 5 5-year Ex post Efficient Portfolio Weights

Notes: Exhibit plots the portfolio weights that would have produced the highest ratio of risk to excess return (maximum Sharpe ratio) over the previous five years on a rolling basis. For example, the values plotted at 1970 indicate that the optimal portfolio over the period of February 1965 to January 1970 consisted of 100% Equities, 0% Treasuries, and 0% Commodity Futures. U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. Data accumulated April 2012.
Past performance is no guarantee of future results.
Source: Salient Capital Advisors, LLC, April 2012.

	Economic Growth	Inflation	Equity Returns	Commodity Returns	Treasury Returns
Economic Growth	1.00				
Inflation	-0.21	1.00			
Equity Returns	0.34	-0.19	1.00		
Commodity Returns	0.20	0.23	0.11	1.00	
Treasury Returns	-0.31	-0.36	0.01	-0.29	1.00

Exhibit 6 Correlations between Asset Returns and Macroeconomic Variables

Notes: Exhibit shows the correlation between annual asset returns and macroeconomic variables. Macroeconomic data is from the Federal Reserve Bank of St. Louis FRED database. U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. Data accumulated April 2012.
Source: Salient Capital Advisors, LLC, April 2012.

our view, the more relevant question for strategic asset allocators: how to achieve results on par with the optimal long-run allocation.

Next we want to compare the short- and long-run optimal portfolios to the results we could have achieved using Ex Ante Risk Parity. In Exhibit 7, we plot the portfolio weights generated by Ex Ante Risk Parity. Comparing them with the short-run optimal weights in Exhibit 5 suggests that Ex Ante Risk Parity has little in common with short-run optimal allocations. Risk parity allocations evolve slowly to reflect changes in individual asset volatilities and inter-asset correlation, while the short-run optimal portfolio is largely dependent on which asset class performed best over the past five years. Notice, however, that the risk parity portfolio increased its allocation to commodities in advance of periods of commodity outperformance—identified by observing large allocations to commodities in Exhibit 5—in the 1970s, 1980s, and early 2000s. Similarly, interest rate exposure rose concurrently with long periods of Treasury Bond outperformance during the early 1970s, early 2000s, and late 2000s. The intuition for this result is that risk parity increases allocations to assets as their volatility and correlation to other assets fall. Declining volatility is generally accompanied by positive asset returns, so risk parity produces portfolio weights that gently drift toward assets with improving performance. Some critics of risk parity point to this tendency to "buy high and sell low" as a reason to avoid the strategy. Next, we will use our data to gauge the merit of this criticism.

In order to study the effectiveness of risk parity as an asset allocation strategy over the period of 1958 to 2011, we will compare risk-adjusted risk parity and 60/40 returns with those generated by the optimal portfolio. Exhibit 8 depicts these relationships in a scatter plot. The X-value of each coordinate in the exhibit indicates the Sharpe ratio of the optimal portfolio, while its Y-value indicates the Sharpe ratio of either risk parity (blue for short-run,

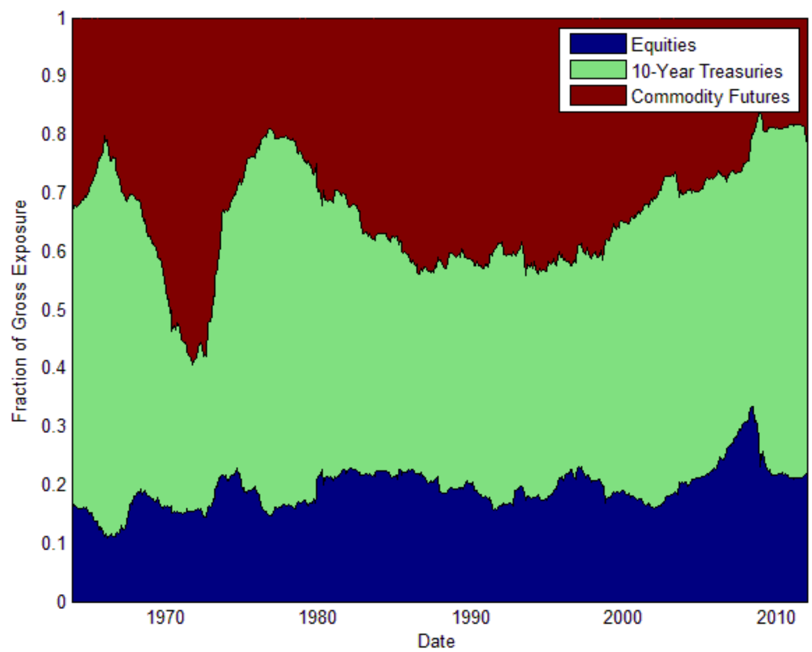


Exhibit 7 Ex Ante Risk Parity Portfolio Weights

Notes: Exhibit plots ex ante risk parity portfolio weights. For example, the weights plotted for January 1970 are based on the covariance of monthly asset returns from January 1958 to December 1959. U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. Data accumulated April 2012.
Past performance is no guarantee of future results.
Source: Salient Capital Advisors, LLC, April 2012.

green for long-run) or the 60/40 portfolio (red for short-run, yellow for long-run). Points along the 45° line indicate that the portfolio—whether it be 60/40 or risk parity—had a Sharpe ratio equal to that of the optimal portfolio over that same time period. Points below the 45° line indicate that the portfolio produced lower risk-adjusted returns than the optimal portfolio, while points above the 45° line indicate that a portfolio produced risk-adjusted returns better than the optimal portfolio. It is important to note that, because the risk parity strategy changes allocations within each period during which these statistics are calculated, it is possible for it to achieve risk-adjusted returns in excess of the optimal portfolio.

Three primary results emerge from study of Exhibit 8: First, neither risk parity nor the 60/40 consistently generates returns on par with short-run optimal allocations, which would appear as marks along the line. This is exactly what we should expect given that the short-run optimal allocation is chosen with full knowledge of risk and return for each

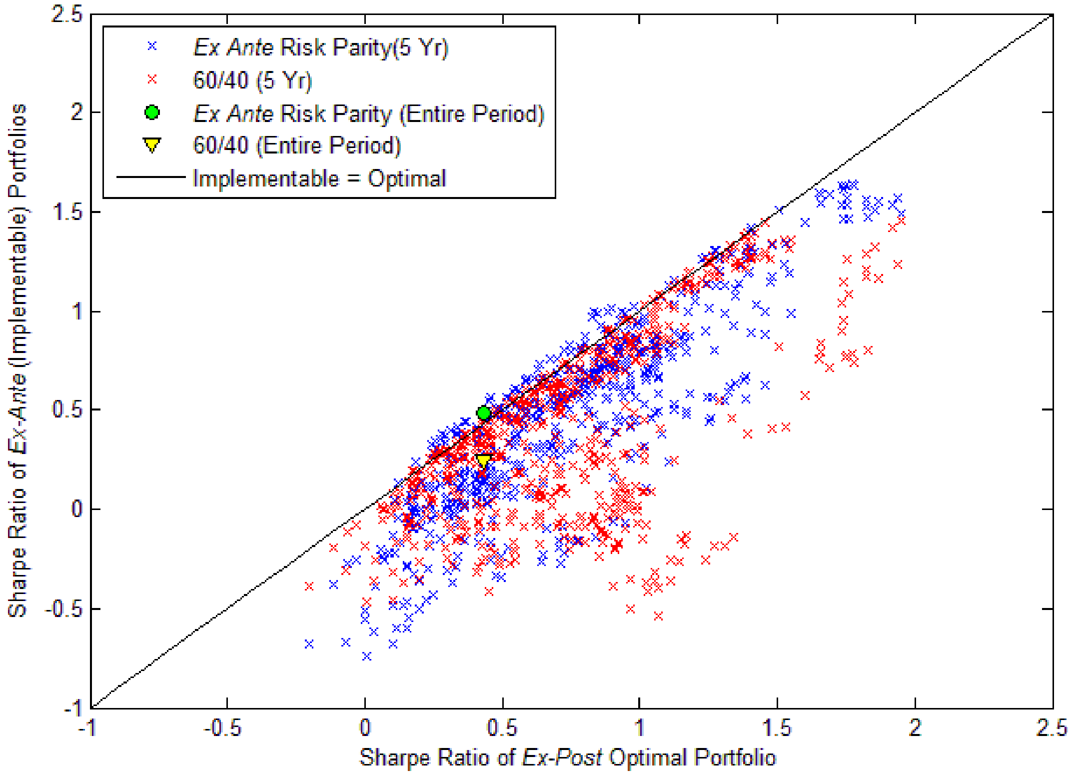


Exhibit 8 Sharpe Ratio Scatter Plot

Notes: Exhibit plots Sharpe ratio of the short-run ex post efficient (un-implementable optimal) portfolio on the x-axis versus the short-run ex ante (implementable) risk parity (blue) and 60/40 (red) Sharpe ratios from the same time period on the y-axis. Exhibit also plots the Sharpe ratio of the long-run ex post efficient (un-implementable optimal) portfolio on the x-axis versus the Sharpe ratio generated by risk parity (green) and the 60/40 portfolio (yellow) over the long run on the y axis. The 45° line indicates perfect equality between implementable and non-implementable strategies. Points above the 45° line indicate implementable strategies that outperform the optimal allocation, while points below the 45° line indicate strategies that underperform the optimal static allocation.
Past performance is not indicative of future results.
Source: U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. Data accumulated April 2012.

asset. Second, the 60/40 portfolio gets close to the maximum Sharpe ratio more frequently in the short run than does risk parity, shown by the larger number of red versus blue marks in the vicinity of the 45 degree line. However, the 60/40 portfolio also produces the largest outliers—it misses by a very wide margin more often. To understand the intuition for this result, first recognize that the 60/40 portfolio behaves similarly to an all-equity portfolio (87% of the variance of 60/40 returns came from equity during the period from October 1958 to December 2011).

Because equities performed well during most of the 5-year overlapping periods used to generate Exhibit 8, the 60/40 portfolio generally resides near the line. Perhaps this helps explain the prevalence of 60/40 strategies among institutional investors. However, because the 60/40 portfolio is so equity-dominated, it also produced more large drawdowns relative to the optimal portfolio, which by construction held no equity during periods when stocks did very poorly. Third, when we consider our entire sample, Ex Ante Risk Parity outperforms both the ex post optimal static portfolio and the 60/40 portfolio. This mirrors what we found in the case of two assets. It also suggests that the benefits of consistent, systematic diversification may outweigh the costs of "buying high and selling low," or at least they have over the last 53 years.

This third point, that risk parity dominates both the long-run ex post optimal and 60/40 portfolio deserves further consideration. Recall from earlier in the discussion that the ex post optimal portfolio over the period of October 1958 to December 2011 was 16.6% Equity, 48% Treasuries, and 35.4% Commodity Futures. This allocation is very different from most of the allocations shown in Exhibit 2, and most of the short-run optimal portfolios are very different from the long-run optimal allocation. Ex Ante Risk Parity generates allocations that are, on average, more similar to the long-run optimal allocation than they are to most of the short-run optimal allocation. Also note that because the Ex Ante Risk Parity risk parity allocation changes over time, it is possible for it to outperform the optimal static allocation as it does in our analysis.

4. Conclusions

Financial theory shows that the risk parity portfolio will be identical to the MSRP if all assets have identical Sharpe ratios and equal cross-correlations with one-another. We showed that the first of these conditions may be true, but that the second is most likely not. While this implies that the risk parity portfolio will be slightly different from the MSRP, we find that this difference was relatively minor in practice, even when considering an implementable Ex Ante Risk Parity strategy.

No naïve strategy—Ex Ante Risk Parity included—can rival the performance of portfolios formed with full knowledge of what assets will outperform in the near future. Over the long run, however, because the economic environment is continually in flux, risk parity presents itself as a potential strategy with which to approximate the optimal static portfolio because it provides equal risk exposure to assets that typically perform well in different economic environments.

[1]See Partridge, Croce, and Kellert (2011).
[2]Here ex-ante means a portfolio was allocated using only information that was available at the time an investment would have been made and where ex post means allocations chosen using information that would not have been available at the time the investment was made.
[3]The maximum Sharpe ratio portfolio is a unique portfolio in the investor's opportunity set that offers the highest level of expected excess return per unit of annualized monthly return standard deviation; the Sharpe ratio is our metric for risk-adjusted return. In this document, maximum Sharpe ratio will be used interchangeably with optimal portfolio.
[4]Our return data covers more than 53 years and will be discussed in detail in later sections of this document.
[5]Excess return is asset return less return on the risk-free asset.
[6]In order to achieve risk-return combinations on the CML to the right of the tangency point, investors would borrow at the risk-free rate and invest both their own capital and the loan proceeds in the maximum Sharpe ratio portfolio. Investors who prefer risk-return combinations on the CML to the left of the tangency point would hold less than 100% of their assets in the maximum Sharpe ratio portfolio and would lend at the risk-free rate with what remains.
[7]U.S. Equity returns are value-weighted returns from the NYSE, Amex, and NASDAQ downloaded from CRSP. 10-year treasury returns are also from CRSP. Commodity Futures returns are given by the Continuous Commodity Index and are downloaded from Bloomberg. The risk-free rate is the return on 3-month T-bills, downloaded from Bloomberg. All data accumulated Salient Capital Advisors, LLC, April 2012.
[8]The statistical test used to reject equal correlations is due to Hotelling (1940).
[9]See, for example, Poterba and Summers (1987).

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Research Review

Tail Risk Literature Review

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The Global Financial Crisis brought with it a resurgence of interest in tail risk, both within the financial services industry and the academic world. However, tail risk has been an important topic in financial literature since academic researchers realized that market returns often violate normality assumptions. In this article, we provide a brief literature review of the evolution of tail risk measures, as well as research on tail dependency. We also document a number of academic studies that assess tail risk and tail dependency of hedge fund returns.

The literature related to tail risk and its measurement dates back to the early 1960s. Mandelbrot (1963) challenged the usual assumption of Gaussian return distributions by applying the power law to describe the unconditional tail distributions of financial returns. Consistent with Mandelbrot, Fama (1963) argued that prices in certain markets show large, abrupt movements that one wouldn't expect under a model of Gaussian distributed returns. Blattberg and Gonedes (1974) proposed using the Student (or t) distribution to account for the fat tails of return distributions observed in earlier studies. Akgiray and Booth (1988), Hols and de Vries (1991), and Jansen and de Vries (1991) extended the literature on the shape of fat tails, demonstrating that the tail behavior of returns is fundamentally different from the remainder of the return distribution.

In light of the findings contraindicating the Gaussian assumption, a greater number of economists considered the asymmetry of return distributions in their research. Sortino and Price (1994) advocated the use of downside deviation as a risk measure rather than traditional (Gaussian-based) risk measures such as standard deviation and beta. The Sortino risk measure never achieved the level of acceptance of other measures, such as Value at Risk (VAR), perhaps due to the fact that it does not consider the full distribution of returns. However, many researchers have argued that VaR has several significant drawbacks. Beder (1995) pointed out that VaR is extremely sensitive to parameter choice. Artzner, et al. (1999) demonstrated that VaR is not coherent, i.e., it doesn't possess desirable properties of a risk measure, such as subadditivity, under certain market circumstances. Despite its flaws, VaR remained popular in the financial community, particularly prior to the demise of Long Term Capital Management (LTCM) in 1998.

After the LTCM incident, VaR was criticized as an inaccurate measure of downside risk exposure and researchers began to examine new measures to better estimate the extreme tail. Li (1999) proposed a new approach to estimate VaR based on skewness and kurtosis in addition to volatility. In a similar approach, Favre and

Galeano (2002) developed a new method called Modified Value at Risk in which they use a Corner-Fisher expansion in computing VaR. Rockafellar and Uryasev (2000) proposed another risk measure called expected shortfall (ES) or conditional VaR (CVaR) which has desirable properties of convexity and coherence. Alexander and Baptista (2004) compared VaR and CVaR in their study and demonstrated that CVaR is a more effective constraint on the mean-variance model, especially when a risk-free security is present. Agarwal and Naik (2004) also argued that the left-tail is underestimated in the common mean-variance framework and supported the use of CVaR as an alternative.

Researchers also analyzed quantitative theories in order to provide more accurate estimates of tail risk. Since 2000, an increasing number of studies have used Extreme Value Theory (EVT) to model tail-behavior, based only on the extreme values. Bali (2003) examined the asymptotic behavior of extreme changes in the U.S. Treasury market and claimed that standard VaR approaches can be significantly improved by utilizing EVT. Gencay and Selcuk (2004) demonstrated that EVT based models outperformed classical VaR models in emerging markets. Marimoutou, Raggad, and Trabelsi (2009) applied EVT models in energy markets and found that such models offer significant improvements in estimating tail risk when compared to other traditional techniques such as GARCH, historical simulation and filtered historical simulation.

During the last decade, the topics of tail dependence and time-varying tail distributions have been covered extensively. Because of its effectiveness in capturing different patterns of tail dependence, copula theory has become a popular statistical modeling tool. By conditioning variables with an extension of copula theory, Patton (2006) observed different degrees of correlations in exchange rates during joint appreciations versus joint depreciations. Michelis and Ning (2010) employed a Symmetrized Joe-Clayton (SJC) copula to assess the tail dependence between stock returns and exchange rates. They found a higher dependency of returns in the left-tail of the joint distribution. Litzenberger and Modest (2008) and Billio et al. (2007) extended the literature on tail risk by utilizing Markov regime switching processes to capture time varying risk exposures in different market conditions.

Since alternative investments, particularly hedge funds, display asymmetric return profiles much academic research is aimed at assessing the tail risk of hedge funds. Edward and Caglayan (2001) demonstrated that hedge funds have higher positive correlations with stock returns in bear markets. Agarwal and Naik (2004) analyzed equity-oriented hedge funds and found that hedge funds exhibit short option-like payoffs, bearing significant left-tail risk which is underestimated by a traditional mean-variance framework. In another study, Agarwal, Bakshi and Huij (2008) examined higher moment risks in cross-sectional hedge fund returns. They discovered that hedge funds have considerable exposure to higher moment risks and that these exposures generate significant returns for the funds.

In addition to tail risk, scholars also investigated the tail dependency of returns in the hedge fund industry. Geman and Kharoubi (2003) found that normality assumptions are not appropriate for hedge funds. In addition, they discovered significant left-tail dependence between returns of most hedge funds and traditional assets, suggesting that most hedge funds provide less diversification in large negative market moves than previously thought. They found that the equity market neutral strategy was an exception, providing diversification benefits in down moves. Similarly, Bacmann and Gawron (2004) analyzed return dependency among different hedge fund styles and stocks and bonds. In their study, they claimed a substantial left-tail dependency between funds of hedge funds without managed futures exposure and the stock market, caused by the lack of liquidity during the LTCM and the Russian crises. On the other hand, Brown and Spitzer (2006) observed a similar left-tail dependency in hedge fund returns with stocks even after the elimination of the financial crisis periods from their analysis and concluded that funds of hedge funds are exposed to significant tail risk. However, Distaso, et al. (2009) criticized previous studies on unconditional tail risk after they found significant conditional time-variation in tail dependency even for hedge funds that display little unconditional tail dependency.

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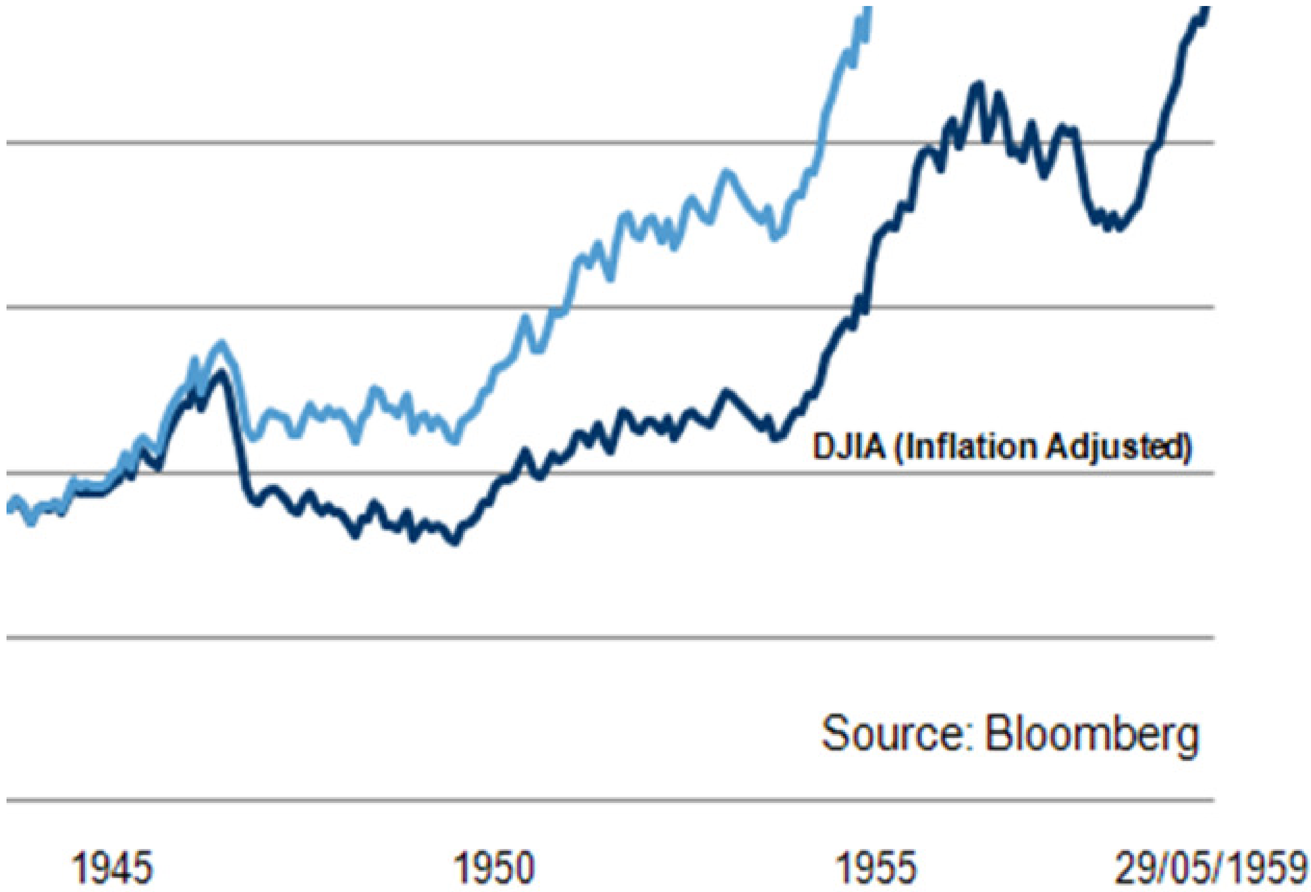
CAIA Member Contribution



Long Term Investors, Tail Risk Hedging, and the Role of Global Macro in Institutional Portfolios

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1. Introduction

This paper focuses on two related topics: the tension between the fundamental premise of long-term investing and the post-crisis pressure to mitigate tail risks; and new approaches to asset allocation and the potential role of global macro strategies in institutional portfolios.

To really understand why these issues are increasingly coming to the fore, it is important to recall the sheer magnitude of losses suffered by sovereign wealth funds and other long-term investors at the peak of the recent financial crisis and to appreciate how shocked they were to see large double-digit percentage drops, not only in their own portfolios, but also in portfolios of institutions that many of them were looking to as potential role models, namely the likes of Yale and Harvard university endowments. Losses for many broadly diversified, multi-asset class portfolios ranged anywhere from 20% to 30% in the course of just a few months. In one of the better publicized cases, Norway's sovereign fund lost more than 23%, or in dollar equivalent more than $96 billion, an amount that at the time constituted their entire accumulated investment returns since inception in 1996. Some of the longer standing sovereign wealth funds in Asia and the Middle East, which had long invested in a wide range of alternative asset classes such as private equity, real estate and hedge funds, are rumoured to have done even worse in that infamous year.

Not surprisingly, in the crisis post-mortem, sovereign investors have been asking some pretty tough questions: what went wrong with our asset allocation; we thought we had sufficient diversification, but being invested in a broad range of asset classes clearly failed to protect us at precisely the time when it mattered most. In other words, the tail events of 2008 proved to be as unexpected as they were painful. If diversification didn't work, what can long-term investors do to protect their portfolios going forward?

2. Broad equity risk as the main culprit

In trying to explain the failure of classic portfolio diversification during the crisis of 2008, there is one particularly compelling line of inquiry which looks to map various common risk factors onto asset classes to ascertain contributions to overall risk in a typical institutional portfolio. A number of asset management firms have done such analyses and the results surprised many institutional investors, showing far more concentrated exposures to broad equity risk than had been implied by asset class weights. While this is not news to most asset allocation experts, for many non-specialist audiences and stakeholders in SWF nations this may come as a revelation, since in the past most discussions of portfolio diversification revolved almost exclusively around asset class weights rather than the esoteric concepts of risk factors and risk premia.[1]

To illustrate the point, let's first look at the classic 60/40 institutional portfolio, which has come to represent the typical case of a generic pension fund in the U.S. and increasingly elsewhere around the world. This portfolio is managed in a way that maintains long-term allocation of 60% to broadly diversified equity, typically dominated by developed markets, and 40% to broadly diversified bonds, with a strong bias toward the U.S., Japan, and other government issuers. As one asset management firm recently demonstrated in its proprietary research, while traditional asset allocation exposure to equity is limited to 60%, in terms of relative risk contributions, equity accounts for more than 95% of total portfolio risk.

While the 60/40 model may be representative of the broader pension fund industry, this is not how most sophisticated endowments and sovereign wealth funds would have allocated their capital prior to the crisis. However, even in portfolios much more broadly diversified by asset class, broad equity risk still dominates. Continuing with the above analysis, the asset management firm in question looked at a hypothetical portfolio of 9 different asset classes, with individual allocations ranging from 5% to 15%, and discovered that broad equity risk still accounted for more than 80% of total portfolio risk.

There is nothing untoward with a combined equity position - including both public and private equities in developed and emerging markets - being the largest allocation in a long-term, saving-oriented institutional portfolio. Conceptually it makes sense: residual claims on productive capital stock and real assets have always been considered the best long-term bet on real growth in a portfolio. Empirically, there is also overwhelming historical evidence in support of superior expected long-term returns from equity compared to bonds, bills and cash. Therefore, it is only natural that long-term institutional investors have come to rely on equity as the main growth engine in their portfolios.

However, if the actual exposure to broad equity risk turns out to be much larger and more concentrated than previously thought, two questions arise. First, can the stakeholders in the fund get comfortable with this higher level of equity risk and the concomitant exposure to tail events, such as 2008? This question goes to the very heart of the debate about liability profiles, time horizons and investment beliefs, and how they influence strategic asset allocation. If the answer to this question is no, then the second question is: how does one protect the portfolio from tail risks?

Before we consider these questions, we need to think carefully about what we mean by tail risks and which specific tail events are most relevant in the context of long-term investing.

3. Tail-risk hedging

In the post-crisis environment, "tail-risk hedging" has become a buzzword. Not only are investment banks falling over themselves to offer various clever ideas of hedging left tail risk, but also in the hedge fund space the past two years has seen significant growth in the number of new funds dedicated to tail-risk hedging. A quick search on the internet will reveal a dozen such dedicated funds, with the vast majority set up in the last 12-18 months.

While all of them differ markedly in their philosophy, approach, and instruments used, on the most basic level they are all trying to achieve the same objective: provide the end-investor with an optimal combination of "convex" exposures that will be a drag on performance in good years, but offer spectacular returns in bad years, counterbalancing the collapse in the more traditional 'growth assets', such as equity and corporate bonds, thereby helping to mitigate the left tail risk. One can think of a continuum of tail risk solutions, depending on the desired level of hedging precision; whether the end-investors want to do it themselves directly in the capital markets or through a dedicated fund; and how active or passive they are prepared to be in this activity.

An example of a passive approach, in its most basic form, would be to buy out-of-the-money put options on underlying equity indices. The upside is that the basis risk is low to non-existent, as you are protecting your portfolio precisely against the risks it is exposed to, but of course it is costly to keep rolling over these protection programs, especially during crises and in their immediate aftermath, when implied volatility tends to spike up dramatically.

At the other end of the spectrum are various active hedging programs, which seek to lower the on-going costs of tail risk protection by broadening the eligible universe of instruments and accepting a much higher basis risk. In other words, they try to make the underlying portfolios more robust to shocks on an on-going and cost-efficient basis, but they do so at the expense of much lower precision. Typically, such managers will look beyond the plain vanilla stock index put options to consider some optimal combination of volatility options (e.g., options on VIX), variance swaps, out-of-the-money Treasury calls, CDS protection, long positions in carry-funding currencies like the Japanese yen and the Swiss franc, and so on. Inevitably, there is a trade-off between lower costs of hedging and a higher basis risk, but for an investor who is looking for on-going and open-ended protection against undefined tail risk events this might be a better solution.

3.1. Tail-risk hedging vs. global macro

In extremis, a very active approach to tail risk hedging can converge on global macro, not least due to the similarities in their active trading styles and the broad universe of eligible instruments. Much more important are the following two considerations. First, both strategies tend to do very well in times of market dislocation and economic distress: in industry parlance, both tend to be 'long volatility' and 'long convexity.' Secondly, in order to construct a very elaborate, actively managed tail-risk hedging solution, the specialist manager needs to be very good at formulating and thinking through different macroeconomic scenarios and how they might impact various macro-financial linkages between economies, markets and instruments. For example, if you are trying to protect a U.S. equity-centric portfolio by buying, amongst other things, protection on Spanish and Portuguese sovereign debt, you are likely to have a pretty good idea of the various types of macroeconomic scenarios that may unfold in the near future, as well as their respective probabilities, and the transmission mechanisms linking underlying instruments. Conceptually, this is global macro investing at its finest.

Yet specialist tail-risk managers by definition focus only on one area, left tail risk. Macro managers, on the other hand, consider not only the left tail, but also the entire return distribution – they have the flexibility, nimbleness, and ability to go long volatility whenever they choose. And this is a key difference: dedicated tail risk funds are structurally long volatility, "bleeding" money during good times in the hope of shooting the lights out during a crisis. Global macro managers are not structurally disadvantaged in the same way: as long as they continue to operate in the most liquid markets and maintain rigorous stop-loss discipline, during quiescent periods they can be short volatility and long carry, thus making money in macroeconomic environments where tail-risk hedgers are designed to lose money. In other words, good and experienced global macro managers tend to have positive expected returns over the entire return distribution and across different market cycles. In the context of recent tail-risk hedging discussions, a sizable institutional allocation to a carefully selected portfolio of global macro managers may turn out to be both a cheaper and a more efficient solution for those investors who discovered in the recent crisis that they do need such protection.

A more interesting and challenging question, however, is how the other institutional investors should think about tail risks. Specifically, if you are a genuinely unconstrained, long-term and patient investor, as many sovereign wealth funds are, should you be buying such tail risk protection? Or should you not instead be a seller of such insurance? After all, isn't it a natural and normal part of the process of earning long-term expected risk premia to accept higher interim volatility and to ride out the occasional storm that other, more constrained or shorter horizon investors cannot afford? In fact, this exact point was one of the key findings and recommendations by a group of experts who recently published a seminal report looking into potential ways of improving the management of Norway's sovereign wealth fund and achieving better long-term investment returns.

3.2. The true tail risk for long-term investors

This brings us to an important insight: the relevant definition of a tail risk that can be truly disastrous for long-term institutional investors may not be a short-term, or medium-term, double-digit drop in the value of their portfolios, for this is par for the course if you are in the business of earning long-term risk premia. Instead, it is more likely to be the failure to earn and accrue such risk premia over the multi-decade investment horizon.

And according to Modern Portfolio Theory, this is indeed a variation of a tail risk. Typically, conventional wisdom supporting the notion of long-term equity exposure is based on the so-called 'time diversification' argument – the idea that if you have a long investment horizon, you can afford to tolerate more risk, because the annualized variability of returns and the likelihood of loss diminish dramatically through time. While this is true, what often gets omitted in these discussions is the all-important corollary: that the distribution of terminal wealth increases with time, thus increasing the potential magnitude of end-of-horizon losses. As in the earlier discussion above, this also constitutes a tail risk, inasmuch as it represents a low-probability, high-impact event. However, it is a tail risk of a very different kind, which cannot easily be hedged in the capital markets: just ask a broker-dealer for terms on a 30-year stock index put option. Option pricing theory effectively corroborates the point that risky assets get riskier with time.

But what about empirical evidence? Aren't we taught that over long enough periods, equity returns handily beat bonds and cash? They do, but there are always exceptions, especially if you were a passive investor in the Japanese equity market for the two 'lost decades' since January 1990 (see Exhibit 1).

And what about the worst economic debacle of the 20th century, the Great Depression? As Exhibit 2 shows, after the spectacular collapse in 1929, the Dow Jones Industrial Average did not recover in nominal terms until mid-1950s and in real terms not until the end of that decade. For a long-term investor, who risks capital in the short term to accrue the equity risk premium over the long term, this constitutes not two, but three lost decades! So if this tail risk is the one that really matters to long-term investors and if there are no hedging solutions readily available in the capital markets, what, if anything, can be done about it? This is where some new developments in asset allocation theory look particularly promising.

4. New approaches to asset allocation

One proposition that is being increasingly researched and discussed in this context is the so-called "risk-factor-

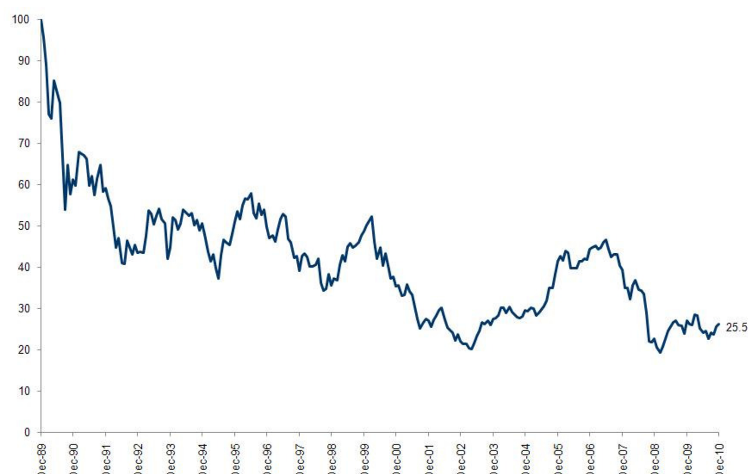

Exhibit 1 Performance of the Nikkei 1990-2010
Source: Bloomberg

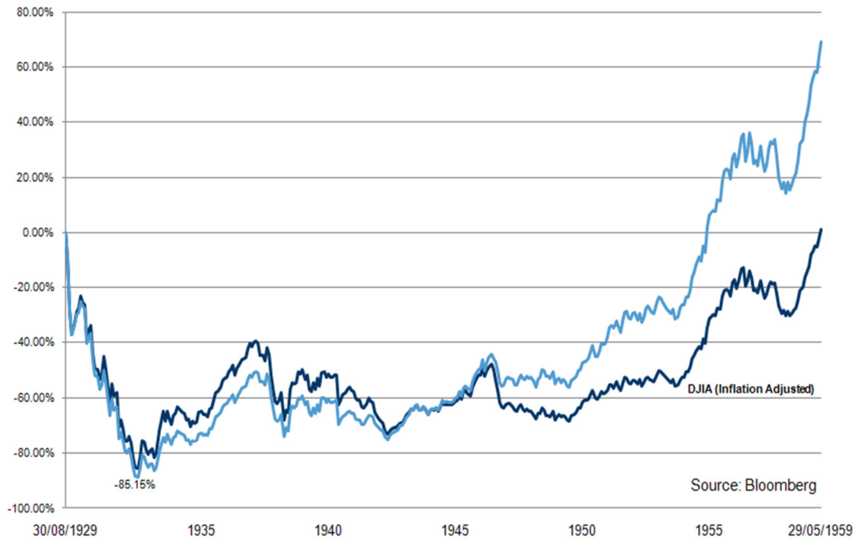

Exhibit 2 Performance of the U.S. Stock Market 1929-1959
Source: Bloomberg

based approach" (as opposed to the traditional asset-class-based approach), which actually builds on seminal academic research into common risk factors undertaken back in the 1970s and 1980s and which today is getting more traction thanks to research by people like Andrew Ang, a professor at Columbia Business School in New York. Specifically, in a 2010 paper on sovereign wealth fund management, he proposed what might be called a "nutritionist's view of asset allocation", which he described as follows:

"Factors are to assets what nutrients are to food. [Consider] the five essential nutrients necessary for life: water, carbohydrates, protein, fiber, and fat. Factors are the nutrients of the financial world... Factor risk is reflected in different assets just as nutrients are obtained by eating different foods… Assets are bundles of different types of factors just as foods contain different combinations of nutrients... This is the modern theory of asset pricing: assets have returns, but these returns reflect the underlying factors behind those assets."

As noted earlier, even the most sophisticated institutional portfolios tend to be dominated by the three 'growth asset' risk premia: equity, credit and illiquidity. To the extent that hedge funds in their entirety are viewed as an asset class and analyzed through the lens of broad-based hedge fund indices, it can be shown that they too tend to be dominated by the same three risk premia. However, we do not believe that this type of analysis does justice to hedge funds, which – in our view – cannot, and should not, be viewed as a stand-alone, homogenous asset class like all the others. In fact, we are of the opinion that in order to take full advantage of the 'nutritionist's view of asset allocation,' it is imperative to unbundle the multitude of risk factors and risk premia contained in different hedge fund strategies. If analyzed on a granular enough level, and decomposed and reconstituted in a highly customized and structured way, different hedge fund strategies can offer access to a much broader set of risk factors – not just equity, term, credit and illiquidity, but also value, size, momentum, carry and volatility, to name just the most obvious ones. For illustration purposes, Exhibit 3 summarizes long-term evidence on various risk premia, which comes from the previously mentioned expert report commissioned by Norway's sovereign wealth fund.

The promise that this approach holds to mitigating multi-decade tail risks threatening long-term investors is

Exhibit 3 Average Risk Premia

Premium	Data source	Average reward	Period
Equity premium	U.S. stocks vs. bills	5.2%	1900–2009
Term premium	U.S. bonds vs. bills	1.0%	1900–2009
Credit premium	U.S. corporates vs. Treasuries	0.4%	1926–2009
Value premium	UK value vs. growth	2.9%	1900–2009
Size premium	UK small vs. market	2.4%	1955–2009
Momentum premium	UK winners vs. losers	10.3%	1900–2009
Carry premium	Currencies	6.1%	1983–2009

Source: "Investment Strategy and the Government Pension Fund Global – Strategy Council 2010"

in its potential to combine genuinely orthogonal risk premia, allowing for much better calibrated and more sophisticated portfolio growth engines.

Another promising direction in asset allocation research focuses on more dynamic and discretionary approaches, based on broader asset class definitions geared to different macroeconomic regimes. The underlying idea is very simple: different macroeconomic environments – growth, inflation, recession, deflation, contraction, stagflation, etc. – impact different types of assets and strategies differently. The traditional equity-centric portfolio, even when it is supposedly reasonably well diversified, is effectively geared to only one type of macroeconomic environment: high growth, low inflation, low or stable interest rates and volatility, reasonable access to credit and liquidity. Yet in most other macroeconomic environments it is effectively suboptimal.

If one could come up with a different typology of asset classes and strategies, fully taking into account their respective sensitivities to different macroeconomic conditions, then arguably one could construct a portfolio that is more robust and resilient to major macroeconomic and policy shifts. If one could then take this investment process a step further by developing a reasonably successful analytical framework to not simply react to, but to pre-empt such major shifts, then this asset allocation approach may hold even more promise. While completely different in its philosophy to the risk-factor-based approach, it too could help mitigate long-term tail risks.

5. The role of global macro in institutional portfolios

In our view, all of this bodes extremely well for the future of hedge funds in general and global macro strategies in particular. For starters, if institutional investors begin to think less in terms of asset classes and more in terms of risk factors and risk premia, then the age-old distinction between 'traditional' and 'alternative' investments will increasingly become obsolete. More and more funds who perhaps have shunned hedge funds or were not allowed to invest in them, may well seek out those providers who can construct better growth engines for their portfolios, irrespective of where the underlying components may be sourced. In this context, global macro funds have the added advantage of being in a very small class of strategies that can offer investors 'long volatility' and 'long convexity' exposure in times of market dislocation and distress. This becomes even more compelling when one compares and contrasts them to dedicated tail-risk hedge funds, as discussed previously.

As for those long-term investors who decide against tail-risk hedging and instead become providers of insurance themselves, there is still a place for global macro strategies in their portfolios, as there will be a place for highly liquid government bonds: the only difference will be in the allocation amount, which will be dictated not by liquidity and insurance considerations, but by the optimal long-term trade-off between diversification and expected return. To the extent that some of these investors eventually shift to some form of a macroeconomic regime-based asset allocation system, as described above, the logic of allocating a meaningful amount to global macro strategies will become even more compelling. It is early morning in global macro land.

[1]The other two risk premia that were present in most multi-asset class portfolios and arguably aggravated the situation in 2008 were credit and illiquidity. Just like with equity risk premium, they tend to generate their best returns in the same type of environment. One can think of all three as 'growth asset' premia.

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Author Bio

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Before joining Permal, Mr. Rozanov was at State Street, where he was Managing Director and Head of Sovereign Advisory, working closely with the Portfolio and Risk Management Group. Prior to that, he held various roles at State Street Corporation in London and Tokyo, and he also worked at UBS Investment Bank in Japan. Mr. Rozanov is well known in the industry for having introduced the term 'sovereign wealth funds' in an article in Central Banking Journal in 2005. He is a Chartered Financial Analyst (CFA), a Financial Risk Manager (FRM), and a Chartered Alternative Investment Analyst (CAIA). He holds a Master's equivalent degree in Asian and African Studies from Moscow State University.

A Comparison of Tail Risk Protection Strategies in the U.S. Market

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1. Introduction

The global financial crisis (GFC) of 2007-08 was remarkably severe not only in the magnitude of drawdowns suffered by individual asset classes, but also the drawdowns of portfolios thought to be well diversified. The risk of such an outcome has come to be labeled tail risk in reference to the extreme left tail of an asset's or portfolio's return distribution. Since the GFC, many investment organizations have launched tail risk protection strategies designed to address such periods of severe market distress. Likewise, flows into managed futures strategies (commonly thought to profit during periods of elevated volatility) increased dramatically .[1]

Tail risk represents the loss at the most negative part of an asset or portfolio's return distribution, or the left tail. Many studies show that equity market returns do not follow a normal distribution, with tails fatter than predicted (Fama (1965)). Extreme losses occur during times of crisis or financial market distress. In these times, we observe a contagion effect marked by a pronounced rise in many asset class correlations to equities. Since it stands out as the dominant explanatory risk factor in multi-asset class portfolios, equity return is used as a proxy for financial market risk in our study. While protection against tail risk has generated considerable attention and asset flows, there is significant disagreement regarding the efficacy of such strategies and their cost/benefit tradeoffs. Theoretically, a tail risk strategy should have a low required rate of return because it pays off at times of market distress.

This paper measures the benefits and costs of several candidate tail risk protection strategies empirically using more than 20 years of monthly data from U.S. markets. We analyze four methods for controlling tail risk: (1) long volatility, (2) low volatility equity, (3) trend following, and (4) equity exposure management.

We consider an investment strategy to offer tail risk protection if it consistently outperforms equities when equity returns are most negative. We define portfolio tail risk as the conditional mean portfolio return in months where equity returns exceed a loss of five percent. For each tail risk strategy, we estimate the fixed allocation, that when combined with an equity portfolio, reduces tail risk by a constant proportion. In this way each tail risk strategy is compared on an equal footing based on its contribution to tail risk reduction.

This paper also introduces two new measures of tail risk protection efficacy. First, we measure the cost of the protection in terms of annual performance drag when added to an equity portfolio. Then, we measure the certainty, or consistency, of the tail risk protection. The ideal tail risk strategy combines a low performance drag with a high certainty of protection. We identify a number of tail risk strategies that perform well along these two measures.

2. The Benefits of Tail Protection

Good tail risk protection may benefit portfolios in several ways. Bhansali and Davis (2010) show that tail risk hedging can boost total portfolio profitability since a hedged portfolio allows for a more growth-oriented asset allocation. In addition, Fama and French (1989) demonstrate that expected returns are time-varying. Expected returns are likely to rise during periods of market distress, in order to compensate those investors willing to bear market risk. In fact, Kelly (2011) showed that tail risk has a significant, positive relationship with forward expected returns.

Time-varying expected returns that are correlated to business conditions and recent market volatility increase the benefits to an efficiently run tail risk hedging program. Presumably, if an investor can truncate losses during a significant market drawdown, saving their "dry powder," the investor can then re-allocate toward riskier assets after the drawdown in order to benefit from rising return premiums.

Exhibit 1 provides supportive evidence of time-varying expected returns. Using capitalization-weighted U.S. equity returns from 1926, the table shows that the market often rebounds significantly in the quarter following a sharp decline. Both the average return and the probability of a positive return rises as the magnitude of the prior market decline increases.

3. Diversification

An investment manager's first tool to curtail tail risk is typically to diversify among asset classes with low correlation. However, simply diversifying global equity with fixed income, for example, does not do enough to limit tail risk. A portfolio with a traditional 60% equity, 40% fixed income allocation derives over 90% of portfolio risk from the equity component (Qian (2011)).

One limitation to the diversification approach is that asset class return correlations rise in times of crisis, as shown

Exhibit 1 Forward Equity Returns Increase Following a Crisis, June 1926 - June 2011, S&P 500 Index

Quarterly Returns since 1926	Occurances	% Followed by Positive Return	Following Quarters Average Return
Market Fall > 5%	54	61%	3.34
Market Fall > 10%	29	69%	9.23
Market Fall > 15%	16	75%	9.75
All Quarters	340	68%	3.04

Source: Factset, Standard & Poor's. Past performance is not a guarantee of future results.

Exhibit 2 Asset Correlations in Normal and Crisis States, January 1990 – September 2011

Normal

	S&P500
S&P500	1.00
Russell2000	0.70
MSCI World x US	0.61
MSCI EM	0.54
US Aggregate	0.18
High Yield	0.51
S&P GSCI	0.02
FTSE NAREIT	0.42
HFRI Fund Weighted	0.60

Crisis

	S&P500
S&P500	1.00
Russell2000	0.75
MSCI World x US	0.77
MSCI EM	0.73
US Aggregate	0.34
High Yield	0.75
S&P GSCI	0.46
FTSE NAREIT	0.66
HFRI Fund Weighted	0.71

Crisis - Normal

	S&P500
S&P500	1.00
Russell2000	0.05
MSCI World x US	0.16
MSCI EM	0.19
US Aggregate	0.15
High Yield	0.23
S&P GSCI	0.43
FTSE NAREIT	0.25
HFRI Fund Weighted	0.11

Source: Fact Set, Standard & Poor's, Russell, MSCI, Barclays, FTSE, HFRI in Exhibit 2. We define a normal state as any month when the S&P 500 returned greater (more positive) than -5%, and a crisis state as any month when the S&P 500 fell -5% or worse. There were 261 total months in this test. Of those months, 234 were normal and 27 were crisis months.

The left panel shows asset correlations for the normal months versus the S&P 500, while the middle panel summarizes the correlations for the crisis months. The right panel simply shows the difference between a crisis state and a normal state correlation of each asset class versus the S&P 500. Notice that in each case, asset class correlations rise when moving from a normal to a crisis state.

The correlation coefficient measures the degree to which the movements of two variables are related. For example, a correlation of 1.00 would indicate that the two asset classes monthly returns move in the same direction (positive or negative) for the stated time period. In contrast, a correlation coefficient of -1.00 would mean that the two indices move in opposite direction. A correlation of zero indicates that the two exhibit no discernible relationship.

The analysis from Exhibit 2 underscores some of the challenges when only using diversification as the tail risk hedging tool. First, finding truly uncorrelated asset returns is difficult. Many non-equity asset classes are positively correlated to equities, suggesting they carry significant equity "beta" exposure. Second, correlations rise just when they are needed most. For example hedge fund indices, high yield debt, and REITS all correlate between 0.66 and 0.75 with the equity market during crisis periods.

4. Measuring Tail Risk: Equity Exposure

The foregoing hints at the pervasive nature of equity risk that affects even well-diversified multi-asset class portfolios. Indeed, Bhansali (2011) finds an equity market risk factor explains the largest portion of cross-sectional asset class return variance. One may think of this risk factor as shifts in economic growth expectations or investor risk aversion that afflict many assets simultaneously. Given the above reasoning, along with a heavy equity bias in most institutional allocations, we use equity index losses as a proxy measure for portfolio tail risk exposure in our study.

Exhibit 3 graphically shows the magnitude and frequency of tail events illustrated by the peak-to-trough drawdown losses of the U.S. market since 1926. The data series is constructed by Ibbotson Associates and represents a back-casted S&P 500 return. Every time the line hits the top axis, the equity market has reached or exceeded its previous peak. The S&P 500 has experienced 24 drawdown events of 20% or more since 1926, averaging one event every 3.54 years. Exhibit 4 documents these events. We calculate the beginning of a new drawdown event either once a new peak has been hit or once there has been a previous 20% drawdown event. For example, if there were two consecutive monthly returns of -20%, we would consider this to be two distinct 20% drawdown events.

Although some might consider prolonged drawdowns during recessionary markets as one event, we believe our methodology more accurately reflects the risk to an investor from entering the market at any time during that period. Excluding depression-era stock market performance, we find that a drawdown event of 20% or greater occurred every 7.08 years since 1940. More recently, the S&P 500 drawdown of -49.84% during the 2007-08 global financial crisis eclipsed the -44.73% drawdown in September 2002 after the bursting of the technology bubble began in early 2001 and is the largest peak to trough drawdown since the end of the Great Depression.

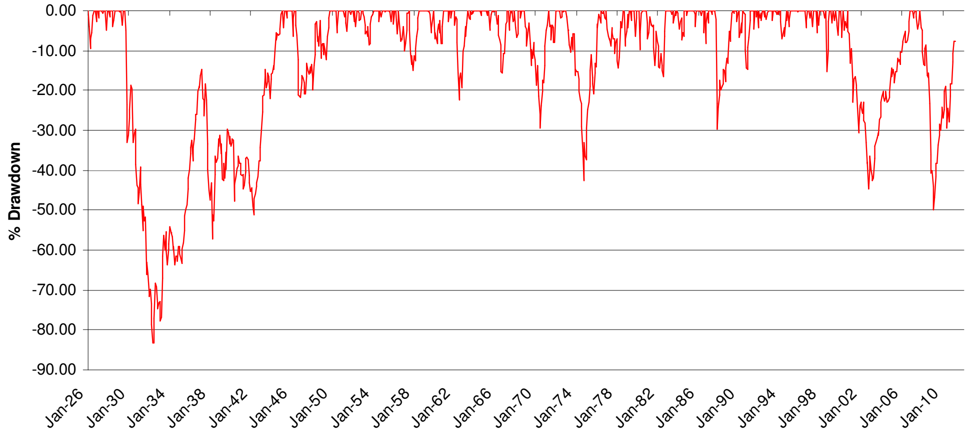

Exhibit 3 Equity Market Drawdown in the S&P 500 (January 1926 – March 2011)

Source: Standard and Poor's, Fact Set

Exhibit 4 S&P 500 Periods of Drawdown January 1926 – March 2011

Periods of Drawdowns (January 1926 -March 2011)		
Periods	*Breaks 20% Drawdown*	*Max Drawdown**
Sept 1929 - Dec 1944		83.41%
Oct-1929	-23.55%	
Sep-1930	-24.45%	
May-1931	-27.00%	
Sep-1931	-33.62%	
Jan-1932	-23.01%	
Apr-1932	-29.24%	
May-1932	-21.96%	
Feb-1933	-29.82%	
Jul-1934	-20.71%	
Sep-1937	-21.92%	
Dec-1937	-21.40%	
Mar-1938	-24.87%	
May-1940	-25.72%	
Apr-1942	-23.08%	
Jun 1946 - Sep 1949		-21.76%
Sep-1946	-21.08%	
Jan 1962 -Mar 1963		-22.28%
Jun-1962	-22.28%	
Dec 1968 - Feb 1971		-29.33%
Apr-1970	-21.33%	
Jan 1973 - Jun 1976		-42.65%
Apr-1974	-20.07%	
Sep-1974	-28.25%	
Sept 1987 - Apr 1989		-29.58%
Oct-1987	-23.26%	
Sept 2000 - Sept 2006		-44.37%
Mar-2001	-23.04%	
Jul-2002	-26.22%	
Nov 2007 - ?		-49.84%
Sep-2008	-23.19%	
Nov-2008	-22.76%	

Note: Past performance is not a guarantee of future results.
Source: Standard and Poor's, Fact Set

5. Tail Risk Strategy Analysis

In this section we examine a number of tail risk strategies, grouping them into four categories: (1) long volatility, (2) low volatility equity investing (stock selection), (3) trend following, and (4) equity exposure management. The calculations and indices used for strategy performance are detailed in the Appendix.

Strategies in the long volatility category are VIX futures (*VIX1m* and *VIX5m*) and variance swaps (*VARSWP1m* and *VARSWP3m6m*). *VIX1m* and *VIX5m* hold a combination of VIX futures contracts to maintain a constant 1-month

Exhibit 5 Tail Risk Strategies Stand Alone Performance March 1990 – March 2011

Strategy Type	Strategy	Annual Return	Annual Std Dev	IR	Correlation S&P 500	Beta S&P500	Correlation VIX
	S&P 500	9.08	15.11	0.60	1.00	1.00	-0.63
Cash	TBILL	3.59	0.59	6.04	0.06	0.00	0.07
Volatility Based	VIX1m	-45.55	52.86	-0.86	-0.59	-2.07	0.75
Volatility Based	VIX5m	-5.57	29.93	-0.19	-0.54	-1.07	0.68
Volatility Based	VARSWP1m	-4.03	7.24	-0.56	-0.34	-0.16	0.41
Volatility Based	VARSWP3m6m	-0.54	15.96	-0.03	-0.61	-0.64	0.58
Low Vol Equity	LBMHB	-0.82	24.26	-0.03	-0.69	-1.10	0.42
Low Vol Equity	DSB	-0.53	19.23	-0.03	-0.71	-0.90	0.47
Trend Following	MGDFUT	6.34	8.32	0.76	-0.10	-0.06	0.08
Exposure Mgmnt	PUT	-2.75	4.27	-0.64	-0.55	-0.16	0.44
Exposure Mgmnt	TACT	8.62	15.13	0.57	-0.05	-0.05	-0.01

Source: Factset, Standard & Poor's, Bloomberg, Ibbotson Associates, Commodity Systems Inc., Barclays, Hedge Fund Research, Inc.

(30-day) and 5-month time to maturity. They are tracked by the highly liquid ETNs (NYSE Tickers: VXX and VXZ). *VARSWP1m* is a rolling investment in 1-month to maturity variance swaps, struck at prevailing S&P 500 implied variance, and receives realized variance. *VARSWP3m6m* invests in a forward start variance swap struck at the S&P 500 implied variance at three months' time, and receives the six month realized variance over the period starting at three months' time. Long volatility strategies are a natural equity hedge because equity market declines are often accompanied by jumps in volatility.

The low volatility equity investing (stock selection) strategies are negative beta stock portfolios that benefit from return anomalies or stock picking ability. The negative beta of these portfolios make them an obvious equity hedge, meanwhile the portfolios are designed to provide an alpha component beyond their systematic risk exposure. The low beta minus high beta strategy (LBMHB) is 100% long the low-beta quintile and 100% short the high-beta quintile of liquid US stocks within the Russell 3000 Index. Prior to portfolio formation, betas are estimated for each stock by regressing its daily returns on the daily market returns over the prior two years. This decile spread represents the active return from a low volatility or minimum variance equity portfolio when compared to the S&P 500 Index. The dedicated short bias (DSB) strategy is represented by the HFRI Short Bias Index. Managers comprising this index rely on their skill in shorting overvalued companies.

The trend following strategy (MGDFUT) is represented by the Barclay's CTA Index, a composite of managed futures funds. Commodity trading advisors primarily rely on a trend-following approach to add value. Fung and Hsieh (2001) showed that trend-following strategies have the payoff profile of a lookback straddle with higher performance in pronounced market uptrends and downtrends.

The fourth and final category, equity exposure management, comprises strategies that limit equity exposure. The put option (PUT) strategy purchases one-month to maturity 8.5% out-of-the-money puts on the S&P 500 index and liquidates one day prior to expiration. The tactical equity strategy (TACT) invests in the S&P 500 index when it lies above its ten-month moving average and shorts the index when it falls below its moving average.[2] Put options, by design, and a tactical equity strategy with skill at timing when to short, will both pay off during equity downturns.

Exhibit 5 summarizes the stand-alone performance of our collection of tail risk strategies along with the S&P 500 and cash (one-month Treasury Bill) over our sample from March 1990 – March 2011. S&P 500 returns averaged 9.08%per year with 15.11% annual risk during this time period. Since the annual return and risk figures are close to or even above their long term average, the period of analysis will not bias our study toward making tail risk solutions look effective. From Exhibit 5, we see that monthly returns to the S&P 500 are very negatively correlated (-0.63) to monthly percent changes in the CBOE VIX index. Most tail risk strategies exhibit negative correlation with equity returns and positive correlations to changes in VIX.

At first glance, the collection of tail risk strategies may not elicit any optimism because of their low or negative stand-alone annualized returns. However, it is precisely their ability to have a positive payoff in bad times that drives down the expected risk premia for tail risk solutions.[3]

6. Tail Risk Hedging Power – Performance in Crisis

Before combining each tail risk hedging strategy with an equity portfolio, we examine historically how each strategy performs during a tail risk event, defined as a month where the S&P 500 declines by 5% or more.[4] Column 3 of Exhibit 6 reports the average return of the tail risk strategies as well as the S&P 500 during such crisis months between March 1990 and March 2011. In these months, the average return for the S&P 500 is -8.10% while average return to all of the tail risk strategies is positive. Column 4 of the table shows excess return to the S&P 500 during crisis months for each strategy and represents hedging power. The two VIX futures strategies have the greatest hedging power, outperforming the S&P 500 by 24.7% and 19.2%. All strategies have stronger tail risk hedging power than a Cash allocation (*TBILL*) which outperforms by 8.3%.

7. Adopting a Tail Risk Strategy

We now evaluate the effects on portfolio performance of allocating to different tail risk strategies. To make a fair comparison, we estimate the fixed allocation between the S&P 500 and each strategy that achieves a targeted reduction in tail risk. First, we define portfolio tail risk for portfolio j which we abbreviate PTR_j:

$$PTR_j = E[\, R_j \mid R_{SP500} < -5\% \,] \qquad (1)$$

Exhibit 6 Tail Risk Hedging Power

Strategy Type	Strategy	Average Rtn (S&P < -5%)	Excess Rtn (S&P < -5%)
	S&P 500	-8.10	0.00
Cash	TBILL	0.24	8.34
Volatility Based	VIX1m	16.57	24.67
Volatility Based	VIX5m	11.09	19.19
Volatility Based	VARSWP1m	1.59	9.69
Volatility Based	VARSWP3m6m	6.87	14.97
Low Vol Equity	LBMHB	10.78	18.88
Low Vol Equity	DSB	7.01	15.11
Trend Following	MGDFUT	1.73	9.83
Exposure Mgmnt	PUT	1.57	9.67
Exposure Mgmnt	TACT	3.65	11.75

Source: Factset, Standard & Poor's, Bloomberg, Ibbotson Associates, Commodity Systems Inc., Barclays, Hedge Fund Research, Inc.
Note: see appendix for description of indices used and construction of tail risk strategy performance.

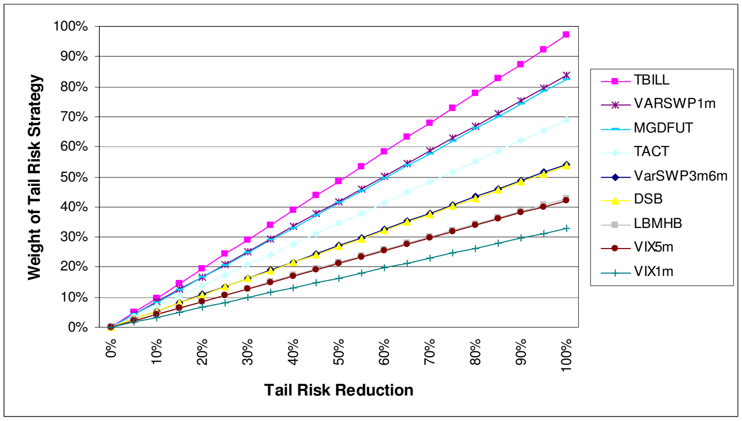

Exhibit 7 Tail Risk Strategy Allocation Frontier

Note: See appendix for description of indices used and construction of tail risk strategy performance.
Source: Factset, Standard & Poor's, Bloomberg, Ibbotson Associates, Commodity Systems Inc., Barclays, Hedge Fund Research, Inc.

Portfolio tail risk is defined as the conditional mean monthly portfolio return during months the S&P 500 loses in excess of 5%. In essence, we measure how fat is the left tail of the portfolio's return distribution. From Exhibit 6, we can see PTR_{SP500} = -8.10%. By our measure, a portfolio with 10% lower tail risk would have PTR = -7.29% (-8.10% x 0.90). Since each strategy has an excess return to the S&P 500 at its left tail (see Exhibit 6), we expect a combined S&P 500 and tail risk solution portfolio to have portfolio tail risk measure less than PTR_{SP500}.

Because each strategy has varying sensitivity to the equity market during a crisis, a different allocation to each strategy is necessary to achieve the same tail risk reduction. This is illustrated in Exhibit 7 which is a "frontier" of the required allocation to each tail risk strategy (y-axis) to achieve a certain amount of portfolio tail risk reduction (x-axis).

As expected, to gain more tail risk reduction, further investment is needed into the tail risk strategies and away from the S&P 500. The two extremes in hedging power are represented in the top and bottom lines in Exhibit 7: *TBILL* requires the largest and VIX1m the smallest allocation to reduce portfolio tail risk by a given amount. A higher required weight signifies a higher opportunity cost to the total portfolio, since less weight can be devoted to growth-seeking asset classes. Using this metric, cash (*TBILL*) is an expensive tail-risk hedge.

8. Performance Drag Measure

For the remainder of our analysis we use the allocation to each tail risk strategy that achieves a 20% reduction in portfolio tail risk. Each combined portfolio has the same portfolio tail risk (PTR_j = -6.48%, which is 80% of -8.10%); in this way we compare tail risk strategies on an equal tail risk adjusted basis.

The allocation that reduces portfolio tail risk by 20% when combined with the S&P 500 is given in the first column of Exhibit 8.[5] Some tail risk strategies require a larger allocation than others. For the put option strategy, we chose the 8.5% out of the money options as the strike that exactly achieves 20% portfolio tail risk reduction and so the allocation is given as 100%.

We introduce our first measure of tail risk efficiency which we term performance drag. Performance drag is the reduction in annual return when adopting a tail risk strategy and is shown in Exhibit 8. As an example, allocating the required 19.4% to Cash and the remaining 81.6% to the S&P 500 reduces annualized return from 9.08% to 8.19%, resulting in a performance drag of 89 basis points. The combined S&P 500/Cash portfolio achieves 80%

Exhibit 8 Performance Drag when Adopting Tail Risk Strategy

Strategy Type	Strategy	Allocation	Performance Drag	portfolio performance: Annual Return	Annual Std Dev	IR	reduction in risk measures: Annual Std Dev	Maximum Drawdown	PTR: Avg Rtn (S&P < -5%)
	S&P 500		0.00	9.08	15.11	0.60	100%	100%	100%
Cash	TBILL	19.4%	0.89	8.19	12.18	0.67	81%	84%	80%
Volatility Based	VIX1m	6.6%	3.55	5.52	12.39	0.45	82%	84%	80%
Volatility Based	VIX5m	8.4%	0.65	8.43	12.65	0.67	84%	84%	80%
Volatility Based	VARSWP1m	16.7%	2.03	7.04	12.22	0.58	81%	82%	80%
Volatility Based	VARSWP3m6m	10.8%	0.68	8.40	12.50	0.67	83%	85%	80%
Low Vol Equity	LBMHB	8.6%	0.32	8.76	12.47	0.70	83%	88%	80%
Low Vol Equity	DSB	10.7%	0.55	8.53	12.12	0.70	80%	87%	80%
Trend Following	MGDFUT	16.5%	0.21	8.87	12.55	0.71	83%	84%	80%
Exposure Mgmnt	PUT	100.0%	2.68	6.40	13.18	0.49	87%	87%	80%
Exposure Mgmnt	TACT	13.8%	-0.25	9.33	13.08	0.71	87%	79%	80%

Source: Factset, Standard & Poor's, Bloomberg, Ibbotson Associates, Commodity Systems Inc., Barclays, Hedge Fund Research, Inc.
Note: See appendix for description of indices used and construction of tail risk strategy performance.

portfolio tail risk (by design) and 81% of portfolio standard deviation as compared to an S&P 500 only portfolio, and risk-adjusted performance given by an information ratio of 0.67.

The performance drag from cash serves as a useful benchmark; to be viable, tail risk strategies should do better. However, several candidate tail risk strategies fail to meet this standard. The long volatility strategies with allocations to VIX1m and VARSWP1m have performance drags of 355 and 203 basis points respectively, both worse than Cash. The strategy allocating to put options (PUT) also has a large performance drag of 268 basis points per year.

Poor performance for the strategies allocating to VARSWP1m and PUT is explained by the volatility risk premium. The cost of put options and variance swaps depends on implied volatility of equity index options, which usually trade at a premium to realized volatility.[6] The sizeable drag of the VIX1m strategy is due to the historical contango relationship in VIX futures; short term VIX futures usually trade at a premium to spot VIX. We estimate the average roll cost to maintain a one month to maturity VIX futures at 3.62% per month (more detail in the Appendix).

On the brighter side, the majority of strategies included in our study feature lower performance drag than cash, making them historically viable solutions for managing tail risk. All of the following strategies improved tail risk adjusted return as well. The VIX5m long volatility strategy (8.4% Vix5m/91.6% S&P 500) had a performance drag of 65 basis points per year. The VIX futures term structure flattens at longer maturities, reducing estimated roll cost for VIX5m. For similar reasons, the forward start variance swap strategy VARSWP3m6m had a performance drag of 68 basis points.

Both strategies allocating to low volatility equity (stock selection) fared well while reducing tail risk. The portfolio allocating a portion to low beta minus high beta (LBMHB) underperformed a pure S&P 500 investment by only 32 basis points. The portfolio allocating a portion to dedicated short bias (DSB) underperformed a pure S&P 500 investment by 55 basis points. The strategy allocating 16.5% to managed futures (MGDFUT) did well as it had an annual performance drag of only 21 basis points.

The best tail risk strategy on our performance drag measure was tactical equity (TACT) which actually outperformed the S&P 500 by 25 basis points per year while still reducing tail risk by 20%. We combined this timing strategy with the S&P 500 as we did the other strategies (in this case the S&P 500 was 86.2% of the portfolio). As a reminder, our tactical equity strategy uses a simple trading rule and is long the S&P 500 index when above its 10 month moving average and short the index when below. Remarkably, of the 24 months with greater than 5% loss in the S&P 500 between March 1990 and March 2011, 17 of them (or 71%) occurred with the S&P 500 below its 10-month moving average.[7]

9. Certainty Measure

A second way to evaluate the effectiveness of a tail risk strategy is to look at the consistency with which it outperforms during a crisis. We introduce a measure we call certainty of tail risk protection, abbreviated Cj which we define as the conditional information ratio of tail risk strategy k's excess return to S&P 500 during a tail risk event (months where the S&P 500 falls more than 5%):

$$Ck = IR \left[Rk - R_{SP500} \mid R_{SP500} < -5\% \right] \text{ or} \quad (2)$$

$$Ck = E \left[Rk - R_{SP500} \mid R_{SP500} < -5\% \right] / SD \left[Rk - R_{SP500} \mid R_{SP500} < -5\% \right]$$

Certainty of tail risk protection is summarized in Exhibit 9 where we also show the mean and standard deviation of excess return used to calculate the conditional IR. The final column in Exhibit 9 shows the frequency with which each strategy had a positive return in a tail risk event. The high frequency of positive performance, often approaching 100% of the time, validates the inclusion of these strategies in our study. Because tail risk events are by definition infrequent, we want some degree of confidence that a tail risk strategy will pay off when needed and in a predictable fashion.

We consider a certainty measure of 1.0 as a reasonable minimum threshold from a tail risk strategy. All strategies in our study have a certainty measure above 1.0 with the exception of VIX1m (0.87). Cash (TBILL) is the most consistent tail risk hedge with a 2.94 certainty measure, due to low variation in T-Bill returns. The VIX-based strategies have the largest variability in excess return and the long volatility strategies fare the worst as a group

Exhibit 9 Certainty of Tail Risk Strategy Protection

Strategy Type	Strategy	Certainty Measure	Average Excess Return	Std Dev Excess Return	% Positive Return
Cash	TBILL	2.94	8.34	2.84	100%
Volatility Based	VIX1m	0.87	24.67	28.39	83%
Volatility Based	VIX5m	1.50	19.19	12.75	100%
Volatility Based	VARSWP1m	1.34	9.69	7.25	54%
Volatility Based	VARSWP3m6m	1.50	14.97	9.95	100%
Low Vol Equity	LBMHB	2.25	18.88	8.38	88%
Low Vol Equity	DSB	2.42	15.11	6.24	96%
Trend Following	MGDFUT	2.19	9.83	4.49	67%
Exposure Mgmnt	PUT	1.96	9.67	4.94	79%
Exposure Mgmnt	TACT	1.32	11.75	8.92	71%

Source: Factset, Standard & Poor's, Bloomberg, Ibbotson Associates, Commodity Systems Inc., Barclays, Hedge Fund Research, Inc.
Note: see appendix for description of indices used and construction of tail risk strategy performance.

on our certainty measure. Strategies that provide highly consistent protection are the two low volatility equity (stock selection) strategies and managed futures, all of which feature certainty measures above 2.0.

The ideal tail risk strategy has low performance drag and high certainty of protection. Exhibit 10 displays each tail risk strategy along these two dimensions where strategies to the upper left are preferred.

It is clear from Exhibit 10 that three tail risk strategies are dominated by the others. These inferior strategies are put options, VIX one month futures, and one month variance swaps. Furthermore, VIX five month futures, and 3 month variance swaps are both dominated by Short bias, Low minus High Beta and Managed Futures. Several strategies remain that are not dominated and meet our two criteria of a certainty measure above 1.0 and a performance drag lower than Cash – namely Short bias, Low minus High Beta, Managed Futures and Tactical Equity. Depending upon our willingness to trade off return (performance drag) for risk (certainty of protection) the strategies contained in the shaded region appear to be historically viable choices for managing tail risk.

10. Conclusion

Modest allocations to a handful of tail risk protection strategies may significantly improve portfolio performance in times of tail risk events. Protecting against tail events can help improve long-term performance for even well diversified investors seeking to capture premia from risky assets. Protection during periods of market distress allows managers to reallocate to riskier assets in the aftermath of the event, just when expected returns are the highest.

A number of tail risk solutions showcased in this study feature low performance drag and offer high certainty of protection. In addition, skilled active management holds the potential to improve each tail risk strategy we identify in this study. For example, dedicated short bias and managed futures are represented by industry composites;

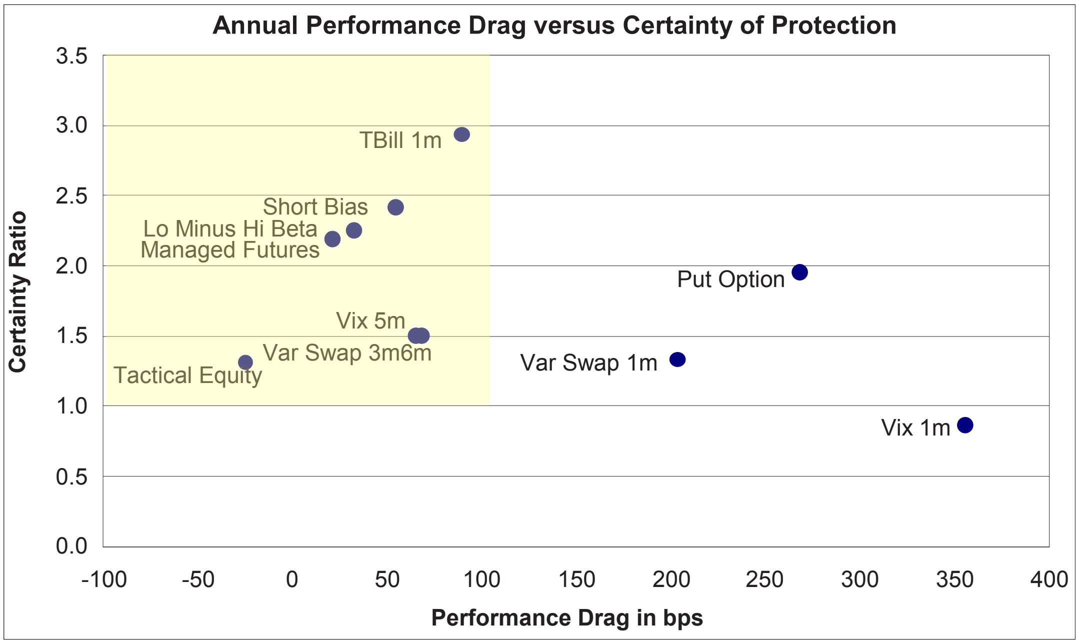

Exhibit 10 Tradeoff of Annual Performance Drag versus Certainty of Protection
Source: Factset, Standard & Poor's, Bloomberg, Ibbotson Associates, Commodity Systems Inc., Barclays, Hedge Fund Research, Inc.

high performing managers beat average peer performance. Low volatility or minimum variance portfolios are composed differently by each manager and variations can lead to better performance. Skilled volatility regime forecasts can lead to a more robust dynamic allocation of VIX futures contracts. Similarly, sophisticated tactical asset allocation models can potentially outperform the simple moving average crossover model used in the tactical equity strategy. Ultimately, the choice of tail risk strategy will depend on a prospective evaluation of strategy performance, in conjunction with an investor's asset allocation preference. The framework used in this analysis can serve as a starting point for investors interested in tail risk hedging.

Appendix

Sources of Indices Used and Construction of Tail Risk Strategy Performance

TBILL is the U.S. 30 Day Treasury Bill Total Return from Ibbotson Associates' Stocks, Bonds, Bills and Inflation.

VIX1m and VIX5m represent an investment in a synthetic one-month and five-month constant maturity VIX futures as calculated by Chicago Board of Options Exchange (CBOE) indices SPVXSTR and SPVXMTR available from Bloomberg January 2006 to March 2011.

Prior to 2006, VIX futures index data are unavailable. We backfill VIX futures index using CBOE VIX index returns (also sourced from Bloomberg) which are available throughout our sample period with the following methodology. For January 2006 to March 2011, we estimate the relationship between monthly VIX futures index return and the spot VIX index return in a regression.

As expected the return to the VIX futures contracts are very significantly positively related to VIX return with the VIX 1m Future having a lot higher sensitivity, +0.70, than the VIX 5m Future, +0.31. The regression for the VIX 1m Future has a large negative constant, -3.62 percent per month, that reflects the negative roll yield associated with owning VIX short term futures contracts in this time period. The VIX futures term structure has typically been upward sloping, or in contango, at short maturities. In contrast, the VIX 5m Future has very little monthly roll cost as estimated by the above regression, -0.16%per month, as the VIX futures term structure has been relatively flat at five months.

We backfill VIX1m and VIX5m by simulation using (1) coefficients from the above regression, (2) the actual levels of VIX available from 1990-2005, and (3) a simulated error term that reflects the unexplained error from above regression and the observed error correlation across VIX1m and VIX5m futures. A slightly more sophisticated

Exhibit A1 Regression of Monthly VIX Futures Index versus VIX return

Dep. Variable	Intercept	Beta VIX	R-SQ
	(t-stat)	(t-stat)	
VIX1m Future	-3.62	0.70	0.55
	(-1.99)	(8.56)	
VIX5m Future	-0.16	0.31	0.47
	(-0.17)	(7.32)	

regression model incorporating a two term intercept reflecting a different term structure slope depending on whether VIX was above or below average was also estimated. Performance results from this second model are nearly identical to those achieved with the model presented which is chosen for its ease of exposition.

VARSWP1m uses the S&P 500 Volatility Arbitrage Index SPARBV available from Bloomberg. Since SPARBV represents a one-month swap that pays realized variance and receives implied variance, we use the negative of this index to represent a swap paying realized variance and receiving implied variance. To make it a total return index we also add on the interest component, or the difference between SPARBVT and SPARBV, the total and excess return versions of this index.

VARSWP3m6m uses the Deutsche Bank Equity Long Volatility Investment Strategy Index DBVELVIS available from Bloomberg.

LBMHB uses the most liquid 2,300 stocks, or roughly 75%, of the Russell 3000 universe where liquidity is estimated using trailing six month median daily dollar trading volume. For each stock we estimate a historical beta to the Russell 1000 index using two years of trailing daily returns. Performance is calculated as a quintile spread buying the 20% of stocks with lowest beta and selling the 20% of stocks with the highest beta each month. The strategy represents an equal weight portfolio long 460 low beta and short 460 high beta liquid U.S. stocks rebalanced monthly.

A long short portfolio replicating the LBMHB strategy would also have its performance supplemented by its cash holdings. Detracting from performance would be trading costs from turnover and additional interest costs for harder to borrow securities. Using estimates of all of these costs from trading similar strategies along with historical interest rates, we expect performance for the LBMHB strategy that includes cash and net of transaction costs to be higher than those presented.

DSB uses the HFRI Short Bias Index HFRISHSE as calculated by Hedge Fund Research, Inc. and available from Bloomberg.
MGDFUT uses the Barclay CTA Index BARCCTA available from Bloomberg.
PUT uses S&P 500 index option data available from Commodity Systems Inc.
TACT uses monthly levels of the Standard & Poor's 500 Index available from Facstet and we calculate its ten-month moving average. At each month end, if the S&P 500 lies above its ten-month moving average, the next month's strategy performance equals a long S&P 500 investment. When the S&P 500 lies below its ten-month moving average, the subsequent month's strategy performance equals a short S&P 500 investment.

The model portfolio performance shown was created by Alternatives Team. The model portfolio performance does not reflect actual trading and does not reflect the impact that material economic and market factors may have had on SSgA decision-making. The results shown were achieved by means of a mathematical formula. The model performance shown is not indicative of actual future performance, which could differ substantially.

[1]According to Barclay Hedge, managed futures strategies experienced $114 (B) in asset growth, representing a 55% increase, since the end of 2008. During that period, the Barclays CTA Index had a 3.54% return, signaling most of this growth is due asset inflows, not appreciation.
[2]We could just as easily construct the tactical equity strategy to be asymmetric so that it shorts the S&P 500 index when below its moving average and otherwise invests in cash.
[3]The required risk premium for any asset reflects its covariation with bad times. (Ilmanen 2011 p. 69)
[4]In our study period March 1990 – March 2011, a decline in the S&P 500 exceeding 5% occurs in 24 months or 9.5% of the time.
[5]A 20% reduction in tail risk is chosen to guide the analysis. Required allocations scale linearly to the chosen level of tail risk reduction (see Exhibit 7) because we use mean returns in our calculations. For example, a 40% reduction in tail risk requires twice the allocations given in Exhibit 8.
[6]Between March 1990 and March 2011, we estimate that realized forward one-month S&P 500 volatility exceeds implied volatility, given by VIX, in only 15.0% of the months. S&P 500 realized volatility is measured using daily returns.
[7]The ten-month or 200-day moving average is a popular technical indicator among market participants; its effectiveness in asset class timing is documented by Faber (2005).

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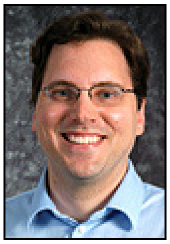
Author Bios



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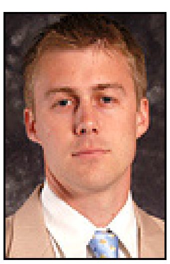

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Practitioner Perspectives

Tales from the Downside:
Risk Reduction Strategies

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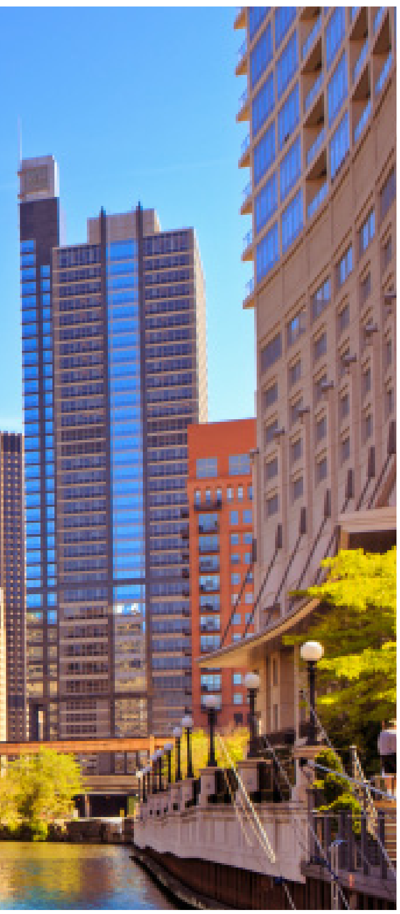
1. Introduction

Equity market volatility in the past decade has at times reached levels not seen since the Great Depression. We forecast that risk will continue to be elevated for several years to come, as economic and market uncertainty persist. Some clients have limited ability to absorb further capital losses of the magnitude experienced in 2008-09.



The primary lever clients have to reduce total portfolio risk is a shift from return-seeking (equity, risky fixed income and alternative assets) to risk-reducing (fixed income) assets. But historically low fixed-income yields mean bond allocations won't likely contribute much toward total portfolio return objectives, while at the same time they carry risk in terms of falling bond prices when rates rise. Investors want a way to reduce risk, especially the risk of large losses in tail events, but without giving up much return. At the same time, some investors have dampened enthusiasm for traditional active management to improve on capitalization-weighted indexes in terms of either value added or downside risk protection.

Consequently, a host of products advertised to reduce risk, without reducing return, have appeared since 2008. We'll discuss several potential strategies for limiting risk, including low volatility equity strategies, tail risk products, and managed futures and global macro hedge fund strategies.

2. Low-Volatility Equity Strategies

Low volatility equity strategies operate on the belief that the traditional relationship between higher risk (as measured by volatility or beta) and higher expected return does not hold within publicly traded equities.[1] Under this belief, an investor could construct a portfolio of stocks with low aggregate volatility, without giving up expected return.

How has this strategy performed? Exhibit 1 shows the returns of the S&P 500 index of large-cap U.S. stocks, and the S&P 500 Low Volatility Index of the 100 historically least volatile stocks in the S&P 500. Lower volatility stocks performed significantly better over the past ten years, with the low volatility S&P 500 outperforming the standard index by 2.9 percentage points per year. While low volatility stocks lagged in the bull market of the late 1990s, they outperformed significantly in the market crises of 2000-02 and 2008-early 2009, and over the entire period since 1990.

3. Previous Industry Research

In a frequently cited research paper, authors Baker, Bradley and Wurgler [2011] examine the historical relationship between equity return and risk, as measured by both volatility

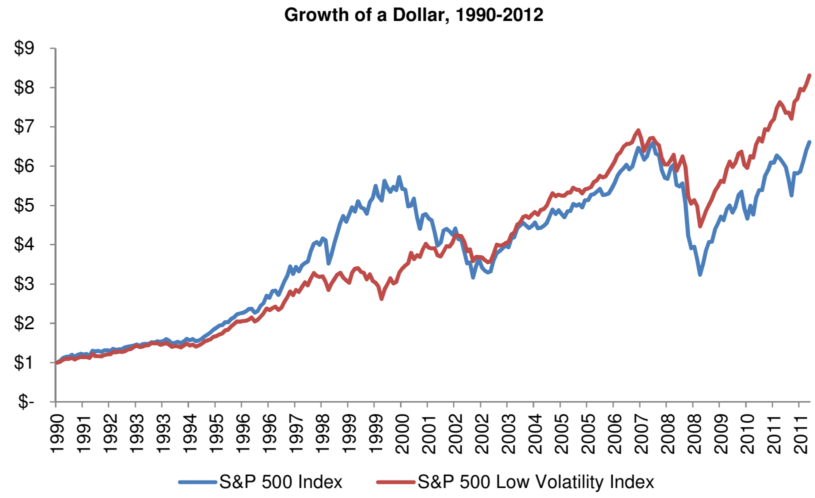


Exhibit 1 S&P 500 and S&P 500 Low Volatility 1990-2012

and beta, in a broad sample of large and small-cap stocks. They find that the returns of low-risk stocks exceeded those of high-risk stocks from 1968 to 2008. Specifically, the value of a dollar invested in the 20% of stocks with the lowest historical volatility grew to $59.55 over the period; the value of a dollar in the highest-volatility 20% fell to $0.58, a vast difference. Notably, while there was a negative relationship between volatility and return across the board, the highest-volatility portfolio was the clear outlier in terms of poor performance, providing the dramatic results cited above.

Why would a negative relationship between volatility and return, never mind such a huge one, exist, and why would investors fail to exploit it and arbitrage it away? The authors of the study argue that investors disproportionately demand high-risk stocks, and thus they are overpriced and offer low returns, for two main reasons. First, investors value the lottery-like aspects of high-risk stocks, irrationally believing that their road to outperformance must lie in identifying the next runaway success story. Second, low volatility stocks must overcome the reduced market-related return and higher tracking error they bring to a portfolio before they are attractive to benchmark-focused investors.

As an outgrowth of results like this, and investor concerns about market volatility and risk, several well-known providers have developed indexes that are constructed using a low-volatility approach, for a passive implementation of the style. Active strategies focused on the low-volatility anomaly have also been developed.

4. Analysis

Should clients allocate funds to a low volatility strategy? We begin our assessment with a straightforward analysis of the potential effect in a sample of large, liquid stocks.

We calculated five-year rolling betas for the 100 largest stocks in the S&P 500 index, over the period 1990-2011, to rank stocks by level of market risk. [2] The stocks were divided into three groups in each month; the lowest-risk 30%, the middle 40% and the highest-risk 30%. Stocks were equal-weighted within each group. We avoided capitalization weighting to be consistent with actual low volatility equity strategies, which more closely approximate equal weighting (in an active strategy) or weighting by volatility rank (many indexes). The weighting scheme is an important detail to which we will return later.

4.1. Are Risk and Return Related in Public Equity?

Over the entire period of our study (January 1990 – October 2011), we found that the risk/return relationship suggested by the Capital Asset Pricing Model (CAPM) was still intact: The high-beta stocks had the highest returns while the low-beta stocks had the lowest returns. In other words, we found no evidence of a low-volatility effect.

Our analysis generally found the theoretically expected relationship between market risk and return in up

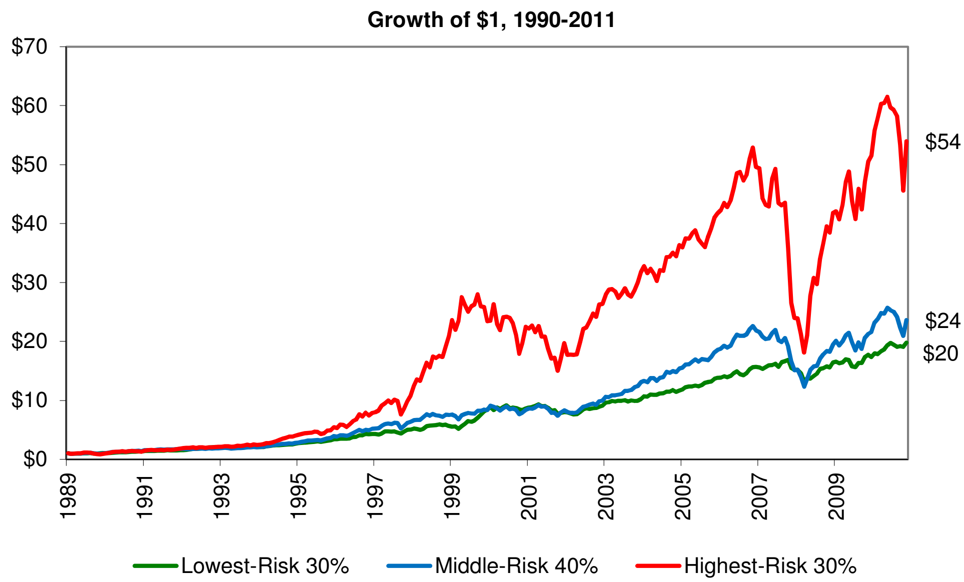


Exhibit 2 Low-, Mid- and High-Risk Portfolios 1990-2011

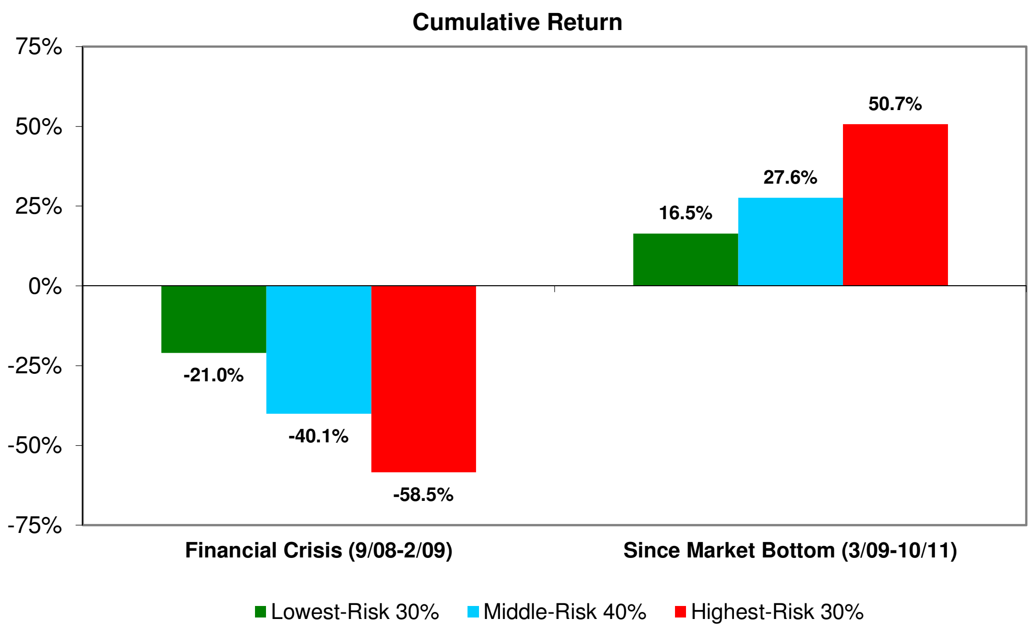


Exhibit 3 Returns in High-Risk and Low-Risk Markets

and down markets, shown in Exhibit 3. Higher-risk stocks suffered larger losses in the 2008-09 financial crisis but outperformed strongly in the recovery.

4.2. Is Risk Stable Through Time?

A key consideration for an investment strategy based on risk is whether future risk can be predicted. For a passive low-volatility strategy that seeks to outperform by overweighting historically low-risk stocks and underweighting or eliminating high-risk stocks, that means risk that is stable through time, so past risk is a good predictor of future risk. We found that betas can vary significantly over time, making prediction difficult. Idiosyncratic risks can cause betas to spike unexpectedly. Most of the stocks we analyzed had their beta fluctuate between the low and high groups over the period of study. For example, Johnson & Johnson, which many would consider a defensive stock, had only 50% of its monthly returns in the low beta bucket, and 26% in the high beta bucket. This implies

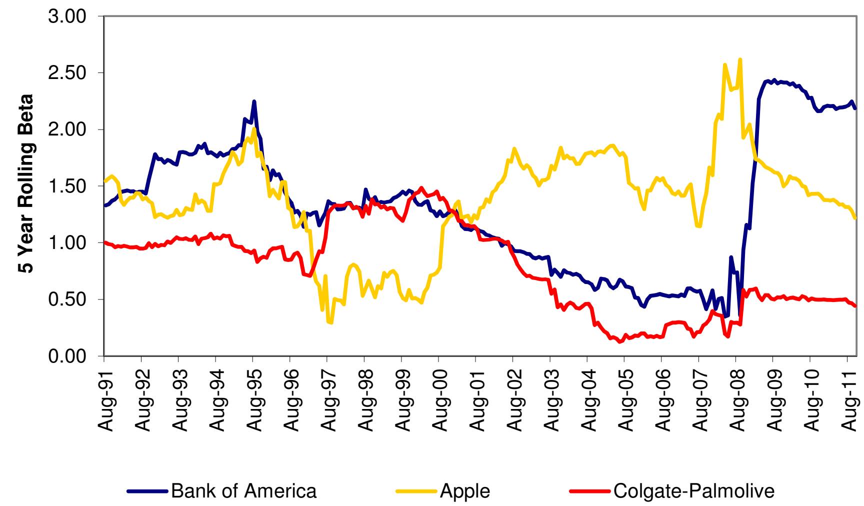


Exhibit 4 Bank of America, Apple and Colgate-Palmolive Rolling Betas

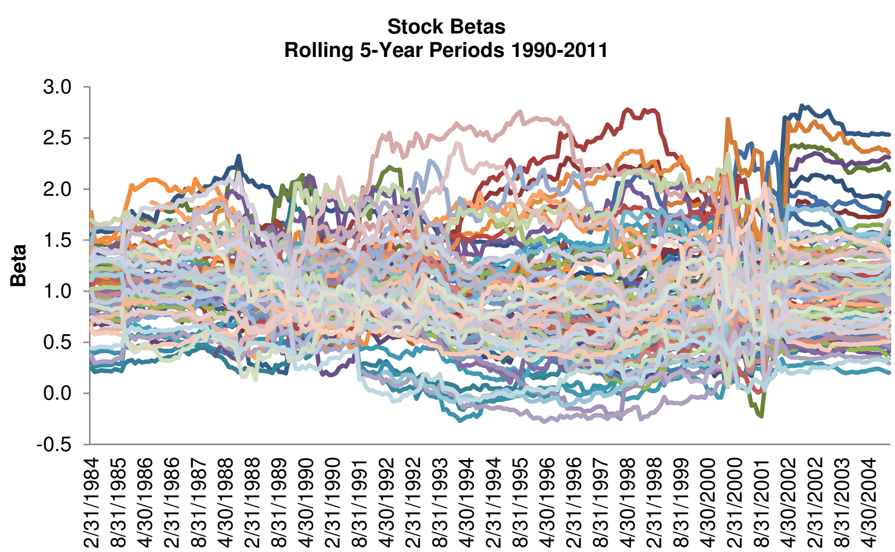


Exhibit 5 Full Sample Rolling 5-Year Stock Betas

that historical risk is not a good predictor of future risk. Other prominent stocks that exhibited shifting measures of risk are shown in Exhibit 4.

Looking more broadly across all of the stocks in our analysis, the market risk of the 100 individual stocks varied widely through time (Exhibit 5). And market events such as the 2007-09 financial crisis, had a profound effect on risk.

5. Putting It All Together

Some evidence suggests that a low-volatility anomaly exists; stocks with high risk underperform and lower-risk stocks outperform in capitalization-weighted samples of large and small stocks.

Other evidence, however, indicates that the anomaly is highly dependent on how it is measured. Short-term reversals in return may explain the underperformance of an unrebalanced, capitalization-weighted portfolio of high-volatility stocks.[3] Past winners, which make up a larger part of cap-weighted portfolios, become tomorrow's losers and drag down returns. In equal-weighted portfolios, these reversals may cancel out, explaining part of our finding of no low-volatility effect using equal-weighted samples.

Researchers do not yet agree why the effect may exist, a clear buyer-beware warning in the world of investing anomalies. Some—as much as half—of the phenomenon is probably due to the effects of valuation and size, which overlap with measures of individual stock risk.[4] (The low volatility effect, by the way, is similar in many ways to the value premium. Many investors concede that it probably exists at least some of the time, but few institutional investors attempt to exploit it as a matter of policy, instead leaving it to their active managers.) Like the value and small cap effects, the low volatility premium is not constant through time, with much of the outperformance found in the Baker study concentrated just in the chaotic period of 2000-02.

Most of the effect is also found in the very highest-risk subset of stocks. These stocks may well also be the smallest and least liquid, and therefore the most difficult and expensive to trade. Sullivan (2012) finds that transaction costs wipe out gains from the anomaly in portfolios designed to exploit it. Our study of large, liquid stocks found no evidence of the low volatility effect. The very riskiness of high-volatility stocks may explain the persistence of any anomaly—investors attempting to profit from arbitrage may find the effect swamped by the stocks' price fluctuations.[5]

Lastly, the premise of low volatility investing is that investors know what is, and will be, low volatility. But our examination of historical market risk shows that yesterday's low volatility stock may be tomorrow's risky venture. We found that betas spike when companies are distressed. Low historical beta/risk may not translate into low future risk. Even stocks that are considered defensive have had significant changes to their betas over time. Given historical beta is not a good predictor of future beta, some firms rely on forecast beta or use quality screen overlays to try to avoid the risk traps. Once portfolio managers start down the road of quality screens, then the process begins to resemble traditional fundamental equity management.

5.1. Recommendation on Low Volatility Strategies

Low volatility, in our view, joins the list of potential stock anomalies, like value, small-cap and the January effect, that are well suited as one tool in the kits of skilled active managers who can exploit them when and where they work, and focus elsewhere when they don't. Investors should continue to use a broadly diversified portfolio of stocks, high risk and low, as the foundation of their public equity investments.

6. Tail Risk Strategies

Following 2008, several investment managers developed products that are designed to perform extremely well in periods of market distress. This is accomplished through a combination of strategies, including derivatives contracted on the returns of major markets. Such protection strategies have one common characteristic—because they provide protection from risk, like homeowner's insurance, they have a cost, like an insurance premium, associated with them in normal (non-crisis) times. This is termed a negative carry—a consistent, regular loss attributed to the strategy to cover the costs of protection. This negative carry is made worse by management fees, which can be substantial.

Tail risk strategies have a natural appeal to those who want some protection from another market meltdown. Investors with tail risk allocations will be glad they have them should another major down market period appear, and the gains in such a period may well offset the cost of the strategy in more normal times. But we believe that most investors are best served by each element of their portfolio providing a consistent contribution to the bottom line in the form of positive return. The consistent drip of portfolio value from a tail risk strategy in return for protection from an unknown future event may be difficult to stomach.

It may be difficult to stick with such a strategy in the long term in the face of turnover among investment committee members and other decision makers. And most severe risks are the ones that occur in unpredictable ways and places. Will strategies designed with hindsight protect against the unknown risks of the future?

7. Managed Futures and Global Macro

So far we have discussed strategies that are intended to reduce risk. But some strategies may exist that possess some risk mitigation properties as part of a traditional strategy to produce favorable returns at an appropriate level of risk.

7.1. Managed Futures

Managed futures, sometimes called systematic global macro strategies, seek to add value through unconstrained, quantitatively-driven investment processes implemented primarily through futures contracts in the areas of equities, fixed income, commodities and currencies. They are often also called trend followers because a significant feature of the strategy is the exploitation of the anomaly of many markets to exhibit momentum, or trends, in returns. Therefore, they tend to profit from rising markets as they continue to rise and, because the strategies involve short as well as long investments, gain from falling markets as they continue to fall. Managed futures returns have an options-like payoff structure, where all else equal returns benefit from periods of persistent market volatility, illustrated in Exhibit 6. As a result, managed futures have historically offered strong returns in volatile and negative market environments, as shown in Exhibit 7.

A disadvantage of tail risk protection strategies as described earlier is their ongoing cost of hedging, which results in a drag on total fund returns, or a need for successful market timing to add tail risk protection just before it is needed most. With their ability to add to returns in normal times, managed futures have what can be described as an offensive, rather than defensive, approach to downside risk.[6]

Managed futures investing does involve risks of which a potential investor should be aware. They operate at high level of volatility, similar to that of public equity, relative to other hedge fund strategies. And their momentum-based investment strategy will lag when markets quickly reverse direction.

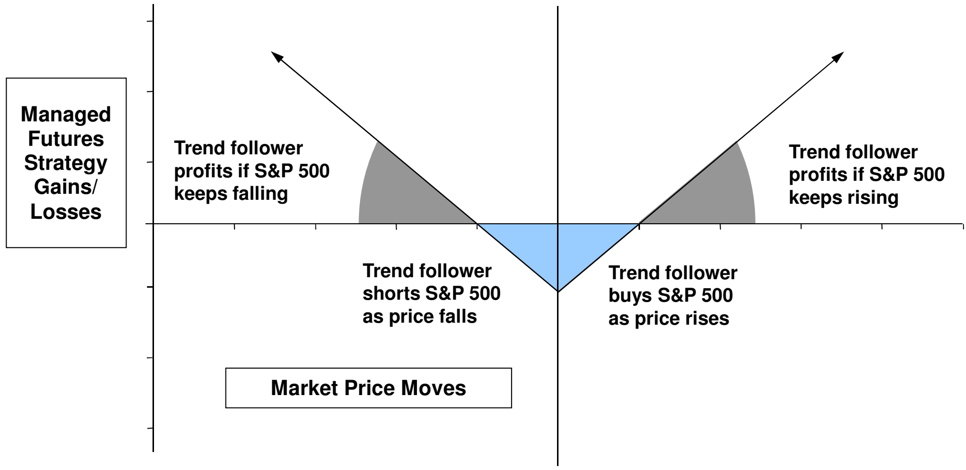


Exhibit 6 Trend Follower Performance

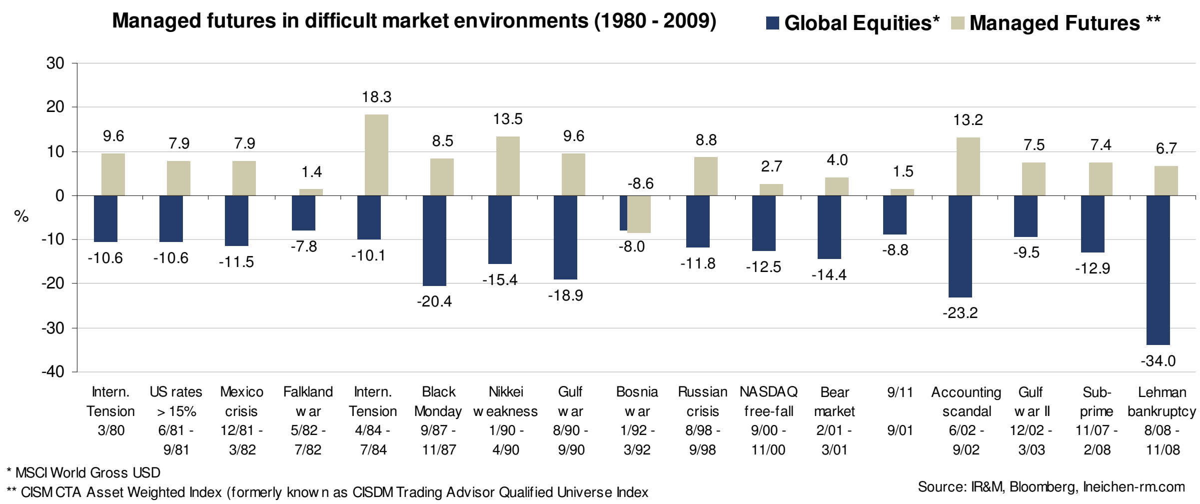


Exhibit 7 Managed Futures Performance in Difficult Markets

7.2. Global Macro

Global macro hedge funds represent possibly the most unconstrained investment strategy available. Similar to managed futures, but with a much stronger emphasis on discretionary, judgment-based portfolio management as opposed to quantitative, algorithmic trading, global macro managers invest in a wide variety of asset classes using mostly derivatives to maximize flexibility and minimize trading cost.

Trading, as they do, among major markets such as stocks and bonds, global macro strategies thrive in periods of elevated volatility. Their go-anywhere style allows them to emphasize, or avoid entirely, entire markets depending on their views—uniquely suiting them to navigate market uncertainty.

We recommend that clients who wish to make some protection from tail risk a part of their investment strategy consider allocating a portion of their alternatives or hedge fund allocations to a diversified group of managed futures and global macro managers.

[1]Beta is a measure of market risk. The market (index) is defined as having a beta of 1; an investment with a beta of 2 has twice the market risk and would be expected to generate twice the market's excess return over the risk-free (cash) return, whether positive in an up-market or negative in a down-market, if the Capital Asset Pricing Model (CAPM), which links beta and return, holds true.
[2]Stocks were required to have 15 years of return history. Transaction costs and fees were ignored in the analysis.
[3]See Huang, Liu, Ghon Ree and Zhang [2007]
[4]See, for example, Blitz and van Vliet [2007]
[5]See Cao [2009] for a discussion of idiosyncratic risk as a limit to arbitrage.
[6]See Tee (2012)

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Author Bios

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