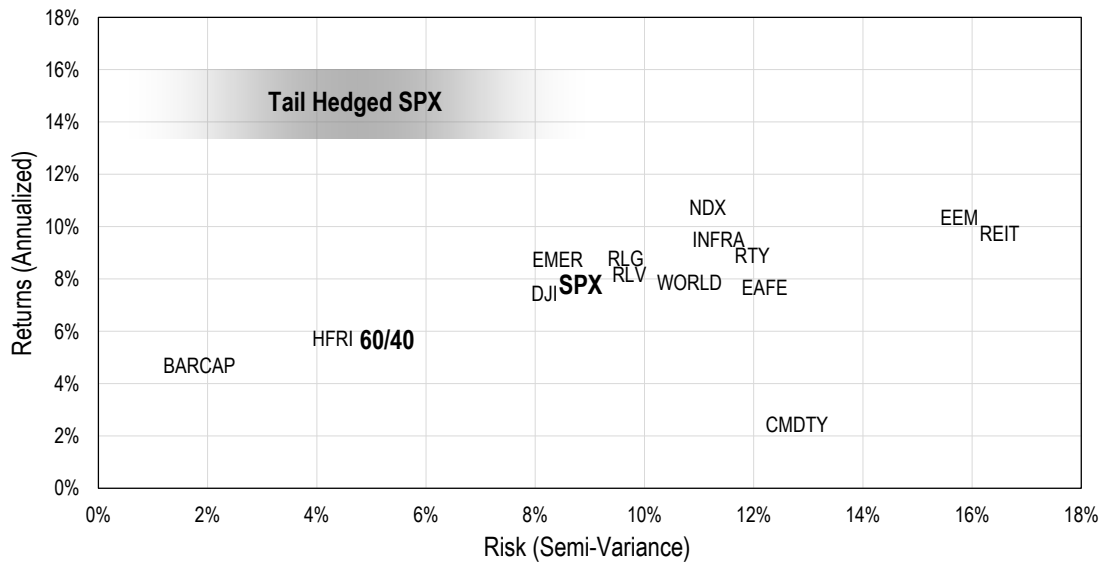


Capital Asset Pricing Mistakes: The Consistent Opportunities in Tail Hedged Equities

Chitpuneet Mann, Mark Spitznagel, and Brandon Yarckin

The introduction of asymmetric beta to the CAPM framework can allow an investor to construct a portfolio with expectations well above the security market line. Incorporating asymmetric beta provides evidence of a mispricing in certain payoff profiles, namely tail hedged equities, that can be analyzed by using variants of the CAPM type of framework. CAPM based asset allocations are misspecified and ill-equipped to handle asymmetric returns.

Risk-Return Profile (01/2004-06/2014)



60/40	60% S&P 500/40% CASH	BARCAP	BARCLAYS US AGG	RLV	RUSSELL 1000 VALUE
CMDTY	TR/CC CRB COMMODITY INDEX	EAFE	MSCI EAFE	RTY	RUSSELL 2000
EEM	ISHARES MSCI EMERGING MARKET	WORLD	MSCI WORLD	INFRA	S&P GLOBAL INFRA
HFRI	HFRI FUND WEIGHTED INDEX	NDX	NASDAQ 100	SPX	S&P 500
DJI	DOW JONES INDUS. AVG	REIT	DOW JONES EQUITY REIT	Tail Hedged SPX	TAIL-HEDGED PORTFOLIO
EMER	JPM EMERGING MKTS BOND INDEX	RLG	RUSSELL 1000 GROWTH		

The Capital Asset Pricing Model is a fundamental building block with which investors make allocation decisions over time. Investment decisions are made based on risk-return constructs, and in this framework, CAPM, for the most part, has stood the test of time. Due to its simplicity, it is widely used when an equity investor wants to roughly estimate the expected returns of one's portfolio.

We want to appraise the value of tail hedging within a CAPM framework, and thereby show the efficacy of tail hedging and the misspecification of the model itself.

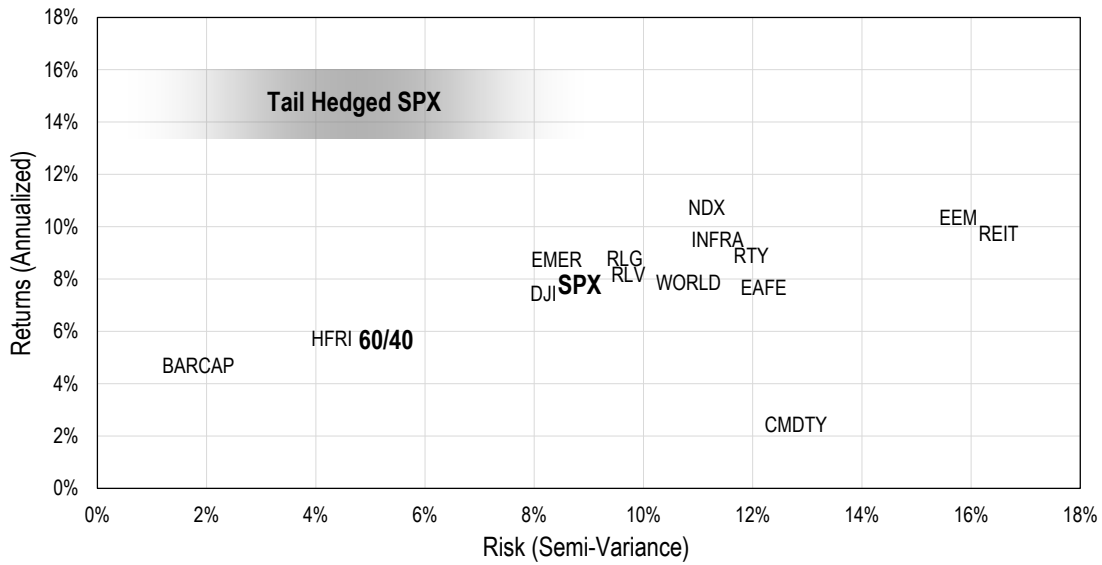
By using Harry Markowitz's efficient frontier[1], one can roughly compare different asset classes based on their consensus expected returns and observed risk (mostly computed using standard deviation of asset returns). However, this measure of risk is fairly naive since it has been well documented that most, if not all, asset classes have non-normal, fat-tailed and often asymmetric return distributions. Asymmetric properties are not well accounted for in a mean-variance framework as they underestimate tail risk in negatively-skewed portfolios. Stress tests should thus be used, as they are critical risk estimation tools that transparently demonstrate vulnerabilities to large deviations that can impact long-term expected returns. (We recognize successful empirical research stating that multifactor models[2] can explain and predict investment returns, but they have similar limitations.)

Due to the principal-agent problem in the asset management industry, most money managers rationally have a propensity to use a negatively-skewed payoff distribution[3]. This kind of behavior, in aggregate, is also evidenced in the historical data, which shows significant losses for professional investors during the largest market downturns[4]. Most investors and asset allocators, in addition to these negatively-skewed positions, further view the returns of hedging strategies in a vacuum, rather than as a holistic part of their broader portfolio. Thus, they are likely to consider portfolio hedging programs to be a drag on their performance numbers and further undervalue them. We believe that these factors, among others, contribute to a market segmentation that creates an undervaluation in tail-risk hedges.

Assuming there are such opportunities in hedging tail risk, let's evaluate how one can depict an asset class's risk-return profile and see if using a fair proxy tail-risk hedging program could help investors better maneuver these not-so-uncommon market crashes. We use Markowitz's efficient frontier type of framework to plot a 'risk measure' on the x-axis (which is the average semi-variance for three-year rolling monthly returns) and the corresponding asset's annualized returns on the y-axis.

From Figure 1, we can safely ascertain that from a risk-reward standpoint, an investment in the S&P 500 Index plus short-term Treasuries could be considered a benchmark for validating a tail hedge argument. Thus, we choose a vanilla 60/40 portfolio -- 60% invested in the S&P 500 and 40% in short-term Treasuries, rebalanced monthly. On the other hand, our tail-hedged portfolio consists of S&P 500 and out-of-the-money put options (specifically one delta which has a strike roughly 30-35% below spot) on the S&P 500. At the beginning of every calendar month, using actual option prices, the number of third-month options (with a maturity from 11 to 12 weeks, and also carrying over the payoff from unexpired options) is determined such that the tail-hedged portfolio breaks even for a down 20% move in the S&P 500 over a month. From practice, for scaling the payoff, we can safely assume that the S&P 500 options' implied volatility, or IVol, surface would look similar to the one observed after the lows of the October 2002 crash (an observed in-sample data point for the backtest period).

Figure 1
Risk-Return Profile (01/2004-06/2014)



60/40	60% S&P 500/40% CASH	BARCAP	BARCLAYS US AGG	RLV	RUSSELL 1000 VALUE
CMDTY	TR/CC CRB COMMODITY INDEX	EAFE	MSCI EAFE	RTY	RUSSELL 2000
EEM	ISHARES MSCI EMERGING MARKET	WORLD	MSCI WORLD	INFRA	S&P GLOBAL INFRA
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EMER	JPM EMERGING MKTS BOND INDEX	RLG	RUSSELL 1000 GROWTH		

Mark-to-market fluctuations in the options position of the tail-hedged portfolio (i.e. giving back small unrealized gains) can cause its risks to be overstated by semi-variance. We can, however, overcome this limitation by using model-free stress tests.

Below we have defined a conservative stress test with monthly price and IVol shifts such that the IVol is unchanged for down 5% and 10% moves (which is still included in this test as a shoulder risk, although we consider it to be a remote possibility), and for down 20%, we report the average results (in Figure 2) when we assume that the IVol surface would look similar to the one observed after five different crashes (August 1998, October 2002, October 2008, May 2010 and August 2011) in the past two decades. The benchmark portfolio would have the same risk throughout the time horizon as the price shift is defined in terms of moves in the S&P 500; however, the tail-hedged portfolio will reflect varying risk profiles depending on how often the hedge is rebalanced.

As we have defined and constructed the hedge portion of the tail-hedged portfolio in a very simplistic manner with minimal ongoing trading/rebalancing, we could evaluate the mean portfolio returns of daily stress tests to get a fair idea of what the risk characteristics look like throughout the investment horizon. Figure 2 demonstrates that the tail-hedged portfolio is increasingly less risky than the 60/40 benchmark for left fat tail moves over most of the investment horizon.

Figure 2
Stress Test

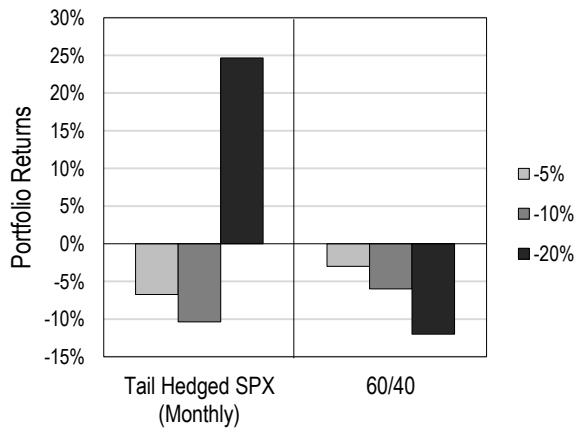
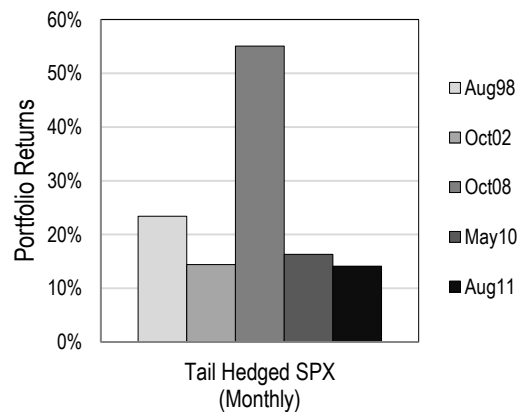
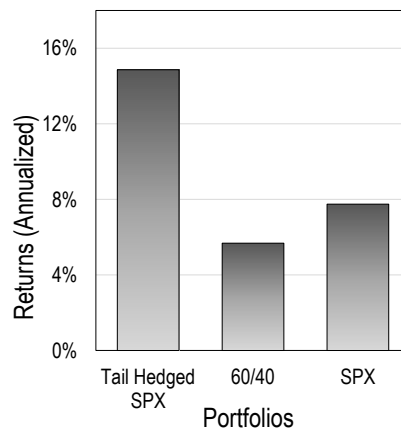


Figure 3
-20% Stress Test (Detailed)



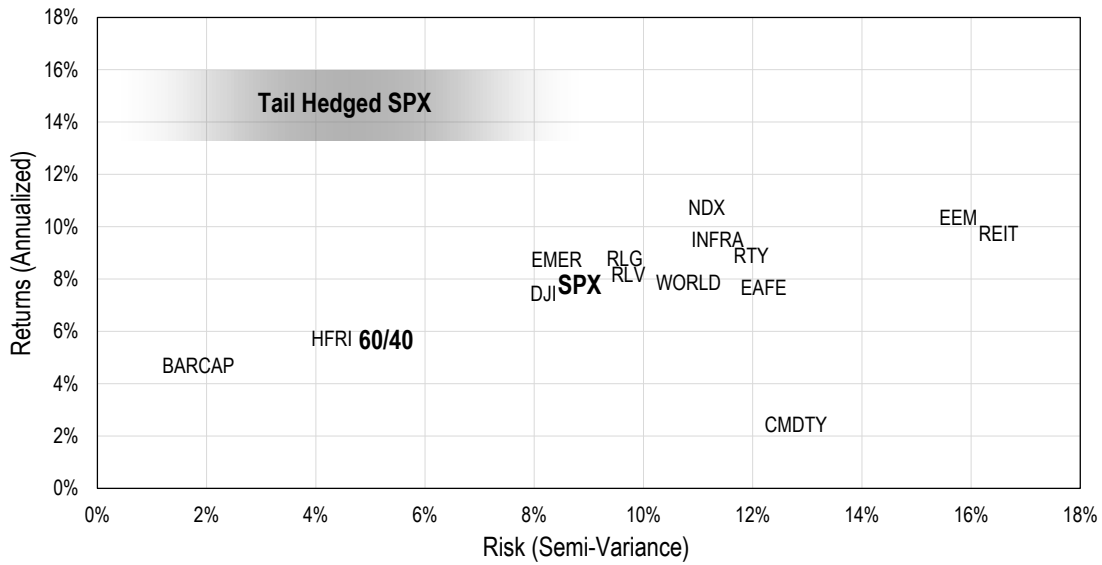
Being conservative, let's assume that the tail-hedged portfolio has similar risk properties as the benchmark portfolio. Using Figure 4, we can see that not only does the tail-hedged portfolio perform better than our benchmark (since the inclusion of options in the portfolio clips the fat left tail and allows us to take more equity risk and invest in S&P 500), it also has a roughly 7% annualized outperformance over the S&P 500 itself.

Figure 4
Historical Annualized Returns (01/2004-06/2014)



Moreover, if we overlay our hedged portfolio performance on the previously demonstrated risk-reward plot, we would get the shaded annualized return distribution region (for robustness, we tweaked the parameters of tail-hedged portfolio construction methodology and plotted the returns of the different variations) in Figure 5, and the risk is approximated as being similar to the benchmark. Further, it is likely that a similar profile is replicable on other asset classes by incorporating tail hedges where available, but we focus on the S&P because it has the longest history of options data.

Figure 5
Risk-Return Profile (01/2004-06/2014)



Asymmetric profiles, as evidenced by the tail-hedged portfolio, significantly raise both the returns and the risk-adjusted returns of equity portfolios, which should be deterministic in allowing one to capture much greater equity risk premium over time. Asset allocation decisions should be refined when analyzing asymmetric returns to include additional stress tests that identify potential portfolio tail risks and appraise their mitigation.

Here we have shown that CAPM type of frameworks are misspecified and leave out a whole class of securities that have highly non-linear payoffs, and because of this exclusion, they are ignored by capital allocators, and thus provide returns well above the security market line.

Appendix: References

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