

# Quant Lab

## Hedging Tail Risk

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# Introduction

In the wake of the worst equity market drawdown since the financial crisis, investors are now revisiting the topic of portfolio protection and tail risk hedging. In this paper, we go back-to-basics to understand how investors perceive the term “tail risk”. We discuss when investors can expect a tail-hedge portfolio to generate outsized gains to compensate for heavy portfolio losses and the merits of portfolio insurance versus simple diversification through asset allocation.

# Defining tail risk

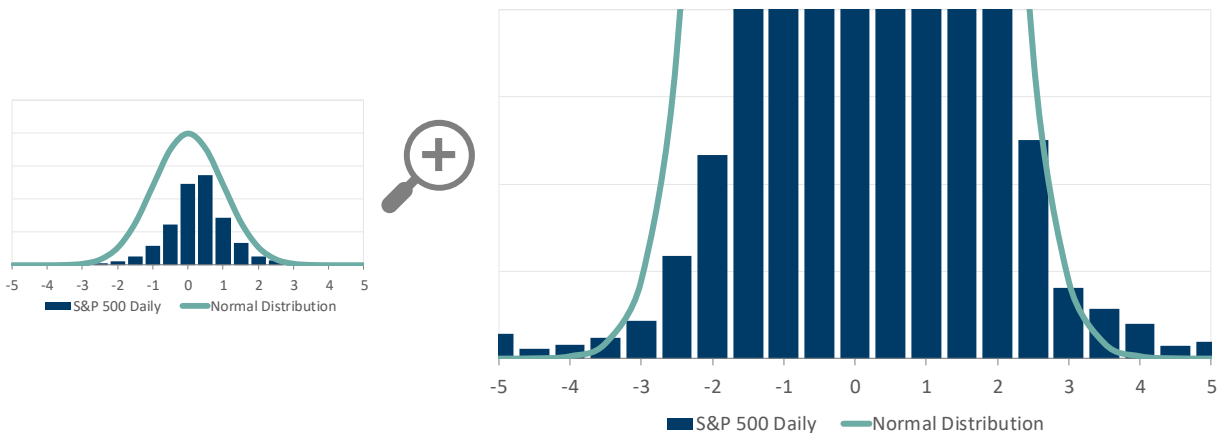
At its core, tail risk refers to the risk of an extremely rare and unexpected event. Such events are referred to as “tail events” as their probability of occurrence lies far out in the left or right “tails” of a forecast probability distribution. For the purposes of this paper, we will only discuss left-tail events and protection, as this is what concerns most investors.

Another popular name for such an occurrence is a “black swan event”. Such events tend to be understood as a market move unaccounted for by most financial models in excess of three standard deviations from the mean. Market participants often underestimate the frequency of such events due to a central assumption underpinning most

financial models – namely that market returns follow a normal distribution.

For example, Harry Markowitz’s Modern Portfolio Theory and the Black-Scholes Merton options pricing model both assume normal distributions of equity returns. In practice, however, historical equity returns have demonstrated a higher probability of tail events, or excess Kurtosis. Kurtosis is a statistical measure that indicates whether observed data follow a heavy or light tailed distribution in relation to the normal distribution. As the chart below shows, both the left and right tails of daily returns for the S&P 500 are ‘fatter’ than a normal distribution would suggest.

## S&P 500 daily returns probability distribution vs. normal distribution



Source: Bloomberg, Tages Capital

Since the global financial crisis (“GFC”), central banks have become more wary of the long term and deep economic impacts of sharp market dislocations. They are also more attentive to the “too big to fail” systemic risk posed by large financial institutions and interconnectedness of the

financial system through trillions of dollars of intra-bank and intra-counterparty transactions. As a result of these concerns, they have intervened more and more often than any other time in history, hence dampening market volatility versus what it would otherwise be over this period.

Similarly, factors such as the increase in short volatility positions and the rise of systematic and risk parity strategies, also contribute to a snowball effect in any sharp sell-off in financial markets.

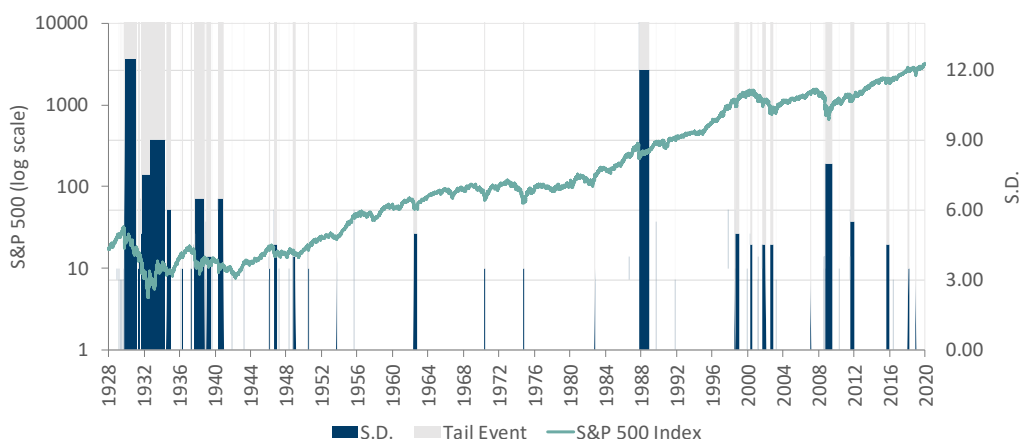
Despite post GFC central bank and regulatory actions, there have been almost four times more tail events during the last 30 years than during the previous 30 years.

## History of tail events

It is important to differentiate tail events from bear markets, large market corrections or 1- to 2-day corrections. We subscribe to the most common definition of a tail event being one that corresponds to a three standard deviation (S.D.) move in the S&P 500 over daily, weekly or monthly periods. As most fundamental investors do not have the possibility of reacting to market events intraday or on a daily basis, they might be more interested in the

distribution of monthly returns and the impact of such moves on portfolios which are more often than not overexposed to equity risk. The monthly calculation excludes certain very short-term events, such as, for example, the flash crash of May 2010 where the stock market plunged about 9% within 5 minutes only to recover a few hours later. The table below shows tail events as defined above on daily S&P 500 returns since 1928.

### The cumulative return of the S&P 500 vs. the S.D. moves during tail events since 1928<sup>1</sup>



Source: Bloomberg, Tages Capital

<sup>1</sup> Tail event defined as a three standard deviation move from the mean in the S&P 500

The table on the following page shows the expected frequency of various market moves based on a normal distribution. In this, we see that a three standard deviation event (our accepted definition of a tail event) is supposed to happen once every 35 months. In reality, we have experienced one such

event every 10 months since 1970. Larger outcomes such as 5, 7 or 8 standard deviation events should only happen extremely rarely, however, we have experienced two eight standard deviation events in recent history, in 1987 and 2008.

This alone should be evidence that market tails are fatter than a normal distribution. We contend that increasing correlations across stocks produce fat

tails beyond what most financial models suggest in crisis periods.

### Normal distribution by S&P 500

# S.D.	Normal Distribution		S&P 500 (since 1970)	
	Probability	Frequency	Probability	Frequency
1	15.866%	1 every 6 days	8.848%	1 every 11 days
2	2.275%	1 every 2 months	1.830%	1 every 3 months
3	0.135%	1 every 35 months	0.483%	1 every 10 months
4	0.003%	1 every 121 years	0.222%	1 every 2 years
5	0.000%	1 every 13,418 years	0.127%	1 every 3 years
6	0.000%	1 every 3,898,441 years	0.063%	1 every 6 years
7	0.000%	1 every 3,005,247,811 years	0.040%	1 every 10 years

Source: Bloomberg, Tages Capital

## Choosing the right hedging strategy

In an ideal world, investment horizons would be infinite, and investors would not need to worry about occasional sharp selloffs, as a sufficient risk premium could be collected over the long term to compensate. However, even long-term investors reach a point when there is pressure to reduce risk in the portfolio and the decision to de-risk is often made when markets are close to bottoming out.

Tail events are rare, by definition, but they tend to inflict large losses to investment portfolios. Therefore, protection from tail events can be a valuable component of a diverse portfolio. Tail risk hedging (“TRH”) has been one of the most important subjects discussed amongst investors in the aftermath of the 2008 GFC, as has often been the case after a large market dislocation.

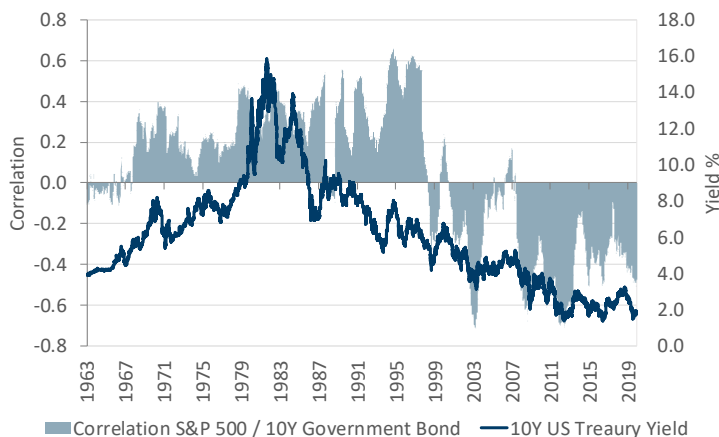
Investors need to consider four important questions when considering portfolio hedging:

- 1. What is the risk to the portfolio in a tail event?**
- 2. What is the appropriate hedging strategy to adopt?**
- 3. What is the correct size of the hedge or the appropriate hedge ratio?**
- 4. What is the cost of the hedge versus the potential benefit derived?**

Diversification has traditionally been the most popular tool to protect portfolios against sharp drops in asset prices. Historically, fixed income securities tend to offer some protection against sharp falls in equity markets. Traditional 60/40 portfolios are considered a good solution by certain investors even though the risk allocation of such portfolios includes a much higher exposure to equity versus fixed income risk. We should point out that since the GFC, traditional 60/40 portfolios have had above-average returns and lower average risk when compared to long-term metrics, and it is unreasonable to expect this positive dynamic to last forever.

Seemingly diversified portfolios are often subject to significant risk associated with a sustained fall in equity prices, as correlations across different markets and instruments rise to close to one in times of crisis. Risk parity portfolio construction methodology was one response to this unbalanced risk allocation across equity and fixed income, however, the leverage typically employed by risk parity portfolios to attain a higher target volatility often has the undesirable effect of intensifying drawdowns during periods of simultaneous bond and equity market selloffs. In addition, the negative correlation between bonds and equities has not persisted as strongly in the current, extremely low interest rates environment.

### Correlation of equities and bonds vs. 10 year US treasury yields



Source: Bloomberg

Due to the unpredictability and devastating effects of tail events, many investors now consider TRH as a critical feature in their portfolio construction process. Investors have typically used options, tail risk funds, CTAs and macro funds to provide

protection for their portfolios. It is important to clearly appreciate the costs and benefits of these solutions during times of market stress to decide upon an optimal portfolio hedging solution.

## Options

Options have long been used by investors for the purposes of hedging downside risk in portfolios and can be highly effective if they are purchased at the right time. However, they are also generally the costliest solution with time decay and negative carry contributing to losses. Hedging a 60/40 portfolio using put options can result in a -2% reduction in annualised returns. Furthermore, portfolios using put options for downside protection have tended to perform poorly in periods of prolonged drawdowns; put options are better

## Managed futures and macro funds

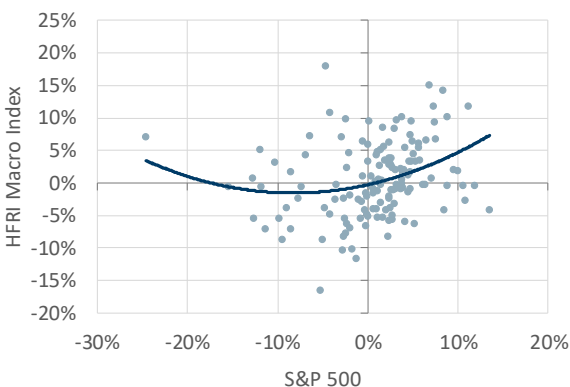
Investors have also considered CTA and macro strategies as good diversifiers due to their lack of long-term beta to equity markets. Both strategies adapt their positions to changing markets and can potentially generate strong risk-adjusted returns in selloffs.

Having said that, macro funds do not demonstrate consistent negative correlation to equity or bond markets. Instead, a decreasing correlation against

equities is observed in some crisis periods. This qualifies them as decent diversifying strategies but not necessarily as a hedge. Additionally, one needs to invest with the right manager, as fund selection is particularly important in a space characterised by a high dispersion in fund returns. Furthermore, macro funds have historically demonstrated better results in bullish tail events than in bearish ones.

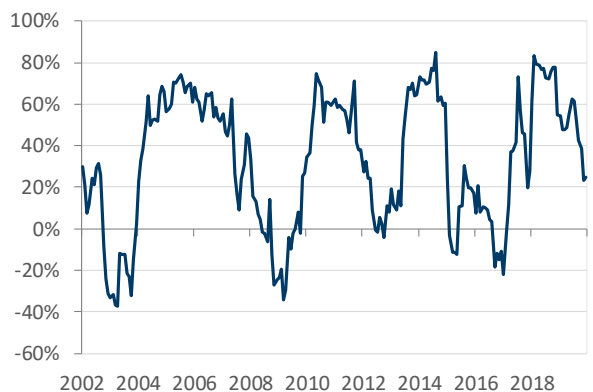
suiting to sharp market selloffs. The issue with option strategies is the choice of the most appropriate expiry and strike. To deal with the high cost of holding options, investors have often been drawn into attempting to time the purchase of options. Such timing is, by itself, considered a speculative activity as tail events and sharp spikes in volatility are hard to predict. Getting the timing and options structure right is key to the use of options as an effective hedging strategy.

HFRI Macro / S&P 500 regression: Feb 2008 - present



Source: Bloomberg, Tages Capital

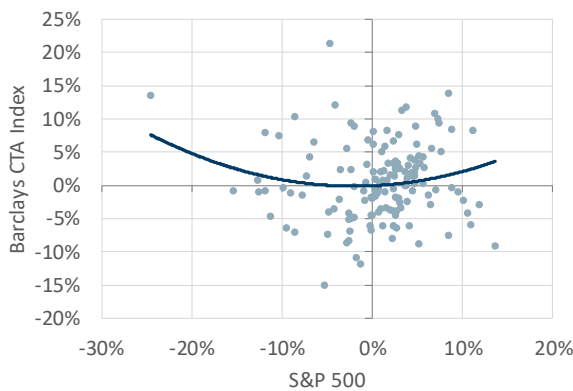
Correlation HFRI Macro / S&P 500



CTAs and other momentum strategies are designed to go long in a bullish trending market and go short in a trending bear market, generally increasing their exposure the longer the trend persists. Sharp and sudden selloffs often result in losses for CTAs as their signals can take time (weeks to months) to identify the change in market trend. A long crisis such as the GFC suited CTAs quite well, while shorter tail events have usually not been helpful for

the strategy. The shape and path of market correction will determine whether a short-term CTA or a longer-term strategy is more successful as a hedging tool. As it is not possible to determine this in advance, most institutional investors hold a diversified basket of CTAs with different holding periods. Overall, CTAs have demonstrated more negative correlation to equities than macro funds.

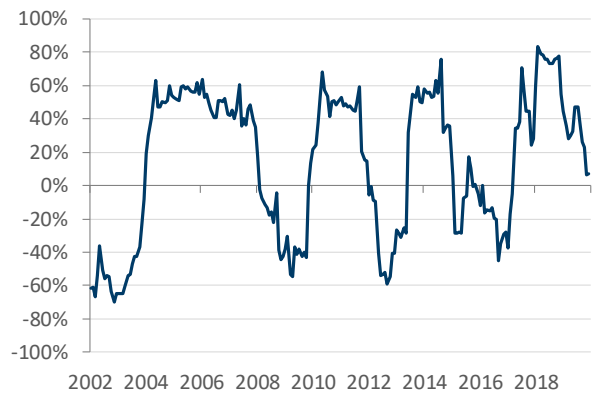
**CTA / S&P 500 regression: Feb 2008 - present**



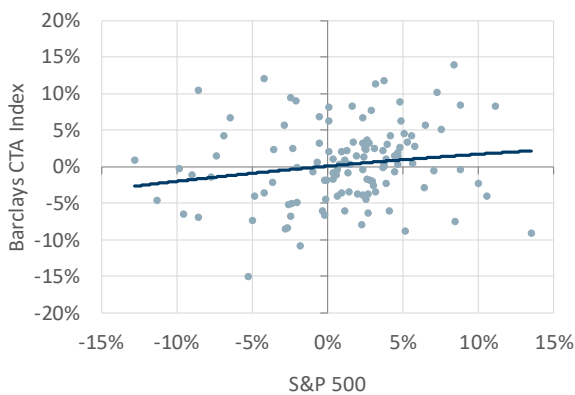
Source: Bloomberg, Tages Capital

Looking at monthly returns of the Barclays CTA and HFRI Macro indices, one notices little downside protection for the long period after the 2008 GFC.

**Correlation CTA / S&P 500**

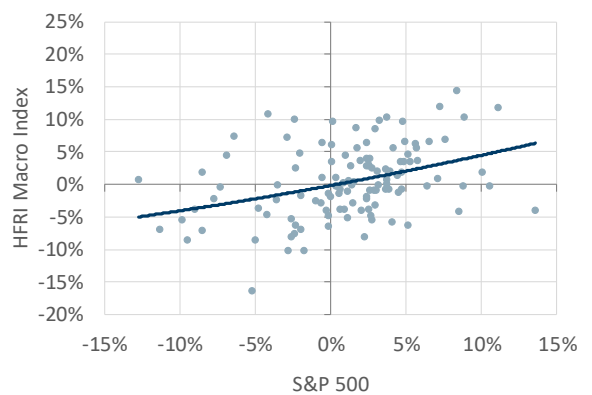


**CTA / S&P 500 regression: Feb 2010 - present**



Source: Bloomberg, Tages Capital

**HFRI Macro / S&P 500 regression: Feb 2010 - present**





## Long volatility funds

Long volatility funds aim to maintain a net long volatility exposure, usually with a bias towards equity options with the goal of delivering positive returns in high volatility regimes. They are negatively correlated to equity markets which makes them strong tail hedge candidates.

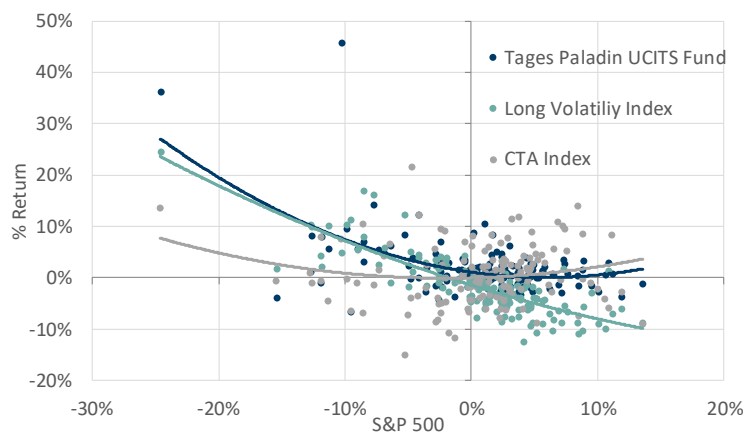
These funds tend to be cheaper to hold over the long term than an in-house managed program as the choice of Greeks (Vega, Gamma, Theta, etc.) is

## Tail risk funds

Tail risk funds seek outsized capital appreciation during periods of intense market stress. Tail risk funds have a tendency to cost less in sideways markets as such managers aim to select the above strategies that are long volatility and convexity during stress periods, but at a lower cost in normal functioning market conditions. Another important feature of tail risk funds is that their exposure is typically to a variety of asset classes such as equity,

fixed-income and commodities. The chart below shows a monthly regression analysis of Barclays CTA index, Eurekahedge Long Volatility index, our Tages Paladin UCITS Fund's actual and back tested returns (as there is no tail-risk index with long enough data) against the S&P 500 index since January 2008. You will see that the tail risk portfolio has a stronger return for cost profile than the other hedging options.

## Regression of different hedging strategies vs. S&P 500



Source: Bloomberg

Performance results prior to July 2018 represent hypothetical simulated returns. The returns do not demonstrate actual performance and there is no guarantee that these results could have been achieved in practice. Strategy baskets were weighted based on an inverse proportion to volatility. Performance from August 2018 onwards is live performance from the Tages Paladin UCITS Fund.

# Portfolio Hedging Scenarios

In the following table, we compare the returns of a 60/40 portfolio against several diversified or hedged combinations. To allocate to hedging solutions, one must free up some capital, however, this does not always mean that returns will be lower. We have chosen to analyse returns from January 2008 to cover a period that includes a

diverse set of market circumstances, but would like to reiterate that these combinations could result in different outcomes across other cycles. You will notice below that a 20% allocation to a tail hedge portfolio provides both a better return and lower risk than a straight 60/40 portfolio, or one with a different type of hedging strategy.

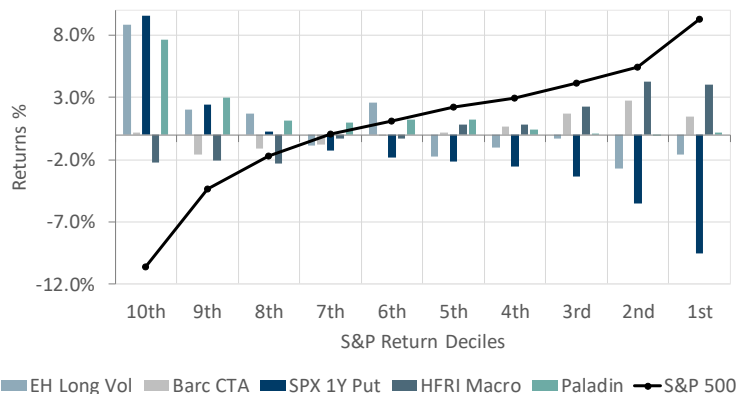
Portfolio of Weights	60/40	Risk Parity	60/40 with Put	60/40 with CTA	60/40 with Paladin
Global Equities	60%	~20%	48%	48%	48%
Global Bonds	40%	~80%	32%	32%	32%
1Y Put Overlay			20%		
CTA Overlay				20%	
Paladin Overlay					20%
Average Return	5.38%	4.39%	3.20%	4.67%	6.17%
Volatility	10.57%	6.98%	7.13%	8.58%	7.95%
Sharpe	0.51	0.63	0.45	0.54	0.78
Loss Beyond 60/40 VaR	-7.18%	-4.46%	-4.84%	-5.68%	-5.11%

Notes: 1) Risk parity portfolio is rebalanced monthly, 2) Put index refers to the BNPPIRPU index: S&P 1 Year ATM Put, 3) CTA refers to Barclays CTA Index, 4) Paladin refers to Tages Paladin UCITS Fund returns and back tested for the period before August 2018, 5) Loss Beyond 60/40 VaR -7.18 is the average loss of a 60/40 portfolio when it loses more than its VaR. For other portfolios, the average loss is calculated for similar periods as for the 60/40.

The chart below corresponds to the average monthly return of various strategies against the worst 10th decile performance of the S&P 500 (on the left) to the best decile (on the right) since

January 2008. We have used the EurekaHedge Long Volatility index, Barclays CTA index, SPX 1 Year put index, HFRI Macro fund index and the Paladin tail risk fund (incl. back tested) returns for this purpose.

## Example instruments and fund returns in up and down markets



Source: Bloomberg

# Conclusion

Financial returns are not normally distributed and tail risks have manifested themselves with increasing frequency since 2000. After the worst market correction since the financial crisis last month, investors are once again turning their attention to tail risk and looking at ways to alleviate losses to mitigate left tails by adopting a more defensive positioning.

We argue that most portfolios are, by design, heavily exposed to equity risk and that it is this such risk which matters most in a tail risk event. As a result, investors need to have a portfolio structured to cope with the risk of a severe market drawdown to avoid cutting equity risk just as markets bottom out.

We show that a 20% allocation to a hedging strategy combined with a 60/40 portfolio can improve risk-adjusted returns. Investors are rightly wary of a put-like insurance approach that is a drag to long-term performance, as the costs tend to be high when insurance is most needed. A tail-hedge strategy that minimises bleed in an upward trending market whilst delivering outsized returns in severe market corrections can provide the peace of mind to allow investors to remain fully invested.

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