



The Tao of Tail

Tail events

A tail event is a low probability event which has massive consequences. In portfolio terms, it is defined as a three standard deviation event, or an event where market levels are down between 30% and 50%.

A tail event is the 'He Who Shall Not Be Named' of portfolio management. We fear it. We ignore it for the most part but whilst we can ignore the actual tail event possibility, we cannot avoid the possible consequences of it: A permanent loss of capital.

I have a friend who was a deca-millionaire in Jan 08 only to be living in his sister's garage by the end. He wasn't a speculator. He was Joe average.

At best, a tail event can leave you way shy of your financial objectives and radically change your life (or the lives of your clients). At worst it can be devastating.

How can you hedge this risk? Whatever you use, it must contain the following characteristics:

- Negatively correlated to the portfolio you are hedging
- Asymmetry – you can lose a small premium to make a large pay-off
- Convexity – this pay-off must snowball, i.e. the larger the event the exponentially higher the pay-off

In addition it should be long volatility, long correlation and long liquidity.

We believe that options are the best instruments to hedge tail risk. However, they cost money to buy and over time their value wastes away (in the absence of an event) and this is where most people have a problem.

Tail risk hedging – is it worth it?

I hear it often said, especially at this time in the market cycle, that tail risk hedging is a waste – of time, of resources, of upside potential.

OK. I hear you. But here is my question: If tail risk hedging were free, would it be worth it?

Of course it would. Everybody of sane mind would get some in their portfolio. In fact you would overstock tail risk insurance if it were for free, because you would have a free option.

I think everyone agrees on this point. So what people are generally saying is that they don't like paying for tail insurance.

The answer to the "is it worth it?" question is simply this: Tail risk hedges are worth it when their presence in the portfolio improves the expected terminal wealth of the overall portfolio over time. Nothing more, nothing less.

However, they cost money to buy so where is the point which turns a tail hedge from 'worth it' to 'not worth it'?

There is a time to buy tail hedges and a time not to buy.

There are cycles in portfolio management. The underlying assets are subject to the fear and greed cycle, AKA the economic cycle, amongst others.

Right here and now I want to state emphatically that it is unlikely you will be able to time the cycle of the underlying asset or asset class – don't even try. There is however a cycle, the volatility cycle, which is mean reverting and which therefore follows a pattern. The volatility cycle cannot predict the tail event but it can give us an idea of when the tail event insurance is cheap and when it is expensive.

Why? Volatility is the biggest determinant of the price of an option – which in turn is the best tail hedge instrument. Ergo propter hoc... the lower volatility becomes, the cheaper a tail hedge becomes.

The correct timing for tail event hedging has nothing to do with the underlying asset price and everything to do with the level of volatility.

The level of volatility is normally lowest when markets are at their most fragile... Counterintuitively!

Selecting the right proxy

So options, in my opinion, are the best instruments to use for tail hedging. I would further state that long dated options are more efficient at the right price because they have greater exposure to volatility. In addition, out-of-the-money long dated options are even better because they have large asymmetry and convexity.

The best proxy instrument for a tail risk hedge is a long dated OTM put option on an asset or asset class. Where possible, this hedge should be directly related to your portfolio but if the “direct” hedge is too expensive, proxies are fine.

Why? In a tail event, correlation of all traditional asset classes tend to go to one and volatilities rise simultaneously. So proxies can be effectively used, if they can be found significantly cheaper.

For example, if the pay-off in a tail event is standardised at 100 dollars and, if hedges could be bought at 50 dollars for a direct hedge or 10 dollars for an indirect hedge or proxy, then the proxy should be bought. The pay-off in the case of the event equals 10x as opposed 2x, which more than compensates for the proxy risk.

It does not matter greatly that the hedge is not directly related to your portfolio. What matters is the ‘in-cost’ which, in turn, is related to the level of global volatility.

So, a long dated out-of-the-money option (rare event option) is an effective tail hedge. Use of pan asset class proxies are fine when they cheapen the in-cost significantly vis-à-vis the pay-off.

How do we determine the value?

The nature of an option is one of a probabilistic outcome. The only difference to a bet on a roulette wheel is that the number of possibilities is known in roulette, whereas in life there are infinite possibilities. Perhaps insurance is a better proxy, as actuaries also work out the likelihood of something happening and then indicate what the fair value of the insurance should be.

Let’s use the analogy of rare event insurance, like hurricane insurance. Insurers and reinsurers vary the price of insurance based on how frequent they believe hurricanes are likely to be.

We human beings are influenced by many biases, including the recency bias (yes – even actuaries). The more recently something has happened, the more likely we deem it to happen again. This creates a cycle where the price of insurance varies. It shouldn’t vary much – but it does. People come up with new-fangled theories why this time it is different, but it hardly ever is. It is the same with tail risk hedging and the price of the hedge: the price of long dated options varies with the price of volatility because they are intimately related. The lower the expectation of future volatility, the lower the price of the option and therefore the lower the price of tail risk hedging and vice versa.

The price of tail risk hedging varies massively with fluctuations in the hedge option price, and this in turn depends on our view of future volatility of underlying prices, i.e. implied volatility.

Here is a table showing the expected payoff of a tail hedge option on the S&P, depending on at what level of implied volatility you bought the option. The first row shows the in-price of your tail hedge option (which in turn is dependent on implied volatility at purchase).

Example: S&P 500 spot 2700 5Yr put. Strike 1890 (30% OTM)

Date of event	Volatility at purchase	15%	20%	30%
	Volatility at sale	40%	40%	40%
Immediate	Return if spot falls 30% (to 1890)	1,227%	492%	150%
End of year 1	Return if spot falls 30% (to 1890)	1,125%	447%	131%
End of year 2	Return if spot falls 30% (to 1890)	998%	390%	107%
End of year 3	Return if spot falls 30% (to 1890)	820%	311%	74%
End of year 4	Return if spot falls 30% (to 1890)	568%	198%	26%

Source: Bloomberg 10 January 2018

What is the fair value for this hedge?

One can see clearly that if one buys a hedge at too high a volatility, your profit is unlikely to be sufficient to offset your losses, i.e. up a maximum of 150% if you buy when implied volatility is at 30%.

On the other hand, if you buy when volatility is low, i.e. 15%, and an event subsequently occurs, you stand to make a minimum of 568% with a maximum of 1,227% should the event occur right after you buy the option.

The level of volatility when you buy will affect your outcome.

Because of its mean reversion characteristics, the long volatility cycle follows a broad pattern; it is, by its nature, cyclical. It is also investable because it is deep and liquid – everybody is normally selling when you should be buying and vice versa!

Therefore, we believe you can time tail risk hedges, based on the volatility cycle.

Timing the volatility cycle – a counterintuitive proposition

Ok this sounds pretty easy.

Buy when the cost of tail hedges is low, i.e. a long dated OTM option is cheap. This option will be cheap when the markets expect future volatility to be low. If bought at this point, the position has a positive return expectation in an event, and is negatively correlated to traditional assets. Smart move!

The problem is that the market's guess of future volatility is **counterintuitive**. It always feels wrong to buy it when it's cheap because there is normally no volatility on the horizon!

This means that you need to overcome your natural biases and buy low when it feels wrong.

Let's first assume that everybody has an identical percentage of wealth invested in the equity market.

We believe there is a simple rule of thumb. We believe the equity market is generally very astute over the long run and therefore the fair price of an equity tail hedge would be the average price of a tail hedge or five year OTM option on the S&P over a whole volatility cycle.

Implied volatility for 5 year OTM options can vary between 18% and 50%. Let us say the average or mean is around 30%. Let us use this as a rule of thumb as to what represents a fair value for the input into an option, being an option which best represents a tail risk hedge, i.e. 5 year OTM S&P option.

If bought at any time where the implied volatility was over the 5 year rolling mean (i.e. 30%) then the option is generally going to return negatively over the whole cycle. If bought under 30% implied volatility, this will generally represent a **positive expected return** i.e. it should make a positive contribution **over the whole cycle**.

S&P 500 5Yr 10 delta put implied volatility



If a tail risk hedge is expected to make positive returns over time, it should be bought.

What about when there is a negative expected return?

What about the times it doesn't make positive returns – when the tail hedge is overvalued, should it not be done? The answer is maybe, maybe not.

Daniel Bernoulli had the answer in 1738 in his article: Evolution and economics under risk¹ – and it has been largely forgotten.

The answer depends on how consequential the loss is, if it occurs, i.e. if you only have 10% invested in the equity market it is totally different to if you have 100% invested.

Bernoulli illustrated the geometric mean with an example of a merchant wondering whether he should purchase insurance on goods he is about to ship:

“Suppose Caius, a Petersburg merchant, has purchased commodities in Amsterdam which he could sell for ten thousand rubles if he had them in Petersburg. He therefore orders them to be shipped there by sea, but is in doubt whether or not to insure them. He is well aware of the fact that that at this time of year of one hundred ships which sail from Amsterdam to Petersburg, five are usually lost. However, there is no insurance available below a price of eight hundred rubles a cargo, an amount which he considers outrageously high. The question is, therefore, how much wealth must Caius possess apart from the goods under consideration in order that it be sensible for him to abstain from insuring them?

If x represents his fortune, then this together with the value of the expectation of the safe arrival of his goods is given by $((x + 10000)^{95}x^5)^{1/100}$ in case he abstains. With insurance he will have a certain fortune of $x + 9200$.

Equating these two magnitudes we get:

$$(x + 10000)^{19}x = (x + 9200)^{20} \text{ or approximately } 5043.$$

¹ Daniel Bernoulli (1738): Evolution and economics under risk (PDF Download Available). Available from: https://www.researchgate.net/publication/12302048_Daniel_Bernoulli_1738_Evolution_and_economics_under_risk [accessed Dec 19 2017]. Cargo ships

If, therefore, Caius, apart from the expectation of receiving his commodities, possesses an amount greater than 5043 rubles he will be right in not buying insurance. If, on the contrary, his wealth is less than this amount he should insure his cargo." (op. cit. p 30).

The take-outs of this are as follows:

- Sometimes it pays to have 'insurance' which has a negative return expectation over time if our expected wealth is greater with the insurance (because of the consequence of loss can be catastrophic).
- This can occur even though the provider of insurance is making positive returns as well. This is a win-win scenario and is the basis for all of insurance.
- *Sometimes it even pays to buy the tail hedge when it is a negative expected return over the volatility cycle.*

Summary

There are times when tail hedges should be bought. The "when" depends not on the market valuation, i.e. rich or cheap but at what price you can buy the tail risk hedge, i.e. the price of a long dated OTM option.

We believe the approximate rule of thumb is the 5 year mean of long dated (5 year) OTM implied volatility is the benchmark for what would be considered a cheap or expensive tail risk hedge.

Currently this 5-year mean is approximately 30% implied volatility while the current implied volatility is approximately 24%. Shorter maturities are much cheaper and can be used as proxies. E.g. a 2 year option has 22% implied volatility.

Bernoulli has a formula which can show that tail hedges should be bought even at negative expected return if the consequence of loss i.e. your percentage invested in the equity market, is high.

We believe that when tail risk hedges are available at implied volatilities below their 5 year mean, they should be bought.

When tail risk hedges are available at slightly above the mean but the consequences of catastrophic loss is great, they should probably still be bought even though they have a negative expected return.

When tail hedges are available at more than one standard deviation above their long term mean, they should probably not be bought. In fact it stands to reason that they could be sold.

Where are we now?

Tail risk hedges are available at far below their long term mean.

I'll let you draw your own conclusions.

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