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Hedging Equity Exposures

A Costly-Effective Approach

Rock Creek Group

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This paper evaluates several commonly used strategies to hedge tail risks in equity portfolios. It concludes that most of these options are expensive to implement. Much like insurance, the implementation of tail hedges cannot be timed, and their costs make it difficult for investors to sustain them over the long-term. The paper proposes the use of a mix of realized and implied volatilities as a tail hedge, and demonstrates that this mix is significantly more cost effective than other option strategies.

1. Introduction

The typical 60/40 investment portfolio seeks to strike an appropriate balance between two conflicting emotions: greed and fear. The 60% invested in equities comprises the greed element and the 40% in fixed income comprises the fear element. One seeks to grow capital, while the other seeks to preserve capital. A key attribute that helped shape their respective roles was the negative correlation of their long-term returns. When the long-term returns of equities turned negative it was its negative correlation with bonds that helped the portfolio preserve capital.

Although this simple paradigm served many portfolios well in the years leading up to the financial crisis in 2008, it faltered in the subsequent years for two reasons. First, the quantitative easing by many central banks brought yields on fixed-income instruments at or close to zero. As a result, a portfolio with 40% invested in fixed income witnessed a significant degradation in total returns. Second, the lower bound of bond yields tends to be around zero; and in a low yield environment, the potential appreciation in bonds when equities turn negative is limited. In other words, fixed income bonds stopped being a good hedge, and the 60/40 paradigm stopped being the appropriate approach for constructing portfolios.

The years following the financial crisis have witnessed a strong bull market in equities. The low yields in bonds provided the support for the run-up in equity valuations. From 2008 until 2016, the S&P 500 generated an annualized return of about 14%, even though the real economy grew at a meager 2%. Over this period, we saw five corrections in U.S. equities of more than 5% for a range of socio/economic reasons such as the Greek crisis in 2010, the euro crisis in 2011, the Chinese slowdown in 2015, and the emerging market sell-off in 2016. While these corrections raised the fear level in investors, they were transitory. The expectation of continuing accommodation by central banks, the so-called central bank put, made the equity market appear more attractive after these sell-offs.

This brings us to the current environment, which features an equity market that is trading at three times the level it was in early 2009 and a fixed-income market with rates on the rise. A strong economy coupled with low unemployment has increased the probability of higher inflation; and those odds have not been helped by the recent uptick in hourly wages. The fear of inflation coupled with higher long-term rates could quite easily be a catalyst for a sell-off in U.S. equities, alongside a sell-off in bonds, i.e., a positive correlation in returns. If this were to happen, traditional fixed income will be a poor hedge against capital losses in equities. This realization has caused U.S. equity investors to explore other alternatives to hedge their equity investments.

This paper seeks to advance these efforts by suggesting suitable alternatives for hedging equity exposures and determining the costs and benefits of these alternatives. These alternatives involve the use of option or volatility strategies whose costs and benefits are path dependent. As the future evolution of equity prices cannot be forecasted with reasonable accuracy, we are left to use historical data of equity returns and volatility for analyzing the attractiveness of the various alternatives

2. Data

The paper uses monthly returns of the S&P 500 total return index for the period starting January 2010 and ending December 2017, inclusive. The period was chosen because of data availability for monthly implied volatility at different levels of maturity and moneyness. More specifically, this data can be used to price the costs of option strategies involving the use of one-year 20% OTM calls and puts, six-month 20% OTM calls and puts, and one-year 10% OTM calls and puts. The paper uses the three-month T-bill rates as the measure of the risk-free rate. Plots of the monthly S&P 500 returns, implied volatility, and risk-free rates are shown in Figure 1.

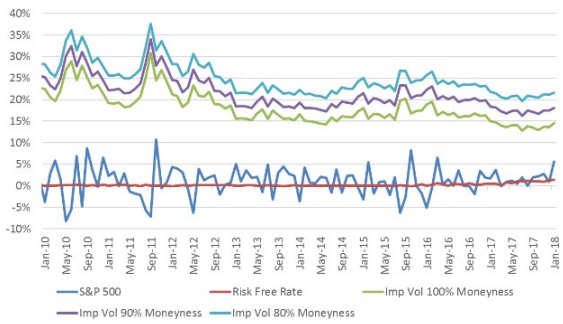

Figure 1: Implied volatility of S&P 500

A potential critique related to using data starting in 2010 is that this data does not cover the most important period for tail hedges – the global financial crisis in 2008. This omission may call into question the robustness of the paper's conclusions. However, we are confident in the robustness of the paper's conclusions for two reasons. First, the 2008 meltdown was relatively unique and is unlikely to recur in an investor's lifetime; it is not the appropriate market event for which an investor should seek protection. Second, the sharp sell-off in equities in September and October 2008 was followed by an equally sharp rally in 2009. If both 2008 and 2009 were included in any analysis, it is very likely that the costs/benefits of the tail hedge in 2008 are completely reversed in2009. In other words, the inclusion of both years will not have a meaningful impact on the overall cost-benefit conclusions of this paper.

Over the eight-year period (2010-2017) the S&P 500 generated an annualized return of 13.92%. Over the same period, it had five drawdowns of more than 5%. Table 1 provides the periods and magnitude of these five drawdowns. The S&P 500 has had other drawdowns but these have been much smaller. During these drawdowns, the benefits of protection strategies have been modest. For ease of exposition, we have restricted our analysis and discussions to the five major drawdowns. The cumulative drawdown for these five periods is about 42% (on a compounded basis)

Date	S&P 500 Return
May-June 2010	-12.80%
May-September 2011	-16.26%
April - May 2012	-6.60%
August-September 2015	-8.36%
Dec 2015 - Feb 2016	-6.59%

Table 1 : The five largest S&P 500 drawdown since January 2010.

3. Methodology

The paper evaluates the costs and benefits of six option and volatility-based strategies to provide tail protection to the nominal exposure of a long S&P 500 investment.

More specifically the six alternatives considered involved allocating 5% of the nominal exposure as follows:

1. Long 20% OTM 12-month put on the S&P 500 index that is rolled over monthly;
2. A Collar Strategy that is long 20% OTM 12-month put on the S&P 500 index and short 20% OTM 12-month call on the S&P 500 index. Both puts and calls are rolled over monthly;
3. Beta Reduction by which the nominal exposure is reduced;
4. Long Implied Volatility in which the portfolio is long VXX ETF (that is a combination of the first and second VIX futures contracts such that the weighted average maturity is constant at 30 days);
5. Long Realized Volatility in which the portfolio is long a return stream generated by going long and short S&P 500 futures that mimics the realized volatility of S&P 500;
6. A combination of alternatives 4 and 5 to minimize annualized costs and provide similar protection to that offered by alternative 1.

Alternatives 1, 2, and 4 (collectively, the "option strategies") require the investor to bear annual implementation costs of between 3% and 5% of the nominal exposure. For the option strategies the paper assumes the implementation costs associated with these strategies are raised from sources other than the nominal exposure being protected. Consequently, the amount to be protected every month is set equal to the compounded value of the nominal exposure of the S&P 500 from inception to the end of prior month. However, it is worth noting that if the implementation costs are met by the liquidation of the nominal S&P 500 exposure, then the costs of option strategies will be lower as the nominal exposure needing protection is lower. Alternative 3 is self-explanatory and involves reducing the nominal exposure to be protected and keeping the proceeds in risk-free assets. Alternative 5 is based off a proprietary strategy developed at Rock Creek in which the returns mimic that of a long realized volatility strategy[1]. Alternative 6 is a combination of alternatives 4 and 5.

Alternative 4, the realized volatility strategy, is more of an investment strategy than a tail hedge protection strategy. Consequently, it does not incur an annual implementation cost; in fact, it delivers an annualized positive return over the period. However, it faces a drawback: the tail protection it offers in the short run is modest compared to the option strategies. The monthly returns of option protection strategies on average have a high negative correlation with those of the nominal exposure (usually -0.9). Consequently, these strategies tend to generate strong positive returns contemporaneously with the negative returns of the nominal exposure. On the other hand, the monthly returns of the realized volatility strategy have a much lower negative correlation with the nominal exposure returns (usually - 0.3). Ultimately, this alternative provides a much lower level of protection over a month than the option strategies.

However, if the time horizon over which the alternatives are evaluated is increased from one month to one year, the results are strikingly different. The annual returns of the

[1] For a more detailed discussion of this strategy please refer to 'Diversification Strategies for Equity Dominant Portfolios', Rock Creek Group (2012)

option protection strategies have a lower negative correlation with the annual returns of the nominal exposure (usually -0.6). On the other hand, the negative correlation of annual realized volatility strategy returns with those of the nominal exposures is higher (usually -0.8). In other words, an investor who is willing to be patient is better served by a realized volatility strategy than by the option protection strategies. The protection on an annual basis is just as good for the realized volatility strategy as it is for any of the option protection strategies. More importantly, the realized volatility strategy generates a positive return even as it provides protection, unlike option protection strategies that impose an annual deadweight cost.

It is quite difficult to compare an investment strategy alternative (such as a realized volatility strategy) with option protection strategies that face annual implementation costs. Like many other investment strategies, the realized volatility strategy uses S&P 500 futures and as such can be conveniently levered up or down to change the strategy's annual return and maximum drawdown. However, a change in leverage will not change the ratio of the strategy's annual return to maximum drawdown. To permit a comparison of this alternative to option strategies, we set the maximum cumulative daily drawdown of the realized volatility strategy (over the eight years) equal to the maximum monthly loss of alternative 1, the put strategy (which we will use as a benchmark going forward).[2] More specifically, the maximum monthly loss of the 20% OTM 12-month put strategy rolled monthly over the eight years is 3.1% of the nominal exposure. The maximum cumulative daily loss of the realized volatility strategy occurred in 2011. To realize a maximum cumulative daily drawdown of 3.1% in 2011, the realized volatility strategy's maximum exposure will need to be constrained at 25% of the nominal exposure. A maximum leverage of 5 on the S&P 500 futures would, in turn, imply allocating 5% of capital to this alternative. Stated differently, an allocation of 5% of capital to the realized volatility strategy with a maximum permissible leverage of 5 will result in a maximum cumulative daily drawdown of 3.1% which equals that of the put strategy. It is the costs and benefits of this allocation that are included in the results for this alternative.

4. Results

The most basic of protection strategies is alternative 1 that involves investing 5% in a long 20% OTM 12-month put that is rolled monthly. Table 2 provides the returns, costs, and benefits of this alternative by year and on an annualized basis.[3] It also provides the returns, cost, and benefits of rolling 20% OTM 6-month puts and 10% OTM 12 month puts to determine the sensitivity of the cost-benefit ratio to changes in the maturity or moneyness of the option.[4]

It should be no surprise that annualized returns, benefits and costs decrease with the maturity of the put option and increase with its moneyness. Although the annualized benefit to annualized return ratio does not change appreciably with moneyness, it does increase significantly for shorter maturities. With options, costs are a reality while benefits are probabilistic. As costs are significantly higher for the strategy with higher moneyness (the 10% OTM option) it appears prudent (and a lot less expensive) to use the rolling one-year 20% OTM put as the benchmark alternative.

Table 3 shows the year-by-year returns, the annualized costs, and benefits of the six alternatives viz., put, collar, beta reduction, VIX futures, realized volatility, combination VXX + realized volatility. Alternatives 1, 2, and 4 all have annualized returns of around 3.5% per annum. It is surprising that the using the sale of calls to reduce the cost of implementing the strategy does not achieve that goal. The sale of calls does, however, result in higher benefits and in turn a slightly better reduction ratio.

For alternative 3, the beta reduction strategy, the reduction ratio is 5% in line with the 5% reduction in nominal exposure. If we want the reduction ratio to be around 0.2 (as it is for alternative 1) then we would need to reduce the nominal exposure to 80%. This will, in turn, increase the annualized return of -0.69 fourfold to -2.76. This alternative has a lower negative annualized return than alternative 1, i.e., it is a more cost-effective way of tail hedging the portfolio than buying a put option. While this result holds over the past eight years, the conclusion may not hold in the future. However, it would not be unreasonable to posit that a beta-reduction strategy is likely to provide as good protection as the more complicated option strategies and should be seriously considered by investors seeking to use option protection.

The annualized returns, costs, and benefits of alternative 5 – realized volatility – are quite different from those other alternatives. Unlike the other alternatives, the annualized return for realized volatility is positive i.e., the alternative generates a positive return. While that is an attractive feature, it is worth noting that the reduction ratio for realized volatility is much lower than it is for the other

[2] This is conservative approach because all other alternatives are evaluated on annualized returns and not the maximum cumulative daily drawdown that will, in general, be more negative. In the case of the realized volatility strategy a maximum cumulative daily drawdown of -3.1 results in a maximum monthly loss of -0.38 (see Table 3

[3] The returns are generated assuming monthly rebalancing.

[4] The annualized returns of the alternatives are the annualized measure of the total compounded returns associated with implementing the strategy for the entire eight-year period. The annualized returns are decomposed into annualized costs and annualized benefits. The annualized benefits are the annualized returns of the alternatives during the five drawdown periods identified in Table1. The annualized costs are the annualized returns over all periods (excluding the five drawdown periods).

alternatives. Since alternative 5 is an investment strategy with positive return, we assume that it will have a capital allocation of 5%, like the 5% beta reduction for alternative 3.

	12 M 20% OTM Put	6 M 20% OTM Put	12 M 10% OTM Put	S&P 500
2010	-4.53%	-4.50%	-6.08%	15.06%
2011	-2.24%	-2.96%	-2.47%	2.11%
2012	-5.76%	-4.73%	-7.61%	16.00%
2013	-4.55%	-2.99%	-7.64%	32.39%
2014	-2.12%	-1.85%	-3.41%	13.69%
2015	-2.17%	-2.45%	-2.43%	1.38%
2016	-3.34%	-3.07%	-4.53%	11.96%
2017	-3.32%	-2.31%	-5.44%	21.83%
Total Return	-24.88%	-22.35%	-33.50%	183.69%
Maximum Monthly Loss	-3.08%	-2.41%	-4.29%	-7.99%
May-June 2010	3.34%	1.88%	4.95%	-12.80%
May-Sept. 2011	4.22%	2.38%	6.73%	-16.26%
April - May 2012	1.52%	0.62%	2.55%	-6.60%
August-Sept. 2015	1.50%	0.69%	2.76%s	-8.36%
Dec 2015 - Feb 2016	0.39%	-0.12%	1.14%	-6.59%
Total Benefit	11.43%	5.54%	19.39%	-41.62%
Reduction Ratio[5]	0.20	0.10	0.33	
Annualized Return	-3.51%	-3.11%	-4.97%	
Annualized Benefit	1.36%	0.68%	2.24%	
Annualized Cost	- 4.88%	-3.79%	-7.21%	

Table 2 : Changes in Returns of Put Strategy across varying Maturities and Moneyness

Alternative 6 is a mix of alternatives 4 and 5: it combines the alternative with a high reduction ratio (VXX) with one that has a reduction ratio (realized volatility). The intent is to maximize benefits while keeping costs close to zero. We believe that for an alternative to be viable it needs to provide immediate benefit and ensure that it does not impose costs. A mix that allocates 1.25% of capital to the VXX strategy and 3.75% to realized volatility (for a total capital equal to 5% of the nominal exposure, as for alternatives 3 and 5) rebalanced monthly, will have reduction ratio that is one half of that obtained by a put strategy but with much lower costs. To make alternative 6 comparable to alternative 1, it is necessary to allocate 10% of the nominal exposure to this alternative. In that case the annualized return in Table 3 will double from -0.37 to -0.74, while the annualized benefit doubles from 0.64 to 1.28. We will use the 10% capital allocation for this alternative as the appropriate tail hedge going forward.

Figure 2 plots the cumulative returns of the S&P 500 (scale on RHS) and of the six alternatives (scale on LHS) for the period from 2010 to 2017.During this period, the S&P 500 had an annualized return of 13.92%, leading to a cumulative return of 183%. This strong performance, in turn, led to the hedging strategy having to increasing levels of nominal exposure. Alternatives 1, 2, 3, and 4 all have large negative cumulative returns of between 50% and 60%. The large negative number is because of the increasing levels of nominal exposure that had to be protected. These results suggest that traditional hedging strategies would have reduced the cumulative returns of the S&P 500 by nearly a third.

Alternative 5 had a cumulative positive return of about 15% over the time period. A closer examination of the various plots shows that while alternatives 1, 2, 3, and 4 provide tail protection in periods in which the S&P500 has drawdowns, alternative 5 does this to a more modest

[5] The reduction ratio is the ratio of the total benefits of an alternative to the total loss of the S&P 500 during the five drawdown periods. It is a measure of the fraction of drawdown of the S&P 500 during the five drawdown periods that is compensated for by the alternative.

extent. Alternative 6 (with 10% capital allocation), a combination of 4 and 5, has a cumulative negative return of only 10% over eight years, but provides almost the same level of protection as alternatives 1, 2, 3, and 4.

	12M 20%	12M 20%	5% Beta	Long VXX	Realized	1/4 VXX +	S&P 500
2010	-4.53%	-5.19%	-0.79%	-5.16%	0.57%	-0.88%	15.06%
2011	-2.24%	-1.62%	-0.16%	1.18%	3.20%	2.71%	2.11%
2012	-5.76%	-5.43%	-0.77%	-6.10%	-0.01%	-1.56%	16.00%
2013	-4.55%	-5.67%	-1.43%	-4.72%	-0.25%	-1.39%	32.39%
2014	-2.12%	-2.30%	-0.66%	-1.11%	0.72%	0.27%	13.69%
2015	-2.17%	-1.70%	-0.11%	-0.80%	1.48%	0.92%	1.38%
2016	-3.34%	-3.62%	-0.59%	-4.82%	-0.03%	-1.24%	11.96%
2017	-3.32%	-3.47%	-0.99%	-5.84%	-0.32%	-1.72%	21.83%
Total Return	-24.88%	-25.65%	-5.39%	-24.51%	5.45%	-2.94%	183.69%
Max Monthly Loss	-3.08%	-3.83%	-0.55%	-1.58%	-0.38%[6]	-0.64%	-7.99%
May-June 2010	3.34%	4.85%	0.66%	2.20%	0.11%	0.63%	-12.80%
May-Sep. 2011	4.22%	5.09%	0.87%	5.33%	1.60%	2.53%	-16.26%
April - May 2012	1.52%	1.76%	0.33%	1.22%	0.10%	0.38%	-6.60%
August-Sept. 2015	1.50%	1.75%	0.43%	3.15%	0.30%	1.02%	-8.36%
Dec 2015 – Feb	0.39%	0.71%	0.33%	1.51%	0.27%	0.58%	-6.59%
Total Benefit	11.43%	14.89%	2.65%	14.09%	2.40%	5.23%	-41.62%
Reduction Ratio	0.20	0.26	0.05	0.24	0.04	0.10	
Annualized Return	-3.51%	-3.64%	-0.69%	-3.45%	0.67%	-0.37%	
Annualized Benefit	1.36%	1.75%	0.33%	1.66%	0.30%	0.64%	
Annualized Cost	4.88%	5.39%	1.02%	5.12%	-0.37%	1.01%	

Table 3 : Cost Benefit Analysis of Six Protection Strategies for Equity Portfolios (5% allocation)

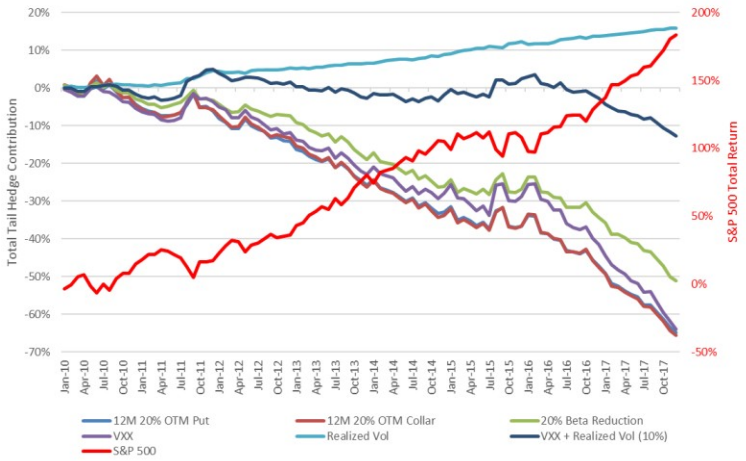

Figure 2 : Historical Performance of S&P 500 with Tail Hedge (Alternatives 1 through 6)

[6] The maximum monthly loss of the realized volatility strategy is -0.38%, although the maximum daily loss is -3.1%.

5. Conclusions

We recommend that investors seeking tail hedges use alternative 6, which is a combination of implied and realized volatility. Combining the realized volatility strategy with VIX futures improves the magnitude of the protection but increases costs. A combination of 25% of capital in VIX futures and 75% in realized volatility maximizes the protection but lower costs than a simple put strategy. Allocating 10% capital to this alternative gives the investor the same level of protection as a simple put strategy, but with much lower costs.

	VXX + Realized Vol	SPY
Total Return	3.28%	-1.80%
Benefit (January 26 – February 8)	3.04%	-10.1%
Reduction Ratio	0.28	
Cost	-0.24%	
Correlation to S&P	-0.45	

Table 4 : Returns and Benefits of Mixed Implied and Realized Volatility Strategies

5. Out of Sample Results

The analysis presented in this paper used historical data. To test the validity of the proposed tail hedging strategy, we constructed a portfolio with 100% allocation to SPY, 2.5% to VXX, and 7.5% to realized volatility strategy on January 1, 2018. The VXX position is rebalanced to 2.5% when it increases above 3% or decreases below 2%. The following table and charts show the return of this portfolio compared to that of 100% SPY for the period from January 2, 2018 to March 16, 2018. The results (albeit for a very short period) presented in Table 4 and Figure 3 confirm the conclusions of this paper.

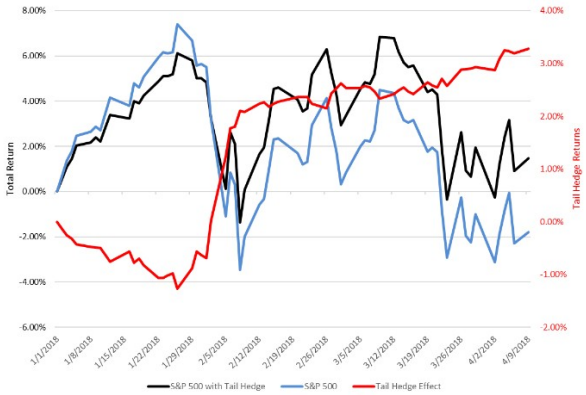

Figure 3 : Performance of S&P 500 with Tail Hedge (Mixed Implied and Realized Volatility).

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