portfolio construction forum

Volatility overlay- reconnecting risk & return for equities

Triple3 Partners | July 2014

This paper explores volatility overlay. It is a strategy that at each point in time, selects a combination of options to minimise the volatility of a portfolio, subject to the constraint that the expected cost of the options (i.e. the loss of returns in expected value) be less than a pre-specified monthly percentage. Volatility overlay aims to reduce the volatility of a portfolio in the most cost-efficient manner. This paper argues that, for long-run investors, it is more productive to focus on reducing portfolio volatility by any means available than to continuously cut off the left tail of the profit distribution as in tail hedging strategies. Volatility overlay is implemented trading very liquid options, and is more practical, quicker and more effective than traditional portfolio diversification. The relationship between volatility reduction and cost of the strategy (in expected returns) is completely transparent. Large reductions in portfolio volatility can be achieved at zero or moderate costs.

1. INTRODUCTION

Maximize returns. Reduce risk. A professional investor's decisions revolve around these goals. Finding good profit opportunities may be more of an art than a science: complex models and strategies rarely prove more lucrative than simpler alternatives. Understanding risk, on the other hand, requires more specialized statistical skills. Reducing risk via portfolio diversification remains a good idea, but cross-correlations between assets and markets have steadily increased in the last decades, and are well known to spike during times of financial distress. A traditional approach to risk reduction is to buy put options, a strategy currently referred to as tail risk hedging. Buying put options month after month is so expensive, however, that risk-averse investors may as well keep their money in cash. Costs aside, even if the monthly (say) distribution of returns is truncated to the left, over longer periods the effect fades away and extremely large losses are still possible.

This paper explores a different approach to portfolio risk reduction, Volatility Overlay. Its aim is to reduce the volatility of a portfolio in the most cost efficient manner at each particular point in time. Volatility Overlay is implemented by trading very liquid index options. The relationship between volatility reduction and cost of the strategy (in expected returns) is completely transparent at each point in time. This facilitates the client's decision making in allocating a budget to risk reduction. The analysis shows that large reductions in portfolio volatility can be achieved at zero expected costs.

Also refer to the associated Due Diligence Forum Presentation in the Conference 2014 Resources Kit.

In what follows, the following observations are developed:-

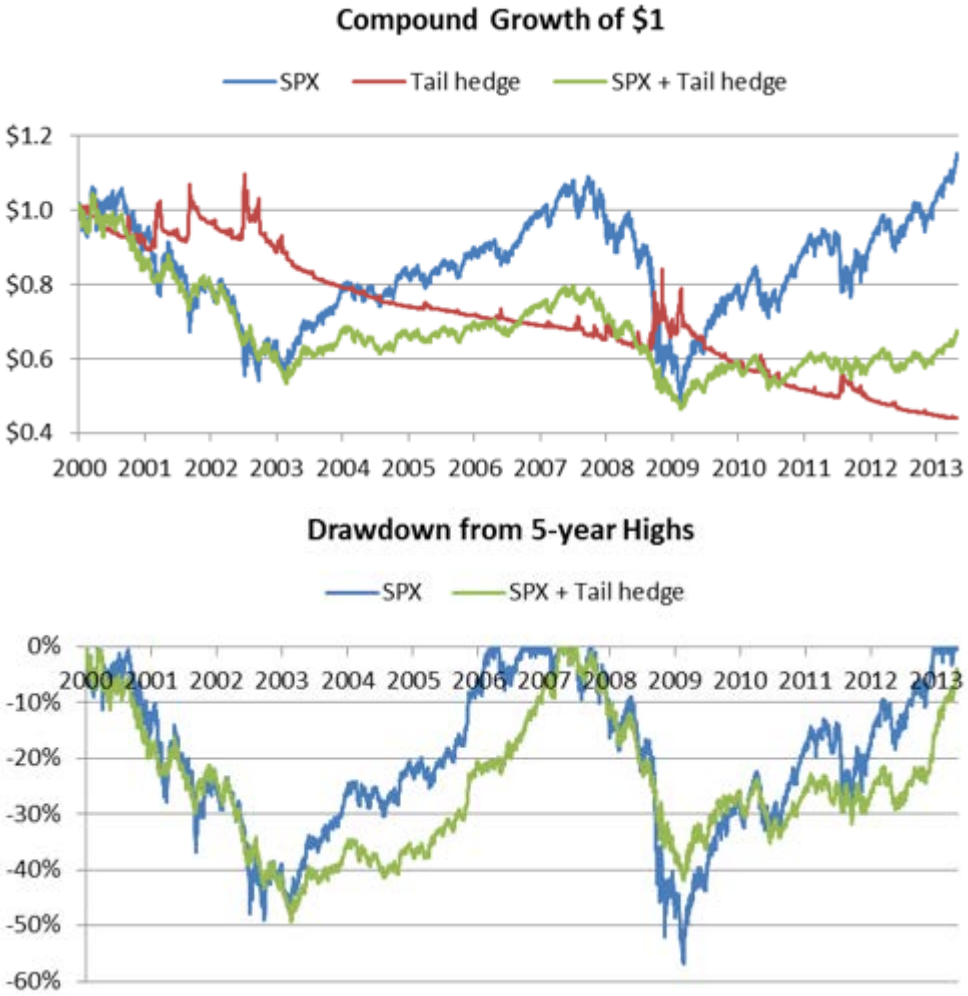
1. Options can be used to shape the distribution of portfolio returns to suit each investor's preferences more efficiently and reliably than is possible by using a portfolio of standard assets only.
2. For a long-run investor, it is more productive to focus on reducing portfolio volatility (by any means possible) than to cut off the left tail of the return distribution as its side effects are often detrimental to returns.
3. Options are often not fairly priced, so that a given percentage reduction in the volatility of a portfolio can be obtained at a cost (in terms of decreased expected returns) sizably smaller than that same percentage. Equivalently, it is possible, at least at times, to run a more aggressive trading strategy (increase leverage or exposure to risky assets) without increasing portfolio volatility.
4. It is possible to achieve the dual aim of increasing returns and reducing risk in significantly long time periods by actively seeking for alpha in the options market while at the same time controlling for overall portfolio volatility.

2. THE LIMITS OF TAIL RISK HEDGING

The most common use of options is probably to buy or sell only one, for the full notional amount of the capital, which truncates the distribution of returns. However, there is no reason to consider only such simple portfolios. An infinite number of distributions can be obtained by varying the mix of traded options. The original distribution of the underlying asset can be stretched, compressed and reshaped far more precisely and reliably than is possible by adding other traditional assets to the portfolio. Portfolio diversification of course remains a wise idea, but it is a blunt tool and of limited use in avoiding large portfolio losses, as most assets have substantial correlations which tend to increase in times of financial distress.

Tail hedging strategies buy put options to truncate the distribution of returns to the left, so that extreme losses are not possible in any one period. Cost considerations are probably responsible for the limited adoption of tail hedging in wide sectors of the investment industry. Such considerations are not unwarranted. Figure 1 plots a strategy investing in the
S&P 500 index (denoted SPX) over the period from Jan 2000 to May 2013 together with a tail hedging strategy - a portfolio comprising one unit of the S&P 500 and one unit of a 95% strike put on the same index. Trading costs are set at 10c per option. The result is significantly reduced risk[1] with the detrimental side effect of far inferior returns.

Figure 1: Strategy investing in S&P 500 Index with a tail hedging strategy
Jan 2000 to May 2013



Sources: Yahoo!Finance and Triple3. The top chart shows the compound growth of one dollar for the long SPX only strategy and one with a one-month 95% put tail hedge. The middle chart plots the return drawdowns from 5-year highs. The bottom chart shows the quarterly realized volatilities (negative deviations) of the strategies.

The put options reduced the average realized volatility (negative deviation) of quarterly returns by 35% (from 18.7% to 12.2%) and the maximum by 56% (from 72.1% to 31.4%). But, this is achieved at a very substantial cost to realized returns. Puts on the S&P 500 are, on average, a very expensive type of insurance. What is less intuitive is that tail hedging as a stand-alone strategy is not even much of insurance. Notice the hedge does not help at all in the 2000 to 2002 period when the S&P 500 gradually loses close to 50% of its value. The hedge is marginal at best in reducing drawdowns during the Global Financial Crisis of 2007 to 2008. The mechanism behind this surprising result is as follows: the one month option does cushion the portfolio against the first bad month, but at that point new options of much lower strikes have to be purchased at exorbitant prices. Moreover, if the option is out of the money when the market is only down moderately, as is often the case in the early 2000s, the portfolio can still suffer considerable losses month after month.

One may alter the tail hedge to obtain more favorable results, by for example, varying the strike price and expiry month of the put options, trading frequency and/or deploying position management rather than the buy and hold approach used here. But, overall, this is a sub-optimal way to protect a portfolio as it completely disregards the cost of insurance and the entire return distribution but the far left tail. It is far more appropriate, and prudent, to consider all negative returns in the risk management process.

Choosing a distribution: the optimal mix of options

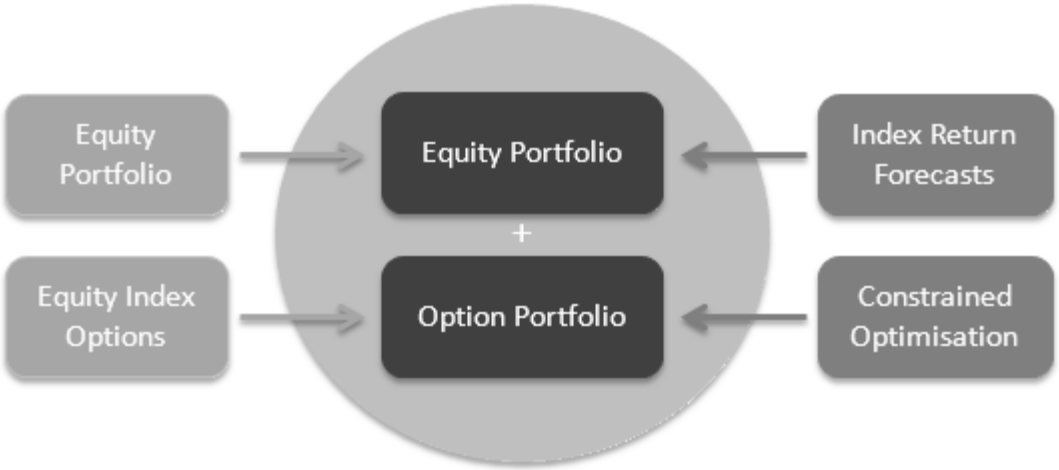
Most tail hedging strategies are mechanical in nature and have no formal model or definition of goals. Much more sophisticated approaches are possible and, preferable. Several options can be bought and sold at any one time, and there is no reason for the notional amount of the options bought or sold to be the same as the asset allocation amount, or to be constant. Importantly in our opinion, statistical considerations[2] suggest that most investors should focus on reducing the volatility of their portfolio in the most cost effective way. Cutting off the left tail is only one of infinite ways of reducing volatility.

3. VOLATILITY OVERLAY STRATEGIES

This paper defines volatility overlay as a strategy that, at each point in time, selects a combination of options to minimise the volatility of an equity portfolio, subject to the constraint that the expected cost of the options (i.e. the loss of returns in expected value) be less than a pre-specified percentage (plus other constraints). Some investors may prefer to work with the dual problem of minimizing the expected cost needed (i.e. maximizing expected returns) given a maximum level of expected volatility. This formulation allows the investor to simultaneously achieve the twin goals of generating alpha and precisely control the preferred level of portfolio volatility. These will be explored in more detail in the following sections.

Figure 2 demonstrates the general approach of Volatility Overlay. Here the equity portfolio is represented by the S&P 500 index, and options on this index are used to construct the overlay portfolio. Return forecasts using a proprietary statistical model are used to calculate expected risk and returns for the portfolios.

Figure 2: The general approach of Volatility Overlay



Equity Portfolio with Volatility Overlay: an options portfolio is dynamically imposed on an existing equity portfolio subject to a set of risk constraints such that the volatility of the overall portfolio is being controlled for under different environments.

Backtest settings

All return forecasts are pseudo out-of-sample in the sense that to generate at time t forecasts for values of the S&P 500 at time $t + H$ the model is estimated and run only with information available up to time t. The horizon H is usually between one and six weeks. Each time five calls and five puts (two at-the-money and eight out-of-the-money strikes) are used to construct the option overlay portfolio. Each option that is bought or sold is held to maturity. Every week, a fraction of the risk capital is allocated, so four or five trades are performed over the course of an expiry month. Historical option prices for the S&P 500 are used for the period 2000-01-03 to 2013-05-16. Trading costs are set at 10c per option. In all the backtests, a no net short puts constraint is imposed (i.e. the sum of all notional positions in put options must be non-negative) as it is undesirable to introduce potential of unlimited losses on the downside in addition to the risk the portfolio already bears by owning the equity index.

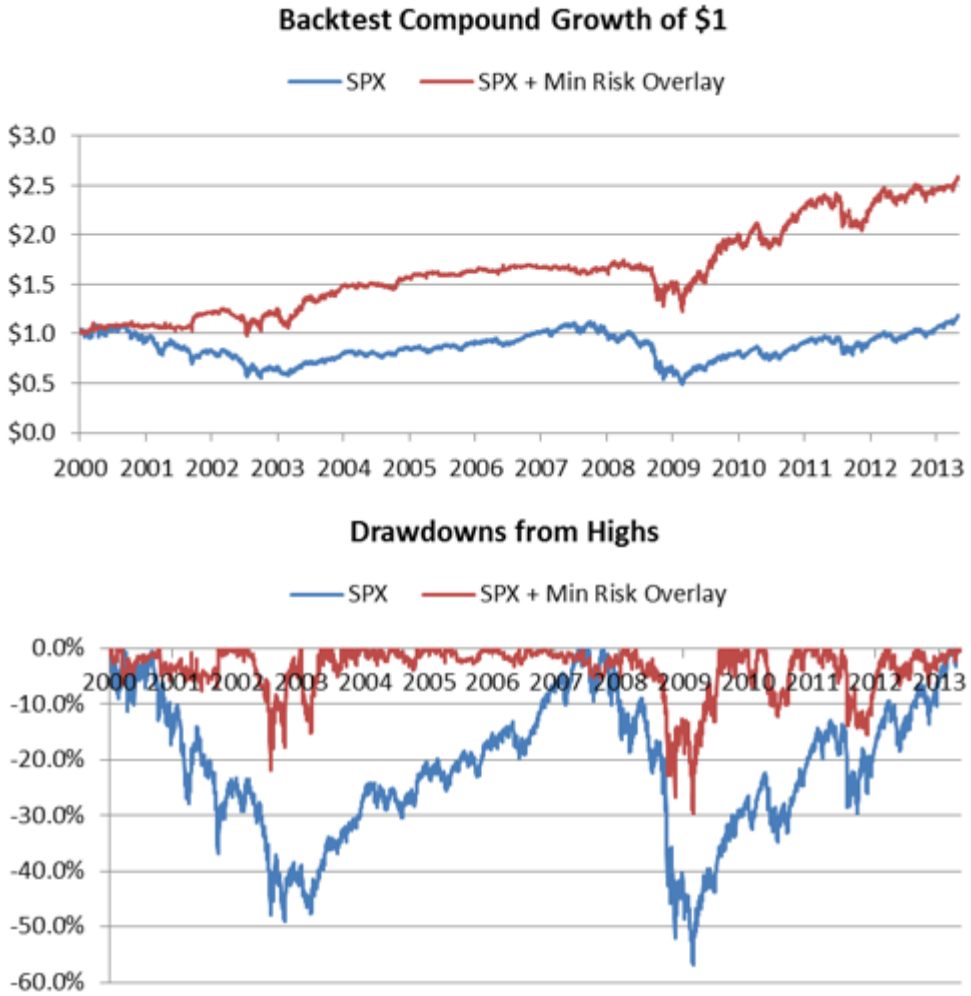
3.1 Backtest: Volatility overlay at no (expected) cost

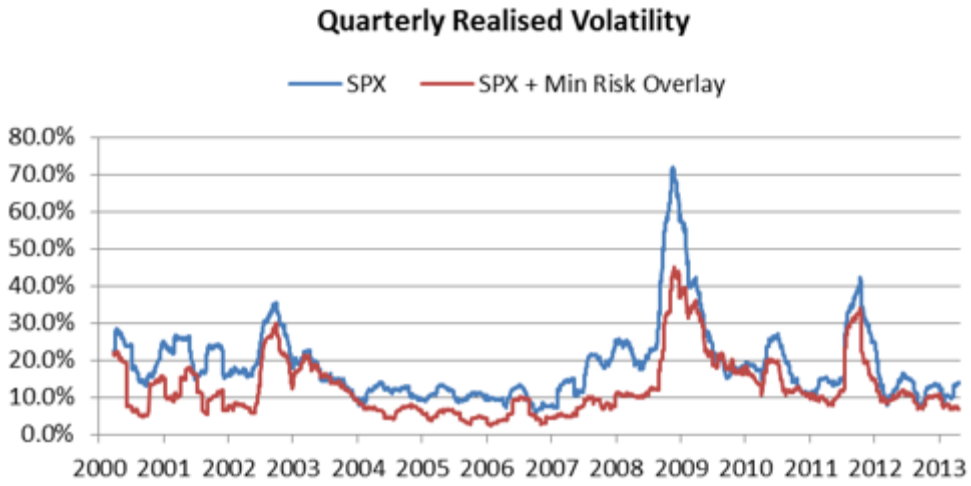
Consider an investor who is not willing to sacrifice any share of expected returns to reduce volatility – transactions in options must have a non-negative expected value. The strategy then would seek to minimize portfolio risk given this constraint. The results are illustrated in Figure 3. Returns are substantially improved (from 1.2% to 7.4% p.a.), especially during the two major bear markets where drawdowns are reduced significantly. A decrease in

negative deviation of 32% is achieved for the entire backtest period, while the maximum quarterly volatility (i.e. during the fall of 2008) is reduced by 37%.

During rising markets (the boom years of 2006 and 2013 in particular), the overlay strategy underperforms the equity index as the expected risk of the portfolio is minimized to very low levels, close to nil in many instances.[3] Hence ex-post returns will lag the market if it rises at an unexpectedly fast rate. However, since realized volatility on average is almost cut in half during those years, an investor may achieve higher returns by using the reduction in volatility to invest more aggressively through leverage or reduced allocation in safe assets.

Figure 3: Backtest: Volatility overlay at no (expected) cost





Sources: Yahoo!Finance and Triple3. Top chart shows the daily compounded growth of one dollar for the long SPX only strategy and Volatility Overlay which minimizes risk at zero expected cost. The middle chart plots the return drawdowns, and the bottom graph shows the quarterly realized volatilities (negative deviations) of the strategies.

Despite the above shortcoming, it is still a far more favorable risk control solution than any typical tail hedging strategy. The difficult dual aim of improving return while reducing risk is demonstratively achieved over a backtest period of almost 13.5 years.

3.2 Backtest: Volatility overlay with alpha generation

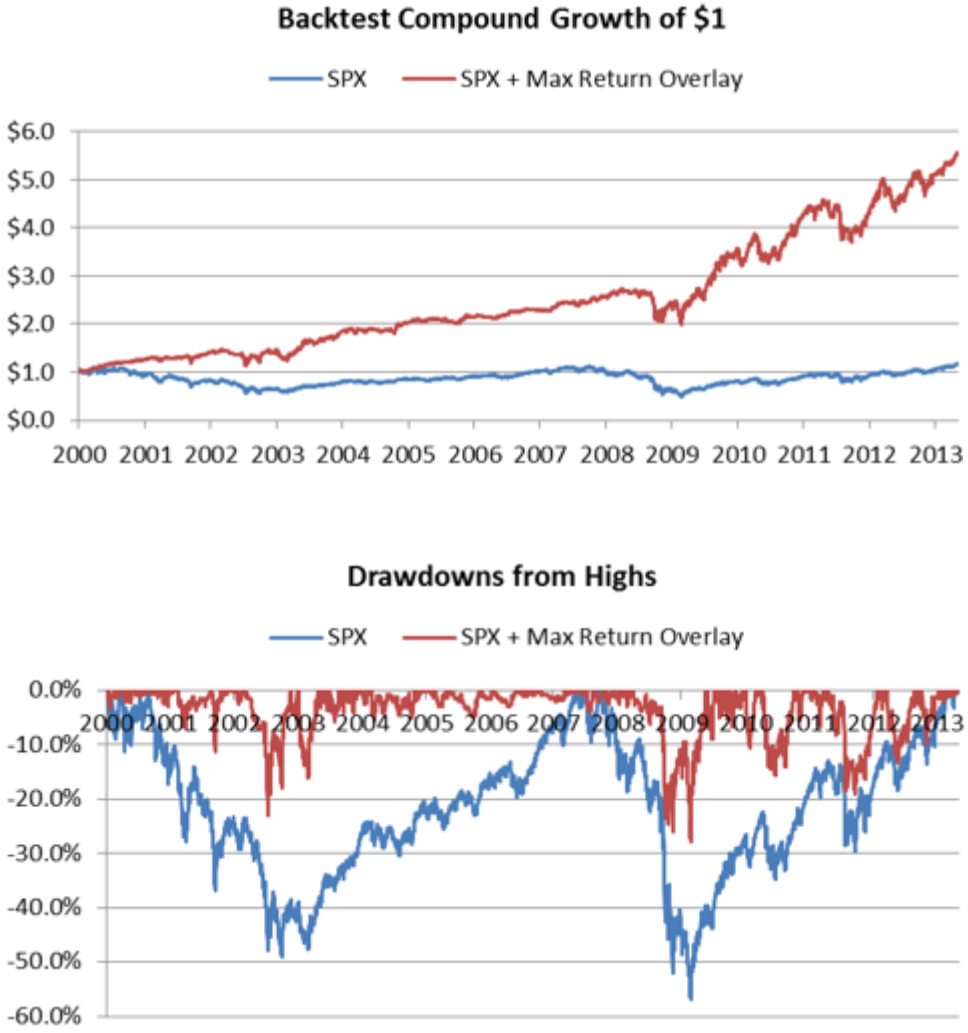
Instead of minimizing expected volatility for a fixed expected cost, some investors may prefer to work with the "dual problem" of minimizing expected costs (i.e. maximizing returns) for a fixed expected volatility. The costs may then turn into alpha and profits (on average), and Volatility Overlay can be used to select a preferred combination of expected volatility and returns. Notice in periods of severe market stress, the volatility constraint may not be satisfied and has to be relaxed. Furthermore, instead of maximizing the expected return of the options only, we consider maximizing it for the entire portfolio. This is far more appealing from an investment standpoint as it is total returns that matter.

Figure 4 shows backtest results of Volatility Overlay targeting an ex-ante negative deviation of 5% per month (17.3% annualised which is similar to the long run average volatility of the S&P 500 index), and trying to maximize returns subject to that constraint. If the 5% limit cannot be achieved, it is relaxed in 1% increments until it can be satisfied.

As alpha is being actively sought after, backtest returns for this more aggressive version of Volatility Overlay are even stronger than the previous one. Average annual return is 13.7%, with 16.8% volatility (a reduction of 24% over the index). Notice the ex-post volatility is very much in line with the ex-ante target of 17.3%. Compared to the risk minimization version

similar improvement in draw down levels is achieved. And it outperforms the S&P 500 index by a significant margin every year except 2006 and 2013.

Figure 4: Backtest: Volatility overlay with alpha generation

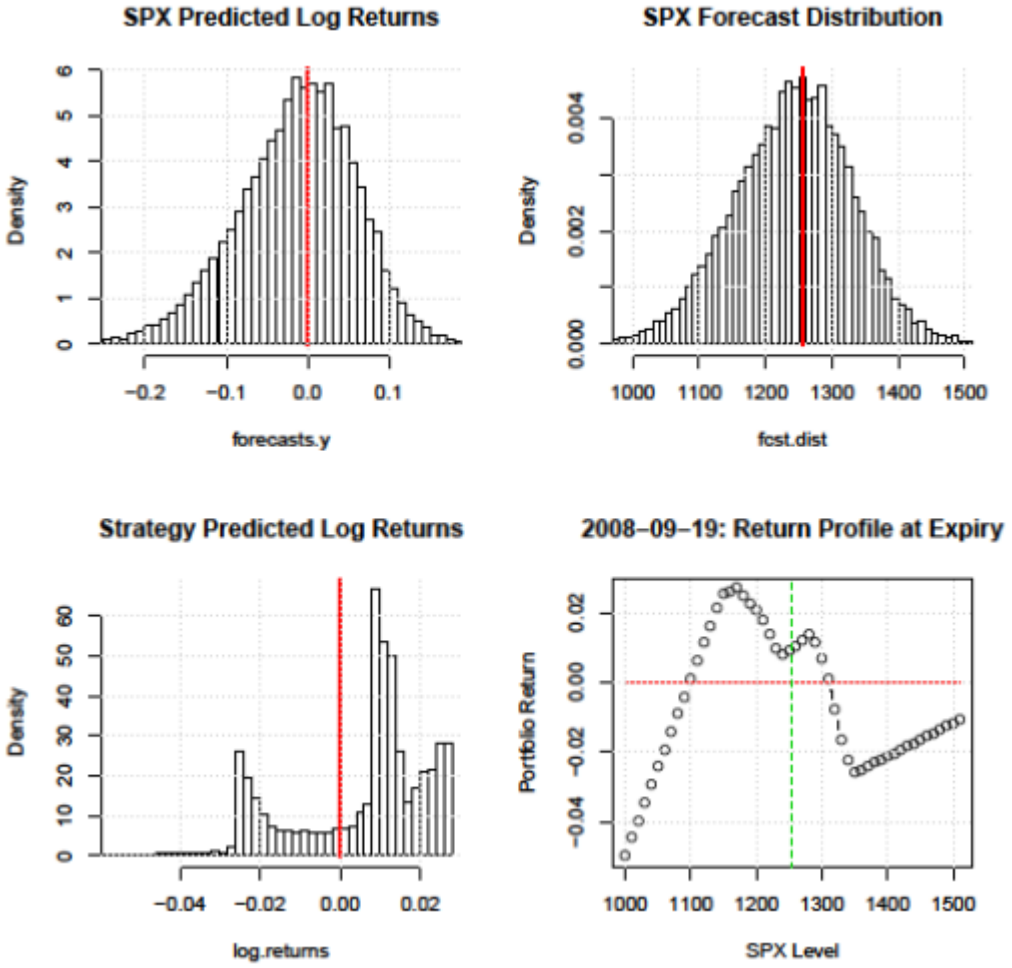


Sources: Yahoo!Finance and Triple3. Top chart shows the daily compounded growth of one dollar for the long SPX only strategy and Volatility Overlay which maximizes portfolio expected returns subject to a monthly risk budget of 5%. The middle chart plots the return drawdowns, and the bottom graph shows the quarterly realized volatilities (negative deviations) of the strategies.

3.3 Example of Volatility Overlay

It is instructive to show an example on how Volatility Overlay can be implemented in practice to demonstrate its flexibility and illustrate how options can be used to completely reshape the return distribution of a portfolio. Figure 5 below shows how an option portfolio would have been constructed on 19 Sep 2008, shortly before the Global Financial Crisis. The S&P 500 index was at 1,255. The objective is to maximise portfolio returns subject to a monthly risk budget of 5%. The resulting hypothetical option portfolio is shown in Figure 6. The option weights are such that the corresponding percentage of the notional value is invested in each option.

Figure 5: Example of Volatility Overlay on 2008-09-19



Source: Triple3. The top left graph shows the one-month forecast distribution of S&P 500 index logarithmic returns. The top right graph is the corresponding index distribution. Bottom right chart illustrates the return profile of the portfolio as a function of the index. Bottom left plot is the return distribution for the overlay portfolio.

Figure 6: Example of Volatility Overlay on 2008-09-19

Portfolio	Out-of-the-money				At-the-money		Out-of-the-money			
Option	Put 1	Put 2	Put 3	Put 4	Put 5	Put 6	Put 7	Put 8	Put 9	Put 10
Delta	-0.15	-0.20	-0.30	-0.40	-0.50	0.50	0.40	0.30	0.20	0.15
Weighting	-44%	-58%	94%	0%	91%	-81%	-78%	-18%	8%	69%

Source: Triple3. Hypothetical option portfolio for Volatility Overlay on 19 Sep 2008. Option weights are presented as percentage of notional for the underlying equity index.

As shown in the bottom right diagram of Figure 5, the portfolio with Volatility Overlay would generate positive returns if the S&P 500 index ends anywhere between 1,100 and 1,300 in a month's time. Hence, the portfolio is fully protected on the downside unless the market falls significantly more than 10% within the next month. This is a far more reassuring position to be in compared to holding the market index unprotected.

This example also demonstrates the flexibility of the approach. Rather than buying a downside put option outright with no regard to its worthiness, the portfolio optimizer looks for the best value in the options market to achieve the desired level of protection.

Figure 7 summarises the performance of Volatility Overlay and compares to the long only index strategy. It is interesting to note that, the backtest that maximizes returns actually outperforms the index in a rising market as well as in a falling market.

Figure 7: Performance of Volatility Overlay strategies
Jan 2000 – May 2013

	SPX	SPX + Minimum Risk Overlay	SPX + Maximum Return Overlay
Annual Compound Return	1..2%	7.4%	13.7%
Annual Volatility (Negative Deviation)	22.0%	15.0%	16.8%
Percentage in Risk Reduction		-32%	-24%
Sortino Ratio	0.06	0.49	0.82
Maximum Drawdown from Peak	-56.8%	-29.6%	-27.9%
Quarterly Return when the S&P 500 is Up	6.1%	4.3%	6.8%
Quarterly Return when the S&P 500 is Down	-6.9%	-1.5%	-1.2%

Source: Yahoo!Finance and Triple3. Summary statistics for Volatility Overlay strategies using S&P 500 index options and comparison to the long index only strategy demonstrating clear improvement in both risk and return. Backtest period is from Jan 2000 to May 2013.

4. CONCLUSION

Volatility Overlay seeks the portfolio of options that, at each point in time and for a given cost, delivers the maximal reduction in volatility. Equivalently, Volatility Overlay can find the portfolio of options that maximizes returns for a given target volatility. The backtests presented here show that, in the period 2000 to 2013, large reductions in portfolio volatility would have been possible at no expected cost, and instead with noticeable improvement in overall returns. Because the relation between the expected reduction in volatility and the expected cost can be continuously monitored, Volatility Overlay is transparent and leaves investors in full control of their portfolios. The fact that once established, the option positions are held to expiry and require no further maintenance (e.g. delta hedging), makes Volatility Overlay a very practical tool for investors to manage the risk of their equity portfolio.

As demonstrated, Volatility Overlay presents an attractive alternative to traditional asset allocation, as it provides an efficient and cost effective way to control risk and generate alpha. It also reduces the need to move investment capital between the different asset classes.

ENDNOTES

1. In this paper, realized risk/volatility is measured as the negative deviation of returns, which is the standard deviation of negative returns only. Mathematically, it is defined as the annualized square root of the average squared negative returns.

2. Central Limit Theorem arguments suggest that truncating the tail of the distribution of returns one period ahead, period after period, does not truncate the tails of the distribution of cumulative returns that is of greater interest to a long-run investor. Rather, that the shape of the long-run distribution is driven only by the average expected return and by the average variance of returns.

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