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## Strategy and Solutions Research

### Moderating Volatility and Equity Exposures

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A note on potential changes to the CBOE's standard *VIX* formula, investigating methods of increasing responsiveness to diminishing fear in equity markets.

### Executive Summary

- Simple volatility triggers lag bullish moves in equities.
- A hangover of expected volatility in instruments such as the *VIX* can cause actively managed funds to miss significant rallies at the start of bull markets.
- By incorporating trends in the range of options strike prices into the *VIX* formula, redeployment of capital can be accelerated.
- Whilst inclusion of such trends should prove beneficial when purchasing stocks, the sudden, erratic spikes for which the *VIX* is well known will render them of little use at the beginning of bear markets.
- Funds could be allocated to specific sectors in response to the new *VIX* formula with more speculative investments favoured as the updated volatility value falls into its bottom quartile.

### Active Underperformance

It has been established that the majority of active funds fail to beat their benchmarks during bull markets. The opposite would appear to be true as asset values decline, with a *Vanguard* study in 2008 finding 60% of active funds successfully outperformed during the last bear market. The contributing factors to this underperformance are easily identifiable; significant and often complex fee structures, cash positions, and active hedges work together to lessen returns when equities advance. Additionally, fund governance requirements and psychological factors play a role, particularly at the beginning of bull market cycles.

Whilst hedge funds and prop. shops are more likely to utilise aggressive strategies in volatile markets, reallocating capital into equities, more conservative managers such as those running pension and mutual funds will often find themselves corsetted by board limitations. For example maximum levels of portfolio volatility, articulated in the funds investment policy statements, may disincentivise managers from attempting to call the bottom and subsequent rally from a bear market.

Beginning with a simple back-test highlighting this issue around the inflection points between bull and bear markets, this note proposes modifications to the *VIX* formula in an attempt to remedy the problem.

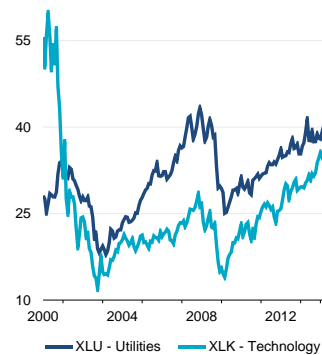
### Illustrative Back-test

The back-test, *VSP(20)*, below utilises a binary trigger of 20.00 on the *VIX* to either allocate funds into an ETF tracking the S&P500 or simply hold cash. This trigger was chosen as a result of the following, high-level information.

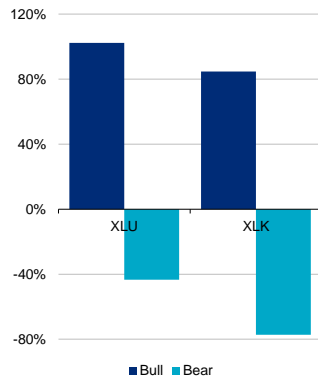
- There is a low negative correlation of -0.46 between the *VIX* and the *S&P500* (Jan'00-June'14), as illustrated in figure 1.
- Although not strictly mean-reverting the 14-year average of the *VIX* is 21.16, with the instrument spending c60% of all trading days below 22.00.

Further strategy variables are detailed below.

## Development: Sector Rotation

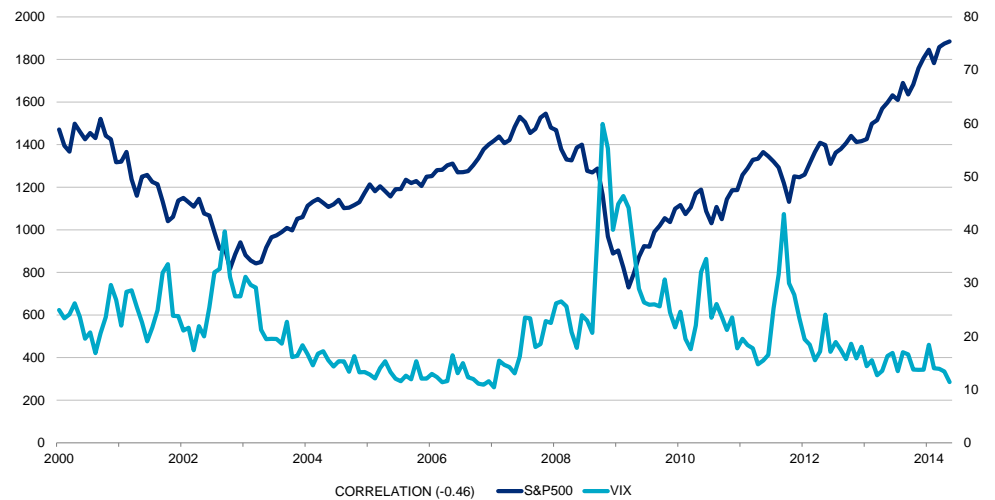


Performance of sector specific ETF's  
(01/01/00 – 31/06/14).



Performance of sector specific ETF's during  
bear ('00-'03, '08-'09) / bull ('04-'07, '10-'13)  
markets.

Figure 1: Correlation – S&P500 vs. VIX (01/01/00 – 31/06/14)



In back testing the *VSP(20)* an initial account balance of USD100,000.00 was assumed, with a fixed 200 point Stop / Loss and no Limit order. The strategy enters into a long position on the first trading day of each month, when the *VIX* >20.00. Positions will be held until the close of the final trading day of the month, subject to the Stop / Loss remaining dormant.

The study utilises data from *IG Markets* and, as such, may deliver results which differ slightly from similar examinations employing more widely traded ETF's (due to varying commission and financing levels).

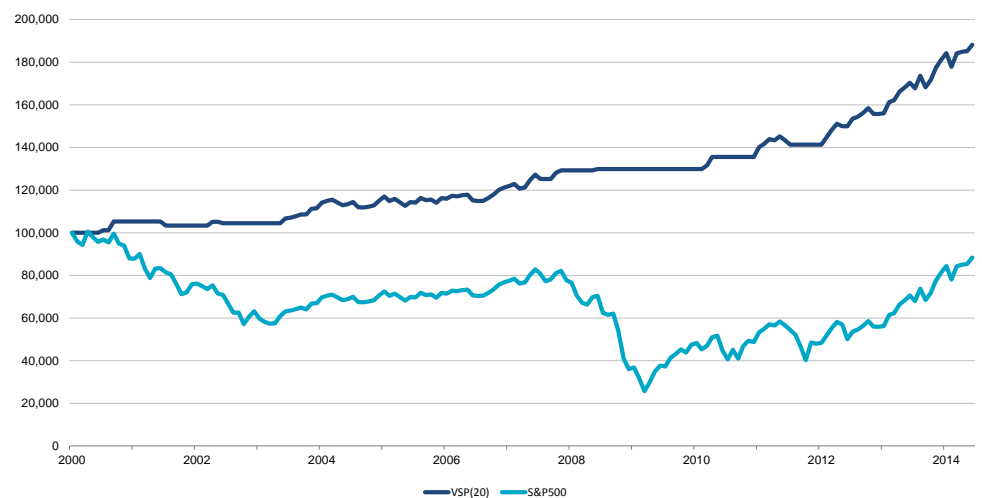
## Timeframe and Risk Management

Trades were held for a period of one month to minimise the impact of daily market noise and smaller price swings, and to deliver returns in line with the prevailing volatility. In addition to incurring greater financing charges it stands to reason that correlation with the markets present perception of volatility would decrease over a larger timeframe.

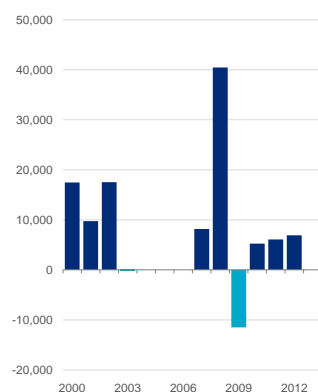
## Results and Benchmarking

The obvious benchmark for the *VSP(20)* strategy is the *S&P500* itself, comparisons with which can be seen in figures 2 and 3.

Figure 2: Benchmarking – VSP(20) vs. S&P500 (01/01/00 – 31/06/14)



**VSP(20) vs. S&P500 (Annual)**



Year	VSP(20)	S&P500	+/-
2000	5330.37	(12,139.36)	17,469.73
2001	(1,934.50)	(11,676.59)	9,742.09
2002	1,111.32	(16,420.48)	17,531.80
2003	9,637.46	9,884.66	(247.20)
2004	2,870.55	2,870.55	-
2005	(1,038.97)	(1,038.97)	-
2006	6,005.37	6,005.37	-
2007	7,281.53	(879.49)	8,161.02
2008	617.90	(39,834.61)	40,452.51
2009	-	11,494.03	(11,494.03)
2010	10,208.93	4,961.74	5,247.19
2011	1,255.14	(4,831.86)	6,087.00
2012	14,760.71	7,857.89	6,902.82
2013	28,182.41	28,182.41	-

All figures USD

**Figure 3: VSP(20) back-test results (01/01/00 – 31/06/14)**

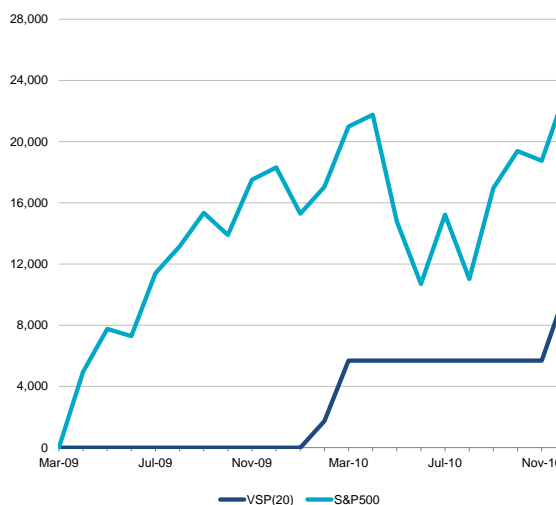
	VSP(20)	S&P500
<b>Final Equity</b>	<b>188,229.75</b>	<b>88,376.79</b>
Profit	88,229.75	(11,623.21)
Total profit (%)	88.2	(11.6)
Annualised profit (%)	6.3	(0.8)
In-market (%)	54.3	100
Volatility	4.18	20.86
Months	173	173
Trades	94	173
Winning trades	71	97
Winning trades (%)	76	56
Losing trades	23	76
Losing trades (%)	24	44

All figures USD

Although VSP(20) did not utilize leverage to enhance returns, the combination of a wide Stop / Loss order and aggressive position sizing had the potential to result in significant drawdowns of up to 10% of total equity. January 2014 saw the back-tests biggest realised monthly loss (-3.14%), whilst the largest paper loss stood at -4.59% in June 2011. These results are far superior to those of the S&P500, which experienced ten drawdowns in excess of 10%, with the largest unprotected loss reaching -23.9%.

Whilst the simple VSP(20) strategy performed well, the shortcomings of inflection point underperformance are clearly evident and illustrated in figure 4. Much of this 22-month period from 2009-10 saw the hangover from the global economic crisis support the VIX above the 20.00 point trigger, in spite of a surge in the S&P.

**Figure 4: Underperformance – VSP(20) vs. S&P500 (01/03/09 – 30/11/10)**



## Enhancing Volatility Triggers

### Increasing Volatility

One potential solution for the latency detailed above could be to increase the sensitivity of the VIX, in relation to the short term trend of options on the S&P500. Allowing for a more responsive VIX during periods of heightened, yet steadily decreasing market unrest (such as March 2009), would enable long positions to be entered into earlier than otherwise condoned by the binary threshold.

Figures 5 and 6 below illustrate both the current VIX formula and the revised version, which looks to increase the volatility of the indicator in response to trending SPX options interest.

**Figure 5: VIX generalised formula**

$$\sigma^2 = \frac{2}{T} \sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2$$

**Figure 6: Revised VIX formula**

$$\sigma^2 = \frac{2}{T} \sum_i C_j - \frac{1}{T} \left[ \frac{F}{K_0} - 1 \right]^2$$

where:

$dF$  contribution to strike at  $F$  - contribution to strike at  $K_i$

$x$  monthly range of strike prices

$C_j = \left( \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) \right) + \frac{dF}{10}$  if  $x < x_{-1} < x_{-2} < x_{-3}$  and  $\left( \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) \right) < \text{Put / Call Average}$

or

$C_j = \left( \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) \right) + \frac{dF}{3}$  if  $x > x_{-1} > x_{-2} > x_{-3}$  and  $\left( \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) \right) > \text{Put / Call Average}$

else

$C_j = \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i)$

### Explanation

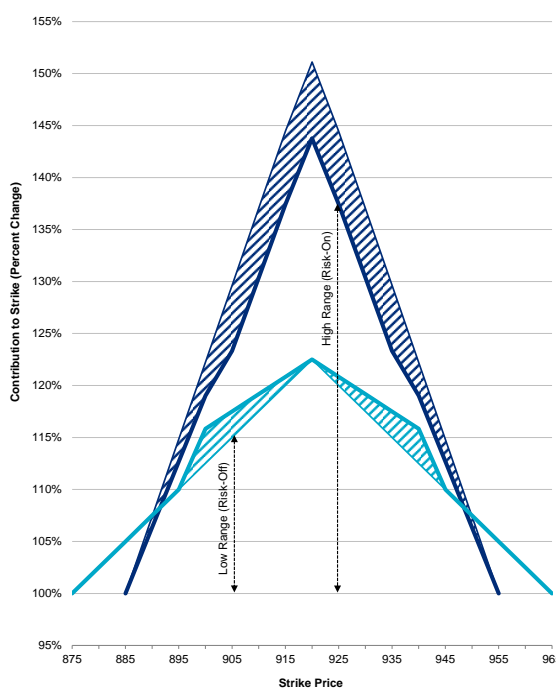
Under the standard VIX formula the range of options included within the calculation fluctuates in response to demand at different prices. Through monitoring the scope and trend of this demand, and weighting the value of strike prices as a result, the revised formula should prove more responsive to changes in sentiment among market participants.

### Volatility, Variables and Weighting

The revised formula introduces variable,  $C_j$  which has the potential to alter the 'contribution to strike' value of each individual strike price, dependent on the short term trend of monthly strike prices ( $x$ ). Should the range trend lower for three consecutive months,  $C_j$  decreases the 'contribution to strike' values around  $F$ , lessening the VIX at a time when uncertainty in the marketplace is beginning to decrease. Inversely, if the range of strike prices trends higher for three months in a row, 'contribution to strike' values were be heightened around  $F$  to represent increased perceptions of unpredictability.

These alterations are illustrated in figure 7 below which details the change in contribution to strike values for a range of example strike prices, in both of the scenarios above.

**Figure 7: VIX vs. Revised VIX – Range variations in contribution to strike**



The thin lines in figure 7 denote the standard increase in contribution to strike values as strike prices near  $F$ , whilst the heavier lines indicate the new, post-weighted values in response to the trend in  $x$ . The lighter blue lines demonstrate a market in which the range of  $x$  values is expanding, whilst the dark blue line experiences a contraction in contribution to strike outputs as volatility in the underlying SPX options falls.

In theory these changes would significantly contribute towards remedying the underperformance issue identified within the *VSP(20)* back-test.

## Review

Whilst the analysis above proposes that increasing the volatility of the *VIX* following periods of uncertainty could enhance returns, it is less clear what the predictive powers of the revised formula would be at the beginning of bear cycles. This is due to the manner in which fear manifests itself in the marketplace, often arriving unannounced and with extreme, reactionary consequences. The *VIX*'s infamous spikes, which are often not preceded by a steady increase in the index's value, are a testament to this.

## Weaknesses

- Whilst the *VIX* is usually an accurate representation of underlying volatility in the market there exist other factors which may influence the value of equities, whilst causing no meaningful change in the instrument. The period May'13 – Apr'14 in a backtest of *VSP(20)* on the *FTSE100* is a good example of this. Whilst the *VIX* trended lower throughout the period, the *FTSE* whipsawed back and forth in a tight range as the psychological factor of a new all time high tempered good economic data and steadily decreasing uncertainty over the stability of the British economy.
- The range of strike prices ( $x$ ) can be easily skewed by small, speculative orders at the extremes of the options strike price and takes no account of the strength of demand at each end of the bell curve.
- Correlation to the underlying index remains a key weakness of *VSP(20)*, however the strategy does allow, and would benefit from, further diversification by both instrument and geography.

### **Manipulation**

It must be noted that this study's manipulation of the *VIX* formula is subject to hindsight bias and, whilst the 14-year back test period of *VSP(20)* does encompass a broad range of market conditions, the revisions proposed above represent remedies to historical events.

### **Opportunities**

Further studies could experiment with combining sector rotational theories to the revised *VIX* formula. In place of buying into an ETF tracking a national bourse, sector specific instruments could be purchased in relation to the value of the enhanced *VIX*, with more historically speculative areas such as *Technology* favoured as *x* values trend lower, and a more conservative asset allocation into *Utilities* as they expand.