GLOBAL VOLATILITY SUMMIT

August 2017 Newsletter

Dear Investor,

The Global Volatility Summit ("GVS") brings together volatility and tail hedge managers, institutional investors, thought-provoking speakers, and other industry experts to discuss the volatility markets and the roles volatility strategies can play in institutional investment portfolios. The GVS aims to keep investors updated on the volatility markets throughout the year, and educated on innovations within the space.

BlueMountain Capital has provided the latest piece in the GVS newsletter series.

Cheers,
Global Volatility Summit

Event

The ninth annual Global Volatility Summit ("GVS") is scheduled for Wednesday, March 14th, 2018 at Pier 60 in New York City. Alongside our featured volatility managers, we are excited to announce the addition of a Quantitative and CTA manager panel, featuring prominent portfolio managers in the space to share their views on the volatility markets and resulting impact on these strategies.

2017 MANAGER PARTICIPANTS

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Capstone Investment Advisors
BlueMountain Capital
Capula Investment Management
Dominicé & Co
Fort LP
Graham Capital Management
III Capital Management
Ionic Capital Management
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2017 Event Recap

The 8th Annual Global Volatility Summit was held on March 15, 2017 at Chelsea Piers in New York City. Presenting to and networking with a well-attended crowd was an exciting lineup of 15 hedge fund managers, plus industry experts, hedge fund consultants, and institutional investors addressing the use of volatility, hedging, CTA and quantitative strategies within institutional investment portfolios.

BARCLAYS

Equity Research

7 August 2017

Index Volatility Weekly

What will happen if VIX spikes?

- **The low level of VIX has raised concerns that a fundamentally driven move in VIX might be exacerbated due to positioning in VIX products.** In this note, we show that while a rude awakening from the prevailing complacency could indeed lead to significant increase in VIX, some of the positioning-related concerns are misplaced.
- **We estimate that in a shock scenario 1M VIX futures could spike by 50% in a day.** Using data from 1926 we show that large one-day SPX drops are rare after a period of complacency (low realized volatility) and a -5% move is an adequate shock scenario. We estimate that this translates into a move of 14 points for the VIX and ~6 points for the VIX 1M future or -50% return for the SPVXSP index (which is the benchmark for VIX ETPs).
- **However, in such a scenario, volume in VIX futures could easily cross $1Bn vega.** Liquidity in VIX futures has increased substantially in terms of both base of the volume and its tendency to spike during risk-off events. We construct a multi-factor model for VIX futures volume which predicts it will likely cross a million contracts ($1Bn vega) in a shock scenario.
- **Flow from managers of Leveraged VIX Exchange Traded Products (LETP flow) saturates for large VIX moves.** We show that the VIX futures demand due to LETP negative gamma does not increase linearly but eventually saturates for large positive moves. In our shock scenario we estimate a demand of ~$110Mn vega which is only 10% of the likely VIX futures volume. On the other hand, for a large drop in VIX futures, the supply is not bounded and is thus a bigger concern.
- **Flow due to forced unwind of inverse VIX ETPs if VIX futures increase by ~100% is not an incremental effect.** The impact of the managers of XIV exercising their option to close the fund or potential margin call for SVXY in this scenario is already reflected in the LETP flow calculation and is not an additional effect. We demonstrate that negative LETP gamma is precisely the managers meeting margin calls by reducing positions.
- **Short interest in inverse VIX ETPs has increased sharply, which will likely mitigate the impact of LETP flow.** A potential reason is that this roundabout way of going long volatility is more cost effective due to the positive carry from the negative LETP gamma. However, this strategy, whose payoff resembles a covered call in VIX futures, underperforms for extreme moves in VIX futures.
- **In our opinion, the counterparties of the short-sellers of inverse ETPs are market-makers whose long gamma is mitigating the impact of LETP manager flow.** One piece of evidence is that the LETP flow as measured by the intra-day autocorrelation of VIX futures has declined substantially over the past few years.

DERIVATIVES

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PLEASE SEE ANALYST CERTIFICATION(S) AND IMPORTANT DISCLOSURES BEGINNING ON PAGE 23.

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VOLATILITY OUTLOOK

Summary

The low level of VIX has raised concerns that a fundamentally driven move in VIX might be exacerbated due to positioning in VIX products. As the equity market continues to make new highs amid historically low realized and implied volatilities, investors have begun to fear that the market has become too complacent. The worry is that an unexpected shock could lead to sudden down move in equities and an attendant spike in VIX and VIX futures. In this report we focus on the impact from the leveraged VIX ETPs (which include the inverse VIX ETPs such as XIV and SVXY and the 2x leveraged ETPs such as TVIX and UVXY). We show that while a rude awakening from the prevailing complacency could indeed lead to significant increase in VIX, some of the positioning-related concerns are misplaced.

We estimate that in a shock scenario 1M VIX futures could spike by 50% in a day. Using data from 1926 we show that large one-day SPX drops are rare after a period of complacency (low realized volatility) and a -5% move is an adequate shock scenario. We estimate that this translates into a move of 14 points for the VIX and ~6 points for the VIX 1M future or -50% return for the SPVXSP index (which is the benchmark for VIX ETPs).

However, in such a scenario, volume in VIX futures could easily cross $1Bn vega. Liquidity in VIX futures has increased substantially in terms of both base of the volume and its tendency to spike during risk-off events. We construct a multi-factor model for VIX futures volume which predicts it will likely cross a million contracts ($1Bn vega) in a shock scenario.

Flow from managers of Leveraged VIX Exchange Traded Products (LETP flow) saturates for large VIX moves. We show that the VIX futures demand due to LETP negative gamma does not increase linearly but eventually saturates for large positive moves. In our shock scenario we estimate a demand of ~$110Mn vega which is only 10% of the likely VIX futures volume. On the other hand, for a large drop in VIX futures, the supply is not bounded and is thus a bigger concern.

Flow due to forced unwind of inverse VIX ETPs if VIX futures increase by ~100% is not an incremental effect. The impact of the managers of XIV exercising their option to close the fund or potential margin call for SVXY in this scenario is already reflected in the LETP flow calculation and is not an additional effect. We demonstrate that negative LETP gamma is precisely the managers meeting margin calls by reducing positions.

Short interest in inverse VIX ETPs has increased sharply which will likely mitigate the impact of LETP flow. A potential reason is that this roundabout way of going long volatility is more cost effective due to the positive carry from the negative LETP gamma. However, this strategy, whose payoff resembles a covered call in VIX futures, underperforms for extreme moves in VIX futures.

In our opinion, the counterparties of the short-sellers of inverse ETPs are market-makers whose long gamma is mitigating the impact of LETP manager flow. One piece of evidence is that the LETP flow as measured by the intra-day autocorrelation of VIX futures has declined substantially over the past few years.

Quantifying a shock scenario

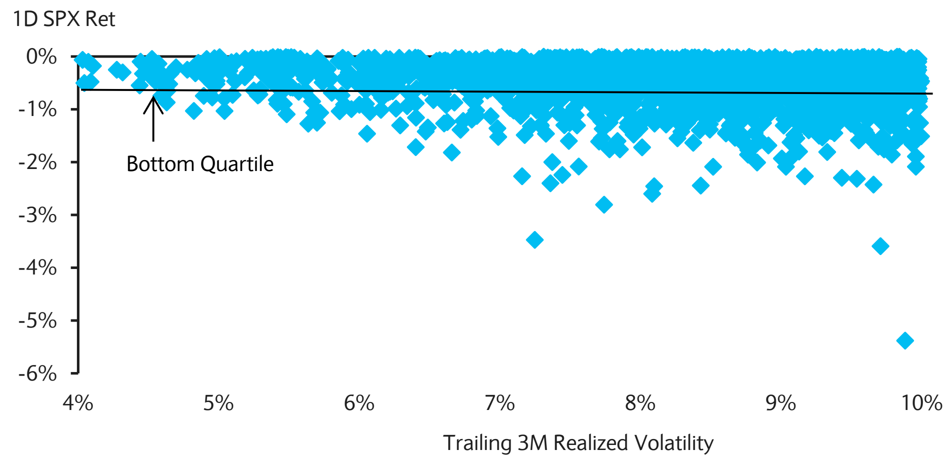
In this section, we quantify the magnitude of a potential “shock scenario” by using history as a guide. Our goal is to quantify the potential one-day move in SPX and then translate that into a move in VIX and VIX futures.

Using all one-day returns for SPX since 1926 as a guide, the potential one-day move can of course be quite large. SPX has dropped by ~10% several times in one day during the Great Depression (1929-1933). More recently it dropped by 20% during 1987 and by 5-8% during the 2008 crises. However, for our purposes the important question is: what is the expected move when we start with a period of low volatility similar to what we are experiencing now? In other words, historically, have periods of complacency resulted in significant negative returns in equities?

Figure 1 plots the negative moves in SPX when the trailing 3M realized volatility was less than 10% (a total of ~2500 samples). We see that in an overwhelming majority of cases the one-day returns have been quite low (the bottom quartile is only -0.6%). There have been only three episodes with moves worse than -3%. Thus the more substantial negative moves have not occurred suddenly but have been preceded by a period of elevated volatility. Still, to be conservative, we will assume a shock scenario of 5% for the purpose of this report.

FIGURE 1

SPX moves after a period of complacency



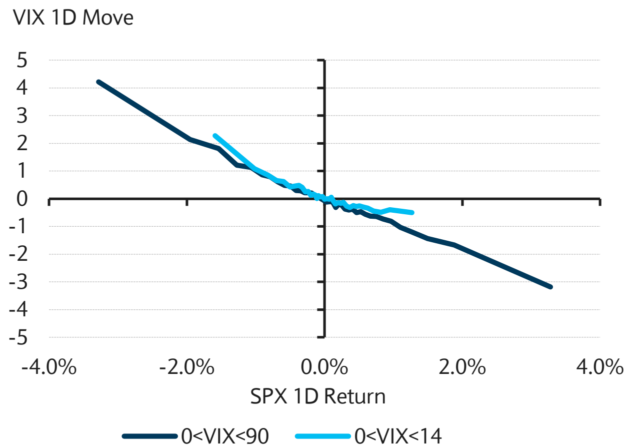
Source: Barclays Research, Bloomberg

The next question is how much will VIX move in such a scenario? As we have discussed in previous reports, it is more natural to model changes in VIX versus SPX returns. Figure 2 plots the 1D change in VIX as a function of one-day SPX returns. Using all the data since 1990, we see that the relationship is quite linear and we have the rough rule that VIX moves by one point for a 1% move in SPX.

One key concern is the move in VIX might be larger if the starting value of VIX is low. Hence, we also show the relationship using only data points where the starting value of VIX is below 14. The range of SPX returns for this subset of data is of course much smaller. However, we do see a higher convexity indicating that in the unlikely event of a large move in SPX starting from a low value of VIX, the potential moves in VIX could be larger than what is predicted using all data points.

FIGURE 2

VIX moves are convex relative to SPX returns for low starting values of VIX

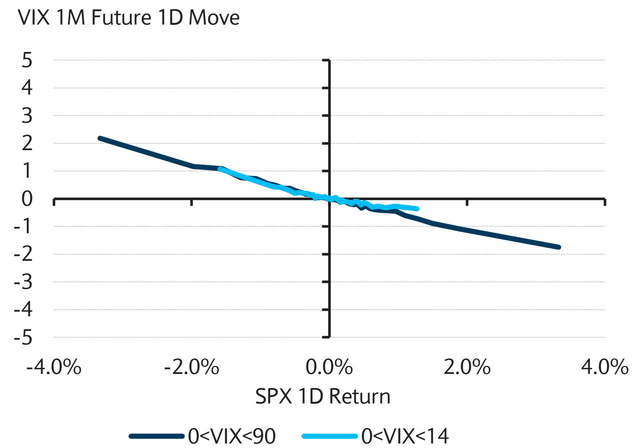


Source: Barclays Research

Note: Data from Jan 1990 to July 2017

FIGURE 3

The beta of VIX futures moves is half that of VIX and the convexity is much lower



Source: Barclays Research

Note: Data from Jan 1992 to July 2017. Constant maturity 1M VIX future calculated by interpolating the front two calendar VIX futures. VIX futures prior to Dec 2005 are theoretical values calculated using SPX forward variance swaps.

However, what really matters for VIX ETPs is the move in VIX futures. Almost all of the relevant VIX ETPs are benchmarked to the SPVXSP index, which holds a portfolio of the front two VIX futures weighted so that it has exposure to the constant maturity 1M VIX future. Figure 3 plots the relationship between the moves in the constant maturity 1M VIX future and SPX returns. VIX futures only started trading since 2005 and before that we proxy VIX future returns using forward variance swaps. We again see that the relationship is quite linear using all the data and the beta of the VIX futures is roughly half that of VIX. Further, the convexity is not as extreme as VIX for low starting values of VIX. Thus, although the moves in VIX are quite large for sell-offs from a low base in VIX the moves in VIX futures are not as extreme. This is because the term structure steepens for unexpected moves in SPX.

We construct a non-linear model of VIX and 1M VIX Future moves as a function SPX returns and SPX returns squared to capture this effect:

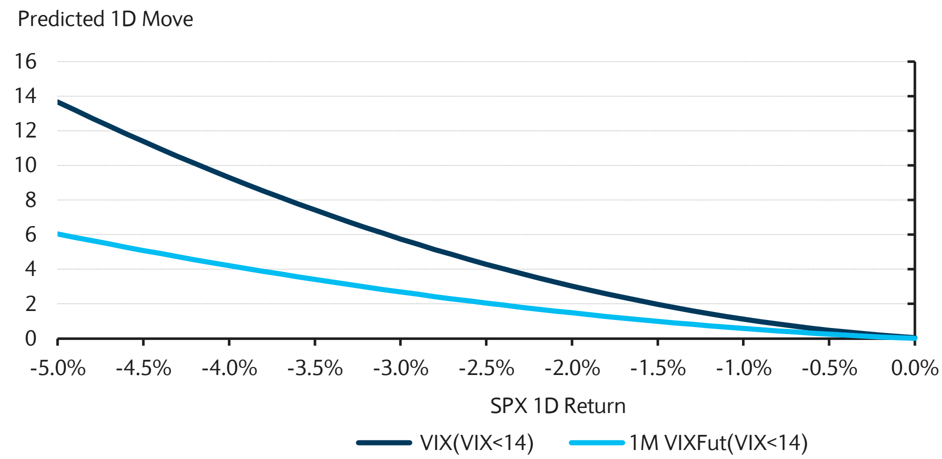
$$\Delta VIX \sim r_{SPX} + r_{SPX}^2$$

We restrict ourselves to days where the SPX return is negative and the starting value of VIX is less than 14. We can then use these models to forecast the moves in VIX and VIX futures for large negative SPX shocks. We emphasize that this amounts to significant extrapolation of the empirical data.

The results are shown in Figure 4. Thus we see that for a 5% down move in SPX, VIX is expected to increase by 14 volatility points and the VIX futures by 6 points. In other words, the SPVXSP index will increase by roughly 50% in our shock scenario since the current value of 1M VIX futures is approximately 12.

FIGURE 4

Regression model predicts that VIX futures will increase by ~50% during a shock scenario



Source: Barclays Research

Note: Predicted moves calculated by regressing moves in VIX and 1M VIX Future versus SPX 1D return and return squared for days when starting value of VIX is less than 14 and the SPX return is negative.

Impact of skew

Intuitively, if most of the move in VIX comes because the ATM strike changes as the SPX moves, one expects that the move in VIX should be higher for higher skew. Thus the regression model becomes:

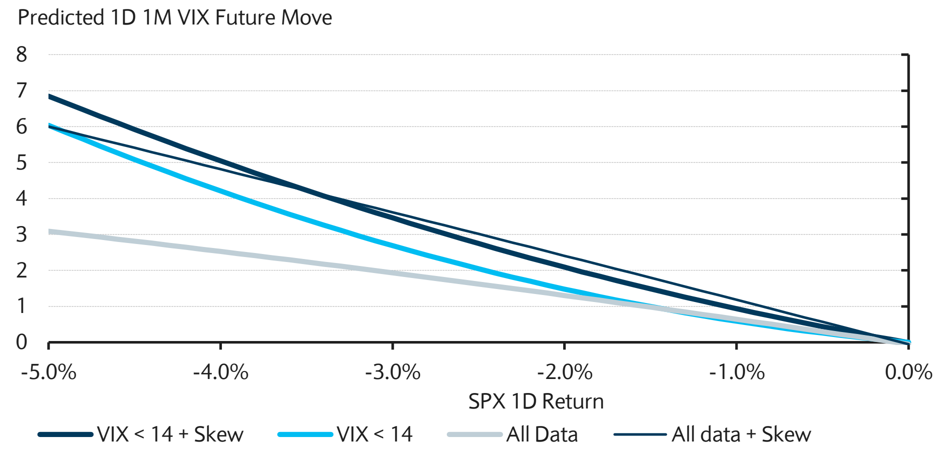
$$\Delta VIX \sim Skew * r_{SPX} + r_{SPX}^2$$

The coefficient of the linear term is also called the Skew Stickiness ratio (SSR) (*Special Report: Market Neutral Variance Swap & VIX Futures Strategies*, April 28, 2014). This issue is particularly germane since short dated skew is quite elevated at the current time and is almost 2x that of its long term historical range.

Figure 5 plots the predicted moves in the 1M VIX Future using this type of model where we have fixed the skew to be the current value. We see that if we incorporate the effect of skew and use all the data points the predicted moves are indeed almost 2x that of the simple return model. However, fitting the same type of model where we restrict ourselves to low initial values of VIX we see that the effect of skew is not that substantial. The reason for this is that in the model for very large moves the convexity term is the main contributor and that does change substantially even when skew is introduced.

FIGURE 5

Incorporating effect of skew does not materially change the prediction of the model which only uses low starting values of VIX



Source: Barclays Research

Note: Predicted moves calculated by regressing moves 1M VIX Future versus SPX 1D return and return squared for days using different models. All Data uses all data points, (VIX<14) uses only points when starting value of VIX is less than 14. Models with Skew regress skew-adjusted SPX 1D return for the linear term. All regressions only use data points where SPX return is negative.

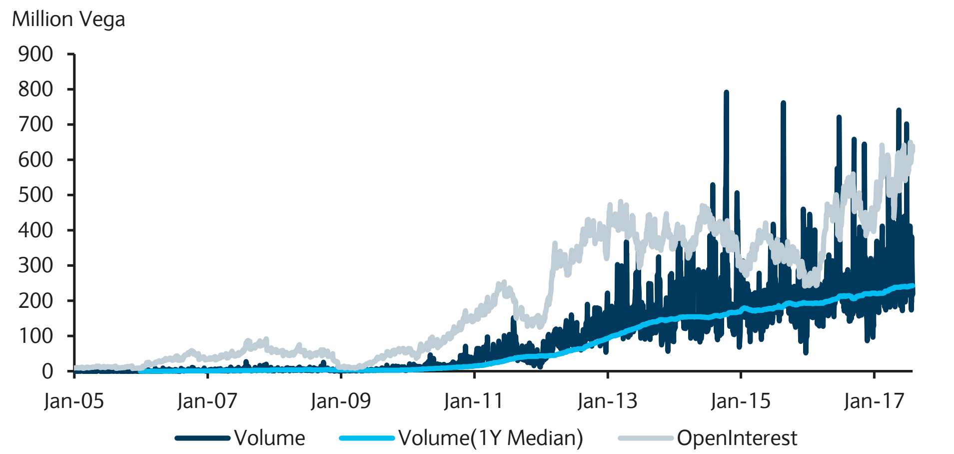
How will VIX futures volume react if VIX spikes?

In this section, we construct a model for estimating VIX futures volume for large moves in VIX. This is critical since the impact of potential VIX-related flows during a shock scenario will be determined not only by their magnitude but also by the overall liquidity in VIX futures at that time. Our key conclusion is that VIX futures volumes could surpass $1Bn vega (1Mn contracts) for large moves in VIX.

Figure 6 shows the trend in VIX futures liquidity by plotting aggregate open interest and volume over the last decade and we see that it has increased dramatically over this time period. Since the futures volume tends to increase when VIX spikes, we also show the one-year moving median of the volume to capture the "base" volume which continues to trend up and is now ~$200M vega/day. Importantly, we see that the volume frequently spiked to ~$800M vega over the past few years.

FIGURE 6

VIX Futures liquidity continues to increase

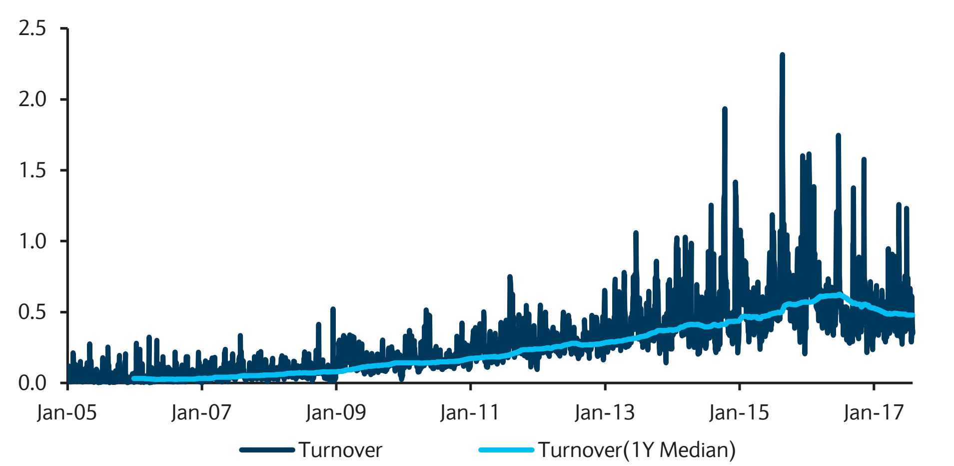


Source: Barclays Research, CBOE, Bloomberg
Note: Aggregate Volume and Open Interest across all VIX futures

Figure 7 plots the ratio of the volume and the open interest or the turnover. Interestingly, while this is somewhat more range bound, this has also continued to trend up. In other words, the VIX futures volumes have been growing much faster than open interest. However, more recently the turnover has declined, indicating that this outperformance has stabilized.

FIGURE 7

VIX futures volume have grown more rapidly than open interest but have stabilized recently



Source: Barclays Research, CBOE, Bloomberg
Note: Turnover = Aggregate Volume/Aggregate Open Interest for VIX futures

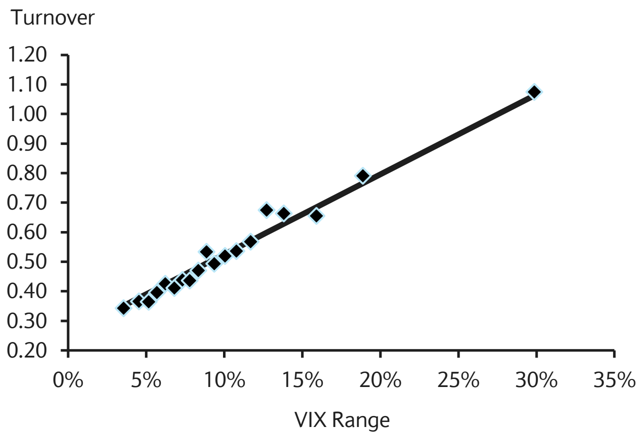
Given its relatively higher stability we will use the turnover as the dependent variable in our model. We start our analysis since 2013 since that captures the period after which the open interest reached a new level driven by the increase in AUM in leveraged VIX ETPs. We find that three variables are useful to explain variation in VIX futures volume:

- *VIX Intraday Range:* For any asset volume tends to naturally increase when it moves. While it is tempting to use the full-day return, what is more important is the intra-day range. Thus even if the close-to-close move is small, a large intra-day range is likely to generate large volume. We define the VIX range as the difference between the high for the day and the minimum of low and previous close normalized by the previous close. We find that this VIX futures volume has much higher correlation with this metric relative to a simple close-to-close return. Figure 8 plots the dependence of the VIX future volume on the range and we see that the dependence appears quite linear.

- *VIX Level:* VIX futures volume also depends on the absolute level of the closing level of VIX as shown in Figure 9. However, the dependence is quite non-linear: for VIX less than ~13.5 the turnover is almost constant and then starts increasing but at a decreasing rate. Figure 9 shows a non-linear model which provides a good fit to the data.
- *Previous Turnover:* Finally, as might be expected, there is strong auto-correlation in the VIX futures volume indicating that large volume episodes cluster. We find that simply using previous day's volume captures most of this effect.

FIGURE 8

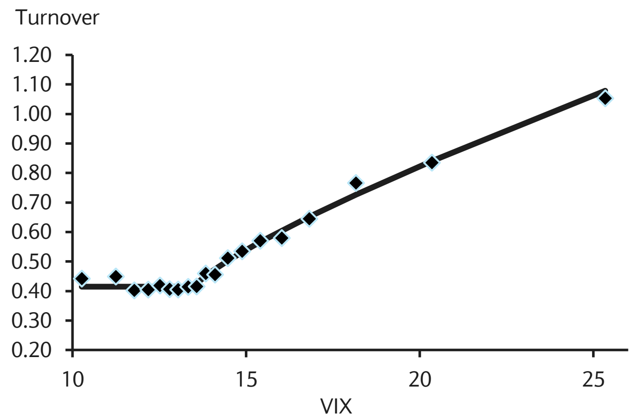
VIX Futures Turnover linearly increases with VIX intra-day range



Source: Barclays Research, CBOE, Bloomberg
Note: Turnover = Aggregate Volume/Aggregate Open Interest for VIX futures, Range = (max(High, Prev Close) – min(Low,Prev Close))/Prev Close. Solid line represents a linear fit

FIGURE 9

Non-linear dependence of Turnover on level of VIX

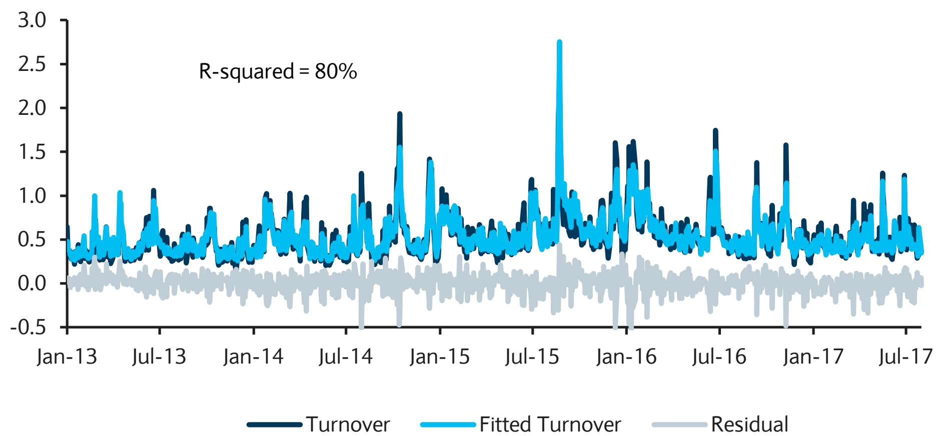


Source: Barclays Research, CBOE, Bloomberg
Note: = Aggregate Volume/Aggregate Open Interest for VIX futures. Solid line represents a model of the form f(x) = A + B*max(0, (x-13.5)^0.8)

We construct a joint regression model which includes these three factors and find that the t-stats for all three are significant, indicating that all of them provide incremental explanatory power. The R-square of the joint model is quite robust at ~80%. Figure 10 compares the fitted normalized futures volume with the actual values and we see that this model does an adequate job in describing the variation in futures volume. Note that the model is not fully able to capture the spikes, and thus, if anything, it appears to be slightly conservative.

FIGURE 10

Three factor model captures the variation in VIX futures volumes over time

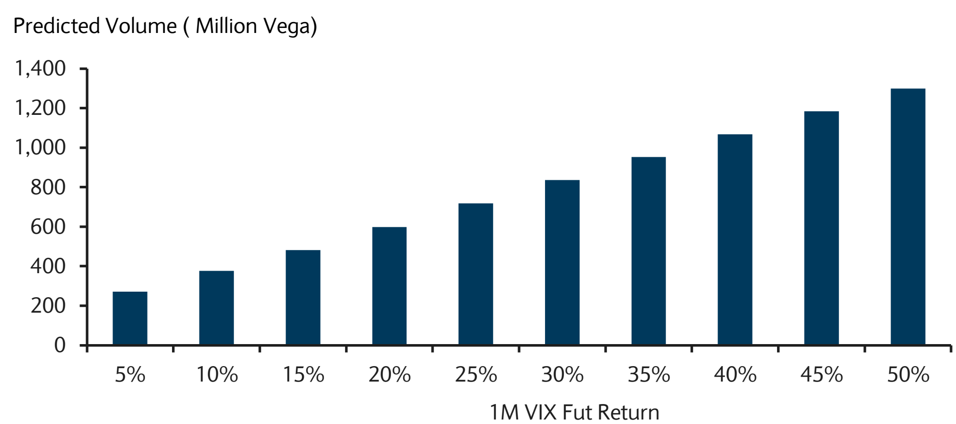


Source: Barclays Research, CBOE, Bloomberg
Note: Fitted Turnover calculated using a regression of Turnover versus VIX Range, non linear function of VIX and previous days turnover.

Armed with this model we can then forecast the potential volume for large moves in VIX. Figure 11 assumes a starting value of VIX of 10 and then simulates the volume for different shocks (we assume that VIX settles at its highs). Our model provides a link between VIX returns and turnover. We convert the turnover into VIX future volumes using the current value of the open interest and the VIX index returns into returns of the 1M VIX future using a beta of 0.5.

FIGURE 11

Our model predicts that VIX futures volume could cross $1Bn vega in a shock scenario



Source: Barclays Research, CBOE, Bloomberg
Note: Predicted Volume calculated based on a regression model of Turnover versus VIX Range, non linear function of VIX and previous days turnover.

Thus we see that for a 50% move in the 1M VIX Futures, VIX future volumes are likely to surpass $1Bn vega (1Mn contracts).

Understanding LETP manager flow

In this section we analyze the flow generated by managers of leveraged VIX Exchange Traded Products (LETP flow). We provide a mathematical derivation of the formula for the flow and analyze its implications for large positive and negative moves in VIX futures.

Theoretical derivation of the LETP flow formula

The key reason for the LETP flow is requirement that these ETPs target a constant daily leverage. Thus the inverse ETPs (XIV and SVXY) target a return which is negative of the SPVXSP (the underlying) asset and a 2x leveraged VIX ETP like TVIX and UVXY target double the return of SPVXSP. We first recap the mathematical derivation of formula for this flow (*Leveraged ETPs: Myths & Reality*, November 17, 2009).

In general, suppose we have an m times leveraged ETP with a current AUM of $\$X_t$ at time at the close on day t. In order to guarantee the m times return over the next day, the ETP manager needs to hold a position of $\$mX_t$ of the underlying index which we label as the target hedge, H_t. As we will see below, it is important to distinguish between the target and actual value (H_t) of the hedge. We assume at t that the manager is correctly hedged and so:

$$\text{Target and Actual Hedge(\$) at time } t = H_t = \widetilde{H}_t = mX_t$$

Suppose now the index move by r percent between times t and $t+1$. Then:

$$=> \text{Value of Hedge(\$) at time } t+1 = \widetilde{H}_{t+1} = mX_t(1+r)$$

$$=> \text{New AUM(\$) at time } t+1 = X_{t+1} = X_t + \widetilde{H}_{t+1} - \widetilde{H}_t = X_t(1+mr)$$

Thus ETP successfully provided a one day return of mr. However, now value of the target hedge is not the same as the actual value of the hedge.

$$\text{Target Hedge(\$) at time } t+1 = H_{t+1} = mX_{t+1} = mX_t(1+mr)$$

Thus the manager must rebalance the hedge at the close of $t+1$. Thus the LETP flow in notional terms is:

$$=> \text{LETP Flow(\$)} = H_{t+1} - \widetilde{H}_{t+1} = rm(m-1)X_t$$

Thus notional ETP flow is simply proportional to the return of the underlying asset. Note that the sign of the flow is always the same as that of the return *r*. Thus as the VIX futures move up (down) the manager needs to buy (sell) VIX futures and thus the manager behaves as if he has negative gamma. Note that this formula is also valid even for inverse ETPs with a negative *m*. In fact for both inverse and 2x leveraged ETPs $m(m-1) = 2$ and thus the flow for both inverse and 2x leveraged ETPs is equal for the same AUM.

However, what we really care about is the number of shares of the asset (which is equivalent to the number of VIX futures or vega) that need to be traded:

$$=> \text{LETP flow (Shares of underlying)} = \frac{rm(m-1)X_t}{S_{t+1}} = m(m-1)\frac{r}{1+r}\frac{X_t}{S_t}$$

Expressing everything in vega terms:

$$=> \mathbf{LETP\ Flow\ (Vega)} = \boldsymbol{m(m-1)\frac{r}{1+r}X_{Vt}}$$

Where X_{Vt} is the AUM expressed in terms of vega (or number of VIX futures).

For small values of r, the above formula can be written as:

$$\text{LETP Flow (Vega)} \approx X_{Vt}m(m-1)r$$

Thus for small moves in the underlying the hedge rebalance increases linearly with *r*. Hence in our *VIX Compass* publication, we simply show the flow across all LETPs for a 10% move in SPVXSP.

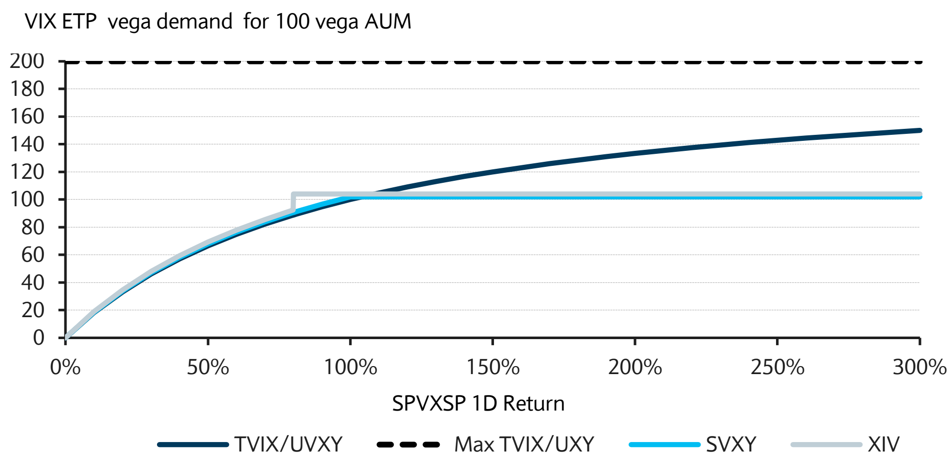
However, for large moves the non-linearity plays an important role. Further, a crucial difference emerges across the different ETPs for positive and negative moves in the underlying index.

Growth in LETP flow for large increase in VIX futures

Figure 12 plots the hedging demand for SVXY, XIV and TVIX (the demand for UVXY is the same as TVIX) as a function of (positive) one-day returns of SPVXSP. To facilitate comparison across products, we calculate the flow for an AUM of $100 vega for each product.

FIGURE 12

When volatility increases, the demand from inverse VIX ETPs caps out at current AUM while that for 2x leveraged ETPs continues to increase albeit at a decreasing rate



Source: Barclays Research

We see that for TVIX/UVXY the rate of increase of the flow starts to decline with increasing SPVXSP return and the maximum flow caps out at $2X_{Vt}$ for large r. This is simply because: $\lim_{r\to\infty}\frac{r}{1+r}=1$. Since this is the value of their current hedge, the 2x leveraged ETPs will at worse be forced to double their existing hedge for extreme positive moves.

However, for inverse ETPs the situation is more subtle. We see that the flow from SVXY and TVIX are same until $r = 80\%$, diverge after that and then flat-line to 100 for $r > 100\%$.

The primary reason for the flat-line for large moves in VIX is that for $r = 100\%$ the return of the inverse ETP is -100% and hence its value goes to zero. Crucially even if $r > 100\%$, the value of inverse ETP is still floored at zero since *ETPs are non-recourse instruments*. Investors in these products can only lose their initial investment in these products and the manager cannot demand additional cash.

Note the above formula correctly predicts that for $r = 100\%$, the flow is X_{Vt}. For the inverse ETP this is of course also the value of the hedge and thus the issuer simply buys back the entire hedge and closes the fund. Thus, interestingly we see that for both inverse and 2x leveraged products the maximum demand when VIX futures increase is the current value of their hedge.

What will happen if the one-day return is higher than 100% ($r > 100\%$)? The issuer will still only buy back the original hedge but now the loss after closing the position is larger than the equity in the fund. For an ETN, this extra loss is borne by the issuer (since an ETN is essentially a bond issued by the issuer). For an ETF the situation is less clear since the manager is only an investment advisor with the assets of the fund being held in trust. Our best guess is that the risk is probably borne by the counterparty to the hedge.

This gap risk explains why XIV (which is an ETN) has a clause that the issuer has the option of closing the fund if its value drops by 80%. Essentially, the remaining 20% value of the fund provides the issuer with a buffer to unwind the entire hedge. As a result, as shown in Figure 12, if SPVXSP increases by 80%, while the SXVY manager will buy back $2 \times \frac{0.8}{1+0.8}$ =89% of its hedge, the XIV manager will buy back 100% of its hedge.

Forced unwind risk of inverse ETPs is not an incremental risk

There has been quite a lot of discussion among market participants about the risk of a "forced unwind" of XIV if SPVXSP increases by 80% and the issuer exercises this option. Similarly, since the initial and maintenance margin for VIX futures is currently 62% and 56%, respectively, there are concerns that SVXY will face a margin call if SPVXSP increases significantly.

While this is no doubt a risk, this is already captured in negative-gamma-driven flow and is thus not an additional risk. Indeed, the negative gamma dynamic of LETPs can be interpreted as the result of the negative ETP managers meeting margin calls (*Leveraged ETPs : Myths & Reality*, November 17, 2009). Consider an investor who takes a leveraged position in an asset. Then the exchange or his prime-broker would require him to post initial margin to protect itself from the risk of the investor defaulting after a large adverse move in the underlying. If the asset does move in an adverse direction, the investor is required to post more cash (maintenance margin). However, the investor always has the option to reduce his position to be consistent with the value of the existing cash in his account. Essentially, after an adverse move, his leverage increases and he can bring the leverage in line with the maintenance margin by reducing his position. This is exactly what the leveraged ETP managers do. In fact they have no choice but to do this since they cannot request more money from their end investors. Thus, all LETPs (including SVXY) are meeting margin calls every day by reducing their exposure.

The accelerated redemption of XIV if VIX futures were to increase by 80% does lead to an additional effect but that simply accelerates the unwind of the remaining 11% of the AUM. The buy-back of 89% of the hedge is already included in the negative gamma effect. As a result, as shown in Figure 12, the flow for XIV and SVYY diverge after $r = 80\%$.

Unfortunately, a common error we have noticed is that market participants calculate the flow from the negative gamma effect and then layer on an additional impact of the "forced unwind" or "margin call" for the inverse ETPs. The above discussion indicates that this amounts to double counting.

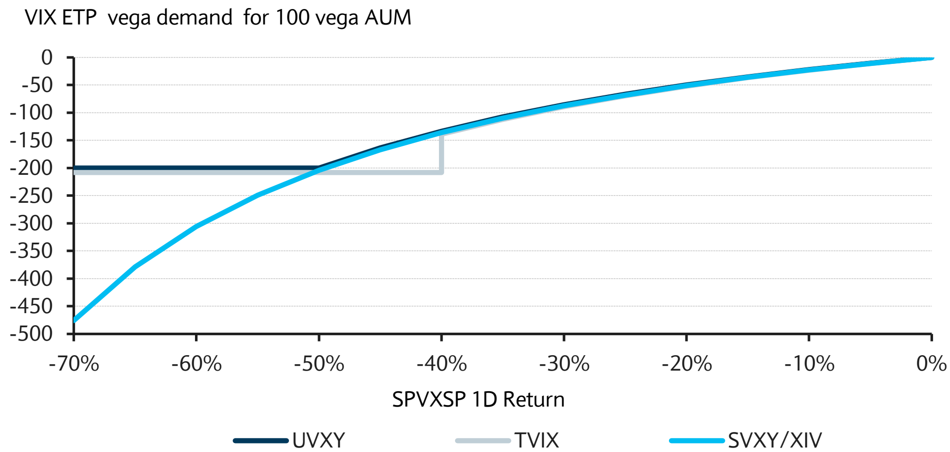
To summarize, for the same AUM, the 2x leveraged ETPs are far more of a concern relative to the inverse ETPs. The hedging demand from the latter caps out at their value of AUM for $r = 100\%$. The 2x leveraged ETPs will only buy back half of their hedge when $r = 100\%$ and for larger moves their hedging demand continues to increase but eventually caps out at the value of their current hedge.

Large drops in VIX futures pose a much bigger risk

For large negative moves the situation is (partially) reversed as shown in Figure 13. For small negative moves the situation is exactly the opposite that of small positive moves as discussed above. However, again we see a remarkable divergence for large negative moves in SPVXSP.

FIGURE 13

When volatility declines, the supply from 2x leveraged products is limited to their current hedge but that for inverse ETPs continues to accelerate



Source: Barclays Research

For if $r = -50\%$, it is the value of a 2x LETP that goes to zero and the manager will unwind their entire hedge. This is the maximum supply from 2x LETPs even if $r < -50\%$. TVIX (which is an ETN) also has the clause that its issuer has the option of unwinding the entire fund if its value drops by 80% and hence the flow for TVIX drops to 200 once we hit this point.

The situation for inverse ETPs is quite different. For $r = -50\%$, the supply is already equal to twice the current vega of the hedge. Moreover, for $r < -50\%$, the supply from the inverse ETPs keeps on increasing similar to what happens to 2x leveraged products for $r > 100\%$. However, while the demand the 2x leveraged ETPs is capped at the current value of the hedge for positive moves, there is no cap in the supply from the inverse product for negative moves since $\lim_{r\to-1}\frac{r}{1+r} = -\infty$. In the unlikely event that VIX futures drop by 90% they would 18x of their current AUM.

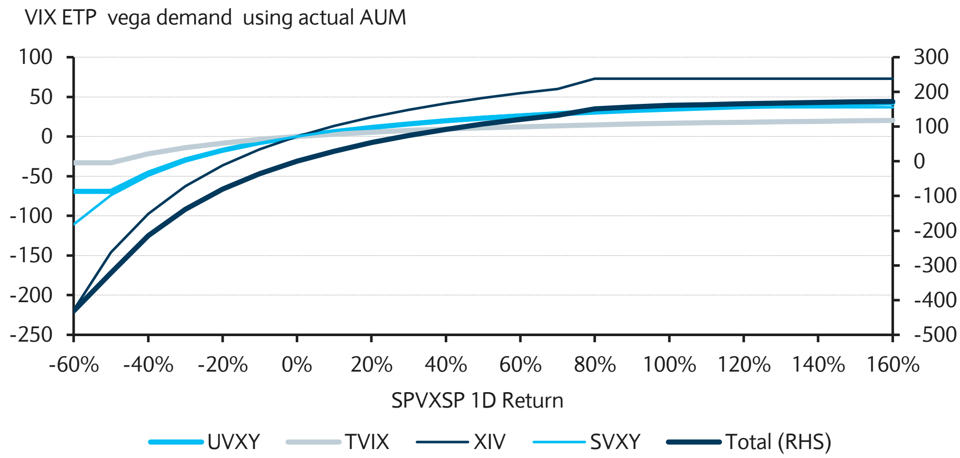
While a significant down move in VIX futures is unlikely when the market is in a risk-on mode and VIX is low, the likelihood of this scenario increases significantly if VIX is already at elevated levels.

Expected flows in a shock scenario given current AUMs are not large relative to expected volume

Figure 14 plots the total demand using the current AUMs in the four major LETPs.

FIGURE 14

While large expected flows are not a significant fraction of expected volumes



Source: Barclays Research, CBOE, Bloomberg

Thus we see that for our shock scenario of a 50% increase in 1M VIX futures the demand would be ~$110Mn vega. Even for extremely large positive moves of 160%, the demand only increases to ~170M vega (or 170k VIX futures). As discussed in the previous section, we estimate that VIX futures volumes will cross $1Bn vega in such a scenario and thus this demand will likely be easily absorbed, in our opinion.

Note that the supply for a 50% down move in VIX futures the supply is already at ~$320Mn and it continues to increase after that point.

Impact of Short Interest in Inverse VIX ETPs

In this section we discuss the impact of the elevated short interest in inverse VIX ETPs that we first highlighted in a previous publication (*Index Volatility Weekly: UPDATE: A new source of risk: Short Interest in Leveraged VIX ETPs*, March 21, 2017).

In general, an investor can use VIX ETPs to get positive or negative exposure to volatility using four different channels. Figure 15 plots the evolution of these four exposures over time. We see that since 2009, when VIX ETPs were first launched, each of these channels have successively become active.

1. *Long volatility exposure via investing in Long Volatility ETPs:* Investors can go long volatility by investing directly in a long volatility ETP. These can be un-leveraged and provide 1x exposure to the underlying index (SPVXSP) or can be leveraged and provide 2x the exposure to the SPVXSP. These were introduced in 2009 and quickly increased to ~$100Mn vega. The AUM reached a new plateau of ~$200Mn in 2012 after the introduction of the 2x leveraged ETPs. The AUM increased to ~$300Mn in 1Q2016 and has reverted back to ~$200Mn recently.

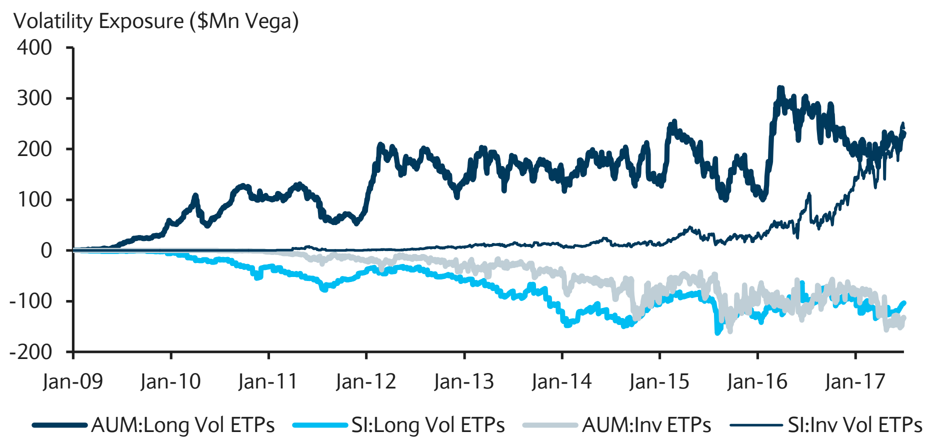
2. *Short volatility exposure via shorting Long Volatility ETPs:* Since ETPs are similar to ordinary stocks they can also be shorted. In this case the investor shorts the long volatility ETPs and thereby gets a short volatility exposure. Note that similar to any short position, the potential loss from this position is (in principle) unlimited. Further, the investor is subject to margin calls for adverse moves. The vega exposure from this channel has steadily increased over time. Relative to the long volatility exposure, while it was quite large during 2011 (almost 2x) it is now slightly smaller.

3. *Short volatility exposure via investing in Inverse Volatility ETPs:* Here the investor simply buys an inverse volatility ETP such as XIV or SVXY. In this case, the potential loss for the investor is limited to his investment and he does not get a margin call. Thus some risk management is directly built into these products. However, this benefit comes at a cost of negative carry induced by the negative gamma dynamic discussed in the previous section. These were introduced in 4Q2010 and their AUM has steadily increased over time at now stands at ~$150M.

4. Long volatility exposure via shorting Inverse Volatility ETPs: Here the investor shorts an inverse ETP and thus gains a long exposure to volatility. While it was quite small it has grown exponentially over the past two years and in fact it is slightly larger than the AUM in long volatility ETPs.

FIGURE 15

The four channels for getting volatility exposure using VIX ETPs



Source: Barclays Research, Bloomberg, CBOE

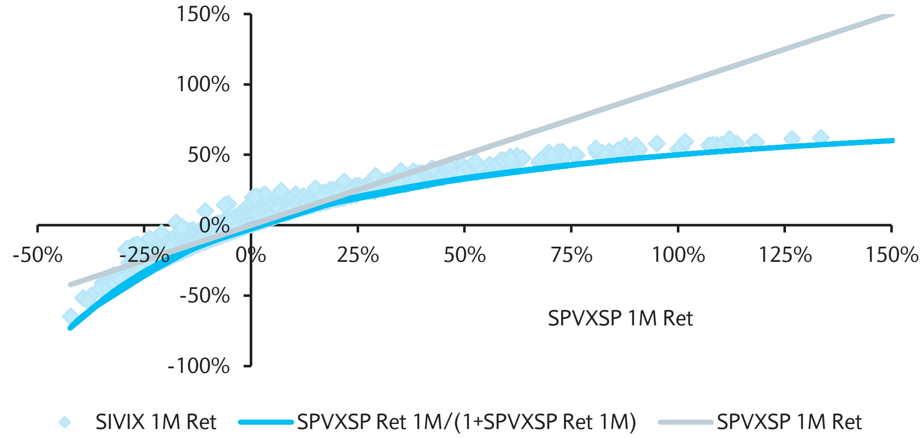
Risk Reward of Shorting inverse VIX ETPs

Shorting inverse VIX ETPs appears to be quite a convoluted way to gain long volatility exposure relative to simply buying a long volatility ETP. In this section, we try to shed some light on why the former strategy appears to be becoming more popular.

In Figure 16 compares the risk reward profiles of simply going long the SPVXSP index versus shorting the inverse VIX ETP (which we label as the SIVIX strategy). We show the 1M returns of these two strategies as a function of SPVXSP returns.

FIGURE 16

Comparing risk-reward of buying long volatility ETPs versus shorting inverse ETPs



Source: Barclays Research, Bloomberg

We clearly see that the SIVIX strategy outperforms SPVXSP for small moves in SPVXSP and then underperforms for both large positive and negative moves in SPVXSP. This can be understood using the "golden rule" for Leveraged ETPs that we have derived in our previous publications (*Leveraged ETPs : Myths & Reality*, November 17, 2009 and *Update: Index Volatility Weekly - Implications of Recent Dynamics of TVIX*, February 29, 2012). In general the price of the *m*X leveraged ETP after time T can be written as:

$$\frac{L_T}{L_0} = 1 + R_T = \left(\frac{S_T}{S_0}\right)^m D \ = (1 + r_T)^m D$$

$$D = \ e^{-\frac{1}{2}m(m-1)\int_0^T \sigma^2(t)dt}$$

Here σ is the realized volatility of the underlying during this time period. Thus price of the LETP is path dependent in that it is depends on the final price of the underlying index and its realized volatility over that time period.

However the dependence on the underlying index is not linear but a convex function. Thus for large moves in the underlying this factor will always outperform a static leveraged position. However the return of the LETP is always lower than that implied by the power law since D ("the drag") is always less than 1. This drag precisely captures the negative gamma effect discussed in an earlier section above. Note that this equation is exact and remains valid even if the underlying follows a general stochastic process. If it followed a simple Black-Scholes model then D ("the drag factor") is a constant but in general it is also a random quantity.

As we discussed in our previous report, buying a LETP can be viewed as buying a power option with a convex payoff of $\left(\frac{S_T}{S_0}\right)^m$. Since the payoff is convex it resembles an option and indeed exposure to it would require an investor pay an "option premium" to a market maker. In our previous publication we showed that in a Black-Scholes world the premium is exactly equal to $1/D$. In the drag in the LETP, assuming implied and realized volatility are equal, the investor pays the premium "as he goes" instead of paying it upfront.

For the SIVIX strategy, ignoring the drag, the return would be: $1 - \frac{1}{1+r_T}$ which we plot also in Figure 16. As expected the actual return is always higher (since the strategy receives this premium).

The power law payoff can be replicated using a strip of options and thus the SIVIX strategy is equivalent to going to long SPVXSP and shorting a strip of options on SPVXSP (a sort of covered call strategy).

Of course this still maintains a long volatility exposure and a more neutral approach would be short SPVXSP. In our previous publications we had suggested that some investors might be implementing this strategy. However, there are two reasons which argue against this possibility. Firstly, this strategy can also be done by shorting the 2x LETPs and that short interest is not as high as that in inverse VIX ETPs ($41Mn and $245Mn respectively). In fact as shown in Figure 15 the total short interest in long volatility ETPs ($102Mn) is lower than the short interest in inverse ETPs. Thus a more reasonable interpretation is that investors are seeking outright long volatility via the SIVIX strategy.

Who are the counterparties of short-sellers of inverse VIX ETPs?

Although it is obvious, it is important to remember that when an investor short-sells a security in the market some other market participant has to buy it. But who is the counterparty in this case? There are two possibilities:

- She is simply another regular investor who wants to go long an inverse VIX ETP. This effectively increases the synthetic AUM in the inverse ETP. In this case the net exposure does not change but the gross increases.
- The counterparty is a market-maker. In this case, she has two choices: a) She tenders these shares to the ETP manager; or b) She holds on to the shares but hedges the exposure using VIX futures herself. Irrespective of the market maker's choice the net exposure declines and the gross exposure remains the same.

Figure 17 illustrates these scenarios. Thus we assume that the ETP Issuer has issued 100 vega of the inverse VIX ETP which are bought by Investor A and Investor B. The Issuer hedges by selling 100 VIX futures.

FIGURE 17

Scenarios for how a short-seller in an Inverse VIX ETP would affect positioning

Inverse ETP / VIX Future Exposure	Issuer	Investor A	Investor B	Short Seller	Investor C	Market Maker	Net VIX Future
Initial	**-100/-100**	**75/0**	**25/0**				**-100**
Scenario A	-100/-100	75/0	25/0	-25/0	25/0		-100
Scenario B	-100/-100	75/0	25/0	-25/0		25/25	-75
Scenario C (Step 1)	-100/-100	75/0	25/0	-25/0		25/25	-75
Scenario C (Step 2)	-75/-75	75/0	25/0	-25/0		0/0	75

Source: Barclays Research

Now suppose a Short Seller wants to short 25 shares. He borrows them from Investor B who of course retains the economic exposure of this asset. The Short Seller then sells it in the market and this exposure to the ETP is now -25. Now we consider three scenarios.

Scenario A: The counterparty to the Short Seller is Investor C who simply buys the ETP and holds it. In this scenario then net flow to VIX futures does not change.

Scenario B: In this case the counterparty is a Market Maker who hedges his long exposure by buying 25 VIX futures. In this scenario, the net flow to VIX futures has now decreased to 75.

Scenario C: Here the first step is the same as Scenario B but in the second step the market maker sells his 25 shares to the issuer. This reduces the overall shares outstanding to 75 and the issuer then reduces his hedge to 75. Thus from the perspective of VIX future demand this is the same as Scenario B.

Simply looking at the AUM and Short Interest it is not possible to know whether we are in Scenarios A or B/C and in reality it is a mixture of these two. Note that as far as the rebalancing that happens as VIX moves, there is no difference between Initial situation and Scenario A. However in Scenarios B and C the net flow into VIX futures market will decrease. In the next section we provide some evidence that we might be closer to Scenarios B/C.

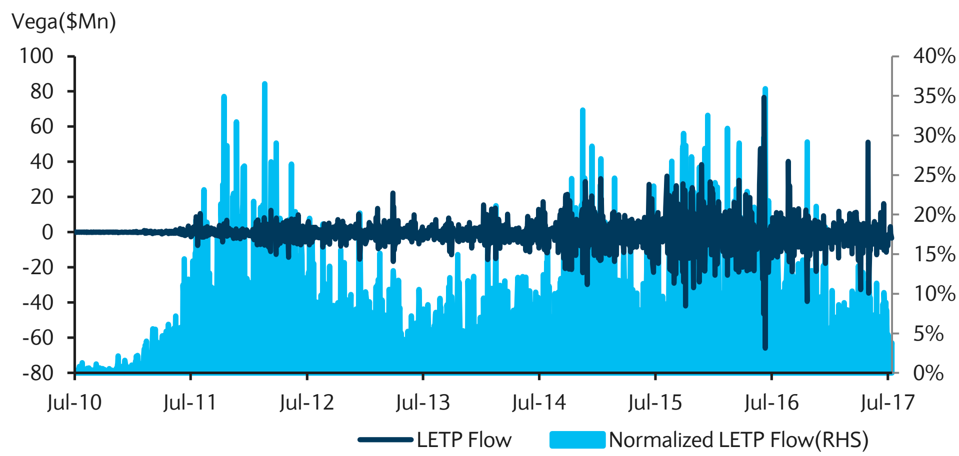
Assessing the impact of the LETP flow

In this section we examine whether the flows in VIX ETP managers have actually impacted VIX future prices.

Figure 18 plots the actual LETP flow (calculated by using the AUMs across all LETPs and actual move in SPVXSP) on a daily basis. We see that the magnitude of this flow has increased quite substantially as the AUM in the LETPs has increased. In particular during the volatility during the Brexit vote in 2016, the flows would have been as high as ~$80Mn vega. However, as discussed in the section on liquidity (Figure 6), VIX future volumes also increased dramatically during that time to ~$800M vega. Figure 18 also plots the ratio of LETP flow with the weighted volume in the front two VIX futures (which are a more relevant metric for assessing impact). We see that the normalized flow has remained in the 30%-40% range which was similar to its range during 2012 when both the AUM and volumes were much lower.

FIGURE 18

The LETP flow has increased substantially in absolute terms but is more range bound relative to future volume

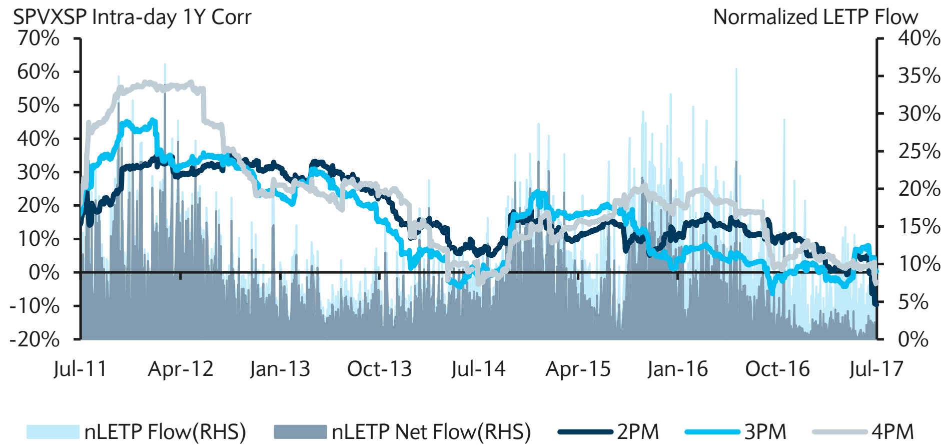


Source: Barclays Research, CBOE, Bloomberg

This much flow, especially if concentrated near the close, should have had a meaningful impact on VIX future prices and should have exacerbated the moves in VIX futures near the close. One way to quantify this impact is to calculate the auto-correlation between the move in SPVXSP from the previous close to 3 p.m., and from 3 p.m. to the close at 4:15 p.m. Of course, VIX futures can move because of moves in S&P futures. Hence we first calculate the (one year trailing) beta adjusted returns of SPVXSP. To ensure that there is nothing idiosyncratic about the 3 p.m. point we also calculate the correlations for several different intra-day times.

FIGURE 19

Intra-day autocorrelation in VIX futures have declined over time



Source: Barclays Research, CBOE, Bloomberg

Note: Intra-day correlation calculated by calculating the correlation between moves in SPVXSP from previous day to an intra-day time (2, 3 and 4 pm) and the beta-adjusted SPVXSP return from that time to the VIX futures close (4:15 pm). nLETP flow = ratio of flow based on LETP AUMs and weighted front two futures volume. nLETP Net Flow calculated by first netting the AUM with the Short Interest in LETPs.

The results are shown in Figure 19 and we see several interesting trends:

- Broadly the auto-correlations were significantly positive initially during 2012 when the LETPs were first introduced and the normalized LETP flow was in the ~30% range.
- During this time, autocorrelation was highest at 4 p.m., indicating that much of the trading was being done near the close. However, over time the difference across different times has become less.
- Over the next few years (until 2014), the normalized LETP flow declined mainly because of increasing liquidity and the autocorrelation declined along with it.
- However, beginning in 2015, the normalized LETP flow began to increase driven by the increase in AUM in LETPs, and although the autocorrelation increased it did not go back to the 2012 level.
- Beginning in 2016, even though the normalized LETP flow has declined the auto-correlation has declined much more rapidly

One possible explanation is that the net normalized LETP flow (which is calculated by netting the AUM and Short Interest in LETPs has declined much more significantly due to the increase in short interest. Thus this analysis provides some evidence that the counterparties to the short-sellers in inverse ETPs are market-makers whose hedging activity is mitigating the impact of the flows from the LETP managers.

Summary

Thus in summary:

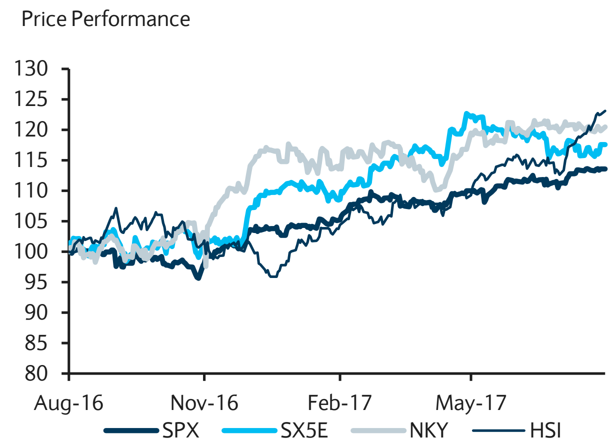
- Based on history, complacency does not necessarily lead to large negative moves in SPX
- In the event of a shock scenario, VIX futures volumes will likely cross $1Bn vega
- The LETP flow does not increase linearly with VIX future move but saturates for large moves

- The “forced unwind” scenario for inverse VIX ETPs is already included in the LETP flow calculation
- The flow from market makers who are the counterparties to short sellers of inverse VIX ETPs will likely counteract the flow from LETP managers

Hence, in summary we don’t expect LETP flow to be a major source of stress in the VIX futures market.

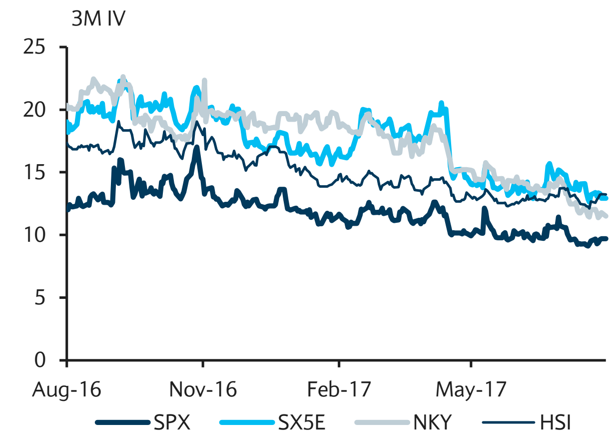
Global Volatility Snapshot

FIGURE 20
Price Performance



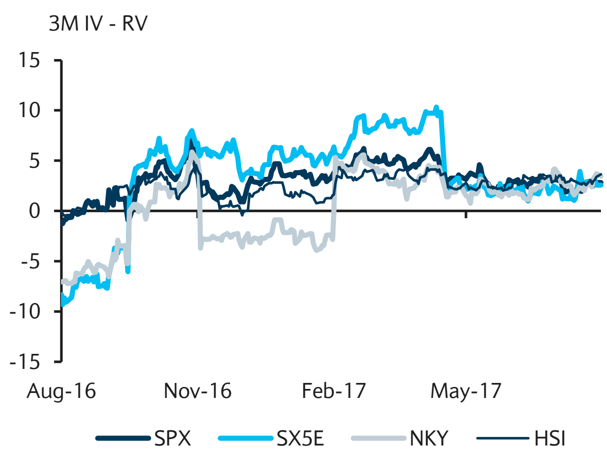
Source: Barclays Research, Bloomberg, OptionMetrics
Past performance is not a guarantee of future results.

FIGURE 21
Implied Volatility



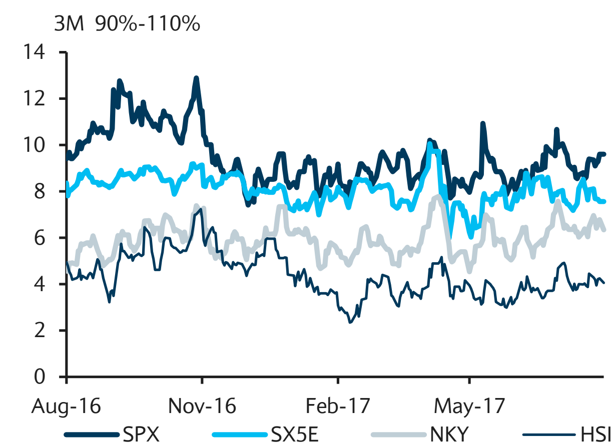
Source: Barclays Research, Bloomberg, OptionMetrics

FIGURE 22
Implied - Realized Volatility



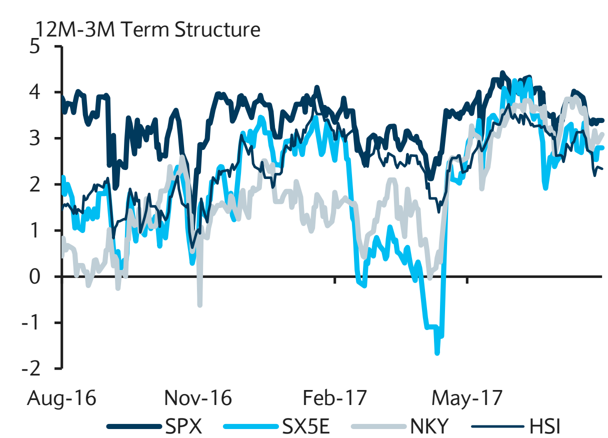
Source: Barclays Research, Bloomberg, OptionMetrics

FIGURE 23
Skew



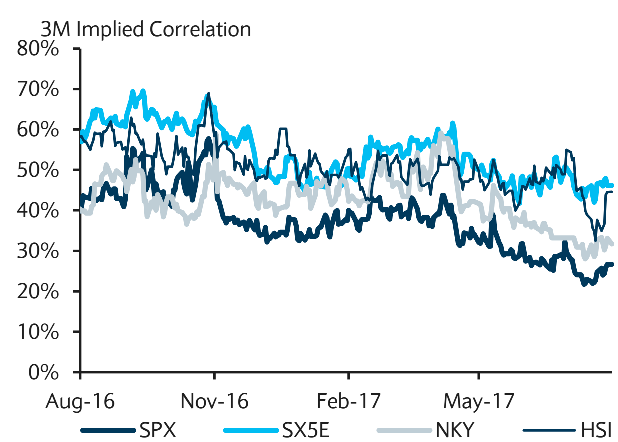
Source: Barclays Research, Bloomberg, OptionMetrics

FIGURE 24
Term Structure



Source: Barclays Research, Bloomberg, OptionMetrics

FIGURE 25
Implied Correlation



Source: Barclays Research, Bloomberg, OptionMetrics

FIGURE 26

Global Index Volatility Snapshot

	3M Implied Volatility			3M Skew			12M -3M Term Structure			3M Implied Correlation		
Ticker	**Level**	**Δ 1W**	**2Y %-ile**	**Level**	**Δ 1W**	**2Y %-ile**	**Level**	**Δ 1W**	**2Y %-ile**	**Level**	**Δ 1W**	**2Y %-ile**
Americas												
SPX	**9.7%**	**0.2%**	**4%**	**9.6%**	**0.2%**	**35%**	**3.4%**	**0.0%**	**65%**	**26.7%**	**2.0%**	**5%**
NDX	14.6%	-0.3%	23%	10.2%	0.0%	60%	1.5%	0.0%	22%	37.4%	0.2%	50%
RUY	14.7%	0.5%	4%	8.1%	-0.2%	26%	2.7%	-0.4%	83%	22.7%	2.6%	7%
EMEA												
SX5E	**12.9%**	**-0.3%**	**1%**	**7.6%**	**-0.5%**	**17%**	**2.8%**	**0.0%**	**84%**	**46.1%**	**-0.4%**	**6%**
UKX	9.9%	-0.5%	1%	6.8%	0.6%	14%	3.2%	0.0%	78%	22.8%	1.0%	4%
DAX	13.2%	-0.1%	6%	7.5%	0.1%	21%	2.1%	-0.2%	75%	48.7%	1.6%	15%
SMI	10.7%	-0.7%	1%	7.7%	0.4%	51%	2.5%	0.3%	91%	39.2%	-7.7%	19%
Asia												
NKY	**11.5%**	**-0.5%**	**1%**	**6.3%**	**-0.6%**	**63%**	**3.1%**	**0.3%**	**90%**	**31.7%**	**-1.7%**	**3%**
HSCEI	**16.3%**	**0.9%**	**12%**	**2.9%**	**-1.0%**	**21%**	**2.3%**	**-0.3%**	**70%**	**58.1%**	**9.4%**	**6%**
HSI	13.2%	0.7%	13%	4.1%	-0.2%	27%	2.3%	-0.3%	70%	44.6%	9.7%	5%
KOSPI2	11.2%	0.1%	6%	4.8%	-0.4%	27%	1.8%	-0.4%	30%	0.0%	0.0%	0%
NIFTY	11.4%	0.3%	15%	4.3%	0.9%	32%	2.2%	-0.2%	81%	-	-	-
TAMSCI	11.9%	0.7%	6%	4.2%	0.8%	25%	1.7%	-1.3%	47%	-	-	-
AS51	11.9%	-0.3%	7%	5.4%	-0.2%	10%	2.1%	-0.1%	58%	24.7%	-2.6%	1%

Source: Barclays Research, Bloomberg, OptionMetrics

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Uncovered put writing: The risk of selling an uncovered put is significant and may result in losses significantly greater than the premium received.

Call or put vertical spread purchasing (same expiration month for both options): The basic risk of effecting a long spread transaction is limited to the premium paid when the position is established.

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Stock Rating

Overweight - The stock is expected to outperform the unweighted expected total return of the industry coverage universe over a 12-month investment horizon.

Equal Weight - The stock is expected to perform in line with the unweighted expected total return of the industry coverage universe over a 12-month investment horizon.

Underweight - The stock is expected to underperform the unweighted expected total return of the industry coverage universe over a 12-month investment horizon.

Rating Suspended - The rating and target price have been suspended temporarily due to market events that made coverage impracticable or to comply with applicable regulations and/or firm policies in certain circumstances including where the Investment Bank of Barclays Bank PLC is acting in an advisory capacity in a merger or strategic transaction involving the company.

Industry View

Positive - industry coverage universe fundamentals/valuations are improving.

Neutral - industry coverage universe fundamentals/valuations are steady, neither improving nor deteriorating.

Negative - industry coverage universe fundamentals/valuations are deteriorating.

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