

# The Volatility Index

(TERM STRCUTURE AND STRATEGY)



# VIX Index

## Description

The VIX index, commonly thought as the “fear index” is a weighted blend of all out-of-the-money calls and puts for the front month (near-term) and second month (next-term) expirations, therefore representing the expected range of movement in the S&P 500 index over the next month, at a 68% confidence level.

Technically, the index uses the standard 3<sup>rd</sup> Friday as well as the weekly SPX options with more than 23 days and less than 37 days to expiration reflecting prices observed at 9.46am Chicago time. Developed and published by the CBOE, the VIX index preceded the VXO, which didn’t take into account volatility “skew”.

The generalized formula to calculate the VIX is\*:

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

and,

$$F = K_0 + e^{RT} (C(K_i) - P(K_i))$$

where:

$\sigma$ : Volatility (i.e.  $VIX = \sigma \times 100$ )

$T$ : Time to expiration and  $T = \frac{\{M_{Current\ day} + M_{Settlement\ day} + M_{Other\ days}\}}{Minutes\ in\ a\ Year}$ , where  $M_{Current\ Day}$  are the minutes remaining until midnight of the current day,  $M_{Other\ days}$  are the total minutes in the days between current day and expiration day, and  $M_{Settlement\ day}$  are the minutes from midnight until 8:30 a.m. for “standard” SPX expirations; or minutes from midnight until 3:00 p.m. for “weekly” SPX expirations.

$F$ : Forward index level desired from index option prices, identified where the strike price at which the absolute difference between the call  $C(K_i)$  and put  $P(K_i)$  prices is the smallest.

$K_0$ : First strike immediately below the forward index level  $F$ .

$K_i$ : Strike price of the  $i$ th out-of-the money option; a call if  $K_i > K_0$  and a put if  $K_i < K_0$ ; the average of both, put and call if  $K_i = K_0$

$\Delta K_i$ : Interval between strike prices. Specifically is the difference between the nearest strike on either side of  $K_i$  in which the option bid price is not zero: 
$$\Delta K_i = \frac{K_{i+1} - K_{i-1}}{2}$$

$R$ : Risk free interest rate to expiration.

$Q(K_i)$ : The midpoint of the bid-ask spread for each option.

In essence, the VIX is an amalgam of the information reflected in the prices of all of the selected options. The contribution of a single option to the VIX value is proportional to  $\Delta K$  and the price of that option, and inversely proportional to the square of the option’s strike price. So as volatility rises and falls, the strike price range of options with non-zero bids tends to expand and contract, and the number of options used in the VIX calculation may vary from month-to-month, day-to-day and possibly, even minute-to-minute. Similarly, the bigger the difference in out-of-the-money strike prices in proportion to the midpoint strike price of the option the bigger the weight of that option price in the calculation of the index.

# VIX Index Strategies

Traders and wrapped products use a rollover strategy in order to speculate on the direction of the volatility in the short term by going long or short the front two months. So for example if a trader wanted to speculate that 30-day volatility in the S&P500 index (SPX) will go up, he/she can go long a 30-day synthetic position of the near/front and next/second month VIX futures contract (i.e. so that the weighted average of the number of days to expiration equals 30). Alternatively, if he/she thinks SPX volatility will go down, he/she will sell a synthetic 30-day VIX futures contract.

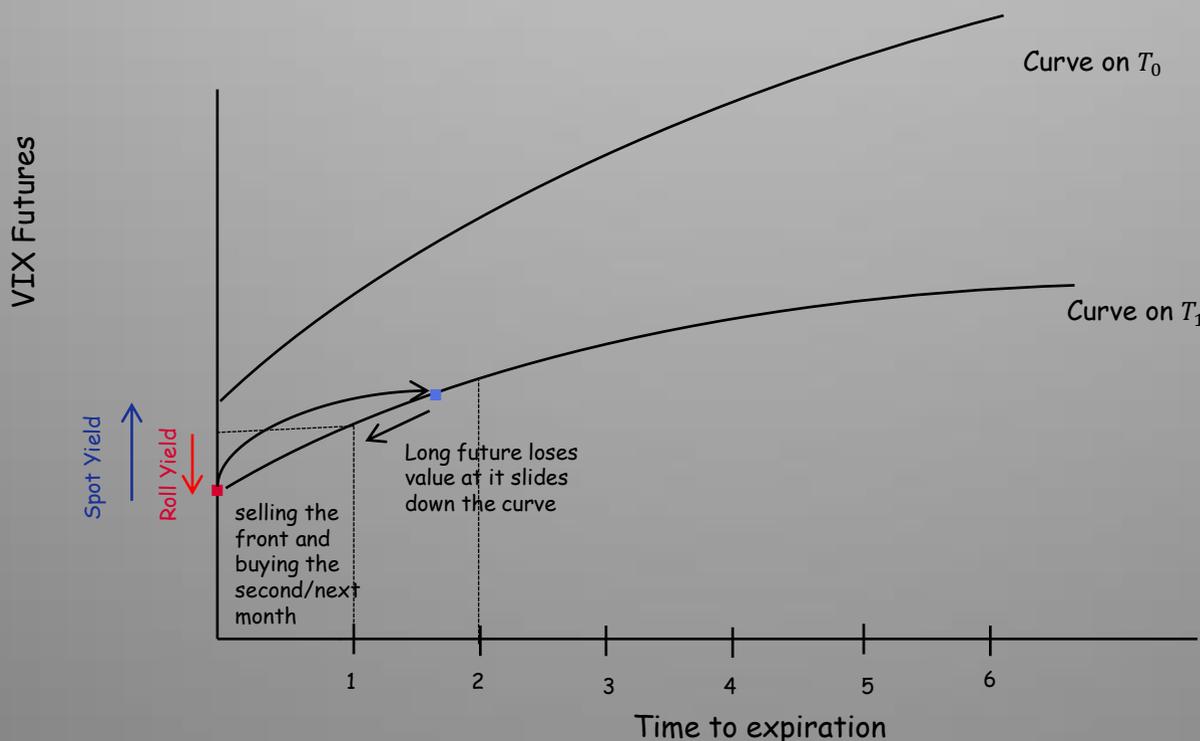
In the case of a long VIX position, each day the strategy will sell a 1/30<sup>th</sup> of a position of the front end contract and buys 1/30<sup>th</sup> of the position on the second month. By doing so, the strategy is “sliding” up or down the VIX curve and rebalancing (if he’s constantly positioned on the strategy), so that if the spot prices and futures curve remains the same, and the curve is in “contango” (spot prices are lower than future prices) the trader is selling and rolling over this futures positions at a loss, because the futures price lose value as time passes (commonly called roll yield). On the case of a short strategy, he/she would be buying back the front contracts and selling the next month contracts and rebalancing at a gain.

The opposite of these cases would happen, if spot prices and curve remained the same, if the futures curve remained in “backwardation” (spot prices are higher than future prices).

Nonetheless, the strategy return is mainly dictated by the spot yield, or the return generated by the changes in the spot price of the VIX. For total return strategies, such as funded products, the return is further enhanced by the cash return, or the return generated by the position, mostly in T-bills, in which the margin and excess cash is parked. In summary, the total return strategy is:

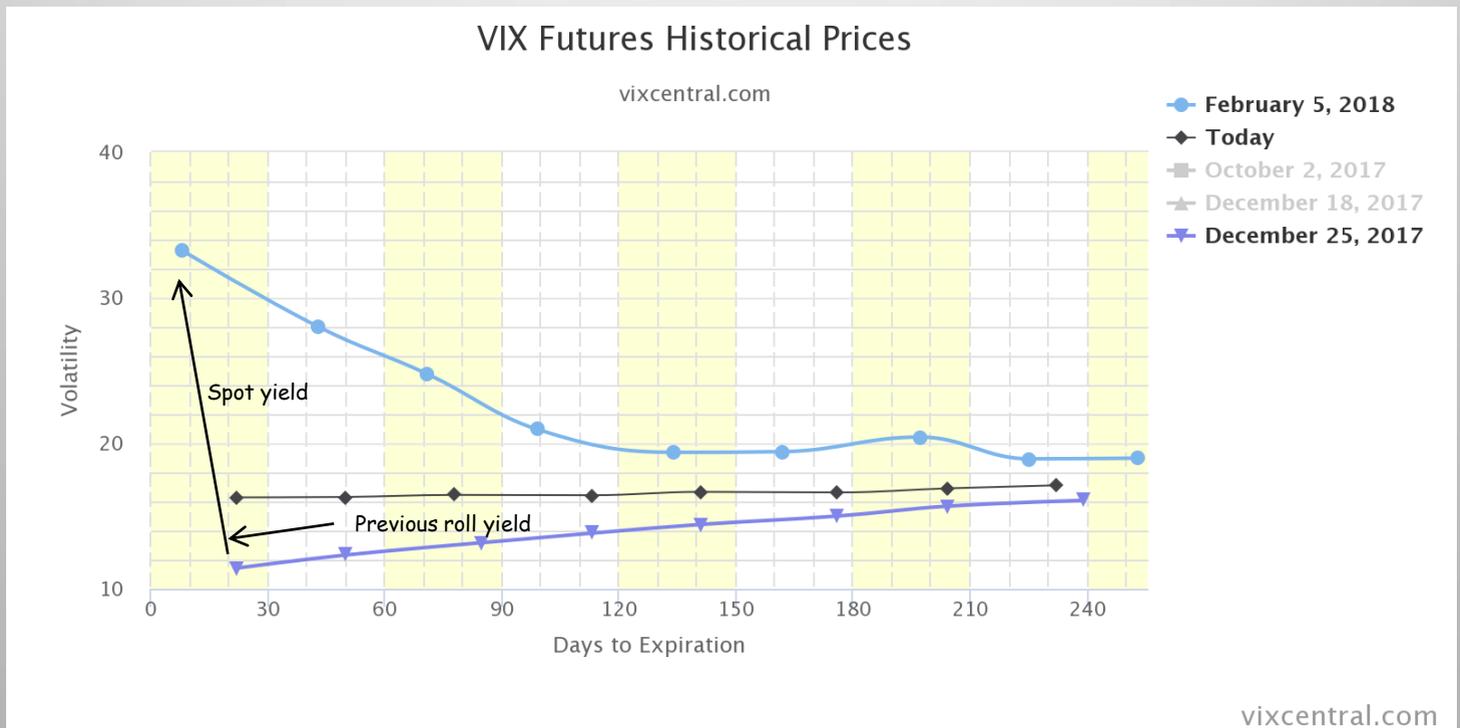
$$\text{Total Return} = \text{Spot Yield} + \text{Roll Yield} + \text{Cash Yield}$$

## Long VIX Strategy (Hypothetical Case)



# VIX Index Term Structure

Backwardation and Contango in just a few days...



On February 5<sup>th</sup>, 2018 the S&P500 dropped more than 6%, and volatility spiked up, pushing the VIX more than two and half fold in a matter of hours. Short VIX futures positions, which were capturing small roll and some spot yields on previous months were suddenly hit massively by the negative spot yields, triggering margin calls and position limits and making the strategy unviable.

Exchanges suspended trading on funded products like short VIX ETFs and ETNs, and some triggered accelerated redemption clauses and were early redeemed, wiping out 90 percent of the funds value and generating significant losses to investors.

Most of these products follow indices that are designed to provide investors with exposure to one or more maturities of futures contracts on the VIX index, intended to reflect the returns that are potentially available through an unleveraged investment in the relevant futures contract or contracts on the VIX Index. One of the most popular is the S&P 500 VIX Short-Term Futures™ Index ER (SPVXSP) which targets a 30-day constant weighted average futures maturity and the S&P 500 VIX Mid-Term Futures™ Index ER (SPVXMP) targets a constant weighted average futures maturity of five months.

After the collapse several fund product sponsors have moved to reduce the leverage involved in the strategy, and some industry analysts, traders, investors and academics are calling for more oversight by regulators given suspicions of market manipulation on the SPX options market to influence the VIX direction. Some fund sponsors (such as ProShares - SVXY) have already reduced leverage given the VIX futures exchanges adjusted margin requirements and proposed to reduce an acceleration event in order to avoid the product closure and reduce reputational risk.

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\* CBOE white paper: "The CBOE Volatility Index - VIX®"