

CBOE VIX PREMIUM STRATEGY INDEX (VPDSM)

CAPPED VIX PREMIUM STRATEGY INDEX (VPNSM)

The steady growth of CBOE's volatility complex provides a unique opportunity for investors intent on capturing the "volatility premium." The volatility premium is the risk premium that the market seems willing to pay to own realized or implied volatility. The prevalent conjecture among financial economists is that the volatility premium is explained by the negative correlation between S&P 500 volatility and S&P 500 returns. The volatility premium has always been reflected in the difference between implied and realized volatility, and it now has become apparent in the historical returns of short positions in CBOE Volatility Index[®] (VIX[®]) and variance futures.

To benchmark the returns of short volatility strategies, CBOE has developed two different types of indexes. The CBOE S&P 500[®] VARB-X[™] Strategy Benchmark (VTY) is based on selling realized variance while the VIX Premium Strategy Index (VPD) and Capped VIX Premium Strategy Index (VPN) are based on selling implied volatility proxied by the VIX. The capped version of the VIX Premium Strategy Index limits the risk of a short VIX exposure with long out-of-the-money VIX calls.

To clarify the difference between the VPD and VPN and the VARB-X Benchmark, note that the VPD and VPN strategies involve selling a succession of one-month VIX futures while the VARB-X strategy involves selling a series of three-month realized variance futures. The VPD and VPN create a sequence of short exposures to forward one-month S&P 500 implied volatility while the VARB-X creates a sequence of short exposures to spot S&P 500 3-month realized variance. This implies that the VPD and VPN are inherently more volatile than the VARB-X because implied volatility risk stays constant as VIX futures move towards expiry while realized variance risk gradually decreases as each day reveals a new term of the final variance.

This article focuses on the VPD and VPN. The VPD tracks the value of a portfolio that overlays a sequence of short one-month VIX futures on a money market account. The VIX futures are held until expiration and new VIX futures are then sold. The money market account decreases leverage relative to a stand-alone short position in VIX futures. To further decrease the risk of being short implied volatility, the number of VIX futures sold at each roll is set to preserve 75% of the initial value of the portfolio in the event that VIX futures increase by 25 points¹.

¹ The decision to target the maximum loss resulting from a 25 point increase in VIX futures is based on the historical frequency distribution of one-month changes in implied volatility, as proxied by VXO, the old VIX. Over any one-month period between January 1986 and July 2007, VXO has increased by more than 25 points 0.34% of the time, and 0.037% if we omit the fall of 1987.

Similar to the VPD, the VPN sells monthly VIX futures over a money market account. In addition, it limits the risk of the short VIX exposure with long VIX calls struck 25 points higher than the VIX futures price, or at the closest strike below when this strike is not listed. Since the multiplier of VIX options is 100, each VIX futures is covered by 10 VIX calls.

Construction of CBOE VIX Premium Strategy Index

The VPD represents the value of an initial investment of \$100 in a portfolio that passively follows the VIX Premium Index Strategy. The portfolio is managed and calculated as follows:

- At the close of June 15, 2004, the inception date, \$100 is invested at the three-month Treasury bill rate². On June 16, 2004, the first roll date, VIX futures are sold at the opening bid price of VIX futures. From thereon, the futures are marked-to-market daily at the close and the resulting cash flow is credited to or debited from the opening money market balance.
- At the next expiration, July 14, 2004, the futures position is settled at the open to the final settlement price, new VIX futures are sold at the opening bid price. The cash flows from the final mark of expiring contracts and from the daily closing marks of the new contracts are financed from the money market balance.

This process is repeated from expiration to expiration³.

Final Settlement Price of Expiring VIX Futures and Options

At expiration, VIX futures and options are settled to a Special Opening Quotation (SOQ) of VIX. The SOQ is a special calculation of VIX compiled from the opening prices of S&P 500 Index (SPXSM) options.

Calculation of VPD

CBOE currently calculates the VPD once per day at the close of trading. On any given date, the index represents the mark-to-market value of the initial \$100 invested in the VIX Premium Index Strategy.

At the close of every business date, the value of the VIX Premium Index is equal to the value of the Treasury bill account, obtained by compounding the Treasury Bill balance at

² The intra-day cash from settling futures at the open is deemed to be invested at the close of the roll date. Similarly, settlement losses are deemed to be financed at the close.

³ During the first two years of VIX futures, new contracts expiring in the next month were not listed on several occasions. The index was then calculated using a position in the second month.

the previous close by the Treasury rate and netting the cash flow from marking VIX futures to market:

$$VPD_t = M_t = (1 + r_{t-1})VPD_{t-1} - 1000N_{last}(F_t - F_{t-1})$$

where M_t is the Treasury bill balance at the close of date t , r_{t-1} is the effective Treasury bill rate from date $t-1$ to date t , N_{last} is the number of futures sold at the last roll date, F_t is the daily settlement price of VIX futures t , and 1000 is the multiplier of VIX futures.

On a roll date, the cash flow from final settlement of the expiring futures and their daily mark at the close are both netted from the money market balance:

$$VPD_t = (1 + r_{t-1})VPD_{t-1} - 1000(N_{last}(SOQ_t - F_{t-1}) - N_{new}(F_t - F_{bid}))$$

where SOQ_t is the final settlement price of the expiring VIX futures, N_{new} is the number of new VIX futures sold, and F_{bid} is the opening bid price of VIX futures. This balance is reinvested at the daily Treasury rate until the next date.

The number of new VIX futures sold at the open on a roll date t is set such that a 25 point increase of VIX futures at the next roll still preserves 75% of capital available after the final settlement of VIX futures:

$$N_{new} = M_t^o(1 + R_t - .75)/(1000 * 25)$$

where M_t^o is the amount in the money market account at the open after the final settlement of VIX futures, and R_t is the effective three-month Treasury bill rate to the next roll date.

$$M_t^o = M_{t-1} - 1000N_{last}(SOQ_t - F_{t-1})$$

Construction of CBOE Capped VIX Premium Strategy Index

The VPN represents the value of an initial investment of \$100 in a portfolio that passively follows the Capped VIX Premium Index Strategy. The portfolio is managed similarly to the uncapped portfolio. The difference is that one-month out-of-the-money VIX calls are bought at the same time that VIX futures are sold:

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- At the close of June 15, 2004, the inception date, \$100 is invested at the three-month Treasury bill rate⁴. On June 16, 2004, the first roll date, VIX futures are sold at the opening bid price of VIX futures and 10 times as many VIX calls are bought at a strike price 25 points greater than the opening bid price of VIX futures. If this strike price is not listed, the calls are bought at the closest strike below. From thereon, as for the VPD, the futures are marked-to-market daily at the close and the resulting cash flow is credited to or debited from the money market balance.
- At the next expiration, July 14, 2004, the futures and option positions are settled at the open to the final settlement price, new VIX futures are sold at the opening bid price and new VIX calls are bought at the opening ask price. The cash flows from the final mark of expiring contracts and from the daily closing marks of the new futures are financed from the money market balance.

This process is repeated from expiration to expiration⁵.

Calculation of VPN

CBOE currently calculates the VPN once per day at the close of trading. On any given date, the index represents the mark-to-market value of the initial \$100 invested in the Capped VIX Premium Index strategy.

At the close of every business date, the value of the VPN is equal to the closing value of the Treasury bill account plus the mark-to-market value of the VIX calls:

$$VPN_t = M_t + 100 * 10 N_{last} C_t$$

where M_t is the Treasury bill balance at the close of date t , N_{last} is the number of futures sold and $10 N_{last}$ is the number of VIX options bought at the last roll date, F_t is the daily settlement price of VIX futures t , and C_t is the average of the bid and ask quotes of the VIX calls at the close. The Treasury bill balance is obtained by compounding the previous closing Treasury balance at the three-month Treasury bill rate and netting the cash flow from the mark of VIX futures:

$$M_t = (1 + r_{t-1})M_{t-1} - 1000N_{last}(F_t - F_{t-1})$$

$$M_{t-1} = VPN_{t-1} - 1000N_{last}C_{t-1}$$

⁴ The intra-day cash from settling futures at the open is deemed to be invested at the close of the roll date. Similarly, settlement losses are deemed to be financed at the close.

⁵ During the first two years of VIX futures, new contracts expiring in the next month were not listed on several occasions. The index was then calculated using a position in the second month.

where r_{t-1} is the effective Treasury bill rate from date t-1 to date t.

At the close of a roll date, as on regular days, the index is equal to the closing Treasury balance plus the mark of the new options. The closing Treasury balance is now equal to the Treasury balance at the previous close compounded by the daily Treasury rate net of the cash flows from (1) final settlements of VIX futures and options, (2) the daily mark of new VIX futures and (3) the purchase of new VIX calls.

$$VPN_t = (1 + r_{t-1})M_{t-1} + 1000N_{last} (\max[0, SOQ_t - K] - (SOQ_t - F_{t-1})) + 1000N_{new} (C_t - C_a - (F_t - F_{bid}))$$

where SOQ_t is the final settlement price of the expiring VIX futures, K is the strike of the expiring VIX calls, N_{new} is the number of new VIX futures sold, C^a is the ask price of the VIX calls bought at the open, F_{bid} is the opening bid price of VIX futures. As on non-roll dates, the Treasury balance is reinvested at the Treasury rate.

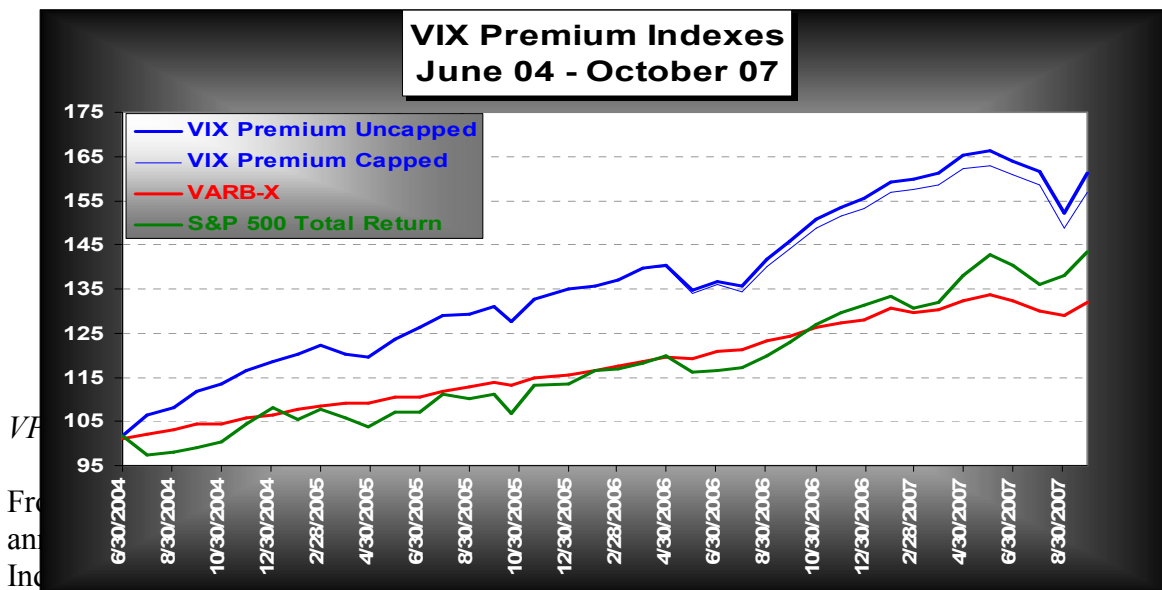
The number of new VIX futures sold on a roll date t is set such that a 25 point increase of VIX futures at the next roll still preserves 75% of capital available after the final settlement of the VIX futures and options:

$$N_{new} = M_t^o (1 + R_t - .75) / (1000 * (25 + (1 + R_t)C_{ask}))$$

$$M_t^o = (1 + r_{t-1})M_{t-1} + 1000N_{last} (\max[0, SOQ_t - K] - (SOQ_t - F_{t-1}))$$

where R_t is the effective three-month Treasury bill rate to the next roll date.

Historical Performance

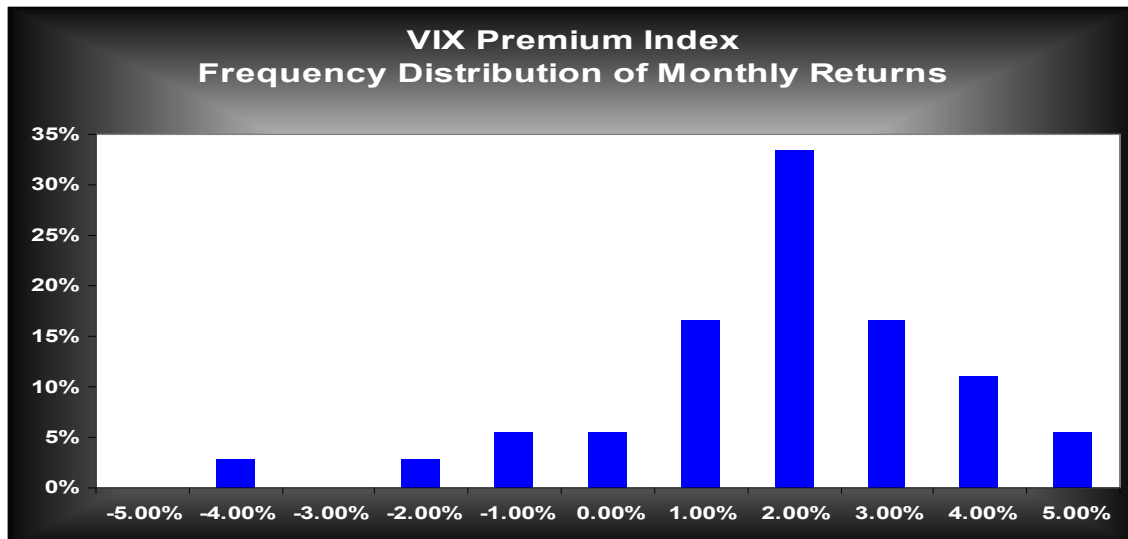


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11.08%. The pronounced skew of the VPD indicates that the Sharpe ratio, based on the standard deviation of the return, is a misleading measure of risk-adjusted return. The semi-Sharpe ratio based on the semi-deviation is preferable. The semi-standard deviation of the VIX Premium Index was 5.31%, equal to the semi-deviation of the S&P 500 Total Return Index. Adjusting its monthly rate of return by its semi-deviation, the VPD performed better than the S&P 500 but not as well as VARB-X.

Chart 2



Monthly Returns 6/04-10/07	S&P 500	VARB-X	VIX Premium 25% loss at 25 pt vol increase	VIX Premium Capped
Minimum Return	-4.24%	-1.77%	-5.82%	-6.29%
Arithmetic Mean Monthly	0.91%	0.69%	1.21%	1.14%
Annualized Geometric Mean	11.08%	8.50%	15.17%	14.22%
Annualized Std. Deviation	8.47%	2.89%	8.04%	8.11%
Monthly Sharpe Ratio	0.24	0.44	0.38	0.35
Annualized Semi-Deviation	5.31%	1.74%	5.31%	5.29%
Monthly Semi-Sharpe Ratio	0.11	0.21	0.17	0.16
Skew	-0.32	-0.94	-0.87	-0.98
Excess Kurtosis	-3.40	-1.85	-1.51	-1.21

In Chart 1, the reason the VPN coincides with the VPD until March 2006 is that's when VIX options were introduced. From March 2006 to October 2007, the VPN earned an

annual geometric return of 14.22%, compared to 15.17% for VPD and 11.08% for the S&P500 Total Return Index. This smaller return will typically be the case because the probability of exercising calls purchased 25 points out-of-the-money is very small. Its semi standard deviation was comparable to that of the VPD as was its semi-Sharpe ratio.

Monthly Returns 3/06-10/07	S&P 500	VARB-X	VIX Premium 25% loss at 25 pt vol increase	VIX Premium Capped
Minimum Return	-3.10%	-1.77%	-5.82%	-6.29%
Arithmetic Mean Monthly	1.11%	0.61%	0.89%	0.75%
Annualized Geometric Mean	13.82%	7.55%	10.70%	8.84%
Annualized Std. Deviation	8.47%	2.89%	8.04%	8.11%
Monthly Sharpe Ratio	0.36	0.28	0.21	0.15
Annualized Semi-Deviation	5.31%	1.74%	5.31%	5.29%
Monthly Semi-Sharpe Ratio	0.15	0.17	0.11	0.08
Skew	-0.63	-0.67	-0.77	-0.88
Excess Kurtosis	-3.28	-3.18	-1.93	-1.70

Conclusion

The market demand for volatility hedges has made it profitable to sell volatility. While selling realized volatility is a well-established strategy, the attractive if riskier alternative of selling pure implied volatility is relatively recent as it could not be easily implemented before VIX futures and options were introduced. The VIX Premium Strategy Index and Capped VIX Premium Strategy Index codify short implied volatility strategies and give investors useful benchmarks to gauge their performance.

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