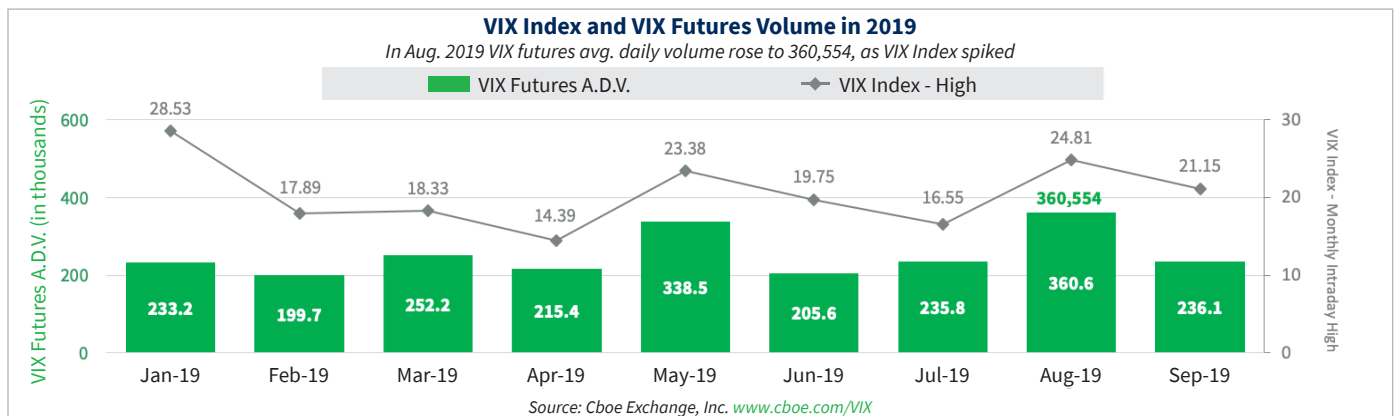


With the increased use of volatility in asset allocation decisions, coupled with elevated levels of volatility in the marketplace, the interest in the use of products linked to the Cboe Volatility Index® (VIX® Index) for risk management has grown significantly.

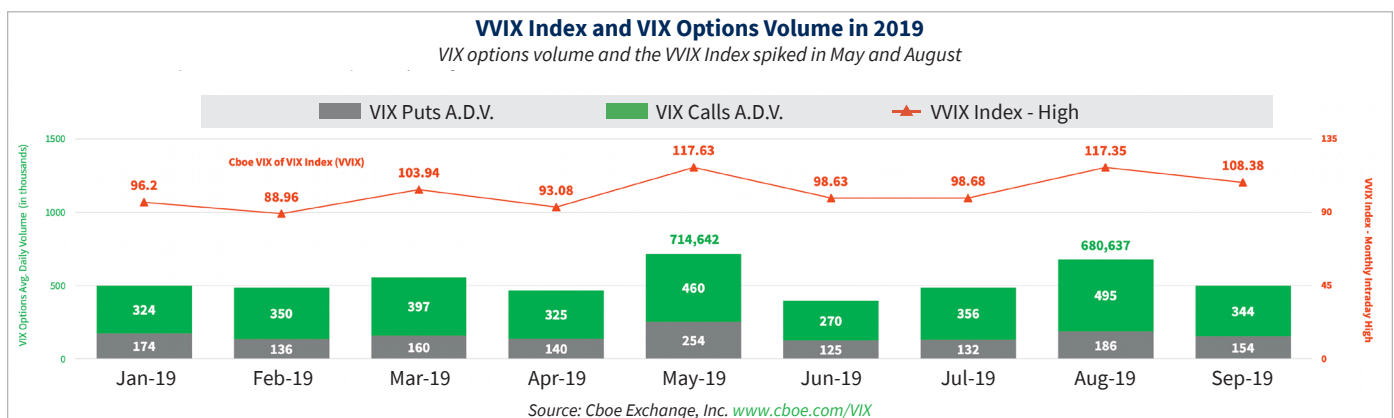
VIX Futures

- Introduced in 2004 on Cboe Futures Exchange (CFE), VIX futures provide market participants with the ability to trade a CFTC-regulated volatility product with price and quote **transparency** and **guarantees** by the Options Clearing Corporation (OCC). VIX futures provide market participants with a variety of opportunities to implement their view using volatility trading strategies, including **risk management**, **alpha generation** and **portfolio diversification**.
- \$1000 Multiplier.** Cash-settled VIX futures have monthly and weekly expirations, usually on **Wednesday mornings**, with **ticker symbols** VX, and VX01 through VX53. VIX futures trade nearly **24 hours a day**, five days a week.
- Volume and Open Interest** In 2019 (through September) VIX futures had average daily volume of **255,000** contracts (or 255 million vega), and average daily open interest of **390,000** contracts.



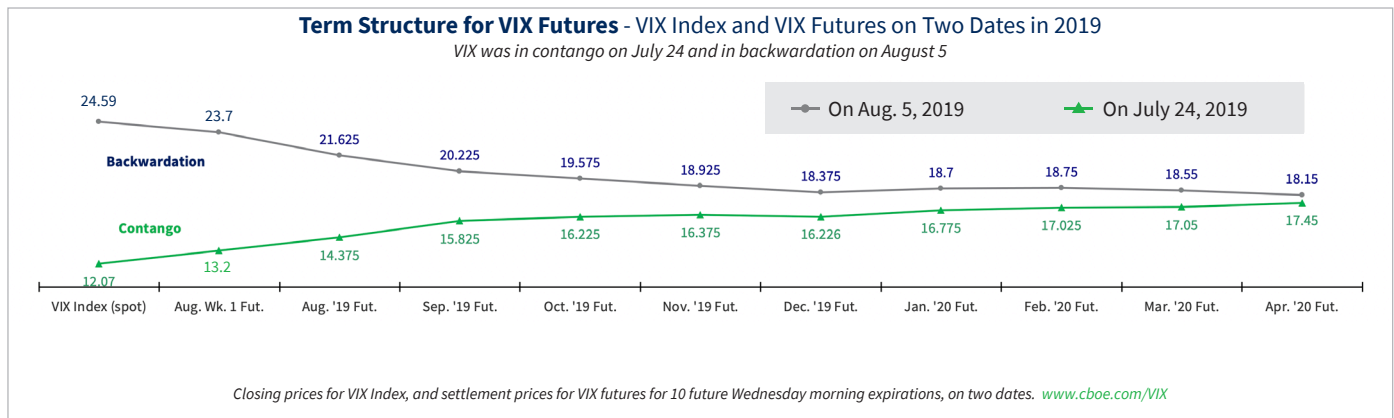
VIX Options

- Cboe Options Exchange introduced VIX options in 2006, providing market participants with an **SEC-regulated** security with price and quote **transparency** and **guarantees** by OCC. VIX options enable market participants to **hedge** portfolio volatility risk distinct from market price risk, and to **trade** based on their view of the future direction or movement of volatility.
- \$100 Multiplier.** Monthly and weekly expirations usually are on **Wednesday mornings**, and the options trade during U.S. regular trading hours, and also during a **global trading hours** session (3:00 a.m. to 9:15 a.m. ET).
- Volume and Open Interest** In 2019 (through September) VIX options had average daily volume of **534,000**, and average daily open interest of **8.4 million** contracts.

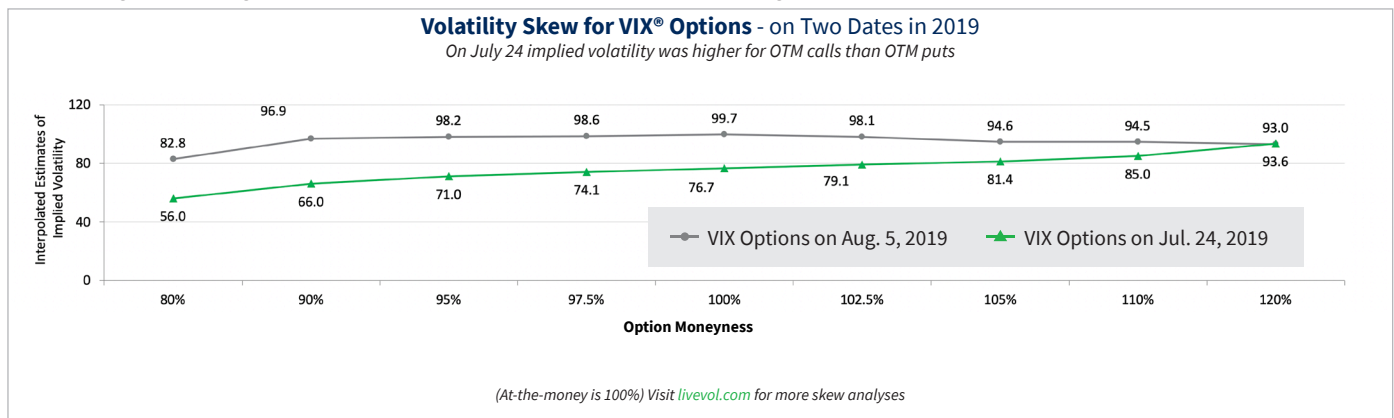


VIX Futures and Options (cont.)

VIX Futures Term Structure VIX futures reflect the market's estimate of the value of the VIX Index on various expiration dates in the future. VIX futures can be in backwardation or contango.

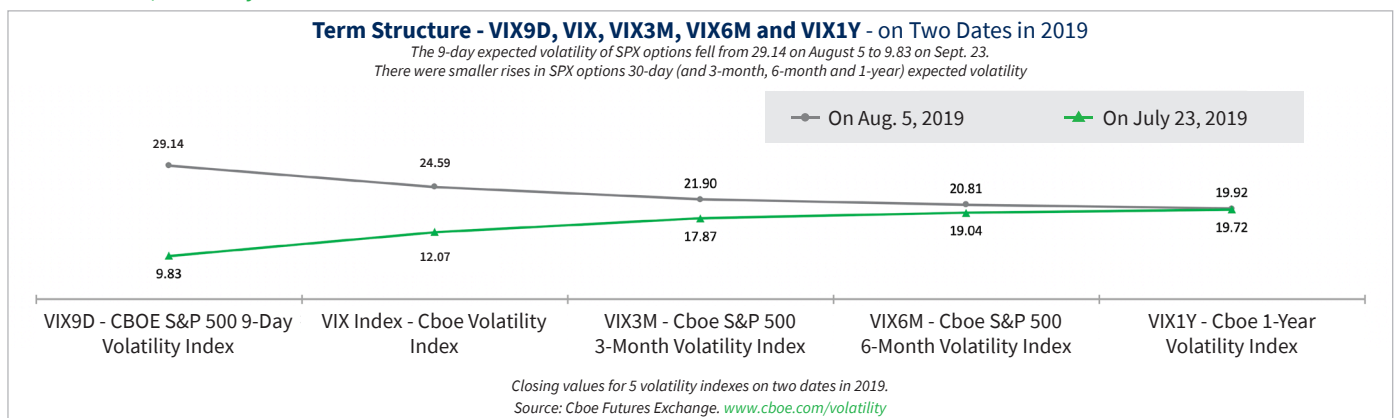


Volatility Skew for VIX options often is different than the volatility skew for equity options, as VIX options implied volatility for OTM calls often is generally higher than for OTM puts, and OTM VIX calls are bought for portfolio protection.



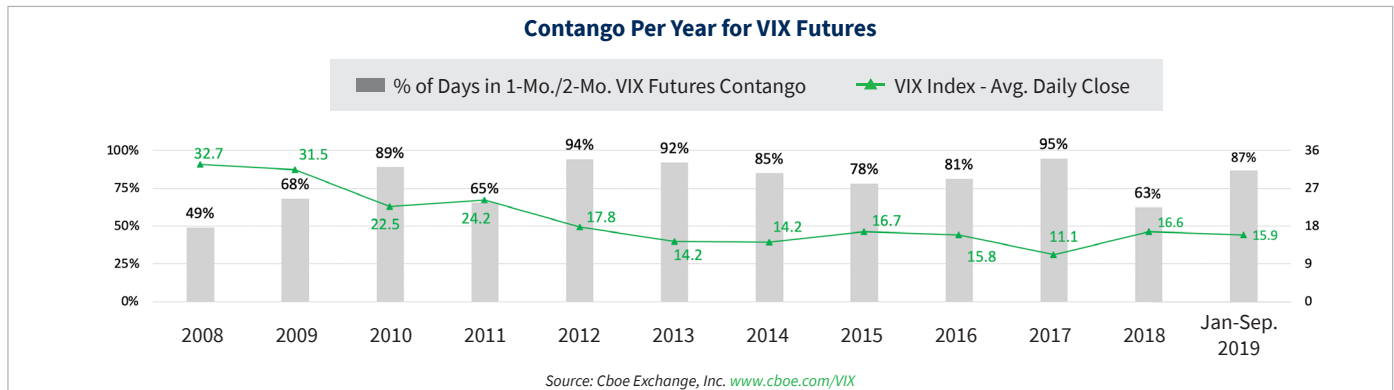
Indexes for Term Structure Cboe offers 5 volatility indexes - VIX9DSM, VIX Index, VIX3MSM, VIX6MSM, and VIX1YSM – that give analysts and traders the ability to track the term structure and the relationship of nearby and long-term expected volatility.

www.cboe.com/volatility

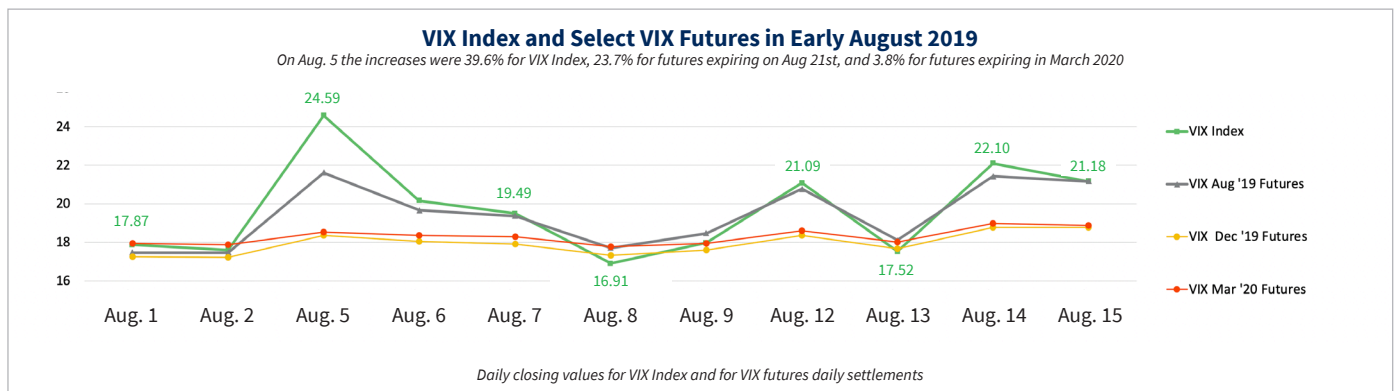


VIX Futures and Options (cont.)

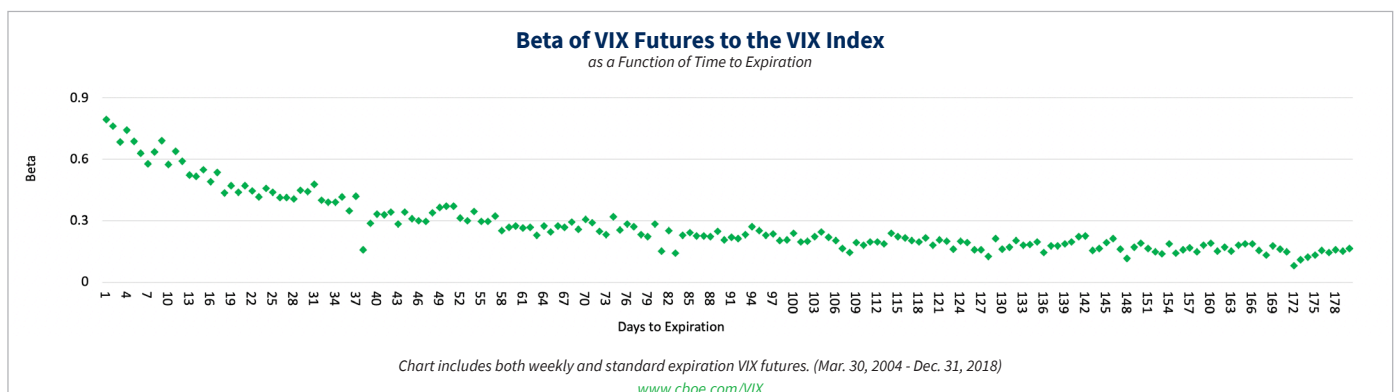
Contango on Most Dates Since 2008, VIX 2nd-month futures have been priced higher than VIX front-month futures on about 80% of all trading days, and this has stimulated interest in strategies that sell VIX futures (see page 7 for benchmark indexes).



VIX Futures - Different Price Movements Over 11 Trading Days In early August 2019 the price moves were bigger for the VIX Index and nearby VIX futures, while there were smaller price moves for longer-dated futures (which reflect expectations for 30-day volatility in future months).

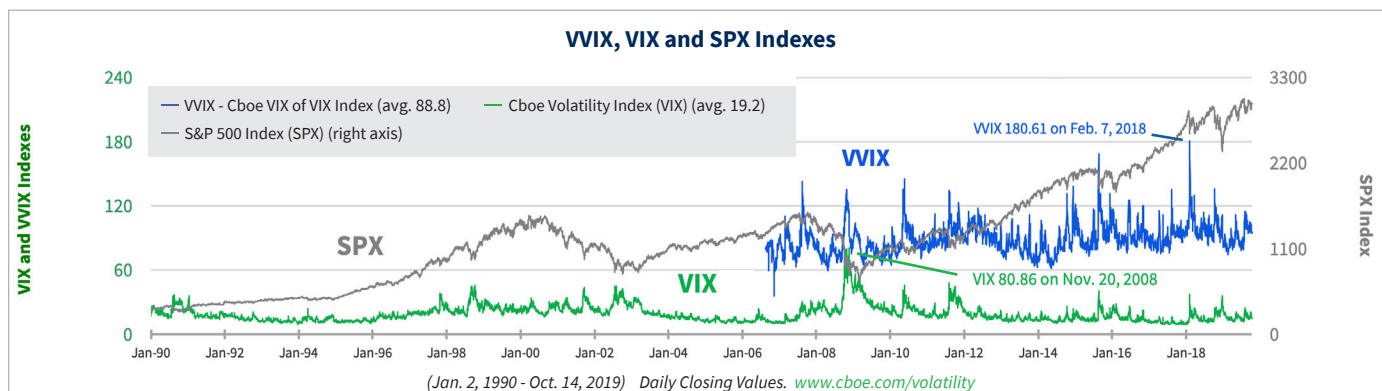


Responsiveness of VIX Futures VIX futures with near-term expirations generally have tended to be much more sensitive to changes in the VIX Index than VIX futures with long-term expirations.



Cboe Volatility Index® (VIX® Index) and Cboe VIX of VIX Index (VVIXSM)

The Cboe Volatility Index® (VIX® Index) is a calculation designed to produce a measure of constant, 30-day expected volatility of the U.S. stock market, derived from real-time, mid-quote prices of S&P 500® Index (SPXSM) call and put options. On a global basis, it is one of the most recognized measures of volatility -- widely reported by financial media and closely followed by a variety of market participants as a daily market indicator. The Cboe VIX of VIX® (VVIXSM) Index is an indicator of the expected volatility of the 30-day forward price of the VIX, and is related to nearby VIX option prices. www.cboe.com/VVIX. In the chart below note that the VIX Index often has been mean-reverting, with a negative correlation to the moves of the S&P 500 Index.

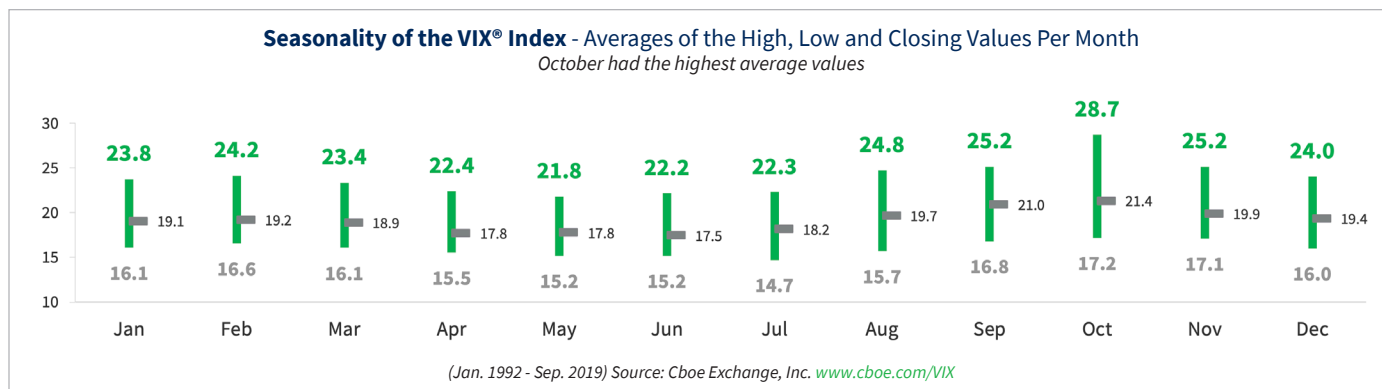


Annual Statistics													
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019 (through Sept)
% Change	S&P 500	-38.5%	23.5%	12.8%	0.0%	13.4%	29.6%	11.4%	-0.7%	9.5%	19.4%	-7.0%	18.7%
	VIX Index	77.8%	-45.8%	-18.1%	31.8%	-23.0%	-23.9%	39.9%	-5.2%	-22.9%	-21.4%	156.7%	-36.1%
	VVIX Index	4.1%	-12.4%	15.2%	6.2%	09.9%	-23.4%	59.6%	-11.4%	-8.6%	10.0%	-9.4%	12.1%
Avg. Daily Close	VIX Index	32.7	31.5	22.5	24.2	17.8	14.2	14.2	16.7	15.8	11.1	16.6	15.9
	VVIX Index	81.9	79.8	88.3	92.9	94.8	80.5	83.0	94.8	92.8	90.0	102.3	89.8

For all years since 1990, the highest values are in highlighted in green and the lowest values are highlighted in red. www.cboe.com/volatility.

Volatile Years As shown above, the volatility indexes' highest average daily closing values in a year were **32.7** for the VIX Index in **2008**, and **102.3** for the VVIX Index in **2018**.

Volatile Months and Seasonality In the chart below showing the averages of the high, low, and closing VIX Index values per month, October had the highest values, and May, June and July had some of the lowest values.



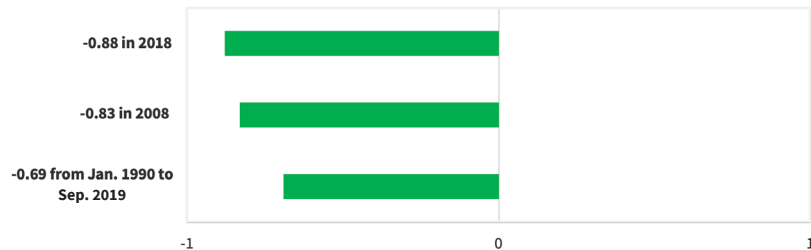
Cboe Volatility Index® (VIX® Index) (cont.)

Negative Correlations, Big Moves, and Convexity

Negative Correlations The price movements of the VIX Index and SPX Index have had a negative correlation of around -0.69 since 1990. The correlations were even more negative in the volatile years of 2008 (-0.83) and 2018 (-0.88).

Correlations Weekly Price Movements for SPX and VIX Indexes

Correlations can become even more negative in volatile time periods



Source: Cboe Exchange, Inc. www.cboe.com/VIX

Dates with Big Moves for SPX Index - 12 Dates on Which SPX Moved More than 6.5% (from 1990 to Sept. 2019)

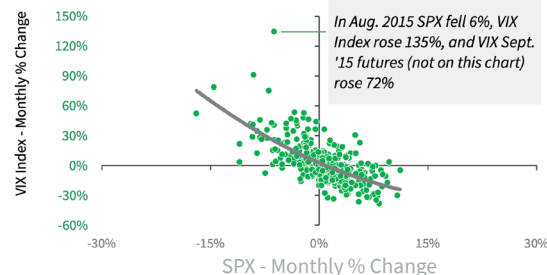
On the 8 dates that the SPX dropped more than 6.5%, the average up-move for the VIX Index was 25%.

		SPX Index	Cboe VIX Index	Cboe VVIX Index
1	15-Oct-2008	-9.0%	25.6%	4.0%
2	1-Dec-2008	-8.9%	23.9%	-3.8%
3	29-Sep-2008	-8.8%	34.5%	-7.6%
4	9-Oct-2008	-7.6%	11.1%	7.4%
5	27-Oct-1997	-6.9%	34.3%	N/A
6	31-Aug-1998	-6.8%	11.8%	N/A
7	20-Nov-2008	-6.7%	8.9%	-6.8%
8	8-Aug-2011	-6.7%	50.0%	-16.2%
9	13-Nov-2008	6.9%	-10.0%	1.0%
10	23-Mar-2009	7.1%	-5.8%	-1.7%
11	28-Oct-2008	10.8%	-16.4%	-2.1%
12	13-Oct-2008	11.6%	-21.4%	-4.0%

Large Price Moves On dates with large price moves for the SPX Index, the VIX Index often had even bigger moves in the opposite direction

Convexity of VIX Price Moves Volatility traders like to note the convexity of VIX price movements. In August 2015 the SPX Index fell 6%, the VIX Index rose 135%, and the VIX Sept. '15 futures (not on this chart) rose 72%.

Convexity of Monthly Changes for VIX and SPX Indexes



(Feb. 1990 - Aug. 2019) Source: Cboe Exchange, Inc. www.cboe.com/VIX

Trading & Investing Strategies

VIX® Futures & Options Strategies

VIX futures and options have unique characteristics and behave differently than other financial-based commodity or equity products. Understanding these traits and their implications is important. VIX futures and options may provide market participants with flexibility to hedge a portfolio, employ strategies in an effort to generate returns from relative pricing differences, or express a bullish, bearish or neutral outlook for broad market implied volatility.



Portfolio Hedging

One of the biggest risks to an equity portfolio is a broad market decline. The VIX Index has had a historically strong inverse relationship with the S&P 500® Index (see the Correlations and Convexity charts on the previous page). Consequently, a long exposure to volatility may offset an adverse impact of falling stock prices. Market participants should consider the time frame and characteristics associated with VIX futures and options to determine the utility of such a hedge.



Risk Premium Yield

Over long periods, index options have tended to price in slightly more uncertainty than the market ultimately realizes. Specifically, the expected volatility implied by SPX option prices tends to trade at a premium relative to subsequent realized volatility in the S&P 500 Index. Market participants have used VIX futures and options to capitalize on this general difference between expected (implied) and realized (actual) volatility, and other types of volatility arbitrage strategies.



Long/Short Volatility

VIX futures provide a pure play on the level of expected volatility. Expressing a long or short sentiment may involve buying or selling VIX futures. Alternatively, VIX options may provide similar means to position a portfolio for potential increases or decreases in anticipated volatility.



Term Structure Trading

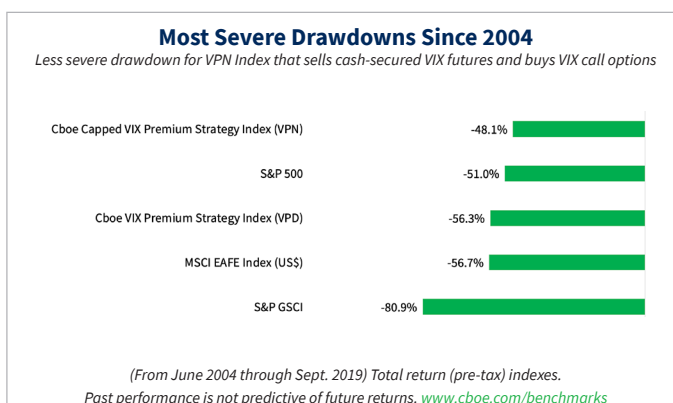
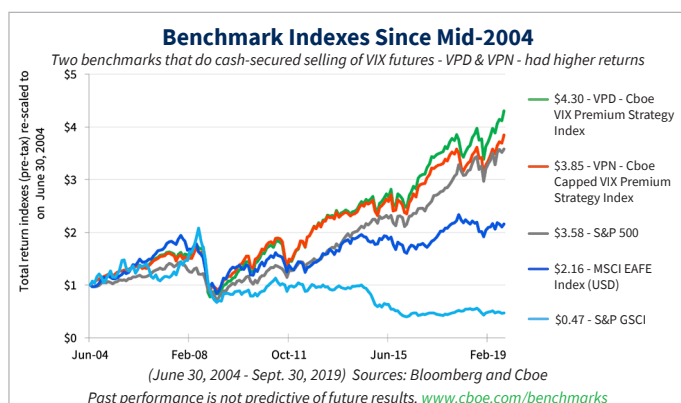
One of the unique properties of volatility – and the VIX Index – is that its level is expected to trend toward a long-term average over time, a property commonly known as “mean-reversion.” The mean reverting nature of volatility is a key driver of the shape of the VIX futures term structure and the way it can move in response to changes in perceived risk. CFE lists nine standard (monthly) VIX futures contracts, and six weekly expirations in VIX futures. As such, there is a wide variety of potential calendar spreading opportunities depending on expectations for implied volatility.

VPD & VPN Benchmark Indexes - Cash-Secured Selling of VIX Futures

In light of the fact that the VIX Index is often in contango, in recent years Cboe has observed an increase in strategies that sell VIX futures. In 2007 Cboe introduced two benchmark indexes to measure hypothetical strategies that sell cash-secured VIX futures (the cash-secured feature helps lower index volatility)

- **Cboe VIX Premium Strategy Index (VPDSM)** - tracks the performance of a strategy that (1) systematically sells 1-month VIX futures, and (2) holds 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 limit risk, 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 points. www.cboe.com/VPD.
- **Cboe Capped VIX Premium Strategy Index (VPNSM)** - tracks the performance of a strategy that (1) systematically sells 1-month VIX futures, (2) holds a money-market account, and (3) buys VIX **call options** struck 25 points higher than the VIX futures price, or at the closest strike below when this strike is not listed. www.cboe.com/VPN.

Higher Returns and Less Severe Drawdowns for Cash-Secured Selling In the period from mid-2004 through the third-quarter of 2019, the VPN Index had higher returns and less severe drawdowns than the stock and commodity indexes in the charts below. The VIX calls and cash-secured feature helped mitigate drawdown risk, while contango facilitated higher returns.



Metrics for 5 Benchmark Indexes

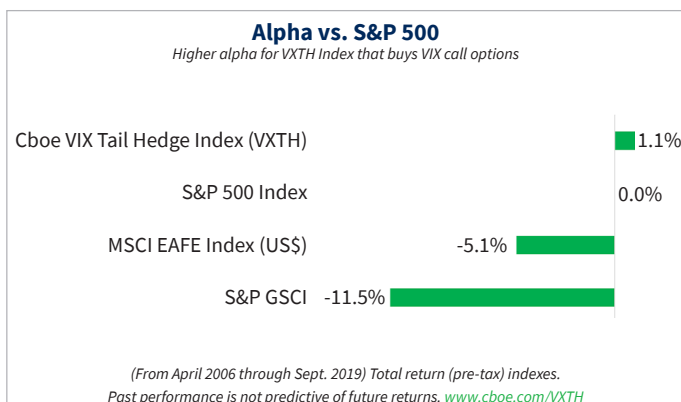
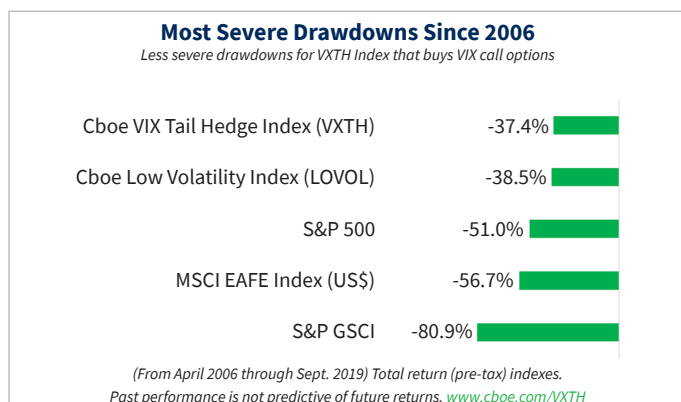
	Maximum Drawdown	Annualized Return	Standard Deviation	Beta vs. Market	Alpha vs. Market	Sharpe Ratio	Sortino Ratio (MAR = 0.00%)	Skewness
Cboe Capped VIX Premium Strategy Index (VPN)	-48.1%	9.2%	16.9%	0.97	1.32%	0.47	0.73	-1.74
S&P 500 Index	-51.0%	8.7%	13.7%	1.00	0.00%	0.54	0.93	-0.8
Cboe VIX Premium Strategy Index (VPD)	-56.7%	10.0%	18.8%	1.06	1.75%	0.46	0.69	-2.99
MSCI EAFE® Index (US\$)	-56.7%	5.2%	16.4%	1.04	-3.24%	0.24	0.45	-0.74
S&P GSCI	-80.9%	-4.8%	22.5%	0.73	-8.77%	-0.27	-0.28	-0.53

(March 31, 2006 - Sept. 30, 2019) Total return (pre-tax) indexes. Sources for charts on this page include: Cboe Exchange, Inc. and Zephyr StyleAdvisor.
More information, including data, charts, and links to white papers, is at www.cboe.com/VIX and www.cboe.com/Benchmarks.

VXTH & LOVOL Benchmark Indexes - Buying of VIX Call Options

- **Cboe VIX Tail Hedge Index (VXTHSM)** - tracks the performance of a strategy that (1) buys and holds an S&P 500 portfolio, and (2) buys one-month 30-delta call options. The weight of the VIX calls in the portfolio varies from 0% to 1% at each roll and depends on the forward value of VIX; for the weightings schedule please visit www.cboe.com/VXTH.
- **Cboe Low Volatility Index (LOVOLSM)** - is a benchmark index that is a 40% / 60% blend of the Cboe S&P 500 BuyWrite Index (BXMSM) (that writes ATM SPX options) and VXTH Index. www.cboe.com/LOVOL.

Higher Alpha and Less Severe Drawdown The VXTH Index had higher alpha, lower standard deviation, and less severe maximum drawdowns than the stock and commodity indexes in the charts below.



Metrics for 4 Benchmark Indexes								
	Maximum Drawdown	Annualized Return	Standard Deviation	Beta vs. Market	Alpha vs. Market	Sharpe Ratio	Sortino Ratio (MAR = 0.00%)	Skewness
Cboe VIX Tail Hedge Index (VXTH)	-37.4%	6.8%	12.2%	0.67	1.1%	0.46	0.83	-0.48
S&P 500 Index	-51.0%	8.6%	14.4%	1.00	0.0%	0.52	0.87	-0.79
MSCI EAFE® Index (US\$)	-56.7%	3.1%	16.9%	1.04	-5.1%	0.12	0.26	-0.69
S&P GSCI	-80.9%	-7.2%	22.0%	0.78	-11.5%	-0.38	-0.41	-0.64

(March 31, 2006 - Sept. 30, 2019) Total return (pre-tax) indexes. Sources for charts on this page include: Cboe Exchange, Inc. and Zephyr StyleAdvisor.
More information, including data, charts, and links to white papers, is at www.cboe.com/VIX and www.cboe.com/Benchmarks.

❖ Please visit Cboe.com/VIX for more details.

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