

S&P Dow Jones
Indices

An S&P Global Division

CBOE

indexology®

{at work}

VIX® THE CBOE VOLATILITY INDEX®



WHAT IS VIX & WHAT DOES IT MEASURE?

THE INDUSTRY STANDARD IN VOLATILITY MEASUREMENT & FORECASTING

The CBOE Volatility Index, better known as VIX, projects the probable range of movement in the U.S. equity markets, above and below their current level, in the immediate future. Specifically, VIX measures the implied volatility of the S&P 500® (SPX) for the next 30 days. When implied volatility is high, the VIX level is high and the range of likely values is broad. When implied volatility is low, the VIX level is low and the range is narrow.

Since VIX reaches its highest levels when the stock market is most unsettled, the media tend to refer to VIX as a fear gauge. In the sense that VIX is a measure of sentiment—of worry in particular—the description is on the mark.



VIX and the S&P 500 typically move in opposite directions, with VIX anticipating the S&P 500's behavior 30 days out.

Implied volatility typically increases when markets are turbulent or the economy is faltering. In contrast, if stock prices are rising and no dramatic changes seem probable, VIX tends to fall or remain steady at the lower end of its scale. VIX, in other words, is negatively correlated with stock performance.

For example, in November 2008, as stock prices sank, VIX reached an all-time high of 80.86. In the winter of 2013, with stock prices high, VIX hovered around 12.

WHAT VIX MEASURES

VIX measures implied volatility by averaging the weighted prices of a wide range of put and call options. When investors buy and sell options, the positions they take—either puts or calls—the prices they are willing to pay, and the strike prices they choose, all reflect how much and how quickly they think the underlying index level will move. In fact, that's what volatility is: the pace and amount of change. VIX uses options prices rather than stock prices in its calculation because options prices reflect the volatility buyers and sellers expect. That's what implied in implied volatility means.

The options used to calculate VIX are put and call options on the S&P 500. Because the index represents approximately 80% of the total market value of U.S. equities and benefits from one of the most liquid markets in the world, using S&P 500 options ensures that VIX represents a broad—and current—view on volatility. What's more, VIX uses a specific combination of options that is designed to balance out all the other factors that generally affect option prices, resulting in an index that parallels volatility expectations alone.

The VIX time frame is significant. VIX anticipates moves in the S&P 500 specifically over the next 30 days. That is enough time for investors to make decisions and act on them, but close enough to add a note of urgency if significant change is forecast.

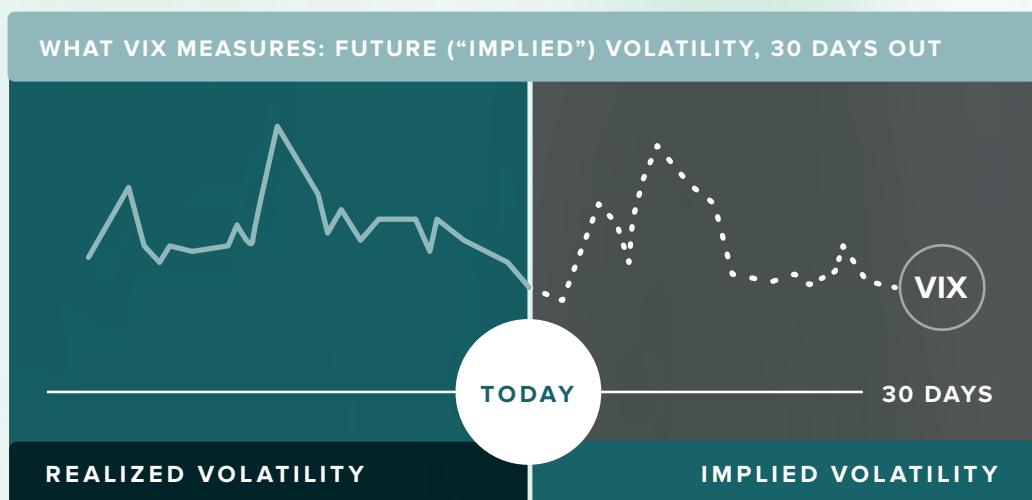
Simply put, VIX measures the expectation of stock-market volatility as communicated by options prices. Rather than measuring “realized” or historical volatility, VIX projects “implied” or expected volatility—specifically 30 days in the future—by measuring changes in the prices of options on the S&P 500.

PUTS & CALLS



Holding an index call option gives you the right to a cash settlement if the index value is higher than the strike price of the option.

Holding an index put option gives you the right to a cash settlement if the index value is lower than the strike price of the option.



HOW INVESTORS USE VIX

DIVERSIFYING A PORTFOLIO

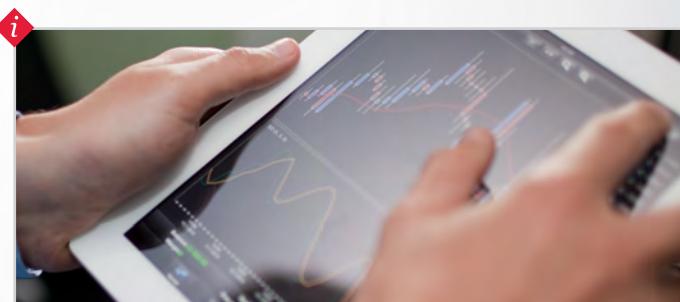
Many investors use an investment linked to the VIX to diversify their portfolios, seeking to hedge portfolio risk without significantly reducing potential return. For example, when markets are unsettled, investors may allocate a small percentage of their capital to VIX-related products, such as ETFs or ETNs linked to VIX Futures, hoping to offset anticipated losses in their investment portfolios.

What makes VIX attractive in a diversification strategy is first its consistently negative correlation with equity securities: the more the market falls, the more volatility increases.

Second, VIX tends to rise more dramatically when markets fall significantly. For example, if equities, or the S&P 500, were to lose 50% of their value, VIX might be anticipated to increase several hundred percent. This

characteristic of typically reacting more dramatically to a large equity loss than to a large equity gain is called convexity. Convexity means the investments associated with VIX may provide greater protection when it is needed most.

VOLATILITY AS AN ASSET CLASS



Volatility can be bought or sold. It works as a diversification tool. It can provide a positive return, although it pays no interest or dividends. But unlike most traditional asset classes, volatility is never a long-term investment.

TRADING FOR PROFITS

The recurring up and down pattern of the market cycle may encourage investors to sell VIX-linked products following a weak period in equity markets. In this case, they anticipate equities will begin to gain value and the prices of volatility-linked products will decline. Alternatively, when VIX is low, investors may wish to buy VIX-linked products in anticipation of a future period of weakness. These similar trading strategies aim to exploit the historical tendency of VIX to revert to its mean after a period of increasingly higher or lower levels.

Investors may also seek arbitrage opportunities that result from mispricing of VIX-linked products. For example, they may sell individual options and take an opposite position in VIX-linked products, particularly if the implied volatilities of the individual options look expensive compared to VIX. Or, they may take opposite positions in VIX options or futures with different maturities. In some cases, for example, premiums on VIX-linked options may be higher or lower than realized volatility justifies, and exploiting this discrepancy may produce a profit.

USING WHAT VIX COMMUNICATES

Like other indices, VIX is expressed as a level, or number. Changes in the level, up or down, are expressed as percentages. But unlike other indices, whose results indicate market performance, the VIX level communicates a different type of information: the 30-day implied volatility of the S&P 500. Implied volatility, in turn, indicates the expected range of the S&P 500, above and below its current level, over the next 30 days.

The higher the VIX level on any given day, the higher the implied volatility and the wider the range of potential variation in the level of the S&P 500. For example, if the current level were 10—which is at the low end of historical readings—the deannualized 30-day implied volatility is 2.9%. This means in 30 days the S&P 500 is expected to trade between 2.9% lower and 2.9% higher than its current level. On the other hand, if the VIX level were 30, it would imply an expected level of the S&P 500 between 8.7% lower and 8.7% higher in 30 days.

WHAT VIX TELLS US ABOUT THE S&P 500

VIX
LEVEL



EXPECTED RANGE
OF THE S&P 500

10 »



+/- 2.9%

15 »



+/- 4.3%

20 »



DIVIDE BY $\sqrt{12}$



+/- 5.8%

25 »



+/- 7.2%

30 »



+/- 8.7%

35 »



+/- 10.1%

THE 30-DAY IMPLIED VOLATILITY

To find the 30-day implied volatility of the S&P 500 from the VIX level involves several relatively simple steps. As an illustration, assume that the VIX level is 18, and the current value of the S&P 500 is 1850.

By following the steps presented in the diagram below, you can calculate where the market reasonably expects the S&P 500 to trade in 30 days. It's information many investors use to make near-term trading decisions.

TIME & VOLATILITY



VIX is reported as an annualized number. Since volatility is statistically defined as the square root of variance, the monthly volatility implied by VIX can be calculated by dividing its level by the square root of 12 because there are 12 months in a year.



HOW TO USE VIX TO CALCULATE THE EXPECTED RANGE OF THE S&P 500

1

CONVERT THE VIX LEVEL TO AN ANNUAL PERCENTAGE

So a VIX reading of

$$18 \equiv 18\%$$

2

Divide the annual percentage

BY THE SQUARE ROOT OF 12 (3.464)
FOR THE 30-DAY IMPLIED VOLATILITY

$$\frac{18\%}{\sqrt{12}} \equiv 5.20\%$$

3

To assess the potential effect on the level of the S&P 500

MULTIPLY THE CURRENT S&P 500 LEVEL BY 5.20%

IF S&P 500 IS

$$1850 \times 5.20\% \equiv 96.2$$

4

To determine the expected range of S&P 500 levels:

↑ UPPER LEVEL

$$1850 + 96.2 \equiv 1946.2$$

↓ LOWER LEVEL

$$1850 - 96.2 \equiv 1753.8$$

HOW IT'S BUILT & CALCULATED

VIX METHODOLOGY

VIX, or the annualized 30-day implied volatility of the S&P 500, is calculated throughout each trading day by averaging the weighted prices of a specific group of S&P 500 call and put options. As with other S&P DJI indices, the methodology used to calculate VIX is rigorous and transparent, though it differs from other indices in that it measures volatility rather than changes in security prices.

[VIEW THE COMPLETE VIX METHODOLOGY](#) >

The VIX methodology specifies that S&P 500 option contracts with more than 23 days and less than 37 days to expiration are used to calculate the index. Both standard and weekly option contracts with expirations in the 23 to 37 day range are eligible.

Once a week, the options used to calculate VIX roll to new contract maturities. For example, on the second Tuesday in October, VIX would be calculated using two sets of options—a “near-term” option expiring 24 days later and a “next-term” option expiring 31 days later. On the following day, the options that expire in 30 calendar days would become the near-term options in the calculation and SPX options that expire in 37 calendar days would become the new next-term options. In this example, the near-term options would be standard S&P 500 options with 25 days to expiration, whereas the next-term options would be weekly options with 32 days to expiration.

As each VIX calculation begins, the first step is determining which option contracts, with strike prices higher and lower than the current SPX level, will be included. The number of contracts may vary from calculation to calculation, but typically includes more than 100 puts and calls. To make the cut, the contracts must have current non-zero bid and ask prices, or what is known as a quote, from investors willing to buy or sell at that price. The further a strike price is from the current SPX level, the less likelihood there is of finding a

quote, and contracts without quotes are excluded. At the point that two contracts with consecutive strike prices do not have quotes, no additional contracts are eligible for inclusion and the components are set.

In the next step, the options contracts that have been selected are weighted to ensure that each has the required impact on the calculation. The VIX formula is designed to combine options in a way that means that subsequent movements in the VIX are dependent only on the volatility of the underlying. Changes in the S&P 500 level, dividends, interest rates, or other factors have no impact because they have been balanced out and removed. The precise justification for the weighting is technical, but it results in a system that weights each option in inverse proportion to the square of the option strike price. Accordingly, VIX is more sensitive to changes in the prices of options with lower strikes and less sensitive to options with higher strikes.



3 BASIC STEPS IN EACH CALCULATION



DETERMINE WHICH OPTIONS CONTRACTS ON THE S&P 500 TO INCLUDE IN THE CALCULATION



WEIGHT THE
SELECTED OPTIONS



APPLY THE MATHEMATICAL
FORMULA TO DETERMINE VIX RESULTS

VIX-RELATED PRODUCTS AND BENCHMARKS

It is not possible to invest in VIX directly or to replicate VIX performance. So investors use products linked to VIX to hedge their portfolios against market risk or to trade volatility. The roster of these products includes ETFs and ETNs linked to S&P VIX Futures Indices, futures contracts listed on the Chicago Futures Exchange (CFE), options contracts listed on the Chicago Board Options Exchange (CBOE), and

some over-the-counter (OTC) alternatives, such as variance swaps.

Each of these products works differently, attracts investors for different reasons, and poses different potential risks. What links them, however, is that as equity markets fall, VIX rises, prompting a corresponding though not identical change in the value of products linked to VIX.

ABOUT ETFs & ETNS

ETFs and ETNs linked to S&P 500 VIX Futures Indices, which were introduced in 2009, provide a way for securities investors to hedge their equity portfolios, and in some cases their bond portfolios, against a market downturn or to speculate on a change in volatility. Any increase in the value of the ETFs and ETNs they own can be used to offset portfolio losses or to realize a profit.

Returns on both the ETFs and the ETNs are determined by the changing values of the underlying VIX futures contracts rather than by the changing value of VIX itself. This means the returns may, and often do, diverge from the implied volatility indicated by the actual VIX level and from investors' expectations.

The greater potential risk, however, is the result of the characteristic market expectation that VIX in the future will be higher than current VIX—an outlook that is even more pronounced when the VIX level is low.

This anticipation increases what investors in VIX futures are willing to pay for new contracts,

creating a situation known as contango. When a market is in contango, the price of a futures contract with a later expiration date is higher than the spot price of the current contract.

What this means for investors in some VIX-linked products is that every month, as expiration of the underlying futures contracts approaches, the investor effectively sells the contracts they hold and purchase the next month's contracts, to create what is known as a rolling long position.

When each new contract costs more than the one it is replacing, contango creates a recurring month-by-month loss that can sap a significant portion of an investor's principal in a single year if he or she holds the product for the full period.

That possibility makes these VIX-linked products typically appropriate only as very short-term investments, often as short as a single day. The problem is that this approach runs counter to the buy-and-hold strategy that investors often adopt with ETFs and ETNs linked to traditional indices.

NEW PRODUCTS

Recently, some issuers have launched VIX-linked products—typically tied to more sophisticated investment strategies—that are potentially more appropriate to be used as buy-and-hold investments. A full list of VIX-linked ETFs and ETNs is available on the [VIX page of the S&P Dow Jones Indices Web site](#).

Further, it is possible to buy leveraged or inverse ETFs or ETNs in addition to the standard variety.

A leveraged ETF or ETN promises twice (2x) or three times (3x) the daily return of the underlying index and uses derivative products to meet its obligation to deliver the promised return.

An inverse ETF or ETN promises a daily return that is the opposite of the actual return: a negative return if the actual return is positive and vice versa.

However, in nearly all situations, leveraged and inverse ETFs and ETNs are used to take short-term trading positions and are not typically appropriate investments unless they are monitored during very short-term periods, such as a single trading day.

COMPARING ETFS AND ETNS

ETFs and ETNs tracking S&P 500 VIX Futures Indices are extremely liquid and can be bought and sold, as other ETFs and ETNs are, through a brokerage account. However, there are key differences between these products:

All ETFs are equity securities while all ETNs are debt securities and so expose investors to credit as well as market risk.

ETFs seek to replicate the return of the underlying index by buying the futures contracts that the index tracks.

ETNs determine return based on the performance of the underlying index but do not own the futures contracts in the index.

ETF LIST

INDEX NAME	PRODUCT NAME
↗ S&P 500 VIX Short-Term Futures Index	S&P 500 VIX Futures ETF
↗ S&P 500 VIX Short-Term Futures Index	ProShares Short VIX Short-Term Futures ETF
↗ S&P 500 VIX Short-Term Futures Index	ProShares Ultra VIX Short-Term Futures ETF
↗ S&P 500 VIX Short-Term Futures Index	ProShares VIX Short-Term Futures ETF
↗ S&P 500 VIX Short-Term Futures Index	Kokusai S&P500 VIX Mid-Term Futures Index ETF
↗ S&P 500 VIX Short-Term Futures Index	Horizons BetaPro S&P 500 VIX Short-Term Futures Bull Plus ETF
↗ S&P 500 VIX Short-Term Futures Index	Horizons BetaPro S&P 500 VIX Short-Term Futures ETF
↗ S&P 500 VIX Short-Term Futures Index	Horizons BetaPro S&P 500 VIX Short-Term Futures Inverse ETF
↗ S&P 500 VIX Mid-Term Futures Index	ProShares VIX Mid-Term Futures ETF
↗ S&P 500 VIX Mid-Term Futures Index	Kokusai S&P500 VIX Mid-Term Futures Index ETF
↗ S&P 500 VIX Futures Enhanced Roll	Lyxor ETF Unleveraged S&P 500 VIX Futures Enhanced Roll - C-EU
↗ S&P 500 VIX Futures Enhanced Roll	Lyxor ETF Unleveraged S&P 500 VIX Futures Enhanced Roll - C-USD
↗ S&P 500 VIX Futures Enhanced Roll	Lyxor ETF S&P 500 VIX Futures Enhanced Roll C-EUR

ETN LIST

INDEX NAME	PRODUCT NAME
↗ S&P 500 VIX Short-Term Futures Index	iPath S&P 500 VIX Short-Term Futures CAD Hedged ETN
↗ S&P 500 VIX Short-Term Futures Index	iPath S&P 500 VIX Short-Term Futures Index ETN
↗ S&P 500 VIX Short-Term Futures Index	iPath Inverse S&P 500 VIX Short-Term Futures ETN
↗ S&P 500 VIX Short-Term Futures Index	iPath Inverse S&P 500 VIX Short-Term Futures ETN II
↗ S&P 500 VIX Short-Term Futures Index	iPath S&P 500 VIX Short-Term Futures ETN
↗ S&P 500 VIX Short-Term Futures Index	VelocityShares Daily 2x VIX Short Term ETN
↗ S&P 500 VIX Short-Term Futures Index	VelocityShares Daily Inverse VIX Short Term ETN
↗ S&P 500 VIX Short-Term Futures Index	VelocityShares VIX Short Term ETN
↗ S&P 500 VIX Short-Term Futures Index	iPath S&P 500 VIX Mid-Term Futures ETN
↗ S&P 500 VIX Mid-Term Futures Index	VelocityShares Daily 2x VIX Medium Term ETN
↗ S&P 500 VIX Mid-Term Futures Index	VelocityShares Daily Inverse VIX Medium Term ETN
↗ S&P 500 VIX Futures Enhanced Roll	VelocityShares VIX Medium Term ETN
↗ S&P 500 VIX Futures Enhanced Roll	iPath S&P 500 Dynamic VIX ETN

CBOE FUTURES

Retail and institutional investors use VIX futures contracts, which were introduced in 2004, much as they use futures contracts on other financial indices: to hedge their portfolios or to speculate in search of profit. The prices of VIX futures are not driven only by the spot price of an underlying security or index, but are also determined by where the market expects VIX to be when the contract expires.

VIX futures investors give orders to buy or sell VIX futures at a specific expiration date at the price determined by trading on the CFE. Among

the factors that these investors must evaluate are the direction they expect VIX to move, the level they expect it to reach, and the timing of that move, based on what they expect to happen in the stock market as represented by the S&P 500.

The primary risk that futures investors face, whether they buy or sell a contract, is a possible, and potentially substantial, loss as the price of the contract fluctuates before expiration.

CBOE OPTIONS

Options contracts on VIX, which were introduced in 2006, allow investors to hedge their equity portfolios against falling stock prices or position themselves to profit from a change in the VIX level.

To accomplish their objectives, options investors, like futures investors, have to anticipate not only where VIX will be in the future but also the timing of the move.

If investors expect the S&P 500 to lose value, they might buy call options on VIX. If the equity market goes down and the VIX options are in the money, they collect a payment based on the amount by which their options are in the money. Or, if they were right in anticipating the direction of VIX, they might choose to sell their contracts before expiration for more than they paid to

purchase them, also realizing a profit. In contrast, if investors expect the S&P 500 to go up, they might buy put options on VIX, anticipating a profit if they exercise at expiration or sell to close out their position before expiration.

The biggest risk VIX options buyers face is the possible loss of the premium they paid to purchase the option if it turns out they were wrong about the direction and timing of a change in VIX. However, this premium can be substantial in a period of increasing market instability and rising volatility. Options sellers, on the other hand, face a greater risk than buyers because if an option they sold is exercised, they are responsible for paying the settlement price. To protect against this loss, they may offset their position before expiration.

FUTURES CONTRACTS

i

- CBOE Volatility Index Futures
- CBOE Short-Term Volatility Index Futures



OPTIONS CONTRACTS

i

- CBOE Volatility Index Options
- CBOE Short-Term Volatility Index Options



VIX NETWORK MEMBERS

The VIX® Network is an association of exchanges and index providers dedicated to establishing standards that help investors understand, measure, and manage volatility. The network's members have obtained, from CBOE and S&P DJI, the rights to use the VIX methodology to calculate their own volatility indices.

MEMBER EXCHANGES AND FIRMS



- ↗ Australian Securities Exchange
- ↗ CME Group
- ↗ Deutsche Borse AG
- ↗ Hang Seng Indexes
- ↗ LIFFE
- ↗ National Stock Exchange
- ↗ Taiwan Futures Exchange
- ↗ TMX Group

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