

# VIX Summary

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## Key Takeaways

- VIX index is a measure of market volatility based on S&P 500 index option bid/ask prices
- VIX cannot be traded, but its derivatives can (i.e VXX)
- VIX index calculates volatility of the S&P 500 30 days out, but there exist a family of VIX indices which calculate volatility for different time periods
- VIX is a function of near term options, next-term options, and risk free treasury bill interest rates
- VIX index is calculated and updated at 15 second intervals by a deterministic formula and selection algorithm
- VIX tends to be inversely correlated with S&P 500
- There is free historic data of VIX, VIX derivatives, and VIX family indices that is updated daily; however, that data is generally limited to EOD levels.
- CBOE sells VIX data at 15 second intervals by the month for 10 dollars per dataset

## General Notes

- Operated by the Chicago Board Options Exchange, the VIX index is an up-to-the-minute measure of market volatility based on the midpoints of S&P 500 index option bid/ask quotes
- The current VIX index measures the expected annualized change in the S&P 500 index in the next 30 days as calculated by options pricings
- Essentially, the VIX is a measure of the markets prediction of S&P 500 volatility 30 days in the future
- **VIX cannot be traded**; instead, it is traded through derivative contracts like futures, ETFs, and options
- Related CBOE Products:
  - VIX9DSM (Short Term Volatility Index)
  - VIX3MSM (3 Month Volatility Index)
  - VIX6MSM (6 Month Volatility Index)
  - VIX1YSM (1 Year Volatility Index)
  - VXNSM (NASDAQ-100 Volatility Index)
  - VXDMSM (DOW Volatility Index)
  - RVXSM (Russell 2000 Volatility Index)
  - VVIX (VIX on VIX)
- VIX is a function of S&P 500 index options for near term options (less than 23 days till expiry), next-term options (less than 37 days till expiry), and risk free U.S. Treasury Bill interest rates
- The VIX is the volatility of variance swap

## Quick Interlude into Variance Swaps

- Variance Swap is a derivative contract dependent on the changes in the underlying asset's price (volatility)
- Essentially, one party agrees to pay the implied variance (strike) to the other party who will then pay back the actual variance at the end of the contract
- Profits are realized when the actual variance is greater than the implied variance (calculated from options contracts)
- Variance swaps function similarly to options contracts; however, since option contracts are dependent on directionality, time, expiration, and implied volatility, variance swap contracts tend to be less risky
- Actual variance is calculated from daily log returns (natural log of the difference between given day and previous day price)
- The VIX index is calculated as the square root of a risk-neutral expectation of the S&P 500 variance over 30 days and is quoted as an annualized standard deviation
- VIX is calculated by a weighted portfolio of out-of-the-money European-style options of the S&P 500
  - Unlike their American counterparts, European options can only be exercised on the expiration date rather than at anytime before it
  - Most index options are European-style options
  - Black-Scholes Equation models European-style options

- VIX Formula:

$$VIX = 100 * \sqrt{\frac{2e^{r\tau}}{\tau} \left( \int_0^F \frac{P(K)}{K^2} dK + \int_0^\infty \frac{C(K)}{K^2} dK \right)} \quad (1)$$

- $\tau$  is the average days in a month (30)
- $r$  is the risk-free rate (Calculated by subtracting inflation rate from the yield of a US treasury bond matching investment duration)
- $F$  is the 30 day forward price on the S&P 500
- $P(K)$  is the price for a put of with strike price  $K$  30 days from expiration
- $C(K)$  is similarly the price for a call with a strike price of  $K$  30 days from expiry
- More details on how the individual variables are calculated can be found in the whitepaper: [https://cdn.cboe.com/api/global/us\\_indices/governance/VIX\\_Methodology.pdf](https://cdn.cboe.com/api/global/us_indices/governance/VIX_Methodology.pdf)
- VIX is only calculated based on options expiring on Fridays
- Intraday VIX index values are calculated based on the bid/ask quotes of SPX options at 15 second intervals
- In order to filter extraneous movement in option pricing, the VIX index is filtered before being updated
  - An initial baseline VIX index value is calculated
  - The baseline is updated if the VIX index moves by more than 0.49 in each direction within 2 minutes of the original baseline calculation
  - If there is no change after the 2 minute period, the VIX index is updated to the first value calculated after the 2 minute interval
- Generally, the VIX index is inversely correlated with S&P 500 Index
- The VIX Index tends to be used for risk management or hedging and usually tends towards its historical average
- VIX Futures contracts
  - VXX: Long position in 1st and 2nd month VIX futures that roll daily
    - \* Negative Roll Yield (long-term holders face penalties on returns)

- \* Stronger in short-term than long-term
- VXX: Long position in fourth-, fifth-, sixth-, and seventh- month VIX futures
  - \* Negative Roll Yield (long-term holders face penalties on returns)
  - \* Stronger in short-term than long-term
- Criticism against the efficacy of the VIX index
  - Some critics say that the VIX is just a measure of current pricing of index options
  - Similar to simpler volatility metrics (past volatility)
  - Lacks predictive power and simply just the inverse of pricing

## Datasets

- VIX Index Values by 15 seconds: <https://datashop.cboe.com/volatility-index-spot-values>
  - Costs 10 dollars per month
- VIX Future Trades: <https://datashop.cboe.com/cfe-vix-volatility-index-futures-trades-quotes>
  - Costs 50 dollars per month
- VIX Index Values: [https://www.cboe.com/tradable\\_products/vix/vix\\_historical\\_data/](https://www.cboe.com/tradable_products/vix/vix_historical_data/)
  - Free and updated daily
  - Only Open, High, Low, and Close data
  - Also available through Yahoo Finance: <https://finance.yahoo.com/quote/%5EVIX/history?p=%5EVIX>
- VIX of VIX Index: [https://www.cboe.com/tradable\\_products/vix/vix\\_historical\\_data/](https://www.cboe.com/tradable_products/vix/vix_historical_data/)
  - Free and updated daily
  - Only EOD
- 9-day VIX Index: [https://www.cboe.com/tradable\\_products/vix/vix\\_historical\\_data/](https://www.cboe.com/tradable_products/vix/vix_historical_data/)
  - Free and updated daily
  - Only Open, High, Low, and Close data
- VX Futures: [https://www.cboe.com/us/futures/market\\_statistics/historical\\_data/](https://www.cboe.com/us/futures/market_statistics/historical_data/)
  - Free and contains futures contract data
- VIX Options: [https://www.cboe.com/us/options/market\\_statistics/historical\\_data/](https://www.cboe.com/us/options/market_statistics/historical_data/)
- VXX: <https://finance.yahoo.com/quote/VXX/history?p=VXX>
  - Daily historical data