Quantcha US Equity Volatilities (VOL)

Volatility measurements provide insight as to the actual or expected variation in the price of a stock over a given period of time. It's one of the most important metrics used in finance as it provides insight as to the behavior of a given underlying over time, usually with respect to price.

Types of Volatility

There are two types of volatility: historical and implied. Historical volatility is the objective measurement of volatility based on past prices of the underlying that have already been recorded. Implied, on the other hand, is a forward-looking measurement derived from the current prices of unexpired options.

Implied Volatility

Implied volatility (IV) is an invaluable resource as it quantifies the expected movement in an underlying in the future. The measurement itself doesn't suggest directionality, but it does suggest magnitude and timing. It's all based on the notion that every security (options and the underlying) is priced to break even and that there are no arbitrage opportunities.

The fair market price of a given option can be calculated based on five factors:

1. The current price of the stock
2. The current price of the option (typically calculated as the average of the best bid and ask prices for the option)
3. The amount of time until expiration
4. The risk-free rate of return (typically the Treasury rate for that duration)
5. Ordinary dividends, if expected
6. The expected volatility of the stock

All of the pricing parameters above are objectively observable, except for the expected volatility. As market forces apply to the supply and demand for given options, the pricing of each series adapts until it reaches equilibrium. At that time, it is possible to derive the expected volatility each option's price implies. This is where the term "implied" volatility comes from.

With all other factors being equal, increased price in an option necessitates an increase in its IV and vice versa. As a result, periods of high option demand, such as when there is greater uncertainty, drive up the IV for options. When the uncertainty subsides, IV recedes.

Put vs. Call vs. Mean Implied Volatility

Most implied volatilities referenced are mean implied volatilities, which is the average of the put and call IVs at the same strike. However, there are often insights that can be extracted by comparing the IV measurements for puts and calls relative to each other. While they should generally be about the same, there are often market factors that drive them apart. When call IV runs higher than put IV, it's a bullish sign that the market is buying calls and selling puts. On the other hand, it's a bearish sign when the market is buying puts and selling calls, resulting in higher put IV relative to call IV.

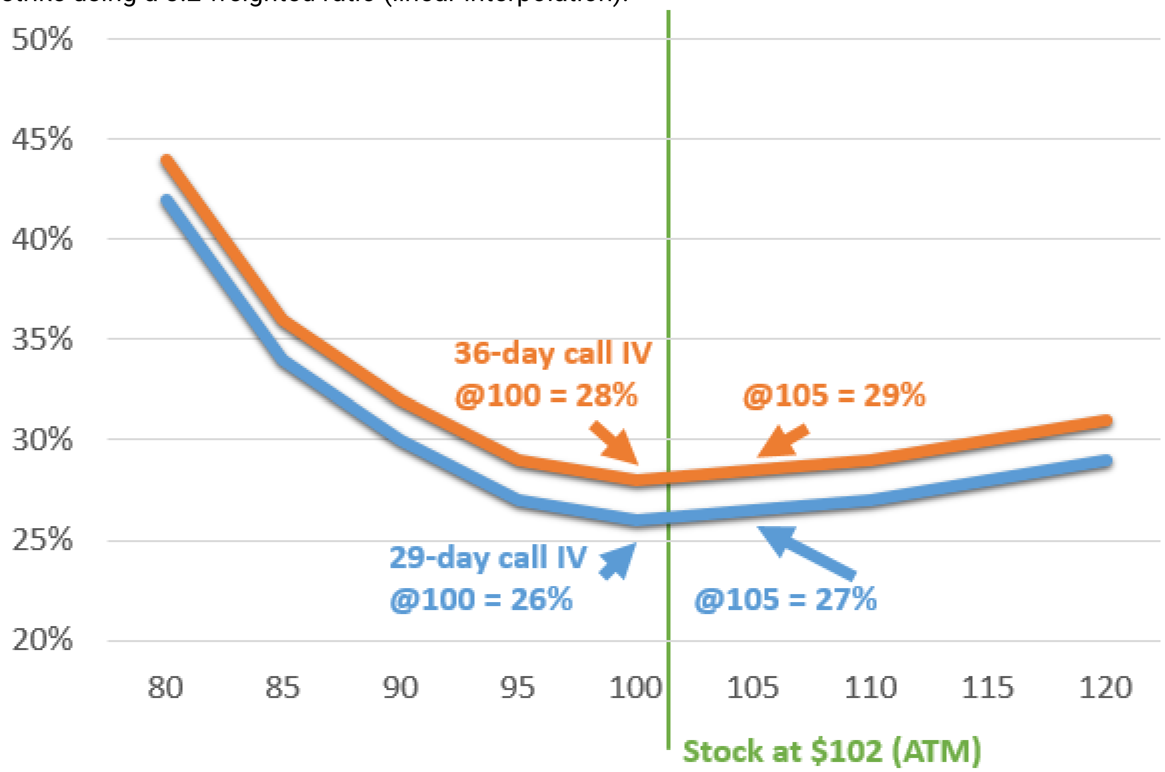
Implied Volatility in this Data Set

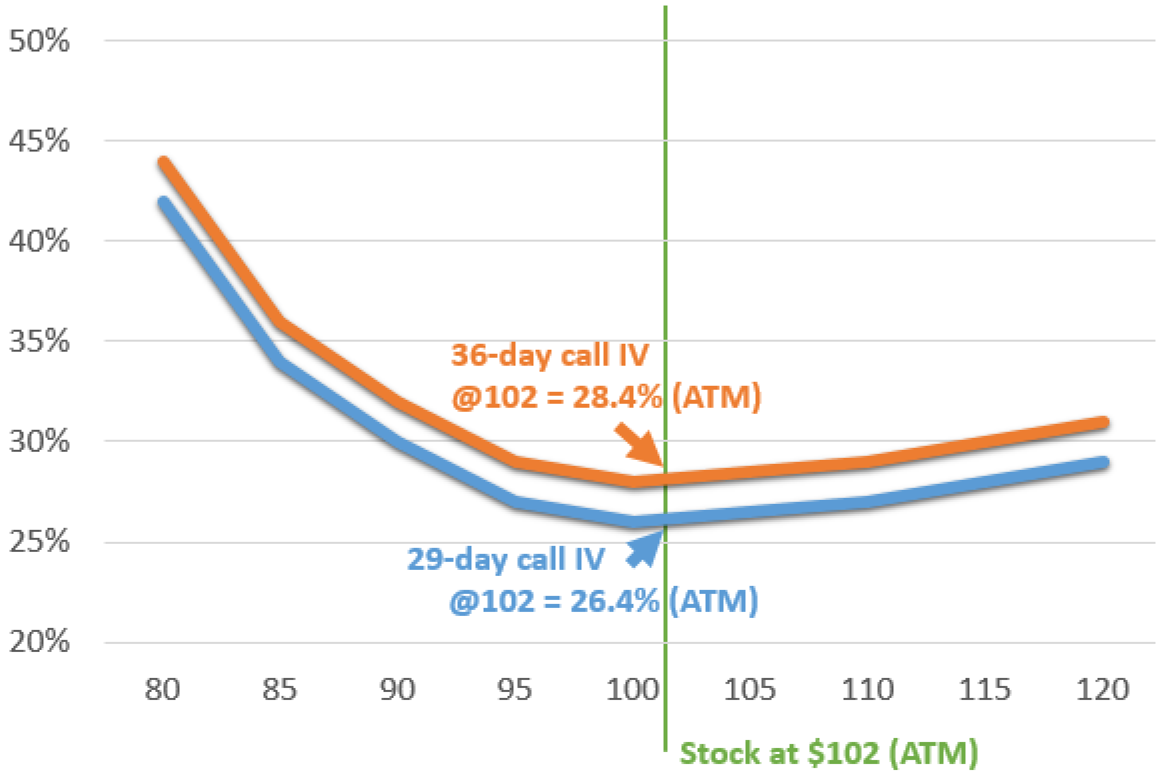
The implied volatility measurements provided in this data set are calculated for calls, puts, and means using at-the-money (ATM) options for predefined durations. An ATM option is one whose strike price is the closing price as of the date of calculation, which may be rounded to two decimals, such as $12.34. The durations are all measured in calendar days.

For example, the IvCall30 provides the implied volatility of the ATM call for the stock with an expiration 30 calendar days from the measurement date. If the stock closed at $12.34 on that day, the option used would be the call with the strike at $12.34. IvPut30 represents the implied volatility for the comparable put, and IvMean30 is simply the average of IvCall30 and IvPut30. The provided durations are 10, 20, 30, 60, 90, 120, 150, 180, 270, 360, 720, and 1080 calendar days.

As it is very uncommon for there to be options that precisely fit the strike and expiration requirements to fulfill these measurements, a multi-step process is employed to calculate the values.

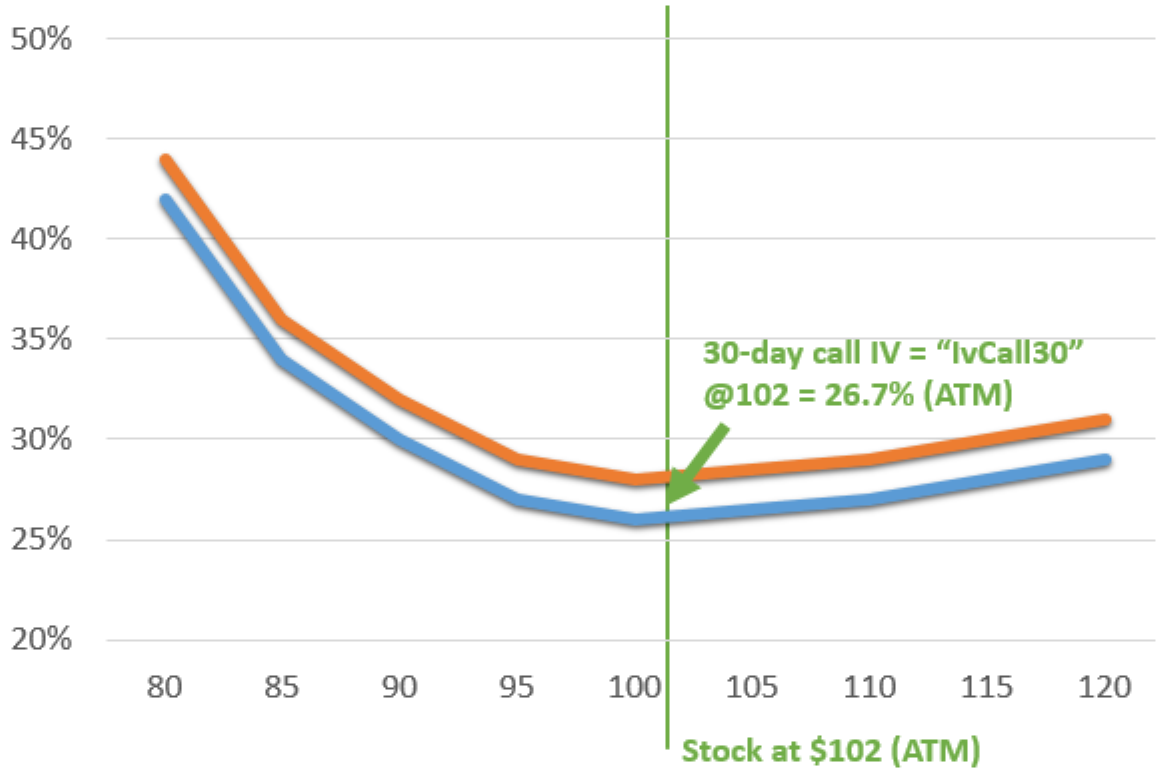
1. The implied volatility for each of the available options is calculated. If there are no ordinary dividends to be distributed over the remaining lifetime of a given option, the Black-Scholes model is employed. If there are ordinary dividends to be distributed, the system uses the Cox-Ross-Rubinstein binomial model. For long-range options, the system infers the likelihood of future dividends based on the current expectations for ordinary dividends over the next year.
2. Once the implied volatility has been calculated for each option, the ATM option for that duration is calculated using linear interpolation of the two options straddling the ATM price. For example, if the ATM price is $102, the system may use the $100 and $105 strikes to calculate the theoretical $102 strike using a 3:2 weighted ratio (linear interpolation).





In the rare case where all options are above or below the ATM price, the implied volatility of the option closest to the money is used. Note that only call options are used to calculate call implied volatilities and only puts are used for put implied volatilities.

3. At this point, the system has the ATM implied volatilities for each actual expiration of the options available for the stock. To calculate the implied volatilities for the predefined durations, the system uses linear interpolation between the two expiration periods straddling the target expiration. For example, if the target duration is 30 days, the system may use the 29-day and 36-day ATM implied volatilities at a ratio of 6:1 (linear interpolation) to calculate the theoretical 30-day implied volatility.



Using Implied Volatility

There are several ways to quickly apply implied volatility to research and investing.

As a Standard Deviation

Implied volatility is the annualized standard deviation of the expected price change. As a result, it can be inserted into any statistics process relying on a standard deviation for modeling. Note that price changes are follow a lognormal distribution.

With A Cumulative Distribution Function

The implied volatility can be used as the standard deviation parameter to a cumulative distribution function (CDF). This enables calculation of the probability that the underlying closes at or below an arbitrary price on a date in the future. Subtracting this value from 100% provides the probability it closes above this price.

To calculate the probability for the underlying closing within a range, simply subtract the CDF for the lower price from the CDF for the higher price. Like above, calculate the probability it closes outside the range by subtracting that value from 100%.

Quantcha Volatility Worksheet

Please see the [Quantcha Volatility Worksheet (Excel)]() for an example of how these values can be calculated and rendered.

Quantcha Volatility Worksheet

https://data.nasdaq.com/VOL

Quantcha
https://quantcha.com

Market	
Interest Rate	5.00%

Underlying	
Last	$ 100.00
IV	25.00%
Dividends	$ -

Model Date	
Calendar Days	10

Calculations	
Calendar Years	0.027
Periodic Volatility	4.14%
Periodic Interest	0.14%
Forward Price	$ 100.14

Key
Variables To Edit
Calculated
Labels

Vol Move Prices							
Vols	-3.00	-2.00	-1.00	0.00	1.00	2.00	3.00
Price	$ 87.71	$ 91.85	$ 96.00	$ 100.14	$ 104.28	$ 108.43	$ 112.57

Probability Close Below Price							
Price	$ 94.00	$ 96.00	$ 98.00	$ 100.00	$ 102.00	$ 104.00	$ 106.00
Change (From Last)	-6.00%	-4.00%	-2.00%	0.00%	2.00%	4.00%	6.00%
Change (From Forward)	-6.13%	-4.13%	-2.14%	-0.14%	1.86%	3.85%	5.85%
Probability	6.31%	15.38%	30.08%	48.65%	67.17%	81.96%	91.53%

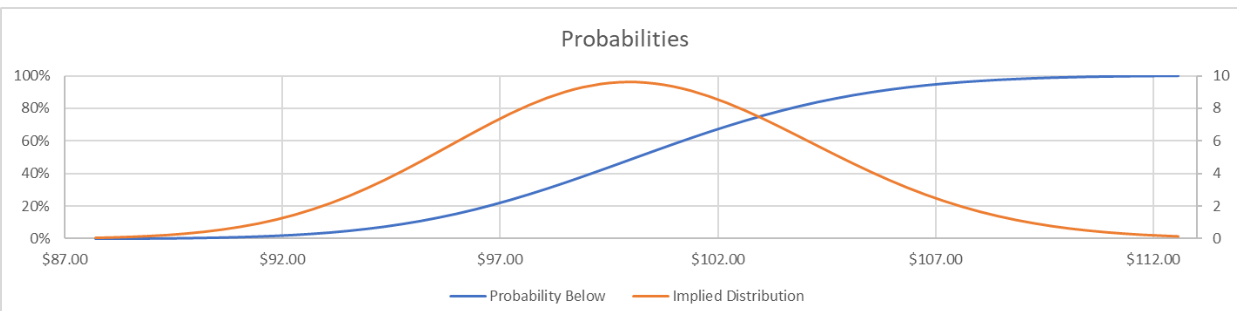
Probability Close Below Change From Last Price							
Change (From Last)	-6%	-4%	-2%	0%	2%	4%	6%
Price	$ 94.00	$ 96.00	$ 98.00	$ 100.00	$ 102.00	$ 104.00	$ 106.00
Change (From Forward)	-6.13%	-4.13%	-2.14%	-0.14%	1.86%	3.85%	5.85%
Probability	6.31%	15.38%	30.08%	48.65%	67.17%	81.96%	91.53%

Price Range Probability		
Price	$ 94.00	$ 96.00
Change (From Last)	-6.00%	-4.00%
Change (From Forward)	-6.13%	-4.13%
Probability Below	6.31%	15.38%
Probability In Range		9.07%

Change Range Probability		
Change (From Last)	-6%	-4%
Price	$ 94.00	$ 96.00
Change (From Forward)	-6.13%	-4.13%
Probability Below	6.31%	15.38%
Probability In Range		9.07%

With A Probability Density Function

The implied volatility can be used as the standard deviation parameter to a probability density function (PDF). The values returned for each price change indicate their relative probability to each other. In aggregate, these values can be used to generate implied lognormal distributions of pricing.

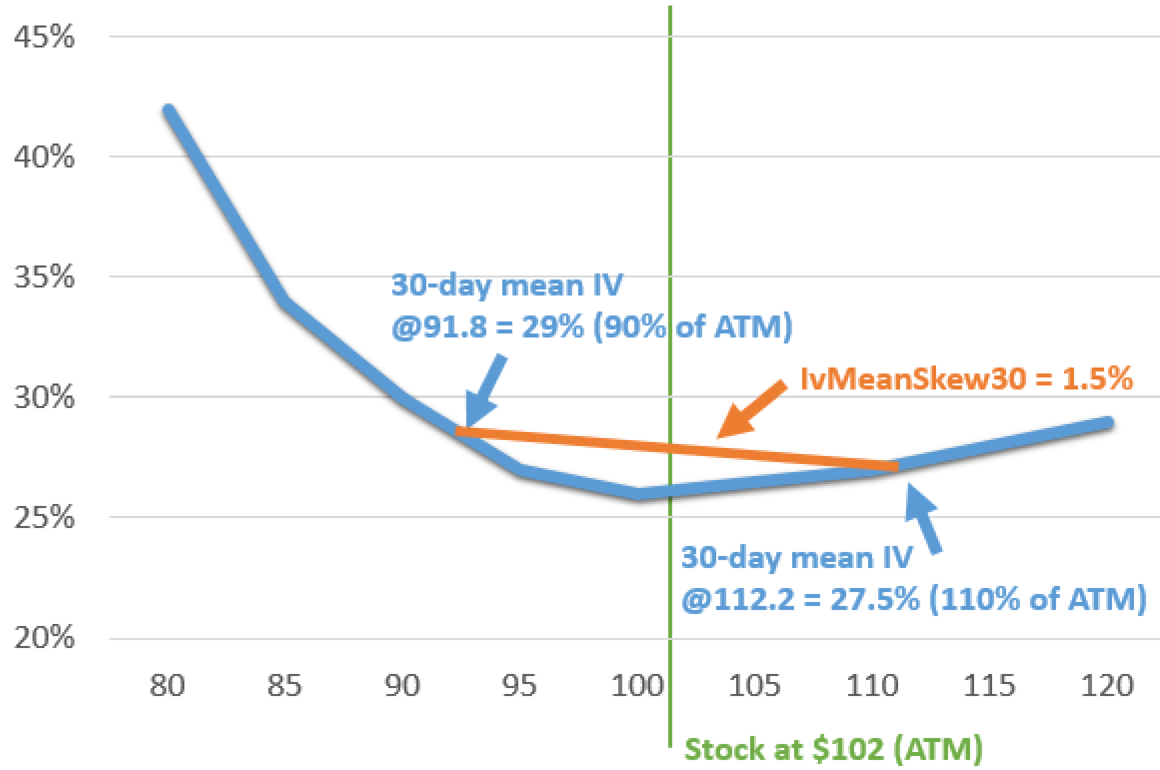


Volatility Skew

Implied volatilities for the same expiration period vary across the different strike prices. In general, the shape of the graph of implied volatilities against strikes takes the form of a “skew” or “smile” where the implied volatilities are highest for the lowest strike prices and slope downward to reach a low near the money. Then, under normal circumstances, the strikes above-the-money will curve back upward to roughly mirror the IV measurements of below-the-money strikes. Subtracting the IV at the current underlying price +10% from the price at -10% provides the current measurement of this skew.

However, market sentiment will often impact these skew measurements as investors look to make outsized plays with out of the money options. For example, when the market is bearish, investors will increasingly buy out-of-the-money puts. Speculators are looking to profit from downward movement, while portfolio managers are buying insurance against a price drop. This provides upward pressure on the price of those puts and raises their IV. At the same time, they may finance those purchases by selling out-of-the-money calls, which has the result of driving those IVs down. As this process continues, the skew shifts more and more positive as the lower strike IVs will be notable higher than the higher strikes.

Note that these sentiments may not always be apparent by just eyeballing a skew. It's important to precisely measure the difference in right side of the skew as well as compare it with historical values for a given underlying and term.



Skew measurements also uncover bullish sentiment. This occurs when speculators buy calls and portfolio managers sell puts to liquidate insurance. This has the effect of driving down the skew measurements.

Historical Volatility

Historical volatility (HV) is the measure of actual price movement for the stock in the past.

Using Historical Volatility

Historical volatility is a key measurement because volatility tends to be mean-reverting. While it's expected that IV will almost always exaggerate future volatility, HV offers a clear view into how a stock has actually traded so that investors know what levels of volatility they are likely to actually see. One of the most reliable methods for measuring the current valuation of IV is to simply divide a given IV term into the appropriate HV term.

Historical Volatility in this Data Set

There are several ways to calculate historical volatility, and this data set provides the two most popular methods:

- **Close-to-close volatility** ("Hv", such as Hv10, etc) is calculated using the closing price of the stock on each trading day for a calendar period leading up to the most recent trading close.

- **Parkinson volatility** (“Phv”, such as Phv10, etc) is calculated using the high and low prices of the stock on each trading day for a calendar period leading up to the most recent trading close.

The numbers in each volatility field represent a duration in calendar days. For example, Hv30 indicates the historical close-to-close volatility for approximately 30 calendar days, Phv180 indicates the historical Parkinson volatility for approximately 180 calendar days, and so on. Note that these calendar durations are approximations based on a predefined set of trading days over that calendar period as defined in the table below.

Calendar Days	Trading Days
10	7
20	14
30	21
60	41
90	62
120	83
150	104
180	124

Based on this table, an Hv60 would be calculated using the close price differences between the last 41 trading days and the close prices on their respective previous trading days. By standardizing on this methodology, the historical volatility of any given duration can be cleanly compared with the other historical or implied volatilities of the same duration without having to consider the conversion between calendar and historical days or non-trading calendar days, such as weekends or holidays.

All closing prices are obtained using the CRSP methodology.

Data Details

This database covers over 11,000 optionable US equities with history to 2002. There are over 5,000 optionable stocks currently trading. Data is updated by 5:30PM ET on market days.

Data Dictionary

Field	Description	Other terms
Hv10	The 10-day close-to-close historical volatility.	20, 30, 60, 90, 120, 150, 180
Phv10	The 10-day Parkinson historical volatility.	20, 30, 60, 90, 120, 150, 180
IvCall10	The 10-day IV for calls.	20, 30, 60, 90, 120, 150, 180, 270, 360, 720, 1080
IvPut10	The 10-day IV for puts.	20, 30, 60, 90, 120, 150, 180, 270, 360, 720, 1080
IvMean10	The average of the IvCall10 and IvPut10.	20, 30, 60, 90, 120, 150, 180, 270, 360, 720, 1080
IvMeanSkew10	The +10% IV less the -10% IV at 10 days.	20, 30, 60, 90, 120, 150, 180, 270, 360, 720, 1080