

IVolatility Data Guide.

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Introduction.

IVolatility.com has specialized in providing professional services in equity derivatives since 1999. We cover the entire scope of options trading, from traditional market making to screen based trading and electronic market making to analytical trading and risk management.

The core of many our solutions is our powerful IVolatility.com database which supplies traders with historical, daily, and intraday data for building custom analytics, backtesting trading strategies, and analyzing market performance over time.

This guide explains the usage of analytical data calculated in IVolatility.

For a technical guide, focused on methodologies, cleansing details, please read IV Methodology guide.

Population and cleansing

IVolatility developed technology and methodology to capture, cleanse and calculate derived data. Our goal is to provide our customers with accurate and reliable data which they can utilize for analysis right away. To achieve this, we do the following:

- use a well regarded market data vendors. This is the first step to get accurate market information such as: prices, dividends, volume, etc...
- use backup vendors to assure our database continuity in case of any failures
- our dedicated team takes care of tracking all corporate actions events such as splits, mergers, spin-offs, distributions, etc.. and applies the correspondent ticker changes to keep continuity of equity history
- our analysts manually verify the data received from datafeed and accuracy of dividend and prices based on our own proprietary filters
- when calculating implied volatilities, proprietary algorithms automatically perform filtering of bad data and replacing with interpolated volatilities, which avoids occasional spikes

- use a combination of Black&Scholes and Binomial Tree 100 steps, that provides for accuracy of the implied volatilities and Greeks.
- after calculations, proprietary algorithms perform scans of calculated data and reveal abnormalities which are then reviewed by our analysts and corrected unless considered to be a market event
- quality of our data was tested as well by our clients over 15 years.
- to our clients we deliver the final product...completely verified and corrected data

Markets Coverage

Currently we cover US, Canadian, European, Russian and Asian exchanges.

We have end-of-the-day (EOD) data which represent market at the close and intraday data (20 minutes delayed) which provide all information during market hours.

In EOD we cover the following markets:

US:

- equities (stocks, ETFs, funds, etc...) and their options (OPRA data). There is more than 5000 US names now with options. More than 800,000 options traded every day in US. End of the day data includes as well 3-45pm EST snapshot.
- futures from US exchanges and future options. It is up to 200 different futures products (Oil, Gold, Eurodollar, etc...) with about 100 that trade options actively.

Canada:

- equities and equity options. It is about 300 stocks with options.

Europe:

- equities and equity options from the following stock exchanges:

- London Stock Exchange,
- Euronext Amsterdam,
- Euronext Brussels,
- Euronext Paris,
- Euronext Lisbon,
- Bolsa de Madrid,
- Borsa Italiana,
- SIX Swiss exchange,
- Swiss Blue Chip Segment,
- Frankfurt Stock Exchange,
- Xetra

and options exchanges:

- Euronext LIFFE, Eurex, OMX
- Borsa Italiana,
- MEFF.

It is up to 600 names with options.

- Futures and futures options from ICE (50+ products)

EOD data for US, Canada, Europe starts from November 2000 (SPX starts 1990), for US equity options, 3-45 pm additional snapshot starts 2005, and is updated every day.

Russia:

- FORTS market with all futures and futures options data

EOD data for FORTS starts September 2009 and is updated daily.

Asia:

We cover Australia, Hong Kong, India, Japan, Singapore, South Korea, Taiwan, all equities (including major indices) and derivatives (futures and options) traded on following exchanges:

- Australia Securities Exchange
- Sydney Futures Exchange
- Hong Kong Stock Exchange
- Hong Kong Futures
- National Stock Exchange of India
- Osaka Securities Exchange
- Tokyo Stock Exchange
- Singapore Exchange
- Korea Stock Exchange (Kospi Index)
- Taiwan index (Taiex Index)
- China, Shanghai Stock Exchange (with the first options launched Feb2015 on China ETF50)
-

EOD Asian data goes back to November 2008 and it is up to 800 names with options.

In intraday 20 minutes delayed data we cover all US markets: equities and equity options, futures and future options.

US & Canada data vendor is Activ Financial , European and Asian data are provided by Morningstar (except China, which is provided by Datayes), all of them are well regarded market data vendors. We also use backup vendors to assure our database continuity in case of any failures.

We continuously expand our coverage to other markets.

Available Metrics

In the equity options universe IVolatility's database offers the most complete and accurate source of implied volatilities available. Coverage includes U.S., Canadian, European, Asian, Russian listed stocks, indices, futures and their options; this is more than 5,000 optionable names. History goes back to 2000 (and for some data even further to 1995). Data is computed based on both an end-of-day and intraday basis.

We offer several different ways of representing volatility, including several varieties of implied and historical volatility, as well as other auxiliary metrics required for option trading analysis.

Implied Volatilities datasets

Implied Volatility datasets are available as end-of-day time series and with intraday updates.

- **Implied Volatility Index (IV Index)**, a measure of a stock's expected volatility based on weighted at-the-money volatilities and estimated for different time terms. This is the best measure of averaged implied volatility for the equity.

Terms: 1,2,3,4,5,6, 9, 12 months and 2,3 years

End of the day history: from 2000

IVIndex is a principal factor for volatility study.

- IVIndex provides one composite value of volatility for each maturity. In most volatility studies, one would need to review historically stock volatility, identify clusters presence and mean reversal principles or any other specific behavior. And in all these cases one would prefer to use one volatility rather than dozens of values from each option. IVX is a VIX-like measure and uses similar methodology to calculate IV, but we apply this methodology to all optionable names and for a set of maturities from 1m to 1y. See picture below to compare IVX of SPX and VIX history:



- Often IVIndex 30 days is used as a benchmark volatility for equity when one needs to have just a single volatility value. See Figure 1.

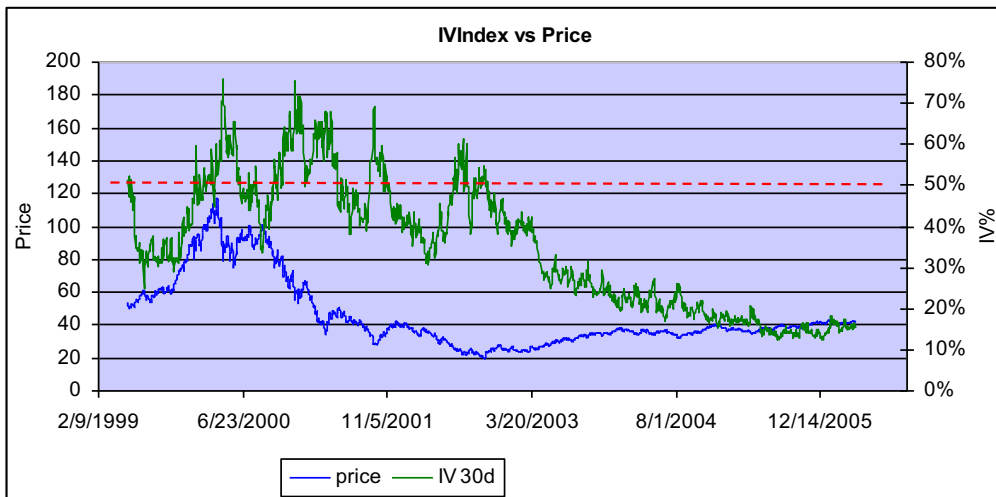


Figure 1. IVIndex (green line) is plotted for 6 years, average is drawn as dashed red line and price as blue one. As one can see historically IV was pretty high and more volatile at times when price was high and recent years it smoothly goes down as long as price smoothly fluctuates around 40. Such simple analysis gives broad idea of volatility behavior and tells that recent years options are priced relatively cheap. Sure, to identify specific option strike cheapness, one would need to do more detailed analysis mentioned below, however, reviewing IVIndex past performance can help in general to identify good candidates with cheap or expensive options and save a lot of time before going into deeper details.

- One of the popular volatility studies applies comparing IVIndex and Historical Volatility. IVIndex is the expected volatility while HV is the actual realized one, so when selecting true volatility value for pricing of options or risk evaluation, one has a choice between these two. See Figure 2.

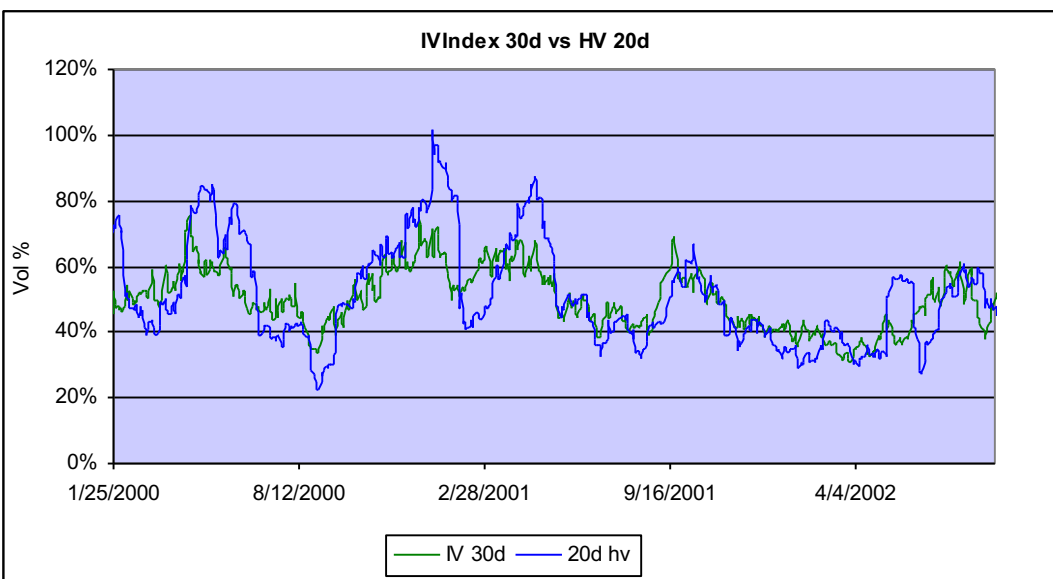


Figure 2. *IVIndex 30 days (green) versus HV 20 days (blue). Note- 20 days from HV are business days what exactly corresponds to 30 calendar days for IVIndex. As you can see on the chart it provides a sufficiently accurate forecast, and all drops and jumps in IV Index correspond to drops and jumps of actual volatility that occurred in the next 20 days. This allows to use approach that if current IVIndex level is higher than HV, this implies more expensive*

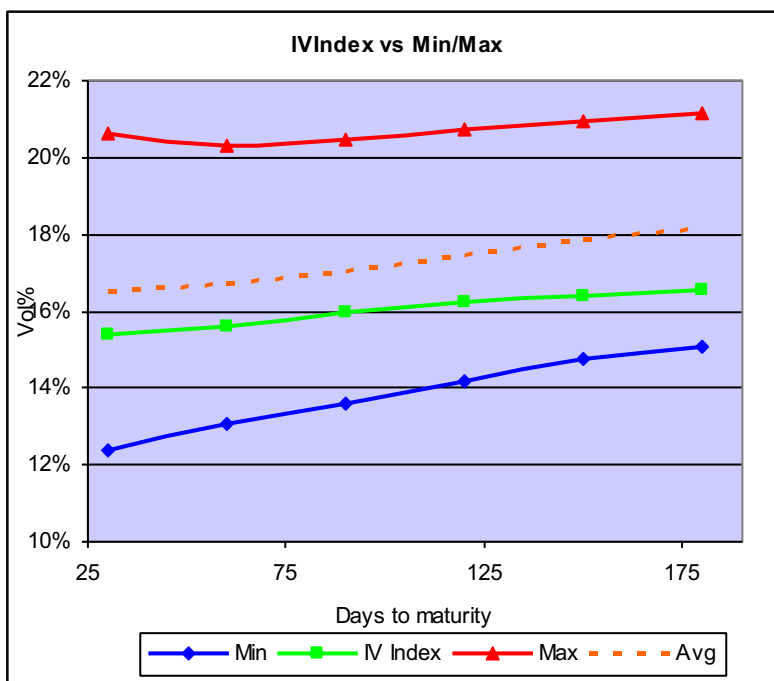


Figure 3. *it shows IVIndex all terms (6 points) with current value (green), minimum(blue) and maximum (red) for each term over last year and average (dashed orange). As you can see current IVIndex for all terms is below its average.*

Another useful study is based on analyzing IVIndex current level and comparing it to historical extremes over last year. 1 year is the most common term and one can run this study for different time periods as well. See Figure 3.

- Next example of the IVIndex application is research of how volatility changes for longer maturities and their relationship. See Figure 4.

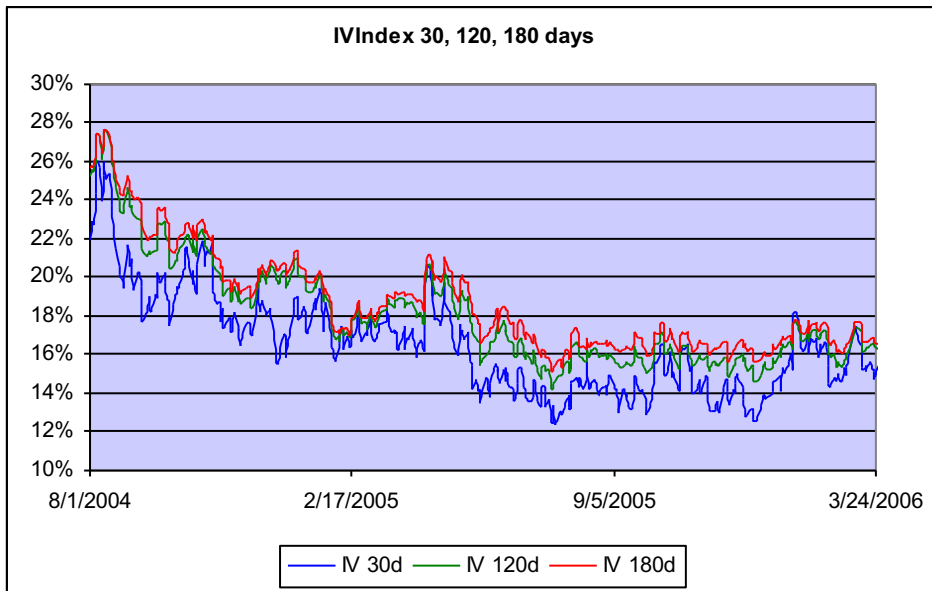


Figure 4. it shows IVIndex for 30, 120 and 180 days (blue, green, red). You see that usually vol increases for longer maturities and this relationship has been hold during history. 30 days vol usually was lower then 120 days and last was lower than 180 days. That's actually not a common case if you look at other stocks, but for this specific stock it is important to know that when you plan create any spread strategy.

- **Individual Option Contract Implied Volatility “raw” data (Raw IV)** on each option provides actual implied volatility and Greeks based on the full string for the listed contracts.

Terms: all actual traded expirations
 End of the day history: from 2000 (for US eq.options, 3-45 snapshot available since 2005)

- Raw IV can be used for study of the specific options performance over time. If you have a strategy with pure volatility trading where your payoff is dependant on volatility, it is important to track over time implied volatility of your specific options in your portfolio. You would not prefer to eliminate every single splash because this is your payoff diagram.

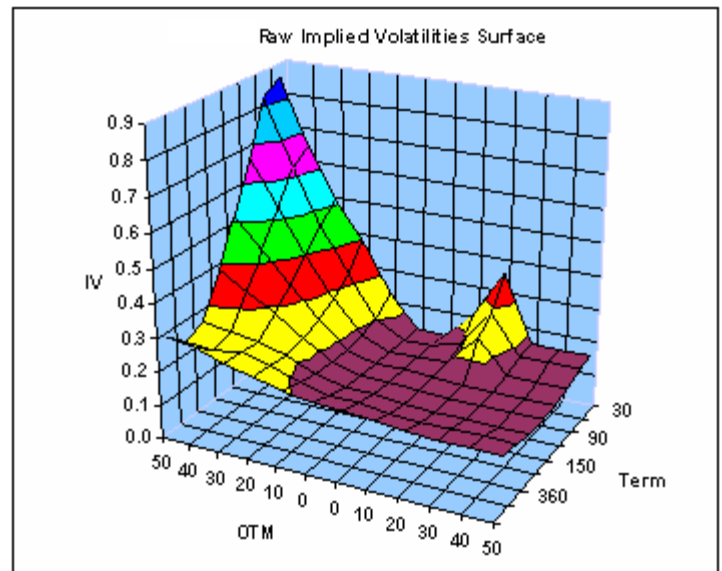


Figure 5. IV versus Term (Days to expirations) and OTM (moneyness, from lower strikes to upper from left to right). Expirations from 90 days and further show plain skew decrease to upside strikes, however in short term maturities you see abnormal spike at 20% outside central strike. You would need to check and see if this is a market event and possibly sell such options as they show high volatility

- As long as Raw IV provides actual options volatilities, you can search for particular splash or drop in actual strike and use this to identify an opportunity whether this option is over- or under-valued across other strikes. See Figure 5.

- Raw IV is also a good choice to analyze the relationship between volatility smiles in different expirations and strikes. See Figure 6.

And you definitely will use Raw IV if you will work on developing models that describe shape of the curve. See Figures 7 and 8 below.

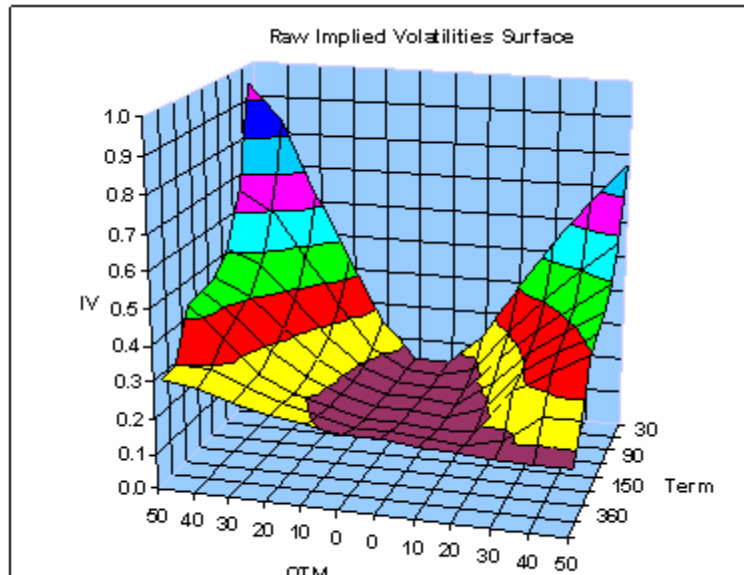


Figure 6. IV versus Term (Days to expirations) and OTM (moneyness, from lower strikes to upper from left to right). This stock shows pretty standard relationship which one can learn from this chart:

- in general, volatility decreases for longer expirations
- in general, lower strikes with the same moneyness have higher volatility than upside strikes
- volatility curve becomes flatter for long term expirations

Knowing such a basic rules for stock, you can keep an eye on any usual behavior.

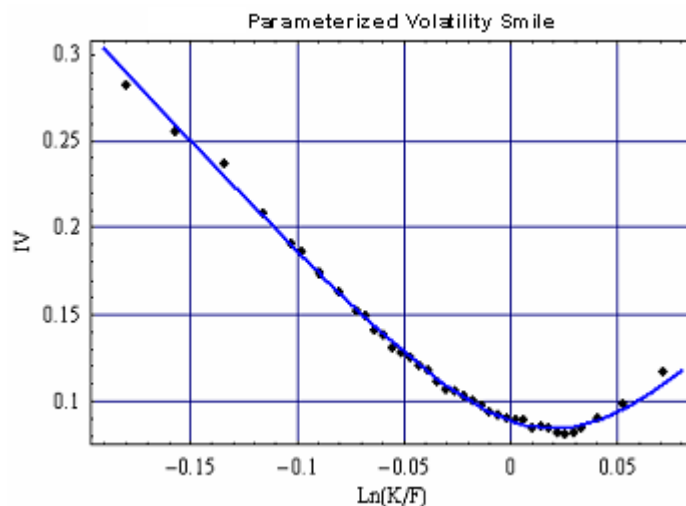


Figure 7. IV versus $\text{Ln}(\text{Strike}/\text{ForwardPrice})$. Accuracy of parameterization is more than 99% but instead of storing volatility of more than 40 options, you can use just 3 parameters to build the same parabola. This could be a strong reason why to use parameterization sometimes.

- **NEW: Individual Option Contract parameterized volatility data:** using proprietary technique we smooth our raw implied data and parameterize by a set of coefficients.

Terms: all actual traded expirations
 End of the day history: from 2000

- This decreases the amount of data from hundreds of options string to just a few parameters.
- One can easily build implied volatility curve from these parameters- even in Excel. See Figure 7.

If you are not looking for a specific strike performance over time but rather want in general to analyze how an in-the-money or out-of-the-money options were priced, parameterized curve is a better choice.

- **Implied Volatility Surface by Moneyness:** a surface normalized by moneyness (strike distance from spot) and maturity built on “raw” IV basis by interpolation. IV Surface provides 12 fixed moneyness point per term, and provides maturities out to 720 days. Along with IV values, it includes a Delta for each fixed moneyness point.

Terms: 1,2,3,4,5,6,12 months and 2,3 years
 Moneyness: (-50% to +50% with 5 % step)
 End of the day history: from 2000

Many of the above examples can be applied for this dataset as well, and let us mention here the most important study one can run with this volatilities:

- Volatility Surface by moneyness allows to execute historical analysis of implied volatility (thus option price level), i.e. to compare the current option price (IV) with the price of the option (IV) with the same moneyness and days remaining until expiration, that was observed in the market some time ago. Simply drawing the historical IV chart of an option can be useful but it can't answer the question-whether today's option is cheap or expensive? The solution is simple- we can find a virtual option within our history which has the same parameters term (Maturity) and Moneyness as the current option. The Volatility Surface enables us to realize this.

See Figure 9.

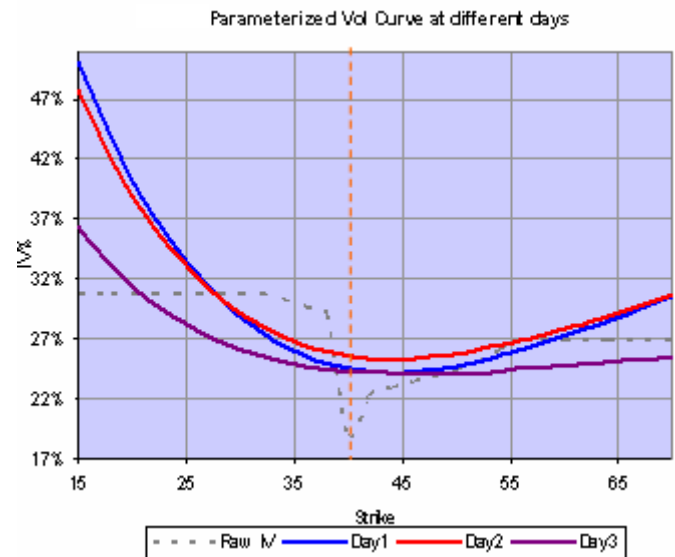


Figure 8. Vol Curve at the same expiration plotted at different dates (Day1- blue, Day2-red, Day 3- magenta) and with Raw IV(dashed line). Curves avoid spikes and allow averagely comparing how each slope changed from day to day.

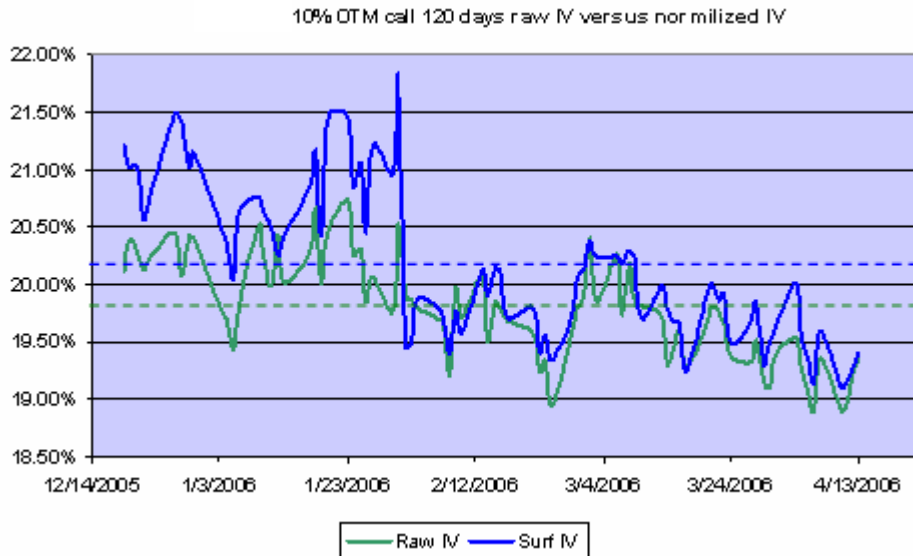


Figure 9. On chart you see that actual implied volatility (green line) in general shows lower values over time rather than normalized volatility (blue line) by time=days to expiration today and by moneyness=today's moneyness 10%. Average of raw IV was about 19.7% while average of normalized was 20.2% what implies cheaper vol than actual implied history.

Another advantage of this dataset is in the practical usage of the surface. A trader doesn't have to worry about corporate actions and strikes adjustments (splits, stock dividends, mergers, etc) Volatility solves this problem because the surface is based on moneyness and is not dependent on strike adjustments.

- To expand further the ideas above, here is one more practical application of the surface. We calculate Volatility Bands. For each of the 96 points (moneyness, maturity) in the surface we calculate minimum and maximum values reached for the last year (time axis). Then adjust to today's options moneyness and maturity and this allows traders to use these bands as a corridor of volatility. Knowing the mean reversion rule we can monitor how far from the average value volatility curves are and make decisions about its future movements. If curves are approaching the bands this as well indicates what options (OTM, ITM, ATM) are more over or under priced.

See Figure 10.

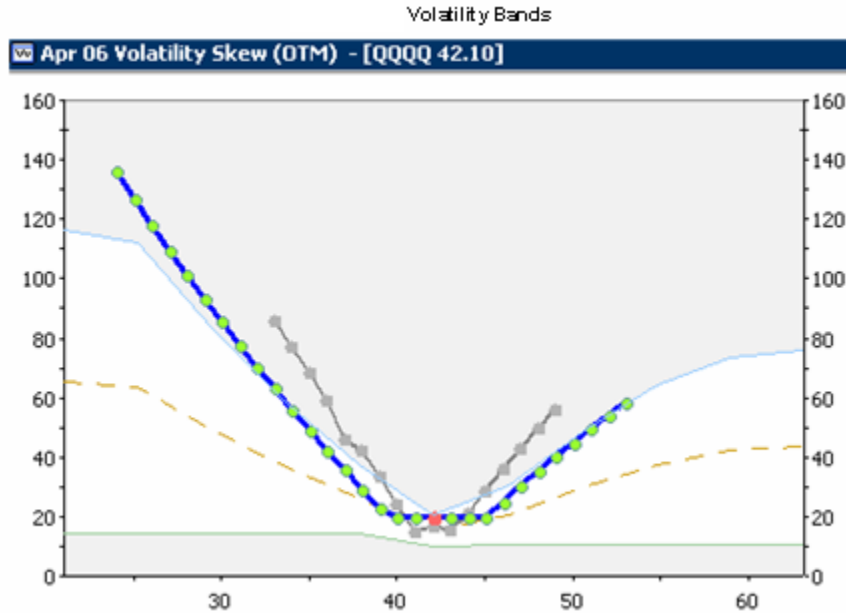


Figure 10. Green is a minimum, Blue is a maximum, orange dashed is an average, grey is implied volatilities currently observed on market (bold blue is a user expectation about volatility which he enters into the program). You see that market curve is out of range what can mean that today's options are priced high.

NEW: Implied Volatility Surface by Delta: a surface normalized by delta and maturity built on parameterized IV basis. For each fixed delta it also includes a moneyness value. Surface by Delta is the most accurate way to analyze historical behavior of particular option with a given delta.

Terms: 1,2,3,4,5,6, 9, 12,24 months
 Deltas: (from 0.1 to 0.9 with step 0.05)
 End of the day history: from 2000

Surface by Delta is a analogous to surface by moneyness, and one can apply the same application as mentioned above (historically analyze performance of an option with a fixed delta/maturity and calculate volatility corridors for today's options).

However, Delta Surface has a few major differences:

- While Surface by Moneyness provides IV for each fixed moneyness along with a delta, Surface by Delta provides an IV for each fixed delta along with moneyness

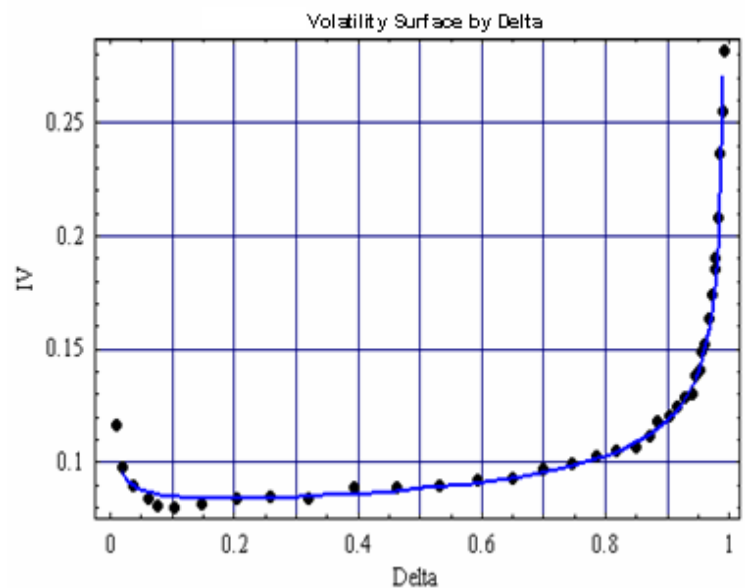


Figure 11. Look at this chart and you will see that surface by Delta is kind of stretched across delta axis. That's because in commonly used volatility smiles by strike or moneyness, the shorter is expiration, the steeper becomes volatility curve and when you move from ATM point to next one by strike or moneyness you can move from 0.5 delta to 1 or 0 delta. That's normal for short expirations, however if use delta surface, it will provide you with volatility for every delta from 0.2 to 0.8 not depending on how close is expiration.

- It is built on the basis of the parameterized curve
- Delta Surface provides more detailed volatility data in the at-the-money range. See Figure 11.

Realized Volatilities Datasets.

Available as end-of-day time series data.

- **Realized (Historical) Volatility (both end-of-day and Parkinson's):** historical volatility calculated from equity prices over different period of time.

Terms: 10, 20, 30, 60, 90, 120, 150, 180 days

End of the day history: from 1999 (from 1995 for top liquid stocks).

This represents the actual volatility of a stock accumulated over some historical periods. There are different ways how to estimate realized volatility and we utilize the most common ways using close-to-close standard deviation, and Parkinson's high-low methodologies. See Figure 12.

Historical Volatility is usually used along with Implied Volatility analysis, see Figure 2.

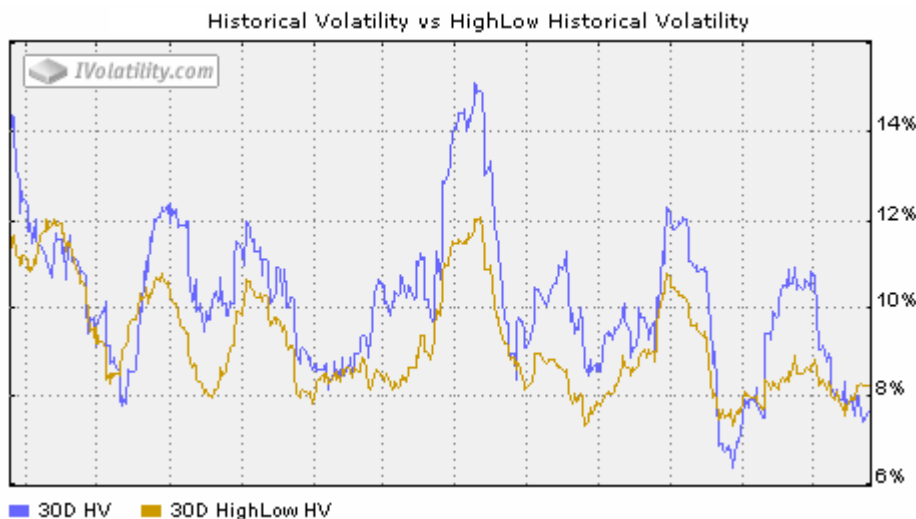


Figure 12. Both of volatilities (30D HV is a close-to-close and 30D HighLow HV is a Parkinson one) show pretty the same behavior regarding spikes and drops, so it is up to trader to select which historical values to use in his analysis.

Correlations Datasets.

Available as end-of-day time series data.

Correlation and Betas are significant auxiliary factors in options trading:

Correlation and Beta Between Stocks and Indices price returns: a measures of how specific instrument is correlated with major market indexes.

Terms: 10, 20, 30, 60, 90, 120, 150, 180 , 252 days

End of the day history: from 1999 (from 1995 for liquid top stocks, term 252 is available only for last date)

- Price correlation and beta against market indexes help to identify liquid equities that are highly correlated with the market (which means they move in the same direction as the market).

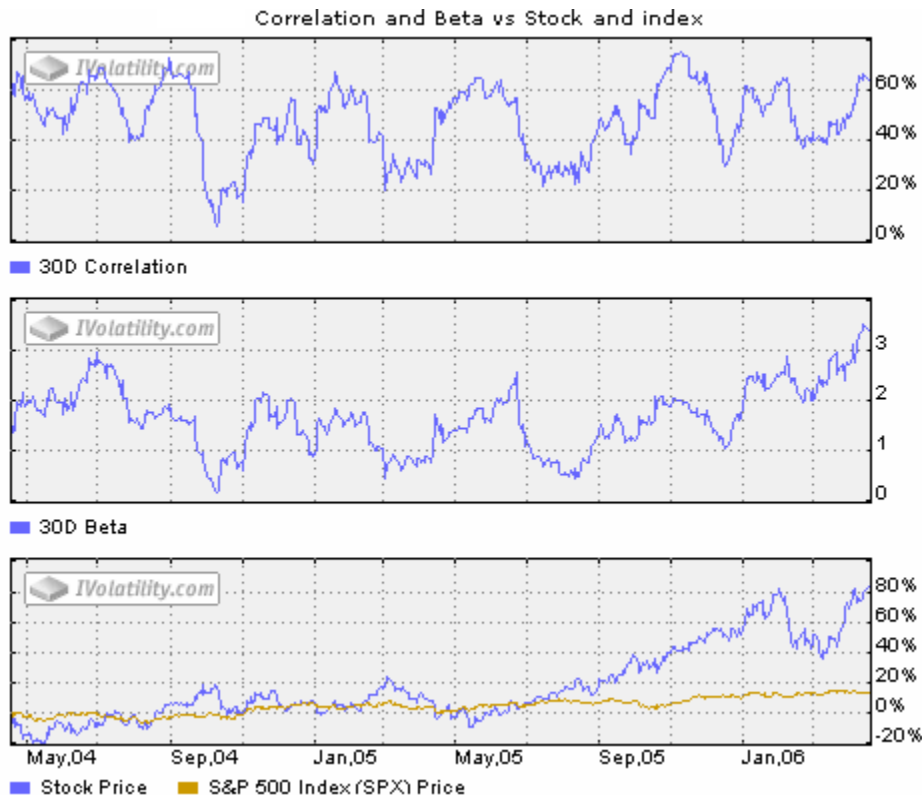


Figure 13. an example of positively correlated stock with Beta >1 over recent time. That means that comparing to market, this stock provides better return over last months

- Cross-stock price and volatility returns correlation and Beta:** a measure of how specific stocks correlate together with regard to price and volatility.
 Terms: 10, 20, 30, 60, 90, 120, 150, 180, 252 days
 End of the day history: only last trading day's data
 Correlation and Betas are used for designing portfolios desired risk level, calculating VAR value.
 One would need cross-pair correlations for all stocks in portfolio. See Figure 14.

Cross Pair Volatility Correlation Matrix

	ABT	ABX	ACF	CBE	DD	DHR	DJX	EK	HPC	INTC	IP	MIR	MMM	OEX
ABT	1.00													
ABX	0.11	1.00												
ACF	0.09	0.16	1.00											
CBE	0.25	0.17	0.20	1.00										
DD	0.22	0.08	0.36	0.19	1.00									
DHR	0.10	0.05	0.12	0.15	0.13	1.00								
DJX	0.29	0.17	0.23	0.24	0.45	0.35	1.00							
EK	0.21	0.22	0.14	0.15	0.14	0.11	0.13	1.00						
HPC	0.05	0.01	0.04	0.10	0.07	-0.04	0.18	-0.06	1.00					
INTC	0.18	0.12	0.16	0.24	0.17	0.13	0.34	0.14	0.11	1.00				
IP	0.16	0.13	0.26	0.19	0.34	0.36	0.35	0.12	0.18	0.20	1.00			
MIR	0.02	0.02	0.35	0.17	0.16	0.09	0.03	-0.24	0.16	0.12	0.31	1.00		
MMM	0.22	0.30	0.22	0.30	0.33	0.30	0.46	0.08	0.19	0.33	0.37	0.28	1.00	
OEX	0.28	0.18	0.21	0.26	0.43	0.32	0.85	0.19	0.10	0.33	0.32	-0.10	0.45	1.00

Figure 14. Cross pair volatility correlation matrix of a group of stocks. This is example from Advanced Volatility Manager system where correlations between stocks volatilities are used to determine good volatility driver among group of equities. Highlighted yellow are correlations that are not significant for such purpose and should be excluded.

- Another important use of correlation/beta is in hedging. Popular hedging strategies today in the market involve hedging portfolio with index options. Price beta and correlation can be used for delta-hedging while Volatility Correlation and Beta are used for hedging Vega risk. For example, one can hedge each stock delta separately by buying/selling shares and then hedge residual delta risk from all stocks by the use of index options. In the case of trading index basket components, some can hedge delta with index options. In all these cases, one would need to know how the stock is correlated with the index in order to build correct hedge.
- In portfolio risk analysis, one would use correlation and betas for “what-if” analysis, to see how portfolios will behave if the market changes based on price correlation for spot change, and volatility correlation for volatility change. This will provide a real simulation of the market conditions applied
- to your portfolio.

Complementary datasets.

Available as end-of-day time series data and intraday updates (Options Prices dataset).

- **Splits, dividends, multiple-terms interest rates** - all data needed for correct implied volatility calculation
- **Options prices (NBBO) with volume and open interest** – all options chains with expiration, strike, option symbol and market daily data recorded at the end of each day with bid, ask prices, daily volume, total open interest, stock price.

Proprietary metrics.

We also provide historical and daily analysis of the market based on major indexes (S&P 500, S&P100, Nasdaq 100, Dow Jones Index, etc..) using a dispersion approach. Data is available as end-of-day time series.

Terms: 10, 20, 30, 60, 90, 120, 150, 180 days (Implied Volatility starts from 30 days)
End of the day history: from 2000

- **Implied Correlation:** averaged correlation between a specific index and its components computed from implied volatilities
- **Realized Correlation:** averaged correlation between a specific index and its components computed from prices

- Averaged correlations provide a good insight into the market as they represent how coordinated are price and volatility movements for major stocks.

See Figure 15.

- Theoretical **Implied Volatilities:** implied volatility of a specific index computed from the component’s implied volatilities using different weightings and approaches.

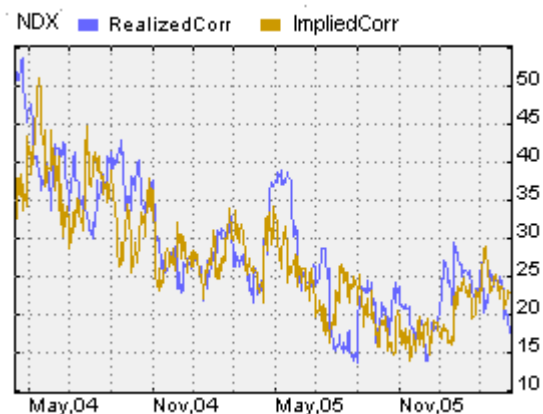


Figure 15. Implied and Realized Correlation over time. It decreased over last year from 45 to 15 and shows some increase over last few months up to 20-25. Higher correlations values indicate usually good time for Dispersions trading (selling correlation).

These metrics allow a trader to keep an eye on the market, and for those who trade dispersion strategies, these are crucial metrics to identify the best time to engage in selling/buying correlation.

Custom metrics.

Given our expertise and technology, we can provide custom analytics per your specification as well.

Data Products

To our clients we finally delivery only verified data.

Historical EOD Data

Each client may select from several dataset alternatives including history length and coverage of names.

3 Delivery choices are available:

- Historical data – one (or several) CSV files for each kind of data (for example separate file for IV Index, separate file for IV Surface etc). Daily updates published daily on the web site (password-protected URL) in the same format as historical dataset. Client is responsible for data import into internal DB.

- MANAGED DB (MS SQL/PostgreSQL) Historical data is prepared in native DB format. Daily updates published on the web/FTP site (password protected). The replication service provides data maintenance like adding new names, maintaining market structure changes, changing index composition and fixing of errors in history. The automatic updates of the replication is performed on a scheduled time.

- MANAGED DB (any relational DB) Historical data is prepared in CSV format. Daily updates published on the web/FTP site (password protected). Fundamental market (adding new names, maintaining market structure changes, changing index composition etc) provided in daily files along with possible corrections of historical data.

Time of delivery.

Data are ready the same day after close for each region. For US data are delivered 9pm-1am est time.

Historical 1 minute and tick data

Created by the same team and based on the same methodology as our award-winning End-Of-the-Day database used by many leading firms in the industry, our Historical 1 minute Intraday Options data and Tick level trades data take the next big step.

1 minute options data includes snapshots with options bid/ask prices&sizes, volume and implied volatilities data & Greeks, along with underlying's prices and volumes captured every minute for whole US options market.

- 1 minute history starts August 2011
- Daily update service is available after the close, or intraday in delayed/real-time mode.

Tick level Option Trades include tick by tick option trade prices with sizes (time and sales data) with options' bid/ask quotations at the moment of trade and underlying's bid/ask/trade prices at the moment of option's trade, Implied Vols and Greeks based on trade's price. All US equity options coverage is included.

- History since Jan -2014
- Ongoing daily update right after the close

How to use our data

IVolatility historical database is used for various purposes:

- backtest your trading ideas and see how current strategies worked in the past

- analyze historical data and learn how different techniques of trading worked over various period and which indicators worked best
- build custom analytics for trading (for example, compare your vols with vols from market and find opportunity)
- research historically the market behavior especially in crisis times like Sept 2001
- plug our volatilities into your risk management system for evaluating your portfolio risks
- and much more that your fantasy can tell you

With volatilities offered intraday, you can make your intraday trading more effective:

- evaluate your risks continuously based on market volatilities and perform intraday hedging
- keep an eye how the market moves based on how volatility curves change
- run your custom analytics intraday, scan the market and find opportunities to trade

Our clients

17 years of work and constant development have resulted in more than 70,000 clients from all over the world using **IVolatility.com** trading and risk management systems for US, European and Asian market data and analytics.

IVolatility.com clients are represented in all segments of the global derivatives market. More than half of the top 30 options market makers and US options brokers use **IVolatility.com** financial data services. In addition, **IVolatility.com** clients include 3 out of 5 of the largest US banking institutions and more than half of the top 50 investment banks. Other important clients include the CBOE, the NYSE, financial research and analysis- along with INVESTools, the Options Clearing Corporation, as well as hundreds of investment and hedge funds.