Vol X®

The Company

VolX has developed an array of RealVol Instruments and RealVol Indices based on realized volatility as defined by the RealVol Formulas.

Overview

Each RealVol Index has its own unique formula, but all are, at their core, based on the realized volatility of some underlying.

Uses

RealVol Indices are designed to measure key elements of risk of an underlying. In addition, tradable instruments may be listed such that they would settle to one of the flagship RealVol Indices. Participants might then profit from or hedge against realized volatility movements.

Realized Volatility Defined

Realized volatility is a measure of the magnitude of daily price movements, regardless of direction, of some underlying, over a specific period.

Realized vs. Implied

Realized volatility is functionally very different from implied volatility. Realized volatility is based on the actual movement of an underlying, while implied volatility is based on a value derived from associated options prices. In essence, RealVol Indices measure real risk.

Flagship Index

Our flagship index is the 1-month RealVol Index (VOL). This index is used to settle all RealVol Instruments and is calculated in two ways: real-time and daily.

RealVol Real-Time Index

There is only one *real-time* index based on the flagship 21-day realized volatility of an underlying. Both the real-time and daily versions are equal at day's end.

RealVol Daily Indices

For each underlying, there are generally six time frames and seven types of *daily* indices (40 in total).

Six Time Frames
1. 1 day
2. 1 week (5 trading days)
3. 1 month (21 trading days)
4. 1 quarter (63 trading days)
5. 1 half year (126 trading days)
6. 1 year (252 trading days)

Seven Types
1. Realized volatility (vol)
2. Realized vol of vol
3. Overnight/intraday vol
4. Correlation (underlying vs. vol)
5. Realized variance
6. Rough forecast vol
7. HARK forecast vol

Other types of indices may be added in the future.

"What's past is prologue."
— William Shakespeare

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$$\sqrt{\frac{252}{n}\sum_{t=1}^{n}R_t^2}$$

Types of RealVol Indices

RealVol Real-Time Index

The flagship RealVol Real-Time Index (VOL) uses time-weighted, intraday underlying prices to provide a real-time, 1-month (21-day), realized volatility.

RealVol Daily Indices

All other RealVol Indices are daily. This means that they are updated only once each trading day and are based only on daily observations of the underlying. In addition, all RealVol Daily Indices come in six time frames: 1 day, 1 week (5 trading days), 1 month (21 trading days), 1 quarter (63 trading days), 1 half year (126 trading days), and 1 year (252 trading days). The six time frames correspond to the investment horizon of most traders. For periods longer than one year, realized volatility deviates little from its very long-term average so is generally estimated to be a constant.

VOL Indices

The realized volatility indices (VOL) measure the inter-day (close-to-close) realized volatility of an underlying using the RealVol Daily and Real-Time Formula. As discussed, there are six time frames for all indices including VOL. The special flagship VOL Index is based on the 1-month time frame only. The reason for flagship status is that the 1-month version is the only one that will be used for tradable instruments.

VOV Indices

Realized volatility of realized volatility indices (VOV) measure the realized volatility of VOL using the RealVol Daily Formula a second time on the same data. Trading instruments on realized volatility compels one to discover the risk of those instruments. To do so, one needs to calculate the vol of vol. (Note: The second iteration through the data is always performed on a 1-month (21-day) basis, regardless of the time frame of VOL.)

DVOL Indices

The full day, overnight/intraday realized volatility indices (DVOL) measure the realized volatility based on the previous day's close and today's open, high, and low data of an underlying using the RealVol Overnight/Intraday Formula. One can think of DVOL as another measure of 24-hour price risk of an underlying using additional data points for greater accuracy.

VCOR Indices

Correlation indices (VCOR) measure the correlation between the underlying and its VOL. They are calculated by using the RealVol Correlation Formula. Use VCOR for insight into the linear relationship between the underlying and its realized volatility. (Note: Two time frames, the 1-day and 1-week correlations, will not be calculated.)

VAR Indices

Realized variance indices (VAR) measure the interday realized variance of an underlying using the RealVar Daily Formula. VAR Indices are simply the square of VOL. One can think of VAR as another measure of interday price risk of an underlying. Variances are easier to sum, average, and combine because the result is linear as opposed to that of volatility, which is a curve function.

RVOL Indices

The Rough Vol model (Rough Fractional Stochastic Volatility or "RFSV") forecasts realized volatility. According to the model, created by Professor James Gatheral of Baruch College, the log of daily high/low realized volatilities is well approximated by fractional Brownian motion with a Hurst parameter H close to zero. VolX uses the Rough Vol model to create the RVOL indices, which forecast realized volatility over six standardized time frames.

HVOL Indices

HARK (Heterogeneous auto-regressive model cast into a Kalman filter framework) is a forecast of realized volatility. It is a dynamic extension of the asymmetric (i.e., with leverage effects) HAR model where the parameters are continuously and optimally updated by the Kalman filter according to the statistical properties of an intraday realized volatility input. This allows flexibility and fast adaptation to the original HAR model, which was created by Professor Fulvio Corsi of Ca' Foscari University of Venice. VolX uses the HARK model to create the HVOL indices, which forecast realized volatility over six standardized time frames.

Our preliminary research has shown that the HARK Vol and Rough Vol models approximate future realized volatility more accurately than the market (based on implied volatility).

RealVol Indices

Base Symbol	Description	Day	Week (5-day)	Month (21-day)	Quarter (63-day)	Half Year (126-day)	Year (252-day)
VOL	Realized Volatility	VOLd	VOLw	VOLm	VOLq	VOLh	VOLy
VOV	Realized Volatility of Realized Volatility	VOVd	VOVw	VOVm	VOVq	VOVh	VOVy
DVOL	Overnight/ Intraday "Daily" Realized Volatility	DVOLd	DVOLw	DVOLm	DVOLq	DVOLh	DVOLy
VCOR	Correlation of Underlying vs. VOL	N/A	N/A	VCORm	VCORq	VCORh	VCORy
VAR	Realized Variance	VARd	VARw	VARm	VARq	VARh	VARy
RVOL	RFSV "Rough" Model Forecast of VOL	RVOLd	RVOLw	RVOLm	RVOLq	RVOLh	RVOLy
HVOL	HARK Model Forecast of VOL	HVOLd	HVOLw	HVOLm	HVOLq	HVOLh	HVOLy

Note: The highlighted index (VOLm) is the flagship index. The flagship index will be used to settle tradable RealVol Instruments. The other indices could be used to guide investment decisions.

Special Notes*

Data Points

Statistically, there need to be 20 or more data points for any standard deviation calculation to be considered valid. Because realized volatility is based on the principles of standard deviation, valid realized volatility calculations should have at least 20 data points as well. This is why the 21-day realized volatility is the flagship index at VolX. It surpasses the 20-day requirement and corresponds to approximately one month of trading days — a key metric in the world of finance.

Reduced Set of Data Points

VolX also calculates 1-day and 1-week indices. Statistically, these measures are not valid. However, there are still interesting insights that can be gleaned from observing shorter-term periods.

DVOL

DVOL is approximately five times more accurate than VOL at recording the "true" volatility of an asset. A weekly DVOL, therefore, has approximately the same error rate as a monthly VOL.

Forecasting Accuracy

As a general rule, forecasts of futures volatility levels are more accurate for shorter time periods. For example, it is easier to predict the volatility for tomorrow than the volatility for the next month or next year. A parallel can be drawn to weather forecasting. It is much easier to forecast the weather in the near future than the distant future.

Historical Accuracy

It is interesting to note that the longer the time frame for the measurement of realized volatility, the less the results deviate from historical averages. In other words, with more data, the more "average" the result becomes.

Parallel Construction

Therefore, forecasting models work better in the near term, while historical volatility converges to average volatility over the long term. This makes for a bit of a mismatch. To alleviate this concern, VolX decided to publish historical volatility from one day to one year looking back, and also to publish forecast volatility from one day to one year forward. Such an approach should give market participants and researchers a complete picture of the risk of the underlying.

Forecasting Indices

The two forecasting indices (RVOL and HVOL) attempt to forecast future realized volatility. Specifically, these two types of indices are forecasting the realized volatility up to some future point.

One should be aware that no model is flawless. The future has a way of

offering the unexpected. However, preliminary studies show that such models have had impressive track records.

Institutional Quality Indices

Realized volatility is not difficult to calculate. It can be accomplished in two columns in a spreadsheet. However, adjustments need to be made to the data to account for phantom volatility, dividends, underlyings that expire, and market disruption events to name a few. RealVol Indices take all of these factors into account. In addition, now that a standard method has been created, and the data adjusted, it is much easier for forecasting models to be created that use the same criteria across all time frames and varying underlying assets.

Base Formula

As mentioned on the cover page, all RealVol Indices, at their core, are based on the principles of realized volatility. There are subtle variations to the way realized volatility could be calculated. VolX settled on the same formula as used in the over-the-counter market for volatility and variance swaps (i.e., zero mean, 252-day annualization factor, and no degrees of freedom). All RealVol Indices expressly relate to this key volatility metric known as the RealVol Formula.

For more information
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$$Vol = 100 \bullet \sqrt{\frac{252}{n} \sum_{t=1}^{n} R_t^2}$$

*Subject to change. RealVol Indices are expected to be calculated on an array of underlying assets. Some indices require a license from the entity supplying the data, which may not yet be secured, and may never be secured. Other indices may be added in the future. Details may vary according to the underlying asset. The information provided herein must not be relied upon and The VolX Group Corporation will not be liable for actions taken or not taken in reliance thereon.