Demand Derivatives

RealVol® Strategies

Issue # 7

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

Advances in Forecasting Risk

Strategy Article #7 describes two cutting-edge models that seem to show that they can forecast volatility better than the market itself can. The team at Demand Derivatives decided to create indices of these forecasts, over six time frames, backfilled typically for decades, and based on 40 key global assets. Having such an extensive dataset allows investors and traders to acquire a deep understanding of the performance of these models over many business cycles. This paper focuses on Rough Vol (symbol RVOL) and HARK Vol (symbol HVOL) indices. Before they are explained, some background information will prove useful.

Realized Volatility

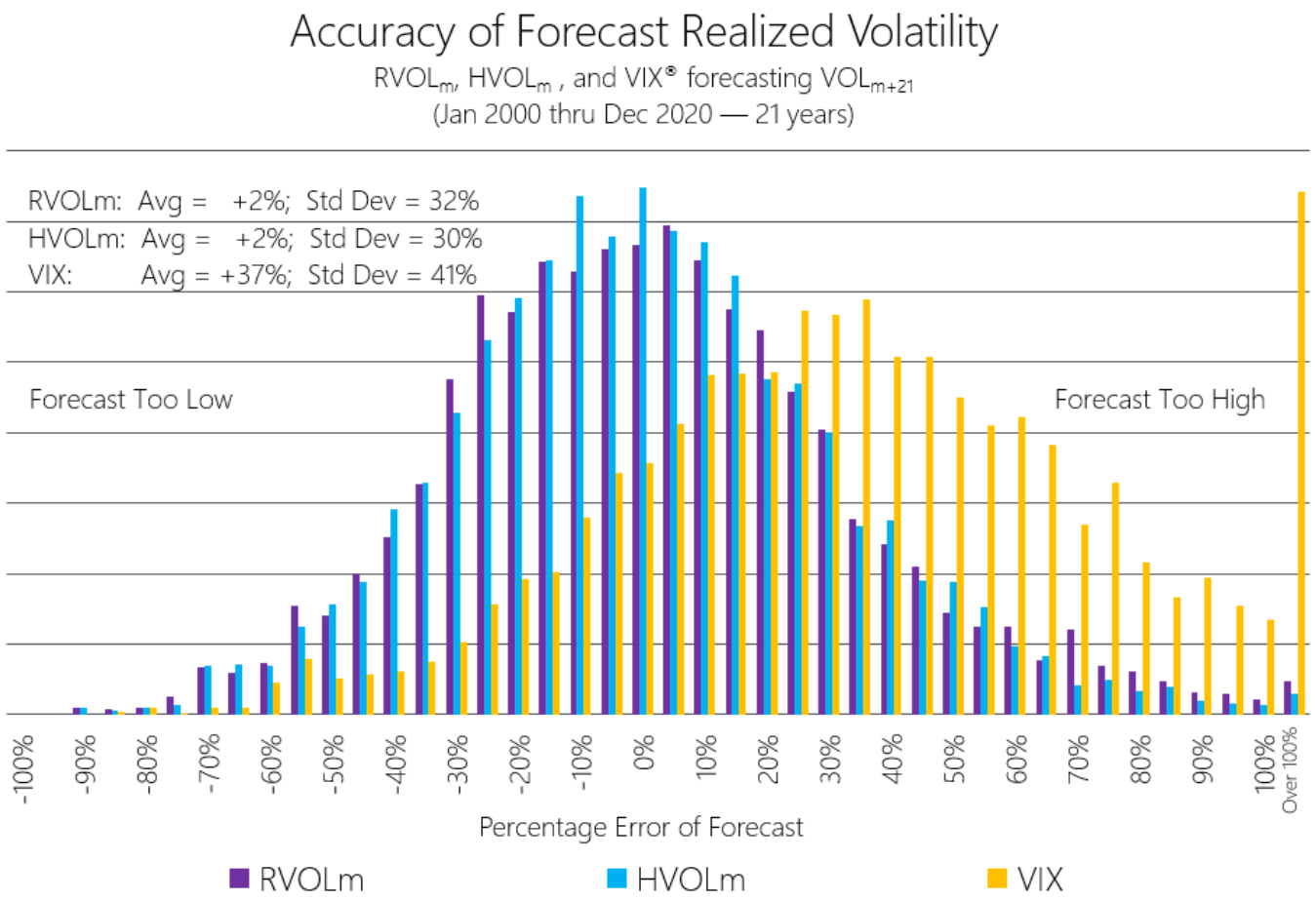
There are various ways to measure risk. Realized volatility attempts to measure the actual risk of some underlying asset over a certain time frame, typically using daily closing values only. The RealVol indices of realized volatility are labeled VOL.

Implied Volatility

Implied volatility is derived from options prices typically using an options model and working backwards to find a volatility input that would generate the premium being traded in the market. In other words, an option's premium implies a certain expected risk level.

Meaning of the Two Volatilities

While no measurement is perfect, the formula for assessing realized volatility on a close-to-close basis has been shown to be a fairly accurate gauge of actual price risk (as long as there are enough observations). Implied volatility is quite different. While this traded premium is, theoretically, a forecast of the risk to come, in actuality it is simply the price at which market participants are willing to execute an options transaction. Academics measure the difference between the forecast of risk and the price at which participants are willing to transact as the "risk premium." The risk premium can vary. And, because we know that forecasts can also change, there are two effects occurring simultaneously, which are difficult to separate, when using an implied volatility index such as the VIX®. However, researchers have shown the risk premium to be, on average, a significant positive value. Essentially, buyers of options are willing to pay a price above theoretical value for the protection that an option offers. In other words, "peace of mind" has a quantifiable value.



RVOL and HVOL Histogram

The purple and blue bars of the histogram above attempt to display graphically the accuracy of the RealVol models RVOL and HVOL, respectively. In this example, the *1-month* forecasts are shown (hence the symbols RVOLm and HVOLm). To begin the collection of the data, forecasts of RVOLm and HVOLm are observed for a specific day. Those forecasts are then compared to the actual realized volatility over the next one month or 21 trading days (VOL $_{m+21}$). If this process is repeated for each day in the sample of historical data, with the percentage errors plotted on a histogram, one can discern the relative precision of the forecasts. For example, suppose that the HVOL model forecasts that the coming month's realized volatility (VOL) will be 20%. Looking forward in time 21 days later, the VOL index (VOL $_{m+21}$) turns out to be 30%. In this hypothetical example, the 20% forecast was 33% too low (20%/30% – 1).

VIX Histogram

To highlight the relative accuracy of these models, a third plot (green bars) was performed using the VIX® index (source Cboe). Some would argue that implied volatility levels are not a good predictor of future realized volatility. Others would say that VIX ought to be the best predictor available (after adjusting for the risk premium) because the index is the result of trader interactions and should incorporate all known information. Regardless of one's view, it is evident that implied volatility, as represented by VIX, is typically too high (as compared to future realized volatility). This corresponds to the academic literature describing how, normally, options prices, especially out-of-the-money puts, often contain a substantial risk premium. During the period studied, using VIX to forecast realized volatility levels produced values that were, on average, 37% too high. For example, if VIX were currently at 20%, the resulting realized volatility one month later would be, on average, 14.60% (20%/1.37). Again, since the risk premium is not a constant, it is difficult to separate the forecast from its risk premium. However, if the risk premium *were* constant, then the forecast of realized volatility does not rival RVOL and HVOL's accuracy.

Accuracy

In addition to measuring the means of the various forecasts, the second statistic to observe is the dispersion of those predictions (the standard deviation, or s.d.) around their means. If, for example, VIX were perfect at predicting future realized volatilities but consistently guessed 37% too high, it would be trivial to ascertain the "correct" future realized volatility simply by reducing the VIX forecast by the amount of the upward bias. Of course, it is difficult to predict the future; hence the s.d. around the average. It is important to note that not only do the RVOL and HVOL models have little or no bias in their average forecast values (+2% each), but their standard deviations are also smaller than that of VIX, seemingly indicating more accurate forecasts by roughly 24% (1 – 31%/41%) to 27% (1 – 30%/41%), respectively.

RVOL Indices

The Rough Vol model (Rough Fractional Stochastic Volatility) forecasts realized volatility. According to the model, created by Professor James Gatheral of Baruch College in New York City, the log of daily high/low realized volatilities is well approximated by fractional Brownian motion with a Hurst parameter H close to zero.

HVOL Indices

HARK (Heterogeneous Auto-Regressive model cast into a Kalman filter framework) is a forecast of realized volatility, created by Professor Fulvio Corsi of the University of Pisa and City University of London. It is a dynamic extension of his asymmetric (i.e., with leverage effects) HAR model, but where the parameters are continuously and optimally updated by the Kalman filter according to the statistical properties of the overnight/intraday RealVol Index (DVOL). This allows flexibility and fast adaptation to the original HAR model, which was also created by Professor Corsi.

Our research has shown that both the RVOL and HVOL models approximate future realized volatility more accurately than VIX. Both models have similar long-run predictive accuracy, but arrive at their forecasts in quite different manners — often diverging significantly over short periods of time. To get an idea of how each model behaves during times of stress, let's focus on the economic crisis of 2008.

Economic Crisis of 2008 in Focus

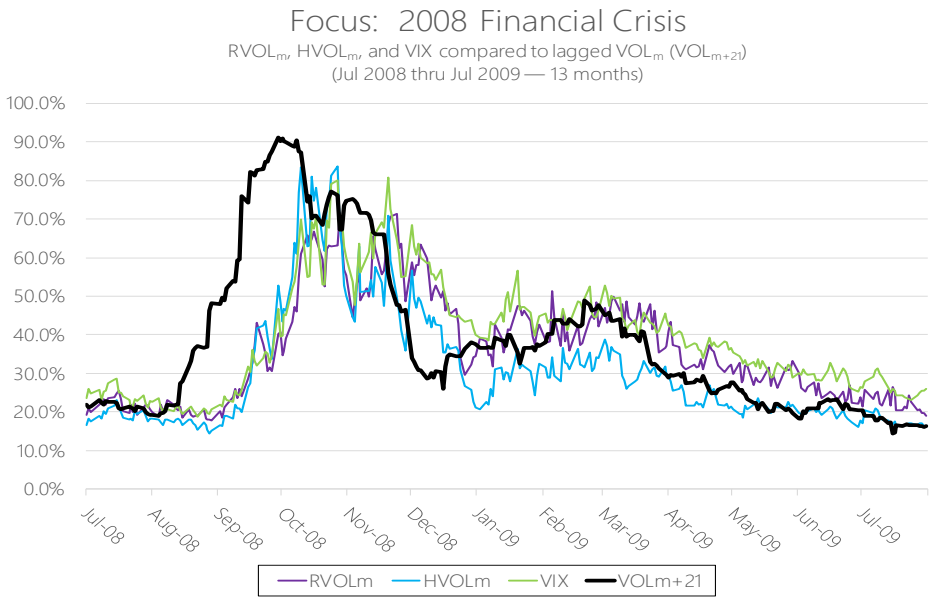
On the following page, two charts are shown. The top chart plots RVOLm, HVOLm, and VIX for the 13-month period of July 2008 through July 2009. In addition, the dark black line is the lagged VOLm (VOL_{m+21}). Again, VOLm is lagged so that the three indicators' forecasts line up with the actual results one month later. The bottom chart displays the accuracy (i.e., the difference between the forecast and the results).

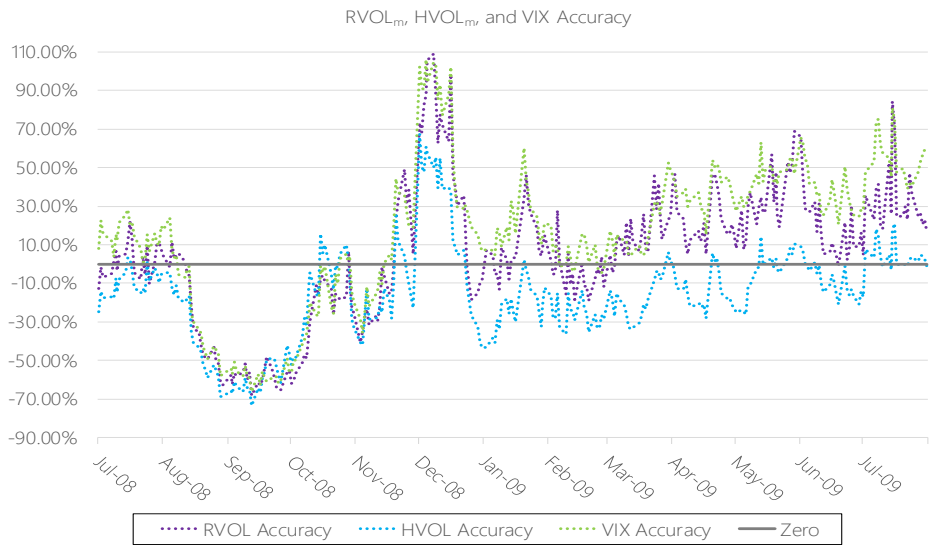
As one can easily see, all forecasts take a while to ramp up (i.e., they underestimate the extent of the upcoming volatility spike). Subsequently, after volatility peaks, all forecasts wildly overestimate the volatility contraction, especially during the December 2008 time frame.

Notice how RVOL estimated nearly correctly in the early part of 2009 but then drifted upward to continuously overestimate through the summer of 2009. HVOL, in contrast, underestimated in early 2009, then drifted to be nearly spot on as the year progressed.

While the economic crisis of 2008 proved difficult for all volatility forecasts, during "normal" times, RVOL and HVOL appear to be more accurate than VIX in predicting future realized volatility (even after adjusting VIX for the risk premium).

Extensive daily data (40 volatility indices on each of 40 major assets, 1,600 in all) are now available on Bloomberg, Quandl, and realvol.com.





Getting the Data

On the main page of the website realvol.com, there are links to historical and forecast RealVol index charts on SPY. The charts include the RVOL and HVOL model forecasts. Index data on gold is currently available at no charge through Bloomberg and Quandl. Subscribers can receive the entire 1,600 RealVol indices (40 index types on 40 of the world's key assets) for a monthly fee. To subscribe on Bloomberg, type RVOL <Go> on the Bloomberg Terminal. To subscribe via Quandl, simply click on the orange "Subscribe" button on the main page of the realvol.com website.

RealVol LLC
a subsidiary of
Demand Derivatives Corp.
demandderivatives.com
info@demandderivatives.com
1-888-865-9267