Realized Volatility Forecasting using mixed-frequency time series prediction for Options

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Our Team

Systematic Trading

Florian
Kollarczik

Co-Head

- Concept
- RVOL Forecasting
- GARCH-MIDAS

- B.S. – BESC (WU)

Andrii
Mudrak

Associate

- Concept
- Backtesting

- M.S. – B&F
- B.S. – ISM

Daria
Isakova

Analyst

- RVOL Forecasting
- GARCH

- M.S. – B&F

Aleksy
Klimovicz

Analyst

- RVOL Forecasting
- EGARCH

- M.S. – QFin (WU)
- B.A. – Fin&II (UW)

Peter
Prlleshi

Analyst

- RVOL Forecasting
- EWMA

- B.S. – BBE (WU)

Concept & Strategy

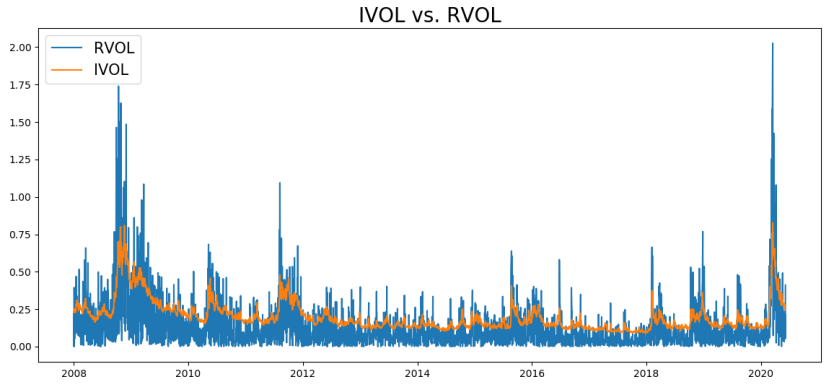
Methodology

Trading Options based on predicted future RVOL

- Constant volatility as B&S-Formula's most significant impediment
- Predicting future RVOL to later be used for Black & Scholes calculations
- Valuations of ATM-Options to be more accurate → trade the difference

Terminology:

- IVOL: market price of volatility (VIX)
- RVOL: standard deviation of the market returns
- VRP: the premium that can be earned by selling or buying volatility. It is the difference between IVOL and RVOL.



Black & Scholes Formula

Basic Formula:

$$C(S,t) = S\Phi(d_1) - Ke^{-r(T-t)}\Phi(d_2)$$

With:

$$\Phi(x) = \int_{-\infty}^{x} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right) dz$$

$$d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}}$$

$$d_2 = \frac{\ln(S/K) + (r - \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}} = d_1 - \sigma\sqrt{T-t}$$

Forecasting future RVOL

- Several models, but no model is clearly the best one
- We decided on testing multiple different approaches such as:

- **Model 1:** Exponentially Weighted Moving Average (EWMA)
- **Model 2:** GARCH
- **Model 3:** EGARCH
- **Model 4:** GARCH-MIDAS
- **Model 5:** Double Asymmetric GARCH-MIDAS

E.g. GARCH-MIDAS

Forecasting RVOL

GARCH-MIDAS Formula

$$\hat{\sigma}_{i,t}^2 = \tau_t * g_{i,t}$$

where

$$g_{i,t} = (1 - \alpha - \beta) + \alpha \frac{\left(r_{i-1,t}\right)^2}{\tau_t} + \beta g_{i-1,t}$$

$$\tau_t = \exp(m + \theta \sum_{k=1}^{K} \delta_k(\omega) X_{t-k})$$

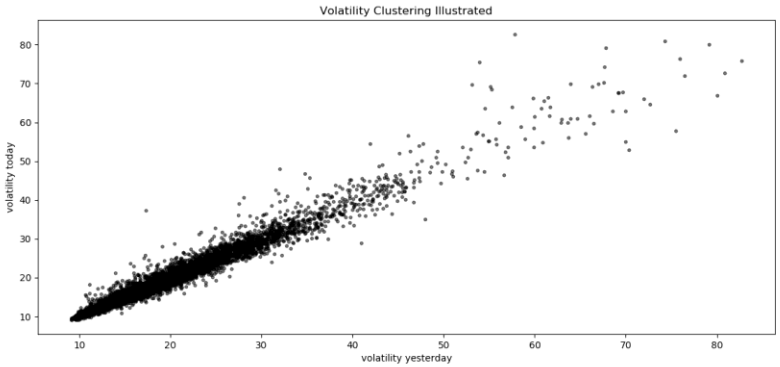
with

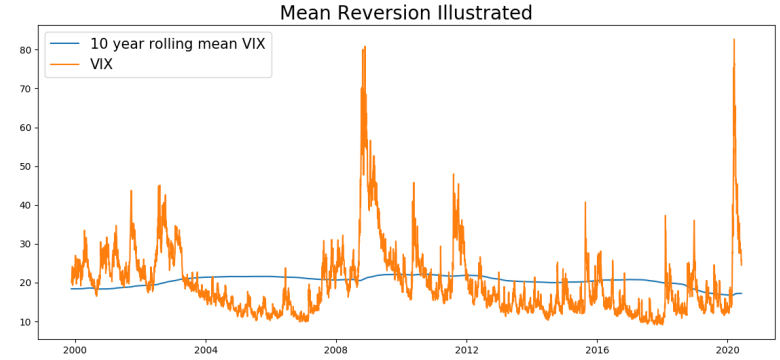
$$\delta_k(\omega) = \frac{(k/K)^{\omega_1 - 1}(1 - k/K)^{\omega_2 - 1}}{\sum_{j=1}^{K}(j/K)^{\omega_1 - 1}(1 - j/K)^{\omega_2 - 1}}$$

Low Frequency Inputs

- Weekly
  - 5-minute intraday variance
  - National Financial Conditions Index
- Monthly
  - Industrial Production Index
  - Chicago Fed National Activity Index
  - New privately owned housing units started

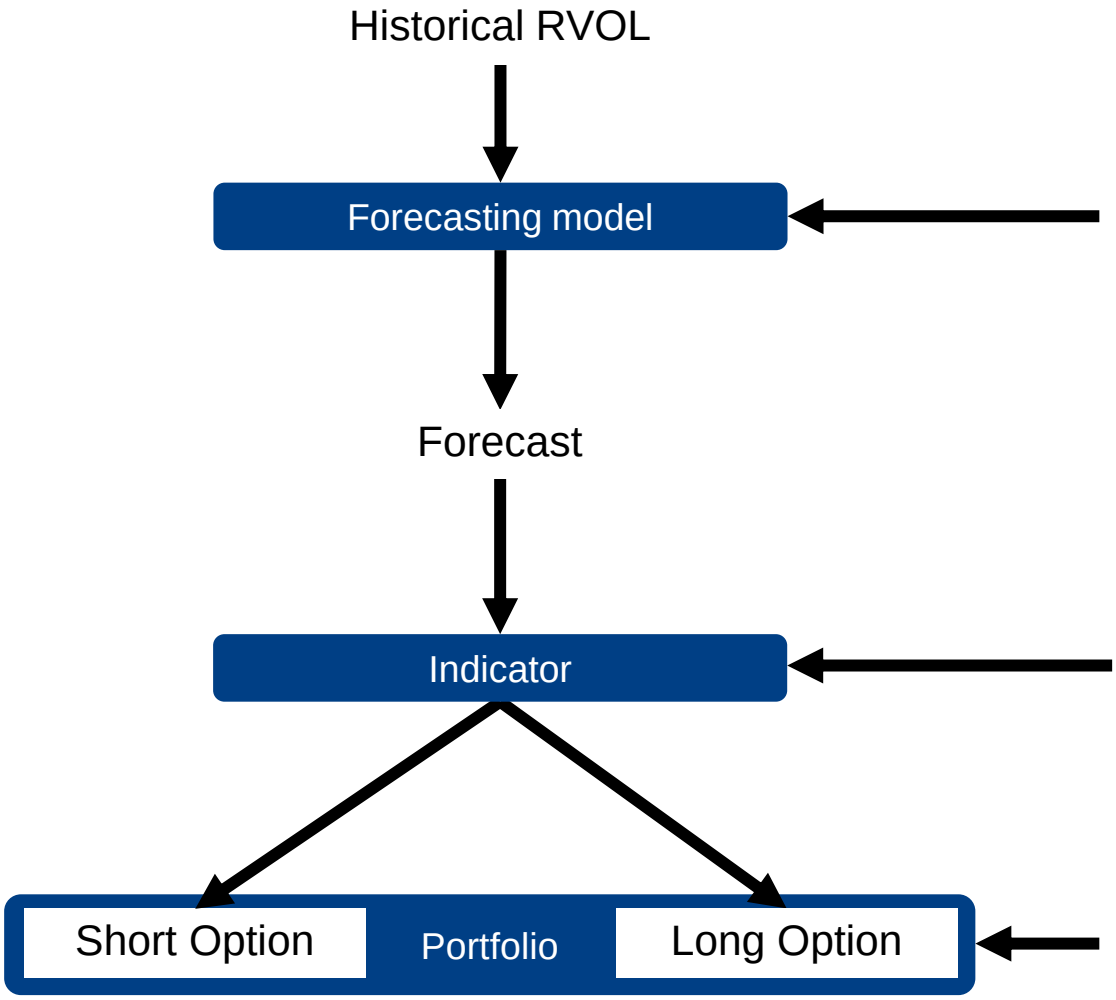
Why it works





Backtesting Model

Methodology



- Exponentially Weighted Moving Average
- GARCH
- EGARCH
- GARCH-MIDAS
- Double Asymmetric GARCH-MIDAS

- Binary
- Scaled (RSI)

- Rebalanced daily at closing
- ATM options are used
- 75% are always in cash