Projects - Financial econometrics

We analyze high frequency time series data to study daily as well as intra-day volatility and to compute the Value at Risk.

Step 1. Exploratory data analysis What information can you extract from your data ? Give an informative summary of your dataset, using appropriate numerical and graphical methods.

Step 2. Analysis of daily time series and VaR (choose one) Extract the daily closing price to define a daily time series returns data. Use these to estimate VaR.

1. VaR under IID
2. VaR under non-stationary time series

Formulate the model and use appropriate hypothesis to compute VaR. Assess whether your hypothesis is supported by the dataset and suggest any modification to improve your results.

Step 3. Conditional volatility with GARCH model and VaR Assess whether GARCH(1,1) model is suitable to your returns data. Using the (pseudo) log-likelihood method, find the estimates as well as their standard errors. Use this model to estimate VaR and compare the results to the previous analysis (2a or 2b). Critically analyze your results and suggest any modifications, if any.

Step 4. High-frequency time series modelling (choose one)

1. Intraday volatility estimation and assessment of microstructure noise
   The aim is to estimate the daily volatility from high frequency time series data and to assess the effect of the microstructure noise. You are expected to estimate and plot the values of the estimated realized volatility by varying the observation frequencies, for example, ranging from a few seconds to some minutes. Compare these estimations with the long range estimation of the volatility (based on the analysis of of daily data in Step 2). Investigate whether there is a need to account for micro-structure noise and demonstrate how to improve your estimation. Based on your analysis, suggest a method to compute VaR with high frequency time series data.
2. GARCH model for high frequency returns
   Assess the utility of the GARCH model for high frequency return series. Based on your analysis, suggest a method to compute VaR with high frequency time series data.
3. Functional data analysis for intraday cumulative log returns
   Under the functional data framework, the data can be expressed as

$$Y_n(t_{nj}) = X_n(t_{nj}) + \varepsilon_{nj}\,, \quad n = 1, \ldots, N\,, j = 1, \ldots, J_n\,,$$

   where $\varepsilon_{nj} \sim (0, \sigma^2)$ and

$$X_n(t) = \mu(t) + \sum_{k=1}^{p} \xi_{nk}\psi_k(t)\,.$$

Give an interpretation of the eigenfunctions and assess if ξ_{nk} follows a normal distribution for each k. Also examine if $(\xi_{nk})_{n=1,\dots,N}$ can be considered as a white noise process. Based on your analysis, give an estimate of the noise variance and assess the quality of the fit as a function of p.

Now, consider a time-series model for the sequence of the coefficients $(\xi_{n,k})_{n=1,\dots,N}$ to develop forecasting methods :

$$\widetilde{X}_{N+h|N}(t) = \mu(t) + \sum_{k=1}^{p} \tilde{\xi}_{N+h,k}\psi_k(t)\,,$$

where $\tilde{\xi}_{N+h,k}$ is h-step ahead forecasts from $\xi_{N,k}$. Evaluate prediction performance. You may use the first few years of data to build your model and the later year to evaluate prediction performance.

Project group allocation Go to the link to put your group member and your preferences in Step 4. Project group