Due Date: May 30 (Evening) and May 31 (Campus), 2017.

Remark: The grade for homework assignments is based on the best five of the six assignments.

This assignment is concerned with Value at Risk and Expected Shortfall. Assume that the tail probability of interest is 1% and the portfolio consists of two stocks, namely Amazon (AMZN) and Merck (MRK). The sample period is from January 2, 2004 to May 19, 2017. The data can be downloaded from Yahoo) Google via the quantmod package. Use the (adjusted) closing prices to compute the daily log returns. For Questions 1 to 4, assume that you hold both stocks valued at $1 million each (long position).

1. Consider the Amazon stock only.
   - Calculate the VaR of your position for the next trading day using the RiskMetrics method on May 19, 2017. You must estimate the corresponding IGARCH(1,1) model. What is the associated expected shortfall? Also, what is the VaR for the next 10 trading days?
   - Build a GARCH(1,1) model for the log return series with Gaussian innovations. What is the VaR based on the fitted model for the next trading day? What is the corresponding expected shortfall?
   - Build a GARCH(1,1) model with Student-t innovations for the log return series. What is the VaR for the next trading day based on the fitted model? What is the corresponding expected shortfall?

2. Consider the daily log returns of Amazon stock. The goal here is to use EVT to estimate financial risk. Using blocks of size 21, fit a generalized extreme value distribution to a proper return series. Write down the estimates and their standard errors. Compute the 1% VaR of your financial position based on the fitted parameters. What is the 1% VaR of your financial position for the next 10 trading days?

3. Again, consider the log returns of the Amazon stock. Fit a generalized Pareto distribution to the return series with threshold 2.0%. Based on the fitted model, what is the 1% VaR of your position? What is the associated expected shortfall? Repeat the analysis using threshold 3.0%. Are the results sensitive to the choice of thresholds? Why?
4. Consider the log returns of Merck stock. Calculate the VaR using the RiskMetrics method. Also, what is the VaR for the combined position of Amazon and Merck stocks? Next, what is the VaR for the combined position of AMZN and MRK if we entertain time-varying correlations between the two stocks. More specifically, use \[ \text{Cov}(X, Y) = 0.25[\text{Var}(X + Y) - \text{Var}(X - Y)] \] to compute the time-varying covariances between the two assets. That is, fit IGARCH models as before to \( X + Y \) and \( X - Y \) to obtain the time-varying covariance. The volatilities of \( X \) and \( Y \) were obtained in the prior questions.

5. Consider the trading of Walgreens stock on February 6, 2017. The data are available from HW5. The price change, duration between trades, and size (volume/100) have been computed and the price changes are divided in 7 categories, name

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< -0.02, [-0.02, -0.01), [-0.01, 0), (0, 0.01], (0.01, 0.02], > 0.02
\]

The resulting data are in the file taq-wba-cpch-feb06-2017.txt. The variables are price-change category, price-change, duration, and size. Analyze the price change using the ordered probit model with the following explanatory variables: (1) lag-1 category, (2) lag-2 category, (3) lag-1 price change, (4) lag-2 price change, (5) lag-3 price change, (6) lag-2 size, and (7) lag-3 size. Are all estimates statistically significant at the 5% level? Why? Based on the fitted model, compute \( P(pc = 4) \), that is, the probability of the no price change given that both lag-1 and lag-2 price changes are in Category 4, actual previous price changes are 0, 0, 0.01 and previous sizes are all 1.