FE 5217: Seminar in Risk Management and Alternative Investment: Algorithmic Trading and Quantitative Strategies

Assignment 1

Due: Jan 27, 2014

Instructions:

- This assignment can be done individually or in a team of two.
- Please attach the relevant R code and provide any outputs and/or plots to support your answers, giving clear narratives of how those outputs lead you to your stated conclusions.
- Turn in your submissions in class

Data files:

- The file `d_15stocks.csv` and `m_15stocks.csv` contain daily and monthly stock returns data for 15 stocks from Jan 11, 2000 to Mar 31, 2013.
- The file `d_indexes.csv` and `m_indexes.csv` contain daily and monthly returns data for the volume-weighted and equal-weighted S&P500 market indices (VWRETD and EWRETD, respectively) from Jan 11, 2000 to Mar 31, 2013.
- The file `d_aapl.txt` contains the daily price of AAPL stock from Jan 3, 2003 to Jun 28, 2013.

1. Using daily and monthly returns data for 15 individual stocks from `d_15stocks.csv` and `m_15stocks.csv`, and the equal-weighted and value-weighted CRSP market indexes (EWRETD and VWRETD, respectively) from `d_indexes.csv` and `m_indexes.csv`, perform the following statistical analyses using R. For the subsample analyses, split the available observations into equal-sized subsamples.

   (a) Compute the sample mean $\hat{\mu}$, standard deviation $\hat{\sigma}$, and first-order autocorrelation coefficient $\hat{\rho}(1)$ for daily simple returns over the entire sample period for the 15 stocks and two indexes. Split the sample into 4 equal subperiods and compute the same statistics in each subperiod – are they stable over time?

   (b) Plot histograms of daily simple returns for VWRETD and EWRETD over the entire sample period. Plot another histogram of the normal distribution with mean and variance equal to the sample mean and variance of the returns plotted in the first histograms. Do daily simple returns look approximately normal? Which looks closer to normal: VWRETD or EWRETD?

   (c) Using daily simple returns for the sample period, construct 99% confidence intervals for $\hat{\mu}$ for VWRETD and EWRETD, and the 15 individual stock return series. Divide the sample into 4 equal subperiods and construct 99% confidence intervals in each of the four subperiods for the 17 series – do they shift a great deal?

   (d) Compute the skewness, kurtosis, and studentized range of daily simple returns of VWRETD, EWRETD, and the 15 individual stocks over the entire sample period, and in each of the 4 equal subperiods. Which of the skewness, kurtosis, and studentized range estimates are statistically different from the skewness, kurtosis, and studentized range of a normal random variable at the 5% level? For these 17 series, perform the same calculations using monthly data. What do you conclude about the normality of these return series, and why?

2. Consider daily price of AAPL stock from `d_aapl.csv`. The data are obtained from Yahoo Finance and have 7 columns (namely, Date, Open, High, Low, Close, Volume, Adj Close). We focus on the adjusted closing price in the last column. (You can use the R function `rev` to reverse the time series.)

   (a) Compute the daily log returns of AAPL stock. Is there any serial correlation in the daily log returns? To answer this question, perform the test $H_0 : \rho_1 = \cdots = \rho_{10} = 0$ versus $H_1 : \rho_i \neq 0$ for some $1 \leq i \leq 10$. What is your conclusion?

   (b) Use the function `ar` with the maximum likelihood (MLE) method to select an AR model for the log return series. What is the specified order? Perform model fitting and write down the fitted model. Are all AR coefficients significant at the 5% level? Why?

   (c) Focus on the AR model specified in (b). Simplify the APR model by fixing the insignificant coefficients to 0. Write down the final model with all AR coefficients significant at the 5% level.

   (d) Consider the log price series of AAPL stock. Is the log price series unit-root nonstationary? Perform a unit-root test to answer the question and present your conclusion. [Hint: You may use the order specified in (b) in the test.]

3. Consider daily price of AAPL stock from `d_aapl.csv`. Compute the daily log returns of the stock. Use an ARMA model to remove any serial correlations in the log returns, if necessary.

   (a) Is there any ARCH effect in the daily log returns of AAPL stock? Justify your answer.

(b) Fit a GARCH(1,1) model for the log return of AAPL stock using Gaussian distribution for the innovations. Perform model checking, and write down the fitted model.

(c) Fit the GARCH(1,1) model again using the Student-t distribution for the innovations. Write down the fitted model.

(d) Fit an IGARCH(1,1) model with Gaussian innovations to the AAPL stock returns. Write down the fitted model. [Note: This is the model used in RiskMetrics to compute VaR.]

(e) Among the three fitted volatility models, choose the one that appears to be the best. Why?