Financial Time Series
Project 3: Volatility Modeling
Due Dates: Part I: June 13th, Part II: June 20th

In this project, Splus programming language will be used to reveal the characteristic of ARCH model and practice the method of analyzing this kind of time series. This project is divided into two parts. The first part we use the simulated data to get a basic understanding of ARCH model. For the second part, you are asked to model real data.

Part I: Simulated Data

Problem 1: Simulate a series with length 300 from the model $r_t = 0.0196 + a_t$ and

$$\sigma_t^2 = 0.00998 + 0.4437a_{t-1}^2.$$

For the simulated data,

(a) Show the time plots of the series and the squared series.

(b) Show the sample ACF of the series.

(c) Does the series show serial correlation?

(d) Find the sample PACF of the squared series.

Problem 2: Model the simulated data.

Problem 3: Repeat Problems 1 and 2 ten times and summarize your findings.

Part II: Real Data

Here we consider four data sets. The first data set is monthly simple returns of Merck stocks from June 1946 to December 1999. The second data set is the monthly log return and date for 3M stock.

Problem 4: For the Merck stock, is there evidence of ARCH effects in the data? Use Ljung-Box statistics for the squared returns with 5 and 10 lags. Use the PACF of the squared returns to identify an ARCH model and fit the identified model.

Problem 5: For the 3M stock, is there evidence of ARCH effects in the data? Use Ljung-Box statistics for the squared returns with 5 and 10 lags. Use the PACF of the squared returns to identify an ARCH model and fit the identified model. There are 623 data points. Use the fitted model to predict the volatilities for $t = 624$ and $t = 625$ (the forecast origin is 623).