**Volatility**

Notes: datasets are published in the course's website. Use 5% significance level. For daily series, use 10 lags in all ACFs or ARCH-effect tests. For monthly series, use 12 lags. The models of all the volatility questions (1-3), should include both the mean and volatility equations. You should always perform model checking to confirm the adequacy of a fitted model.

1. Consider the daily returns of the exchange trade fund (ETF) SPDR S&P 500 of State Street Global Advisors from September 4, 2001 to September 30, 2011. The tick symbol is `SPY` and there are 2535 observations. The simple returns are available from CRSP and in the file `d-spy-0111.txt`. Transform the simple returns to log returns.

   (a) Is the expected log return zero? Are there any serial correlations in the log returns? Is there ARCH effect in the log returns?

   (b) Fit a Gaussian ARMA-GARCH model for the log return series. Perform model checking, obtain the QQ-plot of the standardized residuals, and write down the fitted model. [Hint: Try GARCH(2,1).]

   (c) Build an ARMA-GARCH model with Student-$t$ innovations for the log return series. Perform model checking and write down the fitted model.

   (d) Fit an ARMA-APARCH model with Student-$t$ innovations to the data. Write down the fitted model and perform 1- to 5-step ahead predictions of the series and its volatility.

2. Consider the monthly stock returns of the Coca-Cola Company (KO) from January 1961 to September 2011. The simple returns are available from CRSP and in the file `m-ko-6111.txt`. Transform the simple returns to log returns.

   (a) Is the expected monthly log return zero? Is there any serial correlction in the log returns? Is there any ARCH effect in the log returns?

   (b) Build a Gaussian GARCH model for the log returns. Perform model checking and write down the fitted model.

   (c) Build a GARCH model with Student-$t$ innovations for the log returns. Perform model checking, obtain the QQ-plot of the standardized residuals, and write down the fitted model. Also, obtain 1- to 5-step ahead volatility predictions.

3. Consider again the monthly log returns of KO stock. Multiple the log returns by 100. i.e., use percentage log returns.

   (a) Fit a TGARCH model to the series. Perform model checking and write down the fitted model. Is the leverage effect different from zero?

   (b) Fit a GARCH-M model to the series. Perform model checking and write down the fitted model. Is the risk premium significant? Why?