Assignment #2

Due Date: April 24 (Campus) and April 26 (Weekend), before class

Notes:

- Use 5% level in all tests.
- The notation $\rho_i$ is the lag-$i$ autocorrelation coefficient.
- In some of the problems, I provide guidances to specify a time series model. This is to help you gain experience in empirical data analysis. You can try your own models to gain further experience. The assignments show that multiple models can fit a given data set well and seasonally adjusted data might still have some residual seasonality.

Assignment:

1. Consider the monthly series of Consumer Sentiment of the University of Michigan. This survey series is widely used to indicate the consumer confidence about the U.S. economy. The data are available from FRED of the Federal Reserve Bank of St. Louis and also in the file `m-umcsent.txt`. The sample period is from January 1978 to August 2013.

   (a) Plot the monthly consumer sentiment series.
   (b) Is there a unit root in the monthly sentiment series? Why?
   (c) Consider the change series of the sentiment, i.e. the first differenced data. Test the hypothesis that the expected change of the sentiment is zero versus the alternative that the expected change is non-zero.
   (d) Focus on the change series. Test the null hypothesis $H_0 : \rho_1 = \rho_2 = \cdots = \rho_{12} = 0$ versus the alternative $H_a : \rho_i \neq 0$ for some $i \in [1, 12]$. Draw your conclusion.

2. Again, consider the change series of consumer sentiment of Problem 1.

   (a) Use the command `ar` with method `mle` to find the order.
   (b) Build an AR model based on the selected order for the change series. Perform model checking to validate the fitted model. Write down the model.
   (c) Does the model imply the existence of business cycles in consumer sentiment? Why?
   (d) Obtain 1-step to 4-step ahead point and 95% interval forecasts for the change series of consumer sentiment at the forecast origin August 1, 2013 (the last data point).

3. Consider, again, the monthly change series of consumer sentiment of Problem 1.
(a) Simplify the fitted AR model of Problem 2 by removing parameter estimates with \( t \)-ratio less than 1.2 in absolute. [Use the fixed subcommand.]

(b) Is the model adequate? Why?

(c) Compare the simplified model with the AR model built in Problem 2. In terms of in-sample fitting, which model is preferred? Why?

(d) Does the simplified model imply the existence of business cycles? Why?

(e) Use backtest to compare the two AR models. You may start the forecast origin at \( t = 380 \). Which model is preferred? Why?

4. Unemployment rate is an important macroeconomic series. Equivalent importance is the duration of unemployment. Consider the mean duration of unemployment is the U.S. from January 1948 to March 2014. The duration is measured in weeks. The data are available from FRED of the Federal Reserve Bank of St Louis and also in the file m-unempmean.txt. The data were seasonally adjusted.

(a) Does the mean duration series have a unit root? Why?

(b) Focus on the change series of duration, i.e. the first differenced series. Denote the change series by \( r_t \) and let \( E(r_t) = \mu \). Test \( H_0 : \mu = 0 \) versus the alternative \( H_a : \mu \neq 0 \). Draw the conclusion.

(c) Build an AR model for \( r_t \) series. Perform model checking using \( \text{gof} = 24 \). Is the model adequate? Why?

(d) Write down the fitted AR model.

(e) Fit a seasonal model for the \( r_t \) series using the command

\[
\text{ms}=\text{arima}(\text{rt},\text{order}=c(2,0,1),\text{seasonal}=\text{list}(\text{order}=c(1,0,1),\text{period}=12),\text{include.mean}=\text{F})
\]

Perform model checking using \( \text{gof} = 24 \). Is the seasonal model adequate? Why?

(f) Based on the in-sample fitting, which model is preferred? Why?

(g) Consider out-of-sample predictions. Use \( t = 750 \) as the starting forecast origin. Which model is preferred based on the out-of-sample predictions?

5. (Commodity prices). Consider the weekly crude oil prices: West Texas Intermediate (WTI), Cushing, Oklahoma. The data are also available from FRED and in the file w-coilwtico.txt. The sample period is from January 3, 1986 to April 2, 2014.

(a) Let \( r_t \) be the growth series, i.e. the first difference of log oil prices. Is there serial correlation in the \( r_t \) series? You may use \( Q(10) \) to draw the conclusion.

(b) Build an AR model for \( r_t \). Check the adequacy of the model, and write down the model.

(c) Fit another model to \( r_t \) using the following command

\[
\text{m5}=\text{arima}(\text{rt},\text{order}=c(3,0,2),\text{include.mean}=\text{F})
\]

This is an ARIMA(3,0,2) model. Write down the model. Based on in-sample fitting, which model is preferred?

Reading assignments: Chapter 2 of the textbook.