

Assignment 4

DUE DATE: Thursday 20th, February 2020.

I pledge to the Honor Code and to obey all rules for taking and performing homework assignments as specified by the course instructor.

Full name _____ **Student ID.** _____

All data are downloadable from BE moodle

1.(40 points) Climate change is a big concern for many. In this problem, we analyze the monthly global temperature anomalies from January 1880 to December 2015 for the Northern Hemisphere. The data consist of measurements from land and sea surface and are in 0.01C. The original data are from Goddard Institute for Space Studies. See <http://data.giss.nasa.gov/gistemp>. The data are available in the file m-globaltemp.txt. To obtain the series, do the following in R:

```
da <- read.table('m-globaltemp.txt',header=T)
dd <- da[,2:13]
xt <- c(t(dd))
zt <- diff(xt)
```

(a) Plot both the monthly temperature and its first differenced series on the same page. [You can use the command `par(mfcol=c(2,1))` in R.]

(b) Let $z_t = x_t - x_{t-1}$ with x_t being the global temperature. Test $H_0 : E(z_t) = 0$ versus $H_a : E(z_t) \neq 0$. Draw your conclusion.

(c) Compute ACF and PACF of the z_t series. Plot them on the same page.

(d) Consider the z_t series. Test $H_0 : \rho_1 = \dots = \rho_{12} = 0$ versus $H_a : \rho_i \neq 0 \exists 1 \leq i \leq 12$. Draw the conclusion.

2. (30 points) Again, consider the first-differenced series z_t of Problem 1.

(a) Using the ACF and PACF to identify the optimal lags of AR model for the z_t series.

(b) Use the `ar` command to identify an AR model for the z_t series. Fit the specified AR model, and write down the fitted model.

(c) Based on the model you get from (a) what is the unconditional mean of z_t .

3.(30 points) Consider the growth rates of the U.S. real gross domestic product (GDP) from 1947.I to 2012.IV. The original data, from Federal Reserve Bank of St Louis, are in the file `q-gdpmc1.txt` (year, month, day, gnp), and the GDP are in millions of 2005 chained dollars. The growth rate is the first differenced series of the $\log(\text{GDP})$.

(a) Build an AR model for the growth rate series. [Use the command `ar` with method `mle` to find the order.] Perform model checking to validate the fitted model. Write down the model.

(b) Obtain 1-step to 8-step ahead point and 95 % interval forecasts for the U.S. quarterly GDP growth rate at the forecast origin October 1, 2012 (the last data point).

4.(40 points) Consider, again, the quarterly U.S. real GDP growth rates from 1947 to 2012 in Problem 1.

(a) Fit a simple AR(1) model to the series. Write down the model.

(b) Is the model adequate? Why?

(c) Compare the AR(1) model with the AR model built in Problem 2. In terms of in-sample fitting, which model is preferred? Why?

(d) Use **backtest** to compare the two AR models. You may use the data in 2008-2012 (inclusive) as the forecasting period. Which model is preferred? Why?