

**Assignment 1** (Due 06/10/2022):

1. Consider the monthly simple returns of the CRSP Decile 1 and 9 portfolios from January 1970 to December 2006. The portfolios consist of NYSE/AMEX/NASDAQ stocks based on market capitalization and rebalanced annually. See CRSP (via WRDS) for more information. The data are in m-dec19.txt with date, Decile-1 return, and Decile-9 return in three columns.

(a) Compute the first 24 lags of ACF and PACF of the simple return series of Decile 1 portfolio.

(b) Test the hypothesis that the first 12 lags of ACF are zero. That is,  $H_0 : \rho_1 = \dots = \rho_{12} = 0$  versus  $H_1 : \rho_i \neq 0$  for some  $1 \leq i \leq 12$ . Draw your conclusion.

2. Consider the monthly simple returns of the CRSP Decile 9 portfolio in Problem 1.

(a) Compute the ACF of the simple returns for the first 12 lags.

(b) Test the hypothesis that all 12 ACFs are zero. That is,  $H_0 : \rho_1 = \dots = \rho_{12} = 0$  versus the alternative hypothesis  $H_1 : \rho_i \neq 0$  for some  $i$ ,  $1 \leq i \leq 12$ . Draw your conclusion.

3. Consider the monthly U.S. Consumer Price Index Less Engery from January 1, 1957 to February 2, 2007. The data are seasonally adjusted and obtained from the Federal Reserve Bank at St Louis. The origin of the data is U.S. Department of Labors, Bureau of Labot Statistics. The data file is m-cpileng.txt (in year, mm, dd, cpi format).

Compute the percentage growth rate series of CPI defined as  $c_t = 100[\ln(X_t) - \ln(X_{t-1})]$ , where  $X_t$  denotes the  $t$ th observation of CPI.

(a) Compute the 12 lags of ACF and PACF of  $c_t$ . Test the null hypothesis that the first 12 lags of ACF are zero. Draw your conclusion.

(b) The patterns of ACF and PACF indicate that the  $c_t$  series does not follow a simple AR or MA model. To gain further insight, compute the first 12 lags of ACF of the differenced series  $z_t = c_t - c_{t-1}$ .

(c) Based on the ACF of  $z_t$ , one may fit an ARMA(1,5) model for the  $c_t$  series. Write down the fitted model.

4. Consider the growth rate of U.S. real GNP series from the 2nd quarter of 1947 to the last quarter of 2006. The data are in the file q-gnprate.txt.

(a) Fit an AR(3) model to the series. Write down the fitted model.

(b) For the fitted AR(3) model, compute the average period of business cycles if they exist?

(c) Compute 1-step to 4-step ahead forecasts of the fitted model at the end of the data, i.e. October (or the fourth quarter) of 2006. Write down the forecasts and their standard errors.

**5.** Consider the monthly simple return of CRSP Decile 9 portfolio from January 1970 to December 2006 of Problem 1.

(a) Fit an MA(1) model to the series. Write down the fitted model.

(b) Is the fitted MA(1) model adequate? Why?

(c) Compute 1-step to 4-step ahead forecasts of the fitted MA(1) model using the last observation as the forecast origin.