STA457H1/STA2202HF: Time Series Analysis
Assignment 2 - Question 3 Due data October 14, 2022

Student Name.....ID number.....

Instructions: *Show your answers in details.*

Q3 (8 points for undergraduate students and 6 points for graduate students): Consider the two weekly time series *oil* and *gas*. The oil series is in dollars per barrel, while the gas series is in cents per gallon.

1. Plot the data on the same graph. Do you believe the series are stationary (explain your answer)?
2. In economics, it is often the percentage change in price (termed growth rate or return), rather than the absolute price change, that is important. Argue that a transformation of the form $y_t = \nabla \log x_t$ might be applied to the data, where x_t is the oil or gas price series.
3. Transform the data as described in part (2), plot the data on the same graph, look at the sample ACFs and CCF of the transformed data, and comment.
4. Exhibit scatterplots of the oil and gas growth rate series for up to three weeks of lead time of oil prices; include a nonparametric smoother in each plot and comment on the results (e.g., Are there outliers? Are the relationships linear?).
5. There have been a number of studies questioning whether gasoline prices respond more quickly when oil prices are rising than when oil prices are falling ("asymmetry"). We will attempt to explore this question here with simple lagged regression; we will ignore some obvious problems such as outliers and autocorrelated errors, so this will not be a definitive analysis. Let G_t and O_t denote the gas and oil growth rates.

   (i) Fit the regression (and comment on the results)

   $$G_t = \beta_0 + \beta_1 I_t + \beta_2 O_t + \beta_3 O_{t-1} + w_t$$

   where $w_t \sim \text{wn}(0, \sigma_w^2)$ and $I_t = 1$ if $O_t \geq 0$ (i.e., I_t is the indicator of increase in the oil price) and 0 otherwise (no positive growth in the oil price).

   (ii) What is the fitted model when there is negative growth in oil price at time t? What is the fitted model when there is no or positive growth in oil price? Do these results support the asymmetry hypothesis?

   (iii) Fit the regression

   $$G_t = \beta_0 + \beta_1 O_t + w_t$$

   and decide (using AIC/BIC) whether it is better than the previous one or not?

   (iv) Test the full model as specified in part (i) against the reduced model as as specified in part (iii).

   (v) Analyze the residuals from the best fit and comment.