ECON 0150 | Spring 2026 | Homework 4.4

Due: Sunday April 5, at 11:59PM

Homework is designed to both test your knowledge and challenge you to apply familiar concepts in new applications. Answer clearly and completely. You are welcomed and encouraged to work in groups so long as your work is your own. Use the provided datasets to answer the following questions. Then submit your figures and answers to Gradescope.

Q1. Okun's Law: Levels Model

Okun's Law is a well-known empirical relationship in macroeconomics: when unemployment rises, GDP tends to grow more slowly, and vice versa. In this question you will explore this relationship using quarterly US data from 1948–2019. The dataset `okun.csv` contains the following variables:

- `gdp`: real GDP (billions of 2017 dollars)
- `unemployment`: unemployment rate (%)
- `gdp_diff`: quarter-over-quarter change in GDP
- `unemployment_diff`: quarter-over-quarter change in unemployment rate
- `gdp_growth`: quarter-over-quarter GDP growth rate

a) Load `okun.csv` and create a scatterplot with `unemployment` on the x-axis and `gdp` on the y-axis.

b) Fit a linear regression model: `gdp ~ unemployment`. Report the estimated coefficients and p-values. Interpret $\hat{\beta}_1$: what does the sign suggest about the relationship between unemployment and GDP?

c) Create a residual plot (predicted values on x-axis, residuals on y-axis). Does the model look well-specified?

d) Create a lagged residual plot. Does the model show autocorrelation? What does this mean for the reliability of the regression results?

Q2. Okun's Law: GDP Growth and Unemployment Changes

The levels model in Q1 regresses the *level* of GDP on the *level* of unemployment. But both variables trend over time: GDP grows while unemployment fluctuates around a stable mean. This shared time trend can create a spurious relationship.

Okun's Law is typically stated in terms of GDP *growth* and *changes* in unemployment: when unemployment rises, GDP growth slows.

a) Create a scatterplot with `unemployment_diff` on the x-axis and `gdp_growth` on the y-axis. How does this scatterplot compare to the one in Q1(a)?

b) Fit the Okun's Law model: `gdp_growth ~ unemployment_diff`. Report the estimated coefficients and p-values. How does the sign of $\hat{\beta}_1$ compare to Q1(b)? Interpret $\hat{\beta}_1$ in context.

c) Create a residual plot for the Okun's Law model. Compare it to the residual plot from Q1(c). Which model appears better specified? Describe the differences you see.

d) Create a lagged residual plot for the Okun's Law model. Compare it to the lagged residual plot from Q1(d). Which model shows less autocorrelation? How can you tell from the plot?

e) Compare the levels model (Q1) and the Okun's Law model (Q2). The levels model shows a *positive* coefficient for unemployment on GDP, while the Okun's Law model shows a *negative* coefficient. Which result is more consistent with economic theory? Why does the levels model give a misleading result?