Name: _____

In-class final, EC421

120 points possible

1 True or false (50 points)

Note: In this section, select the correct answer. You do not need to explain your answer.

1. (2.5 points) **[T/F]** In the presence of omitted-variable bias, ordinary least squares (OLS) regression is still consistent for estimating the βs.
2. (2.5 points) **[T/F]** When disturbances' means differ across groups, we have heteroskedasticity.
3. (2.5 points) **[T/F]** Adding additional variables mechanically increases R^2.
4. (2.5 points) **[T/F]** If an estimator is biased, it is also inconsistent.
5. (2.5 points) **[T/F]** Static time-series models include lags for the explanatory variables but not the dependent variable.
6. (2.5 points) **[T/F]** Random walks are non-stationary because their means change with time.
7. (2.5 points) **[T/F]** Randomizing a variable typically ensures exogeneity.
8. (2.5 points) **[T/F]** Correlated disturbances make OLS biased when estimating standard errors.
9. (2.5 points) **[T/F]** If we estimate the econometric model below via regression, $\hat{\beta}_1$ will equal Average(Income for females) $-$ Average(Income for non-females).

$$\text{Income}_i = \beta_0 + \beta_1 \text{Female}_i + u_i$$

10. (2.5 points) **[T/F]** By including a lagged dependent variable, we implicitly include many lags of the explanatory variable.
11. (2.5 points) **[T/F]** Exogeneity essentially says that the disturbance must be independent of your explanatory variables.

12. (2.5 points) **[T/F]** Autocorrelation means two variables are strongly correlated.

13. (2.5 points) **[T/F]** Suppose the variable x_t is a random walk.
    True or false: $\Delta x_t = x_t - x_{t-1}$ is stationary.

14. (2.5 points) **[T/F]** To be a valid instrument, a variable must (1) correlate with the endogenous regressor and (2) correlate with the disturbance.

15. (2.5 points) **[T/F]** A p-value below 0.05 suggests the data do not support the null hypothesis.

16. (2.5 points) **[T/F]** In the model below, if the disturbance is autocorrelated, then OLS is biased and inconsistent for β_1.

$$\text{Price}_t = \beta_0 + \beta_1 \text{Inflation}_t + \beta_2 \text{Inflation}_{t-1} + u_t$$

17. (2.5 points) **[T/F]** In the first stage of two-stage least squares, we regress the outcome of interest on the instrumental variable.

18. (2.5 points) **[T/F]** The econometric model below allows the effect of income on health to depend upon the individual's age.

$$\text{Health}_i = \beta_0 + \beta_1 \text{Income}_i + \beta_2 \text{Age}_i + u_i$$

19. (2.5 points) **[T/F]** To be able to interpret a regression a causal, exogeneity must hold.

20. (2.5 points) **[T/F]** In the model $\text{Births}_t = \beta_0 + \beta_1 \text{Income}_t + \beta_2 \text{Income}_{t-1} + u_t$, the parameter β_2 gives the effect of today's income on tomorrow's births.

Questions continue on the next page.

2 Short answer (50 points)

Note: In this section, briefly answer the questions/prompts in 1–3 short (and complete) sentences. We will deduct points for excessively long answers.

21. (5 points) Explain how the terms *selection bias* and *omitted-variable bias* are related.

Selection bias and omitted-variable bias are essentially the same idea: the variable of interest is correlated with other factors that affect our outcome. Because of these "other factors", comparisons will confound the effect of our target variable with the influence of other variables.

22. (5 points) What issues can non-stationary data cause? Briefly explain your answer.

Non-stationary data can cause use to find spurious results. When our variables are all changing with time, we may find relationships that aren't really there. Instead, it's just the influence of time.

23. (5 points) What is the purpose of an instrumental variable?

An instrumental variable aims to extract the exogenous variation in our variable of our interest while leaving behind the endogenous part of the variable that is causing bias/inconsistency.

24. (5 points) We've all heard that *correlation is not causation*. Explain how correlation and causation are related.

One way to put it: Correlation plus exogeneity gives causation. For one variable to cause another variable, the two variables should be correlated (when exogeneity is satisfied).

25. (5 points) Where does the "least squares" part of the name in OLS come from?

The "least squares" part of OLS comes from choosing the parameters that minimize the sum of the squared error. The error is defined as the actual value (y) minus the value predicted by the regression line ("y hat").

26. (5 points) Should we be concerned about autocorrelation in cross-sectional data? Explain.

Typically no. Autocorrelation is generally a concern in time-series data. In cross-sectional data, for there to be autocorrelation, there must be something that links one person to the next person in the dataset. This scenario could be true if people who are 'proximate' in the dataset are also proximate in space or through familial relationships.

27. (5 points) In the following model, *Income* is measured in dollars, *Female* is an indicator, and *Age* is reported in years (since birth).

$$\text{Income}_i = \beta_0 + \beta_1 \text{Female}_i + \beta_2 \text{Age}_i + \beta_3 \text{Female}_i \times \text{Age}_i + u_i \tag{1}$$

Answer the following questions (you will have βs in your answers).

- What is the expected income for a 25-year old female?
- What is the average difference between a 50-year-old female and 50-year-old non-female?

The expected in come for a 25-year old female: $\beta_0 + \beta_1 + 25\ \beta_2 + 25\ \beta_3$

The expected difference between a 50-year-old female and male: $\beta_1 + 50\ \beta_3$

28. (5 points) Suppose you wish to estimate the effect of health insurance (*Insurance*, a binary indicator below) on *Health*. Toward this goal, you plan to estimate the following regression using instrumental variables, where *Employed* (a binary indicator) is your instrument.

$$\text{Health}_i = \beta_0 + \beta_1 \text{Insurance}_i + u_i \tag{2}$$

Does the *Employed* meet the requirements for a valid instrument? Explain your answer.

Not likely. While being employed is likely relevant to health insurance (correlated with having insurance), it is unlikely to be exogenous (it likely correlates with the disturbance, since individuals who are employed are often different than individuals who are unemployed on many dimensions that affect health).

29. (5 points) Define and explain the fundamental problem of causal inference.

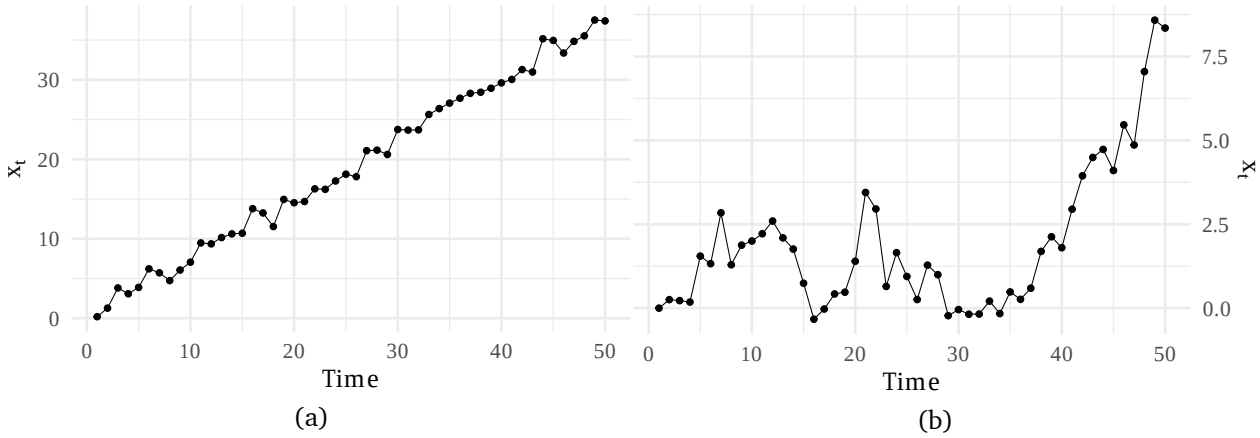
The fundamental problem of causal inference is that we cannot simultaneously observe and individual with treatment and without treatment. To get the true (individual-level) treatment effect, we need to observe the same individual with and without treatment. The problem: We can only observe one.

30. (5 points) For the model below, explain why we might be concerned about reverse causality.

$$\text{Health}_i = \beta_0 + \beta_1 \text{Income}_i + \beta_2 \text{Age}_i + u_i$$

Reverse causality here would mean that we're concerned that health affects income (or age). If more healthy people earn more money, then we have an issue with reverse causality that can lead to a violation of exogeneity.

3 Analyzing graphs (20 points)



(a) (b)

Figure 1: Stationarity

31. (10 points) In Figure 1 (above), each of the two subfigures depicts a 50-period time-series plot for a different random variable x_t.

    For *each* of the figures, discuss whether you believe the variable is (1) mean stationary and (2) variance stationary. Explain your reasoning.

(a) Definitely not mean stationary: the mean is clearly changing with time.
(a) Reasonably variance stationary: no evidence the mean is changing with time.

(b) Could argue that the mean is changing over time (nonstationary). (It actually isn't, but that's fine)
(b) Variance appears to be increasing with time (nonstationary variance)

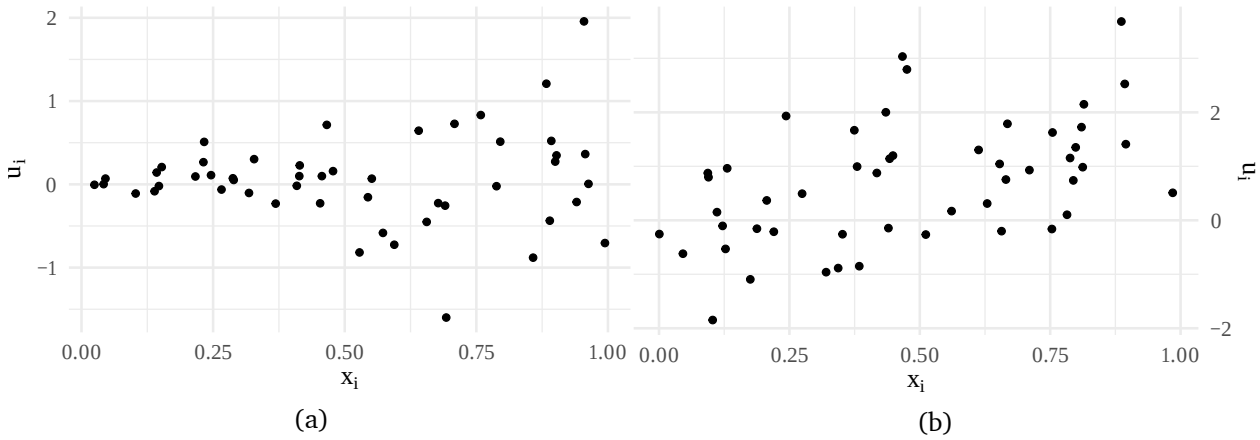


Figure 2: Assumptions

32. (10 points) In Figure 2 (above), each of the subfigures depicts the relationship between an explanatory variable (x_i) on the horizontal axis and the disturbance (u_i) on the vertical axis—for 50 observations. Think of each subfigure as a separate dataset.

    For *each* of the figures, discuss whether you believe the figure suggests the data are (1) exogenous and (2) homoskedastic. Explain your reasoning.

(a) Exogeneity seems valid: the mean of the disturbances is not changing with x.
(a) Violates homoskedasticity: variance of disturbances is increasing with x.

(b) Exogeneity is violated: the mean of the disturbances correlates with x.
(b) Homoskedasticity seems valid: the variance of the disturbances is not increasing with x.