Name: _____

In-class midterm, EC421

145 points possible

1 True or false (75 points; 30 questions)

Note In this section, select the correct answer (true or false). You do not need to explain your answer.

1. (2.5 points) **[T/F]** If the disturbance correlates with a regressor, then exogeneity is violated.
2. (2.5 points) **[T/F]** When OLS is biased for the standard errors, it is also biased for the coefficients.
3. (2.5 points) **[T/F]** The *linearity* assumption in OLS prohibits models from including squared terms like x_i^2.
4. (2.5 points) **[T/F]** Omitted-variable bias occurs when an omitted variable correlates with an included regressor.
5. (2.5 points) **[T/F]** Adding more explanatory variables will always increase R^2.
6. (2.5 points) **[T/F]** Heteroskedasticity makes OLS estimates of coefficients biased.
7. (2.5 points) **[T/F]** Weighted least squares gives more weight to observations with smaller variances in their disturbances.
8. (2.5 points) **[T/F]** Residuals are observable; disturbances are not.
9. (2.5 points) **[T/F]** If $\widehat{\beta}_1 = 0.3$ in a log-log model, a 1% increase in x increases y by 30%.
10. (2.5 points) **[T/F]** A p-value of 0.99 indicates a high degree of statistical significance.
11. (2.5 points) **[T/F]** Consistency describes the behavior of an estimator as sample size grows.
12. (2.5 points) **[T/F]** Heteroskedasticity-robust standard errors are biased in the presence of homoskedasticity.
13. (2.5 points) **[T/F]** Correlated disturbances violate the exogeneity assumption.
14. (2.5 points) **[T/F]** The Goldfeld-Quandt test compares error variances across two subsets of the data.

15. (2.5 points) **[T/F]** A coefficient on an interaction term captures how the effect of one variable depends on the level of another.

16. (2.5 points) **[T/F]** Functional-form misspecification can lead to heteroskedasticity.

17. (2.5 points) **[T/F]** Homoskedasticity means $\text{Var}(u_i) \neq \text{Var}(u_j)$ for two individuals i and j.

18. (2.5 points) **[T/F]** The White test is better than the Goldfeld-Quandt test at detecting general heteroskedasticity.

19. (2.5 points) **[T/F]** The sum of squared residuals directly influences the magnitude of the standard errors.

20. (2.5 points) **[T/F]** If $\text{Cov}(x_i, u_i) \neq 0$, then OLS is still unbiased but inconsistent.

21. (2.5 points) **[T/F]** In the regression $\log(y_i) = \beta_0 + \beta_1 x_i + u_i$, the effect of x on y is percent-based.

22. (2.5 points) **[T/F]** A violation of exogeneity implies biased OLS coefficient estimates.

23. (2.5 points) **[T/F]** OLS minimizes the $\sum_i e_i$, where e_i is the residual.

24. (2.5 points) **[T/F]** The presence of heteroskedasticity invalidates standard OLS hypothesis tests.

25. (2.5 points) **[T/F]** For an estimator with bias $1/n$, the estimator may still be consistent.

26. (2.5 points) **[T/F]** The assumption $\mathbb{E}[u_i^2|X_i] = \sigma^2$ is necessary for OLS to be unbiased for the coefficients.

27. (2.5 points) **[T/F]** The p-value tells us the probability that our hypothesis is true.

28. (2.5 points) **[T/F]** WLS is less efficient that OLS in the presence of heteroskedasticity.

29. (2.5 points) **[T/F]** For the regression model

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

the White test for heteroskedasticity would run the following regression:

$$\text{Income}_i^2 = \beta_0 + \beta_1 \text{Health}_i + \beta_2 \text{Health}_i^2 + u_i.$$

30. (2.5 points) **[T/F]** Heteroskedasticity-robust standard errors and 'plain' OLS standard errors will always use the same coefficient estimates.

2 Multiple choice (20 points; 5 questions)

Note In this section, check (✓ or ×) **all** correct answers. You do not need to explain your answer.

31. (4 points) **[Multiple choice]** Choose *all* correct answers:

    Which of the following assumptions are "classic" regression assumptions?

    ● $E[u_i|X_i] = 0$ ○ $\text{Var}(u_i) = 0$ for all i ○ $\text{Cov}(u_i, u_j) = \sigma$ ● $\text{Var}(X) > 0$

32. (4 points) **[Multiple choice]** Choose *all* correct answers:

    Which of the relationships imply OLS is biased for estimating the coefficients in a regression model?

    ○ $E[u_i|X_i] = 0$ ○ $\text{Var}(u_i) \neq \text{Var}(u_j)$ ● $E\left[\hat{\beta}\right] \neq \beta$ ○ $\text{Cov}(u_i, u_j) = 0$

33. (4 points) **[Multiple choice]** Choose *all* correct answers:

    In the presence of heteroskedasticity, which of the following statements are true?

    ● OLS is unbiased for the coefficients. ● Standard OLS confidence intervals are biased.
    ○ OLS is unbiased for the standard errors. ● OLS is less efficient than WLS.

34. (4 points) **[Multiple choice]** Choose *all* correct answers:

    Imagine you are in a setting where you believe the disturbance is heteroskedastic. What are your 'options' for estimating the model that will yield believable estimates?

    ● Use het.-robust standard errors. ● Estimate the model using WLS.
    ● Check the specification. ○ Look for omitted variables.

35. (4 points) **[Multiple choice]** Choose *all* correct answers:

    Which of the following will generally make our standard errors smaller?

    ● Adding additional regressors to the model. ○ Omitted variable bias.
    ● Ignoring correlated disturbances. ○ Subtracting the mean from the outcome variable.

3 Short answer (50 points; 10 questions)

Note In this section, briefly answer the questions/prompts in 1–3 short (and complete) sentences.

We will deduct points for excessively long answers.

36. (5 points) Define the concept of a *standard error*.

Answer: The standard error is the standard deviation of an estimator's sampling distribution. It quantifies the amount of variability in the estimate due to sampling.

37. (5 points) Explain how OLS defines the "best-fit" line.

Answer: OLS defines the best-fit line by minimizing the sum of squared residuals, where the *residuals* the differences between the observed values and the predicted values (the line).

38. (5 points) Explain the difference between a *residual* and a *disturbance*.

Answer: A residual is the difference between the observed value and the sample line (observable), while a disturbance is the difference between the observed value and the population line (unobservable). The disturbance is the error term in the population model, while the residual is the error term in the sample model.

39. (5 points) We showed in class that the probability limit of the OLS estimator (for the slope coefficient in a simple linear regression) is

$$\text{plim}\,\hat{\beta}_1 = \beta_1 + \frac{\text{Cov}(x,u)}{\text{Var}(x)}$$

Using this formula, explain how our OLS assumptions imply that the OLS estimator is consistent (when the assumptions are satisfied).

Answer: The assumption of exogeneity implies that the covariance between the regressor and the disturbance is zero, *i.e.*, $\text{Cov}(x,u) = 0$.

We also assume that the variance of the regressor is non-zero, *i.e.*, $\text{Var}(x) > 0$.

Together, these two assumptions imply the second term in the equation above is zero.

Thus, the probability limit of the OLS estimator is equal to the true population parameter β_1, which implies that the OLS estimator is consistent.

40. (5 points) Define the two requirements for a variable to cause *omitted-variable bias*.

Answer: The two requirements for a variable to cause omitted-variable bias are:

1. the omitted variable must correlate with the included regressor;
2. the omitted variable must affect the dependent variable.

41. (5 points) How do we quantify the uncertainty behind our OLS estimates?

Answer: We quantify the uncertainty behind our OLS estimates using standard errors, which we use to construct confidence intervals and conduct hypothesis tests.

The questions on this page refer to the regression model below.

$$\text{Health}_i = \beta_0 + \beta_1 \text{Income}_i + \beta_2 \text{Hispanic}_i + \beta_3 \text{Income}_i \times \text{Hispanic}_i + u_i$$

where Health_i is an index that runs between 0 and 100; Income_i measured in thousands of dollars; Hispanic_i is a binary (indicator) variable that equals 1 if individual i is Hispanic and 0 otherwise.

Suppose $\beta_0 = 10$, $\beta_1 = 1$, $\beta_2 = -5$, and $\beta_3 = 0.5$.

42. (5 points) Interpret β_1 and β_3 in the context of the model above.

Answer: The coefficient $\beta_1 = 1$ tells us the effect of income on health for non-Hispanic individuals: for a \$1,000 increase in income, we expect the health index increases by 1 point, holding all else constant.

The coefficient $\beta_3 = 0.5$ tells us how the effect of income on health differs between Hispanic and non-Hispanic individuals. Specifically, the value here indicates that for a \$1,000 increase in income, the health index increases an additional 0.5 points for Hispanic individuals, relative to non-Hispanic individuals.

43. (5 points) What is the expected value of health for a Hispanic individual with an income of \$50,000?

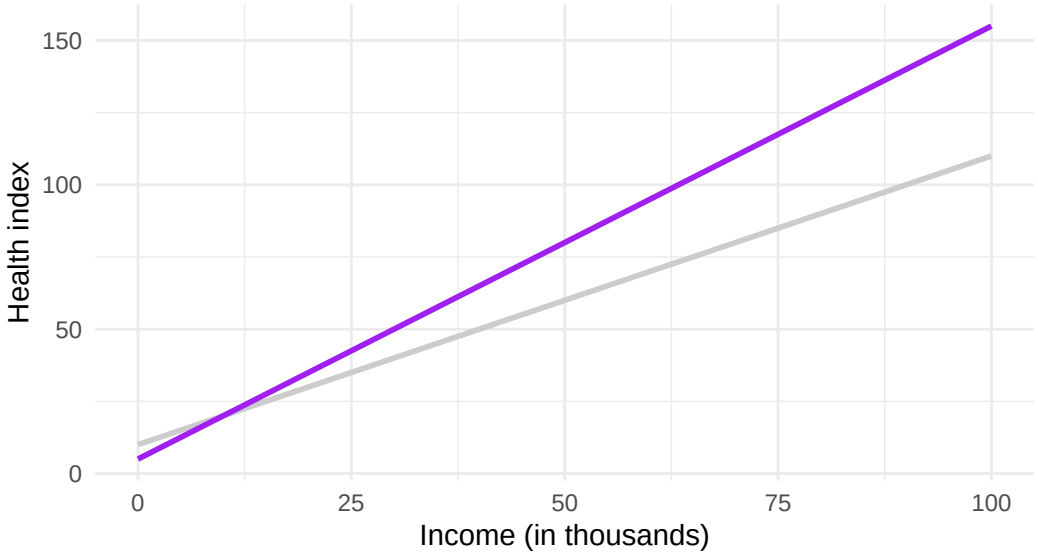
Answer: To find the expected value of health for a Hispanic individual with an income of \$50,000, we plug in the values into the regression equation:

$$\text{Health}_i = 10 + 1 \times 50 + (-5) \times 1 + 0.5 \times 50 \times 1 = 10 + 50 - 5 + 25 = 80$$

Thus, the expected value of health for a Hispanic individual with an income of \$50,000 is 80.

44. (5 points) Draw (approximately) the graph of the two lines implied by the preceding regression model. Don't worry about making it perfect—but do make sure to label the axes and get the general idea right.

Answer: The big thing here is to notice that the line for Hispanic individuals starts lower (has a lower intercept) and has a steeper slope than the line for non-Hispanic individuals.



45. (5 points) Draw a scatter plot that illustrates heteroskedasticity. Label the axes.

Answer: Several options here, but there should be a scatter plot with an explanatory variable on the x-axis and a disturbance on the y-axis. The plot should show that the variance of the disturbance changes with the value of the explanatory variable.