EC 421
Midterm

12 February 2019

Full Name ←

UO ID ←

No phones, calculators, or outside materials.

A. True/False, Multiple Choice, and Fill in the Blank

40 points

Note: You do not need to explain to your answers **in this section**.

01. [T/F] (**2pts**) For the model $\log(y_i) = \beta_0 + \beta_1 x_i + u_i$, we interpret β_1 as the percentage change in y due to a one-unit increase in x.

02. [T/F] (**2pts**) For the model $\log(y_i) = \beta_0 + \beta_1 \log(x_i) + u_i$, we interpret β_1 as the percentage change in y due to a one-unit increase in x.

03. [T/F] (**2pts**) The model $y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + u_i$ violates are linearity assumption by allowing y and x to have a *nonlinear* relationship.

04. [T/F] (**2pts**) When we use heteroskedasticity-robust standard errors, we still use OLS to estimate the coefficients (the β's).

05. [T/F] (**2pts**) Omitted-variable bias occurs whenever we omit a variable from a regression.

06. [T/F] (**2pts**) Heteroskedasticity is a violation of our exogeneity assumption.

07. [T/F] (**2pts**) In the presence of heteroskedasticity, OLS provides unbiased standard errors.

08. [T/F] (**2pts**) Measurement error biases the OLS estimates for the coefficients toward zero.

09. [T/F] (**2pts**) Omitted-variable bias causes OLS estimates for the coefficients to be biased, but OLS is a consistent estimator for the coefficients.

10. [T/F] (**2pts**) OLS is biased for models with lagged explanatory variables.

11. [T/F] (**2pts**) If an estimator is unbiased, then it must be consistent.

12. [T/F] (**2pts**) For random variables X and Y: $\text{plim}(X \times Y) = \text{plim}(X) \times \text{plim}(Y)$.

13. [T/F] (**2pts**) For random variables X and Y: $\boldsymbol{E}[X \times Y] = \boldsymbol{E}[X] \times \boldsymbol{E}[Y]$.

14. [Multiple choice] (**2pts**) In the presence of heteroskedasticity, which of the following is true?

A. OLS and WLS are biased, but OLS is less biased.
B. OLS is biased. WLS is unbiased.
C. OLS is unbiased. WLS is biased.
D. OLS and WLS are unbiased, but OLS is more efficient.
E. OLS and WLS are unbiased, but WLS is more efficient.

15. [Multiple choice] (**2pts**) Which of the following can lead to heteroskedasticity?

A. Adding a lagged outcome variable
B. Misspecification
C. Measurement error
D. Disturbances with different variances

16. [Fill in the blanks] (**4pts**) The **expected value** of an estimator is the _____ of the estimator's distribution (for a set sample size n), whereas the estimator's **probability limit** describes how the estimator behaves as n approaches _____.

17. [Fill in the blank] (**2pts**) If the estimator $\hat{\beta}_1$ is unbiased for β_1, then $\boldsymbol{E}\left[\hat{\beta}_1\right] =$ _____.

18. [Fill in the blank] (**4pts**) If our significance level is 0.05, and our p-value is 0.07, then we _____ the null hypothesis.

B. Short Answer

60 points

Note: You will typically need to explain/justify your answers in this section.

19. (**3pts**) What is the difference between u_i and e_i?

20. (**3pts**) **Briefly explain** what we mean by "the standard error of an estimator"?

21. One of our assumptions is that the errors are homoskedastic.

i. (**2pts**) Formally write down this assumption. *In other words:* Write out this assumption using expected values and/or variances of random variables (*i.e., use 'math'*).

ii. (**3pts**) Informally (in words): What does this assumption mean?

iii. (**2pts**) What does rejecting H_0 in a Goldfeld-Quandt test tell us about this assumption?

22. For each of the four figures below (depicting x_i and u_i), answer whether the figure suggests a violation of homoskedasticity. **Briefly explain** each of your answers.

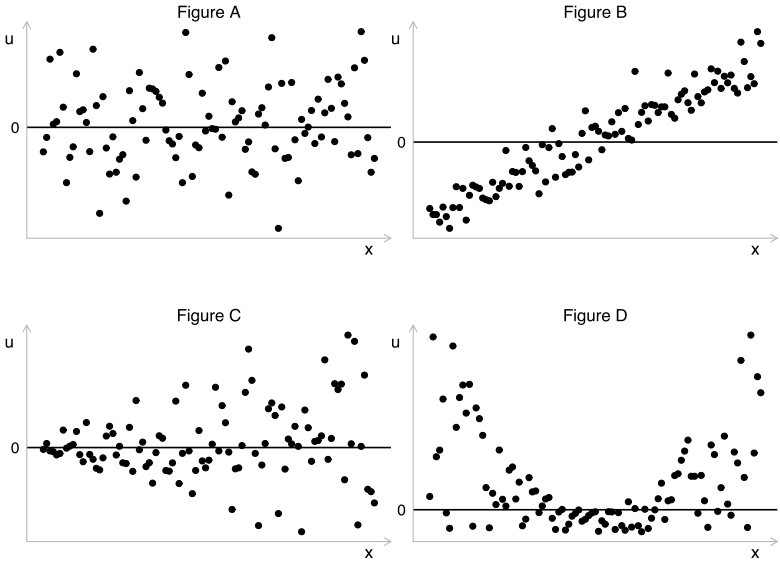


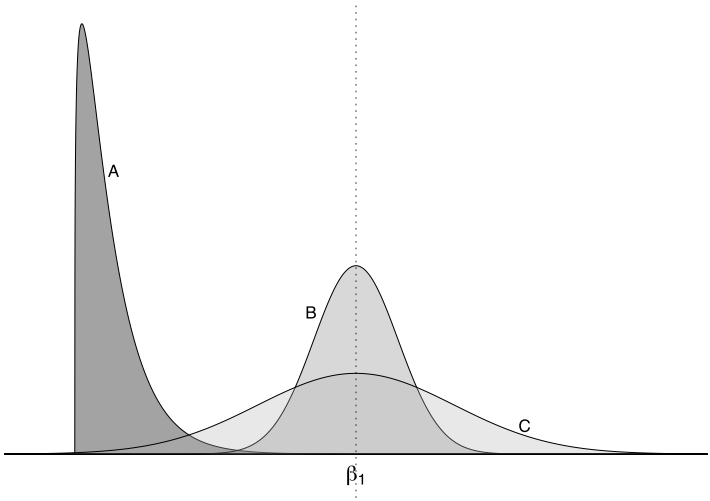
Figure A: (**1pt**)

Figure B: (**1pt**)

Figure C: (**1pt**)

Figure D: (**1pt**)

23. The figure below shows the distributions of three estimators for β_1: A, B, and C.



i. (**4pts**) Which estimators, if any, are unbiased? ***Briefly*** **explain** your answer.

ii. (**2pts**) Which estimator is the most efficient? ***Briefly*** **explain** your answer.

iii. (**2pts**) Does this figure tell us anything about the consistency of estimator **A**? **Explain.**

24. We want test for heteroskedasticity using a Breusch-Pagan test. We start by estimating the model

$$\text{Crime}_i = \beta_0 + \beta_1 \text{Police}_i + \beta_2 \text{Wages}_i + u_i$$

i. (**4pts**) Walk me through the necessary steps for completing the Breusch-Pagan test. Do not estimate anything—just outline the procedure, step by step.

ii. (**3pts**) Suppose we calculate a Breusch-Pagan test statistic of $\text{LM} = 12.3$, which has a p-value of approximately 0.031. Complete the Breusch-Pagan test (with conclusions).

iii. (**2pts**) How would a White test differ from the Breusch-Pagan test?

25. Consider the model

$$\text{Wage}_i = \beta_0 + \beta_1 \text{Experience}_i + \beta_2 \text{Female}_i + u_i$$

where Experience_i measures individual i's experience in the workforce (in years), and Female_i is a binary variable for whether individual i is female.

i. (**4pts**) What is the interpretation of β_1?

ii. (**3pts**) What is the interpretation of β_2?

iii. (**2pts**) Suppose you think the effect of *experience* changes depending upon whether the individual is female. Write down (**1**) a model that could test this hypothesis and (**2**) the null and alternative hypotheses that you would test.

26. (**2pts**) Give an example of a variable that would likely produce measurement error. Briefly explain your answer.

27. Consider the time-series model

$$\text{Births}_t = \beta_0 + \beta_1 \text{Income}_t + \beta_2 \text{Income}_{t-1} + \beta_3 \text{Income}_{t-2} + u_t$$

i. (**2pts**) What are the interpretations of β_1 and β_2 and how do they differ?

ii. (**2pts**) What is the *total* effect of income on births?

28. Suppose that we take a sample. Our observations in this sample come from two groups: **Group A** has very little noise/variation in its disturbances; **Group B** has *a lot* of noise/variation in its disturbances.

i. (**2pts**) **[T/F]** OLS ignores these differences in the variances of the disturbances.

ii. (**2pts**) **Explain the intuition** for how WLS takes advantage of differences in these disturbances' variances.

29. We have in mind the model

$$\text{Income}_i = \beta_0 + \beta_1 \text{Education}_i + \beta_2 \text{Ability}_i + u_i$$

but we cannot observe *Ability*. Instead, we run the regression

$$\text{Income}_i = \hat{\beta}_0 + \hat{\beta}_1 \text{Education}_i + e_i$$

i. (**3pts**) What two conditions are required for omitted-variable bias to bias our estimate of the effect of education on income?

ii. (**2pts**) If we assume that ability positively affects income, and ability is positively correlated with education, then will our estimate of β_1 be biased upward or downward?

iii. (**2pts**) How does your answer to (ii.) change if ability positively affects income but is negatively correlated with education?

C. Extra Credit

10 points

EC$_1$ [T/F] (**2pts**) If you fail to reject the null hypothesis in a Goldfeld-Quandt test, then you can conclude your disturbances are homoskedastic.

EC$_2$ For the `R` code and output below,

```
# The regression
ec_reg ← lm(problems ~ money, data = extra_credit)
# The results
tidy(ec_reg)
```

```
#> # A tibble: 2 x 5
#>   term        estimate std.error statistic   p.value
#>   <chr>          <dbl>     <dbl>     <dbl>     <dbl>
#> 1 (Intercept)    21.7    0.187        116. 1.12e-106
#> 2 money           3.00   0.00335      896. 1.45e-193
```

i. (**2pts**) Write down the model that we are estimating.

ii. (**2pts**) Interpret the output for the intercept—including its statistical significance.

EC$_3$ For each of the four figures below (depicting x_i and u_i), answer whether the figure suggests a violation of exogeneity. **Briefly explain** each of your answers.

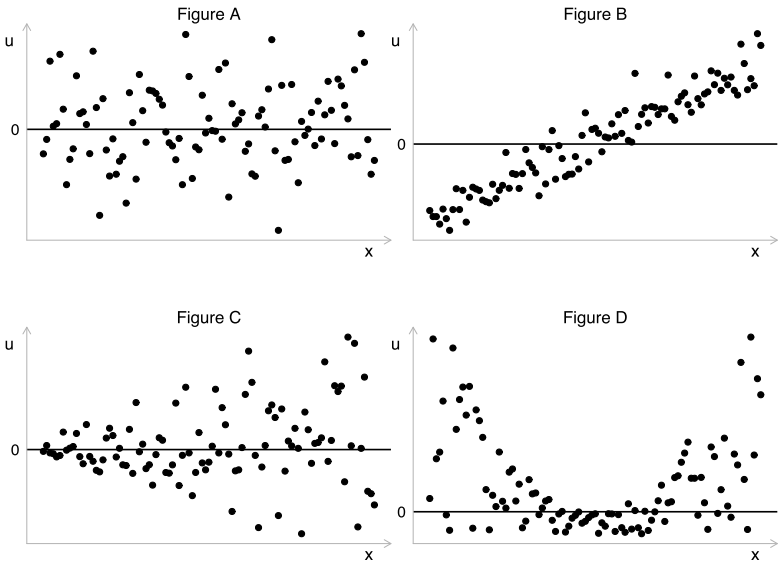


Figure A: (**1pt**)

Figure B: (**1pt**)

Figure C: (**1pt**)

Figure D: (**1pt**)