Name: _____

In-class final, EC607

100 points possible

Instructions For most of the following questions, a short response or derivation suffices.

Do not write more than necessary.

1. (5 points) Use the potential outcomes framework to show how (in expectation) a simple difference in means between the treated units $(\mathsf{D} = 1)$ and the control units $(\mathsf{D} = 0)$ equals the sum of a treatment effect and selection bias. To be clear: The answer should be a mathematical derivation using expectations.

2. (5 points) Continuing the derivation above: Show how a randomized control trial can identify the ATE using a simple difference in means.

3. (5 points) In seminars, it's common for someone to ask, "What about SUTVA?" Many applications of the potential outcomes framework rely on SUTVA—the *Stable Unit Treatment Value Assumption*. This assumption requires that the potential outcomes for one unit are not affected by the treatment status of another unit.

   Explain why this assumption (SUTVA) is important for using the potential outcomes framework to identify treatment effects. Hint: Think about the meaning of Y_{1i}.

4. (5 points) Throughout the course, we discussed at least five different treatment effects that one might recover: ATE, ATT, ATC, CATE, and LATE.

   For each of these treatment effects, provide (1) the name in English, (2) the mathematical expression, and (3) a brief description of what the treatment effect measures.

5. (5 points) The standard 2SLS procedure gives us three different sets of estimates: a first stage, a second stage, and a reduced form. Which of these estimates represents the ITT?

6. (5 points) Explain how 2SLS “adjusts” for noncompliance and why this adjustment is necessary.

7. (5 points) In the context of 2SLS: Define the exclusion restriction. When is it required?

8. (5 points) In the context of 2SLS: Define the monotoniciy assumption. When is it required?

9. (5 points) Define the *curse of dimensionality* and explain why it is a problem for matching estimators.

10. (5 points) How do matching estimators address selection bias? What assumptions do they rely on?

11. (5 points) Draw a DAG that includes

    - a treatment variable D that directly affects an outcome Y;
    - a confounder U that affects both D and Y;
    - a collider C that is affected by D and U.

12. (5 points) In the context of the DAG you drew above, explain why conditioning on C would introduce bias into the estimate of the treatment effect.

13. I have a dataset with 100 observations. I stack the dataset on top of itself to have 200 observations.

(a) (2 points) How would this data trick violate the IID assumption?

(b) (1 point) What would be the likely consequence of this violation?

(c) (2 points) Would using cluster-robust standard errors (clustered by observation) “help”? Explain.

14. (5 points) Compare and contrast selection-on-observables and selection-on-unobservables designs.

15. (5 points) Why do we include covariates in our regression models?

16. (5 points) Can including covariates in a regression model ever introduce bias? Explain your answer.

17. (5 points) Explain how propensity-score methods attempt to avoid the curse of dimensionality.

18. (5 points) When is a regression model causal?

19. (5 points) Suppose I ran 10,000 iterations of a simulation—each with a sample size of 500. Will the distribution of the estimated treatment effects tell me about the estimator's bias, consistency, both, or neither? Explain your answer.

20. (5 points) Explain the difference between identification and inference.