EC 320 Problem Set 1

Winter 2022

INSTRUCTIONS:

There are six big questions in total. Select four of which you can answer best and solve their mini problems.

1. Expectation (10 points)

Suppose there are two random variables, x and y. Answer in the simplest terms possible.

a) Let $z = 2x + 3y$. Find $E(z)$.

b) Let $w = 3x^2 + 2y$. Find $E(w)$.

c) Let $x = 6y$. Find $E(z)$ and $E(w)$.

d) Let $\gamma = 5xy$. Find $E(\gamma)$ and $E(\gamma|x = 2)$.

2. Population (10 points)

The following is a population distribution on some variable y.

y	$p(y)$
1	0.2
3	0.3
5	0.1
7	0.2
9	0.2

a) Calculate $E(y)$.

b) Calculate $E(e^y)$.

c) Calculate $e^{E(y)}$.

d) Calculate $E(2y^{-2} + y)$.

3. Sample (10 points)

The following is a sample data on some variable y and x. Answer the following questions.

id	y	x
1	1	2
2	3	4
3	5	6
4	7	8
5	9	10

a) Find the sample mean of y.

b) Find the sample variance of y.

c) Find the sample mean of x.

d) Find the sample variance of x.

e) Find the sample correlation coefficient between x and y.

4. Estimator (10 points)

a) Define in your own words what estimator is.

b) What is an unbiased estimator of a parameter θ? Use mathematical expressions.

c) Prove that sample mean is an unbiased estimator to estimate population mean μ.

5. Hypothesis Testing (10 points)

a) Describe type I error.

b) Describe type II error.

6. Fundamental Problem of Causal Inference (10 points)

Consider hypothetical data on the countefactual outcomes for six individuals. Answer the following.

i	treatment	y_{0i}	y_{1i}
1	0	7	2
2	0	4	3
3	0	6	9
4	1	5	2
5	1	3	7
6	1	8	1

a) Calculate individual treatment effects.

b) What is the **true** average treatment effect?

c) Fundamental problem of econometrics indicates that we could only observe y_1 for those treated and y_0 for those untreated. We can never observe their counterfactuals. Estimate the average treatment effects now by comparing the mean of the treated group and the mean of the control group.

d) Do you think the difference-in-means is unbiased? Explain your reasoning.