Final Exam Sample: Solutions

ECON 340: Economic Research Methods | Instructor: Div Bhagia

Print Name: ______________________________

This is a closed-book test. You may not use a phone or a computer.

Time allotted: 90 minutes
Total points: 20

Please show sufficient work so that the instructor can follow your work.

I understand and will uphold the ideals of academic honesty as stated in the honor code.

Signature: ____________________

1. (6 pts) Multiple-choice questions

   (a) Why do we use the $Adjusted$-R^2 instead of the R^2 when comparing models with different number of variables?

   - ☑ R^2 is always higher for a model with more variables even if some variables don't make sense.
   - ☐ It's not possible to calculate R^2 for models with more than one variable.
   - ☐ $Adjusted$-R^2 is concerned with whether estimates are causal.
   - ☐ All of the above

   (b) Which of the following is OLS trying to achieve?

   - ☐ Choose β_0 and β_1 to minimize $\sum_{i=1}^{n}(Y_i - \beta_0 - \beta_1 X)$
   - ☑ Choose β_0 and β_1 to minimize $\sum_{i=1}^{n}(Y_i - \beta_0 - \beta_1 X)^2$
   - ☐ Choose β_0 and β_1 to minimize $\sum_{i=1}^{n}(Y_i - (\beta_0 - \beta_1 X)^2)$
   - ☐ None of the above

   (c) The regression model:

$$sales = \beta_0 + \beta_1 advertising\_expenditure + u$$

   yields an R^2 of 0.24, then

   - ☐ Advertising expenditure explains 76% of the variation in sales.
   - ☐ Sales explain 24% of the variation in advertising expenditure.
   - ☑ Advertising expenditure explains 24% of the variation in sales.
   - ☐ None of the above

(d) Suppose I estimate the following model:

$$\ln Y = 100 - 12.45 \ln X$$

Then according to my model:

- ☑ If X increases by 1%, Y decreases by 12.45%
- ☐ If X increases by 1, Y decreases by 12.45%
- ☐ If X increases by 1, Y decreases by 12.45
- ☐ If X increases by 1%, Y decreases by 12.45

(e) Suppose I estimate the following model:

$$\hat{wages} = 500 + 2000age - 10age^2$$

According to this model, predicted wages for a 40-year-old individual are:

- ☐ \$80,500
- ☑ \$64,500
- ☐ \$500
- ☐ \$112,500

(f) Consider the following model:

$$Y = \beta_1 + \beta_2(D_1 \times D_2) + \beta_3 D_1 + \beta_4 D_2$$

where D_1 and D_2 are dummy variables that only take values 1 and 0. Then $E(Y|D_1 = 1, D_2 = 1) - E(Y|D_1 = 1, D_2 = 0)$ is given by:

- ☐ β_2
- ☐ $\beta_2 + \beta_3$
- ☑ $\beta_2 + \beta_4$
- ☐ $\beta_1 + \beta_2$

2. (8 pts) A researcher runs an experiment to determine whether small class sizes improve kindergarten school performance. To this end, kindergarten students are assigned at random to either a *regular* or a *small* class. Based on this experiment, the researcher writes down the following model for test scores:

$$testscore = \beta_0 + \beta_1 smallclass + u$$

where

testscore: test score on a standardized test

smallclass: takes value 1 if the student is assigned to the small class, and 0 otherwise

The researcher estimates the equation by OLS and finds:

$$\hat{\beta_0} = 904.5 \qquad S_{\hat{\beta_0}} = 1.55$$

$$\hat{\beta_1} = 14.35 \qquad S_{\hat{\beta_1}} = 2.63$$

The R^2 from the regression is 0.01.

(a) (2 pts) Given that the students were randomly assigned to the different types of classes, do you think we can interpret β_1 as the causal effect of a small class size on kindergarten performance? Why or why not?

Since students were randomly assigned to classrooms, students in both small and regular classes should be similar on other dimensions. This implies that the exogeneity assumption, i.e. $E(u|smallclass) = 0$ is satisfied here and we can attach a causal interpretation to β_1.

(b) (2 pts) Interpret each coefficient.

$\hat{\beta_0} = 904.5$ *is the average test score for students in regular classrooms. While* $\hat{\beta_1} = 14.35$ *is the increase in student test scores due to the smaller class size.*

(c) (1 pt) How do I interpret $\hat{\beta_0} + \hat{\beta_1}$?

$\hat{\beta_0} + \hat{\beta_1} = 918.85$ *is the average test score for students in small classrooms.*

(d) (1 pt) Does the low R^2 imply that the model is incorrect?

No, the low R^2 does not imply that the model is incorrect. We can still conclude that smaller class sizes increase test scores. The low R^2 is just indicating that there is still a lot of variation in test scores that is not explained by class size.

(e) (2 pts) You want to test the hypothesis that a *small* class is as effective as a *regular* class.

i. Formally state the null and alternative hypothesis.

$$H_0 : \beta_1 = 0 \qquad H_1 : \beta_1 \neq 0$$

ii. Calculate the t-value associated with this test. Can you reject your null at 5% level of significance?

$$t_0 = \frac{\hat{\beta_1}}{S_{\hat{\beta_1}}} = \frac{14.35}{2.63} = 5.46$$

Reject the null at 5% level of significance as $5.46 > 1.96$. So here the effect of small class is statistically significant at 5% level of significance.

3. (3 pts) Suppose the true population is given by:

$$wages = \beta_0 + \beta_1 education + \beta_2 ability + u$$

But instead we estimate the following regression model:

$$Y = \tilde{\beta}_0 + \tilde{\beta}_1 education + \tilde{u}$$

Do you think there will be an upward bias ($\tilde{\beta}_1 > \beta_1$) or a downward bias ($\tilde{\beta}_1 < \beta_1$)? Explain your reasoning.

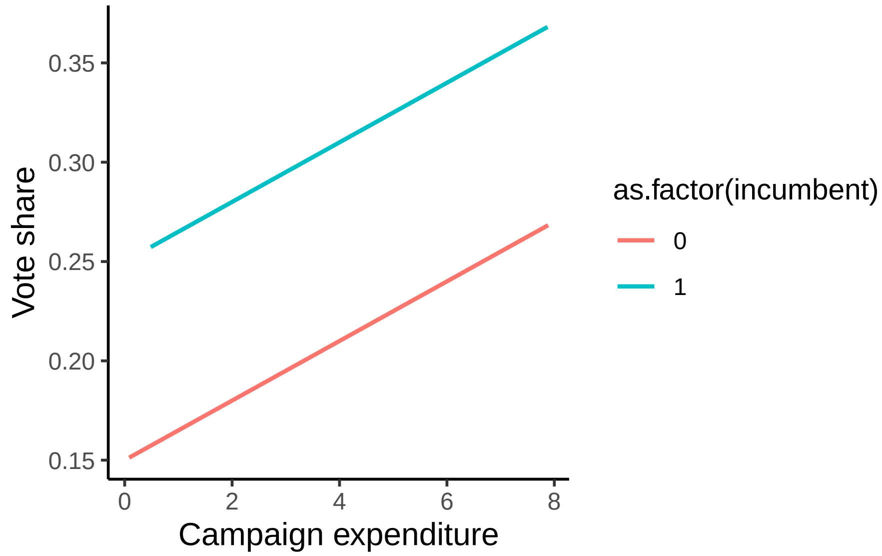
There will be an upward bias, i.e., $\tilde{\beta}_1 > \beta_1$. *Higher-ability individuals are more likely to succeed in attaining higher education and also more likely to earn higher wages. Consequently, excluding ability from our regression model causes the coefficient on education to reflect not only the impact of education but also that of ability.*

4. (3 pts) I estimated the following model:

$$vote\_share = \beta_0 + \beta_1 incumbent + \beta_2 campaign\_exp + u$$

Here, *incumbent* is a binary variable that takes the value 1 if the political candidate is an incumbent (i.e., won the previous election) and 0 if not. $campaign\_exp$ measures money spent on the candidate's campaign leading up to the election in millions of dollars.

The fitted data from this model is presented below. Given the fitted line answer the following.



(a) (1 pt) Is $\hat{\beta}_1 > 0$ or $\hat{\beta}_1 < 0$, or is it not possible to determine the sign of $\hat{\beta}_1$? Explain your reasoning.

$\hat{\beta}_1 > 0$ as the fitted line for incumbent candidates is above the fitted line for non-incumbent candidates.

(b) (1 pt) Is $\hat{\beta}_2 > 0$ or $\hat{\beta}_2 < 0$, or is it not possible to determine the sign of $\hat{\beta}_2$? Explain your reasoning.

$\hat{\beta}_2 > 0$ as the slopes of the fitted lines are positive.

(c) (1 pt) What is the interpretation of β_2?

Every one million dollar increase in campaign expenditure is associated with an increase in the vote share by β_2 percentage points, holding incumbent status constant.