API - 209 | Problem Set 9

Prof. Dan Levy

Due on Tuesday, November 1, 2022 at 10:00 am.

GENERAL INSTRUCTIONS

For questions 1-3, the "normal" rules for collaboration in API-209 problem sets apply, i.e., you are encouraged to work in a study group, but must write up your own answers. For question 3 (final exercise), you are asked to work in a group and everyone in the group should submit the exact same answers.

INSTRUCTIONS

To successfully complete this problem set, please follow these steps:

1. **Download this RMarkdown document file into your computer.**
2. **Insert all your answers into this document.** Guidance **here** on how to insert objects such as handwritten work or screenshot images in your answers.
3. **SAVE your work frequently**.
4. To make things easier to visualize in RStudio, you can set the view mode as "Visual" instead of as "Source" in the top left of your screen (just below the Save button).
5. Once your document is complete, please save it as a PDF by clicking the **KNIT** button.
6. Please submit an electronic copy of the PDF (and any separate requested files) to the Canvas course page.

   6.a) If you want to check a PDF version of this problem set before starting to work on it, you can always knit it. In fact, you can knit the document at any point.

   6.b) If you cannot Knit and it's time to submit the problem set, submit the RMarkdown file and make an appointment with a member of the teaching team
7. Remember to consult the R resources from math camp, particularly the HKS R cheat sheet (available **here**, which contains many of the commands needed to answer the questions in this problem set.

IDENTIFICATION

1. Your information

```
Last Name: Chaturvedi
First Name: Shreya
```

2. Group Members (please list below the classmates you worked with on this problem set):

```
Group members: Manisha Jha
```

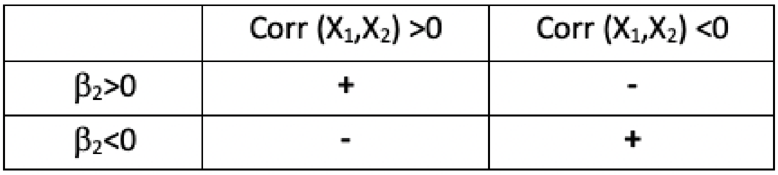
3. Compliance with Harvard Kennedy School Academic Code: Do you certify that my work in this problem set complies with the Harvard Kennedy School Academic Code[1] (mark with an X below)?

```
[ X ] YES                    [   ] NO
```

[1] We abide by the Harvard Kennedy School Academic code (available here) for all aspects of the course. In terms of problem sets, unless explicitly written otherwise, the norms are the following: You are free (and encouraged) to discuss problem sets with your classmates. However, you must hand in your own unique written work and code in all cases. Any copy/paste of another's work is plagiarism. In other words, you can work with your classmate(s), sitting side-by-side and going through the problem set question-by-question, but you must each type your own answers and your own code. For more details, please see syllabus.

QUESTION 1 – OMMITTED VARIABLE BIAS

As indicated in class, the *sign* of the bias of $\hat{\beta}_1$ when omitting X_2 in the estimation of $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u$ can be summarized in the table below:



	Corr (X_1,X_2) >0	Corr (X_1,X_2) <0
β_2>0	+	-
β_2<0	-	+

Pick two of the boxes in the table above. Illustrate ***each*** of these 2 cases with an example. Assume the regression equation you would like to estimate is $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + u$, but for some reason (lack of data or knowledge, for example), you end up omitting X_2 from the regression.

A. Describe the variables Y, X_1, X_2:

Answer:

Please enter your answer here.

Example 1:

Y = Probability of getting diabetes for an individual

X1 = BMI of individual

X2 = Family History of Diabetes (Number of family members with diabetes)

Example 2:

Y = Marathon Finishing Time

X1 = Age

X2 = Fitness Level

B. Indicate the sign of the correlation between X_1 and X_2, and explain why you should expect such sign [1-2 sentences]:

Answer:

Please enter your answer here.

Example 1: There is a positive correlation between X1 and X2 (people with a family history of diabetes and obesity are more predisposed to have a higher BMI).

Example 2: There is a negative correlation between X1 and X2 (people who are older tend to have lower fitness levels than people who are younger).

C. Indicate the sign of β_2, and explain why you would expect such sign [1-2 sentences]:

Answer:

Please enter your answer here.

Example 1: beta2 is positive - Each additional member who has diabetes in one's family increases their odds of being diagnosed with diabetes

Example 2: beta2 is negative - A higher fitness level is associated with a lower marathon finishing time

D. Indicate the sign of the bias if you were to omit X_2 from the regression, and explain why you would expect such sign [1-2 sentences]:

Answer:

Please enter your answer here.

In both cases, the bias would be positive. Without X2, the coefficient of X1 is much larger than what it would have been with X2 for both the examples.

E. Indicate how your estimated $\hat{\beta_1}$ is likely to change when omitting X_2 from the regression, i.e., will it get larger or smaller relative to when you estimate the full regression (with both X_1 and X_2 as explanatory variables)? Explain your reasoning both in technical terms (using your answers to the previous sub questions) and in terms a policy-maker can understand (i.e., explain whether you will be over or understating the importance of X_1).

Answer:

Please enter your answer here.

For both examples, beta1 is likely to get larger as a result of omitting X2 from the regression. As the bias is positive, the coefficient is further pushed away from zero (alpha1 is beta1 + BIAS), hence alpha1> beta1.

Intuitively, we understand that if we remove X2 from the regression (possibly because they are not directly observable in the case of fitness levels or difficult to obtain data on in the case of family history), we overstate the importance of X1 on the dependent variable Y.

F. **Training and Wages:** Suppose that wages depend on two factors: hours of training (`hourstraining`) and years of education (`educ`):

$wage_i = \beta_0 + \beta_1 hourstraining_i + \beta_2 educ_i + u_i$

Suppose that in a certain city, a large subsidy was offered to workers with low levels of schooling such that `hourstraining` and `educ` are negatively correlated. Suppose you had data on workers that live in the city where the program is operating, and you estimate:

$wage_i = \alpha_0 + \alpha_1 hourstraining_i + v_i$

Do you think $\hat{\alpha_1}$ is an unbiased estimator of the causal effect of hours of training on wages? If yes, explain why. If not, explain whether omitting `educ` from the regression is likely to lead to over or understating the importance of hours of training for wages.

Answer:

Please enter your answer here.

No, I do not think alpha1(hat) is an unbiased estimator of the causal effect on hours of training on wages. This is because there is omitted variable bias since hours of training and education are correlated, AND education is also a determinant of wages.
In this case, since beta2(hat) is positive and the correlation between X1 and X2 is negative, the sign of bias is negative. In other words, omitting education from the regression is likely to understate the importance of hours of training on wages.

QUESTION 2 – CONCEPTUAL QUESTIONS ABOUT REGRESSIONS AND RCTs

1. For your first example in the previous question, answer the following question: As you move from the short regression (the one with only one explanatory variable) to the long regression (the one with the two explanatory variables), what do you think will happen to the standard error of $\hat{\beta}_1$?[2]

☒ They would increase
☐ They would stay the same
☐ They would decrease
☐ Not enough information
☐ I don't know

Select your preferred option above, and write a paragraph below justifying your choice:

Answer:

Please insert your answer here.

This is a case of bias-variance trade off. By adding the explanatory variable to our regression, we are removing the omitted variable bias. However, since X1 and X2 are related to each other the regression cannot disentangle the effects from each other. As a result, the standard error of beta1(hat) increases.

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2. Suppose you had a well-designed and conducted randomized trial (RCT) to estimate the effect of an education intervention on test scores. You run a regression $testscore = \beta_0 + \beta_1 treat + u$, where `testscore` represents the test score two years after the intervention. Explain what you think will likely happen to the following if we ran the same regression as before but included test scores at baseline (i.e., before the program took place) as an additional explanatory variable:

a. magnitude of $\hat{\beta}_1$

b. standard error of $\hat{\beta}_1$

Write a paragraph below justifying your choices:

Answer:

Please insert your answer here.

Since this is a perfectly designed and conducted RCT, we can assume that there is no correlation between treatment status (treat) and baseline test scores. This means that there is no omitted variable bias here. As a result the magnitude of beta1(hat) will not change by introducing baseline test scores. Similarly, because baseline test scores and treatment status are not related, adding the extra explanatory variable will not change the standard errors of beta1(hat)

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[2] You may assume homoskedasticity to answer this question.

QUESTION 3A – ONLINE MODULE ON DUMMY VARIABLES

Background: The goal of this problem set question is to help you deepen your understanding of **Dummy Variables**. You will be asked to watch a short module and answer some questions in a quiz. The quiz results will give me information about overall performance of the class that I will use to prepare for class; your individual performance in the quiz will be registered in the system but will not count towards your grade in any way.

To get full credit for this question, you need to engage with the module and complete the quiz. Please make sure you submit your answers at the end of the quiz/survey so that they are registered. The module is available here:

https://canvas.harvard.edu/courses/109224/modules/227112

Answer:

Please enter "Done" in this field once you have completed the quiz.

Done

QUESTION 3B – ONLINE MODULE ON NON-LINEAR REGRESSIONS

Background: The goal of this problem set question is to help you deepen your understanding of **Non-Linear Regressions**. You will be asked to watch a short module and answer some questions in a quiz. The quiz results will give me information about overall performance of the class that I will use to prepare for class; your individual performance in the quiz will be registered in the system but will not count towards your grade in any way.

To get full credit for this question, you need to engage with the module and complete the quiz. Please make sure you **submit** your answers at the end of the quiz/survey so that they are registered.

The module is available here:

https://canvas.harvard.edu/courses/109224/modules/227113

Answer:

Please enter "Done" in this field once you have completed the quiz.

Done

This is the last online module in this course (see full list below). These modules were meant to help you learn things before class, so we can use the in-class time more productively. Please take 3 minutes to complete this brief survey to give anonymous feedback and help improve the modules for the future.

Answer:

Please enter "Done" in this field once you have completed the survey

Done

QUESTION 4 - FINAL EXERCISE

This part of the problem set is designed to be completed with your final exercise team. As opposed to other problem set questions where you are asked to write your answers in your own words, all team members can submit identical answers for this question. But please submit answers individually (as part of the problem set you submit) this time to facilitate the grading.

Note: The goal of this question is to help you advance in the final exercise, so you increase your chances of producing a final product you are proud of. Don't feel too constrained by the specific prompts you see below. You should try to answer each of the prompts but your team should decide how much time it is worth to spend at this time on each of the items below. Ultimate goal is to nudge you in the direction of making progress.

Link to final exercise is here.

The first task for your group is to decide which of the final exercise options you will pursue. Please indicate the members of your team and your final exercise option by filling in this **brief survey**.

NOTE: Only one member of the team should fill in the survey

Please enter "Done" in this field once one member of your team has filled the survey.

Done

OPTION 1 - Mongolia (Macro)

1. Download the datasets and familiarize yourself with the data. Note that some of the data sets are huge, so you will need to store them in a computer with enough memory. Which topics are well-captured by the surveys? Which topics are not? Take note that while the Mongolian National Statistics Office provides most of their micro datasets in English, the reports may be in Mongolian. Be realistic in the language barrier constraints.
2. Download and read the seminal paper Growth Diagnostics (Hausmann, Rodrik and Velasco, 2005). Between your full set of group members, also read the expanded "Mindbook" of Growth Diagnostics (Hausmann, Klinger and Wagner, 2008) and examples of Growth Diagnostics.
3. Read/skim background documents on Mongolia to familiarize yourself with the economic context.
4. Brainstorm some possible "tests" that you would run on each of the branches of the tree to identify a constraint. Start to think about which ones will be easier to conduct given the data available and which ones may prove challenging. If there is confusion over the conceptual underpinnings, consult an example growth diagnostic or the teaching team.
5. Decide how you plan to organize the work. Who will do what? Establish some deadlines.

Please enter your answers here

OPTION 2 - Health in Brazil (Micro)

1. Download the data sets you will need and make sure they contain all the data that you will need for your analysis. Familiarize yourself with the data.
2. Read/skim background documents so that you familiarize yourself with the context.
3. Present summary statistics for the main variables in the PNS, SIM, SIH and CNES data sets. Is there a lot of variation across municipalities and states? What implications does the answer to this question has in terms of coming up with an algorithm that could predict the number the burden of diseases at the municipality level?
4. Start thinking about what predictors you might want to use to predict the burden of diseases in each municipality.
5. Brainstorm some ideas for what hypotheses you might explore and how you might use the data to explore these hypotheses.
6. Decide how you plan to organize the work. Who will do what? Establish some deadlines.

Please enter your answers here

3. This shows that there is a lot of variation since many municipalities are clustered at lower levels of hospitalization and mortality, but some municipalities (most likely cities or urban areas) have really high levels of hospitalization and mortality.
   We will explore assigning weights by population density in our analysis to avoid skewing disproportionately towards urban areas.
4. To start with, we want to dig into the following variables:
   1. Current hospitalization rate
   2. Mortality Rates
   3. Socio-economic and health variables from PNS
   4. Population density
   5. Vaccination Rates
   6. Assess trends in big cities vs small rural areas. Perhaps recommend different strategies for each of these

5. Brainstorm some ideas for **what hypotheses you might explore** and how you might use the data to explore these hypotheses.

a. Population density is inversely related to disease burden.

b. Income level is inversely proportional to disease burden.

c. Municipalities with poor sewer system are in desperate need of better infrastructure.

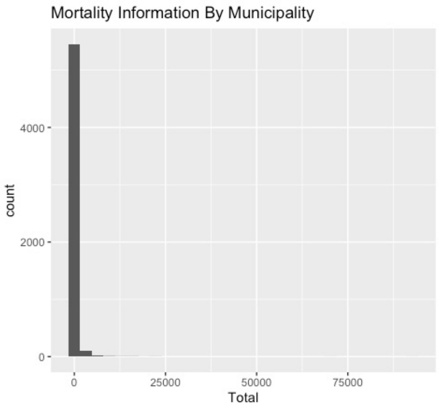
d. The numbers in municipalities with high levels of socio-economic inequality might not be telling the whole story.

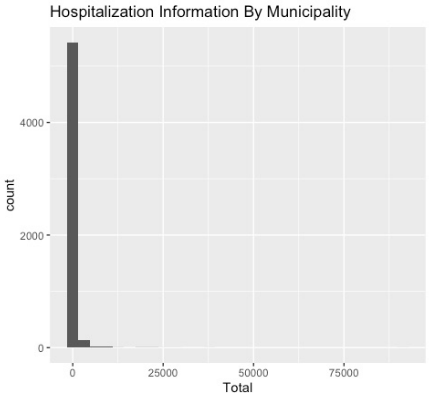
e. Make clusters of municipalities

6. Timelines:
   Launch meeting: Thursday, November 1
   Meet after API-209 classes
   Tentative Roles:

   1. Luisa: Minister of Health. Expert on Brazil. R & Writing the memo
   2. Shreya: R
   3. Bharath: Writing the Memo & PPT
   4. Kwang: Writing the Memo & PPT
   5. Masato: R
   6. Carlos: Writing the Memo & PPT

   Task #1 Deadline: Nov 12
   Task #2 Deadline: Nov 15
   Complete Draft for Memo: Nov 22


Mortality Information By Municipality
count
Total


Hospitalization Information By Municipality
count
Total