

# Midterm - Booklet 1

## Eco 231 - Undergraduate Econometrics

11/02/2011 (Prof. Carolina Caetano)

### INSTRUCTIONS

Reading and understanding the instructions is your responsibility. Failure to comply may result in loss of points, and there will be no leniency on that respect.

1. You have received two booklets. Booklet 1 contains the exam instructions and the exam questions. Booklet 2 contains the numbered pages where you will answer the questions.
2. This exam has 14 questions, and it is worth 100 points. Each question is worth the same. You have until 5 minutes before the end of the regular class time to answer it.
3. You must answer each question exactly in the space provided for each question in Booklet 2. You may use the back of the pages if they are empty. If you answer a question out of the order, or otherwise not on the space provided for it in the second booklet, your question will not be graded. If you need more space, you must ask for extra paper from the TA. It is your responsibility at the end of the exam to staple the extra page exactly in the right place in your exam. You may ask for draft paper if you like.
4. You are not allowed the use of notes, cheat sheets, calculators, or electronic devices of any kind. Turn your cell phone off, and put it away. If you did not bring a watch, check the board. The TAs will write down the time in the board every 15 minutes. If your answers are unclear or illegible you may lose points. You may answer in pencil.
5. If you finished your exam until 10 minutes before the end of class time, you may hand it back and leave the room. However, you may not keep booklet 1.
6. If you finished within 10 minutes of the end of class time, you must remain seated. Do not get up when the TA announces the time is up. Follow the TA's instructions about how to hand booklet 2. You may keep booklet 1 for yourself.
7. Sign and print your name on booklet 2. Your signature demonstrates that you have read and understood the instructions. An exam without the signature will not be graded.

All 14 questions below are worth the same. Here is a breakdown of what I anticipate are the difficulty levels of the questions:

- Easy: 1, 2, 3, 4, 7, 11
- Medium: 5, 6, 9, 10, 12, 14
- Hard: 8, 13

Suppose one is interested in studying the effects of law school reputation on salaries, i.e. whether the name on the diploma matters. In other words, consider two lawyers that are exactly the same in every possible observable and unobservable characteristic, including law knowledge and life experiences. If one has a diploma from a higher ranked school than the other, will they have different salaries? We write the model

$$\log(\textit{salary}) = \beta_0 + \beta_1 \textit{rank} + \beta_2 \textit{LSAT} + \beta_3 \textit{GPA} + \beta_4 \log(\textit{cost}) + u$$

where *salary* is the median starting salary of each graduating class in the sample, *rank* is the law school's ranking (with  $\textit{rank} = 1$  being the best), *LSAT* is the median LSAT score for the graduating class, *GPA* is the median college GPA for the class, and *cost* is the annual cost of attending that law school.

- 1) What is the point of this research question? In other words, who would be concerned with this, and why?
- 2) Why is this such a complex research question? What are the issues to take in consideration when tackling this problem?
- 3) What is the interpretation of  $\beta_1$ ?
- 4) Should  $\log(\textit{cost})$  be included in the regression? Why?
- 5) Can you think on any omitted variable which should be included in the model? Describe in detail why the variable you suggested should be included, and try to predict how this omission affects the OLS estimate of  $\beta_1$ .
- 6) How would you expect the estimate of  $\beta_0$  to change if *GPA* was eliminated from the regression? Justify your answer.
- 7) Enunciate in detail all the assumptions required for the theorem that derives the variance formula of the OLS estimator of  $\beta_1$ .
- 8) Describe why random sampling is necessary for the unbiasedness of the OLS estimator of  $\beta_1$ . In order to do this, consider what would happen if the sample contained only schools in the states of New York and Alabama.

- 9) What will happen to the variance of  $\hat{\beta}_1$  if *LSAT* is eliminated from the model? Explain.
- 10) Consider the “partialling out” interpretation of multiple regression in the context of the example above

$$\hat{\beta}_1 = \frac{\sum_{i=1}^n \hat{r}_{i1} \log(\text{salary})_i}{\sum_{i=1}^n \hat{r}_{i1}^2}$$

where the  $\hat{r}_{i1}$  are the residuals from a simple regression of *rank* onto *LSAT*, *GPA*, and  $\log(\text{cost})$ . Suppose that the assumptions required for the unbiasedness of the OLS estimator hold, and observe that  $\sum_{i=1}^n \hat{r}_{i1} \text{rank}_i = \sum_{i=1}^n \hat{r}_{i1}^2$ , and that  $\sum_{i=1}^n \hat{r}_{i1} \text{LSAT}_i = \sum_{i=1}^n \hat{r}_{i1} \text{GPA}_i = \sum_{i=1}^n \hat{r}_{i1} \log(\text{cost})_i = 0$ . Show that  $\hat{\beta}_1$  is unbiased.

- 11) Suppose that we included dummies of geographical location of the law school, so the model is now

$$\begin{aligned} \log(\text{salary}) = & \beta_0 + \beta_1 \text{rank} + \beta_2 \text{LSAT} + \beta_3 \text{GPA} + \beta_4 \log(\text{cost}) \\ & + \beta_5 W + \beta_6 MW + \beta_7 SW + \beta_8 SE + u \end{aligned}$$

where *W* is a dummy variable which is equal to one if the school is in the West, zero otherwise; *MW* is a dummy variable which is equal to one if the school is in the Midwest, zero otherwise; *SW* is a dummy variable which is equal to one if the school is in the Southwest, zero otherwise, and *SE* is a dummy variable which is equal to one if the school is in the Southeast, zero otherwise.

One of the US regions was not mentioned: the Northeast. Why didn't we include a dummy variable *NE*, which is equal to one if the school is in the Northeast, and zero otherwise?

- 12) Consider the model in the previous question. What is the interpretation of  $\beta_1$ ? Show your reasoning.
- 13) Consider the model in question 11. What is the interpretation of  $\beta_7 - \beta_8$ ? Show your reasoning.
- 14) Suppose that we know that

$$\sqrt{n} \frac{\hat{\beta}_1 - \beta_1}{\sqrt{\widehat{\text{Var}}(\hat{\beta}_1)}} \sim N(0, 1)$$

Observe that if a random variable  $X \sim N(0, 1)$ , then  $P(|X| > 1.96) = 0.05$ . How would you test the hypothesis that the rank of a law school does not have any effect on salaries with 95% confidence?

## Booklet 2 - Midterm (11/02/11) - Eco 231W

1. Name: \_\_\_\_\_

2. Student ID: \_\_\_\_\_

3. Class time: \_\_\_\_\_

Good wishes!

Question 1)



Question 2)



Question 3)



Question 4)



Question 5)



Question 6)

Question 7)

Question 8)





Question 9)

Question 10)



Question 11)

Question 12)

Question 13)

Question 14)

