The University of Kansas

Department of Economics

Midterm 2 — **Nov/02/2018**
Econ 526 - Introduction to Econometrics — **Instructor: Caio Vigo Pereira**

Name:

REGRESSION (A)

Consider a model relating the annual number of crimes on college campuses to the number of police officers and student enrollment. The econometric model is:

$$log(crime) = \beta_0 + \beta_1 police + \beta_2 log(enroll) + u$$

where *crime* is total campus crimes, *police* is the number of employed officers and *enroll* is the total enrollment.
The *R* output is:

	Dependent variable:
	log(crime)
police	0.0240***
	(0.0073)
log(enroll)	0.9767***
	(0.1373)
Constant	-4.3758***
	(1.1990)
Observations	97
R2	0.6277
Adjusted R2	0.6198
Residual Std. Error	[redacted]
F Statistic	79.2389*** [redacted]
Note:	*p<0.1; **p<0.05; ***p<0.01

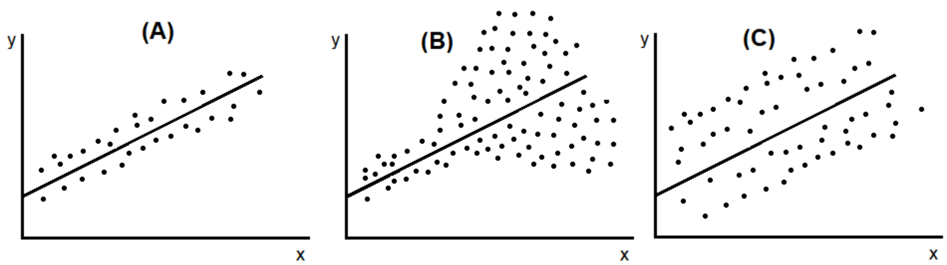
SECTION A - MULTIPLE CHOICE

4% 1. Based on the Regression (A) above, what is the effect on the dependent variable if *police* increases one unit?
A. $\widehat{log(crime)}$ will increase 2.40%
B. $\widehat{crime}$ will increase 2.40%
C. $\widehat{log(crime)}$ will increase 0.0240%
D. $\widehat{crime}$ will increase 0.0240%

$\boxed{4\%}$ 2. Based on the Regression (A) above, what is the effect on the dependent variable if *enroll* increases 10%?

A. $\widehat{crime}$ will increase 9.767%
B. $\widehat{log(crime)}$ will increase 0.9767%
C. $\widehat{log(crime)}$ will increase 9.767%
D. $\widehat{crime}$ will increase 0.9767%

Figure 1:



$\boxed{4\%}$ 3. Consider the models from the Figure 1 above. Which models present heteroskedastic errors?

A. (A) and (B)
B. (B) and (C)
C. (A) and (C)
D. Only (B)

$\boxed{4\%}$ 4. Refer to Figure 1 again. What can you tell about $Var(\hat{\beta})$?

A. The $Var(\hat{\beta})$ from model (A) is larger than the $Var(\hat{\beta})$ from model (B), considering all other factors that may affect the variance the same.
B. The $Var(\hat{\beta})$ from model (B) is larger than the $Var(\hat{\beta})$ from model (A), considering all other factors that may affect the variance the same.
C. The $Var(\hat{\beta})$ from model (C) is larger than the $Var(\hat{\beta})$ from model (A), considering all other factors that may affect the variance the same.
D. The $Var(\hat{\beta})$ from model (A) is larger than the $Var(\hat{\beta})$ from model (C), considering all other factors that may affect the variance the same.

$\boxed{4\%}$ 5. Refer to Figure 1 again. Assuming that assumptions **MLR.1 - MLR.4** hold, for which models the OLS estimator will be unbiased?

A. (A), (B) and (C)
B. (A) and (C) only
C. Only (B)
D. Only (A)

SECTION B - TRUE OR FALSE

$\boxed{3\%}$ 1. An explanatory variable is said to be exogenous if it is correlated with the error term.

◯ True ◯ False

3% 2. (Cobb-Douglas production function) Consider the following model:

$$y_i = \beta_0 x_2^{\beta_1} x_2^{\beta_2} e^u$$

After applying the natural logarithm on both sides, this model is linear in parameters.

◯ True ◯ False

3% 3. Consider the following models:

$$\text{Model 1:} \quad y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + u$$

$$\text{Model 2:} \quad y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + u$$

Then, $R^2_{model1} > R^2_{model2}$.

◯ True ◯ False

3% 4. Consider the following model:

$$log(score) = \beta_0 + \beta_1 log(hsgpa) + \beta_2 log(hsgpa^3) + u$$

Then, this model suffers from perfect collinearity.

◯ True ◯ False

3% 5. Consider the following model:

$$log(wage) = \beta_0 + \beta_1 educ + \beta_2 exper + \beta_3 exper^2 + u$$

Then, this model suffers from perfect collinearity.

◯ True ◯ False

3% 6. Normally distributed errors is a necessary assumption in order to the OLS estimator to be efficient.

◯ True ◯ False

3% 7. Whenever $E(u|x_1, \ldots, x_k) = 0$, we say that $x_1, \ldots, x_k$ are endogenous explanatory variables.

◯ True ◯ False

3% 8. If you omit an important variable in a multiple linear regression this will cause the OLS estimator to be biased.

◯ True ◯ False

3% 9. (*This question refers to Regression (A) on the first page of your exam.*) Based on this model, β_2 represents the elasticity of *crime* with respect to *enroll*.

◯ True ◯ False

3% 10. (*This question refers to Regression (A) on the first page of your exam.*) Based on this model, $100 \cdot \beta_1$ represents the semi-elasticity of *crime* with respect to *police*.

◯ True ◯ False

SECTION C - SHORT ANSWER

1. (*This question refers to Regression (A) on the first page of your exam.*) Below you can find additional information about this regression:

$$x_1 = \text{police}$$

$$x_2 = \log(\text{crime})$$

$$\sum_{i=1}^{97}(y_i - \hat{y}_i)^2 = 68.18$$

$$\sum_{i=1}^{97}(x_{i1} - \bar{x}_{i1})^2 = 23,454.25$$

5% (a) Under the assumption of homoskedastic errors, what is the variance of $\hat{\beta}_{police}$, i.e., what is the formula of $Var(\hat{\beta}_{police})$? [One line answer]

5% (b) What is estimator of the variance of u given x_1, x_2, i.e., the estimator of $Var(u|x_1, x_2)$? [One line answer]

5% (c) Based on your answer above, find $\hat{\sigma}^2$. [If you don't have a calculator with you, you may just show your work to get full credit]

5% (d) Based on your answer above, find $\hat{\sigma}$, i.e., the Residual Standard Error. [If you don't have a calculator with you, you may just show your work to get full credit]

5% (e) Consider the following (additional) regression:

$$\widehat{police} = -93.798 + 12.187\ log(enroll)$$
$$n = 97,\ R^2 = 0.4206$$

What is the $se(\hat{\beta}_{police})$? Is the $se(\hat{\beta}_{police})$ presented in the regression output table correct? [If you don't have a calculator with you, you may just show your work to get full credit]

2. **Gauss-Markov Theorem**

15% (a) Under which assumptions does the Gauss-Markov theorem holds? State and explain each one of them.

5% (b) State precisely the Gauss-Markov theorem? [You may refer to part (a). If you want to use abbreviations or acronyms, you must write what it stands for.]

3. Consider the following regression model:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + u$$

5% (a) Specify the least squares function that is minimized by OLS.

5% (b) EXTRA POINT Find the OLS first order conditions (FOCs). How many FOCs exist?

EXTRA POINTS

2.5% 1. **(A-06)** The assumption that there are no exact linear relationships among the independent variables in a multiple linear regression model fails if ________, where n is the sample size and k is the number of parameters.
A. $n > 2$
B. $n > k + 1$
C. $n < k + 1$
D. $n = (k + 1)^2$

2.5% 2. **(B-11)** Consider the following model:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + u$$

If $corr(x_1, x_2) = 0.97$, the OLS estimator will provide a biased estimates.

◯ True ◯ False