

The University of Tennessee, Knoxville  
Econ 381: Introduction to Econometrics  
Midterm 1  
September 8, 2016

**Do not open this booklet until instructed to do so.**

Name: .....

**Instructions and advice:**

1. There is plenty of time. Take it, do not rush.
2. There are blank pages at the back for rough work, which you should use to show your work. Keep this legible, and write only your final answers on the answers pages.
3. The maximum score in this exam is 100 points. Note the points allocated to each question.
4. There is a big difference between 3 and -3, and there is a big difference between  $Y$  and  $\bar{Y}$ . Be careful with your answers.
5. There is enough room in the spaces provided for a perfect answer. Every question can be answered with a well-structured sentence or two; and you will not receive extra points for long-winded answers.
6. This is a closed book exam, and calculators capable of anything complicated are not allowed.
7. If you cheat, you will fail the course. Avoid the temptation to look into the work of the person next to you.
8. Best of luck.

# Question 1 – Linear Algebra of OLS

You are the new data analyst at Hargaden-Chang Brewing, a Knoxville startup that produces beer. Your boss wants you to estimate the effect of the weather on sales. He gives you two data-points of sales ( $Y$ ) and the temperature in Knoxville in Celsius ( $X_1$ ), and wants you to calculate the linear relationship between the two, allowing for an intercept. He has set up the data for you conveniently, so calculating the intercept ( $\alpha$ , sometimes known as  $\beta_0$ ) and slope ( $\beta_1$ ) is as easy as possible:

$$\begin{array}{cc} Y \text{ (Sales)} & X \text{ (Intercept and temp)} \\ \begin{bmatrix} 10 \\ 16 \end{bmatrix} & \begin{bmatrix} 1 & 12 \\ 1 & 16 \end{bmatrix} \end{array}$$

You might find it useful to know that  $12 \times 12 = 144$ ,  $16 \times 16 = 256$ , and  $28 \times 28 = 784$ .

- If  $X$  is the matrix shown above, what is its transpose  $X'$ ? [5 points]
- Calculate the matrix  $(X'X)$ . [5 points]
- What is the adjoint of  $(X'X)$ ? [5 points]
- What is the determinant of  $(X'X)$ ? [5 points]
- What is the inverse of  $(X'X)$ ? [5 points]
- Using the fact that  $(X'Y) = \begin{bmatrix} 26 \\ 376 \end{bmatrix}$ , calculate the vector  $(X'X)^{-1}(X'Y)$  to obtain  $\hat{\alpha}$  and  $\hat{\beta}$ . [5 points]
- Write an equation predicting sales ( $\hat{Y}$ ) based on temperature ( $X_1$ ), using your actual values for  $\hat{\alpha}$  and  $\hat{\beta}$ . [10 points]

## Question 2 – Application of OLS

Some Stata output is shown below. It is a regression of Real GDP growth (in percentage terms, year-on-year), on the unemployment rate, debt as a percent of GDP, the inflation rate, the openness of the economy to international trade, the natural log of population, and whether the country has a Presidential (`pres=1`) or Parliamentary (`pres=0`) system.

```
. reg realgdpgr unemp debt inf open ln_pop pres
```

Source	SS	df	MS	Number of obs	=	869
Model	375.107697	6	62.5179494	F(6, 862)	=	10.03
Residual	5372.05148	862	6.23207828	Prob > F	=	0.0000
				R-squared	=	0.0653
				Adj R-squared	=	0.0588
Total	5747.15917	868	6.62115112	Root MSE	=	2.4964

realgdpgr	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
unemp	-.0487645	.024176	-2.02	0.044	-.0962153    -.0013138
debt	-.0190942	.0033268	-5.74	0.000	-.0256238    -.0125646
inflation	-.0490558	.014139	-3.47	0.001	-.0768067    -.0213048
openc	-.0014682	.0026837	-0.55	0.584	-.0067354    .0037991
ln_pop	-.0282997	.0769572	-0.37	0.713	-.1793451    .1227457
pres	-.4091282	.2435135	-1.68	0.093	-.8870769    .0688206
_cons	4.940772	.8633701	5.72	0.000	3.246218    6.635326

Don't worry if your answers are slightly repetitive. **Important tip:** take a deep breath, and write out sample answers in the rough work before writing anything on this page.

a. Interpret — precisely, and in one sentence — the coefficient on `inflation`. [10 points]

b. Interpret — precisely, and in one sentence — the coefficient on `pres`. [5 points]

c. In plain English, explain and interpret the R-squared. [10 points]

- d. In the context of this regression output, evaluate the following statement: “Empirical evidence finds countries with Presidential systems would have higher economic growth if they switched to Parliamentary systems.” [10 points]
- e. What would you expect to happen to the coefficient on `unemp` if the sample size quadrupled in size? Be as precise as you can! [5 points]
- f. What would you expect to happen to the standard error on `unemp` if the sample size quadrupled in size? Again, be as precise as you can. [5 points]
- g. Which of the classical assumptions would you be most concerned with in this regression? Why? Take a few sentences to explain why you think it might be a problem. [10 points]
- h. The Solow model of economic growth suggests output is a *non-linear* function, e.g.  $Y = AK^fL^g$  where  $A$  is technology,  $K$  is capital,  $L$  is labor, and  $f$  and  $g$  are parameters to be estimated. OLS is a *linear* operation. Is there any way to estimate  $f$  and  $g$  using OLS? If no, why not? If yes, sketch how. [5 points]

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End of exam, congratulations.





