

**NATIONAL UNIVERSITY OF LESOTHO**  
**B.A. EXAMINATIONS**  
**EC3305 – INTRODUCTORY ECONOMETRICS I**

**January, 2024**

**100 Marks**

**Time: 3 Hours**

---

***Instructions:***

- 1. Answer Sections A and B in separate answer booklets.*
- 2. Answer any TWO questions in section A and*
- 3. In section B, question 4 is compulsory and any other question.*

## SECTION A

### Question 1

- a) Let  $X$  denote the prison sentence, in years, for people convicted of housebreaking in Maseru district. Suppose that the probability density function (pdf) of  $X$  is given by

$$f(x) = \begin{cases} \frac{1}{9}x^2 & 0 < x < 3 \\ 0 & \text{otherwise} \end{cases}$$

What is the average and standard deviation of prison sentences in Maseru? [10]

- b) Explain (with examples) the following properties of estimators;

- i. Unbiasedness [7]
- ii. Consistency [8]

### Question 2

Explain (briefly) the following three general approaches to parameter estimation in econometrics:

- a) Method of Moments (MoM). [8]
- b) Maximum Likelihood Estimation (MLE). [8]
- c) Least Squares (LS). [9]

### Question 3

Consider the savings function:

$$sav = \beta_0 + \beta_1 inc + \mu \quad \mu = \sqrt{inc} \times e$$

where  $inc$  is non-stochastic and  $e$  is a random variable with  $E(e) = 0$  and  $Var(e) = \sigma^2$ .

Assume that  $e$  is independent of  $inc$ , meaning  $E(e|inc) = E(e)$  and  $Var(e|inc) = Var(e)$ .

- a) Show that  $E(\mu|inc) = 0$ , i.e., the zero conditional mean assumption is satisfied. [10]
- b) Show that  $Var(u|inc) = \sigma_e^2 inc$ , i.e., homoskedasticity is violated, meaning the variance of  $sav$  increases with  $inc$ . [10]
- c) Provide a discussion that supports the assumption that the variance of savings increases with family income. [5]

## SECTION B

### Question 4 (Compulsory)

In recent years, many Chinese firms have intensified their efforts to market their products in Africa. A consortium of Chinese firms that produce raw materials used in Lesotho is interested in predicting the level of exports from China to Lesotho, as well as understanding the relationship between Chinese exports to Lesotho and certain variables affecting the economy of this country. The consortium hired an economist to perform an analysis. The economist obtained monthly data on five economic variables for the period January 2018 to July 2023 (a total of 67 months) from Central Bank of Lesotho. The variables are as follows:

- Exports:** Chinese exports to Lesotho in billions of maloti, (the dependent variable)  
**M1:** money supply figures in billions of maloti  
**Lend:** minimum Lesotho bank lending rate in percentage  
**Price:** index of local prices where the base year is 2018  
**Exchange:** exchange rate of Lesotho maloti per Chinese yen.

#### Part I.

The economist performed a multiple regression analysis with Exports as the dependent variable and the four economic variables **M1**, **Lend**, **Price**, and **Exchange** as the explanatory variables. Part of his regression results are shown below:

Regression I				
R Square	0.825			
Adjusted R Square	0.814			
Observations	67			
	<i>Coefficients</i>	<i>Standard Error</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-4.015	2.766	-9.544	1.514
M1	0.368	0.064	0.240	0.496
Lend	0.005	0.049	-0.093	0.103
Price	0.037	0.009	0.019	0.055
Exchange	0.268	1.175		

- a) What are the degrees-of-freedom associated with the coefficients? [3]  
b) Calculate a 95% confidence interval for the true coefficient of the variable **Exchange**. [3]  
c) Which variable(s) among the four do you think is (are) an important explanatory variable(s) for **Exports**? Explain your answer. [4]

- d) The economist next computed the sample correlation between **Price** and **Lend**, which turns out to be 0.745. What problems, if any, can you identify in Regression I based on this information? How would you modify the model to avoid these problems? [8]

**Part II.**

The economist tried two other regression runs with **Exports** as the dependent variable. In one model, he used three independent variables: **M1**, **Price**, and **Exchange**. In the other model, he used only two independent variables: **M1** and **Price**. Part of his regression results are shown below:

Regression II	
R Square	0.825
Adjusted R Square	0.817
Observations	67

	<i>Coefficients</i>	<i>Standard Error</i>
Intercept	-3.995	2.736
M1	0.364	0.041
Price	0.037	0.004
Exchange	0.242	1.135

Regression III	
R Square	0.825
Adjusted R Square	0.819
Observations	67

	<i>Coefficients</i>	<i>Standard Error</i>
Intercept	-3.423	0.541
M1	0.361	0.039
Price	0.037	0.004

- e) In your opinion, which of the three regression models (I, II, III) is the best overall? Support your answer with any statistical reasoning that you feel is appropriate. [8]
- f) What is your estimate of Chinese exports to Lesotho in billions of maloti (using your best model) if **M1** = 9.5, **Lend** = 12.7, **Price** = 155, and **Exchange** = 1.5? [4]

### Question 5

- a) When introducing a new product to the market place a particular company has a policy that a minimum of 40% of those trying the product at the test market stage should express their approval of it. Testing of a new product has just been completed with a sample of 200 people, of whom 78 expressed their approval of the product. Does this result suggest that significantly less than 40% of the people approve of the product? (Conduct your test at the 5% level of significance.) [10]
- b) Two manufacturers of sinus relief tablets, SINUS and ANTIDRIP, have made conflicting claims regarding the effectiveness of their tablets. A private testing organization was hired to evaluate the two tablets. The testing company tried SINUS on 100 sinus congestion sufferers and found the mean time to relief was 85.0 minutes with a sample standard deviation of 6.0 minutes. A sample of 81 sinus congestion sufferers used ANTIDRIP. The mean time to relief was 86.2 minutes, the sample standard deviation 6.8 minutes. Does the evidence suggest a difference in the amount of time required to obtain relief? Use the 0.05 significance level. [10]

### Question 6

Let  $Y_1, Y_2, Y_3$  and  $Y_4$  be independent, identically distributed random variables from a population with mean  $\mu$  and variance  $\sigma^2$ . Let  $\bar{Y} = \frac{1}{4}(Y_1 + Y_2 + Y_3 + Y_4)$  denote the average of these four random variables.

- a) What are the expected value and variance of  $\bar{Y}$  in terms of  $\mu$  and  $\sigma^2$ ? [6]
- b) Now, consider a different estimator of  $\mu$ :

$$W = \frac{1}{8}Y_1 + \frac{1}{8}Y_2 + \frac{1}{4}Y_3 + \frac{1}{2}Y_4$$

- i. Why is  $W$  a weighted average? [8]
- ii. Show that  $W$  is also an unbiased estimator of  $\mu$ . Find the variance of  $W$ . [8]

Based on your answers to parts a. and b., which estimator of  $\mu$  do you prefer,  $\bar{Y}$  or  $W$ ? Explain your answer. [6]