# ZCAS University

## SEC5172 ADVANCED ECONOMETRICS

**TEST**

**25TH OCTOBER 2023**

**TIME: 16:30 – 19:30 HRS**

**TIME ALLOWED: THREE HOURS (plus 5 minutes to read through the paper)**

**INSTRUCTIONS:**

1. Section A: Question One in Section A is **compulsory.**
2. Section B: Answer Two (2) questions from this section.
3. This question paper carries a total of **100 marks.**
4. Statistical tables are provided at the end of the exam questions
5. Candidates must **not turn this page** until the invigilator tells them to do so.

c) Explain one possible variable state of the 'Employment Status' variable. Further, comment on the significance of this variable and its interpretation assuming a 'log-log' model specification. **[5 marks]**

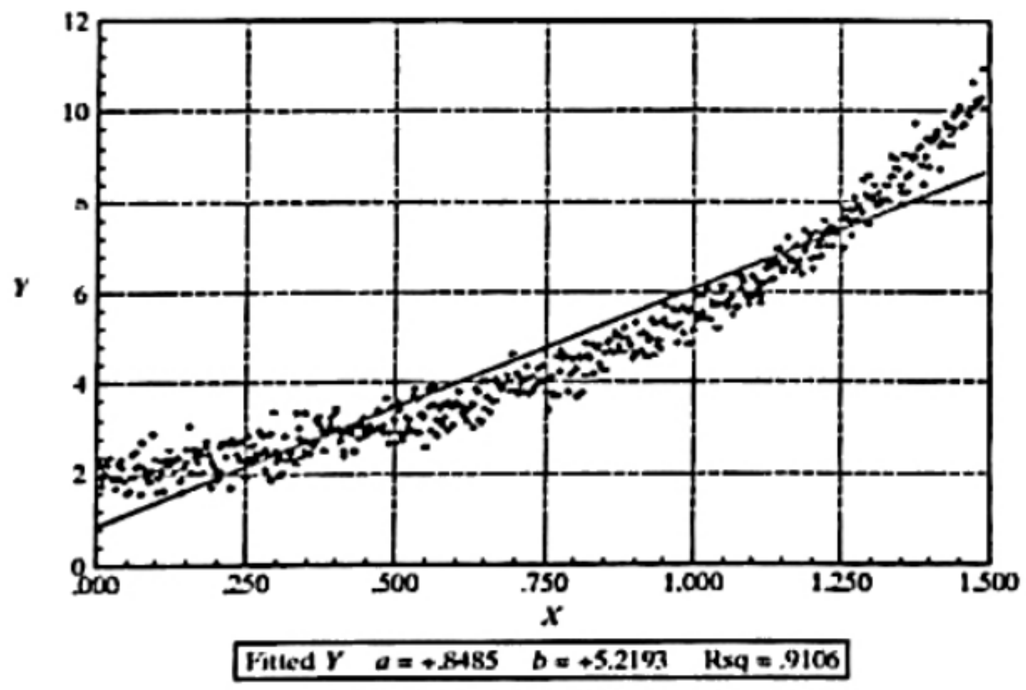
d) Given the information below, comment on the model fit and compare your conclusions to those under the F-test conducted in (i) **[5 marks]**

| **Criteria** | **Model 1** | **Model 2** |
|---|---|---|
| AIC | 4020.12 | 4068.53 |
| BIC | 4055.08 | 4157.82 |
| Adjusted R-squared | 0.68 | 0.64 |

**[5 marks]**

e) It is argued that "there is a temptation of adding insignificant regressors during an estimation". Using appropriate expressions, discuss this assertion. **[5 marks]**

f) Use the figure below to discuss the Classical Linear Regression assumption of strict exogeneity.




Source: Greene (2012)

**[5 marks]**

g) In her estimation, Mrs. Homoscedasticity discovers that she is missing a key regressor in her dataset. However, she has another regressor which through literature is established beyond doubt to be linearly related to the missing regressor. Discuss the impact of completely ignoring the missing regressor in her estimation. Further, explain what remedy options she has. **[10 marks]**

**[Total: 50 marks]**

**SECTION A: Question 1 is compulsory and must be attempted.**

**Question 1**

The 2007/2008 global financial crisis increased scholarly and policymakers' interest in credit risk and bank stability in general, and the problem of non-performing loans as an indicator of loan defaults. A study by Mumba focused on the causes of loan defaults and Non-Performing Loans (NPLs) within commercial banks in Zambia from the perspective of bank employees (Charity Mumba, 2019). The study identifies non-supervision of customers on their loan utilization, Poor Loan Appraisal, Lack of training for the clients before/after disbursement, Non-reminders of some customers concerning repayment obligation, weak penalties for defaulters, Late disbursement of loans by the bank, Lack of compliance to bank credit policy by staff, Lack of staff capacity building by banks, Incompetence by bank staff, Amount of repayment in each month too high, Unfavourable payment terms, High bank staff turnover and Inadequate loan sizes in relation to the client needs as key bank level loan default determinants.

Mrs. Homoscedasticity Mbewe, a Senior Researcher at the Ministry of Finance replicated the study on determinants of loan default in 2021. Using the statistical package Stata, she estimated her first model and obtained the following results:

| Variable | P-value | Coefficient | | Model Values |
|---|---|---|---|---|
| Age | 0.08 | 0.03 | | $R^2$=0.66 |
| Income | 0.00 | 0.08 | | $\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2 = 6020$ |
| Marital status | 0.01 | 0.10 | | |

After presenting her estimation [in the first model] to her supervisor, she was instructed to run another model with additional variables of 'Employment Status' [a dummy for employed] with 0.045 p-value and 0.31 coefficient value, and 'Financial literacy' with 0.23 p-value and 0.013 coefficient value. The sample size (n) of her study was 542 and she used 5% significance level in the estimation. The RSS value of the unrestricted model is 2023.61. Use this information to answer the questions below:

a) In Mumba's 2019 study, what is the expected value of the p-values for the determinants she discusses in the extracted portion above? **[5 mark]**

b) Using the F-test, demonstrate how Mrs. Homoscedasticity can conduct her model comparison (between model 1 and model 2) **[15 marks]**

**SECTION B: Attempt any TWO questions in this section.**

**Question 2**

i) Using the following basic/simple model: $y_i = \beta_1 + \beta_2 x_i + \varepsilon_i$, derive the $\beta_1$ *and* $\beta_2$ estimators of this model. **[5 marks]**

ii) Briefly describe the idea [Ordinary Least Squares] behind the process in question 1 above.

**`Hint:** Use appropriate expressions and figures **[5 marks]**

iii) Using the derived estimators in question 1 and the information in the table below, calculate the estimates of $\beta_1 and\ \beta_2$. **[10 marks]**

| OBSERVATION | WAGE (DEPENDENT) | EDUCATION (REGRESSOR) |
|---|---|---|
| 1 | 1.82 | 2.56 |
| 2 | 2.14 | 2.71 |
| 3 | 1.56 | 2.30 |
| 4 | 1.85 | 2.48 |
| 5 | 2.41 | 2.71 |

iv) Use the estimates in question (iii) above to state the fitted line expression and solve for the residuals of observation 2 and 4 respectively. **[5 marks]**

v) Use information obtained and contained in the above questions to calculate and interpret the $R^2$ given the model is level-level in model specification. **[10 marks]**

**[Total marks: 25 marks]**

**Question 3**

Consider a regression model of workers' wages:

$y = X\beta + \varepsilon$

Let y be a 5 x 1 vector containing wage data. Let matrix X be a 5 x 2 matrix containing a constant and education data. Data are provided in the table below.

| Person | Wage | Constant | Education |
|---|---|---|---|
| 1 | 1.82 | 1 | 2.56 |
| 2 | 2.14 | 1 | 2.71 |
| 3 | 1.56 | 1 | 2.30 |
| 4 | 1.85 | 1 | 2.48 |
| 5 | 2.41 | 1 | 2.71 |

a) Compute X`X, det(X`X), $(X`X)^{-1}$ and X`y. **[6 marks]**

**[4 marks]**

b) Use your results to compute coefficient vector β using the estimator $b = (X'X)^{-1}X'y$.

c) If the data for wage and education are both the natural log transformed values, how would interpret the coefficient on education? **[1 mark]**

d) Projection matrix $P_x = X(X'X)^{-1}X'$. Show that $P_x$ is a square, symmetric and idempotent matrix. **[4 marks]**

e) Explain how the projection matrix can be used to compute the fitted values of wage. **[3 marks]**

f) What are the finite sample properties of the OLS estimator of β? Briefly discuss these. **[2 marks]**

g) You estimate the model $y = X_1\beta_1 + \varepsilon$, whereas the true model is $y = X_1\beta_1 + X_2\beta_2 + \varepsilon$.

h) Under what conditions is the OLS estimator for $\beta_1$ unbiased? **[5 marks]**

**[Total: 25 Marks]**

## Question 4

The table below was extracted from Stata. It is an output of a regression that was conducted on EARNINGS in dollars (dependent variable), and the following as independent variables: AGE (years), S (years in school), MALE (dummy for male), LIBRARY, SIBLINGS (number of siblings), and ETHHISP (dummy for Hispanic respondents). Using the information in the table, answer the questions below:

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| Model | 7454.91824 | 6 | 1242.48637 | Number of obs | = 531 |
| Residual | 28115.9859 | 524 | 53.6564617 | F(6, 524) | = 23.16 |
| | | | | Prob > F | = 0.0000 |
| Total | [ ] | 530 | 67.1149135 | R-squared | = [ ] |
| | | | | Adj R-squared | = 0.2005 |
| | | | | Root MSE | = 7.3251 |

| EARNINGS | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| AGE | .3930994 | .1467907 | [ ] | 0.008 | [ ] | |
| S | 1.278186 | .1407522 | 9.08 | 0.000 | 1.001678 | 1.554694 |
| MALE | 3.590323 | .6458634 | 5.56 | 0.000 | 2.321524 | 4.859123 |
| LIBRARY | 1.010765 | .7641504 | 1.32 | 0.187 | -.4904096 | 2.51194 |
| SIBLINGS | -.1085979 | .1566326 | -0.69 | 0.488 | -.4163029 | .1991072 |
| ETHHISP | -.404548 | 1.356467 | -0.30 | 0.766 | -3.069328 | 2.260233 |
| _cons | -19.26833 | 5.088757 | -3.79 | 0.000 | -29.2652 | -9.271462 |

a.) Using the confidence interval approach, state and explain whether the variable 'AGE' is statistically significant or not. Use 5% level of significance, which give 1.96 critical value. **[10 marks]**

b.) Using the P-value approach, state and explain whether the variable 'S' (years in school) is statistically significant or not. **[5 mark]**

c.) Given the model specification is log-level, interpret the relationship between the 'AGE' variable and the dependent variable (EARNINGS). Hint: Offer a mathematical explanation of the interpretation. `. **[2 marks]**

d.) In the above estimation [in table above], it was later discovered that the variable 'LIBRARY' was an irrelevant variable in this model. Explain the implication of adding this variable in the estimation.

` **[3 marks]**

e.) Further, in the estimation process, the researcher was faced with a decision to make on two estimators. The first estimator had a small variance but was biased, and the other one had a big variance but was unbiased. Explain the concept of unbiasedness/biasedness and indicate which estimator you would choose between the two. Give reasons for your choice. **[5 marks]**

**[Total: 25 marks]**

**END OF TEST**

**F-Tables**

$J = 1$:

$$\begin{bmatrix} \text{Significance} & F_{1,\infty} & F_{1,30} & F_{1,10} \\ 5\% & 3.84 & 4.17 & 4.96 \\ 1\% & 6.63 & 7.56 & 10 \end{bmatrix}$$

$J = 2$:

$$\begin{bmatrix} \text{Significance} & F_{2,\infty} & F_{2,30} & F_{2,10} \\ 5\% & 3 & 3.32 & 4.10 \\ 1\% & 4.61 & 5.39 & 7.56 \end{bmatrix}$$

Source: Brooks (2008), Appendix Tables A2.3-4.

The table entries represent the area under the standard normal curve from 0 to the specified value of z.


| z | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0753 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 |
| 0.6 | .2257 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2517 | .2549 |
| 0.7 | .2580 | .2611 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2995 | .3023 | .3051 | .3078 | .3106 | .3133 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 |
| 1.7 | .4554 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4854 | .4887 | .4890 |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 |
| 3.1 | .4990 | .4991 | .4991 | .4991 | .4992 | .4992 | .4992 | .4992 | .4993 | .4993 |
| 3.2 | .4993 | .4993 | .4994 | .4994 | .4994 | .4994 | .4994 | .4995 | .4995 | .4995 |
| 3.3 | .4995 | .4995 | .4995 | .4996 | .4996 | .4996 | .4996 | .4996 | .4996 | .4997 |
| 3.4 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4998 |
| 3.5 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 |
| 3.6 | .4998 | .4998 | .4998 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 | .4999 |

**END OF TEST PAPER**