Econ 120C **Ramu Ramanathan**
Spring 1998 **Exam #2 (30%)**

Your name (please print it) _____

Your Student Id. (NOT Soc. Sec. no.)_____

DO NOT TURN THE PAGE UNTIL EVERYONE HAS RECEIVED THE EXAM AND YOU ARE GIVEN THE SIGNAL TO START. ALSO, YOU MUST STOP WRITING WHEN YOU ARE ASKED TO DO SO (YOU WILL BE GIVEN A 2 MINUTE WARNING). TEN POINTS WILL BE DEDUCTED FOR EACH MINUTE OF EXTRA TIME IT TAKES YOU TO STOP WRITING.

If you use a pencil, you forfeit the right to complain about grading UNLESS YOU PICK UP THE EXAM FROM THE TA FROM HIS/HER OFFICE AND LOOK AT THE GRADING BEFORE LEAVING THE OFFICE.

Make sure that all pages (1 through 5) are there. Read the questions carefully and make sure that you do not misunderstand them. If you get stuck somewhere, don't waste time but move on.

I CONSIDER CHEATING AS A VERY SERIOUS MATTER AND WILL GIVE AN F IN THE COURSE TO ANY ONE CHEATING AND ALSO REFER HIM/HER TO THE DEAN FOR DISCIPLINARY ACTION.

MAXIMUM NUMBER OF POINTS = 40 + 30 = 70

I. Consider the following model of bus travel.

$$BUSTRAVL_t = \beta_1 + \beta_2 FARE_t + \beta_3 INCOME_t + \beta_4 POP_t + \beta_5 DENSITY + u_t$$

where BUSTRAVL = Demand for urban transportation by bus in thousands of passenger hours, FARE = Bus fare in dollars, INCOME = Average income PER CAPITA, POP = Population of city in thousands, and DENSITY = Density of city in persons/sq. mile. The data are for 40 cities in the U.S.

In order to test for heteroscedasticity, the following auxiliary regression was estimated for the error variance ($\hat{u}_t^2$ is the dependent variable here). The error and total sums of squares for this auxiliary regression are also given.

VARIABLE	COEFFICIENT	STDERROR
constant	-1.052041e+06	4.295272e+06
FARE	3.601043e+06	2.649295e+06
INCOME	-29.202615	503.752997
POP	804.414977	322.077761
DENSITY	75.042426	100.379415
sq_FARE	-2.147132e+06	1.35584e+06
sq_INCOM	-5.194259e-05	0.014922
sq_POP	-0.05149	0.061621
sq_DENSI	-0.006809	0.006205

Error Sum of Squares (ESS)	832.6
Total sum of squares (TSS)	1672.3

I.1 (5 points)
Write down, using symbols rather than numerical values, the auxiliary equation for error variance implied by the above estimates.

I.2 (5 points)
Write down the null hypothesis for homoscedasticity (that is, no heteroscedasticity).

I.3 (3 points)
Compute the numerical value of the test statistic (show your derivations).

I.4 (5 points)
State its distribution under the null including the d.f.

I.5 (5 points)
Write down the critical value (at the 5 percent level) for the test and state whether the null hypothesis is rejected or not. Does this mean that there is a significant heteroscedasticity? Why or why not?

I.6 (5 points)
Based on your test what can you say about the OLS estimators of the model, particularly about unbiasedness, consistency, efficiency, and the reliability of hypothesis tests?

I.7 (12 points)
Regardless of your answer in I.5, assume that there was significant heteroscedasticity. Describe (in the next page) step by step how the above auxiliary equation can be used to obtain Weighted Least Squares of the βs (assume that you don't face the negative variance problem). Your answer should not be in general symbolic terms copied from the index card but very specific to the numerical values in the above table and the variables in the model. Give detailed instructions that demonstrate that you really understand how the procedure works. Not providing enough details or providing irrelevant answers can lose you points. ESL COMMANDS ARE NOT ACCEPTABLE BECAUSE THEY DO NOT DEMONSTRATE THAT YOU REALLY UNDERSTAND HOW THE PROCEDURE IS IMPLEMENTED.

II.

Consider the following model of patents and R&D (research and development) expenditures.

$$\text{PATENTS}_t = \beta_1 + \beta_2 \text{ R\&D}_t + u_t$$

where PATENTS is the number of patent applications files in a given year and R&D is the R&D expenditures in that year. The model was estimated using annual data for the U.S. for the years 1960 through 1993 (n = 34).

I want to use the Durbin-Watson statistic, which had the value d = 0.234, to test the model for first-order serial correlation, that is, for AR(1).

II.1 (3 points) Write down the auxiliary equation for the error term implied by the presence of AR(1).

II.2 (2 points) Write down the null hypothesis for no autocorrelation. _____

II.3 (3 points) Carry out the Durbin-Watson test. Is there significant autocorrelation or not? Show all the details of your procedure.

II.4 (3 points) Describe the auxiliary regression needed to carry out the LM test for AR(1).

Suppose this regression had error sum of squares ESS = 793.09 and total sum of squares TSS = 3,985.38.

II.4 (3 points) Compute the numerical value of the test statistic.

II.5 (3 points) Write down its distribution and d.f. _____

II.6. (3 points) Write down the critical value for a test at the level 0.001. _____

II.7 (3 points) State the decision rule and the conclusion.

II.8 (4 points) Based on your conclusion, are OLS estimates of the parameters of the model,

unbiased? _____ **consistent? _____**

efficient? _____ **are tests valid? _____**

II.9 (3 points) Write down the assumption(s) that is (are) violated by the presence of serial correlation.