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ECO 5350
Intro. Econometrics

Prof. T. Fomby
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Mid-Term Exam

Instructions: Put your name and student ID in the upper right-hand-corner of this exam. This exam is worth a total of 68 points. The breakout of these points by question is as follows:

Q1 = 2 points	Q11 = 5 points	Q21 = 2 points
Q2 = 2 points	Q12 = 3 points	Q22 = 2 points
Q3 = 2 points	Q13 = 3 points	Q23 = 4 points
Q4 = 2 points	Q14 = 4 points	Q24 = 4 points
Q5 = 3 points	Q15 = 4 points	Q25 = 2 points
Q6 = 2 points	Q16 = 2 points	
Q7 = 2 points	Q17 = 4 points	
Q8 = 3 points	Q18 = 2 points	
Q9 = 2 points	Q19 = 2 points	
Q10 = 3 points	Q20 = 2 points	

You have one hour and thirty minutes to take this test. Please note on the last 2 pages of the computer output handout is a **list of formulas** that you can use in answering the questions on this exam. Don't get hung up on any one question. Answer the easy questions first and then go back and pick up the hard ones. Good luck.

2 1. Which of the following properties of the error term e are consistent with the assumptions of the Classical Normal Linear Regression (CNLR) Model:

a. $E(u) = 0$
b. $E(u^2) = \sigma^2$
c. $E(u_i u_j) = 0$
d. u is normally distributed
e. All of the above assumptions are consistent with the CNLR model.

2 2. In question 1 above, the **Independence Assumption** is represented by alternative c.

2 3. In question 1 above, the **Homoscedasticity Assumption** is represented by alternative b.

2 4. True or False. In the case that the errors of the CNLR model are homoscedastic and uncorrelated, we should use (ordinary) least squares for estimation and inference while, if they are not, we should use generalized least squares.

Consider **Computer Output # 1** that reports the CAPM estimation results for Company XYZ. Use this output to answer the following 5 questions.

3 5. Jensen's alpha $\hat{\alpha}$ for XYZ Company is 0.005886. Its standard error is 0.002111. Its t-statistic is 2.788252.

2 6. In the above regression y is called the excess return offered by XYZ stock while x is called the excess return provided by the overall stock market.

2 7. Over the time the XYZ stock is observed, did it return a superior risk-adjusted rate of return? (YES / NO). Circle the correct answer.

3 8. The reason for your conclusion is based on the **one-sided p-value** of the t-statistic for Jensen's alpha which is 0.0015. (Recall that the alternative hypothesis is that the Jensen's alpha is significantly positive.) Since it is (greater / less than) 0.05 we judge Jensen's alpha to be statistically (significant / insignificant.)

2 9. (True / False) Not only can Jensen's alpha be used to judge the stock performance of an individual stock, like the GE stock examined above but also the performance of portfolio manager for a trust fund.

3 10. Let E(X) = 4, Var(X) = 2, E(Y) = 3, Var(Y) = 3 and Cov(X,Y) = 2. Then E(6X + Y) = $6\cdot4+3=27$, Var(4X + Y) = 51, Cov(X,4Y) = 8.

$E(6X+Y) = 6E(X)+E(Y) = 6\cdot4+3 = 27$

$Var(4X+Y) = 4^2 Var(X) + 2\cdot Cov(4X,Y) + Var(Y)$

$= 16\cdot2 + 2\cdot4\, Cov(X,Y) + Var(Y) = 32+8\cdot2+3$

$= 32+16+3 = 51$

$Cov(X,4Y) = 4\,Cov(X,Y) = 4\cdot2 = 8$

(5)

11. Fill in the blanks in the following ANOVA table:

Source	SS	DF	MS	F	P-Value
Regression	24	3	8	4	0.02
Error	62	31	2		
Total	86	34			

N-1

(3)

12. The number of observations used to generate the above ANOVA table is 35. The number of explanatory variables (apart from the intercept) in the above Regression model is 3. The explanatory variables in the regression (are / are not) jointly significant. Circle the correct alternative.

(3)

13. The estimators $\hat{\beta}_0$ and $\hat{\beta}_1$ of the intercept, β_0, and slope, β_1, respectively, in the conditional mean function $E(Y|X) = \beta_0 + \beta_1 X$ are both linear in the observations $Y_1, Y_2, \cdots, Y_N$ and are unbiased in that $E(\hat{\beta}_0) = \beta_0$ and $E(\hat{\beta}_1) = \beta_1$. By the **Gauss-Markov theorem** these estimators are **BLU** estimators. This means that of all the possible estimators that are unbiased and linear functions of the observations $Y_1, Y_2, \cdots, Y_N$, the least squares estimators have the smallest sampling variance.

Consider the SAS output for the estimation of the Fair Model of Presidential Elections we discussed in class that is contained in **Computer Output # 2**. This information will be used to answer the following 9 questions. The variable growth_inflation stands for variable (growth – inflation).

(4)

14. The overall F-statistic of the unrestricted Fair model is 8.11 with p-value of 0.0015. This means that, jointly speaking, the growth and inflation variables are statistically significant explanators of the variation in the dependent variable vote.

(4)

15. Suppose that we are interested in testing the null hypothesis $H_0: \beta_1 + \beta_2 = 0$ versus $H_1: \beta_1 + \beta_2 \neq 0$. Without calculating the exact value of the t-statistic to test H_0, show me how you would calculate it if you had a decent hand calculator:

den = sqrt$(Var(\hat{\beta}_1) + Var(\hat{\beta}_2) + 2Cov(\hat{\beta}_1, \hat{\beta}_2))$

$$t = \frac{0.64342 + (-0.17208) - 0}{\sqrt{0.027 + 0.184 + 2(0.0118)}}$$

(2)

16. **Suppose** that the p-value of the above t-statistic has a p-value of 0.01. How would you interpret the result? I would reject the null hypothesis of $\beta_1 + \beta_2 = 0$ and accept the alternative hypothesis that $\beta_1 + \beta_2 \neq 0$ and the effects of inflation and growth are not equal in magnitude and opposite in effect.

17. Instead of computing the t-statistic to test H_0, we can equivalently calculate an F-statistic based on the results from a restricted model that incorporates the implied restrictions arising from the null hypothesis and an unrestricted model that does not impose the restrictions arising from the null hypothesis. The F-statistic is of the following form:

4

$$F = \frac{[SSR(restricted) - SSR(unrestricted)]/J}{SSR(unrestricted)/(N-K)}$$

In the present case we have SSR(unrestricted) = 761.84, SSR(restricted) = 785.832, J = 1, N = 33. (Note K=3)

2

18. **Suppose** that in question 15 we got the answer that t = 3.0. Then the F-statistic of question 17 would be equal to $3^2 = 9$ and have a p-value of 0.01.

19. To make the computations simple, let us consider the fitted vote model as being

$$\widehat{vote} = 52 + 0.6growth - 0.2inflation$$

2

Suppose that in an upcoming election we know that growth = 3.0 and inflation = 2.0. Then the predicted vote for the presidential candidate of the incumbent part is 53.4. Show your work to get this answer.

$\widehat{vote} = 52 + 0.6(3.0) - 0.2(2.0) = 53.4$

20. The standard error of this forecast is going to be given by

2

$$se(\widehat{vote}) = \sqrt{\hat{\sigma}^2 + Var(\hat{\beta}_0 + \hat{\beta}_1(3.0) + \hat{\beta}_2(2.0))}$$ (see below for more)

(You don't have to do any exact calculations, just give me the numbers that would be used to put in a hand calculator to get the exact answer.)

2

21. Show me the formula for getting the 95% confidence interval for your vote forecast, given that you know $se(\widehat{vote})$. $\widehat{vote} \pm 1.96 \cdot se(\widehat{vote})$.
(Again, there are no exact calculations required here, just a formula that one would use.)

2

22. Suppose that the 95% confidence interval for *vote* is [50.4, 56.4]. How would you interpret this result? We are 95% confident that the candidate of the incumbent party will win the election.

$$= \sqrt{\hat{\sigma}^2 + Var(\hat{\beta}_0) + 3^2 Var(\hat{\beta}_1) + 2^2 Var(\hat{\beta}_2) + 2\cdot 3\, Cov(\hat{\beta}_0, \hat{\beta}_1) + 2\cdot 2\, Cov(\hat{\beta}_0, \hat{\beta}_2) + 2\cdot 3\cdot 2\, Cov(\hat{\beta}_1, \hat{\beta}_2)}$$

$= sqrt(25.39469 + 2.127 + 9\cdot(0.027) + 4\cdot(0.184) + 6(-0.048) + 4\cdot(-0.498) + 12\cdot(0.0118))$

Consider **Computer Output # 3** that is designed to allow us to do a Chow test on the CAPM of a given stock. Use this output to answer the following 2 questions.

23. The Jensen's alpha of this stock is -0.00835. The beta of the stock is -0.0357. Is the stock aggressive or conservative? Is it pro-cyclical, neutral, or countercyclical as compared to the overall stock market? Would you recommend this stock as having exceptional performance that would be worth investing in? Explain your answers. This stock is conservative. The absolute value of the beta is less than one. The stock is countercyclical because its beta is negative and the return of the stock moves counter to the market. Since the α is not statistically significant the stock has not exhibited superior performance.

4

24. Without doing any exact calculations, in the space below show me how you would calculate the Chow F-statistic for structural change in the CAPM model of this stock. Be sure you show me the basic numbers you would use in light of the Computer Output # 3.

4

$$F_{chow} = \frac{[RSS(\text{restricted}) - RSS(\text{unrestricted})]/2}{RSS(\text{unrestricted})/(119-4)}$$

(continued below)

25. Suppose that you estimate the equation $y = \beta_0 + \beta_1 x + u$ but instead the correct model is $y = \beta_0 + \beta_1 x + \beta_2 w + u$. If cov(x,w) > 0 and $\beta_2 < 0$, then

2

a. $E(\hat{\beta}_1) = \beta_1$
b. $E(\hat{\beta}_1) > \beta_1$
c. $E(\hat{\beta}_1) < \beta_1$
d. Not enough information to tell

$corr(X_1, X_2) > 0$
$\beta_2 < 0$
$\Rightarrow$ neg. bias

Refer to Lecture 12 notes
$y = \beta_1 + \beta_2 X_1 + \beta_3 X_2 + e$

$$F_{chow} = \frac{(0.32886 - 0.32835)/2}{0.32835/115}$$

(RSS form of F-stat.)

$$= \frac{(R_u^2 - R_R^2)/J}{(1-R_u^2)/(N-K)} = \frac{(0.0024-0.0008)/2}{(1-0.0024)/(119-4)}$$

(R^2 form of F-stat.)

COMPUTER OUTPUT # 1

Dependent Variable: Y

Included Observations = 119

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005886	0.002111	2.788252	0.0030
X	1.123341	0.104718	10.72730	0.0000

R-squared	0.427535	Mean dependent var	0.013085
Adjusted R-squared	0.422684	S.D. dependent var	0.069895
S.E. of regression	0.053107	Akaike info criterion	-3.016478
Sum squared resid	0.332806	Schwarz criterion	-2.970020
Log likelihood	182.9887	Hannan-Quinn criter.	-2.997611
F-statistic	115.0750	Durbin-Watson stat	2.300931
Prob(F-statistic)	0.000000		

COMPUTER OUTPUT # 2

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: VOTE

Number of Observations Read	33
Number of Observations Used	33

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	412.01004	206.00502	8.11	0.0015
Error	30	761.84057	25.39469		
Corrected Total	32	1173.85061			

Root MSE	5.03931	**R-Square**	0.3510
Dependent Mean	52.09939	**Adj R-Sq**	0.3077
Coeff Var	9.67250		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	52.15653	1.45870	35.76	<.0001
GROWTH	1	0.64342	0.16563	3.88	0.0005
INFLATION	1	-0.17208	0.42896	-0.40	0.6912

Covariance of Estimates

Variable	Intercept	GROWTH	INFLATION
Intercept	2.1278149883	-0.048747577	-0.498010638
GROWTH	-0.048747577	0.0274329412	0.0118598446
INFLATION	-0.498010638	0.0118598446	0.1840026641

The REG Procedure
Model: MODEL1
Dependent Variable: VOTE

Number of Observations Read	33
Number of Observations Used	33

Analysis of Variance

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	1	388.01816	388.01816	15.31	0.0005
Error	31	785.83245	25.34943		
Corrected Total	32	1173.85061			

Root MSE	5.03482	**R-Square**	0.3306
Dependent Mean	52.09939	**Adj R-Sq**	0.3090
Coeff Var	9.66388		

Parameter Estimates

Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	**1**	53.25245	0.92468	57.59	<.0001
growth_inflation	**1**	0.56466	0.14433	3.91	0.0005

COMPUTER OUTPUT # 3

The SAS System

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read	120
Number of Observations Used	119
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.00027345	0.00027345	0.10	0.7557
Error	117	0.32886	0.00281		
Corrected Total	118	0.32913			

Root MSE	0.05302	**R-Square**	0.0008
Dependent Mean	-0.00854	**Adj R-Sq**	-0.0077
Coeff Var	-621.03172		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-0.00835	0.00490	-1.71	0.0905
x	1	-0.03514	0.11268	-0.31	0.7557

Doing the Chow Test for Structural Change
With Additive and Multiplicative Dummy Approach

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read	120
Number of Observations Used	119
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.00078006	0.00026002	0.09	0.9648
Error	115	0.32835	0.00286		
Corrected Total	118	0.32913			

Root MSE	0.05343	**R-Square**	0.0024
Dependent Mean	-0.00854	**Adj R-Sq**	-0.0237
Coeff Var	-625.92604		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-0.00875	0.00696	-1.26	0.2115
x	1	-0.06832	0.13835	-0.49	0.6224
dummy	1	-0.00015151	0.01013	-0.01	0.9881
mult_dummy	1	0.10379	0.24958	0.42	0.6783

FORMULA SHEET

BASIC STATISTICS:

1. Var(X) = $E(X-\mu_x)^2$

2. Cov(X,Y) = $E(X-\mu_x)(Y-\mu_y)$; $Corr(X,Y) = Cov(X,Y)/(Var(X)\cdot Var(Y))^{1/2}$

3. E(aX + bY) = aE(X) + bE(Y)

4. Var(aX + bY) = $a^2 Var(X) + b^2 Var(Y) + 2abCov(X,Y)$

5. Sample Mean: $\bar{Y} = \sum_{1}^{N} Y_i$

6. Sample Variance: $s^2 = \sum_{1}^{N} (Y_i - \bar{Y})^2 / (N-1)$

7. t-statistic for testing population mean:

$$t_{N-1} = \frac{\bar{Y} - \mu_{Y,0}}{se(\bar{Y})}; \text{ where } se(\bar{Y}) = s/\sqrt{N}$$

8. $(1-\alpha)\%$ confidence interval for μ

$$\Pr(\bar{Y} - t_{N-1,\alpha/2}\cdot se(\bar{Y}) < \mu < \bar{Y} + t_{N-1,\alpha/2}\cdot se(\bar{Y})) = 1-\alpha$$

9. Approximate t-statistic for testing difference in means (variances assumed unequal):

$$t = \frac{\bar{Y}_1 - \bar{Y}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \rightarrow Z = N(0,1)$$

10. Exact t-statistic for testing difference in means (variances assumed equal):

$$t = \frac{\bar{Y}_1 - \bar{Y}_2}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \rightarrow t_{n_1+n_2-2}$$

where $s_p^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$

11. F-Test for equal variances across two populations

$$F_{v_1,v_2} = \frac{s_1^2}{s_2^2}$$

where $v_1 = n_1 - 1$ and $v_2 = n_2 - 1$. Also, $F_{1-\alpha/2}(v_1, v_2) = \dfrac{1}{F_{\alpha/2}(v_1, v_2)}$

SOME OLS REGRESSION FORMULAS:

12. $\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \bar{X}$; $\quad Var(\hat{\beta}_0) = \dfrac{\sigma^2 \sum_1^N X_i}{N \sum_1^N (X_i - \bar{X})^2}$

13. $\hat{\beta}_1 = \dfrac{\sum_1^N (X_i - \bar{X}) Y_i}{\sum_1^2 (X_i - \bar{X})^2} = \sum_1^N w_i Y_i$; $\quad Var(\hat{\beta}_1) = \dfrac{\sigma^2}{\sum_1^N (X_i - \bar{X})^2}$

14. $\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 X$

15. TSS = ESS + SSR ; $\sum_1^N (Y_i - \bar{Y})^2 = \sum_1^N (\hat{Y}_i - \bar{Y})^2 + \sum_1^N (Y_i - \hat{Y}_i)^2$; $R^2 = \dfrac{ESS}{TSS}$

16. Adjusted R-square: $\bar{R}^2 = 1 - \frac{SSR/(N-K)}{TSS/(N-1)}$

17. $t = \dfrac{\hat{\beta}_i - \beta_i}{se(\hat{\beta}_i)}$

18. one-tailed p-value: $\Pr(t_0 < t)$ or $\Pr(t < t_0)$

19. two-tailed p-value: $\Pr(|t_0| < t)$

20. $\Pr(\hat{\beta}_i - t_{N-K,\alpha/2} \cdot se(\hat{\beta}_i) < \beta_i < \hat{\beta} + t_{N-K,\alpha/2} \cdot se(\hat{\beta}_i)) = 1 - \alpha$

21. $F_{overall} = \dfrac{R^2/(K-1)}{(1-R^2)/(N-K)}$

22. $F = \dfrac{(RSS_R - RSS_U)/J}{RSS_U/(N-K)} = \dfrac{(R_U^2 - R_R^2)/J}{(1-R_U^2)/(N-K)}$