EXERCISE 9

**ORDERED MULTINOMIAL
LOGIT AND PROBIT MODELS**

Purpose: To learn how to use the **ordered multinomial logit and probit models** to analyze dependent variables that represent three or more ordered (ranked) responses.

Go to my website and download the file CRA.xls into an EVIEWS workfile. This data has been kindly provided to our class by Dr. Jeff Gunther of the Dallas Federal Reserve Bank. The data represent 350 observations on the following variables (in order): **rrating** = community reinvestment act (cra) rating (1=outstanding, 2=satisfactory, 3=needs to improve, and 4=substantial noncompliance), **loa** = loans/total assets ratio, **prl**=troubled assets/total assets, **equ**=equity over assets, **roa**=return on assets, **sec**=securities investments/total assets, **ass**=log of total assets, **metro**=1 for banks headquartered in an MSA (metropolitian statistical area), 0 otherwise, and **growth**=nominal growth of state gdp. For explanation of this data read the article "Between a Rock and a Hard Place: The CRA-Safety and Soundness Pinch" by Jeff that I have handed out in class.

(a) Before you proceed, tell me how you expect the above explanatory variables to affect the cra rating variable **rrating**. That is, which variables should have a positive coefficient and which variables should have a negative coefficient? Explain your reasoning.

(b) In EVIEWS go to "Quick" then "Estimate Equation" then enter (in order) the dependent variable **rrating** and the explanatory variables **loa**, **prl**, **equ**, **roa**, **sec**, **ass**, **metro**, and **growth**. (Note: You don't have to enter a "constant term.") Then choose the estimation method "ordered choice" and for the choice of "error distribution" choose "Normal" (implying that you are estimating the equation using the ordered multinomial **probit** (alternatively called **normit**) model. Examine the statistical significance of the explanatory variables. Are any of the variables statistically insignificant at the 5% level? If so, drop the **least** significant variable (i.e., the variable whose t-statistic has the highest probability level) and re-estimate the model. Continue to do this until all of the variables in your ordered multinomial probit model are statistically significant at the 5% level. Report your estimated equation with coefficient estimates and standard errors. (This is called the **backward-selection model building approach** as compared to the **forward-selection model building approach** that successively adds the most significant variable, one variable at a time.)

(c) Given the output for part (b) above, what are the three "limit points" of your estimated model? Report them to me. What do they mean? Using these limit points, give me the predicted ranking of the 80th bank in your data set? How did you arrive at your answer? Explain. Do the same thing for the 160th, the 240th and 320th banks. What are their predicted rankings? Explain how you got your answer.

(d) Repeat parts (a) and (b) above, but this time use the ordered multinomial **logit** model. (Hint: Use the error distribution labeled "Logistic.") Do the same variables enter your final estimated model? Report the "limit points" for this model. Do you predict the same rankings for the 80th, 160th, 240th, and 320th banks that you obtained by using the ordered multinomial probit model? Explain your answer.

(e) Go to my website and retrieve the SAS computer program CRA.sas. Study the logic of this program carefully. This program (using PROC Logistic) essentially does all of the things that you did in parts (a) through (d) above using EVIEWS. Do you get essentially the same estimated equations and limit points? Explain. Remember, if you work in a company that only has SAS, you can do ordered multinomial probit and logit models using **Proc Logistic**.

(f) Now using the output produced by the program CRA.sas, tell me how SAS produces predicted rankings for the 80th, 160th, 240th, and 320th banks first using the ordered multinomial probit model and then the ordered multinomial logit model. Do you get the same ranking of these banks as you got using EVIEWS?