**UNIVERSITY OF NEVADA LAS VEGAS**

**LEE BUSINESS SCHOOL**

**ECO 772- ECONOMETRICS II**

**ASSIGNMENT #01**

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Problem Set One

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# Problem C17.1

Use the data in PNTSPRD.RAW for this exercise:

## Section (i)

The variable favwin is a binary variable if the team favored by the Las Vegas point spread wins. A linear probability model to estimate the probability that the favored team wins is: P(favwin=1|spread)=beta0 + beta1(spread)

Explain why, if the spread incorporates all relevant information, we expect beta0=0.5

If spread is zero, there is no favorite, and the probability that the team we (arbitrarily) label the favorite should have a 50% chance of winning.

## subsection (ii)

Estimate the model from part (i) by OLS. Test H0:0.5 against a two-sided alternative. Use both the usual and heteroskedasticity-robust standard errors.

## read the data file into R  
data1<-read\_dta("PNTSPRD.dta")

## estimate the model from part(i) by OLS using usual standard erros  
lm1<-lm(favwin~spread, data=data1)  
  
library(AER)

coeftest(lm1)

##   
## t test of coefficients:  
##   
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.5769492 0.0282345 20.4342 < 2.2e-16 \*\*\*  
## spread 0.0193655 0.0023386 8.2806 9.324e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

##testing the hypothesis that H0=0.5  
calculated.t.value1=(0.5769492-0.5)/0.0282345  
calculated.t.value1

## [1] 2.725361

The rule: Reject the null hypothesis if |calculated t value|>|critical t value|,

The decision: since the |calculated.t.value1|>1.96, we reject the null hypothesis

The inference: beta0 is not equal to 0.5.

##estimate the model from part(i) by OLS using heteroskedasticity-robust standard errors  
coeftest(lm1, vcov = vcovHC)

##   
## t test of coefficients:  
##   
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 0.5769492 0.0317187 18.19 < 2.2e-16 \*\*\*  
## spread 0.0193655 0.0019289 10.04 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

##testing the hypothesis that H0=0.5  
calculated.t.value2=(0.5769492-0.5)/0.0317187  
calculated.t.value2

## [1] 2.425988

The rule: Reject the null hypothesis if |calculated t value|>|critical t value|,

The decision: since the |calculated.t.value2|>1.96, we reject the null hypothesis

The inference: beta0 is not equal to 0.5

## Subsection (iii)

Is spread statistically significant? What is the estimated probability that the favored team wins when spread=10?

Yes, spread is statistically significant.

## estimate the Probaility  
newdata1<-data.frame(spread=10)  
predict(lm1, type="response", newdata1)

## 1   
## 0.7706044

The estimated probability is 0.7706042

## Subsection (iv)

Now, estimate a probit model for P(favwin=1|spread ). Interpret and test the null hypothesis that the intercept is zero. [Hint: Remember that theta= 0.5.]

data1$favwin<-as.factor(data1$favwin)  
glm1<-glm(favwin~spread, data=data1, family=binomial(link="probit"))  
stargazer(glm1, type = "text")

##   
## =============================================  
## Dependent variable:   
## ---------------------------  
## favwin   
## ---------------------------------------------  
## spread 0.092\*\*\*   
## (0.012)   
##   
## Constant -0.011   
## (0.103)   
##   
## ---------------------------------------------  
## Observations 553   
## Log Likelihood -263.562   
## Akaike Inf. Crit. 531.124   
## =============================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

## Subsection (v)

Use the probit model to estimate the probability that the favored team wins when spread  10. Compare this with the LPM estimate from part (iii).

## estimated Probaility using the probit model  
newdata2<-data.frame(spread=10)  
predict(glm1, type="response", newdata2)

## 1   
## 0.8196512

The estimated probability is 0.8196512. This probability is higher than the one estimated using the LPM.

## Subsection (vi)

Add the variables favhome, fav25, and und25 to the probit model and test joint significance of these variables using the likelihood ratio test. (How many df are in the chi-square distribution?) Interpret this result, focusing on the question of whether the spread incorporates all observable information prior to a game.

## convert the new variables from character types to factor types  
data1$favhome<-as.factor(data1$favhome)  
data1$fav25<-as.factor(data1$fav25)  
data1$und25<-as.factor(data1$und25)  
  
## add the variables to the probit model  
glm2<-glm(favwin~spread+favhome+fav25+und25, data=data1, family=binomial(link="probit"))  
stargazer(glm2, type = "text")

##   
## =============================================  
## Dependent variable:   
## ---------------------------  
## favwin   
## ---------------------------------------------  
## spread 0.088\*\*\*   
## (0.013)   
##   
## favhome1 0.149   
## (0.137)   
##   
## fav251 0.003   
## (0.159)   
##   
## und251 -0.220   
## (0.251)   
##   
## Constant -0.055   
## (0.129)   
##   
## ---------------------------------------------  
## Observations 553   
## Log Likelihood -262.642   
## Akaike Inf. Crit. 535.284   
## =============================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

The value of the Log Likelihood is -262.642

## calculate the value of the likelihood ratio statistic  
2\*(-262.642 - (-263.562))

## [1] 1.84

Since the likelihood ratio statistic of 1.84 is greater than the p-value from the chi-square distribution of 0.61, the added variables are jointly not significant. This can be infered to mean that these added variables have no additional power for predicting the outcome.

# 

# Problem C17.2

Use the data in LOANAPP.RAW for this exercise

## Subsection (i)

Estimate a probit model of approve on white. Find the estimated probability of loan approval for both whites and nonwhites. How do these compare with the linear probability estimates?

## start by reading the data into R  
data2<-read\_dta("LOANAPP.dta")  
  
## convert the variables from character types to factors  
data2$white<-as.factor(data2$white)  
data2$approve<-as.factor(data2$approve)  
  
## estimate a probit model of approve on white  
glm3<-glm(approve~white, data2, family=binomial(link="probit"))  
stargazer(glm3, type="text")

##   
## =============================================  
## Dependent variable:   
## ---------------------------  
## approve   
## ---------------------------------------------  
## white1 0.784\*\*\*   
## (0.087)   
##   
## Constant 0.547\*\*\*   
## (0.075)   
##   
## ---------------------------------------------  
## Observations 1,989   
## Log Likelihood -700.877   
## Akaike Inf. Crit. 1,405.755   
## =============================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

## find the estimated probability for whites  
newdata3<-data.frame(white=1)  
newdata3$white<-as.factor(newdata3$white)  
predict(glm3, type="response", newdata3)

## 1   
## 0.9083879

# find the estimated probability for non-whites  
newdata4<-data.frame(white=0)  
newdata4$white<-as.factor(newdata4$white)  
predict(glm3, type="response", newdata4)

## 1   
## 0.7077922

The predicted probability for whites and non-whites is 0.9083879 and 0.7077922 respectively.

## Subsection (ii)

Now, add the variables hrat, obrat, loanprc, unem, male, married, dep, sch, cosign, chist, pubrec, mortlat1, mortlat2, and vr to the probit model. Is there statistically significant evidence of discrimination against nonwhites?

## convert some of variables from characters to factors  
data2$male<-as.factor(data2$male)  
data2$married<-as.factor(data2$married)  
data2$dep<-as.factor(data2$dep)  
data2$sch<-as.factor(data2$sch)  
data2$cosign<-as.factor(data2$cosign)  
data2$chist<-as.factor(data2$chist)  
data2$pubrec<-as.factor(data2$pubrec)  
data2$mortlat1<-as.factor(data2$mortlat1)  
data2$mortlat2<-as.factor(data2$mortlat2)  
data2$vr<-as.factor(data2$vr)  
  
  
## estimate the new probit model  
glm4<-glm(approve~white+hrat+obrat+loanprc+unem+male+married+dep+sch+cosign+chist+pubrec+mortlat2+vr, data2, family=binomial(link="probit"))  
stargazer(glm4, type="text")

##   
## =============================================  
## Dependent variable:   
## ---------------------------  
## approve   
## ---------------------------------------------  
## white1 0.525\*\*\*   
## (0.097)   
##   
## hrat 0.009   
## (0.007)   
##   
## obrat -0.029\*\*\*   
## (0.006)   
##   
## loanprc -1.007\*\*\*   
## (0.238)   
##   
## unem -0.037\*\*   
## (0.018)   
##   
## male1 -0.056   
## (0.109)   
##   
## married1 0.266\*\*\*   
## (0.096)   
##   
## dep1 -0.017   
## (0.119)   
##   
## dep2 -0.132   
## (0.121)   
##   
## dep3 -0.115   
## (0.170)   
##   
## dep4 -0.553\*\*   
## (0.280)   
##   
## dep5 4.218   
## (95.018)   
##   
## dep6 3.999   
## (130.569)   
##   
## dep7 2.984   
## (235.034)   
##   
## dep8 3.079   
## (235.034)   
##   
## sch1 0.016   
## (0.096)   
##   
## cosign1 0.055   
## (0.241)   
##   
## chist1 0.589\*\*\*   
## (0.096)   
##   
## pubrec1 -0.759\*\*\*   
## (0.127)   
##   
## mortlat21 -0.491   
## (0.338)   
##   
## vr1 -0.192\*\*   
## (0.082)   
##   
## Constant 2.080\*\*\*   
## (0.315)   
##   
## ---------------------------------------------  
## Observations 1,989   
## Log Likelihood -600.528   
## Akaike Inf. Crit. 1,245.055   
## =============================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

## the calculated t value is  
(0.525-0/0.097)

## [1] 0.525

The point estimate for white = 0.525 with standard errors of 0.097. Since the calculated t-value of 5.412 is greater than the critical t-value of 1.96, we reject the null hypothesis that whites is equal to zero. The inference is that white is significant. Hence there is stilll strong evidence of discrimination against non whites.

## Subsction (iii)

Estimate the model from part (ii) by logit. Compare the coefficient on white to the probit estimate.

## estimate the model by logit  
glm5<-glm(approve~white+hrat+obrat+loanprc+unem+male+married+dep+sch+cosign+chist+pubrec+mortlat2+vr, data2, family=binomial(link="logit"))  
stargazer(glm5, type="text")

##   
## =============================================  
## Dependent variable:   
## ---------------------------  
## approve   
## ---------------------------------------------  
## white1 0.946\*\*\*   
## (0.173)   
##   
## hrat 0.016   
## (0.013)   
##   
## obrat -0.055\*\*\*   
## (0.011)   
##   
## loanprc -1.899\*\*\*   
## (0.456)   
##   
## unem -0.067\*\*   
## (0.033)   
##   
## male1 -0.094   
## (0.205)   
##   
## married1 0.503\*\*\*   
## (0.181)   
##   
## dep1 -0.008   
## (0.225)   
##   
## dep2 -0.258   
## (0.229)   
##   
## dep3 -0.235   
## (0.319)   
##   
## dep4 -0.970\*   
## (0.503)   
##   
## dep5 13.662   
## (599.419)   
##   
## dep6 13.671   
## (814.654)   
##   
## dep7 11.913   
## (1,455.398)   
##   
## dep8 12.091   
## (1,455.398)   
##   
## sch1 0.047   
## (0.178)   
##   
## cosign1 0.068   
## (0.446)   
##   
## chist1 1.072\*\*\*   
## (0.172)   
##   
## pubrec1 -1.308\*\*\*   
## (0.218)   
##   
## mortlat21 -0.900   
## (0.594)   
##   
## vr1 -0.341\*\*   
## (0.154)   
##   
## Constant 3.821\*\*\*   
## (0.593)   
##   
## ---------------------------------------------  
## Observations 1,989   
## Log Likelihood -600.776   
## Akaike Inf. Crit. 1,245.552   
## =============================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

The coefficient of white is 0.946 with a standard error of 0.173.

## Subsection (iv)

Use equation (17.17) to estimate the sizes of the discrimination effects for probit and logit.

## multiply the coefficient from the logit model by 0.625  
0.625\*0.946

## [1] 0.59125

The scaled cofficient from the logit model=0.59125, which is close to the one from the probit model.

# Problem C17.3

Use the data in FRINGE.RAW for this exercise

## Subsection (i)

For what percentage of the workers in the sample is pension equal to zero? What is the range of pension for workers with nonzero pension benefits? Why is a Tobit model appropriate for modeling pension?

## start by reading the data into R  
data3<-read\_dta("FRINGE.dta")  
  
## calculate the percentage of the workers whose pension is equal to zero  
(172/616)\*100

## [1] 27.92208

The range is $7.28 to $2880.27. The tobit model is appropriate because the sample consists of 28% workers with zero pension benefits, and the range of positive benefits is wide.

## Subsection (ii)

Estimate a Tobit model explaining pension in terms of exper, age, tenure, educ, depends, married, white, and male. Do whites and males have statistically significant higher expected pension benefits?

## estimate a tobit model   
data3$exper<-as.numeric(data3$exper)  
data3$age<-as.numeric(data3$age)  
data3$tenure<-as.numeric(data3$tenure)  
data3$educ<-as.numeric(data3$educ)  
data3$depends<-as.numeric(data3$depends)  
data3$married<-as.factor(data3$married)  
data3$white<-as.factor(data3$white)  
data3$male<-as.factor(data3$male)  
  
tobit.model<-tobit(pension~exper+age+tenure+educ+depends+married+white+male, data=data3)  
summary(tobit.model)  
##   
## Observations:  
## Total Left-censored Uncensored Right-censored   
## 616 172 444 0   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.252e+03 2.191e+02 -5.717 1.09e-08 \*\*\*  
## exper 5.203e+00 6.010e+00 0.866 0.387   
## age -4.639e+00 5.711e+00 -0.812 0.417   
## tenure 3.602e+01 4.565e+00 7.892 2.97e-15 \*\*\*  
## educ 9.321e+01 1.089e+01 8.558 < 2e-16 \*\*\*  
## depends 3.528e+01 2.192e+01 1.610 0.107   
## married1 5.369e+01 7.174e+01 0.748 0.454   
## white1 1.441e+02 1.021e+02 1.412 0.158   
## male1 3.082e+02 6.989e+01 4.409 1.04e-05 \*\*\*  
## Log(scale) 6.519e+00 3.562e-02 183.014 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Scale: 677.7   
##   
## Gaussian distribution  
## Number of Newton-Raphson Iterations: 4   
## Log-likelihood: -3673 on 10 Df  
## Wald-statistic: 204.5 on 8 Df, p-value: < 2.22e-16

Male is significant while White is not significant.

## Subsection (iii)

Use the results from part (ii) to estimate the difference in expected pension benefits for a white male and a nonwhite female, both of whom are 35 years old, are single with no dependents, have 16 years of education, and have 10 years of experience.

## create new data frames with the new data points  
newdata5<-data.frame(white="1",male="1",age=35,married="0",depends=0,educ=16,exper=10, tenure=10)  
newdata6<-data.frame(white="0",male="0",age=35,married="0",depends=0,educ=16,exper=10, tenure=10)  
  
## use the predicted values to calculate the difference  
predict(tobit.model, newdata5) - predict(tobit.model, newdata6)   
## 452.236

The difference is $ 452.236

## Subsection (iv)

Add union to the Tobit model and comment on its significance.

## add union to the tobit model and comment on its significance  
data3$union<-as.numeric(data3$union)  
  
tobit.model2<-tobit(pension~exper+age+tenure+educ+depends+married+white+male+union, data=data3)  
summary(tobit.model2)

## Observations:  
## Total Left-censored Uncensored Right-censored   
## 616 172 444 0   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.572e+03 2.185e+02 -7.191 6.44e-13 \*\*\*  
## exper 4.394e+00 5.831e+00 0.753 0.451159   
## age -1.654e+00 5.556e+00 -0.298 0.765987   
## tenure 2.878e+01 4.505e+00 6.388 1.68e-10 \*\*\*  
## educ 1.068e+02 1.077e+01 9.916 < 2e-16 \*\*\*  
## depends 4.147e+01 2.121e+01 1.955 0.050624 .   
## married1 1.975e+01 6.950e+01 0.284 0.776329   
## white1 1.593e+02 9.897e+01 1.610 0.107487   
## male1 2.572e+02 6.802e+01 3.782 0.000156 \*\*\*  
## union 4.390e+02 6.249e+01 7.026 2.12e-12 \*\*\*  
## Log(scale) 6.481e+00 3.548e-02 182.693 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Scale: 652.9   
##   
## Gaussian distribution  
## Number of Newton-Raphson Iterations: 4   
## Log-likelihood: -3649 on 11 Df  
## Wald-statistic: 260.3 on 9 Df, p-value: < 2.22e-16

Union is significant in the model

## Subsection (v)

Apply the Tobit model from part (iv) but with peratio, the pension-earnings ratio, as the dependent variable. (Notice that this is a fraction between zero and one, but,though it often takes on the value zero, it never gets close to being unity. Thus, a Tobit model is fine as an approximation.) Does gender or race have an effect on the pension-earnings ratio?

## using peratio as the dependent variable  
tobit.model3<-tobit(peratio~exper+age+tenure+educ+depends+married+white+male+union, data=data3)  
summary(tobit.model3)

##   
## Call:  
## tobit(formula = peratio ~ exper + age + tenure + educ + depends +   
## married + white + male + union, data = data3)  
##   
## Observations:  
## Total Left-censored Uncensored Right-censored   
## 616 172 444 0   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.0550630 0.0144896 -3.800 0.000145 \*\*\*  
## exper 0.0001697 0.0003861 0.440 0.660230   
## age -0.0002176 0.0003669 -0.593 0.553081   
## tenure 0.0017605 0.0003019 5.832 5.48e-09 \*\*\*  
## educ 0.0053478 0.0007172 7.457 8.88e-14 \*\*\*  
## depends 0.0008265 0.0014185 0.583 0.560140   
## married1 0.0032941 0.0046339 0.711 0.477163   
## white1 0.0031793 0.0065656 0.484 0.628215   
## male1 0.0025937 0.0045309 0.572 0.567021   
## union 0.0300458 0.0041859 7.178 7.08e-13 \*\*\*  
## Log(scale) -3.1270435 0.0359053 -87.091 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Scale: 0.04385   
##   
## Gaussian distribution  
## Number of Newton-Raphson Iterations: 4   
## Log-likelihood: 607.6 on 11 Df  
## Wald-statistic: 163.9 on 9 Df, p-value: < 2.22e-16

Gender and race dont have significants effects the pension-earnings ratio.