HOMEWORK 3 EE325

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1. Which of the following can cause the usual OLS t statistics to be invalid (that is, not to have t distributions under H_0)?

i. Heteroskedasticity.

ANS : YES, it's violate the assumption of homoscedasticity because OLS method includes homoscedasticity as one of its assumption, but if this assumption does not hold, that means if the data turn out to be heteroskedastic the then OLS t statistic will be invalid.

ii. A sample correlation coefficient of .95 between two independent variables that are in the model.

ANS : No, it just requires the coefficient not to be 1.

iii. Omitting an important explanatory variable.

ANS : Yes, violated the 4th assumption which is $E(u|x)=0$ if the ommited is correlated with the independent variable in the model it will definitely cause the t statistic to be invalid

2. Consider an equation to explain salaries of CEOs in terms of annual firm sales, return on equity (*roe*, in percentage form), and return on the firm's stock (*ros*, in percentage form):

$$\log(salary) = \beta_0 + \beta_1 \log(sales) + \beta_2 roe + \beta_3 ros + u.$$

i. In terms of the model parameters, state the null hypothesis that, after controlling for *sales* and *roe*, *ros* has no effect on CEO salary. State the alternative that better stock market performance increases a CEO's salary.

ANS : $H_0: \beta_3 = 0$
$H_a: \beta_3 > 0$

ii. Using the data in CEOSAL1, the following equation was obtained by OLS:

$$\widehat{\log(salary)} = \underset{(.32)}{4.32} + \underset{(.035)}{.280} \log(sales) + \underset{(.0041)}{.0174}\, roe + \underset{(.00054)}{.00024}\, ros$$

$$n = 209, R^2 = .283.$$

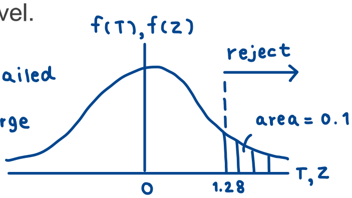
By what percentage is *salary* predicted to increase if *ros* increases by 50 points? Does *ros* have a practically large effect on *salary*?

ANS : The effect on $\widehat{salary}$ is $0.00024(50) = 0.012$ or 1.2%. means that if ros increases by 50 points, salary will predicted to increase by 1.2%. which is a very small effect for such a large change in ros.

iii. Test the null hypothesis that *ros* has no effect on *salary* against the alternative that *ros* has a positive effect. Carry out the test at the 10% significance level.

ANS : One-tailed

- n is relatively large then we will use z-table.



$$t_{\hat{\beta}_3} = \frac{(\hat{\beta}_3 - \beta_3)}{s.e.(\hat{\beta}_3)} = \frac{0.00024 - 0}{0.00054} = 0.44$$

So, $t_{\hat{\beta}_3}$ < critical value ($0.44 < 1.28$) means that we do not reject H_0 at 10% significance level. Therefore, ros has no effect on salary.

iv. Would you include *ros* in a final model explaining CEO compensation in terms of firm performance? Explain.

ANS The estimated ros coefficient appears to be different from zero only because of sampling variation. On the other hand, including ros may not be causing any harm. It depends on how correlated it is with the other independent variable.

C1. The following model can be used to study whether campaign expenditures affect election outcomes:

$$voteA = \beta_0 + \beta_1 \log(expendA) + \beta_2 \log(expendB) + \beta_3 prtystrA + u,$$

where *voteA* is the percentage of the vote received by Candidate A, *expendA* and *expendB* are campaign expenditures by Candidates A and B, and *prtystrA* is a measure of party strength for Candidate A (the percentage of the most recent presidential vote that went to A's party).

i. What is the interpretation of β_1 ?

ANS The elasticity of candidate A's expense. If Expend A change by 1%, Vote A will change by β_1%.

ii. In terms of the parameters, state the null hypothesis that a 1% increase in A's expenditures is offset by a 1% increase in B's expenditures.

ANS $H_0 . \beta_1 = -\beta_2$ or $\beta_1 + \beta_2 = 0$

$H_a : \beta_1 \neq -\beta_2$ or $\beta_1 + \beta_2 \neq 0$

iii. Estimate the given model using the data in VOTE1 and report the results in usual form. Do A's expenditures affect the outcome? What about B's expenditures? Can you use these results to test the hypothesis in part (ii)?

ANS

```
. reg voteA lexpendA lexpendB prtystrA

      Source |       SS           df       MS      Number of obs   =       173
-------------+----------------------------------   F(3, 169)       =    215.23
       Model |  38405.1096         3  12801.7032   Prob > F        =    0.0000
    Residual |  10052.1389       169   59.480112   R-squared       =    0.7926
-------------+----------------------------------   Adj R-squared   =    0.7889
       Total |  48457.2486       172  281.728189   Root MSE        =    7.7123

------------------------------------------------------------------------------
       voteA |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lexpendA |   6.083316     .38215    15.92   0.000     5.328914    6.837719
    lexpendB |  -6.615417   .3788203   -17.46   0.000    -7.363246   -5.867588
    prtystrA |   .1519574   .0620181     2.45   0.015     .0295274    .2743873
       _cons |   45.07893   3.926305    11.48   0.000     37.32801    52.82985
------------------------------------------------------------------------------
```

Both A's expenditures and B's expenditures affect the outcome significantly. According to the estimation, 1% increase in A's expenditure would be increase vote A by 6.087 . Nevertheless, 1% increase in B's expenditure would be decrease Vote B by -6.62%.. Moreover, you cannot test the null hypothesis from part (ii) because we do not have the standard error of $\hat{\beta}_1 + \hat{\beta}_2$

iv. Estimate a model that directly gives the *t* statistic for testing the hypothesis in part (ii). What do you conclude? (Use a two-sided alternative.)

ANS $voteA = \beta_0 + \beta_1 \log(expendA) + \beta_2 \log(expendB) + \beta_3 prtystrA + u$

Would like to test the $H_0 : \beta_1 + \beta_2$

Let $\theta = \beta_1 + \beta_2$

1st) write the t-statistic for testing H_0

$$t = \frac{(\hat{\beta}_1 - 3\hat{\beta}_2) - 1}{s.e(\hat{\beta}_1 - 3\hat{\beta}_2)} \qquad t = \frac{(\beta_1 + \beta_2) - 0}{s.e.(\beta_1 + \beta_2)}$$

2nd) Define $\theta_1 = \beta_1 + \beta_2$ >> $H_0 : \theta_1 = 0$, $H_a : \theta_1 \neq 1$

$$t = \frac{\theta_1 - 1}{s.e.(\theta_1)}$$

Let $\theta = \beta_1 + \beta_2$ and sub in the main regression and get

$$\begin{aligned} voteA &= \beta_0 + \beta_1 \log(expendA) + \beta_2 \log(expendB) + \beta_3 prtystrA + u \\ &= \beta_0 + (\beta_1 + \beta_2 - \beta_2)\log(expendA) + \beta_2 \log(expendB) + \beta_3 prtystrA + u \\ &= \beta_0 + \theta \log(expendA) - \beta_2 \log(expendA) + \beta_2 \log(expendB) + \beta_3 prtystrA + u \\ &= \beta_0 + \theta \log(expendA) + \beta_2(\log(expendB) - \log(expendA)) + \beta_3 prtystrA + u \end{aligned}$$

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      Source |       SS           df       MS      Number of obs   =       173
-------------+----------------------------------   F(  3,    169)  =    215.23
       Model |  38405.1089         3  12801.703   Prob > F         =    0.0000
    Residual |  10052.1397       169  59.4801165   R-squared       =    0.7926
-------------+----------------------------------   Adj R-squared   =    0.7889
       Total |  48457.2486       172  281.728189   Root MSE        =    7.7123

------------------------------------------------------------------------------
       votea |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    lexpenda |   -.532101   .5330858    -1.00   0.320    -1.584466     .520264
         exp |  -6.615417   .3788203   -17.46   0.000    -7.363246   -5.867588
    prtystra |   .1519574   .0620181     2.45   0.015     .0295274    .2743873
       _cons |   45.07893   3.926305    11.48   0.000     37.32801    52.82985
```

According to the result table, it obtain that $\theta_1 = -0.532$ and $s.e. \theta_1 = 0.533$. The t-statistic for the hypothesis in part (ii) is $\frac{-0.532}{0.533} \approx -1$. Therefore, we will not reject the null hypothesis means that 1% increase in A's expenditures is offset by a 1% increase in B's expenditures.

C6. Use the data in WAGE2 for this exercise.

i. Consider the standard wage equation

$$\log(wage) = \beta_0 + \beta_1 educ + \beta_2 exper + \beta_3 tenure + u.$$

State the null hypothesis that another year of general workforce experience has the same effect on $\log(wage)$ as another year of tenure with the current employer.

ANS $H_0 : \beta_2 = \beta_3$ or $\beta_2 - \beta_3 = 0$

$H_a : \beta_2 \neq \beta_3$ or $\beta_2 - \beta_3 \neq 0$

ii. Test the null hypothesis in part (i) against a two-sided alternative, at the 5% significance level, by constructing a 95% confidence interval. What do you conclude?

```
. reg lwage educ exper tenure

      Source |       SS           df       MS      Number of obs   =       935
-------------+----------------------------------   F(3, 931)       =     56.97
       Model |  25.6953242         3  8.56510806   Prob > F        =    0.0000
    Residual |  139.960959       931  .150334005   R-squared       =    0.1551
-------------+----------------------------------   Adj R-squared   =    0.1524
       Total |  165.656283       934  .177362188   Root MSE        =    .38773

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        educ |   .0748638   .0065124    11.50   0.000      .062083    .0876446
       exper |   .0153285   .0033696     4.55   0.000     .0087156    .0219413
      tenure |   .0133748   .0025872     5.17   0.000     .0082974    .0184522
       _cons |   5.496696   .1105282    49.73   0.000     5.279782    5.713609
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```

ANS : According to the estimation table, $\alpha = 0.05$ is not significant at a 95% of confidence interval. So, we will not reject H_0. Therefore, one additional year of general workforce experience has the same effect on log(wage) as another year.

C8. The data set 401KSUBS contains information on net financial wealth (*nettfa*), age of the survey respondent (*age*), annual family income (*inc*), family size (*fsize*), and participation in certain pension plans for people in the United States. The wealth and income variables are both recorded in thousands of dollars. For this question, use only the data for single-person households (so $fsize = 1$).

i. How many single-person households are there in the data set?

```
. reg nettfa inc age if fsize ==1

      Source |       SS           df       MS      Number of obs   =     2,017
-------------+----------------------------------   F(2, 2014)      =    136.46
       Model |  544916.989         2  272458.495   Prob > F        =    0.0000
    Residual |  4021048.06     2,014  1996.54819   R-squared       =    0.1193
-------------+----------------------------------   Adj R-squared   =    0.1185
       Total |  4565965.05     2,016  2264.86361   Root MSE        =    44.683

------------------------------------------------------------------------------
      nettfa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         inc |   .7993167   .0597307    13.38   0.000     .6821762    .9164572
         age |   .8426563   .0920169     9.16   0.000     .6621982    1.023115
       _cons |  -43.03981   4.080393   -10.55   0.000    -51.04204   -35.03758
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```

ANS According to the estimation table, the number of single-person households are 2017 observations.

ii. Use OLS to estimate the model

$$nettfa = \beta_0 + \beta_1 inc + \beta_2 age + u,$$

and report the results using the usual format. Be sure to use only the single-person households in the sample. Interpret the slope coefficients. Are there any surprises in the slope estimates?

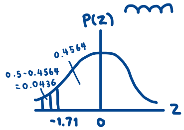
ANS The slope coefficients is $\hat{\beta}_1$ and $\hat{\beta}_2$. With $\hat{\beta}_1$, we can interpret that if income increase by thousands of dollar (\$1000), net finance wealth would be increase by \$799. However, with $\hat{\beta}_2$, we can interpret that if age increase by 1 year, net finance wealth would be increase by \$842.

iii. Does the intercept from the regression in part (ii) have an interesting meaning? Explain.

ANS $\hat{\beta}_0$ is a intercept of regression function means that when their income is 0 and their age is 0, individual's net financial wealth is \$-43.04. Therefore, this is the net financial wealth of newborn babies which it does not seems to be interesting. we can conclude that there is none of them even close to these values in the appropriate population.

iv. Find the *p*-value for the test $\mathrm{H}_0: \beta_2 = 1$ against $\mathrm{H}_1: \beta_2 < 1$. Do you reject H_0 at the 1% significance level?

ANS From the output that we obtain in part (ii), we can conclude that t-statistic is $\dfrac{\hat{\beta}_2 - \beta_2}{s.e.(\hat{\beta}_2)} = \dfrac{0.843-1}{0.092} \approx -1.71$ and the p-value for age is $P(T<-1.71) \approx 0.0436$



Therefore, we will reject Ho at 1% significant level because p-value is less than 1% significant level (0.01).

v. If you do a simple regression of *nettfa* on *inc*, is the estimated coefficient on *inc* much different from the estimate in part (ii)? Why or why not?

ANS The estimated coefficient on $\hat{\beta}_1 = 0.821$ which it is not different much from the estimate of 0.799 in the last regression. Since this is ommitted variable, we need to know the correlated between age and income which we can find to be just only 0.039 means that coefficient does not change much.