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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.

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

   iii. Omitting an important explanatory variable.

(i) Yes, violate the assumption of homoskedascity

(ii) No, it just requires the coefficient not to be 1.

(iii) Yes, violate the 4th assumption $E(u|x) = 0$ if the omitted variable is correlated with the independent variables in the model.

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.

(i) $H_0: \beta_3 = 0$

$H_a: \beta_3 > 0$

   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*?

(ii) The proportionate effect on $\widehat{salary} = 0.00024(50) = 0.012 = 1.2\%$

Therefore, a 50 point ceteris paribus increase in ros is predicted to increase salary by 1.2 %.

   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.

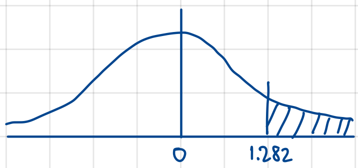
(iii) $H_0 : \beta_3 = 0$ significant level 10% = 0.1

$H_a : \beta_3 > 0$ d.f = 209 - 3 - 1 = 205 > 30 use Z-score

$t_{cri} = 1.282$

$t_{cal} = \dfrac{\hat{\beta}_3 - 0}{SE(\hat{\beta}_3)} = \dfrac{0.0024}{0.00054} = 0.44$ $0.44 < 1.282$

$\therefore$ we cannot reject H_0 at 10% significant level



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

Based on this sample, the estimated ros coefficient appears to be different from zero only because of sampling variation. However, if ros is very correlated with the other explanatory variables than omitting it from the regression may still bias the estimates. We can see that the other explanatory variables are still very significant even with ros included in the regression, which provides evidence againt this.

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 ?

Δvote A $= \beta_1 \Delta \log \langle$Expend A$\rangle$

$= (\beta_1/100)[100 \times \Delta \log($Expand A$)]$

$\approx (\beta_1/100)[\% \Delta \log($Expand A$)]$

$\therefore \beta_1/100$ is the ceteris paribus percentage point change of vote recieved when campaign expenditure by candidate A increases by 1 percent

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.

$H_0: \beta_2 = -\beta_1$

$H_a: \beta_2 \neq -\beta_1$

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)?

C.1

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. 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
------------------------------------------------------------------------------
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regression model in usual form :

vote A $= \langle 45.1 \rangle + 6.08 \log($Expend A$) - 6.62 \log($Expend B$)$
(11.48) (15.92) (-17.46)

$+ 0.152$ (prtystrA)
(2.45)

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.)

rewrite hypothesis $\theta_1 = \beta_1 + \beta_2 \Rightarrow H_0: \theta_1 = 0$ $H_a: \theta_1 \neq 0$

rearrange vote A $= \beta_0 + \theta \log($Expend A$) + \beta_2 [\log($Expend B$) - \log($Expend A$)$
$+ \beta_3$ prtystrA

when estimate equation we obtain $\hat{\beta}_1 \approx -.532$

$se(\hat{\beta}_1) \approx 0.533$

then $t_{cal} = \frac{-.532 - 0}{.533} \approx -1$ $\therefore$ cannot reject H_0 $\beta_2 = -\beta_1$

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.

(i) $H_0: \beta_2 = \beta_3$

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?

(ii) θ is insignificant at a 95% confidence interval, Thus we can't reject H_0. We can conclude that one additional year of general workforce experience has the same effect on log(wage) as another year.

```
. 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
------------------------------------------------------------------------------
```

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?

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?

C.8

```
. 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
------------------------------------------------------------------------------
```

$\hat{\beta}_1$ can be interpret as a $\$1000$ increase in income corresponds to a $\$799$ increase in net financial wealth. We interpret $\hat{\beta}_2$ as a 1 year increase in age corresponds to a $\$842$ increase in net financial wealth.

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

$\hat{\beta}_0 = -43.04$

This is an individual's net financial wealth when their income is $\$0$ and their age is 0. In other word, a net financial wealth of new born babies.

iv. Find the *p*-value for the test $H_0: \beta_2 = 1$ against $H_1: \beta_2 < 1$. Do you reject H_0 at the 1% significance level?

t-statistic $= (0.843 - 1/0.092) \approx -1.71$

Against the one-sided alternative $H_1: \beta_2 < 1$

$\therefore$ reject the null hypothesis at the end of the 5% significance level but not at the 1% sig level.

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?

We get an estimate of $\hat{\beta}_1 = 0.821$ which is not very different from the estimate of 0.799 in the last regression. Since this is an omitted variable question we need to know the correlated between age and income, which we find to be only 0.039. This explains why the coefficient does not change.