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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) OLS includes homoskedasticity, if not, it will be heteroskedasticity and the usual OLS t statistics being invalid

iii) if explanatory variable being omitted the data will be affected and affect result of regression, will cause OLS t statistic being 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.

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*?

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.

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

i) $H_0 : \beta_3 = 0$
$H_a : \beta_3 > 0$

ii) let salary be y
, let ros be x_3
, let $0.00024 = \beta_3$

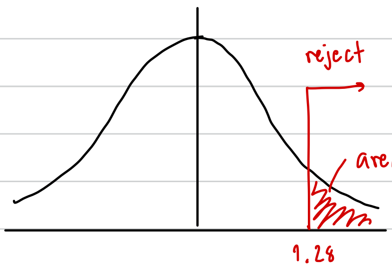
$$\frac{d \log(y)}{dx} = \beta_3 \rightarrow \frac{\frac{1}{y} dy}{dx} = \beta_3$$

$$\frac{100 \frac{1}{y} \Delta y}{dx} = 100\beta_3 \rightarrow \frac{\% \Delta y}{\Delta x} = 100\beta_3$$

$$\rightarrow \frac{\% \Delta(\text{salary})}{\Delta(\text{ros})} = 100(0.00024) = 0.024$$

if ros increase by 50 point, salary will increase by $0.024 \times 50 = 1.2\%$.

iii)



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

at 10% sig. level
d.f. $209 - 3 - 1 = 205 \rightarrow$ z-table

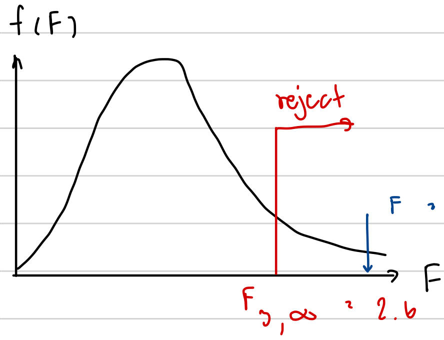
$$z = \frac{\hat{\beta}_3 - \beta_3}{s.e(\hat{\beta}_3)} = \frac{0.00024 - 0}{0.00054} = 0.444 < 0.128$$

So, we accept H_0 at 10% sig. level

iv) r ; $\widehat{\log(salary)} = 4.32 \rightarrow H_0 ; \beta_1 = \beta_2 = \beta_3 = 0$

ur ; $\widehat{\log(salary)} = 4.32 + 0.28 \log(sales) + 0.0174(roe) + 0.00024(ros)$
↳ H_a : otherwise

$$F = \frac{R^2 / k}{(1 - R^2)/n-k-1} = \frac{0.283/3}{0.717/205} = 26.97$$



since, $F = 26.97 > 2.6$ we reject H_0 and conclude that firm performance have joint effect in explaining CEO compensation at 5% sig. level

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.

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?

i) $H_0 : \beta_2 = \beta_3$
$H_a : \beta_2 \neq \beta_3$

ii) $H_0 : \beta_2 = \beta_3 \rightarrow \beta_2 - \beta_3 = 0$
$H_a : \beta_2 \neq \beta_3 \rightarrow \beta_2 - \beta_3 \neq 0$

let $\theta = \beta_2 - \beta_3$ → $H_0 : \theta = 0$, $H_a : \theta \neq 0$

$\beta_2 = \theta + \beta_3$

substitution $\beta_2 = \theta + \beta_3$

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

$$= \beta_0 + \beta_1 educ + \theta\, exper + \beta_3 exper + \beta_3 tenure + u$$

$$= \beta_0 + \beta_1 educ + \theta\, exper + \beta_3 (exper + tenure) + u$$

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. regress lwage educ exper exper_tenure
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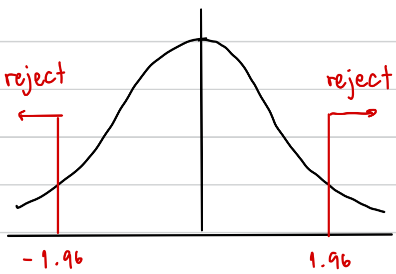
Source	SS	df	MS
Model	25.6953242	3	8.56510806
Residual	139.960959	931	.150334005
Total	165.656283	934	.177362188

Number of obs	=	935
F(3, 931)	=	56.97
Prob > F	=	0.0000
R-squared	=	0.1551
Adj R-squared	=	0.1524
Root MSE	=	.38773

lwage	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
educ	.0748638	.0065124	11.50	0.000	.062083	.0876446
exper	.0019537	.0047434	0.41	0.681	-.0073554	.0112627
exper_tenure	.0133748	.0025872	5.17	0.000	.0082974	.0184522
_cons	5.496696	.1105282	49.73	0.000	5.279782	5.713609

$= \theta$



0.41 < 1.96, t-critical does not fall into rejection region, therefore we accept H_0 at 5% sig. level, both variable have the same impact on log(wage)

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?

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?

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

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?

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?

i) 2017

ii)

. regress nettfa inc age if fsize == 1

Source	SS	df	MS
Model	544916.989	2	272458.495
Residual	4021048.06	2,014	1996.54819
Total	4565965.05	2,016	2264.86361

Number of obs	=	2,017
F(2, 2014)	=	136.46
Prob > F	=	0.0000
R-squared	=	0.1193
Adj R-squared	=	0.1185
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

intercept = β_0 = -43.03981

β_1 = 0.7993 means if annual income increase by 1, net financial wealth will increase by 799.3 \$

β_2 = 0.8427, means if age of the survey respondent increase by 1 year, net financial wealth will increase by 842.7 \$

iii) Yes, because intercept shows what will net financial wealth be if income and age is 0, but it is not possible since minimum income = 10,008 and minimum wage is 25.

iv)

. lincom age - 1

(1) age = 1

nettfa	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
(1)	-.1573437	.0920169	-1.71	0.087	-.3378018	.0231145

. di .087/2
.0435

one-sided p-value = 0.435, which is greater than 0.01, so we accept H_0 at 1% sig. level.

v)

. reg nettfa inc

Source	SS	df	MS
Model	377482.064	1	377482.064
Residual	4188482.98	2,015	2078.6516
Total	4565965.05	2,016	2264.86361

Number of obs	=	2,017
F(1, 2015)	=	181.60
Prob > F	=	0.0000
R-squared	=	0.0827
Adj R-squared	=	0.0822
Root MSE	=	45.592

nettfa	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
inc	.8206815	.0609	13.48	0.000	.7012479	.940115
_cons	-10.57095	2.060678	-5.13	0.000	-14.61223	-6.529671

. corr inc age
(obs=2,017)

	inc	age
inc	1.0000	
age	0.0391	1.0000

coef. inc. is 0.820, from (ii) coef. inc. = 0.799, it is not so different because correlation between income and age is very small.

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 ?

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.

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)?

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.)

i) $\beta_1 = 6.083$, if $\log(\text{expand } A)$ increase by 1, vote A will increase by 6.083 %

ii) $H = \text{expend } A$, $i = \text{vote } A$, $J = \text{expend } B$

$\beta_1 = \dfrac{d \log(H)}{di}$ | $\beta_2 = \dfrac{d \log(J)}{di}$

$100 \beta_1 \, di = 100 \frac{1}{H} dH$ | $100 \beta_2 \, di = 100 \frac{1}{J} dJ$

$100 \beta_1 \Delta i = \% \Delta H$ | $100 \beta_2 \Delta i = \% \Delta J$

$H_0 = \% \Delta H = - \% \Delta J$ | $H_a = \beta_1 \neq -\beta_2$

$100 \beta_1 \Delta i = 100 \beta_2 \Delta i$

$\beta_1 = -\beta_2$

iii)

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. regress voteA lexpendA lexpendB prtystrA
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Source	SS	df	MS		
Model	38405.1096	3	12801.7032	Number of obs =	173
Residual	10052.1389	169	59.480112	F(3, 169) =	215.23
				Prob > F =	0.0000
				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

A's expenditure have positive effect on vote A
B's expenditure have negative effect on vote A
the result cannot be use because it does not directly give t statistic for testing, the result of $\beta_1 + \beta_2$ is not calculated

iv) $H_0: \beta_1 = -\beta_2 \rightarrow \beta_1 + \beta_2 = 0$
$H_a: \beta_1 \neq -\beta_2 \rightarrow \beta_1 + \beta_2 \neq 0$

let $\theta = \beta_1 + \beta_2$ → $H_0: \theta = 0$, $H_a: \theta \neq 0$

$\beta_1 = \theta - \beta_2$

substitute $\beta_1 = \theta - \beta_2$

$$\text{Vote } A = \beta_0 + (\theta - \beta_2) \log(\text{expend } A) + \beta_2 \log(\text{expend } B) + \beta_3 \text{ prtystr } A + u$$

$$= \beta_0 + \theta \log(\text{expend} A) - \beta_2 \log(\text{expend } A) + \beta_2 \log(\text{expend } B) + \beta_3 \text{ prtystr } A + u$$

$$\text{Vote } A = \beta_0 + \theta \log(\text{expend} A) + \beta_2 (\log(\text{expend } B) - \log(\text{expend } A)) + \beta_3 \text{ prtystr } A + u$$

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. regress voteA lexpendA lab prtystrA
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Source	SS	df	MS		
Model	38405.1097	3	12801.7032	Number of obs =	173
Residual	10052.1388	169	59.4801115	F(3, 169) =	215.23
				Prob > F =	0.0000
				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	.5202638
lab	-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

$-1 > -1.96$, t-critical does not fall into rejection region, we accept H_0 at 5 % sig. level, 1 % increase in A's expenditure is offset by 1 % increase by B's expenditure