

Week 11 - Problems

Business Research Methods

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04 May 2021



Problem 1: CEO Salary

Install the package `wooldridge`

- `data: wooldridge::ceosal1`

The data set `ceosal1` contains information on CEOs.

- `salary`: salary in thousands of dollars.
- `roe`: average return on equity (`roe`) for the CEO's firm for the previous three years.

Q1

- 1 Sample size? Find average, minimum and maximum salary.

```
# find n; avg, min, max salary  
ceosal1 %>%  
  summarise(n = n(),  
            avg_sal = mean(salary),  
            min_sal = min(salary),  
            max_sal = max(salary))
```

```
##      n avg_sal min_sal max_sal  
## 1 209 1281.12    223    14822
```

Estimate the model

$$salary = \beta_0 + \beta_1 roe + u.$$

```
model_ceo <- lm(salary ~ roe, data = ceosal1)
model_ceo$coefficients
```

```
## (Intercept)          roe
##    963.19134    18.50119
```

$$\widehat{salary} = 963.191 + 18.501 roe$$

- 2 If roe is 0, what is the predicted salary?

$$\widehat{salary} = 963.191 + 18.501roe$$

If the return on equity is zero, $roe = 0$, then the predicted salary is the intercept, 963.191, which equals \$963,191 because salary is measured in thousands.

$$\widehat{salary} = 963.191 + 18.501ro e$$

- 3 If roe increases by one percentage point, then the salary is predicted to change by ?

If the return on equity increases by one percentage point, $roe = 1$, then salary is predicted to change by about 18.5, or \$18,500.

- 4 If roe is 30, what is the predicted salary?

$$\widehat{salary} = 963.191 + 18.501(30) = 1518.221,$$

which is just over \$1.5 million.

Q5

- 5 *The firm's return on equity explains only about 1.3% of the variation in salaries for this sample of 209 CEOs. That means that 98.7% of the salary variations for these CEOs is left unexplained! — True or False?*

```
summary(model_ceo)$r.squared
```

```
## [1] 0.01318862
```

True!

Q6

- 6 The first four CEOs have lower salaries than what we predicted from the OLS regression line. — True or False?

```
broom::augment(model_ceo) %>% head(n = 4)
```

```
## # A tibble: 4 x 8
```

##	salary	roe	.fitted	.resid	.hat	.sigma	.cooksd	.s
##	<int>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	
## 1	1095	14.1	1224.	-129.	0.00541	1370.	0.0000244	
## 2	1001	10.9	1165.	-164.	0.00740	1370.	0.0000540	
## 3	1122	23.5	1398.	-276.	0.00743	1370.	0.000154	
## 4	578	5.90	1072.	-494.	0.0132	1369.	0.000888	

Q7

- 7 The fifth CEO makes more than predicted from the OLS regression line. — True or False?

```
broom::augment(model_ceo) %>% slice(5)
```

```
## # A tibble: 1 x 8
##   salary    roe .fitted .resid    .hat .sigma    .cooksd .s
##   <int> <dbl>   <dbl> <dbl>   <dbl> <dbl>   <dbl>
## 1   1368  13.8   1219.   149.  0.00554 1370.  0.0000335
```

True!

Q8

- 8 Rather than measuring salary in thousands of dollars, we want to measure it in dollars. Mutate a new variable `salardol` using this expression `salardol = 1000*salary`. Now estimate the following model:

$$\text{salarydol} = \beta_0 + \beta_1 \text{roe} + u.$$

```
# mutate
ceosal1_new <- ceosal1 %>%
  mutate(salarydol = salary*1000)
# model
model_ceo2 <- lm(salarydol ~ roe, data = ceosal1_new)
```

```
model_ceo$coefficients # salary in thousands of dollars
```

```
## (Intercept)          roe  
##    963.19134    18.50119
```

```
model_ceo2$coefficients # salary in dollars
```

```
## (Intercept)          roe  
##   963191.34   18501.19
```

If the dependent variable is multiplied by the constant c – which means each value in the sample is multiplied by c – then the OLS intercept and slope estimates are also multiplied by c . — True!

Problem 2: College GPA

wooldridge::gpa1

- colGPA: college grade point average
- hsGPA: high school GPA
 - both college and high school GPAs are on a four-point scale.
- ACT: standardized test score
- PC: dummy variable
 - 1 if a student owns a personal computer
 - 0 otherwise

Q1

1 How many students own PC?

```
gpa1 %>%  
  count(PC)
```

```
##      PC    n  
## 1     0   85  
## 2     1   56
```

Q2

Estimate the following model:

$$colGPA = \beta_0 + \beta_1 hsGPA + \beta_2 ACT + u.$$

```
model_gpa <- lm(colGPA ~ hsGPA + ACT, data = gpa1)
model_gpa$coefficients
```

```
## (Intercept)          hsGPA          ACT
## 1.286327767 0.453455885 0.009426012
```


$$\widehat{colGPA} = 1.29 + 0.453 \text{ } hsGPA + 0.0094 ACT$$

- 2 *There is a positive partial relationship between colGPA and hsGPA: holding ACT fixed, another point on hsGPA is associated with .453 of a point on the college GPA — True or False?*

True!

$$\widehat{colGPA} = 1.29 + 0.453 \text{ } hsGPA + 0.0094ACT$$

- 3 Given the fact that the highest possible score on the ACT is 36, the coefficient on ACT practically small. — True or False?

True!

Q4

- 4 To determine the effects of computer ownership on college grade point average, estimate the following model:

$$colGPA = \beta_0 + \delta_0 PC + \beta_1 hsGPA + \beta_2 ACT + u.$$

```
model_gpa2 <- lm(colGPA ~ PC + hsGPA + ACT, data = gpa1)
model_gpa2$coefficients
```

## (Intercept)	PC	hsGPA	ACT
## 1.263519813	0.157309205	0.447241653	0.008659005

$$\widehat{colGPA} = 1.26 + 0.157 PC + 0.447 hsGPA + 0.0087 ACT + u.$$

This equation implies that a student who owns a PC has a predicted GPA about 1.6 points higher than a comparable student without a PC.

— True or False?

False!

Q5

- 5 Generate a factor variable PC2: "Yes" if PC = 0 otherwise "No". Similarly, generate PC3 with levels = c("Yes", "No").

```
gpa1 <- gpa1 %>%  
  mutate(PC2 = factor(if_else(PC == 1, "Yes", "No"),  
                        levels = c("Yes", "No")),  
         PC3 = factor(if_else(PC == 1, "Yes", "No")))
```

Estimate the following models:

$$colGPA = \beta_0 + \delta_0 PC2 + \beta_1 hsGPA + \beta_2 ACT + u.$$

$$colGPA = \beta_0 + \delta_0 PC3 + \beta_1 hsGPA + \beta_2 ACT + u.$$

```
model_gpa3 <- lm(colGPA ~ PC2 + hsGPA + ACT, data = gpa1)
model_gpa3$coefficients
```

```
##      (Intercept)          PC2No          hsGPA          ACT
##  1.420829018 -0.157309205  0.447241653  0.008659005
```

```
model_gpa4 <- lm(colGPA ~ PC3 + hsGPA + ACT, data = gpa1)
model_gpa4$coefficients
```

```
##      (Intercept)      PC3Yes          hsGPA          ACT
##  1.263519813  0.157309205  0.447241653  0.008659005
```

Questions?

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