Problem Set 3

Applied Stats/Quant Methods 1

Due: November 20, 2021

Instructions

- Please show your work! You may lose points by simply writing in the answer. If the problem requires you to execute commands in `R`, please include the code you used to get your answers. Please also include the `.R` file that contains your code. If you are not sure if work needs to be shown for a particular problem, please ask.
- Your homework should be submitted electronically on GitHub.
- This problem set is due before 23:59 on Sunday November 20, 2022. No late assignments will be accepted.
- Total available points for this homework is 80.

In this problem set, you will run several regressions and create an add variable plot (see the lecture slides) in `R` using the `incumbents_subset.csv` dataset. Include all of your code.

Question 1

We are interested in knowing how the difference in campaign spending between incumbent and challenger affects the incumbent's vote share.

1. **Run a regression where the outcome variable is `voteshare` and the explanatory variable is `difflog`.**

```
lm_q1 <- lm(voteshare ~ difflog, data = dat)
stargazer(lm_q1, title = "The association between difflog and voteshare")
```

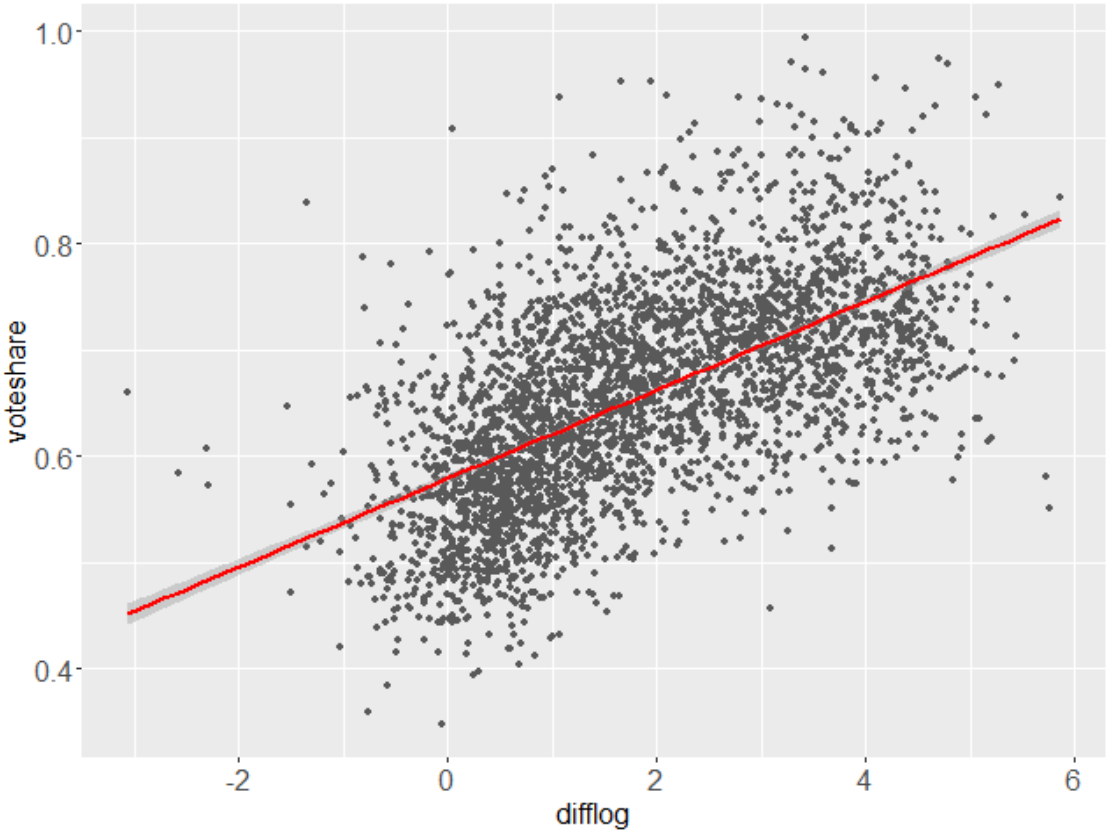
Table 1: The association between `difflog` and `voteshare`

	Dependent variable:
	`voteshare`
`difflog`	0.042***
	(0.001)
Constant	0.579***
	(0.002)
Observations	3,193
R^2	0.367
Adjusted R^2	0.367
Residual Std. Error	0.079 (df = 3191)
F Statistic	1,852.791*** (df = 1; 3191)
Note:	*p<0.1; **p<0.05; ***p<0.01

2. **Make a scatterplot of the two variables and add the regression line.**

```
png("lm_q1.png", 640, 480)
dat %>%
  ggplot(aes(difflog, voteshare)) +
  geom_point(color = "gray35") +
  geom_smooth(method = "lm", color = "red") +
  theme(axis.text = element_text(size = 16), axis.title = element_text(
    size = 16))
dev.off()
```

Figure 1: The association between `difflog` and `voteshare`



3. **Save the residuals of the model in a separate object.**

```
lm_q1_res <- lm_q1$residuals
```

4. **Write the prediction equation.**

$$y = \beta_0 + \beta_1 x$$
$$y = 0.579 + 0.042x$$

Question 2

We are interested in knowing how the difference between incumbent and challenger's spending and the vote share of the presidential candidate of the incumbent's party are related.

1. **Run a regression where the outcome variable is `presvote` and the explanatory variable is `difflog`.**

```
lm_q2 <- lm(presvote ~ difflog, data=dat)
stargazer(lm_q2, title = "The association between difflog and presvote")
```

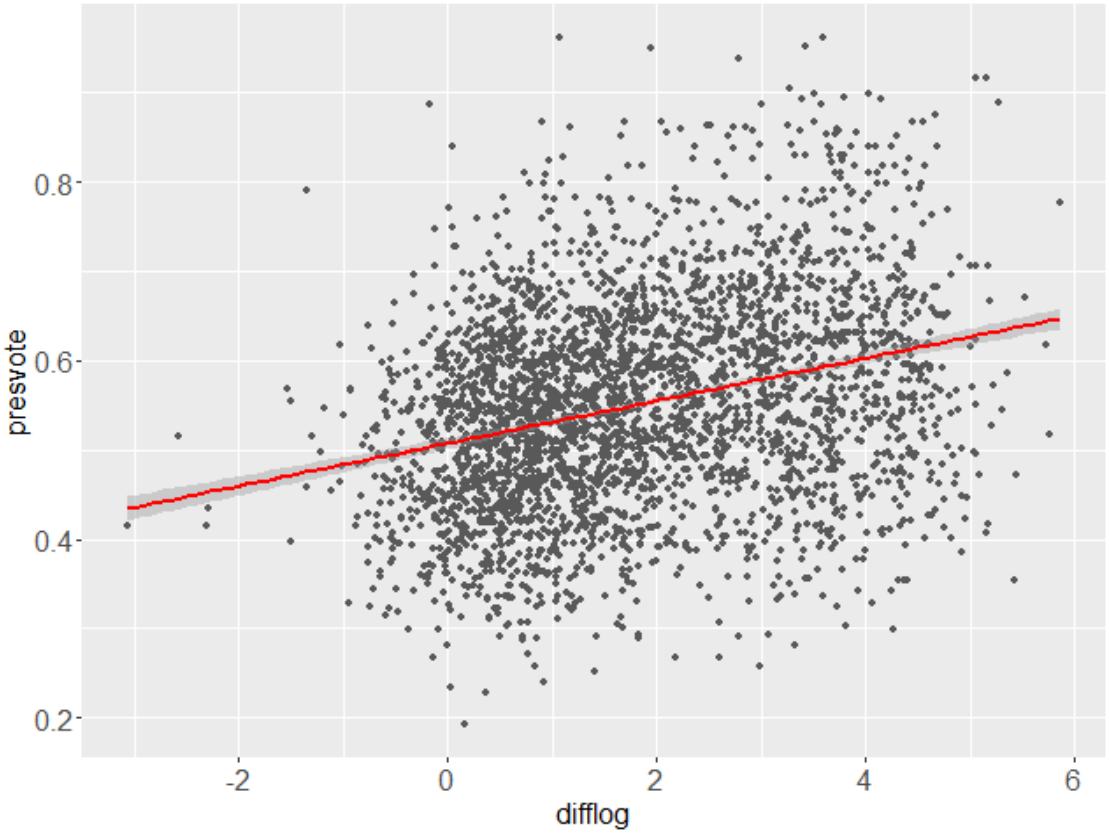
Table 2: The association between `difflog` and `presvote`

	Dependent variable:
	`presvote`
`difflog`	0.024***
	(0.001)
Constant	0.508***
	(0.003)
Observations	3,193
R^2	0.088
Adjusted R^2	0.088
Residual Std. Error	0.110 (df = 3191)
F Statistic	307.715*** (df = 1; 3191)
Note:	*p<0.1; **p<0.05; ***p<0.01

2. **Make a scatterplot of the two variables and add the regression line.**

```
png("lm_q2.png", 640, 480)
dat %>%
  ggplot(aes(difflog, presvote)) +
  geom_point(color = "gray35") +
  geom_smooth(method = "lm", color = "red") +
  theme(axis.text = element_text(size = 16), axis.title = element_text(
    size = 16))
dev.off()
```

Figure 2: The association between `difflog` and `presvote`



3. **Save the residuals of the model in a separate object.**

```
lm_q2_res <- lm_q2$residuals
```

4. **Write the prediction equation.**

$$y = \beta_0 + \beta_1 x$$
$$y = 0.508 + 0.024x$$

Question 3

We are interested in knowing how the vote share of the presidential candidate of the incumbent's party is associated with the incumbent's electoral success.

1. **Run a regression where the outcome variable is `voteshare` and the explanatory variable is `presvote`.**

```
lm_q3 <- lm(voteshare ~ presvote, data=dat)
stargazer(lm_q3, title = "The association between presvote and voteshare")
```

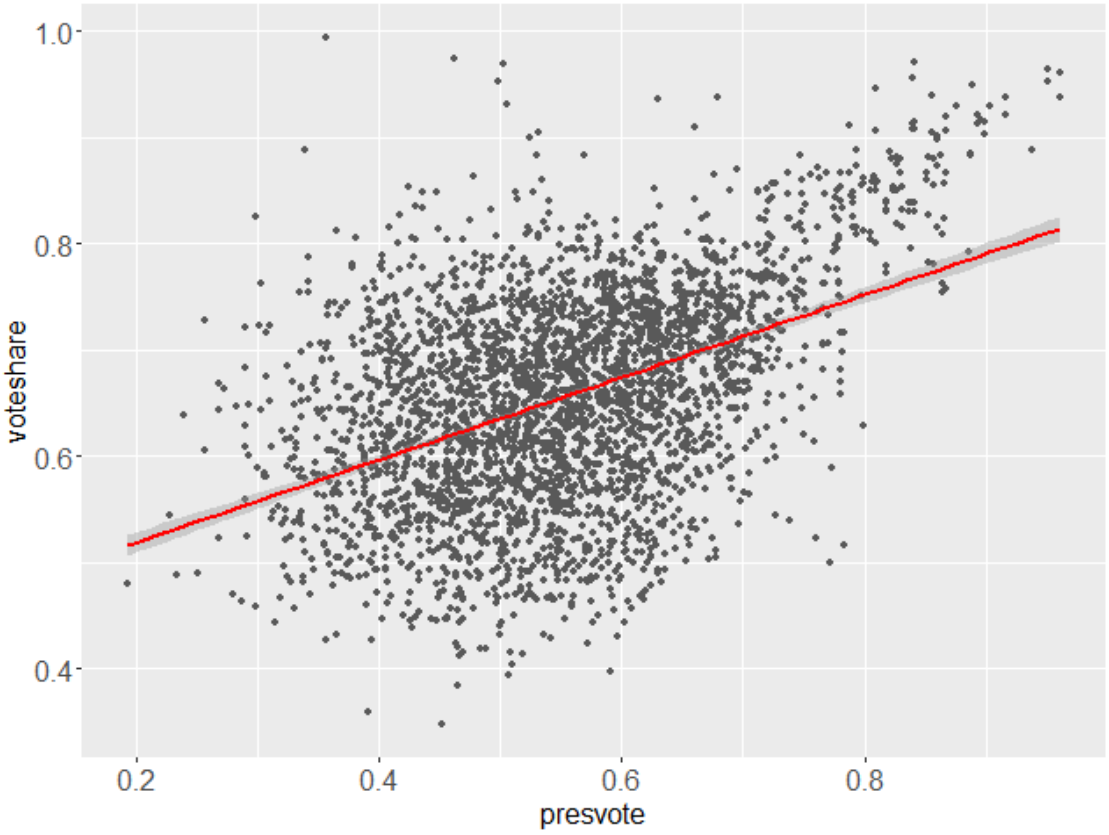
Table 3: The association between `presvote` and `voteshare`

	Dependent variable:
	`voteshare`
`presvote`	0.388***
	(0.013)
Constant	0.441***
	(0.008)
Observations	3,193
R^2	0.206
Adjusted R^2	0.206
Residual Std. Error	0.088 (df = 3191)
F Statistic	826.950*** (df = 1; 3191)
Note:	*p<0.1; **p<0.05; ***p<0.01

2. **Make a scatterplot of the two variables and add the regression line.**

```
png("lm_q3.png", 640, 480)
dat %>%
  ggplot(aes(presvote, voteshare)) +
  geom_point(color = "gray35") +
  geom_smooth(method = "lm", color = "red") +
  theme(axis.text = element_text(size = 16), axis.title = element_text(
    size = 16))
dev.off()
```

Figure 3: The association between `presvote` and `voteshare`



3. **Write the prediction equation.**

$$y = \beta_0 + \beta_1 x$$
$$y = 0.441 + 0.388x$$

Question 4

The residuals from part (a) tell us how much of the variation in `voteshare` is *not* explained by the difference in spending between incumbent and challenger. The residuals in part (b) tell us how much of the variation in `presvote` is *not* explained by the difference in spending between incumbent and challenger in the district.

1. **Run a regression where the outcome variable is the residuals from Question 1 and the explanatory variable is the residuals from Question 2.**

```
lm_q4 <- lm(lm_q1_res ~ lm_q2_res)
stargazer(lm_q4, title = "The association between the residuals from
          Question 1 and Question 2",
          column.labels = "Residuals from Question 1",
          covariate.labels = "Residuals from Question 2")
```

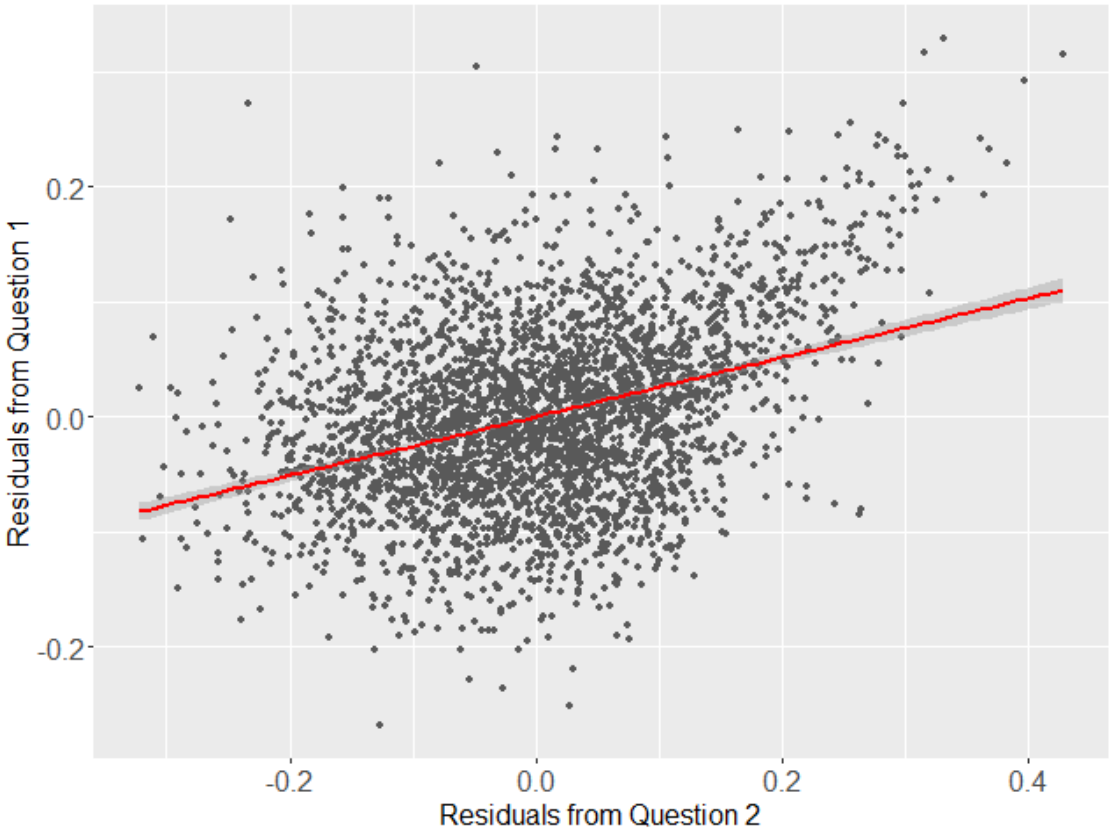
Table 4: The association between the residuals from Question 1 and Question 2

	Dependent variable:
	Residuals from Question 1
Residuals from Question 2	0.257***
	(0.012)
Constant	−0.000
	(0.001)
Observations	3,193
R^2	0.130
Adjusted R^2	0.130
Residual Std. Error	0.073 (df = 3191)
F Statistic	476.975*** (df = 1; 3191)
Note:	*p<0.1; **p<0.05; ***p<0.01

2. **Make a scatterplot of the two residuals and add the regression line.**

```
png("lm_q4.png", 640, 480)
dat %>%
  ggplot(aes(lm_q2_res, lm_q1_res)) +
  geom_point(color = "gray35") +
  geom_smooth(method = "lm", color = "red") +
  xlab("Residuals from Question 2") +
  ylab("Residuals from Question 1") +
  theme(axis.text = element_text(size = 16), axis.title = element_text(
    size = 16))
dev.off()
```

Figure 4: The association between the residuals from Question 1 and Question 2



3. **Write the prediction equation.**

$$y = \beta_0 + \beta_1 x$$
$$y = 0 + 0.257x$$
$$y = 0.257x$$

Question 5

What if the incumbent's vote share is affected by both the president's popularity and the difference in spending between incumbent and challenger?

1. **Run a regression where the outcome variable is the incumbent's `voteshare` and the explanatory variables are `difflog` and `presvote`.**

```
lm_q5 <- lm(voteshare ~ difflog + presvote, data = dat)
stargazer(lm_q1, lm_q3, lm_q5, title="The association among difflog,
    presvote, and voteshare")
```

Table 5: The association among `difflog`, `presvote`, and `voteshare`

	Dependent variable:		
	`voteshare`		
	(1)	(2)	(3)
`difflog`	0.042***		0.036***
	(0.001)		(0.001)
`presvote`		0.388***	0.257***
		(0.013)	(0.012)
Constant	0.579***	0.441***	0.449***
	(0.002)	(0.008)	(0.006)
Observations	3,193	3,193	3,193
R^2	0.367	0.206	0.450
Adjusted R^2	0.367	0.206	0.449
Residual Std. Error	0.079	0.088	0.073
	(df = 3191)	(df = 3191)	(df = 3190)
F Statistic	1,852.791***	826.950***	1,302.947***
	(df = 1; 3191)	(df = 1; 3191)	(df = 2; 3190)
Note:			*p<0.1; **p<0.05; ***p<0.01

2. **Write the prediction equation.**

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

$$y = 0.449 + 0.036 x_1 + 0.257 x_2$$

3. **What is it in this output that is identical to the output in Question 4? Why do you think this is the case?**

   The slope (β_1) in the bivariate regression model of the residuals ($y = 0.257x$) is the same slope (β_2) of the variable `presvote` (x_2) in the multivariate regression model ($y = 0.449 + 0.036x_1 + 0.257x_2$). They are both 0.257.

   To understand why that is the case, let's remember that the residuals regressed in question 4 represent the variations in `voteshare` and `presvote` which are not explained by `difflog`. Therefore, the bivariate regression model of the residuals captures how much of the unexplained variation in `voteshare` is associated to the unexplained variation in `presvote`, after having already considered the impact of `difflog`. In other words, the model of the residuals captures the effect of `presvote` on `voteshare` when we control for `difflog` — which is exactly what β_2 in the multivariate regression model represents.

   For that reason, the slopes in both models are expected to be the same. After all, they are measuring the same thing: the variation in `voteshare` explained by `presvote` while controlling for `difflog`.