EDS241: Assignment 2

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In this assignment, test whether the effects of air quality regulations are the same accorss locations with different racial mix. More specifically, test if the NOx Budget Program, a cap-and-trade market for nitrogen oxides (NOx) emissions from power plants leads to similar effects in counties that are predominantly white versus counties that are predominantly black.

NBP = 1 if the county was regulated under the NOx Budget Program NBP = 0 if the county was NOT regulated under the NOx Budget Program

PctBlack = the fraction of the county population that is black Dnox_masstons = the change in annual NOx emissions from all power plants in a county between 2000 and 2008 (in tons). Dnox_masstons values are negative for counties where emissions of NOx from power plants declined.

1 Read Data

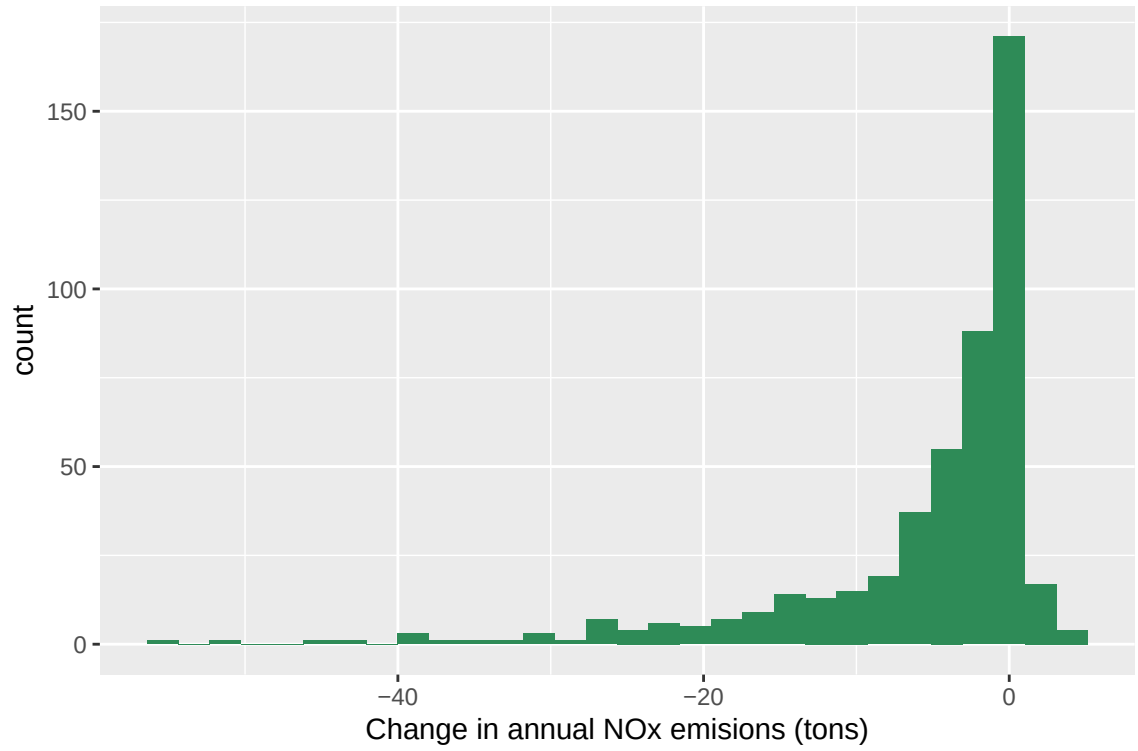
```
data <- read_excel(here("data", "NBP.xls"), sheet = "Sheet1")
```

2 Question a:

Make a histogram depicting the distribution of Dnox_masstons.

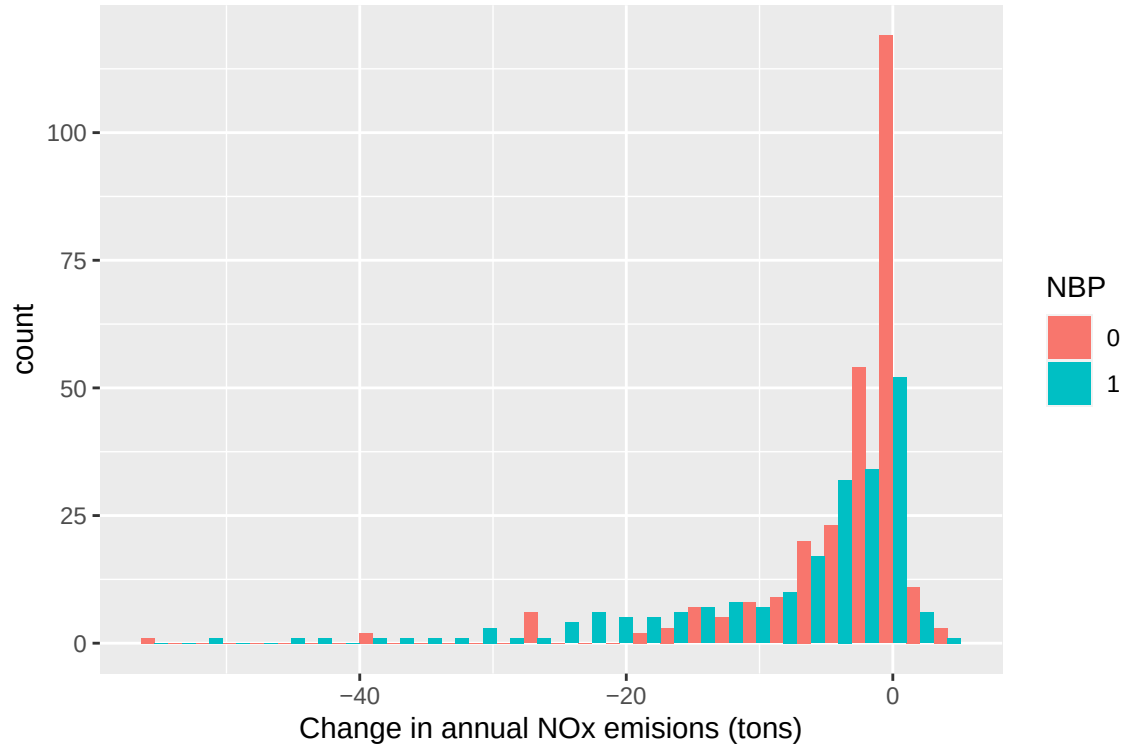
```
Dnox_histogram <- ggplot(data = data, aes(x = Dnox_masstons)) +
  geom_histogram(fill = "seagreen") +
  labs(x = "Change in annual NOx emisions (tons)")
```

Figure 1: Histogram of county level change in annual NOx emissions



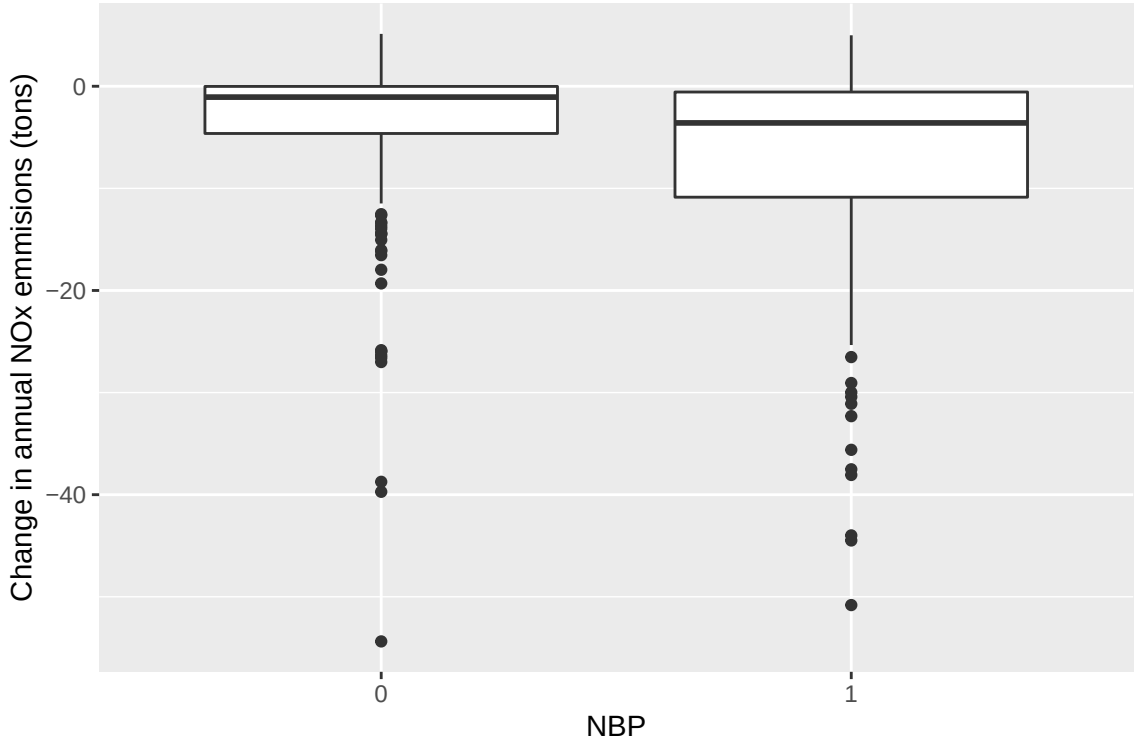

```
Dnox_histogram2 <- ggplot(data = data, aes(x = Dnox_masstons)) +
  geom_histogram(aes(fill = as.factor(NBP)), position = "dodge") +
  labs(x = "Change in annual NOx emisions (tons)", fill = "NBP")
```

Figure 2: Histogram of county level change in annual NOx emissions color coded by NBP status

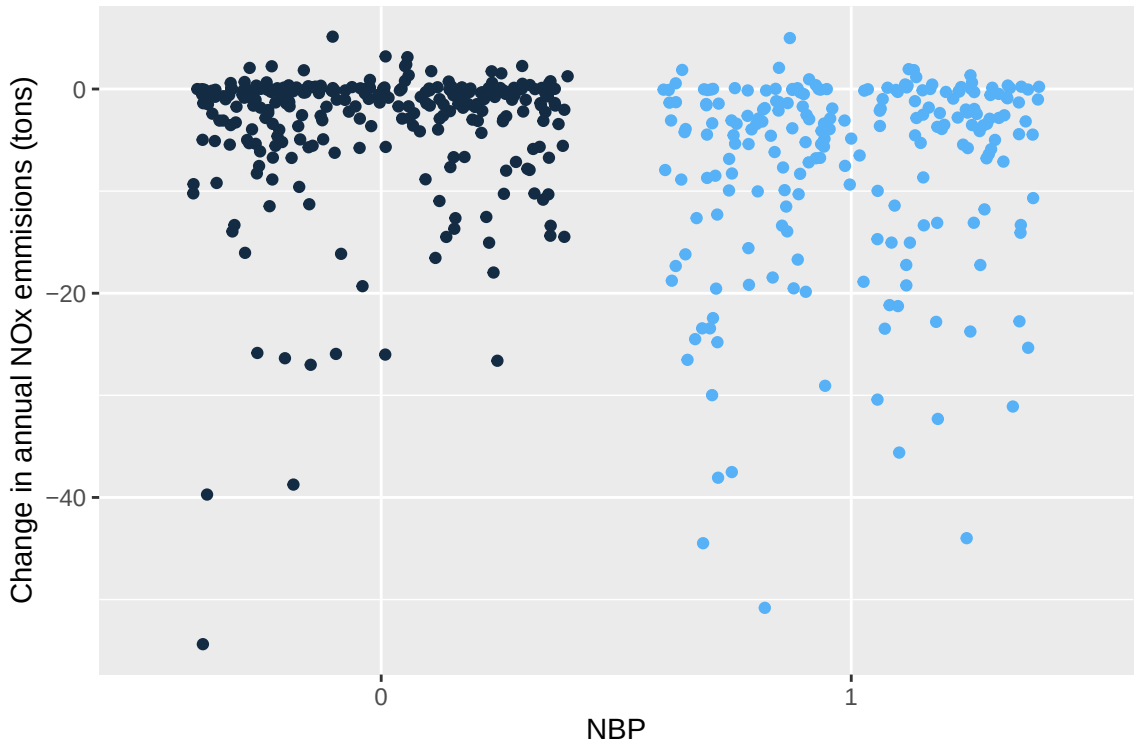


```
boxplot <- ggplot(data = data, aes(x = as.factor(NBP), y = Dnox_masstons)) +
  geom_boxplot() +
  labs(x = "NBP", y = "Change in annual NOx emmisions (tons)")
```

Figure 3: A box plot to show another way of visualizing the county level change in annual NOx emissions based on NBP status




```
# xxx...just for the fun of it
ggplot(data = data, aes(x = as.factor(NBP), y = Dnox_masstons)) +
  geom_jitter(aes(color = NBP), show.legend = FALSE) +
  labs(x = "NBP", y = "Change in annual NOx emmisions (tons)")
```




```
# xxx
data_NBP1 <- data %>%
  filter(NBP == 1)
mean_Dnox_NBP1 <- mean(data_NBP1$Dnox_masstons)
mean_Dnox_NBP1
```

```
## [1] -7.542498
```

```
data_NBP0 <- data %>%
  filter(NBP == 0)
mean_Dnox_NBP0 <- mean(data_NBP0$Dnox_masstons)
mean_Dnox_NBP0
```

```
## [1] -3.622031
```

```
est <- mean_Dnox_NBP1 - mean_Dnox_NBP0
# For linear regression with one categorical variable that only has two values, the regression estimate
```

3 Question b:

Create an indicator = 1 if the county has `PctBlack` above the sample median and 0 otherwise. This is variable D for the rest of the assignment. What is the average of `PctBlack` for counties above the median, ie counties for which D=1?

```
PctBlack_median <- median(data$PctBlack)

data <- data %>%
  mutate(D = if_else(PctBlack > PctBlack_median, true = 1, false = 0))
```

4 Question c:

Estimate a regression of Dnox_masstons on NBP. Interpret the estimated intercept and the coefficient of NBP.

```
Dnox_NBP_model_robust <- lm_robust(formula = Dnox_masstons ~ NBP, data = data)
```

```
# use lm to estimate coefficients
Dnox_NBP_model_lm <- lm(formula = Dnox_masstons ~ NBP, data = data)

# adjust standard errors using estimatr::starprep() instead of estimatr::lm_robust()
se_robust_model <- starprep(Dnox_NBP_model_lm)
```

Table 1: Change in annaul NOx emissions

	Change in annual NOx emissions
NBP	-3.920^{***}
	(0.796)
Observations	485
R^2	0.052
Note:	*p<0.1; **p<0.05; ***p<0.01
	Robust standard errors in parentheses

```
Dnox_NBP_intercept <- Dnox_NBP_model_robust$coefficients[1]
Dnox_NBP_intercept
```

```
## (Intercept)
##   -3.622031
```

```
Dnox_NBP_slope_coef <- Dnox_NBP_model_robust$coefficients[2]
Dnox_NBP_slope_coef
```

```
##       NBP
## -3.920467
```

```
Dnox_NBP_std_err <- Dnox_NBP_model_robust$std.error[2]
Dnox_NBP_std_err
```

```
##       NBP
## 0.7959108
```

Based on the estimated intercept, the predicted change in annual NOx emissions for a county that was NOT regulated under the NOx Budget Program (NBP = 0) is -3.622 tons. Based on the estimated slope coefficient, change in annual NOx emissions was, on average, -3.92 tons higher for counties that were regulated under the NOx Budget Program than counties that were not regulated. Since negative values of `Dnox_masstons` corresponds to a decline in NOx from power plants then the slope coefficient more clearly means that, on average, annual NOx emissions decreased by 3.92 tons more for counties that were regulated under the NOx Budget Program than counties that were not regulated.

```
# xxx...this table doesn't have the robust se
#Dnox_NBP_model_robust
Dnox_NBP_model_lm %>%
  summary() %>%
  xtable() %>%
  kable()
```

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-3.622031	0.5044385	-7.180322	0.0000000
NBP	-3.920467	0.7629766	-5.138384	0.0000004

quantify the difference in average NOx emission change across the two groups of counties

xxx

5 Question d:

Create an interaction between the variables NBP and D. Estimate a regression of Dnox_masstons on NBP, D, and this interaction. Interpret each estimated regression coefficient, including the intercept.

xxx

6 Question e:

What is the predicted Dnox_masstons in a county that was not regulated under NBP and where `PctBlack` is above the sample median (ie. where D=1)? Report the 95% confidence interval for this prediction. Make sure to use "heteroskedasticity-robust" standard errors.

xxx