Assignment 2

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1 Load Data

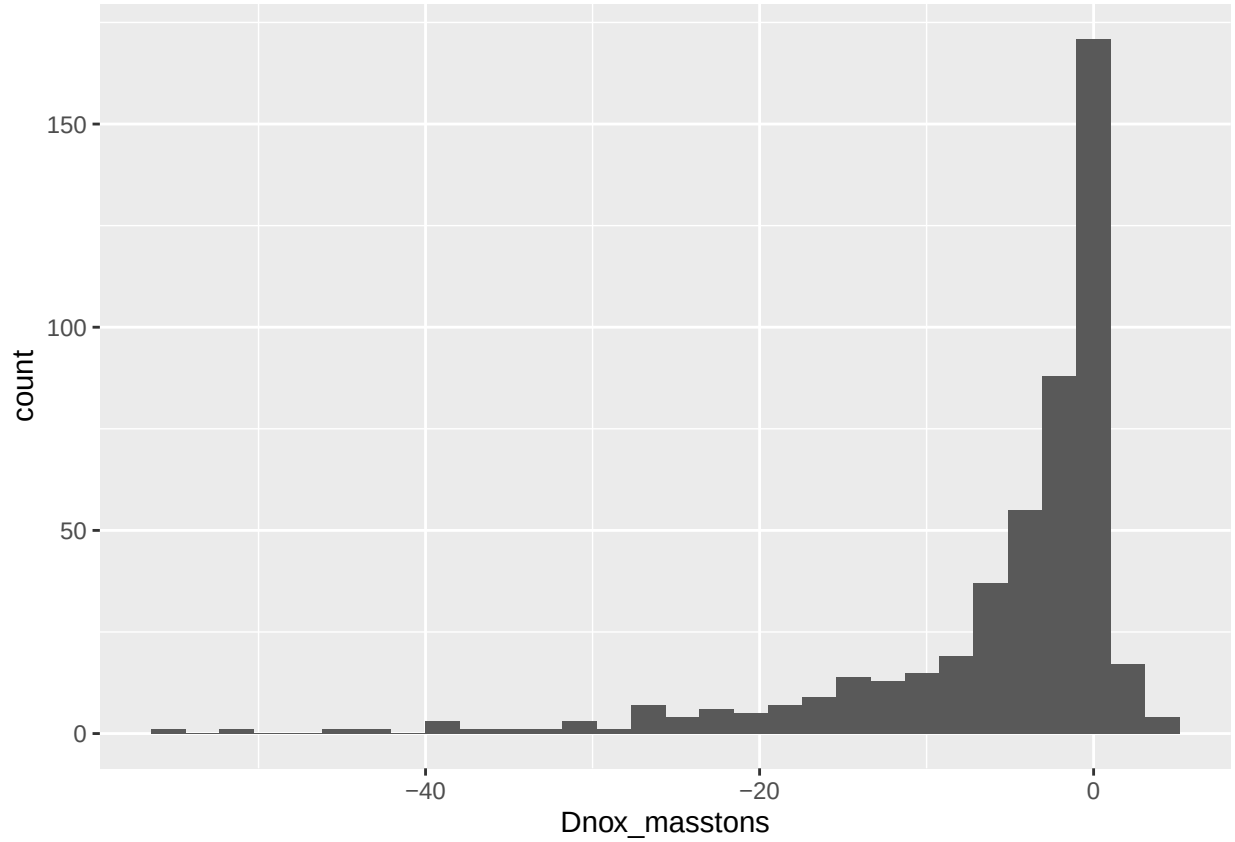
```
nox_df <- readxl::read_excel(here("HW2/NBP.xls"))
```

2 Answers

2.0.1 (a) Make a histogram depicting the distribution of Dnox_masstons.

```
ggplot(data = nox_df, aes(Dnox_masstons)) +
  geom_histogram()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



2.0.2 (b) Create an indicator =1 if the county has PctBlack above the sample median, and =0 otherwise (in the rest of the assignment, I refer to this variable as 'D'). What is the average of PctBlack for counties above the median, i.e. counties for which D=1?

```
med_b <- median(nox_df$PctBlack)

nox_df <- nox_df %>% mutate(D = as.factor(PctBlack > med_b)) %>%
  mutate(D = as.numeric(D) - 1)

high_b_avg <- nox_df %>% filter(D == 1)
```

The mean of `PctBlack` for counties above the median is 19.31375.

2.0.3 (c) Estimate a regression of Dnox_masstons on NBP. Interpret the estimated intercept and the coefficient on NBP.

```
nbp_nox_m <- estimatr::lm_robust(data = nox_df, Dnox_masstons ~ NBP)

summary(nbp_nox_m)
```

```
##
## Call:
## estimatr::lm_robust(formula = Dnox_masstons ~ NBP, data = nox_df)
##
## Standard error type:  HC2
##
## Coefficients:
##             Estimate Std. Error t value  Pr(>|t|) CI Lower CI Upper  DF
## (Intercept)   -3.622     0.4203  -8.617 9.830e-17   -4.448   -2.796 483
## NBP           -3.920     0.7959  -4.926 1.156e-06   -5.484   -2.357 483
##
## Multiple R-squared:  0.05183 ,   Adjusted R-squared:  0.04987
## F-statistic: 24.26 on 1 and 483 DF,  p-value: 0.000001156
```

The intercept of -3.622 indicates that the mean change in Dnox_masstons (tons of nitrogen oxides) of areas that were not regulated under the NOx Budget Program (i.e. did not receive the treatment) was a decrease of 3.6 tons between 2000 and 2008. The NBP coefficient of -3.920 indicates that the treatment group, which were regulated under NBP, saw an *additional* decrease of 3.9 tons NOx over the same time period.

2.0.4 (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.

```
nbp_d_int <- estimatr::lm_robust(data = nox_df, Dnox_masstons ~ NBP*D)
summary(nbp_d_int)
```

```
##
## Call:
## estimatr::lm_robust(formula = Dnox_masstons ~ NBP * D, data = nox_df)
##
## Standard error type:  HC2
##
## Coefficients:
##             Estimate Std. Error t value      Pr(>|t|) CI Lower CI Upper  DF
```

```
## (Intercept)   -2.418     0.4423  -5.467 0.00000007366   -3.287  -1.5490 481
## NBP           -7.141     1.2573  -5.680 0.00000002336   -9.612  -4.6708 481
## D             -2.588     0.8534  -3.033 0.00255418426   -4.265  -0.9113 481
## NBP:D          6.372     1.6144   3.947 0.00009102422    3.200   9.5440 481
##
## Multiple R-squared:  0.08604 ,   Adjusted R-squared:  0.08034
## F-statistic:  14.4 on 3 and 481 DF,  p-value: 0.000000005366
```

- **The intercept of -2.418 indicates that areas that were not regulated under the NOx Budget Program (i.e. did not receive the treatment) and had a lower than average (median) PctBlack population, saw a decrease of 2.4 tons of NOx emissions between 2000 and 2008.**
- **The NBP coefficient of -7.141 shows that areas with NOx regulation (NBP=1) and where PctBlack population is below the median (D=0) decreased NOx emissions by 7.14 more tons than the intercept.**
- **The D coefficient of -2.588 shows that areas without NOx regulation (NBP=0) and where PctBlack population is above the median (D=1) decreased NOx emissions by 2.6 more tons than the intercept.**
- **The NBP:D coefficient of 6.372 shows that implementing NOx regulation in places where PctBlack population is above the median (D=1) reduces the decrease in average NOx emissions by 6.3 more tons compared to areas with D=0 (places where PctBlack is lower than the median). In other words, this coefficient is the difference in NOx regulation effect in high black vs low black areas.**

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

```
df_split <- data.frame(NBP = 0, D = 1)

ci <- predict(object = nbp_d_int,
              newdata = df_split,
              se.fit=TRUE,
              interval = "confidence")
ci
```

```
## $fit
##            fit       lwr       upr
## [1,] -5.006106 -6.440065 -3.572147
##
## $se.fit
##         1
## 0.7297841
```

The predicted change in NOx emissions in a county where D = 1 and NBP = 0 is -5.01, with a heteroskedasticity-robust SE of 0.7298. This gives a 95% CI is between -6.44 and -3.57 tons.