Core Econometrics III: Problem Set 2

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Question 1

```
library(pacman)
p_load(dplyr, tidyverse, stargazer, fixest, magrittr, kableExtra)

data = read.csv("data-002.csv")
```

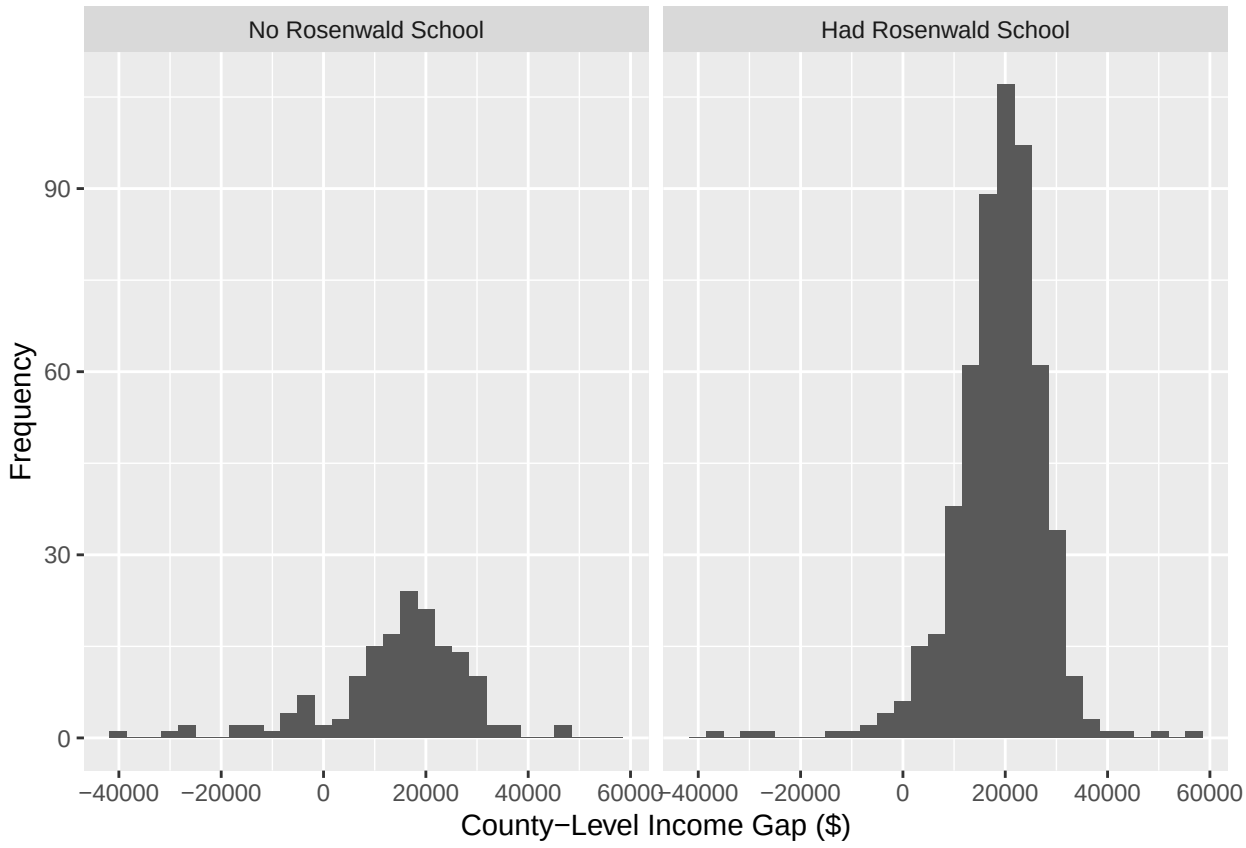
Question 2

```
labels.2.1 = c("No Rosenwald School", "Had Rosenwald School")
names(labels.2.1) = c("0", "1")


ggplot(data) +
  geom_histogram(aes(x = (income_white_2010 - income_black_2010))) +
  facet_wrap(~had_rosenwald_school,
             labeller = labeller(had_rosenwald_school = labels.2.1)) +
  labs(x = "County-Level Income Gap ($)", y = "Frequency")
```

A histogram of the county-level income gap (income_white_2010 - income_black_2010) split by whether the county had a Rosenwald school (had_rosenwald_school)

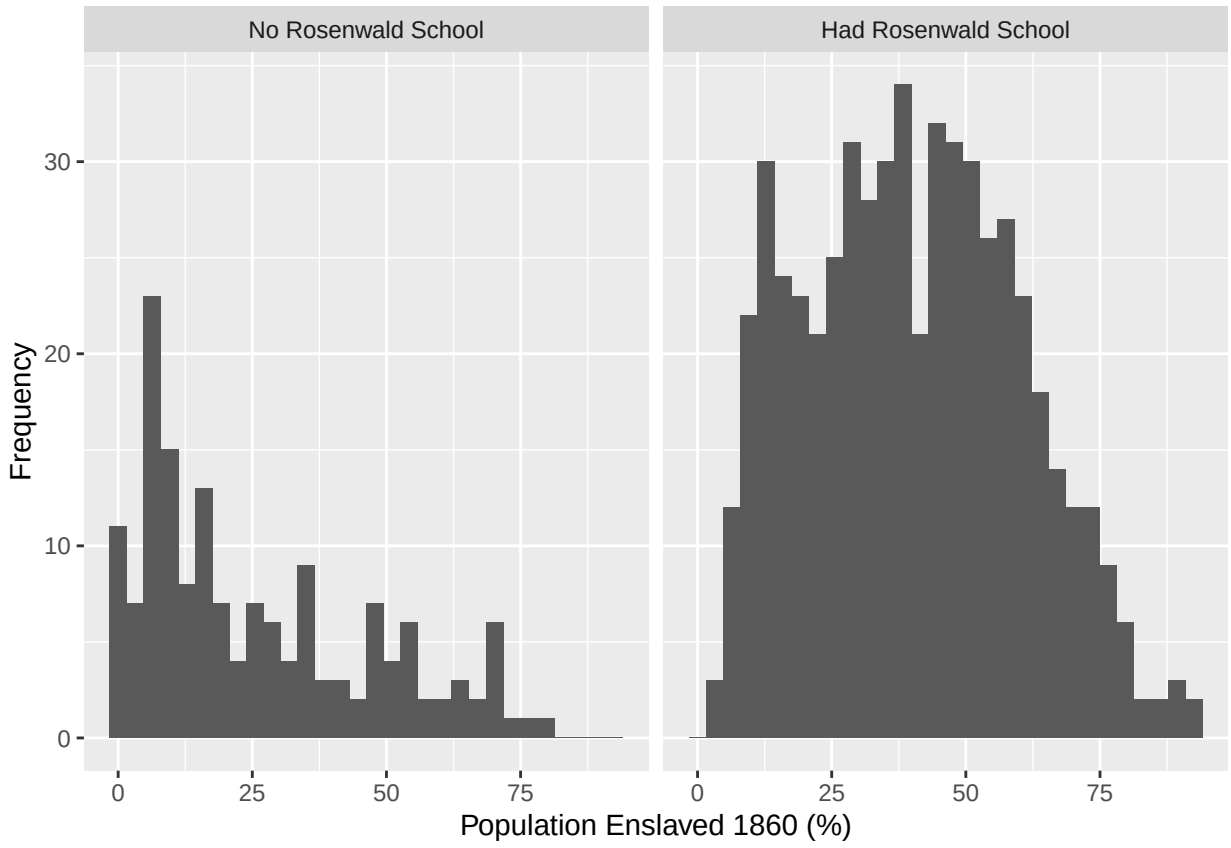
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
ggplot(data) +
  geom_histogram(aes(x = pct_pop_enslaved_1860)) +
  facet_wrap(~had_rosenwald_school,
             labeller = labeller(had_rosenwald_school = labels.2.1)) +
  labs(x = "Population Enslaved 1860 (%)", y = "Frequency")
```

A histogram of the percent of the population in 1860 that was enslaved (pct_pop_enslaved_1860) also split by whether the county had a Rosenwald school (had_rosenwald_school)

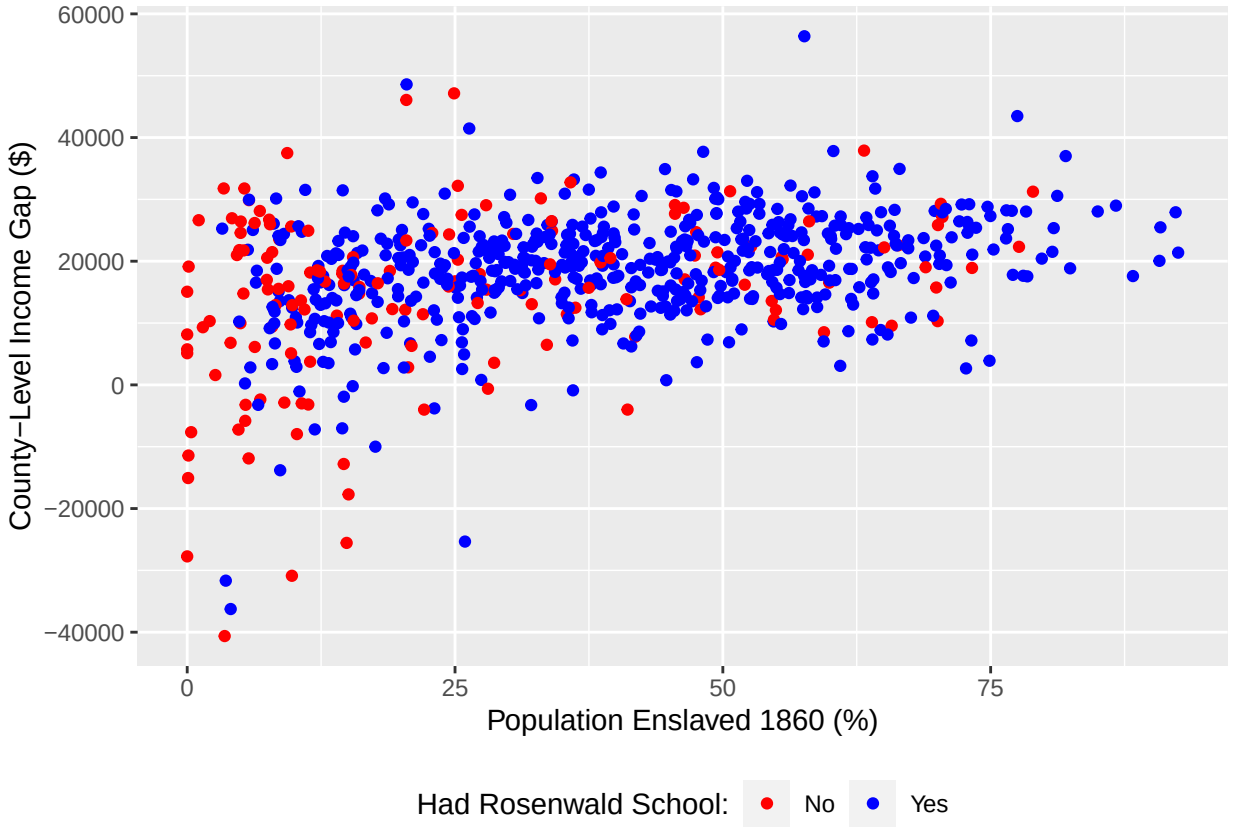
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
# making "had_rosenwald_school" a factor so legend isn't continuous
data %<>% mutate(had_rosenwald_school = factor(had_rosenwald_school))

ggplot(data,
       aes(x = pct_pop_enslaved_1860, y = (income_white_2010 - income_black_2010),
           color = had_rosenwald_school)) +
  scale_color_manual(
    breaks = c("0", "1"),
    values = c("red", "blue"),
    labels = c("No", "Yes"),
    name = "Had Rosenwald School:") +
  geom_point() +
  labs(x = "Population Enslaved 1860 (%)", y = "County-Level Income Gap ($)") +
  theme(legend.position = "bottom")
```

A scatter plot with pct_pop_enslaved_1860 on the x axis and the county income gap on the y axis with the points colored by whether or not the county had a Rosenwald school.



Question 3

```
# create outcome variable
data %<>% mutate(race_income_gap = income_white_2010 - income_black_2010)

# regression of rosenwald school on income gap
reg_3.1 = feols(race_income_gap ~ had_rosenwald_school, data = data)
```

```
table3.1 = etable(reg_3.1,
                  style.tex = style.tex("aer"),
                  tex = TRUE)
```

	Race Income Gap
	(1)
(Intercept)	14,537.5***
	(802.8)
Had Rosenwald School	4,323.7***
	(909.7)
Observations	710
R^2	0.03092
Adjusted R^2	0.02955

The identifying assumptions necessary to interpret these results as causal are that we are estimating the true model, that there are no omitted relevant variables, that the exogenous variables are uncorrelated with the disturbances.

Question 4

```
reg_4.1 = feols(race_income_gap ~ had_rosenwald_school | state, data = data)
```

```
table3.1 = etable(reg_4.1,
                  style.tex = style.tex("aer"),
                  tex = TRUE)
```

	Race Income Gap
	(1)
Had Rosenwald School	4,285.8***
	(1,087.0)
Observations	710
R^2	0.09778
Within R^2	0.02938
State Fixed Effects	✓

The conditional independence assumption required by this regression for a causal interpretation is that conditional on the state a county is in, potential outcomes of racial income gaps in that county are independent of whether or not that county had a Rosenwald School.

Question 5

```
data %<>% mutate(race_income_gap = income_white_2010 - income_black_2010)


reg_5.1 = feols(race_income_gap ~ had_rosenwald_school + pct_pop_enslaved_1860 + pop_total_1860 | state
                data = data)
```

```
table5.1 = etable(reg_5.1,
                  style.tex = style.tex("aer"),
                  tex = TRUE)
```

	Race Income Gap
	(1)
Had Rosenwald School	2,252.9***
	(669.1)
% Population Enslaved 1860	129.1***
	(20.06)
Total Population 1860	0.1062**
	(0.0409)
Observations	710
R^2	0.16186
Within R^2	0.09831
State Fixed Effects	✓

Question 6

If these new variables (pct_pop_enslaved_1860 & pop_total_1860) were causing bias in the regression in question 4, then I would suspect them to be upward biasing factors – since Rosenwald schools were located in areas with high Black populations (as shown in the histograms above), which will likely also be highly populated areas in general – making both of these new variables positively correlated with had_rosenwald_school. Additionally, it makes sense that they would also correlate positively with the race income gap. Since the estimated coefficient on had_rosenwald_school dropped dramatically after adding the new variables into the regression, the omitted variables were biasing the estimate positively, which matches my intuition.

Question 7

07 What is the required conditional independence assumption required by 05? Do you think it is valid? Explain your answer using a DAG (and discuss which variables should and should not be used as controls).

The conditional independence assumption required by the regression in question 5 is that conditional on the percent of population of a county that was in enslaved in 1860 and the total population of that county, potential outcomes of racial income gaps are independent of whether or not that county had a Rosenwals school.

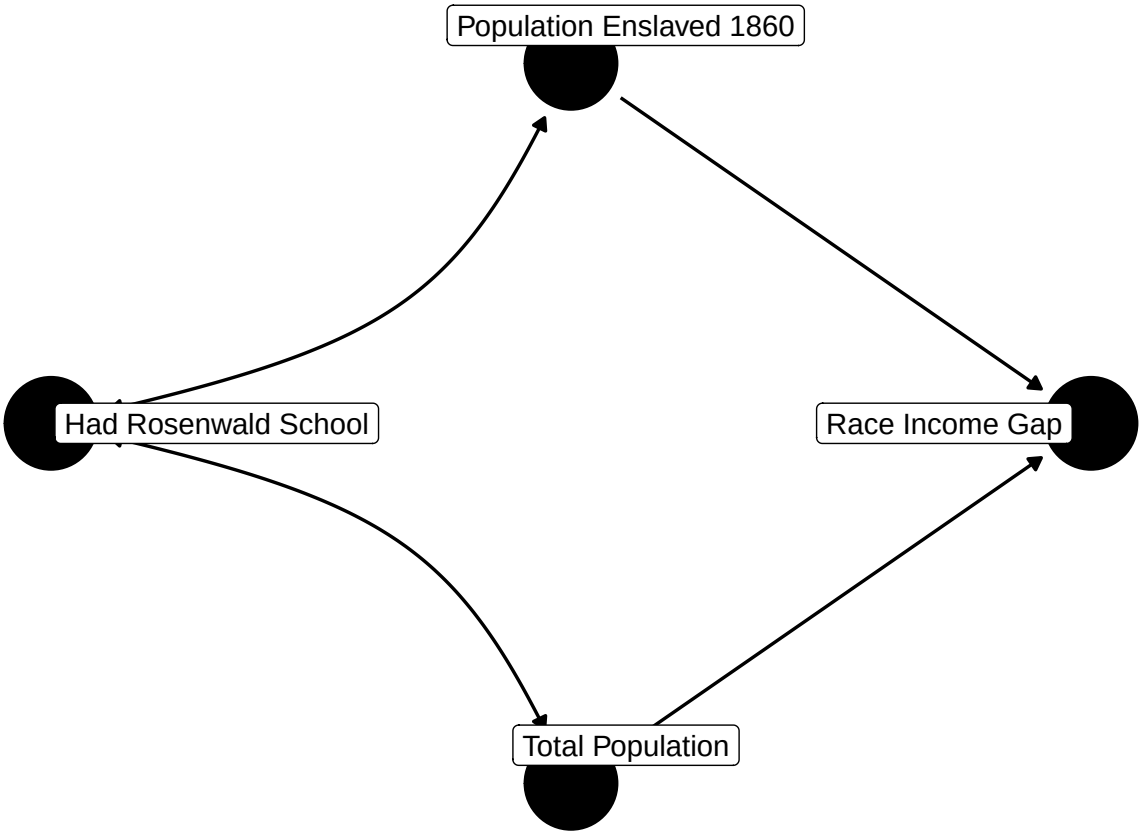
I do not believe this is a valid assumption.

```
p_load(ggdag)

coordinates = list(
  x = c(X = 0, Z = 1, W = 1, Y = 2), # Node name = x coordinate for that node
  y = c(X = 1, Z = 0, W = 2, Y = 1) # Node name = y coordinate for that node
)

dag_7.1 = dagify(W ~~ X,
                 Z ~~ X,
                 Y ~ W,
                 Y ~ Z,
                 coords = coordinates,
                 labels = c(Y = "Race Income Gap",
                            X = "Had Rosenwald School",
                            W = "Population Enslaved 1860",
                            Z = "Total Population"))


ggdag(dag_7.1,
      text = FALSE,
      use_labels = "label") +
  theme_void()
```



Question 8

08 What are your thoughts on adding the county's 2010 population (Black, White, and/or total) as a control in the regression? Will these controls help or hurt our CIA? Explain.

Question 9

09 Let's try some propensity-score matching. Step 1: Estimate some propensity scores!

To estimate propensity scores, we'll use a logistic regression. Don't worry if you don't know what it is. For now, all you need to know is that it is a nonlinear regression used for binary outcomes. We can use feglm from the fixest package to estimate a logistic regression, for example

femlm(binary_y ~ I(x1^2) + I(x2^2) + x1 + x2 + x1:x2, data = fake_df, family = 'logit')

will estimate a logistic regression (notice the argument family = 'logit). The example also shows you how to square variables and take interactions.

You need to estimate a logistic regression as a function of pct_pop_enslaved_1860 and pop_total_1860, their squares, and their interaction.

Finally, you can grab those beautiful (estimated) propensity scores from your saved regression using saved_reg$fitted.values (where saved_reg is my saved regression object output from feglm). You'll want to add those (estimated) propensity scores to your dataset.

Question 10

10 Estimate a regression where you control for the original variables and for the estimated propensity scores. Does anything change?? Report your results.

11 Wait! How does overlap look? Make a figure to document the overlap.

12 What percent of your observations aren't supported by overlap?

13 Why do we care about enforcing overlap?

14 Repeat the regression with overlap enforced. Report your results. Did anything change?

15 Now weight your regression using the (inverse) propensity scores (as discussed in lecture). Report your results. Did anything change yet??

16 Maybe we need a doubly robust approach. Estimate the "controlling for stuff" regression from 06 for each block, where blocks are based upon observations' propensity scores.

Note: If you're using state fixed effects with small-ish blocks, then some of the blocks may not have variation in had_rosenwald_school. For the sake of making your life easier, you can drop the state fixed effects or make the blocks bigger.

Report each block's estimated treatment effect and the ATE.

Q Maybe a selection on unobservables strategy would have been better. Explain your thoughts on the idea of using the county's history of Black enslavement (e.g., pct_pop_enslaved_1860) as an instrument for whether the county received a Rosenwald school.