Kline and Moretti (2014)

Kline and Moretti (2014) analyzes the impacts of the “Tennessee Valley Authority” (TVA) on local agriculture and manufacturing employment.

- The TVA was a huge federal spending program in the 1940s that aimed at electrification of the region, building hundreds of large dams (in Scott’s terms, a ton of ‘bite’)

Large Electrification brought in a lot industry, moving the economy away from agriculture. We are going to test for this in the data using census data (recorded every 10 years).

img/tva_dam.jpeg

img/tva_map.jpeg

Parallel Trends

The region had a large agriculture industry, but very little manufacturing.

In urban economics, we have a concept of ‘regional convergence’ that suggests places with low manufacturing employment will grow faster than places with high manufacturing employment.

- Parallel counterfactual trends is implausible

Conditional Parallel Trends

But, perhaps conditional on 1930 manufacturing (in 1930), we might believe that the trends are parallel.

The thought experiment is:

> Take two counties with similar manufacturing employment in 1930, one that gets TVA and one that does not. The counterfactual trends in manufacturing employment for these two counties should be parallel.

Estimators

Diff-in-diff

First, we will estimate DID parameters. An equivalent way of estimating a 2×2 DID is using *first-differenced* data, $\Delta y_i \equiv y_{i1} - y_{i0}$

The DID parameter can be estimated as

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Since D_i is an indicator, δ is the difference in means of Δy_i:

$$\hat{\delta} = \hat{\mathbb{E}}[\Delta y_i \mid D_i = 1] - \hat{\mathbb{E}}[\Delta y_i \mid D_i = 0]$$

This is the DID estimate!

Outcome Regression

Now, we want to include covariates. Let's use the outcome regression method

Our procedure is:

1. Estimate $\Delta Y_i = X_i\beta + u_i$ using the untreated group $D_i = 0$.
   - $\rightarrow$ This is how we predict $\Delta Y_i(0)$ for the treated units

2. Predict $\widehat{\Delta Y_i(0)} = X_i\hat{\beta}$ for treated units.

Take

$$\delta_{\text{OR}} = \hat{\mathbb{E}}[\Delta Y_i \mid D_i = 1] - \hat{\mathbb{E}}\left[\widehat{\Delta Y_i(0)} \mid D_i = 1\right]$$

IPW

Let's use the IPW method.
Our procedure is:

1. Estimate a logistic regression of D_i on X_i.

2. Predict the propensity scores $\hat{p}_i$ using the results from the logistic regression

3. Form $w_1 = \frac{D_i}{\mathbb{E}[D_i]}$ and $w_0 = \frac{1-D_i}{\mathbb{E}[D_i]} * \frac{p_i}{1-p_i}$

Take

$$\delta_{\text{IPW}} = \hat{\mathbb{E}}[w_1 * \Delta Y_i \mid D_i = 1] - \hat{\mathbb{E}}[w_0 * \Delta Y_i \mid D_i = 0]$$

DRDID

Or we can combine them and use the doubly-robust estimator (what Callaway and Sant'anna use):

$$\delta_{\text{DRDID}} = \hat{\mathbb{E}}\Big[w_1 * \Big(\Delta Y_i - \widehat{\Delta Y_i(0)}\Big) \mid D_i = 1\Big] - \hat{\mathbb{E}}\Big[w_0 * \Big(\Delta Y_i - \widehat{\Delta Y_i(0)}\Big) \mid D_i = 0\Big]$$