Read everything up to §3A (official)

- Angrist-Levy-Schosser } Tuesday (unofficial)
- Becker
- Angrist JLE '96 (Palestinian Labor) } Thursday

Gelbach AER 2003

$$\underbrace{h_{is}}_{\text{hours for mother}} = \alpha_0 + \underbrace{K_{is}^1}_{\text{in kindergarten?}} \beta + X_{is}' \gamma + \alpha_s + \varepsilon_{is}$$

- why not OLS?
  - selection ($K_{is}^1 = 1 \Rightarrow$ different types of mothers)
  - endogenous K_{is}^1 (strategic enrollment)
- use quarter of birth: Q_{is}

$h_{is} = \alpha_0 + Q_{is}'\pi + \ldots$?

From 2SLS: $\hat{\beta} = 2.7$

Omitted variables: # children and age of mother

Differences in differences

Spse interested in effects of immigration on native job market.

Natural experiment: city lets in a lot of workers

assume: $E[\underset{\text{unemployment rate}}{Y} \mid \underset{\text{city}}{c}, \underset{\text{time}}{t}] = \beta_t + \gamma_c$

$$E[Y \mid c, t, \underbrace{T=1}_{\text{treatment?}}] = \beta_t + \gamma_c + \delta$$
$$= E[Y \mid c, t, T=0] + \delta$$

Spse we look at:

$$E[Y \mid c, t, T=1] - E[Y \mid c, t', T=0] = \underbrace{\Delta \beta_t}_{\text{not zero, so this clearly doesn't identify } \delta} + \delta$$

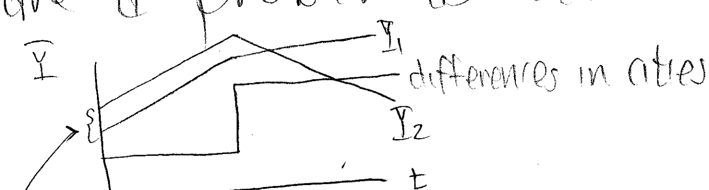
$$E[Y \mid c, t, T=1] - E[Y \mid c', t, T=0] = \underbrace{\Delta \gamma_c}_{\text{similarly}} + \delta$$

Thus, we look at:

$$[E[Y \mid c, t, T=1] - E[Y \mid c, t', T=1]]$$
$$- [E[Y \mid c, t, T=0] - E[Y \mid c, t', T=0]] = \Delta\beta_t - \Delta\beta_t + \delta = \delta$$

- Policy endogeneity is a potential problem. We usually ignore this.
- Interactions are a problem as well

Eissa (1995):



want cities w/similar "pre" trends

- want things to look at this.

- interaction terms matter

Card 1990

- Mariel Boat Lift (Cuban immigration into Miami)
- finds $\delta \approx 0$.

Standard errors were handled incorrectly in the past

Bertrand-Duflo-Mullainathan (BDM)

$$y_{its} = X_{its}'\beta + \varepsilon_{its}.$$

$$Var(\hat{\beta}_{OLS}) = (X'X)^{-1} X' \underbrace{Var(\varepsilon)}_{\Omega} X (X'X)^{-1}$$

iid: $\Omega = \begin{bmatrix} \sigma^2 & & 0 \\ & \ddots & \\ 0 & & \sigma^2 \end{bmatrix} = \sigma^2 I_n$ (sphericality)

Heteroskedasticity: $\Omega = \begin{bmatrix} \sigma_1^2 & & 0 \\ & \ddots & \\ 0 & & \sigma_n^2 \end{bmatrix} = E[\varepsilon\varepsilon']$

$$\widehat{Var(\hat{\beta}_{OLS})} = (X'X)^{-1} \hat{E}[(X'\varepsilon)(X'\varepsilon)'] (X'X)^{-1}$$

$$\rightarrow E[\varepsilon_i^2 X_i X_i'] \leftarrow \frac{1}{n} \sum_{i=1}^{n} \hat{\varepsilon}_i^2 X_i X_i'$$

BDM: $\Omega = \begin{bmatrix} V & & 0 \\ & \ddots & \\ 0 & & V \end{bmatrix}$, where $V = \begin{bmatrix} \sigma_c^2 + \sigma_v^2 & \sigma_c^2 & \cdots & \sigma_c^2 \\ \sigma_c^2 & \sigma_c^2 + \sigma_v^2 & & \\ & & \ddots & \end{bmatrix}$

Moulton correction: can estimate $\hat{\rho}$: $V = \begin{bmatrix} 1 & \hat{\rho} & \cdots & \hat{\rho} \\ & \ddots & & \\ & & & 1 \end{bmatrix}$

- restrictive, since it assumes a pretty restrictive error structure.

also $\rightarrow$ $$\frac{\sigma^2 (X'X)^{-1} X' \Omega X (X'X)^{-1}}{\sigma^2 (X'X)^{-1}} = 1 + \left[\frac{var(m_i)}{\bar{m}} + \bar{m} - 1\right] \rho_X \rho$$

where $\rho_X = corr(X_{is}, X_{js})$

$$\left.\begin{aligned} y_{ts} &= X_{ts}'\beta + \varepsilon_{ts} \\ \varepsilon_{ts} &= \rho\,\varepsilon_{t-1,s} + \nu_t \end{aligned}\right\} \text{serial correlation}$$

Two problems:
- Moulton problem
- serial correlation

Solution: clustering the standard errors

$$\widehat{Var}(\hat{\beta}) = (X'X)^{-1}\left(\sum_{s=1}^{S} X_s'\hat{\varepsilon}_s\hat{\varepsilon}_s' X_s\right)(X'X)^{-1}$$

- need lots of states