Simple Panel Data Methods

1. Two-Period Panel Data Analysis

Two-Period Panel Data Analysis

same units observed over 2 time pds.

- Model

$$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it} + v_{it}$$

Int. for pd. 1 : β_0
" pd. 2 : $\beta_0 + \delta_0$

  - i : person, firm, city, etc. and t : time period
  - $d2$: dummy for pd. 2 (1 → pd. 2, 0 → pd. 1)

- Example

$$crime_{it} = \beta_0 + \delta_0 d2_t + \beta_1 unem_{it} + v_{it}$$
$$prod_{it} = \beta_0 + \delta_0 d2_t + \beta_1 expo_{it} + v_{it}$$

Two-Period Panel Data Analysis (cont.)

idiosyncratic error / time-varying

- Suppose

$$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it} + a_i + u_{it}$$

  - a_i : unobserved effect / fixed effect / unobserved heterogeneity
  - u_{it} :
  - v_{it} : $= a_i + u_{it}$ composite error

- Example

$$crime_{it} = \beta_0 + \delta_0 d2_t + \beta_1 unem_{it} + city_i + u_{it}$$
$$prod_{it} = \beta_0 + \delta_0 d2_t + \beta_1 expo_{it} + mqual_i + u_{it}$$

Two-Period Panel Data Analysis (cont.)

- Estimating β_1

$$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it} + a_i + u_{it}$$

- Pooling the two years and performing OLS : may not work (biased) if a_i and x_{it} are correlated
- One solution: difference the data

Two-Period Panel Data Analysis (cont.)

- Two years

$$y_{i2} = (\beta_0 + \delta_0) + \beta_1 x_{i2} + a_i + u_{i2}$$
$$y_{i1} = \beta_0 + \beta_1 x_{i1} + a_i + u_{i1}$$

- Subtracting

$$y_{i2} - y_{i1} = \delta_0 + \beta_1 (x_{i2} - x_{i1}) + u_{i2} - u_{i1}$$

- The *first-differenced equation*

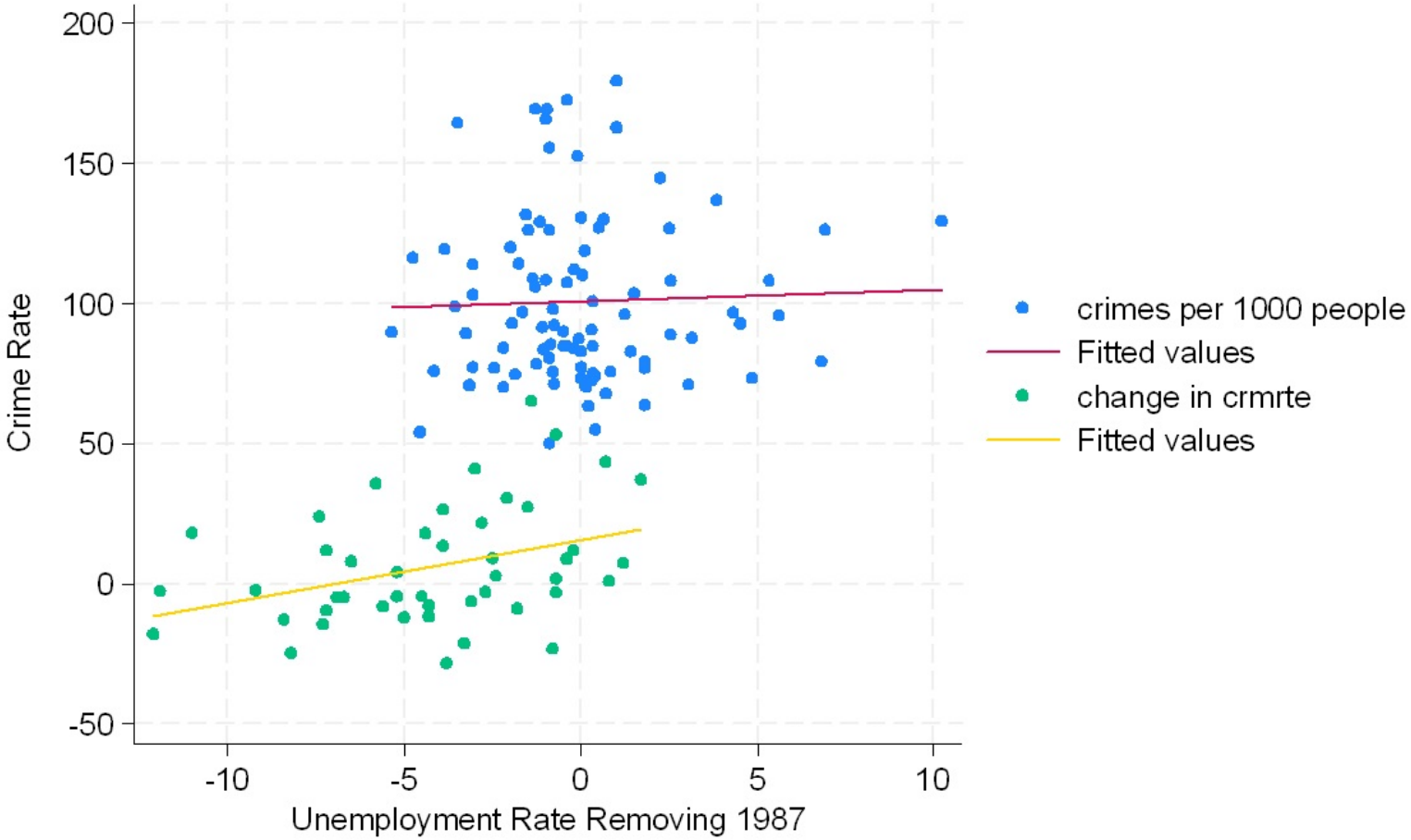
$$\Delta y_i = \delta_0 + \beta_1 \Delta x_i + \Delta u_i$$

β_1: first-differenced estimator

- Example

$$\Delta crime_i = \delta_0 + \beta_1 \Delta unem_i + \Delta u_i$$
$$\Delta prod_i = \delta_0 + \beta_1 \Delta expo_i + \Delta u_i$$

Two-Period Panel Data Analysis (cont.)



Two-Period Panel Data Analysis (cont.)

u & x : uncorr. in same pd. ⇒ contemporaneous exog.

$(u_{i2} - u_{i1})$ ↑ $(x_{i2} - x_{i1})$ ↑

- Note
  - Still need Δu_i to be uncorrelated with Δx_i
  - The *strict exogeneity* assumption
  - Need variation in Δx_i

⇒ u_i should be uncorr. with x_i from both pds.

if x is const. $\Delta x = 0$

if x ↑ by 1 for all $\Delta x = 1$

u & x: uncorr. across all time pds. ⇒ strict exog. → need for first-differenced estimates to be unbiased

y	x	u
crime	unem.	police

strict exog. violated e.g. if u in pd. 2 corr. w/ x in pd. 1