ECON 4151
Lab Session 8: Panel data

Wonjin Lee

Washington University in St. Louis

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Outline

1. Pooling cross sections across time (Wooldridge Ch. 13)

2. Panel data (Wooldridge Ch. 13 & 14 and Gujarati Ch. 17)

FE model vs. DiD model

- The fixed effects model conditions on an individual level effect.

$$\mathbb{E}\left(Y_{0it} | A_i, t\right) = \alpha + \gamma A_i + \lambda_t$$
$$\text{or} \quad \mathbb{E}\left(Y_{0it} | i, t\right) = \alpha_i + \lambda_t$$

- The differences-in-differences model conditions on a group level.

$$\mathbb{E}\left(Y_{0ist} | s, t\right) = \gamma_s + \lambda_t$$

- They make a very similar but different assumption.
- While the basic strategy is the same, the data requirements for DiD are much less.
    - We don't need repeated observations on unit i (i.e. a panel).
    - Repeated cross-sections sampling from the same aggregate units s are sufficient.

Difference-in-differences estimator

- Natural experiment (quasi-experiment)
- Regression specification for two periods:

$$y_{it} = \beta_0 + \delta_0 After_{it} + \beta_1 Treatgrp_i + \delta_1 (Treatgrp * After)_{it} + \epsilon_{it}$$

- Dummy variables:
  - *After*: 0 in the before period and 1 in the after period.
    - It allows for aggregate trends in the dependent variable that would affect both groups.
  - *Treatgrp*: 0 for the comparison group and 1 for the treated group.
    - It allows for systematic differences between treatment and control groups.
- Meaning of Regression Coefficients in DiD

	Before	After	After−Before
Control	β_0	$\beta_0 + \delta_0$	δ_0
Treatment	$\beta_0 + \beta_1$	$\beta_0 + \delta_0 + \beta_1 + \delta_1$	$\delta_0 + \delta_1$
Treatment−Control	β_1	$\beta_1 + \delta_1$	δ_1

Fixed effects model

- Fixed effects model (unobserved effects model):
  - The expectation of our observed Y_{it}:

$$\mathbb{E}\left[Y_{it} \mid X_{it}, A_i, t, D_{it}\right] = \underbrace{\alpha + A_i\gamma}_{\equiv \alpha_i} + \lambda_t + \rho D_{it} + X_{it}\beta$$

    where

    - A_i: Fixed effect, unobserved effect, or unobserved heterogeneity
    - λ_t: Time dummies
  - A regression specification:

$$Y_{it} = \lambda_t + \rho D_{it} + X_{it}\beta + \alpha_i + \epsilon_{it}$$

- $\text{Cov}(x_{itj}, A_i) \neq 0, \quad t = 1, 2, \ldots, T;\ j = 1, 2, \cdots, k$
- Estimate the regression by treating α_i as additional parameters to be estimated and allowing for a separate intercept term for each individual (the dummy variable regression).

First-differenced estimator

- Within-individual differences:

$$\Delta Y_{it} = \Delta \lambda_t + \rho \Delta D_{it} + \Delta X_{it} \beta + \Delta \epsilon_{it}$$

- Maybe good for short time period; ex. $T = 2$ or 3.

Fixed effects estimator (or within estimator)

- The deviations from the individual-specific means:

$$Y_{it} - \bar{Y}_i = \rho\left(D_{it} - \bar{D}_i\right) + \left(X_{it} - \bar{X}_i\right)\beta + \left(\lambda_t - \bar{\lambda}\right) + \left(\epsilon_{it} - \bar{\epsilon}_i\right)$$

- Running mean-corrected regressands on mean-corrected regressors.
  - Within estimator
- The mean-corrected variables wipe out time-invariant variables (ex. gender and race) from the model.
- The fixed effects estimator also can be obtained by the dummy variable regression.
  - Allow each individual to have his or her own time-invariant intercept.
- Note:
  - One-way fixed effects model: yes A_i no λ_t; the intercepts differ among cross-sections (individuals), but not over time.
  - Two-way fixed effects model: yes A_i yes λ_t; add time dummies.
- Fixed effects estimators are always consistent.

Random effects estimator

- Random effects model:

$$\text{Cov}(x_{itj}, A_i) = 0, \quad t = 1, 2, \ldots, T; \; j = 1, 2, \cdots, k$$

- Random effects assumptions:
  1. All of the fixed effects assumptions
  2. a_i is independent of all explanatory variables in all time periods
- We can include time-invariant variables; ex. gender, geographic location, or religion.

Exercise (Gujarati Ch. 17)

- Charitable giving:

$$
\begin{aligned}
C_{it} = & B_{1i} + B_2 Age_{it} + B_3 Income_{it} + B_4 Price_{it} \\
& + B_5 DEPS_{it} + B_6 MS_{it} + u_{it} \\
& i = 1, 2, \ldots, 47; \quad t = 1, 2, \ldots, 10
\end{aligned}
$$

where C is charitable contribution.