Sample Beamer Deck

Custom Environment Showcase

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Itemize and Enumerate

Key concepts in causal inference:

- **Potential outcomes framework** — each unit has outcomes under treatment and control
- **Fundamental problem** — we only observe one potential outcome per unit
  - Selection bias arises when treatment is not randomly assigned
  - Randomization solves this by balancing confounders in expectation
- **Identification strategies** — exploit natural variation or design

1. Formulate a research question
2. Identify a credible source of variation
3. Estimate and interpret with care

Theorem (Frisch–Waugh–Lovell). Consider the regression $Y = X_1\beta_1 + X_2\beta_2 + \varepsilon$. Then $\hat{\beta}_1$ can be obtained by:

$$\hat{\beta}_1 = (X_1' M_2 X_1)^{-1} X_1' M_2 Y$$

where $M_2 = I - X_2(X_2'X_2)^{-1}X_2'$ is the annihilator matrix.

Proof sketch. Partial out X_2 from both Y and X_1, then run OLS on the residuals. The coefficient on the residualized X_1 equals $\hat{\beta}_1$. □

Custom Box Environments

Key Result: Under parallel trends, the DiD estimator is unbiased for the ATT with $\hat{\tau} = (\bar{Y}_{T,post} - \bar{Y}_{T,pre}) - (\bar{Y}_{C,post} - \bar{Y}_{C,pre})$.

Highlight: Staggered adoption requires heterogeneity-robust estimators such as Callaway and Sant'Anna (2021).

Method: Estimate using TWFE with standard errors clustered at the state level. Use 50 bootstrap replications for inference.

Definition Box

The **ATE** is defined as:

$$\tau_{ATE} = E[Y_i(1) - Y_i(0)]$$

where $Y_i(1)$ and $Y_i(0)$ are the potential outcomes under treatment and control, respectively.

The **ATT** conditions on receiving treatment:

$$\tau_{ATT} = E[Y_i(1) - Y_i(0) \mid D_i = 1]$$

Table

Table 1: Regression Results

	(1) OLS	(2) IV
Treatment	0.152***	0.238**
	(0.041)	(0.097)
Controls	Yes	Yes
Fixed Effects	Unit, Time	Unit, Time
Observations	5,000	5,000
R^2	0.43	—
F-stat (1st)	—	24.7

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. SEs clustered by unit.

Two-Column Layout

Advantages of DiD

- Intuitive and transparent
- Controls for time-invariant confounders
- Works with observational data
- Widely applicable

Limitations

- Requires parallel trends
- Sensitive to functional form
- Cannot handle time-varying confounders
- Staggered timing complications