Interpreting IV
LATE

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Extract from: Building Bridges Between Structural and Program Evaluation Approaches to Evaluating Policy (JEL 2010)

Econ 312, Spring 2023

- In the economic theory of policy evaluation, a comparison between marginal benefits and marginal costs determines the optimal size of social programs.
- Consider how the IV estimator as embodied in LATE addresses this question, and how making explicit its implicit economics improves the range of policy questions LATE can answer.

- In the spirit of the program evaluation literature, ignore general equilibrium effects and ignore the *ex-ante* and *ex-post* distinction.
- These topics are addressed in many papers in the structural approach.
- To simplify the notation, keep the conditioning variables X implicit unless it clarifies matters by making them explicit.

Definition of LATE

- $Z = z$: random variable Z takes the value z.
- Z is a vector with K components, $Z = (Z_1, \ldots, Z_K)$.
- z^j means a particular realization of Z, i.e., $z^j = (z_1^j, \ldots, z_K^j)$.
- Assume all means are finite.

- Equation for *ex-post* outcome Y as a function of participation status is

$$Y = \alpha + \beta D + \varepsilon \tag{1}$$

- In terms of counterfactual notation, $\alpha = \mu_0$, $\varepsilon = U_0$ and $Y_0 = \mu_0 + \varepsilon$, and $\beta = (Y_1 - Y_0) = \mu_1 - \mu_0 + U_1 - U_0$.

- Denote the mean of β by $\bar{\beta}$

$$Y = \alpha + \bar{\beta} D + \{\varepsilon + (\beta - \bar{\beta}) D\}, \tag{2}$$

where $\bar{\beta} = \mu_1 - \mu_0$.

- Instrumental variables (IV) do not in general estimate $\bar{\beta}$ and instrumental variables estimators using different instruments have different probability limits.

What Policy Parameter Does LATE Estimate?

- The LATE parameter is widely interpreted as estimating the mean return at the margin defined by manipulation of the instrument.
- One must be very careful in making this interpretation.
- Not generally true.

- In general, LATE is not the same as $\bar{\beta}$, but it might be all that is needed to evaluate any particular policy (Marschak's Maxim).
- Key question: **"what question does LATE answer?"**
- The people induced to go into state 1 ($D = 1$) by a change in any particular instrument need not be the same as the people induced to go to state 1 by policy changes other than those corresponding exactly to the variation in the instrument.
- A desired policy effect may not directly correspond to the variation in the IV.
- In this case, by the people induced to change state by the instrument are not identified in LATE.

- Widely held intuitions about what IV identifies break down in this case since different instruments identify different parameters.
- Moreover, if there is a vector of instruments that generates choices and the components of the vector are intercorrelated, IV estimates using the components of Z as instruments, one at a time, do not, in general, identify the policy effect corresponding to varying that instrument, keeping all other instruments fixed, the *ceteris paribus* effect of the change in the instrument.
- **Using the implicit economics of the model, one can do better than hope that LATE identifies a parameter of interest.**
- **One can also identify the set of persons shifted by the instrument.**

LATE

- LATE is defined by the variation of an instrument.
- The instrument in LATE plays the role of a randomized assignment.
- Randomized assignment is an instrument.
- Y_0 and Y_1 are potential *ex-post* outcomes.
- Instrument Z assumes values in $\mathcal{Z}$, $z \in \mathcal{Z}$.

Some Useful Counterfactuals

- $D(z)$ is an indicator of hypothetical choice representing what choice the individual would have made had the individual's Z been exogenously set to z.
- $D(z) = 1$ if the person chooses (is assigned to) 1.
- $D(z) = 0$, otherwise.
- One can think of the values of z as fixed by an experiment or by some other mechanism independent of (Y_0, Y_1).
- All policies are assumed to operate through their effects on Z.
- It is assumed that Z can be varied conditional on X.

Monotonicity

- $D(z^1) \lesseqgtr D(z^2)$ for all persons (same direction of inequality across all persons).
- This condition is a statement **across** people.
- This condition does not require that for any other two values of Z, say z^3 and z^4, the direction of the inequalities on $D(z^3)$ and $D(z^4)$ have to be ordered in the same direction as they are for $D(z^1)$ and $D(z^2)$.
- It only requires that the direction of the inequalities are the *same across people*.
- Thus for any person, $D(z)$ need not be monotonic in z.
- A better term for monotonicity is **uniformity**.

- Under LATE conditions, for two distinct values of Z, z^1 and z^2, IV applied to (1) identifies

$$\text{LATE}(z^2, z^1) = E(Y_1 - Y_0 \mid D(z^2) = 1, D(z^1) = 0),$$

  if the change from z^1 to z^2 induces people into the program ($D(z^2) \geq D(z^1)$).
- This is the mean return to participation in the program for people induced to switch treatment status by the change from z^1 to z^2.
- Remember X is held fixed.

- LATE does not identify which people are induced to change their treatment status by the change in the instrument.
- It leaves unanswered many policy questions.
- For example, if a proposed program changes the same components of vector Z as used to identify LATE but at different values of Z (say z^4, z^3), LATE(z^2,z^1) does not necessarily identify LATE(z^4, z^3).

- If the policy operates on different components of Z than are used to identify LATE, one cannot, in general, use LATE to identify marginal returns to the policy.
- It does not, in general, identify treatment on the treated, ATE or a variety of criteria.
- But using the implicit economics of the problem one can do better as I show next.