

# Interpreting IV LATE

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- 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,  $Z = (Z_1, \dots, Z_K)$ .
- $z^j$  means a particular realization of  $Z$ , i.e.,  $z^j = (z_1^j, \dots, z_K^j)$ .
- Assume all means are finite.

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

$$Y = \alpha + \beta D + \varepsilon \quad (1)$$

- 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  $\beta$  by  $\bar{\beta}$

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

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.