Econometrics
of Human
Capital

Philipp Eisenhauer

Material available on





Parameters of Interest

Philipp Eisenhauer

Heckman (2008) sets out three tasks for us:

- ▶ Defining the Set of Hypotheticals or Counterfactuals⇒ A Scientific Theory
- Identifying Causal Parameters from Hypothetical Population Data
 - ⇒ Mathematical Analysis of Data Point or Set Identification
- Identifying Parameters from Real Data
 - ⇒ Estimation and Testing Theory

Parameters of Interest

- conventional average effects
- policy-relevant average effects
- marginal effects
- distributional effects
- effects on distributions

Setup

The Generalized Roy Model

Potential Outcomes

$$Y_1 = \mu_1(X) + U_1$$

$$Y = DY_1 + (1 - D)Y_0$$

$$Y_0 = \mu_0(X) + U_0$$

Choice

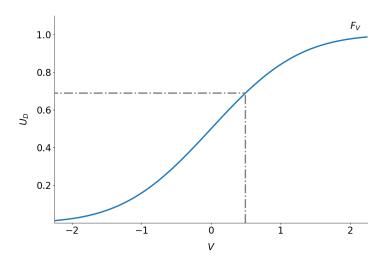
$$D=I[\mu_D(X,Z)-V>0]$$

Useful Notation

$$P(X, Z) = \Pr(D = 1 \mid X, Z) = F_V(\mu_D(X, Z))$$

 $U_D = F_V(V)$

Figure: First-state unobservable



Individual Heterogeneity

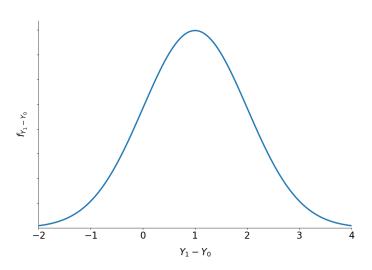
Individual-specific Benefit of Treatment

$$Y_1 - Y_0 = (\mu_1(X) - \mu_0(X)) + (U_1 - U_0)$$

Sources of Heterogeneity

- Difference in Observable Characteristics
- Difference in Unobservable Characteristics
 - Uncertainty
 - Private Information

Figure: Distribution of Benefits



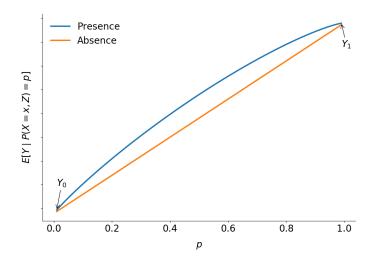
Essential Heterogeneity

Definition: Individuals select their treatment status based on gains unobservable by the econometrician. More formally,

$$Y_1 - Y_0 \not\perp \!\!\!\perp D \mid X = x.$$

⇒ consequences for the estimation strategy

Figure: Conditional Expectation and Essential Heterogeneity



Conventional Average Treatment Effects

Conventional Average Treatment Effects

$$B^{ATE} = E[Y_1 - Y_0]$$

 $B^{TT} = E[Y_1 - Y_0 \mid D = 1]$
 $B^{TUT} = E[Y_1 - Y_0 \mid D = 0]$

⇒ correspond to *extreme* policy alternatives

Selection Problem

$$\begin{split} E[Y \mid D=1] - E[Y \mid D=0] &= \underbrace{E[Y_1 - Y_0]}_{B^{ATE}} \\ &+ \underbrace{E[Y_1 - Y_0 \mid D=1] - E[Y_1 - Y_0]}_{\text{Selection on gains}} \\ &+ \underbrace{E[Y_0 \mid D=1] - E[Y_0 \mid D=0]}_{\text{Selection on levels}} \end{split}$$

$$\begin{split} E[Y \mid D=1] - E[Y \mid D=0] = \underbrace{E[Y_1 - Y_0 \mid D=1]}_{B^{TT}} \\ + \underbrace{E[Y_0 \mid D=1] - E[Y_0 \mid D=0]}_{\text{Selection on levels}} \end{split}$$

⇒ the bias depends on the parameter of interest

Figure: Distribution of Effects with Essential Heterogeneity

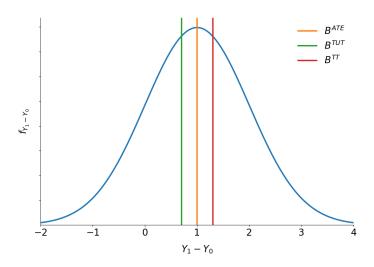
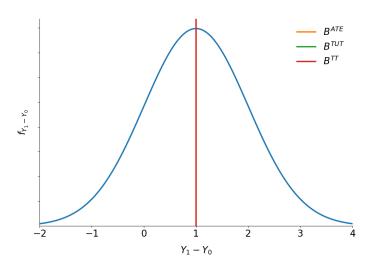


Figure: Distribution of Effects without Essential Heterogeneity



Policy-Relevant Average Treatment Effects

Observed Outcomes

$$Y_B = D_B Y_1 + (1 - D_B) Y_0$$

 $Y_A = D_A Y_1 + (1 - D_A) Y_0$

Effect of Policy

$$B^{PRTE} = \frac{1}{E[D_A] - E[D_B]} (E[Y_A] - E[Y_B])$$

Marginal Effect of Treatment

Marginal Benefit of Treatment

$$B^{MTE}(x, u_D) = E[Y_1 - Y_0 \mid X = x, U_D = u_D]$$

Intuition: Mean gross return to treatment for persons at quantile u_D of the first-stage unobservable V

Figure: Margin of Indifference

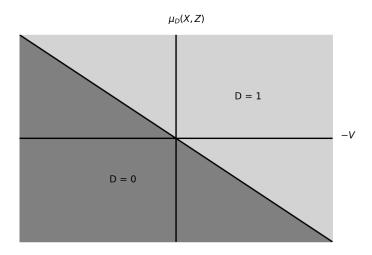
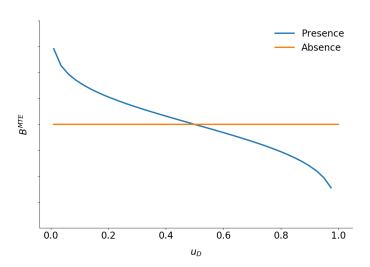


Figure: Marginal Benefit of Treatment



Effects of Treatment as Weighted Averages Parameter Δ_j , can be written as a weighted average of the $B^{MTE}(x, u_D)$.

$$\Delta_j(x) = \int_0^1 B^{MTE}(x, u_D) \omega^j(x, u_D) du_D,$$

where the weights $\omega^{j}(x,u_{D})$ are specific to parameter j and integrate to one.

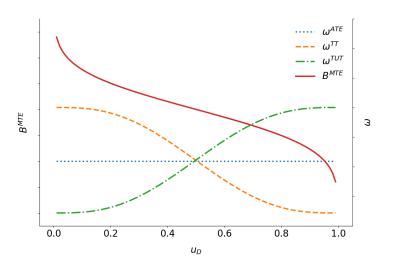
Weights

$$\omega^{ATE}(x, u_D) = 1$$

$$\omega^{TT}(x, u_D) = \frac{1 - F_{P|X=X}(u_D)}{E[P \mid X = X]}$$

$$\omega^{TUT}(x, u_D) = \frac{F_{P|X=X}(u_D)}{E[1 - P \mid X = X]}$$

Figure: Effects of Treatment as Weighted Averages



Local Average Treatment Effect

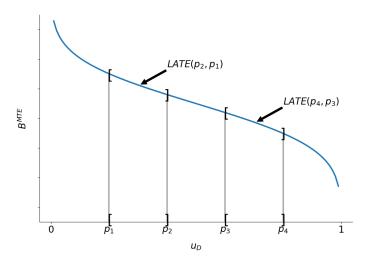
Local Average Treatment Effect

- ▶ Local Average Treatment Effect: Average effect for those induced to change treatment because of a change in the instrument.
 - ⇒ instrument-dependent parameter
- ► Marginal Treatment Effect: Average effect for those individuals with a given unobserved desire to receive treatment.
 - ⇒ deep economic parameter

$$B^{LATE} = \frac{E(Y \mid Z = z) - E[Y \mid Z = z']}{P(z) - P(z')}$$

$$B^{LATE}(x, u_D, u_{S'}) = \frac{1}{u_D - u_{D'}} \int_{u_D}^{u_{S'}} B^{MTE}(x, u) du,$$

Figure: Local Average Treatment Effect



Distributions of Effects

Figure: Distribution of Potential Outcomes

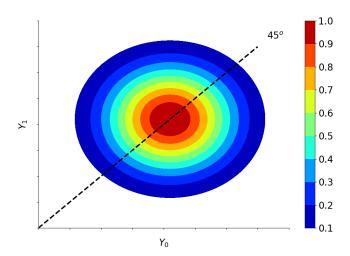
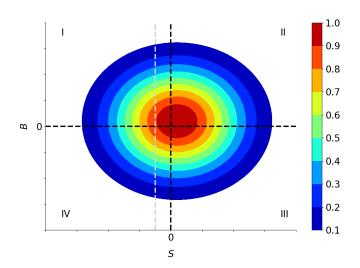


Figure: Distribution of Benefits and Surplus



Appendix

References

- Carneiro, P., Heckman, J. J., & Vytlacil, E. J. (2011). Estimating marginal returns to education. *American Economic Review*, 101(6), 2754–2781.
- Heckman, J. J. (1990). Selection bias and self-selection. In J. Eatwell, M. Milgate, & P. Newman (Eds.), *Econometrics* (pp. 201–224). London: Palgrave Macmillan.
- Heckman, J. J. (2008). Econometric causality. *International Statistical Review*, 76(1), 1–27.
- Heckman, J. J., & Taber, C. (2010). Roy model. In L. E. Blume & S. N. Durlauf (Eds.), *Microeconomet-rics* (pp. 221–228). London: Palgrave Macmillan.