Economics of Human Capital

Static model of educational choice

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Housekeeping

Lecture plan

- Static model of educational choices

- OpenSourceEconomics

- grmpy

- Estimating Marginal Returns to Education (Carneiro, Heckman, & Vytlacil, 2011)

Course program

- economics of human capital

- econometrics of human capital

- research seminar

?

Introduction

J. Heckman (2008) defines three policy evaluation tasks:

- ▶ Evaluating the impact of historical interventions on outcomes including their impact in terms of well-being of the treated and the society at large.

- ▶ Forecasting the impact of historical interventions implemented in one environment in other environments, including their impact in terms of well-being.

- ▶ Forecasting the impacts of interventions never historically experienced to various environments, including their impact on well-being.

Econometrics of policy evaluation

- is important

- is complicated

- is multifaceted

Numerous applications

- Labor Economics

- Development Economics

- Industrial Economics

- Health Economics

Numerous effects

- ▶ Conventional Average Effects

- ▶ Policy-relevant Average Effects

- ▶ Marginal Effects

- ▶ Distributional Effects

- ▶ Effects on Distributions

Numerous estimation strategies

- ▶ Instrumental Variables

- ▶ (Quasi-)Experimental Methods

- ▶ Matching

Model

Generalized Roy model

Potential Outcomes   **Cost**

$$Y_1 = \mu_1(X) + U_1 \qquad C = \mu_C(Z) + U_C$$

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

Observed Outcomes   **Choice**

$$Y = DY_1 + (1-D)Y_0 \qquad S = Y_1 - Y_0 - C$$

$$D = I[S > 0]$$

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 observables

- ▶ Difference in unobservables

    - ▶ Uncertainty

    - ▶ Private information

Figure: Distribution of benefits
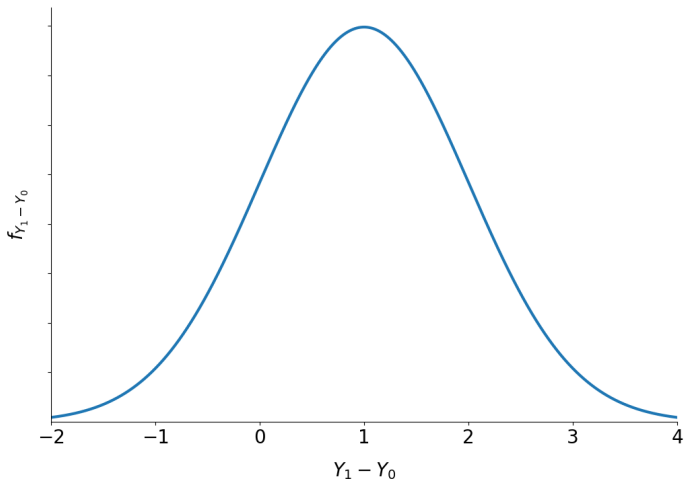
Observed outcome

$$Y_i = Y_{0i} + D_i(Y_{1i} - Y_{0i}) = \begin{cases} Y_{1i} & \text{if} \quad D_i = 1 \\ Y_{0i} & \text{if} \quad D_i = 0 \end{cases}$$

Econometric problems

- **Evaluation problem**, we only observe an individual in either the treated or untreated state.

- **Selection problem**, individuals that select into treatment differ from those that do not.

Essential Heterogeneity

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

$$Y_1 - Y_0 \not\perp\!\!\!\perp D \quad | \, X = x.$$

$\Rightarrow$ consequences for the choice of the estimation strategy

Objects of interest

Useful Notation

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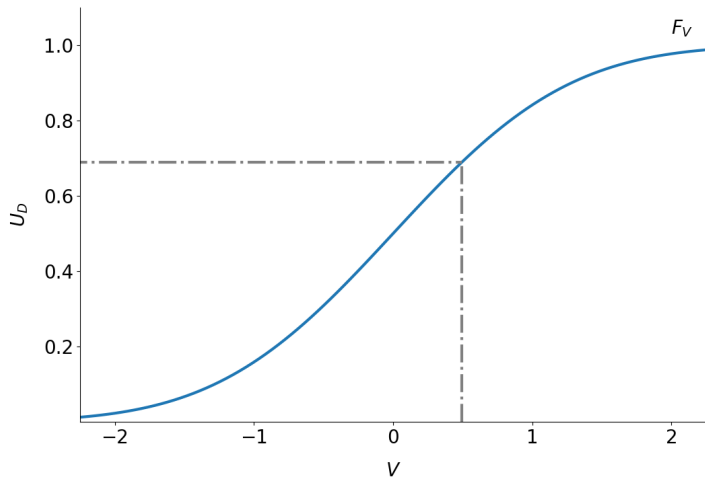$$U_D = F_V(V)$$

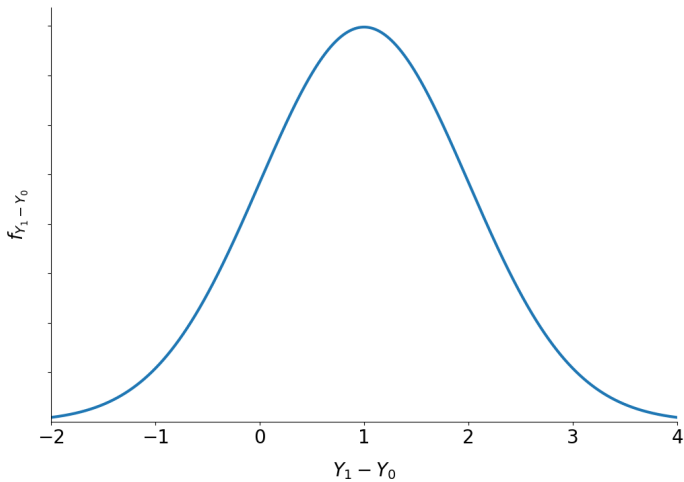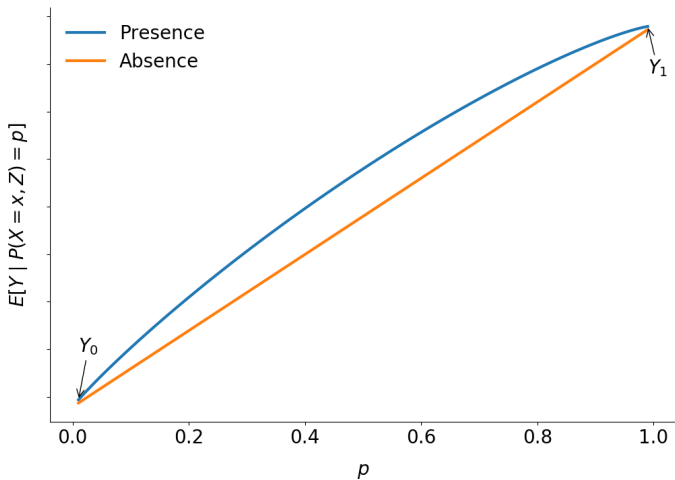Figure: First-stage unobservable

Figure: Distribution of benefits

Figure: Conditional expectation and essential heterogeneity

Conventional Average Treatment Effects

Conventional Average Treatment Effects

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

$\Rightarrow$ correspond to *extreme* policy alternatives

Selection Problem

$$E[Y \mid D = 1] - E[Y \mid D = 0] = \underbrace{E[Y_1 - Y_0]}_{B^{ATE}}$$

$$+ \underbrace{E[Y_1 - Y_0 \mid D = 1] - E[Y_1 - Y_0]}_{\text{Sorting Gain}}$$

$$+ \underbrace{E[Y_0 \mid D = 1] - E[Y_0 \mid D = 0]}_{\text{Selection Bias}}$$

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

⇒ the bias depends on the parameter of interest

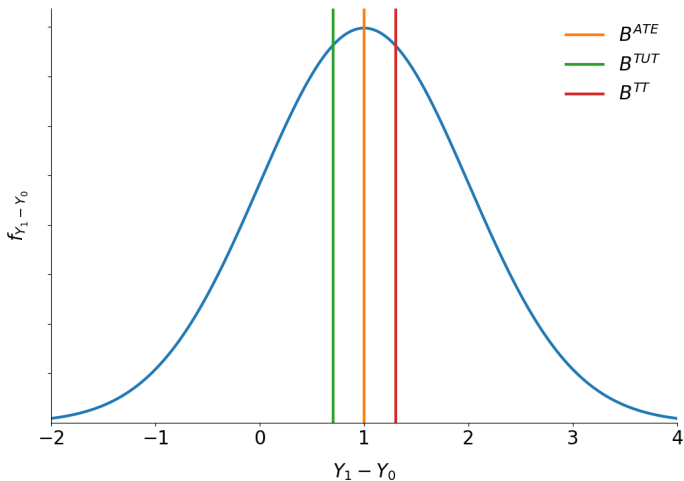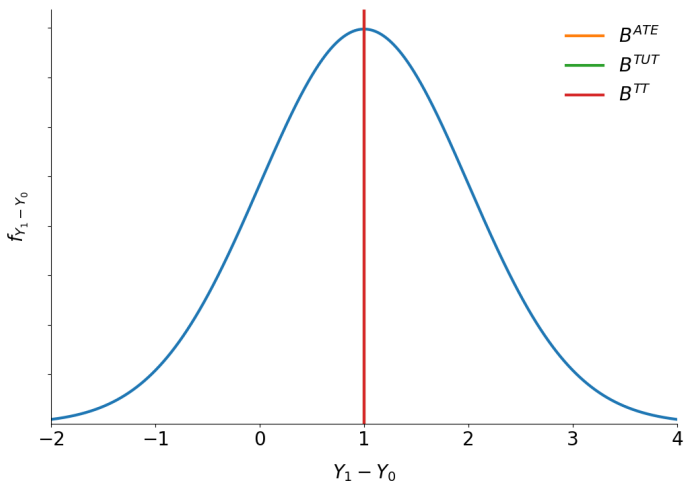# Figure: Distribution of effects with essential heterogeneity

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 or a willingness to pay for individuals at the margin of indifference.
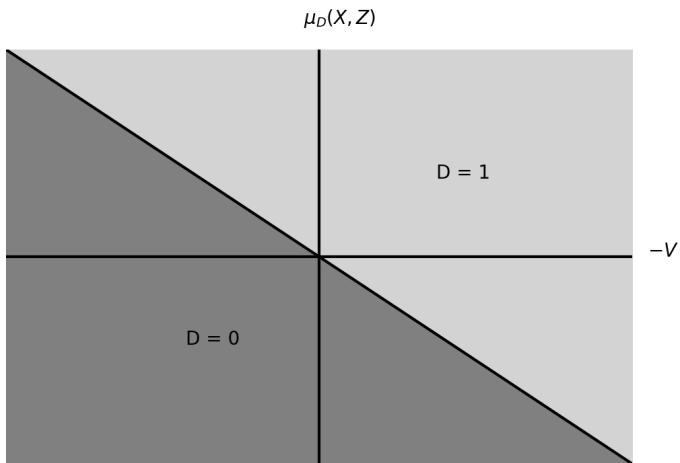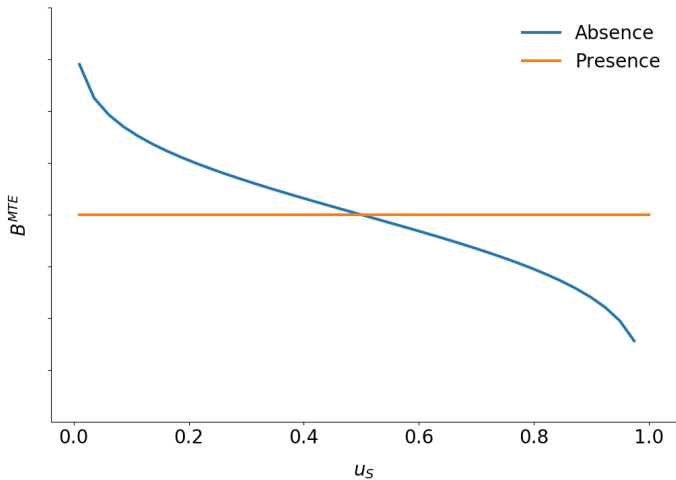
Figure: Margin of indifference

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.
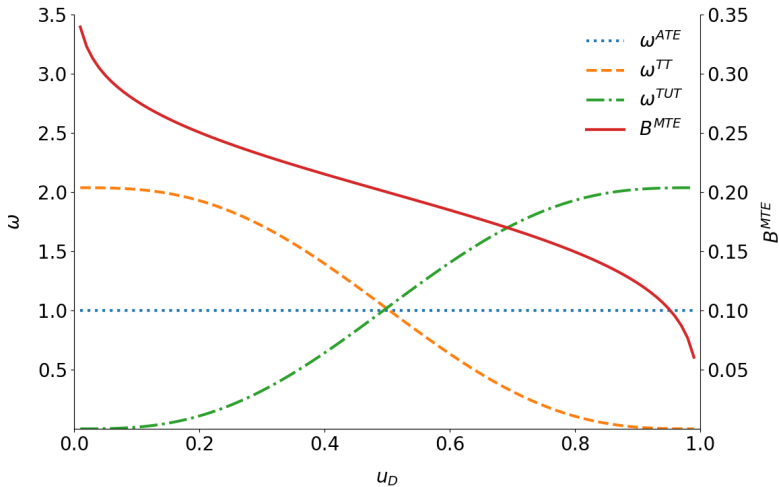
Weights

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

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

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

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

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

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

Figure: Local average treatment effect
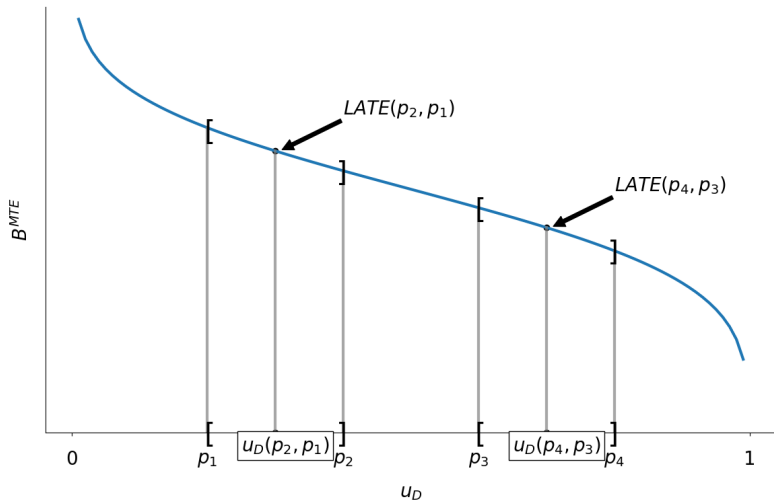
Distributions of Effects

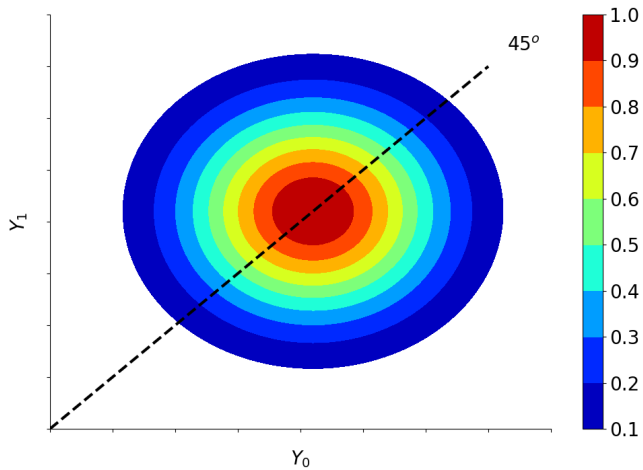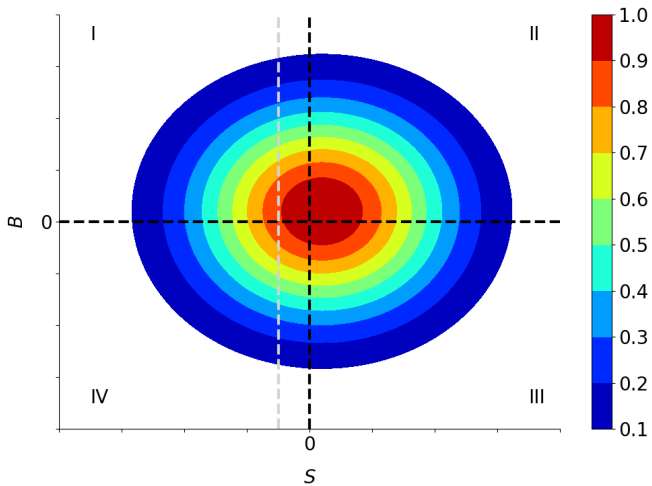# Figure: Distribution of potential outcomes

Figure: Distribution of benefits and surplus

Conclusion

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. (2008). Schools, skills, and synapses. *Economic Inquiry*, *46*, 289–324.

Heckman, J. J., & Vytlacil, E. J. (2007a). Econometric evaluation of social programs, part I: Causal effects, structural models and econometric policy evaluation. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6B, pp. 4779–4874). Amsterdam, Netherlands: Elsevier Science.

Heckman, J. J., & Vytlacil, E. J. (2007b). Econometric evaluation of social programs, part II: Using the marginal treatment effect to organize alternative economic estimators to evaluate social programs and to forecast their effects in new environments. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6B, pp. 4875–5144). Amsterdam, Netherlands: Elsevier Science.