Lecture 1. Econ 374
Economic Approaches to the Evaluation of Public Policy

James J. Heckman

Econ 374, Spring 2012
This draft, March 25, 2012
The economic approach to evaluating public policy addresses clearly stated economic problems.

The emphasis in this course is on econometric cost-benefit analyses.

We discuss economically motivated causal models.
Econometric Causality

- The econometric approach to the study of causality develops explicit models of outcomes where the causes of effects are investigated and the mechanisms governing the choice of treatment are analyzed.

- The relationship between treatment outcomes and treatment choice mechanisms is studied.

- A careful accounting of the unobservables in outcome and treatment choice equations facilitates the design and interpretation of estimators to solve selection and evaluation problems.

- It also facilitates understanding of the causal mechanisms by which outcomes are produced: both outcome equations and treatment assignment (choice) equations.
Both objective and subjective evaluations are considered, where subjective valuations may be those of the persons receiving treatment or of the persons assigning it.

Differences between anticipated and realized objective and subjective outcomes are analyzed.

Models for simultaneous treatment effects are developed. (mutual causation)

A careful distinction is made between models for potential outcomes and empirical methods for identifying treatment effects.
The unaided “treatment effect” model widely used in statistics and popularized in economics is an incomplete framework.

The treatment effect model focuses on “effects of causes” not causes of effects.

The econometric approach examines the “causes of the effects” and the mechanisms that produce outcomes in order to consider and evaluate effective interventions and alternative policies.

Contrast: “structural” versus “treatment effect” approaches.
A simple example of a structural relationship:
(Haavelmo, 1944, *Econometrica*)

\[ Y = X_b\beta_b + X_p\beta_p + U \]  

(*)

*U*: A variable unobserved by the analyst

*X*<sub>b</sub>: background variables, not manipulable.

*X*<sub>p</sub>: policy variables (can manipulate by interventions)

* is an “all causes” model

External manipulations define causal parameters:

Variations in *(X*<sub>p</sub>*) that hold *U* fixed

If the coefficients *(\beta_b, \beta_p)* are invariant to shifts in *(X*<sub>p</sub>*) , then (*) is structural.
Notice that OLS produces the relationship:

\[ E^*(Y \mid X_b, X_p) = X_b \beta_b + X_p \beta_p + E^*(U \mid X_b, X_p) \]

where \( E^* \) is a linear projection.

- OLS does not in general estimate a structural relationship.
- If \( E(U \mid X_b, X_p) = 0 \), OLS gives a structural estimator for \((\beta_b, \beta_p)\).
If

\[ E^*(U \mid X_b, X_p) = E^*(U \mid X_b) \]

and the coefficients \( \beta_b \) and \( \beta_p \) are invariant to manipulations in \( X_p \) then OLS is structural for \( \beta_p \).

But not necessarily for \( \beta_b \).
The Structural Versus the Program Evaluation Approach to Evaluating Economic Policies
Causality is defined at the individual level.

Based on the notion of controlled variation—variation in treatment holding other factors constant.

This is Alfred Marshall’s (1890) *ceteris paribus* clause which has been the operational definition of causality in economics for over a century.

It is distinct from other notions of causality sometimes used in economics that are based on prediction (e.g., Granger, 1969, and Sims, 1972).

See Holland (1986) for a useful discussion.
Two distinct tasks in causal inference and policy analysis: 
(a) Defining counterfactuals and (b) Identifying causal models from data.

Table 1 delineates the two distinct problems.
<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Defining the Set of Hypotheticals or Counterfactuals</td>
<td>A Well-specified Scientific Theory</td>
</tr>
<tr>
<td>2</td>
<td>Identifying Causal Parameters from Data</td>
<td>Mathematical Analysis of Point or Set Identification Joined With Estimation and Testing Theory</td>
</tr>
</tbody>
</table>
Policy Evaluation Problems
Evaluating the Impacts of Implemented Interventions on Outcomes Including Their Impacts on the Well-Being of the Treated and Society at Large.

- Objective evaluations
- Subjective evaluations
- Ex ante and ex post
P2

Forecasting the Impacts (Constructing Counterfactual States) of Interventions Implemented in One Environment in Other Environments, Including Impacts on Well-Being.
This is the problem of *external validity*: taking a treatment parameter or a set of parameters identified in one environment to another environment.
P3

Forecasting the Impacts of Interventions (Constructing Counterfactual States Associated with Interventions) Never Historically Experienced, Including Their Impacts on Well-Being.
- **P3** is a problem that policy analysts have to solve daily.
- Structural econometrics addresses this question.
- The program evaluation approach does not except through “demonstration programs” (i.e. that explicitly implement the policies).
A Prototypical Economic Model for Causal Analysis, Policy Evaluation and Forecasting the Effects of New Policies
Roy (1951): Agents face two potential outcomes \((Y_0, Y_1)\) with distribution \(F_{Y_0, Y_1}(y_0, y_1)\) where “0” refers to a no treatment state and “1” refers to the treated state and \((y_0, y_1)\) are particular values of random variables \((Y_0, Y_1)\).

More generally, set of potential outcomes is \(\{Y_s\}_{s \in S}\) where \(S\) is the set of indices of potential outcomes.

Roy model \(S = \{0, 1\}\).

The \(Y_0, Y_1\) may depend on \(X\), e.g.,
\[
E(Y_0 \mid X) = \mu_0(X) \\
E(Y_1 \mid X) = \mu_1(X)
\]
Analysts observe either $Y_0$ or $Y_1$, but not both, for any person.

In the program evaluation literature, this is called the **evaluation problem**.

This creates a fundamental identification problem.

The solution typically adopted is to attempt to find a person or persons like the “treated” person in most respects and then to compare treated persons to untreated persons.

But which untreated persons?
(i) Untreated persons selected at random from the general population?

(ii) Untreated persons selected at random from the population of people who would have chosen to participate in the program but were somehow randomly denied?

(iii) Untreated persons who would have chosen not to participate?

No single correct answer — depends on the economic question being addressed.
The **selection problem**.

Values of \( Y_0 \) or \( Y_1 \) that are observed are not necessarily a random sample of the potential \( Y_0 \) or \( Y_1 \) distributions.

In the Roy model, an agent selects into sector 1 if \( Y_1 > Y_0 \).

\[
D = 1(Y_1 > Y_0),
\]  

(1)

The observed outcome \( Y \):

\[
Y = DY_1 + (1 - D)Y_0
\]

(2)

i.e. we observe \( Y_1 \), \( Y_0 \) and not both (at least at the same time) for the same person.

In addition, the people we observe are not random samples of the original population.
Generalized Roy model

\[(C \text{ is the cost of going from "0" to "1"})\]

\[D = 1(Y_1 - Y_0 - C > 0).\]  

Example: \(Y_1\) is present value of earnings if person goes to college;
\(Y_0\) is present value of earnings if person stops at secondary school;
\(C\) is cost of going to college.
- $C$ can depend on cost shifters (e.g., $Z$)

$$E(C \mid Z) = \mu_C(Z)$$

- In our analysis cost shifters in $Z$ not in $X$ are candidate instruments (under additional conditions).
Allowing for Imperfect Information

- \( \mathcal{I} \) denotes information set of the agent making the decision.
- In advance of participation, the agent may be uncertain about components of \((Y_0, Y_1, C)\).
- Expected benefit: \( I_D = E(Y_1 - Y_0 - C \mid \mathcal{I}) \).
- Then

\[
D = 1(I_D > 0). \tag{4}
\]
The *ex post* objective outcomes are \((Y_0, Y_1)\).

The *ex ante* outcomes are \(E(Y_0 \mid I)\) and \(E(Y_1 \mid I)\).

The *ex ante* subjective evaluation is \(I_D = E(Y_1 - Y_0 - C \mid I)\).

The *ex post* subjective evaluation is \(Y_1 - Y_0 - C\).

Agents may regret their choices because realizations may differ from anticipations.
The decision maker selecting “treatment” may be different than the person who experiences the outcomes \((Y_0, Y_1)\).

Decision maker may have different costs than the agents whose outcomes are being analyzed.

Example: Conflict between physician preferences and patient preferences. Noncompliance is a source of information on preferences of patient.
\( Y_1 - Y_0 \) is the individual level treatment effect.

More precisely, it is the ex post objective treatment effect.

Also, the Marshallian ceteris paribus causal effect.

Because of the evaluation problem, it is generally impossible to identify individual level treatment effects.

Even if it were possible, \( Y_1 - Y_0 \) does not reveal the ex ante subjective evaluation \( I_D \) or the ex post assessment \( Y_1 - Y_0 - C \).

Pain and suffering of agents; psychic and financial costs.
- Ex Ante Objective Outcome Treatment Effect for a given person:
  \[ E(Y_{1,i} - Y_{0,i} | I_i) \]
  (Randomness at the individual level)
- Ex Post Objective Treatment Effect for person \( i \):
  \[ Y_{1,i} - Y_{0,i} \]
- Subjective Counterparts:
  \[ E(Y_{1,i} - Y_{0,i} - C_i | I_i) \]
  versus
  \[ Y_{1,i} - Y_{0,i} - C_i \]
Can define indicator of subjective treatment effect:

\[ D_i = 1(Y_{1,i} - Y_{0,i} - C_i > 0) \]

or

\[ \tilde{D}_i = 1(E(Y_{1,i} - Y_{0,i} - C_i \mid I_i) > 0) \]
- Economic policies can operate through changing \((Y_0, Y_1)\) or through changing \(C\).
- Changes in \(Y_0, Y_1,\) and \(C\) can be brought about by changing both the \(X\) and the \(Z\).
- The structural approach to program evaluation considers policies affecting both returns and costs.
Population Data:

- The Data typically available are $D$, $Y$, $Z$, $X$ summarized by

\[
F_{Y_0}(y_0 \mid D = 0, X, Z) \\
F_{Y_1}(y_1 \mid D = 1, X, Z) \\
Pr(D = 1 \mid X, Z)
\]

- How to use this information?
Population Parameters of Interest

What are the population parameters of interest?

% with positive gross gain?
\( \Pr(Y_1 - Y_0 > 0) \)?

% with positive gross gain for a given \( X \)?
\( \Pr(Y_1 - Y_0 > 0 \mid X) \)?

% with positive net gain for a given \( X, Z \)?
\( \Pr(Y_1 - Y_0 - C > 0 \mid X, Z) \)?

There are a variety of policy relevant questions and in general they have different answers.
Conventional parameters include the Average Treatment Effect (ATE = \( E(Y_1 - Y_0) \)), the effect of Treatment on The Treated (TT = \( E(Y_1 - Y_0 \mid D = 1) \)), or the effect of Treatment on the Untreated (TUT = \( E(Y_1 - Y_0 \mid D = 0) \)).

In general, these answer different questions.

Examples of when relevant?

- ATE: Universal application of a program.
- TT: Gross Benefit to a Person from participating for persons who participate (e.g., do college people benefit from college).
- TUT: Gross benefit to a person from participating for persons who would choose not to participate.
In positive political economy, the fraction of the population that perceives a benefit from treatment is of interest and is called the **voting criterion** and is

\[ \Pr(I_D > 0) = \Pr(E(Y_1 - Y_0 - C \mid I) > 0). \]

In measuring support for a policy in place, the percentage of the population that *ex post* perceives a benefit is also of interest: \( \Pr(Y_1 - Y_0 - C > 0) \).

Actually this assumes people know what they would have had under different regimes.
Ex Post support may be more accurately represented in the following way:

\( \mathcal{I}_b \) is the information before the program is experienced; 
\( \mathcal{I}_{j,a} \) is the information after experiencing \( j \), \( j \in \{0, 1\} \)

\[
\Pr(E(Y_1 - Y_0 - C \mid \mathcal{I}_b) > 0) \text{ is the ex ante satisfaction with the program.}
\]

Ex post satisfaction for populations with partial participation is

\[
\Pr(E(Y_1 - C \mid \mathcal{I}_{1,a}) - E(Y_0 \mid \mathcal{I}_b) > 0 \mid E(Y_1 - Y_0 - C \mid \mathcal{I}_b) > 0) \\
\cdot \Pr(E(Y_1 - Y_0 - C \mid \mathcal{I}_b) > 0) \\
+ \Pr(E(Y_1 - C \mid \mathcal{I}_b) - E(Y_0 \mid \mathcal{I}_{0,a}) < 0 \mid E(Y_1 - Y_0 - C \mid \mathcal{I}_b) < 0) \\
\cdot \Pr(E(Y_1 - Y_0 - C \mid \mathcal{I}_b) < 0)
\]
- Determining marginal returns to a policy is a central goal of economic analysis.

- In the generalized Roy model, the margin is specified by people who are indifferent between “1” and “0”, i.e., those for whom $I_D = 0$.

- The mean effect of treatment for those at the margin of indifference is

$$E(Y_1 - Y_0 \mid I_D = 0).$$

- This is a key parameter for econometric cost-benefit analysis — determining marginal returns and marginal costs.
Treatment Effects Versus Policy Effects
• Policy Relevant Treatment Effect (Heckman and Vytlacil, 2001) extends the Average Treatment Effect by accounting for voluntary participation in programs.

• Designed to address problems P2 and P3.

• “b”: baseline policy (“before”) and “a” represent a policy being evaluated (“after”).

• $Y^a$: outcome under policy $a$; $Y^b$ is the outcome under the baseline.

• $(Y_0^a, Y_1^a, C^a)$ and $(Y_0^b, Y_1^b, C^b)$ are outcomes under the two policy regimes.
Policy invariance facilitates the job of answering problems P2 and P3.

If some parameters are invariant to policy changes, they can be safely transported to different policy environments.

Structural econometricians search for policy invariant “deep parameters” that can be used to forecast policy changes.
Under one commonly invoked form of policy invariance, policies keep the potential outcomes unchanged for each person: \( Y_0^a = Y_0^b, \ Y_1^a = Y_1^b \), but affect costs (\( C^a \neq C^b \)).

Such invariance rules out social effects including peer effects and general equilibrium effects.
• Assume the form of policy invariance just discussed.
• Let $D^a$ and $D^b$ be the choice taken under each policy regime.
• Invoking invariance of potential outcomes, the observed outcomes under each policy regime are $Y^a = Y_0 D^a + Y_1 (1 - D^a)$ and $Y^b = Y_0 D^b + (1 - D^b)$. 
The **Policy Relevant Treatment Effect** (PRTE) is

\[ \text{PRTE} = E(Y^a - Y^b). \]

This is the Benthamite per capita comparison of aggregate outcomes under policies “a” and “b”. PRTE extends ATE by recognizing that policies affect incentives to participate \((C)\) but do not force people to participate.

Only if \(C\) is very large under \(b\) and very small under \(a\), so there is universal nonparticipation under \(b\) and universal participation under \(a\), would ATE and PRTE be the same parameter.
Econometric approach examines the causes of effects
How $Y_1$ and $Y_0$ vary as $X$ varies
How treatment ($D$) gets determined through variations in $Z$
This is the goal of science
The treatment effect approach looks at effects of causes
Does not investigate mechanisms of causation
Framework is ill-suited to the study of economic policy where causal mechanisms need to be developed
<table>
<thead>
<tr>
<th></th>
<th>Neyman-Rubin Framework</th>
<th>Structural Framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counterfactuals for objective outcomes ((Y_0, Y_1))</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Agent valuations of subjective outcomes ((I_D))</td>
<td>No (choice-mechanism implicit)</td>
<td>Yes</td>
</tr>
<tr>
<td>Models for the causes of potential outcomes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><em>Ex ante</em> versus <em>ex post</em> counterfactuals</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Treatment assignment rules that recognize voluntary nature of participation</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Evaluation of returns at the margin of various policies</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Social interactions, general equilibrium effects and contagion</td>
<td>No (assumed away)</td>
<td>Yes (modeled)</td>
</tr>
<tr>
<td>Internal validity (problem P1)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>External validity (problem P2)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Forecasting effects of new policies (problem P3)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Distributional treatment effects</td>
<td>No(^a)</td>
<td>Yes (for the general case)</td>
</tr>
<tr>
<td>Analyze relationship between outcomes and choice equations</td>
<td>No (implicit)</td>
<td>Yes (explicit)</td>
</tr>
</tbody>
</table>

\(^a\)An exception is the special case of common ranks of individuals across counterfactual states: “rank invariance.” See the discussion in Abbring and Heckman (2007).
Is Randomization the Gold Standard?

- Suppose we can randomize people into treatment status and people comply.

- At best, we identify

\[ F_{Y_1}(y_1 \mid X) \] and \[ F_{Y_0}(y_0 \mid X) \]

but not

\[ F_{Y_0, Y_1}(y_0, y_1 \mid X) \]

- Can estimate \( E(Y_1 - Y_0 \mid X) \)

\[ \therefore \text{Cannot identify } Pr(Y_1 - Y_0 > 0 \mid X) \text{ for example.} \]