The Fundamental Evaluation Problem and its Solution

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1. Evaluation Problem
2. Treatment Effects
3. Selection Bias
4. Solution Approaches

Example: Evaluation of programs of active labour market policy (e.g. job creation measures)

→ Investigation of a program’s effect on a certain outcome variable (e.g. the employment probability)
Measurement of the program‘s success by the share of individuals entering employment during a certain period of time is not sufficient.

↓

**Problem:**
The causal effect of the program is not measured – employment take-up could happen without program participation
Causal effect:
Employment probability of participants versus employment probability of participants had they not participated

Problem:
„counterfactual situation“ – participants cannot simultaneously be non-participants!
1. Evaluation Problem – Example

Solution:
Estimation of the hypothetical employment probability participants in case of non-participation by using the employment probability for non-participants.

Use of a „comparison or control group“, to be able to estimate the success of participation.
In case participants and control group differ with respect to observable or non-observable characteristics that do have an influence on outcome variables

Selection Bias
2. Treatment Effects

**Question:**
What is the effect of a program on the outcome variable $y$?

$y_1$: Outcome variable in case of participation

$y_0$: Outcome variable in case of non-participation

C : Dummy variable, set to 1 in case of participation
The actual observed outcome variable for an individual $i$ results from:

$$y_i = y_{0i} + C_i (y_{1i} - y_{0i})$$

The program is:

$$y_{1i} - y_{0i}$$
Problem:

It is not possible to calculate an individual causal effect.

No individual can be in two different states of participation at the same point in time.
However, it is possible to estimate

- The mean effect of participation on the group of participants ("Average Effect of Treatment on the Treated" – ATT).

- The mean effect of participation expected for an individual drawn randomly from a population of participants and non-participants ("Average Treatment Effect" – ATE).
2. Treatment Effects

(1) \( ATT = E[y_1 - y_0 \mid C = 1] = E[y_1 \mid C = 1] - \underbrace{E[y_0 \mid C = 1]}_{\text{not observable}} \)

(2) \( ATE = E[y_1 - y_0] = E[y_1] - E[y_0] \)

\( E[y_1] \) only is observable for participants and \( E[y_0] \) only is observable for non-participants.

Intuition of ATT/ATE: Actual minus potential outcome of Participants.
Case differentiation:

1. Participants and non-participants („control group“) differ neither with respect to observed nor to unobserved characteristics → consistent estimates of expected value of the outcome variable using the sample mean:
2. Treatment Effects

\[ \hat{ATT} = \frac{1}{T} \sum_{C=1} y_1 - \frac{1}{NT} \sum_{C=0} y_0 \]

Whereas  \( T \): Number of participants  
\( NT \): Number of non-participants
2. Participants and non-participants differ in regard to observed and unobserved characteristics

→ **Selection Bias**

\[ \Rightarrow E[y_0 \mid C = 1] \neq E[y_0 \mid C = 0] \]

→ Difference of sample means does not lead to consistent estimators
2. Treatment Effects – homogeneous vs. heterogeneous

**X-Heterogeneity**: Heterogeneity of the treatment effect that can be explained by differences in observed variables.

**U-Heterogeneity**: Heterogeneity of the treatment effect that can be explained by differences in unobserved variables.
2. Treatment Effects – homogeneous vs. heterogeneous

Definition homogeneous treatment effect:

Treatment has the same effect on individuals with different observed attributes, i.e. no X-heterogeneity.

Measure has the same effect on individuals with different unobserved attributes, i.e. no U-heterogeneity.

Treatment effect is identical for all individuals and ATT=ATE.
2. Treatment Effects –
   homogeneous vs. heterogeneous

X-Heterogeneity / U-Heterogeneity:
→ Heterogeneous treatment effect
→ Selection bias

1. Selection bias due to observed variables
2. Selection bias due to unobserved variables
3. Solution Approaches I

"selection on observables"

"selection on unobservables"

"Propensity-Score-Matching"

Regression Methods

Difference-in-Difference-Estimators (DiD)

Instrumental Variable Approaches (IV)

Selection Models