Reading Notes of *Causal Inference*

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Causal inference without models

1 A definition of causal effect

1.1 Individual causal effects

Causal effect for individual i:

$$Y_i^{a=1} \neq Y_i^{a=0}$$

the treatment A has a causal effect on an individual's outcome Y if $Y^{a=1} \neq Y^{a=0}$ for the individual.

That is, for individual i, $Y^{a=1}$ (is a random variable, read Y under treatment $a = 1$), the outcome variable that would have been observed under the treatment value $a = 1$ is not equal to the outcome variable that would have been observed under the treatment value $a = 0$ ($Y^{a=0}$). The variables $Y^{a=1}$ and $Y^{a=0}$ are referred to as *potential outcomes* or as *counterfactual outcomes*. In economics, we often refer "counterfactual outcomes" to outcomes that had not happend. But here, both $Y^{a=0}$ and $Y^{a=1}$ are counterfactual outcomes, no matter auctually $a = 0$ or $a = 1$.

the counterfactual outcomes that corresponds to the treatment value that the individual actually received is *actually factual*.

Consistency:

$$\text{if } A_i = a, \text{ then } Y_i^a = Y^{A_i} = Y_i$$

an individual with observed treatment $A = a$, has observed outcome Y equal to his counterfactual outcome Y^a.

That is, the observed outcome is equal to what (we think that) would have been observed.

In general, individual causal effects cannot be identified – that is, cannot be expressed as a function of the observed data – because of missing data.

1.2 Average causal effects