Individual causal effect

Regarding the health status of a group of individuals, consider the following random variables:

- $Y_{1,i}$: the health status of individual i if they purchased private health insurance
- $Y_{0,i}$: the health status of individual i if they did not purchase private health insurance
- Y_i: the observed health status of individual i

1. Combine these variables for a third individual k and complete the following equality by adding the causal effect:
$$Y_k = Y_{0,k} + \dots$$
2. Combine these variables for two individuals i (who purchased insurance) and j (who did not purchase insurance) to separate the concept of the causal effect of private health insurance from the concept of selection bias in this context.

Solution

1. The health status of individual k is equal to the health status in the case of not contracting the insurance plus D_k multiplied by the individual causal effect of the insurance contract.

$$Y_k = Y_{0k} + D_k[Y_{1k} - Y_{0k}]$$

If $D_k = 1$

$$Y_k = Y_{0k} + Y_{1k} - Y_{0k} = Y_{1k}$$

Then the individual has the health status of someone who contracted the insurance. If $D_k = 0$,

$$Y_k = Y_{0k}$$

Then the individual has the health status of someone who did not contract the insurance.

2. For Y_i, $D_i = 1$ then

$$Y_i = Y_{1,i}$$

For Y_j, $D_j = 0$ then

$$Y_j = Y_{0,j}$$

Then:

$$Y_i - Y_j = Y_{1,i} - Y_{0,j}$$
$$Y_{1,i} - Y_{0,j} = Y_{1,i} - Y_{0,j} + Y_{0,i} - Y_{0,i}$$

Then:

$$Y_i - Y_j = \underbrace{(Y_{1,i} - Y_{0,i})}_{\text{Causal effect}} + \underbrace{(Y_{0,i} - Y_{0,j})}_{\text{selection bias}}$$

- **Causal effect** $(Y_{1,i} - Y_{0,i})$: Represents the difference in health status of individual i directly attributable to the acquisition of health insurance, assuming that there are no other influencing factors beyond this condition.
- **Selection bias** $(Y_{0,i} - Y_{0,j})$: Indicates differences in health status between two individuals who did not acquire insurance, reflecting variations due to unobserved factors that influence both health and the decision to insure.