Homework for Chapter 10: Treatment Effects

1. Define *in your own words* (i.e., don’t just copy down what’s written in the glossary) each of the following terms:
   1. Conditional average treatment effect

Conditional average treatment effect is treatment effect averages where we only count the average treatment effects among a subgroup of the target population, i.e., the treatment effect averages are conditional on the membership of the group we selected who have certain attributes.

* 1. Average treatment on the treated

Average treatment on the treated is treatment effect averages where we only count the average treatment effects among those who actually received the treatment in a study.

* 1. Average treatment on the untreated

Average treatment on the untreated is treatment effect averages where we only count the average treatment effects among those who are not actually treated in a study.

1. Provide an example of a treatment effect that you would expect to be highly heterogeneous, and explain why you think it is likely to be heterogeneous

I expect the treatment effect of inviting social media influencers to try and promote a product on people’s purchase of the product would be highly heterogeneous across age groups because the younger generations are more exposed to the social media contents, more accustomed to seeking information on social media, and more likely to be attracted by the new products introduced on social media than the older generations.

1. Consider the data in the table below that shows the hypothetical treatment effect of cognitive behavioral therapy on depression for six participants. For the sake of this example, the six participants represent the population of interest.

|  |  |  |  |
| --- | --- | --- | --- |
| Case | Age | Gender | Effect |
| A | 15 | Man | 7 |
| B | 40 | Woman | 3 |
| C | 30 | Woman | 7 |
| D | 20 | Non-binary | 8 |
| E | 15 | Man | 7 |
| F | 25 | Woman | 4 |

* 1. What is the overall average treatment effect for the population?

(7+3+7+8+7+4)/6=6

* 1. What is the average treatment effect for Women?

(3+7+4)/3≈4.67

* 1. If nearly all Non-binary people get treated, and about half of all Women get treated, and we control for the differences between Women and Non-binary people, what kind of treatment effect average will we get, and what can we say about the numerical estimate we’ll get?

The treatment effect average we’ll get is variance-weighted average treatment effects. The final numerical estimate we’ll get will closely reflect the treatment effect among women because the variance in treatment among women is higher than that among Non-binary people in this case. Say 90% (nearly all) of Non-binary people get treated and 50% (about half) of all Women get treated, the weighted average then is (0.5\*\*0.5\*4.67+0.1\*0.9\*8)/(0.25+0.09)≈5.55.

* 1. If we assume that, in the absence of treatment, everyone would have had the same outcome, and also only teenagers (19 or younger) ever receive treatment, and we compare treated people to control people, what kind of treatment effect average will we get, and what can we say about the numerical estimate we’ll get?

Given that everyone would have had the same outcome without the treatment, we can get the counterfactual - the outcome of teenagers under no treatment – from the outcome of the control group. When we only let teenagers (19 or younger) receive treatment, we can only have the outcome of teenagers under treatment. With the outcomes of teenagers under treatment and no treatment, we can get the treatment effect average among those treated (ATT).

\*Assuming that everyone would have had the same outcome without the treatment implies that the outcome is completely unrelated to the probability that they’re treated or not (age) - there is no backdoor between the treatment and outcome, but differences between the outcomes arise only because of the treatment. We cannot get the average treatment effect (ATE) from this because the treatment effect is not the same in treated (teenagers) and untreated groups (non-teenagers) which makes sense because the nonrandom sample is not representative of the population.

This is not conditional average treatment effect neither because the sample selected cannot be grouped as a particular subset of the population that can be defined by certain variables (at least from information we know), it’s just the treatment group is an age group, not the whole sample is a certain subpopulation.

1. Give an example where the average treatment effect on the treated would be more useful to consider than the overall average treatment effect, and explain why.

When the government wants to evaluate the effect of a policy that they have implemented to reduce speeding in certain areas with high rates of overspeed, in this case it’s more useful to consider the average treatment effect on the treated than the overall average treatment effect because policymakers are interested in explicitly evaluating the effect of the policy on those who actually received the treatment but not that on those among whom the treatment was never intended: the research goal is to find out whether and how much the policy intervention reduced speeding in areas where speeding happened a lot rather than in other areas where speeding was already very rare (though such evaluation may be used to assess the impact of such policy on the general population).

1. Which of the following describes the average treatment effect of assigning treatment, whether or not treatment is actually received? c
   1. Local average treatment effect
   2. Average treatment on the treated
   3. Intent-to-treat
   4. Variance-weighted average treatment effect
2. On weighted treatment effects:
   1. Describe what a variance-weighted treatment effect is

A variance-weighted treatment effect is a treatment effect average where each individual’s treatment effect is weighted based on how much variation there is in their treatment variable after back doors are closed.

* 1. Describe what a distribution-weighted treatment effect is

A distribution-weighted treatment effect is a treatment effect average where we sample the treated and untreated groups that have similar values of variables on back door paths (i.e., picking untreated observations to match the treated observations), and end up having individuals with really common values of the variables on which we match weighted more heavily.

* 1. Under what conditions/research designs would we get each of these?

Variance-weighted treatment effect: If we find that some kinds of people have a lot of variation in treatment while others don’t in the target population after we shut the back doors, our estimate may weight the treatment effect of those with variation in treatment more heavily so that we can see the relationship between the treatment and the outcome a lot easier because we can see the former both with and without treatment a lot.

Distribution-weighted treatment effect: If we know that some variation in treatment is connected to back doors which we close to use only the remaining variation by choosing to pick a subsample of the data or pick control observations by matching them with treated observations when random assignment of treatment is not feasible, the average treatment effects we get are weighted by how representative the observations are of the target population.

1. Suppose you are conducting an experiment to see whether pricing cookies at $1.99 versus $2 affects the decision to purchase the cookies. The population of interest is all adults in the United States. You recruit people from your university to participate and randomize them to either see cookies priced as $1.99 or $2, then write down whether they purchased cookies. What kind of average treatment effect can you identify from this experiment?

Conditional average treatment effect because we are getting the average treatment effect conditional on being in our sample, i.e., being a student from my university. The randomization only takes place within the certain group that I isolate.

1. For each of the following identification strategies, what kind of treatment effect(s) is most likely to be identified?
   1. A randomized experiment using a representative sample

Average treatment effect

* 1. True randomization within only a certain demographic group

Conditional average treatment effect

* 1. Closing back door paths connected to variation in treatment

Weighted average treatment effects

* 1. Isolating the part of the variation in treatment variable that is driven by an exogenous variable

Local average treatment effect

* 1. The control group is comparable to the treatment group, but treatment effects may be different across these groups

Average treatment on the treated, Average treatment on the untreated, marginal treatment effect