

CACE vs ITT Estimates



You are an expert in microeconomics and public policy.
Please help to answer the following problem :

The Complier Average Causal Effect (CACE) estimate and Intention to Treat (ITT) estimate will be the same...

- A. when there is perfect compliance
- B. when ITT is 0
- C. amongst compliers
- D. both when there is perfect compliance and amongst compliers



The correct answer is:

D. both when there is perfect compliance and amongst compliers

Explanation:

1. Perfect compliance:

When there is perfect compliance, all individuals assigned to the treatment group receive the treatment, and no individuals in the control group receive the treatment. In this case, the CACE and ITT estimates will be the same because the treatment assignment corresponds exactly to treatment receipt, meaning the groups do not differ in ways other than the treatment.

2. Amongst compliers:

Compliers are the subgroup of individuals who adhere to their assigned treatment (e.g., those in the treatment group who take the treatment and those in the control group who do not take the treatment). The CACE is the causal effect specifically for this group, and the ITT can reflect this causal effect when focusing on the compliers alone.

Hence, the estimates will align in both of these scenarios.



From all the problem and solution above, please extract all the core concepts behind it.
Explain them from scratch.
Include some humor in your explanation.



Sure! Let's break down the **core concepts** behind the problem and solution with a touch of humor to keep things lively. We'll cover:

1. Complier Average Causal Effect (CACE)

2. Intention to Treat (ITT)

3. Compliance

And, of course, we'll do it from scratch. Here we go!

1. Intention to Treat (ITT):

What is it?

Imagine you're running an experiment, say, testing a magic weight-loss cookie. You divide your participants into two groups:

- Group A: Gets the cookie.
- Group B: Gets a placebo (a fake cookie—boo!).

The **ITT estimate** measures the effect of simply assigning people to these groups, regardless of whether they actually ate the cookie or, in true diet-cheater fashion, stuffed it under the couch.

Key idea: ITT focuses on *intentions*, not *actions*. If you were *assigned* a cookie, you're counted as if you ate it. ITT doesn't care if you actually threw the cookie at your cat.

2. Complier Average Causal Effect (CACE):

What is it?

CACE is like the teacher who only cares about the "good kids" who actually follow instructions. It measures the causal effect of the treatment only among the **compliers**—those who actually eat the cookie when assigned to Group A and avoid it when assigned to Group B.

Think of it this way: If you didn't eat the cookie because "ugh, gluten-free," or if you stole a cookie from Group A even though you're in Group B, the CACE estimate waves you off and says, "Not my problem, rebel!"

Key idea: CACE is all about what happened to the *rule-followers* (compliers).

3. Compliance:

What is it?

Compliance is just a fancy way of saying "did you follow the rules?" In an experiment, there are:

- **Compliers:** The angels. If assigned a cookie, they eat it. If not assigned a cookie, they don't eat it.
- **Non-compliers:** The rebels. They either eat the cookie when they weren't supposed to or reject it when it's handed to them. (Also, who rejects free cookies?)

In the context of ITT and CACE:

- ITT includes everyone (angels, rebels, and everyone in between).
 - CACE only cares about the angels.
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Why Do ITT and CACE Sometimes Match?

Now here's where the fun happens! ITT and CACE are like siblings who sometimes look identical and other times don't even seem related. They match when:

1. Perfect Compliance:

Everyone does exactly what they're told. No rebels. No shenanigans. If you're in Group A, you eat the cookie. If you're in Group B, you don't. ITT and CACE hold hands and look the same because there's no difference in how they're calculated.

🤖 **Fun analogy:** Imagine a classroom where everyone does their homework. ITT (teacher's expectation) and CACE (actual results) will match perfectly. Easy peasy.

2. Amongst Compliers:

If you look *only* at the compliers, ITT and CACE are identical because both measures focus on what happened to this group alone. Rebels are kicked out of the equation, and the stats align.

😂 **Fun analogy:** Imagine a party where you only invite the people who RSVP'd "yes." Everyone shows up, and the party's vibe (CACE) matches the invitation list (ITT). No uninvited weirdos ruining the scene.

Takeaways with Humor

- ITT is like saying, "I told you to eat the cookie. Whether you did or not, I'm counting you."
- CACE is like saying, "Only the obedient cookie-eaters matter for my analysis."
- Compliance is like parenting: *if only everyone just listened...*

So, next time you hear about ITT or CACE, remember: it's all about cookies, rules, and whether your stats care about the rebels in the crowd! 🍪



to reinforce the understanding, please generate some relevant T/F questions, and show the solution.



Here are some **True/False questions** to reinforce your understanding of **ITT**, **CACE**, and **compliance**, along with explanations for each answer:

Question 1

The Intention to Treat (ITT) estimate includes all participants in the study, regardless of whether they complied with the treatment assignment.

True/False?

Answer: True

Explanation: ITT is all about analyzing participants based on their assignment, not their actual behavior. Even if someone in the treatment group didn't follow instructions, they're still counted in the ITT estimate. ITT focuses on real-world applicability, including non-compliance.

Question 2

The Complier Average Causal Effect (CACE) estimate only considers participants who followed their treatment assignment.

True/False?

Answer: True

Explanation: CACE is all about the rule-followers, or "compliers." It estimates the causal effect specifically for the subgroup of participants who actually adhered to their assigned treatment or control.

Question 3

When there is perfect compliance, the ITT and CACE estimates will differ significantly.

True/False?

Answer: False

Explanation: When there is perfect compliance, the ITT and CACE estimates will be identical. Since everyone in the treatment group receives the treatment and everyone in the control group does not, the two measures align perfectly.

Question 4

Amongst compliers, the CACE estimate and ITT estimate can sometimes be the same.

True/False?

Answer: True

Explanation: When focusing only on the compliers, the CACE estimate reflects the causal effect on this group. If the ITT is calculated specifically for the compliers, they will match.

Question 5

Non-compliance does not affect the ITT estimate.

True/False?

Answer: True

Explanation: ITT includes everyone as they were assigned, so it doesn't matter whether participants complied with their treatment assignment. The estimate reflects the *intent* to treat, not the actual treatment received.

Question 6

The CACE estimate is more generalizable to the entire population than the ITT estimate.

True/False?

Answer: False

Explanation: The CACE estimate focuses on the subgroup of compliers, so it's less generalizable to the entire population. The ITT estimate, which includes everyone, is often seen as more applicable to real-world scenarios.

Question 7

If the ITT estimate is zero, then the CACE estimate must also be zero.

True/False?

Answer: False

Explanation: A zero ITT estimate means there's no observed effect of treatment assignment across the entire population. However, the CACE estimate might still show an effect for the compliers if the treatment had a causal effect for this subgroup.

Question 8

CACE can still provide a meaningful estimate even when there is non-compliance in the study.

True/False?

Answer: True

Explanation: CACE is specifically designed to account for non-compliance. It isolates the effect of the treatment among those who actually followed their assigned treatment, making it meaningful even when there's non-compliance.

Question 9

Non-compliers are excluded from the ITT estimate.

True/False?

Answer: False

Explanation: Non-compliers are included in the ITT estimate because it calculates the effect based on assignment, not actual behavior. Everyone stays in the ITT analysis, regardless of compliance.

Question 10

CACE assumes that non-compliers have no causal effect from the treatment.

True/False?

Answer: False

Explanation: CACE doesn't assume anything about non-compliers—it simply excludes them from its analysis. Non-compliers may or may not experience a causal effect, but CACE doesn't address their outcomes.

Bonus! 🍪 Cookie Fun Question

If a study involves cookies, and 100% of participants eat their assigned cookies, the ITT estimate is just as sweet as the CACE estimate.

True/False?

Answer: True

Explanation: With perfect compliance, ITT = CACE because everyone eats exactly what they were assigned. No cookie-crumbling chaos here! 🍪



please generate some relevant quantitative examples and show the solution.



Let's tackle **quantitative examples** to solidify your understanding of **ITT**, **CACE**, and compliance concepts. We'll use simple scenarios with calculations to illustrate how these estimates work.

Example 1: ITT and Compliance

You are testing the effectiveness of a new app designed to improve productivity. You randomly assign 100 participants to the **treatment group** (app users) and 100 participants to the **control group** (no app). However, only 80 participants in the treatment group actually use the app, while 20 ignore it. Meanwhile, 10 participants in the control group secretly start using the app.

Here's the data:

- Average productivity improvement in the **treatment group (assigned)**: +5 hours/week.
- Average productivity improvement in the **control group (assigned)**: +2 hours/week.
- Compliance rates:
 - **Treatment group compliers**: $80/100 = 80\%$.
 - **Control group compliers**: $90/100 = 90\%$.

Questions:

1. Calculate the **ITT estimate**.
2. Assume all productivity improvement came from app usage among compliers. Calculate the **CACE estimate**.

Solution:

1. ITT Estimate

The ITT estimate calculates the difference in outcomes based on group assignment:

$$\text{ITT} = \text{Average outcome in treatment group} - \text{Average outcome in control group}$$

$$\text{ITT} = 5 - 2 = 3 \text{ hours/week.}$$

So, the ITT estimate is **+3 hours/week**. This reflects the average effect of being assigned to the app, including non-compliers.

2. CACE Estimate

The CACE estimate focuses only on the compliers. First, calculate the **proportion of compliers** in the treatment group. Let's assume that productivity improvement only occurs in compliers and that non-compliers gain no benefit.

- Proportion of compliers = $\frac{80}{100} = 0.8$.

The CACE estimate adjusts the ITT effect for compliance by dividing it by the compliance rate in the treatment group:

$$\text{CACE} = \frac{\text{ITT}}{\text{Compliance rate in treatment group}}$$

$$\text{CACE} = \frac{3}{0.8} = 3.75 \text{ hours/week.}$$

So, the CACE estimate is **+3.75 hours/week**, reflecting the app's effect on those who actually used it.

Example 2: Non-Compliance and CACE

A clinic is testing a new drug to lower blood pressure. The study involves 200 participants:

- **Treatment group (assigned drug):** 100 people.
- **Control group (assigned placebo):** 100 people.

Here's the data:

- 70 participants in the treatment group took the drug (compliers).
- 90 participants in the control group avoided the drug (compliers).
- Average blood pressure reduction for each group:
 - **Treatment group (assigned):** 10 mmHg.
 - **Control group (assigned):** 5 mmHg.

Questions:

1. Calculate the ITT estimate.
 2. Calculate the CACE estimate.
-

Solution:

1. ITT Estimate

ITT considers outcomes based on group assignment, ignoring compliance.

$$\text{ITT} = \text{Average outcome in treatment group} - \text{Average outcome in control group}$$

$$\text{ITT} = 10 - 5 = 5 \text{ mmHg.}$$

The ITT estimate is **5 mmHg**, the average effect of being assigned to the drug group.

2. CACE Estimate

To calculate the CACE, focus only on the compliers:

- **Compliance rate in treatment group:** $\frac{70}{100} = 0.7$.

CACE adjusts the ITT for compliance:

$$\text{CACE} = \frac{\text{ITT}}{\text{Compliance rate in treatment group}}$$

$$\text{CACE} = \frac{5}{0.7} \approx 7.14 \text{ mmHg.}$$

The CACE estimate is **7.14 mmHg**, reflecting the drug's effect on those who actually took it.

Example 3: When ITT = CACE

Suppose there is **perfect compliance** in a study testing the impact of a fitness program. All participants in the treatment group (100 people) follow the program, and none of the control group (100 people) participate.

Data:

- **Treatment group:** +8 hours of exercise/week.
- **Control group:** +3 hours of exercise/week.

Questions:

1. What is the ITT estimate?
 2. What is the CACE estimate?
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Solution:

1. ITT Estimate

$$\text{ITT} = \text{Average outcome in treatment group} - \text{Average outcome in control group}$$

$$\text{ITT} = 8 - 3 = 5 \text{ hours/week.}$$

ITT is **5 hours/week**.

2. CACE Estimate

Since compliance is perfect, all participants follow their assignments. Hence, the ITT and CACE are identical:

$$\text{CACE} = \text{ITT} = 5 \text{ hours/week.}$$

The CACE estimate is also **5 hours/week**.

These examples illustrate the distinctions between ITT and CACE in scenarios with different compliance rates. They also show how perfect compliance simplifies the relationship between these two estimates!

