

Card and Krueger Study



Please help to solve the following problem:

Fill in the blanks. In the Card and Krueger (1994) study, New Jersey was the ____ group and Pennsylvania was the ____ group.

- A. control; treatment
- B. treatment; control



The correct answer is:

B. treatment; control

Explanation:

In the Card and Krueger (1994) study, the researchers examined the impact of a minimum wage increase in New Jersey on employment in fast food restaurants. New Jersey, which experienced the minimum wage increase, was the **treatment group** because it was the group where the policy intervention occurred. Pennsylvania, where the minimum wage did not change, served as the **control group**, allowing the researchers to compare employment outcomes between the two states.



Fill in the blanks. In the Card and Krueger (1994) study, the difference in employment between the baseline and the endline for Pennsylvania is the ____ effect and Difference-in-Difference estimation ____ this effect.

Option for blank 1:

- A. treatment
- B. control
- C. time

Option for blank 2:

- A. cannot deal with
- B. enhances
- C. eliminates



The correct answer is:

Blank 1: C. time

Blank 2: C. eliminates

Explanation:

- The difference in employment between the baseline and the endline for Pennsylvania is due to **time** effects because Pennsylvania, as the control group, was not affected by the policy intervention. Thus, changes observed there are attributed to factors unrelated to the minimum wage increase (e.g., overall economic trends).
- **Difference-in-Difference (DiD) estimation eliminates this effect** by accounting for time trends that would have occurred in both groups regardless of the treatment. This isolates the true impact of the policy (the treatment effect) by subtracting the time effect observed in Pennsylvania from the observed changes in New Jersey.



What is the most critical assumption for Difference-in-Difference estimation?

- A. It assumes that there must be a time effect.
- B. It assumes that there must be a treatment effect.
- C. It assumes that the time effect (if present) applies equally to treatment and control groups.
- D. It assumes that there is a time effect for the control group but not for the treatment group.



The correct answer is:

C. It assumes that the time effect (if present) applies equally to treatment and control groups.

Explanation:

The most critical assumption for Difference-in-Difference (DiD) estimation is the **parallel trends assumption**. This means that, in the absence of treatment, the treatment and control groups would have experienced the same change over time. In other words, any time effect should affect both groups equally. This allows the method to isolate the causal effect of the treatment by subtracting out common time-related changes that are not due to the treatment itself.



Based on all of the problems and solutions above, please construct an engaging explanation that explains the fancy concepts from scratch behind them.

In the explanation, please include the following:

- all necessary fancy math tools and symbols (if any),
- some tangible examples, or quantitative examples,
- some humor.



An Engaging Guide to Difference-in-Difference (DiD) Estimation: Fancy Math Meets Fast Food 🍔🍟

Imagine you're a curious researcher, hungry for knowledge (and maybe a burger). You want to find out if raising the minimum wage affects fast food employment. Enter **Card and Krueger (1994)**, a legendary study that tackled this exact question using the **Difference-in-Difference (DiD)** method. Let's break this down step by step—sprinkling in some fancy math, quantitative examples, and a dash of humor for flavor!

Setting the Scene: Treatment and Control Groups

The setup:

- **New Jersey** raises the minimum wage.
- **Pennsylvania** does not.

Think of this as a natural experiment where:

- New Jersey = **treatment group** (gets the policy change).
- Pennsylvania = **control group** (keeps things as is).

It's like testing a new recipe at McDonald's: New Jersey gets the new, spicy McWage, while Pennsylvania sticks with the classic dollar-menu wage.

☀️ The Magic of DiD: Why Compare Twice?

The big problem: Many factors can influence employment—economic booms, global burger shortages, or even a fast-food robot uprising. How can we isolate the effect of the wage hike? That's where the **Difference-in-Difference (DiD)** method saves the day!

The Math Behind It:

Let's define:

- E_{NJ}^{after} : Employment in New Jersey after the wage increase.
- E_{NJ}^{before} : Employment in New Jersey before the wage increase.
- E_{PA}^{after} : Employment in Pennsylvania after.
- E_{PA}^{before} : Employment in Pennsylvania before.

We calculate **two differences**:

1. The **change over time** in New Jersey:

$$\Delta_{NJ} = E_{NJ}^{\text{after}} - E_{NJ}^{\text{before}}$$

2. The **change over time** in Pennsylvania:

$$\Delta_{PA} = E_{PA}^{\text{after}} - E_{PA}^{\text{before}}$$

Then subtract the two:

$$\text{DiD Estimate} = \Delta_{NJ} - \Delta_{PA}$$

Why? The second difference (Δ_{PA}) cancels out common time-related effects (like a recession hitting both states) and isolates the **pure treatment effect** of the wage increase.

Tangible Example: Burgers and Math

Suppose the following numbers represent fast food employment in thousands:

State	Before	After	Change (Δ)
New Jersey (NJ)	50	55	$\Delta_{NJ} = +5$
Pennsylvania (PA)	60	58	$\Delta_{PA} = -2$

Now, apply the DiD formula:

$$\text{DiD Estimate} = \Delta_{NJ} - \Delta_{PA} = (+5) - (-2) = +7$$

The estimated effect of the wage hike is **+7**, meaning employment in New Jersey increased by 7,000 workers compared to what would have happened without the policy.

The Critical Assumption: Parallel Trends

Here's the fancy part: DiD only works if the **parallel trends assumption** holds. This means that **in the absence of treatment**, the control (PA) and treatment (NJ) groups would have experienced the same change over time.

Think of it like this: If New Jersey's employment had been on a roller coaster while Pennsylvania's stayed flat, comparing their differences would be like comparing apples to Big Macs. The **parallel trends** ensure we're comparing burgers to burgers.

Why All This Matters: Dealing With Time Effects

Without DiD, you might mistake time effects for treatment effects. For instance:

- If both states saw a drop in employment due to a recession, you'd incorrectly blame the wage hike.
- But DiD **eliminates** this time effect by subtracting it out (fancy math to the rescue!).

A Dash of Humor: Economics Meets Burgers

Imagine a skeptical economist saying, "But what if aliens visited New Jersey and boosted employment with their advanced burger-flipping technology?" Good question! That's why **control groups** (like Pennsylvania) are essential—they remind us what would have happened without interference. DiD saves us from mistaking alien burger boosts for wage policy success. 🛸🍔

Fancy Takeaways: Why DiD Rocks

1. **Math elegance:** By comparing twice, it isolates the true effect of treatment.
2. **Real-world application:** From minimum wage studies to health policies, DiD is everywhere.
3. **Critical assumption:** It hinges on parallel trends—if those break, your analysis becomes a McMess.

Now you know how to combine fancy math, fast food, and parallel trends to answer big questions about policy and economics. So, next time you grab a burger, remember: behind every bite, there might be a Difference-in-Difference story waiting to be told! 🍔📊



To reinforce the understanding, please generate some similar problems and show the solutions.



Practice Problems: Difference-in-Difference (DiD) Scenarios

Let's create three practice problems to reinforce your understanding of DiD and walk through their solutions step by step.

Problem 1: School Policy

A city implements a new teaching policy to improve student test scores. In **District A**, the policy is introduced, while **District B** does not adopt the policy. Test scores are measured before and after the policy implementation. The results are as follows:

District	Before Policy	After Policy	Change (Δ)
District A	70	80	
District B	75	78	

Question:

What is the estimated effect of the new teaching policy on test scores using DiD?

Solution:

1. Calculate the change (Δ) for each district:

$$\Delta_A = 80 - 70 = +10$$

$$\Delta_B = 78 - 75 = +3$$

2. Apply the DiD formula:

$$\text{DiD Estimate} = \Delta_A - \Delta_B = 10 - 3 = +7$$

The new teaching policy is estimated to improve test scores by **7 points**.

Problem 2: A Smoking Ban and Hospital Visits

A city introduces a smoking ban in public places to reduce respiratory-related hospital visits. **City X** implements the ban, while **City Y** does not. Hospital visits are measured before and after the ban. The data is as follows:

City	Before Ban	After Ban	Change (Δ)
City X	150	120	
City Y	140	130	

Question:

What is the estimated effect of the smoking ban on hospital visits using DiD?

Solution:

1. Calculate the change (Δ) for each city:

$$\Delta_X = 120 - 150 = -30$$

$$\Delta_Y = 130 - 140 = -10$$

2. Apply the DiD formula:

$$\text{DiD Estimate} = \Delta_X - \Delta_Y = (-30) - (-10) = -20$$

The smoking ban is estimated to reduce hospital visits by **20 cases**.

Problem 3: Online Learning and Student Engagement

A university introduces an online learning platform in its **Engineering Department**, while the **Arts Department** does not adopt it. Student engagement (measured by average hours of study per week) is recorded before and after the platform's launch:

Department	Before Platform	After Platform	Change (Δ)
Engineering	15	20	
Arts	10	12	

Question:

What is the estimated effect of the online learning platform on student engagement?

Solution:

1. Calculate the change (Δ) for each department:

$$\Delta_{\text{Eng}} = 20 - 15 = +5$$

$$\Delta_{\text{Arts}} = 12 - 10 = +2$$

2. Apply the DiD formula:

$$\text{DiD Estimate} = \Delta_{\text{Eng}} - \Delta_{\text{Arts}} = 5 - 2 = +3$$

The online learning platform is estimated to increase student engagement by **3 hours per week**.

Bonus Humor Problem: Coffee Shop Prices ☕

A coffee chain raises prices in one city (City A) but not in another (City B). Before and after the price increase, the average number of daily customers is:

City	Before Price Hike	After Price Hike	Change (Δ)
City A	100	85	
City B	90	87	

Question:

What is the estimated effect of the price hike on customer visits?

Solution:

1. Calculate the change (Δ) for each city:

$$\Delta_A = 85 - 100 = -15$$

$$\Delta_B = 87 - 90 = -3$$

2. Apply the DiD formula:

$$\text{DiD Estimate} = \Delta_A - \Delta_B = (-15) - (-3) = -12$$

The price hike is estimated to reduce daily customers by **12 customers per day**. That's a latte customers lost! ☕

Takeaways from These Problems:

1. **DiD isolates the treatment effect** by removing common time effects observed in both treatment and control groups.
2. The **parallel trends assumption** is critical: the control group must accurately represent the counterfactual outcome for the treatment group.
3. You can analyze all kinds of policies, from minimum wages to coffee prices, with this elegant method!

So, ready to crunch numbers like a DiD pro? Keep practicing, and you'll master it! 📊🍔