|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Person** | **Y(1)** | **Y(0)** | **Delta** | **Y** | **D** |
| Alice | 15 | 12 |  |  |  |
| Bob | 5 | 10 |  |  |  |
| Chad | 17 | 11 |  |  |  |
| Derrick | 10 | 9 |  |  |  |
| Edith | 9 | 9 |  |  |  |
| Frank | 1 | 5 |  |  |  |
| George | 13 | 9 |  |  |  |
| Hannah | 10 | 8 |  |  |  |
| Ida | 9 | 12 |  |  |  |
| Janice | 8 | 15 |  |  |  |

The above table is a table of potential outcomes for 10 people where the treatment is an app meditation exercise that is supposed to reduce your anxiety. Anxiety is measured on a scale of 1 to 20, with higher numbers being higher levels of anxiety. It is measured using a wearable watch and uploaded to your phone.

1. Calculate the individual treatment effect and comment “is this app good or bad for the person?”
2. Calculate the average treatment effect by averaging over delta. Is the app on average good for people? What does the average mean?
3. Assume that the “perfect doctor” gives the app only to people whose delta is non-negative (i.e., delta=0 or delta>0). Fill out D with who gets the app and who gets nothing
4. Calculate the ATT and compare it with the ATE. Why is it different?

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **ATT STUFF** | | **DID STUFF** | |  |  |
| **year** | **group** | **y1** | **y0** | **y** | **D** | **Pre/Post** |  |
| 1980 | 1 |  | 3.58 |  |  |  |  |
| 1981 | 1 |  | 4.52 |  |  |  |  |
| 1982 | 1 |  | 5.57 |  |  |  |  |
| 1983 | 1 |  | 6.53 |  |  |  |  |
| 1984 | 1 |  | 7.57 |  |  |  |  |
| 1985 | 1 |  | 8.56 |  |  |  |  |
| 1986 | 1 | 19.55 | **9.56** |  |  |  |  |
| 1987 | 1 | 30.59 | **10.59** |  |  |  |  |
| 1988 | 1 | 41.55 | **11.53** |  |  |  |  |
| 1989 | 1 | 52.57 | **12.58** |  |  |  |  |
| 1990 | 1 | 63.56 | **13.56** |  |  |  |  |
| 1980 | 2 |  | 3.59 |  |  |  |  |
| 1981 | 2 |  | 4.56 |  |  |  |  |
| 1982 | 2 |  | 5.59 |  |  |  |  |
| 1983 | 2 |  | 6.54 |  |  |  |  |
| 1984 | 2 |  | 7.55 |  |  |  |  |
| 1985 | 2 |  | 8.58 |  |  |  |  |
| 1986 | 2 |  | 9.58 |  |  |  |  |
| 1987 | 2 |  | 10.58 |  |  |  |  |
| 1988 | 2 |  | 11.62 |  |  |  |  |
| 1989 | 2 |  | 12.58 |  |  |  |  |
| 1990 | 2 |  | 13.58 |  |  |  |  |

The above table has two groups: group 1 and group 2. Group 1 is a firm that adopts a work from home program and group 2 does not. Outcomes are measures of worker productivity (outputs per hour).

1. Group 1 is treated in 1986, but group 2 is never treated. Fill in the D column and mark which periods are pre and post in the last column.
2. Use the switching equation to fill in column Y based on D and the potential outcomes.
3. Calculate the ATT for group 1 for periods 1986 to 1990.
   1. Bonus: If we wanted the ATE, what information would we need?
4. Calculate the difference-in-differences equation using group 2 as the comparison group to group 1. Compare your DiD equation answer to the ATT answer from question 3.
   1. If they are the same, what does that imply?
   2. If they are not the same, what does that imply?
5. Calculate the non-parallel trends bias term.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **ATT STUFF** | | **DID STUFF** | |  |
| **year** | **group** | **y1** | **y0** | **y** | **D** | **Pre/Post** |
| 1980 | 1 |  | 3.58 |  |  |  |
| 1981 | 1 |  | 4.52 |  |  |  |
| 1982 | 1 |  | 5.57 |  |  |  |
| 1983 | 1 |  | 6.53 |  |  |  |
| 1984 | 1 |  | 7.57 |  |  |  |
| 1985 | 1 |  | 8.56 |  |  |  |
| 1986 | 1 | 19.55 | **15** |  |  |  |
| 1987 | 1 | 30.59 | **25** |  |  |  |
| 1988 | 1 | 41.55 | **35** |  |  |  |
| 1989 | 1 | 52.57 | **48** |  |  |  |
| 1990 | 1 | 63.56 | **60** |  |  |  |
| 1980 | 2 |  | 3.59 |  |  |  |
| 1981 | 2 |  | 4.56 |  |  |  |
| 1982 | 2 |  | 5.59 |  |  |  |
| 1983 | 2 |  | 6.54 |  |  |  |
| 1984 | 2 |  | 7.55 |  |  |  |
| 1985 | 2 |  | 8.58 |  |  |  |
| 1986 | 2 |  | 9.58 |  |  |  |
| 1987 | 2 |  | 10.58 |  |  |  |
| 1988 | 2 |  | 11.62 |  |  |  |
| 1989 | 2 |  | 12.58 |  |  |  |
| 1990 | 2 |  | 13.58 |  |  |  |

*Version 2 of the same problem:* The above table has two groups: group 1 and group 2. Group 1 is a firm that adopts a work from home program and group 2 does not. Outcomes are measures of worker productivity (outputs per hour).

1. Group 1 is treated in 1986, but group 2 is never treated. Fill in the D column and mark which periods are pre and post in the last column.
2. Use the switching equation to fill in column Y based on D and the potential outcomes.
3. Calculate the ATT for group 1 for periods 1986 to 1990.
   1. Bonus: If we wanted the ATE, what information would we need?
4. Calculate the difference-in-differences equation using group 2 as the comparison group to group 1. Compare your DiD equation answer to the ATT answer from question 3.
   1. If they are the same, what does that imply?
   2. If they are not the same, what does that imply?
5. Calculate the non-parallel trends bias term.

In the first example, the parallel trends were zero and the DiD = ATT.

In the second example, the parallel trends term was non-zero, and the DID did not equal ATT.

**Conclusion**: Parallel trends is what allows us to get the correct answer, not the estimator because we used the same estimator both times, and in fact the Y and D columns were the same both times.

**Pre-trends vs parallel trends.** We use pre-trends to help us justify a diff-in-diff design. For the following questions, calculate the pre-trends for both worksheets.

1. Write down the formula for parallel trends using
2. Write down a DiD formula comparing the 1983 year to the 1985 baseline year for both groups
3. How are these different from one another?
4. How informative were the pre-trends to whether parallel trends was true?
5. What might be some reasons you can think of for why parallel trends did not hold in the second example, even though pre-trends held?