Detecting an impact
What do we mean by impact?

“An impact evaluation assesses changes in the well-being of individuals, households, communities or firms that can be attributed to a particular project, program or policy.”

Impact Evaluation in Practice, second edition
What do we mean by impact?

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Impact Evaluation in Practice, second edition
Is it really so simple?

What happens with the program = What would have happened without the program

IMPACT
Increasing preschool enrolment
TREATMENT 53% = CONTROL 50%

3 percentage points?

NOT REALLY

We measure things with error
What do you mean by error?

Bad measurement?  NO!

Chance
We’re dealing with random variables

\[ X = 1 \text{ if heads, } X=0 \text{ if tails} \]

\[ X \in [0.28 \text{kg}, 635 \text{kg}] \]
What does this mean for us?

We’re not just estimating a single number, or point estimate.

We’re going to estimate an interval that takes into account this error.
Agenda

1. What is a confidence interval? Statistical significance?

2. When can we say with confidence that we have detected an impact?
We’re dealing with random variables

\( X = 1 \) if heads, \( X = 0 \) if tails

\( X \in [0.28\text{kg}, 635\text{kg}] \)
This randomness generates a distribution
We can make the bins smaller
We can graph probabilities instead

Probability distribution

These bins should add up to 1
We can graph probabilities instead

The area under the curve should add up to 1
We can graph probabilities instead

Area to left of red line:
Probability that weight is less than 70kg.
The average of sample averages is also a random variable

Sample A
Draw a random sample from the population of 12 yr olds.
Calculate the sample average for weight: $\bar{X}^A$

Sample B
Draw another random sample from the population of 12 yr olds
Calculate the sample average for weight: $\bar{X}^B$

Will $\bar{X}^A$ and $\bar{X}^B$ be identical?
Let’s look at the distribution of sample averages.
It will be a normal distribution

\[ f(X) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \]
Why is this good news?

We understand the properties of the normal distribution.

\[ f(X) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2 \sigma^2}} \]
How does the normal distribution help us?

Suppose we want to know average weight in a population
We draw a sample and calculate the average

Q: How large would the true average have to be for us to draw an average of 50kg or below only 5% of the time

Sample average is 50kg

50kg True average (unknown)
We draw a sample and calculate the average

Q: How large would the true average have to be for us to draw an average of 50kg or below only 5% of the time

The normal distribution allows us to calculate this - UPPER BOUND
We draw a sample and calculate the average

Q: How small would the true average have to be for us to draw an average of 50kg or above only 5% of the time?

The normal distribution allows us to calculate this **LOWER BOUND**
We can create an interval around the sample average

90% confidence interval

LOWER BOUND 50kg UPPER BOUND

We draw an average less than this 5% of the time

We draw an average greater than this 5% of the time
We can create an interval around the sample average

90% confidence interval

Values within the interval are not statistically distinguishable
How confident should we be?

90% confidence interval

95% confidence interval

99% confidence interval
<table>
<thead>
<tr>
<th>Confidence Interval</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% confidence interval</td>
<td>Significant at the 10% level</td>
</tr>
<tr>
<td>95% confidence interval</td>
<td>Significant at the 5% level</td>
</tr>
<tr>
<td>99% confidence interval</td>
<td>Significant at the 1% level</td>
</tr>
</tbody>
</table>
Why did you just tell me all of this?

How is this related to estimating impact?
TREATMENT 53% = CONTROL 50% = 3 percentage points?
We want to know if zero is in our confidence interval

95% confidence interval

VALUES WITHIN THE INTERVAL ARE NOT STATISTICALLY DISTINGUISHABLE
If zero lies outside the confidence interval, 0 and 3 can be statistically distinguished.

If zero lies in the confidence interval, 0 and 3 cannot be statistically distinguished.
What do we want to see here?

TREATMENT 53%

CONTROL 50%

3 percentage points

(95% CI 2.54 to 4.1)
### Other stats providing similar information

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-statistic</td>
<td>We typically want this to be above 1.96.</td>
</tr>
<tr>
<td>standard error</td>
<td>The point estimate divided by this gives you the t-stat</td>
</tr>
<tr>
<td>p-value</td>
<td>We typically want this to be 0.05 or below.</td>
</tr>
<tr>
<td></td>
<td>Outcome during first year following experiment</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>(1) Filed FAFSA (based on DOE data) (2) Attended college (based on NSC and OBR data) (3) Attended college and received Pell Grant (based on DOE data)</td>
</tr>
<tr>
<td>Dependent participants (N=868)</td>
<td></td>
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<tr>
<td>Control group mean</td>
<td>0.399</td>
</tr>
<tr>
<td>FAFSA treatment effect</td>
<td>0.157 (0.035)***</td>
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<tr>
<td>Info treatment effect</td>
<td>-0.012 (0.060)</td>
</tr>
<tr>
<td></td>
<td>0.342 (0.035)***</td>
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<tr>
<td></td>
<td>0.081 (0.035)***</td>
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<tr>
<td></td>
<td>-0.004 (0.058)</td>
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<tr>
<td></td>
<td>0.296</td>
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<tr>
<td></td>
<td>0.106 (0.034)***</td>
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<tr>
<td></td>
<td>0.004 (0.056)</td>
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</tbody>
</table>
THANK YOU