Chapter 4.5
Advanced statistical techniques

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Learning objectives

To understand the following more advanced factors to consider in developing an impact evaluation for health emergency and disaster risk management (Health EDRM):

- Different approaches for estimating impact in the absence of random assignment.
- Advantages and disadvantages of the different approaches.
- Importance of baseline data for both intervention and comparison groups.

Why use a quasi-experimental approach?

- Random assignment may not be possible in some Health EDRM settings: for example, after an intervention is already underway or has been completed.
- A range of other non-experimental methods are available which give reliable estimates of impact:
- The key requirement of a quasi-experimental (QE) approach is that there are **data from both an intervention and a comparison population**.

Quasi-experimental methods

This chapter introduces the following non-experimental quantitative methods available for impact evaluation studies in Health EDRM:

1. Propensity Score Matching (**PSM**).
2. Regression Discontinuity Designs (**RDD**).
3. Instrumental Variable Estimation (**IV**).

We overview strengths and limitations of QE approaches with case studies from disasters and other health emergencies.

Propensity score matching

- The propensity score is the **probability** of being exposed to the intervention (being in the treatment group).
- Observations in the *treatment* group are **matched** to *untreated* observations (comparison group) **with similar propensity score**.
- **Impact** of the intervention is estimated by measuring the difference in the outcome indicator of interest between the treatment group and the comparison group.

Case study: *Using PSM to measure the impact of humanitarian aid on the food security in Mali (Tranchant et al., 2019)*

Context: Humanitarian aid in the Mopti region of Northern Mali.

PSM in action:

1. Baseline data (i.e., before humanitarian aid) was used to match *intervention* and *comparison* households on a set of **pre-determined characteristics** (e.g. presence of a secondary school and of a regular market within 5 km, age of the household head).
2. **Difference** in children's nutritional status between the two **matched** groups measured the impact of humanitarian aid on child nutrition and showed a positive impact of humanitarian aid on child nutrition.

Advantages and disadvantages of PSM

Advantages:

- Usually feasible.
- Can be done post-intervention.

Disadvantages:

- Relies on matching on observables:

If selection *(participation) into intervention* ***depends*** *on* ***unobservable*** *characteristics,* ***PSM*** *gives* ***biased impact estimates.***

Regression discontinuity design

- Use **regression discontinuity designs** (RDD) when a **threshold rule** exists for allocation to the intervention, where that threshold is independent of the intervention.
- **Close to either side of the threshold** units are **sufficiently similar** for those excluded from the intervention for these to be a **valid comparison** group.
- The **discontinuity** in the regression line at that point (threshold), is the **measure** of the intervention's **impact**.

Case study: *Using RDD to measure the impact of social protection top up transfers to most vulnerable victims of typhon (World Bank, 2016)*

Context: Social protection top up transfers to the most vulnerable households after Tropical Cyclone Winston.

RDD in action:

1. **Treatment** (eligible to Poverty Benefit Scheme) and **Control** (not eligible to Poverty Benefit Scheme) groups were constructed based on **the 20% Poverty Benefit Scheme (PBS) eligibility threshold**.
2. **RDD** method used to **estimate the impact of top-up transfers** and found the intervention to be an **effective response** to the cyclone.

Advantages and disadvantages of RDD

Advantages:

- If a **threshold exogenous** to participation to the project can be identified, **RDD is as good as a randomised trial**.

Disadvantages :

- RDD is **valid** only for **observations** relatively **close** to the **threshold** (discontinuity point) and there may be so few such observations that it is, therefore, statistically underpowered.

Instrumental variable regression (IV)

- **Regression-based method** is where outcome variable is estimated using a **measure of participation** (the *instrument*) **to the intervention** group **independent** of the **outcome variable.**
- The instrument *has to be* **highly correlated** with **programme participation**.
- The instrument *has to be* **uncorrelated** with the **outcome of interest**.

Case study: *Using IV to estimate if post tsunami reconstruction in Sri Lanka triggered interstate violence (Kikuta; 2019)*

Context: In 2004, Sri Lanka was hit by a massive tsunami that killed more than 35,000 people and destroyed over 78,000 homes in that country alone.

IV in action:

1. Use **tsunami wave** heights as **IV** for post-war housing reconstruction.
2. Instrument measure (tsunami **wave heights**) can be considered **independent** (exogenous) to the **outbreaks of violence** and the study found that housing construction raises the number of violent events.

Advantages and disadvantages of IV

Advantages:

- If a **valid instrument** is found, both observable and unobservable sources of **selection bias** are **controlled** for.

Disadvantages :

- It is often difficult to find a **valid** and **defendable** instrument because many factors that affect decisions to use an intervention typically also affect outcomes.

Key messages

- Estimating impact in the absence of randomization is possible.
- Attention is needed to avoid selection bias (specifically for PSM).
- RDD is closest to a randomised trial but only if a threshold rule exists.
- IV is a good regression-based alternative, but valid instruments are difficult to find.

Further readings

Allaire MC. Disaster loss and social media: Can online information increase flood resilience? Water Resources Research; 2016: 52(9): 7408-23.
This research article presents the results of a study of the effectiveness of online information and social media in enabling households to reduce disaster losses.

White H, Sabarwal S. Quasi-experimental Design and Methods, Methodological Briefs: Impact Evaluation 8. Florence, Italy: UNICEF Office of Research. 2014.
This report from the UNICEF Office of Research focuses on quasi-experimental designs and methods.

White H, Raitzer D, editors. Impact Evaluation of Development Interventions: A Practical Guide. Asian Development Bank. 2017.
Hands on guide to conducting impact evaluations in international development.

Angrist JD, Pischke JS. Mostly Harmless Econometrics. Princeton University Press. 2019.
More advanced reading on methods with worked out applications.

References

This chapter: Vigneri M, White H. Chapter 4.5: Advanced statistical techniques.
Sri Lanka case study: Kikuta K. Postdisaster Reconstruction as a Cause of Intrastate Violence: An Instrumental Variable Analysis with Application to the 2004 Tsunami in Sri Lanka. Journal of Conflict Resolution. 2019: 63(3): 760-85.
Mali case study: Tranchant JP, Gelli A, Bliznashka L, Diallo AS, Sacko M, Assima A, et al. The impact of food assistance on food insecure populations during conflict: Evidence from a quasi-experiment in Mali. World Development. 2019: 119: 185-202.
Tropical Cyclone Winston case study: Mansur A, Doyle J, Ivaschenko O. Cash Transfers for Disaster Response: Lessons from Tropical Cyclone Winston. SSRN Electronic Journal. 2018. https://ssrn.com/abstract=3143459

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