

Statistical Methods for Causal Inference in Observational and Randomized Studies

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DAY TWO: Review and Recap

Discussion Point: Positivity

The identifiability of causal effects requires sufficient variability in treatment or exposure assignment within strata of confounders.

The causal inference literature refers to the assumption of adequate exposure variability within confounder strata as the assumption of positivity or experimental treatment assignment.

Positivity

Positivity violations can arise for two reasons.

- 1 It may be theoretically impossible for individuals with certain covariate values to receive a given exposure of interest.

For example, certain patient characteristics may constitute an absolute contraindication to receipt of a particular treatment.

The threat to causal inference posed by such structural or theoretical violations of positivity does not improve with increasing sample size.

Positivity

Positivity violations can arise for two reasons.

- ② Violations or near violations of positivity can arise in finite samples due to chance.

This is a particular problem in small samples but also occurs frequently in moderate to large samples when the treatment is continuous or can take multiple levels, or when the covariate adjustment set is large or contains continuous or multilevel covariates.

Regardless of the cause, causal effects may be poorly or nonidentified when certain subgroups in a finite sample do not receive some of the treatment levels of interest.

Strong Positivity Assumption

$$\inf_{a \in \mathcal{A}} g(a \mid W) > 0, \text{ } P\text{-a.e.}$$

The strong positivity assumption states that each possible treatment level occurs with some positive probability within each stratum of W .

Positivity Assumption for $\beta(F_X, h, m)$

$$\sup_{a \in \mathcal{A}} \frac{h(a, V)}{g(a \mid W)} < \infty, \text{ } P\text{-a.e.}$$

Estimator-Specific Behavior Under Positivity Violations

- MLE
- IPTW Estimator
- Double Robust Estimators

Diagnosing Bias Due to Positivity Violations

The Parametric Bootstrap as a Diagnostic Tool

Practical Approaches to Positivity Violations

- 1 Change the projection function $h(A, V)$.
- 2 Restrict the adjustment set.
- 3 Restrict the sample.
- 4 Change the intervention of interest.

Selection among a family of parameters.