Statistical Approaches to Studying Mediator Effects in Education Research: Bayesian Estimation vs. Weighted Analysis under Principal Stratification

Overview

In attempts to reveal the mechanisms through which an intervention generates an impact or lack of impact on student outcomes, causal mediation analysis is challenging even when the intervention was randomized due to selection into the observed mediator values under each treatment. This symposium features two papers representing two novel approaches to this problem under the general framework of principal stratification. This framework uses potential outcomes to conceptually distinguish among subpopulations of individuals who would respond to the initial intervention differently at the intermediate stage. The average treatment effects and the mediator effects may differ across principal strata, which gives rise to interesting substantive questions and possibly provides leverage for causal inference. The two papers employ Bayesian estimation and weighted analysis, respectively, to tackle mediation-related causal questions.

The first paper “Principal stratification as a framework for investigating mediational processes in experimental settings” presents a re-analysis of MDRC’s multi-site randomized evaluation of Career Academies. The paper investigates whether students’ increased school-sponsored exposure to the world-of-work through their enrollment in the career academies subsequently led to labor market success. In utilizing principal stratification to examine exposure to the world-of-work as a mediator, the authors stratified the sample on a pair of potential intermediate outcomes—a student’s level of exposure associated assignment to the treatment and the student’s level of exposure associated with assignment to the control. The author utilizes a Bayesian approach to estimation and inference that relies on a set of assumptions, statistical models, and available information to infer each student’s principal stratum membership and to estimate stratum-specific treatment effects. In a principal stratum where the level of the mediator would not be affected by treatment assignment, the stratum-specific ITT effect estimates the direct effect of treatment. In a stratum where the level of the mediator would be affected, the ITT effect estimates the total effect of treatment.

The second paper “Weighting methods for assessing policy effects mediated by peer change” introduces a new set of weighting procedures for revealing the mediation mechanism in multi-level settings. These methods are illustrated through an evaluation of the algebra-for-all policy taking effect in the Chicago Public Schools (CPS) in 1997. The inference is based on a comparison between a pre-policy cohort and a post-policy cohort of students. Through predicting every student’s probability of taking algebra and expected peer composition before and after the policy, the authors identify a principal stratum of lower-achieving students who would experience a change in course-taking and a rise in peer ability due to the policy change. The causal questions focus on decomposing the total policy effect on math learning into the indirect effect mediated by peer composition change and the direct effect of the policy for this subpopulation of students. This study utilizes marginal mean weighting through stratification
(MMW-S) and prognostic score-based adjustment to remove observed and unobserved between-cohort differences. The total effect is then decomposed through ratio-of-mediator-probability weighting (RMPW).