Covariate Adjustment in Completely Randomized Experiments With Noncompliance

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Abstract: Noncompliance is a common problem in completely randomized experiments. When there is noncompliance, investigators are often interested in estimating the complier average causal effect (CACE) and regression adjustments are often used to gain estimation efficiency. The indirect least squares (ILS) and the two stage least squares (TSLS) are two commonly used regression adjustment methods. We show that they are numerically equal to each other under the Neyman-Rubin potential outcomes framework. They are asymptotically normal with the true CACE as their mean, but their asymptotic variances may be larger than that of the unadjusted Wald estimator. In order to reduce the variance, we propose to include the covariates by treatment assignment interaction in the ILS, as in the case of estimating average causal inference without noncompliance. Under mild conditions, we show that this estimator is consistent and asymptotically normal with asymptotic variance no greater than that of the Wald estimator even when the number of covariates is larger than the number of observations. We provide a conservative estimator of the asymptotic variance, which can yield tighter confidence intervals than the Wald estimator. Moreover, we study the TSLS with covariates by treatment received interaction added in the model and show that it can be asymptotically biased if the covariates are not centered appropriately. Simulation studies show that ILS with interaction can be advantageous when compared with other methods.