A COMPARATIVE STUDY OF EXACT VERSUS PROPENSITY MATCHING TECHNIQUES USING MONTE CARLO SIMULATION

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Often researchers face situations where comparative studies between two or more programs are necessary to make causal inferences for informed policy decision-making. Experimental designs employing randomization provide the strongest evidence for causal inferences. However, many pragmatic and ethical challenges may preclude the use of randomized designs. In such situations, subject matching provides an alternative design approach for conducting causal inference studies. This study examined various design conditions hypothesized to affect matching procedures' bias recovery ability.

The study examined three common social science research scenarios for case matching where discrete, continuous, or both types of covariates are employed. For each scenario, the following hypothesized factors were arranged experimentally in a factorial design: (a) bias amount, (b) effect size (ES), (c) covariance among the covariates (CV), and (d) correlation (CR) between the bias amount and the covariate group. Within these between group factors, six matching methods (MM) (random sampling, exact matching, propensity score matching, nearest neighbor matching, radius matching, and Mahalanobis metric matching) were examined in terms of their ability to minimize the difference between "true" and "estimated" effects ($\overline{\hat{Y}_D}$) and hence match groups in terms of bias.

Study conditions were investigated using Monte Carlo techniques. One thousand replicates were drawn from a theoretically defined population. Each replicate included a treatment sample of N=200 and a control population of N=10,000 subjects. From the control population, random samples of N=200 were drawn via each matching method to form comparison group samples with known bias and effect size amounts added.

Results revealed that in the discrete covariate scenario there was a significant MM*Bias*ES 3-way interaction. In the continuous covariate scenarios there were significant 4-way interactions involving MM*ES*CV*CR, MM*Bias*ES*CV, and MM*Bias*ES*CR, while in the mixed scenario there were significant 4-way interactions among MM*Bias*ES*CV, MM*Bias*ES*CR and a significant 3-way interaction for MM*CV*CR.

Overall, this study indicates that the study design conditions do impact various outcomes relative testing the general hypothesis: $\bar{Y}_t - \bar{Y}_C = \overline{\hat{Y}_D}$. Study implications suggest that social science researcher's need to carefully consider multiple factors when employing a propensity-based or exact matching procedure in quasi-experimental designs. Recommendations for further research are offered.