Random-parameter PSM: a novel method of program evaluation for situations when participation is affected by unobservable variables

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A novel method of program evaluation for situations when participation is affected by unobservable variables

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- Proposes the use of a random-parameter probability model in the first stage of PSM
- Our simulations suggest that the new method can reduce selection bias by 12%
- The procedure can be easily implemented able through major statistical packages

INTRODUCTION

- Propensity score matching (PSM) is the most widely used method of program evaluation in situations when only cross-sectional data are available
- PSM matches each participant in the program with a group of non-participants who were equally likely to participate in the program as the participant but chose not to participate
- A well-acknowledged weakness of PSM is that its matching procedure is carried out solely based on observable variables, and therefore the resultant propensity score is biased if any unobservable variable plays part in people's decision whether or not to participate
- Here, we show through a simulation analysis that the application of a random-parameter probability model reduces the aforementioned bias, and that this method can be used as an easily implementable alternative to the standard PSM procedures
- The reason behind the bias reduction is the model's capability to assign a separate estimator for each individual, and hence "absorb" the effect of the individual's unobservable traits on participation

MATERIALS AND METHODS

- A Monte-Carlo simulation was carried out to compare the level of biases expected under the standard logit model and the random-parameter logit model at the estimation of propensity scores
- Synthetic datasets were generated based on the true equation including an unobservable variable, and then used to estimate the equation only with observable variables (Table 1)

Table 1. Unobservable and observable propensity scores

Unobservable (true) propensity score

$$\frac{e^{\beta_0+\beta_1x_1+\beta_2x_2+\beta_3\varepsilon_3}}{1+e^{\beta_0+\beta_1x_1+\beta_2x_2+\beta_3\varepsilon_3}}$$

Observable (real-world) propensity score

$$\frac{e^{\beta_0+\beta_1^ix_1+\beta_2^ix_2}}{1+e^{\beta_0+\beta_1^ix_1+\beta_2^ix_2}}$$

x1, x2: observable independent variables. **ε3:** unobservable variable. Parameters β_1^i and β_2^i are conditioned for each individual under the random-parameter model. Normal distributions were assumed for the two parameters.

- The simulation was conducted with N = 10,000 (large sample) and, for random-parameter estimations, Halton intelligent draws

RESULTS AND DISCUSSION

- The random-parameter approach yielded a considerably better model fit, with the average rate of correct prediction improving from 61.9% to 70.5%
- It also produced propensity scores closer to the true likelihood of participation, with the selection bias attributable to the existence of an unobservable variable reduced on average by 12.0%
- Thus, the proposed method seems to warrant further research, especially with respect to its small sample properties