Simulation-based randomized systematic PPS sampling under substitution of units

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Abstract
The International Tobacco Control (ITC) Policy Evaluation Survey of China uses a multi-stage unequal probability sampling design with upper level clusters selected by the randomized systematic PPS sampling method. A difficulty arises in the execution of the survey: several selected upper level clusters refuse to participate in the survey and have to be replaced by substitute units, selected from units not included in the initial sample and once again using the randomized systematic PPS sampling method. Under such a scenario the first order inclusion probabilities of the final selected units are very difficult to calculate and the second order inclusion probabilities become virtually intractable. In this paper we develop a simulation-based approach for computing the first and the second order inclusion probabilities when direct calculation is prohibitive or impossible. The efficiency and feasibility of the proposed approach are demonstrated through both theoretical considerations and numerical examples. Several R/S-PLUS functions and codes for the proposed procedure are included. The approach can be extended to handle more complex refusal/substitution scenarios one may encounter in practice.

Key Words: Inclusion probability; Horvitz-Thompson estimator; Rao-Sampford method; Relative bias; Unequal probability sampling without replacement.

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