

RESAMPLING METHOD FOR GENERALIZED ONE-PER-STRATUM SAMPLING DESIGNS

Zhonglei Wang and Zhengyuan Zhu*

Xiamen University and Iowa State University

Abstract: In areal surveys, one-per-stratum sampling is commonly used since it achieves spatial balance and improves estimation efficiency. The downside of such a design is that it is challenging to have a good variance estimator. In this paper, we propose a generalized one-per-stratum sampling design to generate a spatially balanced sample. The sample is used to get an M -estimator of the parameters in a spatial linear regression model, and the corresponding variance is estimated by a resampling method. Asymptotic properties of the M -estimator are investigated under the proposed one-per-stratum sampling design. Simulation studies show that the proposed one-per-stratum sampling design achieves good spatial balance, and the M -estimator is more efficient compared with existing designs. The resampling method is applied to investigate the relationship between soil erosion and slope in Iowa using a recent sample from the National Resources Inventory survey.

Key words and phrases: Asymptotics, M -estimator, spatial block bootstrap, spatially balanced sampling, survey variance estimation.

1. Introduction

In environmental studies, observations are spatially dependent in the sense that the correlation is a decreasing function of distance, so it is desirable to obtain a spatially balanced sample, which spread over the sampling domain well, to make efficient inference (Cochran, 1946; Stevens and Olsen, 2004; Grafström, Lundström and Schelin, 2012). For example, stratified sampling is conducted to obtain well-spread samples to study soil erosion by the National Resources Inventory survey (Nusser and Goebel, 1997; Nusser, Breidt and Fuller, 1998); also see the land surveys by the Bureau of Land Management and the June Area survey by the National Agricultural Statistics Service. Even though various spatially balanced sampling designs are applied in practice, how to make valid statistical inference is still an open problem (Stevens and Olsen, 2004; Grafström, Lundström and Schelin, 2012). In this paper, our goal is to propose a general one-per-stratum sampling design and rigorously prove that inference can be made through a resampling method.

Different spatially balanced sampling designs have been proposed. Bartholdi and Platzman (1988) and Lister and Scott (2009) used space-filling curves to

*Corresponding author. E-mail: zhuz@iastate.edu