

A GENERAL CLASS OF ESTIMATORS IN TWO-STAGE SAMPLING WITH TWO AUXILIARY VARIABLES

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Abstract

This paper presents a general class of estimators for a finite population total with the aid of two auxiliary variables in a two-stage sampling with varying probabilities. The methodology developed can be extended readily to three-stage and stratified two-stage sampling designs.

Keywords: Asymptotic variance, Auxiliary variable, Two-stage sampling.

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1. Introduction

Consider U , a finite population consisting of N first stage units (*fsu*) U_1, U_2, \dots, U_N , such that U_i contains M_i second stage units (*ssu*) and $M = \sum_{i=1}^N M_i$. Let Y_i, X_i and Z_i be the totals of U_i in respect of the study variable y , and two auxiliary variables x and z respectively with corresponding overall totals $Y = \sum_{i=1}^N Y_i, X = \sum_{i=1}^N X_i$ and $Z = \sum_{i=1}^N Z_i$. To estimate Y , let us consider a general class of two-stage sampling designs: At stage one, a sample s ($s \subset U$) of n *fsus* is drawn from U according to any design with π_i and π_{ij} as the known first and second order inclusion probabilities. Then for every $i \in s$, a sample s_i of m_i *ssus* is drawn from U_i ($s_i \subset U_i$) with suitable selection probabilities at the second stage. More detailed accounts of two-stage sampling procedure are given in general survey sampling books (cf. Cochran [1], Sarndal *et al* [9]).

Let E_1, E_2 ($V_1, V_2; \text{Cov}_1, \text{Cov}_2$) denote the expectation (variance, covariance) operators over repeated sampling in the first and second stages; by E (V or Cov) we denote the overall expectation (variance or covariance). It is assumed that from the second

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