Model calibration and MRP methods for small area estimation: an empirical comparison

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Abstract

Multilevel regression and post-stratification (MRP) of Gelman and Little (1997) is widely used for small area estimation with probability and non-probability data in public polls and political sciences, as well as in social and health surveys. The properties of the method are rarely discussed from the design-based inference point of view in the literature; Si (2021) provides a recent exception. We investigate with design-based simulation experiments the finite population properties (bias and accuracy) of MRP for the estimation of proportions of a binary variable for population subgroups or domains (small or large). Our focus is in the capacity of MRP to account for unequal probability sampling. We compare MRP with model calibration (MC) of Wu and Sitter (2001); see Lehtonen and Veijanen (2019) for MC in domain estimation. The synthetic (SYN) estimator acts as another reference.

As a model-assisted method, the MC estimator is design consistent irrespective of the correctness of the model. Model-based MRP and SYN estimators can be severely biased if the sampling information is ignored. Our Monte Carlo experiments showed that the bias in small domains does not necessarily vanish as the domain sample size increased, and the bias can become the dominating component of MSE. However, bias can be successfully reduced by incorporating sampling information into the poststratification cell structure, which indicates design consistency. In small domains, MRP can be more accurate than MC when strong auxiliary information is supplied to the model. The difference in accuracy between MRP and MC reduced as the domain sample size increased. The synthetic estimator was less accurate and more severely biased than MRP. Our limited empirical exercise recommends further studies on the limitations and potentials of MRP in relation to other SAE methods.

Keywords: Design consistency; accuracy; Monte Carlo simulation

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