and found that, as expected, there are high positive correlations between yields in neighboring states and between agronomically related crops that are grown in overlapping regions. This research, however, was conducted at the state rather than county level; it is still an open question whether similar relations will be useful at the county level.

Another area for research is in using the historical data on crop production in current county estimates. A natural way to use this information would be in a Bayesian setting such as the hierarchical Bayes estimates described in Section 5.3 of Ghosh and Rao's paper. Indeed, it seems surprising that a noninformative prior would be used in small-area estimation problems involving census data or data from continuing surveys; there is certainly a wealth of information on which to base an informative prior.

Finally, I would like to mention a success story in research in the production of county estimates. Ghosh and Rao describe the experimental research of Battese, Harter and Fuller (1988) on county estimation of crop production using satellite data. This year, for the first time, Arkansas is using satellite data to aid in production of crop acreage estimates as part of their county estimates program. Over the next few years, other states are expected to begin using such data to aid in the production of their crop acreage estimates.

ACKNOWLEDGMENT

This research was supported in part by the USDA/NASS under Cooperative Agreements 58-3AEU-9-80040 and 43-3AEU-3-80083. The author takes sole responsibility for the work.

Comment

Ib Thomsen

It takes talent and hard work to provide an overview and evaluation of a rapidly evolving subject like small area estimation. In my opinion the authors have succeeded in doing this, and I want to congratulate them with a very useful review. In many statistical offices, substantial methodological work is being done to find suitable estimators for small areas. People involved in such work will be grateful to Ghosh and Rao for their present contribution.

Below I shall communicate some experiences gained when developing and using small area estimates within Statistics Norway. But first a few comments to the example given in Section 6 of the paper. In this example a synthetic population is constructed by fitting a nested error regression model to a business population. For this synthetic population, the EBLUB (or EB) and the HB estimators are shown to produce small area estimators which are superior to the ratio-synthetic and a sample-size dependent estimator. As pointed out by the authors, this demonstrates the advantages of using EBLUB or HB estimators when the model fits the data well. A question remains concerning the robustness of these estimators as compared to the simpler sample-size dependent estimator. A column in Table 3 showing the small area means of the real business population could have thrown some light on the robustness of the estimators studied in the paper.

At Statistics Norway, small area estimators have been used for some years now (Laake, 1978). In the beginning we concentrated on synthetic estimators, but more recently composite estimators are being used. In what follows some of our experiences concerning the feasibility of the EB estimator are presented.

I shall look at a very simple situation in which θ_i, $(i = 1, \ldots, T)$ is a small area parameter, and $\overline{X}_i$, $(i = 1, \ldots, T)$ is a direct estimator such that

$$E(\overline{X}_i|\theta_i) = \theta_i \quad i = 1, \ldots, T.$$

The parameters $\theta_1, \theta_2, \ldots, \theta_T$ are considered realizations of a random variable with unknown distribution $G(\cdot)$. The mean μ and variance σ^2 are assumed to be known or that estimates are available. For a set of small areas, unbiased estimators $\overline{X}_1, \ldots, \overline{X}_T$ are available with conditional distributions equal to the binomial.

When $G(\theta)$ is unknown, empirical Bayes estimators generally employ $(\overline{X}_1, \ldots, \overline{X}_T)$ to estimate $E(\theta|\overline{X}_1, \ldots, \overline{X}_T)$. However, for many distribution, $E(\theta|\overline{X}_1, \ldots, \overline{X}_T)$ cannot be consistently estimated un-

Ib Thomsen is Director of Research, Statistics Norway, and Professor of Statistics, University of Oslo, P.B. 8131 Dep, 0033 Oslo, Norway.