when λ is unknown. The point estimates are identical or very similar depending on the choice of $\hat{\lambda}_1$ for each approach but the associated measures of uncertainty could be quite different. In addition to the above modifications which rely on the δ-method, Singh, Stukel and Pfeffermann (1993) also obtain a modification of the asymptotic Bayes method of Hamilton (1986) which uses Monte Carlo integration (MCI) for evaluating the two terms of the posterior variance given by (11) thus avoiding computation of partial derivatives. The MCI simply entails generating λ_1-values from the approximate posterior distribution of λ_1 which is given by $N(\hat{\lambda}_1, \overline{V}(\hat{\lambda}_1))$. It is not difficult to show that the order of the neglected terms in the Hamilton (H) approximation is $O(m^{-1})$ and not $o(m^{-1})$. However, if the posterior distribution of λ_1 is approximated by $N(\hat{\hat{\lambda}}_1, \overline{V}(\hat{\lambda}_1))$, then the modified Hamilton (MH) approximation is of the desired order. Singh, Stukel and Pfeffermann (1993) report results of a Monte Carlo study on the frequentist properties of various approximations. Empirically, it is found that the KS-I approximation is biased downward, but KS-II* adds a positive term (similar to PR) and tends to be conservative. The behaviour of the MH approximation is quite similar to KS-II*, but H tends to be more biased downward than KS-I. The performance of the PR approximation is found to be best overall with respect to the frequentist properties, although other approximations provide useful alternatives. In particular, Bayesian approximations KS-II* and MH have the distinct advantage of having a dual interpretation in both frequentist and Bayesian contexts.

It may be noted that if m is quite large, then there will be hardly any difference between various approximations.

4. REMARKS

It is evident from the paper of Ghosh and Rao that great advances have been made in the field of small area estimation by both Bayesians and frequentists. It is also evident from the present discussion that there may be quite a bit of agreement between the two approaches. However, these advanced tools are not in widespread use, especially by statistical agencies conducting large scale complex surveys who face probably the greatest demand for small area statistics. Perhaps, the reason for this is the practitioner's skepticism in modelling complex survey data. Indeed, for complex surveys there is very little by way of model validation and more so for element-level modelling because of possible selection bias [see section 4 of Ghosh and Rao and a recent review by Pfeffermann (1993)]. There is no doubt that the area of model validation for complex survey data needs more research. This is also recognized by Ghosh and Rao and I would like to emphasize by noting that further work in this direction will be a very valuable contribution.

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Comment

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Ghosh and Rao are to be congratulated for their timely paper reviewing methods for small-area estimation. My main complaint is that a paper such as this was not available five years ago when I began working on small-area estimation problems. I particularly enjoyed the historical perspective offered in the demographics methods section of the paper; I was sorry that section was so short since much of the material described in that section is not readily available to statisticians outside of the government agencies.

As the authors noted, there is a growing demand for small-area estimates and a corresponding interest in research on procedures for producing such estimates. The widely publicized debate on adjusting the U.S. population census for the undercount to produce adjusted counts for states and large cities has made many researchers focus on small area estimation problems related to the population census. There are, however, other long-standing small-area estimation programs. One of these is the USDA's program of county-level estimation of crop and live-

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