A NEW METHOD OF ESTIMAION IN OPTIONAL RANDOMIZED RESPONSE TECHNIQUES FOR QUANTITATIVE CHARACTERISTICS

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Abstract:

Surveys frequently gather information relating to highly sensitive and stigmatized issues such as induced abortion, drug addiction, sexual behaviour and incidence of domestic violence. In such surveys, respondents often provide socially desirable answers or refuse to respond entirely due to social stigma and/or fear. Under such circumstances randomized response (RR) techniques may be utilised to collect a better quality of data, to protect respondents' privacy, or to reduce an unacceptably high rate of nonresponse.

The RR technique was introduced by Warner (1965). Warner's technique was extended by several researchers including Horvitz et al. (1967), Greenberg et al. (1969), Eichhorn and Hayre (1983), Franklin (1989), Arnab (1990, 1996), and Christofides (2003), to increase co-operation from the respondents and improve efficiencies of the estimators.

In an optional randomized response technique (ORT), most of the respondents feel that the subject of enquiry is sensitive, but a minority may feel that it is not sensitive and are therefore willing to provide direct response (DR). For example, HIV/AIDS infection status is a sensitive issue for most people but some respondents are nevertheless willing to reveal their status to the interviewer. A randomized response technique which provides the opportunity to give DR instead of making RR compulsory to all the respondents is known as an ORT. Accordingly in an ORT, respondents provide RR if they feel the subject of enquiry is sensitive, but provide DR if they feel that the enquiry is not sufficiently sensitive to require anonymity. ORT was introduced by Chaudhuri and Mukherjee (1988).

In this article we have extended Gupta et al. (2002) and Huang's (2010) PORT to FORT where the respondents belonging to the sensitive group G provide RR with probability one and the respondents belonging to the complementary group $\bar{G}$ provide DR with probability one. The estimators for the population mean of the sensitive characteristic μ_y and the sensitivity level W under the PORT and FORT for the proposed RR techniques are identical but their variances differ significantly. The magnitude of the difference cannot be identified as it involves several unknown parameters. However, it is found that the variances of the estimators for both the Gupta et al. (2002) and Huang (2010) RR techniques based on the assumption of the FORT provide higher values than that of PORT if the mean μ_{yG} of the sensitive characteristic y for the group G is higher than that of the entire population mean μ_y. The condition $\mu_{yG} \geq \mu_y$ is expected to be valid in practice for sensitive characteristics such as those involving personal income, number of incidence of domestic violence, incidence of cheating in examinations, etc. It is also found that the variance of Huang estimator (2010) based on FORT provides a higher value than that of Gupta et al. (2002) estimator under FORT provided $\mu_{yG} \geq \mu_y$. Furthermore this paper scrutinises the performances of the proposed ORR using simulation studies. These studies reveal that the proposed extension of Huang's (2010) additive model performs better than Gupta et al.'s (2002) model if the multiplicative part remains constant, but the extension of Gupta et al.'s (2002) model performs better if the multiplicative term varies. Both of the ORT techniques proposed by Gupta et al. (2002) and Huang (2010) are applicable to the simple random sampling with replacement (SRSWR) only. In this paper their methods have been extended to the complex survey designs. The present study considers a finite population $U = \{1,..,N\}$ of N identifiable units where y_i denotes the value of the sensitive characteristic y of the ith unit of the population and $\mu_y = \sum_{i \in U} y_i / N$ denotes the population mean.