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# Improved Ratio Estimators in Case Of Non-Response Using Location Parameters

Masroor Majid*[1], S. Maqbool[2], S.A.Mir[3], M.S. Pukhta[4], S. A. Saraf[5], F. A. Lone[6] and Ishrat .F. Bhat[7]

*[1]Ph.D Student, Division of Agricultural Statistics, SKUAST-Kashmir, Shalimar Campus, Srinagar 1900 25- (J&K)*
*[2]Associate Professor, Division of AGB, FVSC and AH, Shuhama, SKUAST-Kashmir, Ganderbal 1912 01- (J&K)*
*[3]Professor and Head, Division of Agricultural Statistics, SKUAST-Kashmir, Shalimar Campus, Srinagar 1900 25- (J&K)*
*[4]Professor, Division of Agricultural Statistics, SKUAST-Kashmir, Shalimar Campus, Srinagar 1900 25- (J&K)*
*[5]Assistant Professor, Division of Agricultural Statistics and Economics, SKUAST-Kashmir Wadoora Sopore 1932 01- (J&K)*
*[6]Professor, Division of Environmental Sciences, SKUAST-Kashmir, Shalimar Campus, Srinagar 1900 25- (J&K)*
*[7]Ph.D Student, School of Agri. Economics & HBM, SKUAST-Kashmir, Shalimar Campus,Srinagar 190 025- (J&K)*

***ABSTRACT***
*The study entitled "Improved ratio Estimators in case of Non-Response Using Location Parameters" was taken with an objective to estimate and modify the estimators in presence of non-response. The non-response in surveys may be due to various conditions, be it faulty questionnaire or incompetence of the enumerator. Non-Response present in studies results in bias in estimators. By taking the motivation from previous estimators improved class of Ratio Estimators was proposed and also their Bias, mean square error and percent relative efficiency were calculated and compared.*

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## I. INTRODUCTION

The traditional ratio estimate of Y is given as follows;

$$\hat{Y}_R = \frac{y}{x} X = \frac{\bar{y}}{\bar{x}} X$$

Where, *y* and *x* are the sample totals of the $y_i$ and $x_i$, respectively.

A well-known result in the regression theory indicates the type of population under which the ratio estimator may be called the best among a wide class of estimators. The result was first approved for infinite populations. Brewer and Royall extended the result to finite populations.

In sample surveys, there may arise a situation of non-response which results in bias. This non-response may be due to various conditions be either faulty questionnaire or the incompetence of the enumerator. In order to get rid of the error in our sampling surveys we modify the existing estimators using various location parameters *viz*, mean, median, mode, decile mean, etc. In this study we have used Decile mean and Median to see which best fits our estimators.

**Existing Estimators**

(a) Upadhaya and Singh (1999) gave the ratio type variance estimator for non-response as;

$$\bar{Y}_{US} = y\left[\frac{\bar{X} + \beta_{2x}}{\bar{x} + \beta_{2x}}\right]$$

(b) Kadilar and Cingi (2006a) gave the ratio type estimator for non-response as;

$$\hat{\bar{Y}}_{KC} = y\left[\frac{\bar{X}+C_x}{\bar{x}+C_x}\right]$$

(c) Singh, H.P. *et.al* (2015) gave the variance estimator for non-response as;

$$\hat{\bar{Y}}_{S} = y\left[\frac{\bar{X}+\alpha Q^2}{\bar{x}+\alpha Q^2}\right]$$

**The bias and mean square error of above mentioned existing estimators is as under**

$$bias(\bar{Y}_{ei}) = \gamma\bar{Y}R_{ei}\left[R_{ei}\left(\beta_{2x}-1\right)-\left(\lambda_{22}-1\right)\right]$$

$$MSE(\hat{\bar{Y}}) = \gamma\bar{Y}^2\left[\left(\beta_{2y}-1\right)+R_{ei}{}^2(\beta_{2x}-1)-2R_{ei}(\lambda_{22}-1)\right]$$

**Improved Estimators in presence of non-response**

$$\hat{\bar{Y}}_{p1} = Ky\left[\frac{\bar{X}+DM}{\bar{x}\rho+DM}\right], \hat{\bar{Y}}_{p2} = Ky\left[\frac{\bar{X}C_x+DM}{\bar{x}C_x+DM}\right], \hat{\bar{Y}}_{p3} = Ky\left[\frac{\bar{X}\beta_1+DM}{\bar{x}\beta_1+DM}\right],$$

$$\hat{\bar{Y}}_{p4} = Ky\left[\frac{\bar{X}+MD}{\bar{x}\rho+MD}\right], \hat{\bar{Y}}_{p5} = Ky\left[\frac{\bar{X}C_x+MD}{\bar{x}C_x+MD}\right], \hat{\bar{Y}}_{p6} = Ky\left[\frac{\bar{X}\beta_1+MD}{\bar{x}\beta_1+MD}\right],$$

Where, K is characterizing scalar to be determined such that the MSE of the proposed estimator is minimized.

**The bias and mean square error of proposed estimators are given as under**

$$bias = \gamma K\bar{Y}R_{pi}\left[R_{pi}\left(\beta_{2x}-1\right)-R_{pi}\left(\lambda_{22}-1\right)\right]+\bar{Y}\left(K-1\right)$$

$$MSE(\bar{Y}_{pi}) = \bar{Y}\left[K^2\gamma\left(\beta_{2y}-1\right)'+\left(3K^2-2K\right)R_{pi}{}^2\left(\beta_{2x}-1\right)-2\left(2K^2-K\right)R_{pi}\gamma\left(\lambda_{22}-1\right)+\left(K-1\right)^2\right]$$

Where, $\gamma = \frac{1-f}{n}$, the minimum value of $K$ is obtained and is given under;

$$K = \frac{1+R_{pi}{}^2\gamma\left(\beta_{2x}-1\right)-R_{pi}{}^2\gamma\left(\lambda_{22}-1\right)}{1+\gamma\left(\beta_{2y}-1\right)+3R_{pi}{}^2\gamma\left(\beta_{2x}-1\right)-4R_i\gamma\left(\lambda_{22}-1\right)}$$

The minimum MSE for the estimator, while substituting the optimum value of K is given as;

$$MSE_{\min}\left(\bar{Y}_{pi}\right) = \bar{Y}\left[1-\frac{\left\{\left(1+R_{pi}{}^2\gamma(\beta_{2x}-1\right)-R_{pi}\gamma\left(\lambda_{22}-1\right)^2\right\}}{1+\gamma\left(\beta_{2y}-1\right)+3R_{pi}{}^2\gamma\left(\beta_{2x}-1\right)-4R_{pi}\gamma\left(\lambda_{22}-1\right)}\right]$$

Where,

$$\left(\beta_{2y}-1\right) = \left(\beta_{2y}-1\right)'$$

**Empirical Study**

We used the data set presented in Sarndal *et.al* (1992) concerning (P85) 1985 population in thousands considered as (*Y*) and (RMT85) revenues from 1985 municipal taxation (in millions of kronor), considered as (*X*). Descriptive of thepopulationare:

$$N = 234, \bar{Y} = 29.36268, \bar{X} = 245.088, S_y = 51.55674, S_x = 596.3325, \rho = 0.96,$$
$$\beta_2(y) = 89.23178, \beta_2(x) = 89.18994, Q_2 = 113.5, DM = 214.49 \, and \, n = 35.$$

We consider 20% weight for non-response (missing values). So, numerical results are provided only for 20% missing values and considering last 47 values as non-respondents. Some important results from that population of non-respondents are as follows.

For 20%;

$$l = 2, S_{y(2)}{}^2 = 2.916, \beta_2(y_{(2)}) = 11.77, N_2 = 47$$

**Table 1: Constant, Bias and MSE of Existing and Proposed Estimators**

| **Estimators** | **Constant** | **Bias** | **MSE** |
|---|---|---|---|
| **$US_1$(Upadaya and Singh)** | 0.8783 | 5.1243 | 13222.65 |
| **$KC_1$(Kadilar and Cingi)** | 1.1862 | 4.9109 | 13039.93 |
| **$S_1$(Singh *et.al*)** | 0.0607 | 3.9725 | 12236.26 |
| **$P_1$** | 0.6267 | 3.4902 | 11823.20 |
| **$P_2$** | 0.8807 | 3.1010 | 11489.90 |
| **$P_3$** | 1.0899 | 2.1003 | 10632.84 |
| **$P_4$** | 0.8081 | 1.8934 | 10455.71 |
| **$P_5$** | 1.0062 | 1.3472 | 9987.94 |
| **$P_6$** | 1.1382 | 0.9601 | 9596.39 |

**Table 2: Percent Relative Efficiency of Proposed Estimators with the Existing Estimators**

| **Estimators** | **$US_1$(Upadhaya and Singh)$_1$** | **$KC_1$(Kadilar and Cingi)$_1$** | **$S_1$(Singh *et.al*)$_1$** |
|---|---|---|---|
| **$P_1$** | 111.84 | 110.29 | 103.49 |
| **$P_2$** | 115.08 | 113.49 | 106.50 |
| **$P_3$** | 124.36 | 122.64 | 115.08 |
| **$P_4$** | 126.46 | 124.72 | 117.03 |
| **$P_5$** | 132.93 | 130.56 | 122.51 |
| **$P_6$** | 137.79 | 135.88 | 127.51 |

## II. CONCLUSION

From table 2 it was observed that the proposed estimator (P6) performed better in terms of less bias and mean square error with 137% efficiency and hence it can be concluded that the linear combination of coefficient of kurtosis and median proved to be better.

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