Demography India (2018) ISSN: 0970-454X
Vol. 47, Issue: 1, pp: 79-88

Research Article

Effect of Sample Size on Estimation of Fertility using Open Birth Interval Data

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Abstract

This paper attempts to provide a sample size with which fertility can be precisely estimated using open-birth interval data. Two fertility estimators, based on open-birth interval information, are used in this paper and it is shown that how the sample size affects the behavior of these estimators. This paper shows that the two estimators use data which involves same cost and labor at the time of collection, in one method the same precision can be obtained with the half of the sample size only that would be required to give fertility estimation using the other estimator. The data used in this paper have been taken from NFHS-3 for three states having different levels of fertility.

Introduction

The aim of demographic studies is to draw valid inferences and provide conclusions about some specific problem using data of surveys and census. Relevant data are collected either through sampling as in many surveys or through complete enumeration; called the census. The cost in terms of money, labour and time involved in the process of complete enumeration technique is much more than that involved in sampling. The non-sampling errors also increase with increasing number of sampling units in the survey. So, to conduct a complete counting, skilled personnel and a great amount of money and time is required. Even if cost is not a matter of concern, sometimes complete enumeration is not possible in cases such as in life testing experiments where units are likely to be destroyed during the course of experiments. Consequently, sampling is preferred over complete counting in many cases. Beside other steps of sampling procedure, one major concern is the determination of 'sample size'. By sample size, it is meant that how many units from the population to be included in the sample. The determination of sample size depends on a great extent to the purpose of the study, cost involved in it and also in which context the information is needed such as in bio-medical aspect in which clinical trials are performed, in industrial surveys where life testing is performed and demographic aspect in which some characteristic of the population is studied. (Desu and Raghavarao, 1990; Lenth, 2001; Sharma 2004)

In the planning of a survey, the problem faced by a researcher is how large should be the sample to provide estimates which are close enough to the true value in the population with a desired level of accuracy. To address this problem, the concept of accuracy and confidence is applied. In estimation; based on sample values, we want to estimate some population characteristic Ywhich is generally unknown. For this, appropriate estimators are proposed which are the functions of sample observations and are supposed to give the estimates of population characteristic. It rarely happens that the 'estimate' coincides with the population parameter. We can only hope it to be very near to the true value. So, there is always some error involved in estimating population values. Now the focus shifts to how much error can we tolerate? There come the concept of confidence interval and allowable margin of error. It may happen sometimes that our sample based confidence interval does

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not cover the true picture. Therefore, there is some probability specified with which the difference between estimated value and true value go beyond the allowable margin.

In the present paper, we are concerned with determining the minimum sample size required estimating the fertility levels using information on last birth interval and births occurred in one year before the survey. The method used for estimating fertility is explained in subsequent sections. Total fertility rate (TFR) is used as a measure of fertility. The data from National Family Health Survey-3 (NFHS-3) conducted in 2005-2006 have been utilized. Three Indian states which are Uttar Pradesh, Maharashtra and Kerala are taken for analysis purpose. These states show a varying level of prevailing fertility; in Kerala, fertility is low, in Uttar Pradesh fertility is high and for Maharashtra, the fertility lies in between these two states. Fig. 1 shows the pattern of fertility for these states from NFHS 3 data. Samples of various sizes have been taken from the data for these states treating NFHS-3 data as population. The methodology used for determining the sample size and results obtained are discussed in next sections.

Estimation of fertility rates using Open-Birth Interval Data

The open-birth interval is defined as the duration between the date of last birth and date of the survey. For women, those have not experienced any births, this duration counted from the date of marriage to the date of the survey. The data on open-birth interval help in fertility analysis. It provides the picture of fertility with using information of recent past. The open-birth interval is expected to be less affected by recall biases as it incorporates information on most recent births. Many researchers have worked on the open-birth interval (Srinivasan 1966, 1972, 1980; Srinivasan et al. 1987; Pathak 1970, 1971; Singh and Yadava, 1977; Pandey, 1985; Schmertmann, 1999; Schmertmann and Caetano, (1999). Feeny (1983), Fenny and Ross, (1984), Yadava et al., (1992), Islam and Yadava (1997), Schmertmann (1999) have worked on open birth interval and provided some procedures for fertility estimation from open-birth interval data. Srinivasan has advocated using open-birth interval approach for fertility estimation. The advantage of working with open birth interval data is that it relates to the births in recent past and consequently has less recall bias.

The time since last birth can be utilized to estimate current fertility. Let births occur over a time period $[0, T]$, a woman states her age as (a) at the time of the survey, and time since her last-birth (if any) is denoted as(u^*). An indicator variable δ is defined which takes value 1 if the birth occurred in $[0, T]$ and 0 otherwise.The time since last birth (u^*) is further truncated to time T to reduce recall bias. So, the time since last birth in past T years becomes as follows:

$$u = \begin{cases} u^* & if\ u^* < T \\ T, & otherwise \end{cases} \qquad (1)$$

Now, the two methods considered in this paper gives estimates of fertility levels as explained below:

1). Birth in Last Year Information

In this method, only those births are utilized which occurred in last-year only. The information on time sincelast birth is truncated and converted to a binary variable defined as in 1:

$$B(u^*) = \begin{cases} 1 & if u^* < 1 \\ 0, & Otherwise \end{cases} \qquad (2)$$

Where B approximates the number of births occurred in a year beforethe survey date. So, mean of B gives an estimate of fertility and also the proportion of women who gave births in last year. If fertility is assumed to be piecewise-constant, the fertility estimate for age-group x can be given as follows:

$$f(x) = B_x / Y_x \qquad (3)$$

Where B_x is the number of births in last year to women and Y_x is the number of women-

years in age-group x. B_x can be obtained counting womenin age-group x with $\delta = 1$ and $u = 0$. This method is referred to as 'births-in-last year' (BLY) method in this paper. With BLY method, the number of women-years will simply be the number of women in the age-group x at the time of the survey. The method is simple though, it discards all potential information of woman who gave before last year.

2). Date of Last Birth Information

Schmertmann (1999) proposed a new method to estimate fertility using open-birth interval data. This estimator has some nice statistical properties. This estimator gives the current fertility rates at the time of the survey. The estimator is less affected by sampling fluctuations as compared to the standard method. This method is referred to as 'Date-of-last-birth' (DLB) method. In DLB method, the values of (a, u, δ) for each woman are used. If fertility is assumed to be piecewise-constant, the estimate of fertility forage-group x is as follows:

$$f(x) = \frac{\sum_i (\delta_i I_x (a_i - u_i)}{\sum_i (\sum_{z=a_i-u_i}^{a_i} I_x(z))} \qquad (4)$$

where I_x is an indicator variable, which takes value 1 if age belongs toage-group $x$and 0 otherwise.

Determination of Sample Size

In this section, a general method for deciding sample size is discussed. Suppose we have a population of size N, Y_N is the population parameter, say mean of the population. Following the usual procedure of sampling, we take a sample of size $n\,(n < N)$ to gain information about population parameter. Let y_n be the sample mean based on n observations and is an estimator for the population mean. Since y_n is based on a random sample of size n, it is also a random quantity having some mean and variance.Sampling error, which is measured by means of standard error, is a measure of the variation of the estimator of a parameter in all of the possible samples (Cochran, 1977). Apart from other factors, the variance of this estimator is affected by sample size. The variance of the estimator decreases as the sample size increases. Now, we have to decide what should be the sample size such that the estimator has a reasonably less variance.

If it is assumed that the population is normally distributed, the sample mean is also normally distributed with mean $Y_N$and variance σ^2/n. If the margin of error in the estimation of the parameter is ϵ, and $(1-\alpha)$ is the confidence coefficient, then the sample size is determined using the following relation

$$Prob[|Y_N - y_n| < \epsilon] = (1-\alpha) \qquad (5)$$

which gives $n = Z^2\sigma^2/\epsilon^2$ where Z is the value of standard normal variate at α level of significance and σ^2 is the variance of the characteristic in the population. The $(1-\alpha)\%$ confidence interval can be defined as following formula

$$CI = Mean \pm Z_{(1-\frac{\alpha}{2})}.S.E. \qquad (6)$$

The above-discussed procedure is valid when the parent population is normal. If the population is not normal, the above method cannot be applied. The distribution of TFR is generally not known but is found to be normal using simulation (Schmertmann 1999, Cusi 2007). We have also used simulation to find the distribution of TFR. To check the normality of the distribution, K-S test has been applied which also indicates that the distribution is normal. The distributions of TFR obtained by both methods are plotted in Figure 2 and 3. The summary measures for distribution of TFR is provided in Table 1. Now, the procedure of finding confidence interval as in Eq. 6 can be applied for TFR also.

Data and Methodology

The data used in this paper have been obtained from NFHS-3 survey. The information on woman's last birth and her age at the date of survey is obtained for women of three states, namely Uttar Pradesh, Maharashtra and Kerala. These states represent high, middle and low fertility. Any women who is between age 15-49 years at the time of survey, whether she has given any birth or not, has been included in the study. The time of her last birth is noted. The total women in these states are 12183, 9034, 3566 respectively.

Simulation Study for finding Minimum Sample Size:

To determine the minimum sample size for fertility estimation, we have used a simulation study. In simulation process we have selected independent samples of size $n = 100, 200, 300, 400, 500, 700, 900, 1000, 1200$ and 1500 from these three states. The selection process is repeated 100 times for each sample size and sampling is done following simple random sampling without replacement. For a large population, sampling with replacement and without replacement does not differ significantly. From these samples, we investigated the behaviour of sample TFR. The mean of sample TFR's and variance of sample TFR's are calculated based on 100 repetitions. These variances give insight to the standard error of TFR.

Result and Discussion

Table 1 shows the distribution of TFR obtained from subsamples of size 500 with 1000 repetition. The standard deviation obtained for distribution of TFR with BLY method is greater than that of the DLB method. The empirical density for TFR from both methods is shown in Fig. 2 and 3. Figures also show that the distribution of TFR from BLY method is more dispersed. Table 2 gives the mean and 95% confidence interval of TFR for varying sample size $n = 100, 200, 300, 400, 500, 700, 900, 1000, 1200$ and 1500 for with 100 repetitions for Kerala. The population TFR value calculated through DLB method is found to be 1.97. From the table we see, for increasing sample size the mean value of sample TFR goes near to the true value of TFR. The confidence interval gets narrower as the sample size increases, which is because of reducing standard error of TFR estimator from DLB method. The bias and MSE of the estimator also decrease as the sample size is increasing. However, the TFR estimator is found to be a biased estimator for population TFR. The bias is only negligible when the sample size has reached to 1200 and 1500.

Table 3 shows the mean, 95% confidence interval, bias and MSE of TFR estimator obtained from BLY method for Kerala, for various sample size with 100 repetitions. Form this table we observe that, BLY TFR estimator is also a biased estimator of population TFR which is found to be 1.85 for the whole population using BLY method. The mean value of sample TFR is close to the true value of TFR for almost each sample size. The confidence interval gets narrower as the sample size increases. Similarly, no definite pattern of reduction in bias is observed as sample size increases, but MSE is found to be decreasing with increased sample size.

From Figure 4, comparing both methods of fertility estimation, we observe that the 95% confidence interval is wider for BLY estimator as compared to that of DLB estimator keeping the same sample size. The confidence interval gets narrower rapidly for DLB estimator than BLY estimator. So, we have to take a larger sample to estimate TFR precisely if BLY method is used. The confidence interval for DLB method reduces rapidly at initial but as the sample size reaches to 500 and 600, this reduction is not sharp. The width of the confidence interval is 0.53 at n=600 and it reduces to only 0.358 when the sample size is doubled (n=1200). So, if we are satisfied with a confidence interval width of 0.5 (approximately) we can use a sample of 600 to estimate TFR using DLB method.

In case of BLY method, the reduction in confidence interval slows down when sample size reaches to 1000 and above. So, to estimate TFR with a confidence interval width ~0.5, we need to take a sample larger than 1000 if BLY method is applied. The findings also reveal that to get more

precise estimates of TFR, the sample size needed to be increased in both methods.

Table 4 shows the mean, confidence interval, bias and MSE for TFR estimator with DLB method of fertility estimation for Maharashtra, and Table 5 shows these values for BLY TFR estimator. Mean TFR values with 95% confidence interval for a varying number of sample sizesare shown in Figure 5. From tables, it is noted that bias and MSE reduce as sample size increase for both estimators. The population TFR is 2.07 with BLY method of estimation and 1.91 with DLB method of estimation. With DLB method, not much reduction in observed in width of confidence interval when sample size reaches 700. So, we can use a sample of size 700 to get an estimate of TFR with a confidence interval of width 0.4. With BLY method, a sample of larger size is needed to get the estimate with narrow confidence limits. A sample of size 1000 or above will be suitable to estimate TFR with BLY method.

Similar results are obtained for Uttar Pradesh. The population TFR from both methods is observed to be 3.54. The mean, bias, MSE and 95% confidence interval for various sample sizes are given in Table 6 and Table 7. Figure 6 shows the mean TFR with a 95% confidence interval for various sample sizes. The bias and MSE decrease as sample size increases for both estimators. The confidence interval for BLY estimator is much wider than that of the DLB estimator with the same sample size. Initially, the confidence interval is much wider for small samples like 100, 200 but as sample size increase, the width gets narrower. But after increasing the sample size to a certain level, the reduction in confidence width is not reduced to a great extent. So, a sample of 700 can be used to estimate TFR with DLB method and with BLY method a minimum sample of 1000 or more is needed.

Table 8 shows the number of sample TFR having the difference from population TFR exceeding allowable error (5% and 10% of the population TFR) estimated using DLB and BLY methods. Fixing the allowable error as 5% of the population TFR, we observe that with a sample of size 1500, 9% (since 100 repetitions are done, these numbers also gives the percentage) sample TFR having difference more than 5% of the population TFR if DLB method is used, the same is 46% if BLY method is used. Fixing allowable error as 10% of the population TFR, there are only 5% such TFR are produced by DLB estimator for sample size 700. On the other hand, if the BLY estimator is used, a sample size of 1500 provides 13% TFR which exceed the margin of allowable error (TFR ± 10% of Population TFR). In the case of Maharashtra, fixing the allowable error at 10% of population TFR, 9% samples TFR exceed allowable range of error.

With BLY method, a sample of size 1500 gives 20% sample TFR which are having more than the allowable difference from population TFR. Similarly, for Kerala, only 8% sample TFR are having more than the allowable difference from population TFR when the sample size is 700 and this percentage reaches 0 as sample size increase to 1500 when DLB estimator has been used. On the other hand, with a sample of size 1500, still, 20% samples TFR exceed allowable difference from population TFR if the allowable error is fixed at 10% of population TFR. From the table, it is observed that a larger sample size is required for greater precision irrespective of the method of estimation. For same precision, BLY method requires a much larger sample as compared to the DLB method. A sample of size 700 can be used for fertility estimation with DLB method if the allowable error is fixed at 10% of population TFR.

Conclusion

In this paper, an attempt has been made to find the reasonable sample size to get the estimates of fertility using open-birth interval. For this purpose, data of NFHS-3 for states of Uttar Pradesh, Maharashtra and Kerala have been utilized. The NFHS-3 data for these populations are treated as population and values of TFR are treated as the parameters. Samples of different sizes have been repeatedly selected using simple random sampling procedure. Observing the behaviour of obtained from these samples it can be concluded that the distribution of TFR is normal. A sample of 700 is expected to provide an estimate of TFR if the date of last birth information is used for all the three states. A sample of size 1000 and above may be considered to provide the estimate of TFR if

information on births in last year only considered for Maharashtra and for Uttar Pradesh and Kerala it is 1200 and 1000 respectively.

References

Cochran, W. G. (1977). Sampling techniques-3.

Cusi, M. L. A. (2007). Estimation of the statistical distribution of the total fertility rate. *Papeles de Poblacin* 13(54).

Desu, M. M. (2012). Sample size methodology. *Elsevier*.

Feeney, G. (1983). Population dynamics based on birth intervals and parity progression. *Population Studies* 37(1): 75-89.

Feeney, G. and Ross, J. A. (1984). Analysing open birth interval distributions. *Population studies* 38(3): 473-478

Islam, M. M. and Yadava, R. (1997). On the estimation of parity progression ratio. Sankhyā: The Indian Journal of Statistics, *Series B* pp. 200-208

Lenth, R. V. (2001). Some practical guidelines for effective sample size determination. *The American Statistician*, 55(3), 187-193.

Pandey, A. (1985). A modified stochastic model to estimate fecundability and secondarysterility from the censored data on open birth interval. *In Proceeding of Indian Congress Association, University of Lucknow*, India.

Pathak, K. (1970). Observations on open birth interval and open status as indicators offertility changes. *Journal of Family Welfare* 16(3): 42-45.

Pathak, K. B. (1971). A stochastic model for the study of open birth interval: A cohort approach. Sankhyā: The Indian Journal of Statistics, Series B, 305-314.

Schmertmann, C. P. (1999). Fertility estimation from open birth-interval data. *Demography* 36(4): 505-519.

Schmertmann, C. P., & Caetano, A. J. (1999). Estimating parametric fertility models with open birth interval data. *Demographic Research*, 1.

Sharma, S. S. (2004). Determination of sample size for birth intervals, *Unpublished Thesis*, Banaras Hindu University

Sheps, M. C., Menken, J. A., Ridley, J. C. and Lingner, J. W.(1970). Truncation effect in closed and open birth interval data. *Journal of the American Statistical Association* 65(330): 678-693

Singh, S. and Yadava, R. (1977). On the distribution of open birth interval. *In International Seminar on Problems of Fertility Control in India, Annamalai University*, Annamalai Nagar.

Singh, S. N., Yadava, R. and Chakrabarty, K.(1982). A parity dependent model for openbirth interval. *Sankhyā: The Indian Journal of Statistics, Series B*, 212-218.

Srinivasan, K.(1966b).The open birth interval as an index of fertility. *Journal of Family Welfare* 13(2): 40-44

Srinivasan, K. (1972).Analytical models for two types of birth intervals with applicationsto Indian population. [sl: sn], 1972 (Trivandrum: St. Joseph's Press)

Srinivasan, K. (1980). Birth interval analysis in fertility surveys.

Srinivasan, K., Pathak, K. and Pandey, A. (1987). On estimating age specific fecundabilityand secondary sterility from the data on open and last closed birth intervals. *Sankhyā: The Indian Journal of Statistics, Series B*. 176-185.

Tanti, S. (2013). On the estimation of open birth interval. *Unpublished Thesis*, Banaras Hindu University

Yadava, R., Pandey, A. and Saxena, N. (1992). Estimation of parity progression ratiosfrom the truncated distribution of closed and open birth intervals. *Mathematical biosciences* 110(2): 181-190.

Table 1. Distribution of TFR Based on 1000 Subsamples of Size 500

	Standard Method (BLY)	Last- Birth Method (DLB)
NFHS TFR	2.7	-
Sample Size	500	500
Distribution		
Mean	2.5	2.4
Standard Deviation	0.37	0.19
Minimum	1.6	1.8
1st Quartile	2.3	2.3
Median	2.6	2.4
3rd Quartile	2.8	2.5
Maximum	3.8	2.9

Table 2. Mean and 95% confidence interval for TFR for various sample size for Kerala using DLB Method, population TFR= 1.97

n	TFR	95% Confidence Interval		Bias	MSE
		Lower	Upper		
100	2.02	1.27	2.76	0.042	0.144
200	1.98	1.44	2.57	0.029	0.084
300	1.99	1.57	2.40	0.005	0.045
400	1.99	1.63	2.34	0.013	0.033
500	1.99	1.67	2.31	0.012	0.027
600	2.00	1.74	2.27	0.026	0.019
700	1.92	1.78	2.24	0.034	0.015
900	1.97	1.74	2.20	-0.005	0.013
1000	1.98	1.77	2.19	0.002	0.011
1200	1.99	1.81	2.17	0.014	0.008
1500	1.98	1.85	2.11	0.001	0.004
2000	1.97	1.87	2.08	-0.003	0.003

Table 3. Mean and 95% confidence interval for TFR for various sample size for Kerala using BLY Method, population TFR= 1.85

n	TFR	95% Confidence Interval		Bias	MSE
		Lower	Upper		
100	1.86	0.36	3.36	0.007	0.579
200	1.89	0.73	3.05	0.038	0.349
300	1.85	1.01	2.69	-0.003	0.180
400	1.87	1.20	2.53	0.016	0.114
500	1.81	1.22	2.40	-0.043	0.091
600	1.93	1.41	2.44	0.074	0.074
700	1.92	1.40	2.45	0.072	0.076
900	1.83	1.40	2.26	-0.021	0.047
1000	1.85	1.46	2.24	-0.005	0.039
1200	1.84	1.51	2.17	-0.016	0.028
1500	1.86	1.59	2.13	0.010	0.019
2000	1.83	1.62	2.04	-0.024	0.012

Table 4. Mean and 95% confidence interval for TFR for various sample size for Maharashtra using DLB Method, the population TFR=1.906

n	Mean TFR	95% Confidence Interval		Bias	MSE
		Lower	Upper		
100	1.99	1.37	2.61	0.084	0.106
200	1.94	1.39	2.49	0.031	0.08
300	1.93	1.53	2.32	0.022	0.041
400	1.92	1.52	2.32	0.012	0.041
500	1.92	1.63	2.21	0.016	0.022
700	1.90	1.67	2.14	-0.004	0.014
900	1.90	1.69	2.11	-0.005	0.011
1000	1.91	1.73	2.13	0.019	0.011
1200	1.91	1.73	2.08	0.002	0.008
1500	1.90	1.73	2.08	-0.002	0.008

Table 5. Mean and 95% confidence interval for TFR for various sample size for Maharashtra using BLY method, population TFR=2.07

n	Mean TFR	95% Confidence Interval		Bias	MSE
		Lower	Upper		
100	2.12	0.57	3.67	0.051	0.619
200	2.08	0.97	3.19	0.01	0.317
300	2.07	1.24	2.91	0.004	0.179
400	2.09	1.30	2.87	0.015	0.160
500	2.05	1.46	2.64	-0.023	0.089
700	2.07	1.55	2.59	-0.001	0.070
900	2.08	1.65	2.51	0.010	0.047
1000	2.11	1.68	2.54	0.040	0.049
1200	2.08	1.70	2.46	0.010	0.037
1500	2.03	1.68	2.39	-0.037	0.033

Table 6. Mean and 95% confidence interval for TFR for various sample size for Uttar Pradesh using DLB Method, population TFR= 3.54

n	TFR	95% Confidence Interval		Bias	MSE
		Lower	Upper		
100	3.65	2.58	4.71	0.105	0.303
200	3.65	2.92	4.39	0.111	0.152
300	3.60	2.98	4.23	0.062	0.105
400	3.54	3.03	4.06	0.001	0.068
500	3.59	3.18	4.00	0.050	0.046
700	3.55	3.18	3.91	0.005	0.035
900	3.54	3.19	3.88	-0.005	0.031
1000	3.57	3.25	3.89	0.028	0.028
1200	3.56	3.25	3.86	0.018	0.024
1500	3.54	3.32	3.75	-0.002	0.012

Table 7. Mean and 95% confidence interval for TFR for various sample size for Uttar Pradesh using BLY Method, population TFR= 3.54

n	TFR	95 % Confidence Interval		Bias	MSE
		Lower	Upper		
100	3.64	1.59	5.70	0.104	1.102
200	3.60	2.18	5.03	0.064	0.529
300	3.55	2.37	4.72	0.008	0.356
400	3.56	2.49	4.63	0.020	0.294
500	3.49	2.57	4.41	-0.051	0.221
700	3.59	2.89	4.30	0.052	0.131
900	3.58	2.99	4.17	0.039	0.092
1000	3.55	2.94	4.17	0.014	0.098
1200	3.55	2.99	4.10	0.005	0.079
1500	3.57	3.12	4.02	0.026	0.053

Table 8. Number of Sample TFR exceeding the Allowable Error of 5% and 10% of Population TFR

n	Uttar Pradesh				Maharashtra				Kerala			
	Allowable Error				Allowable Error				Allowable Error			
	5%		10%		5%		10%		5%		10%	
	DLB	BLY	DLB	BLY	DLB	BLY	DLB	BLY	DLB	BLY	DLB	BLY
100	76	84	52	77	71	87	57	73	77	96	58	83
200	58	74	34	56	80	85	57	71	78	91	52	83
300	58	76	26	54	69	84	32	67	64	29	36	66
400	47	70	18	48	67	80	45	61	60	75	29	47
500	42	70	9	55	52	69	24	50	57	77	21	52
700	33	56	5	23	47	73	9	44	49	67	10	43
900	34	42	3	20	39	61	8	31	48	70	8	44
1000	27	61	2	27	41	67	7	36	40	67	7	36
1200	23	48	3	22	27	62	6	30	32	63	4	30
1500	9	46	0	13	30	61	3	20	13	53	0	20

Figure 1. Fertility Patterns of Uttar Pradesh, Maharashtra and Kerala

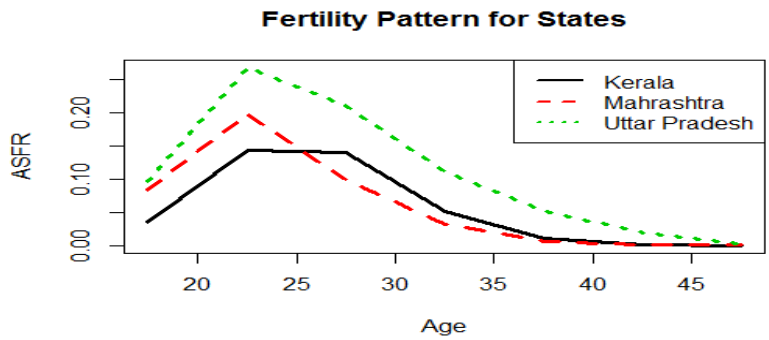

Figure 2.Empirical Distribution of TFR Estimated through BLY method

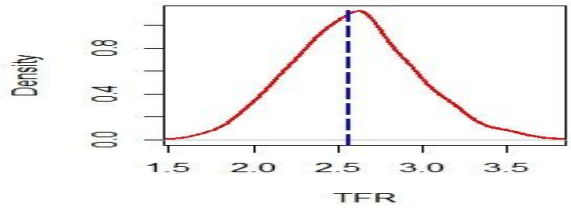

Figure 3.Empirical Distribution of TFR Estimated through DLB method

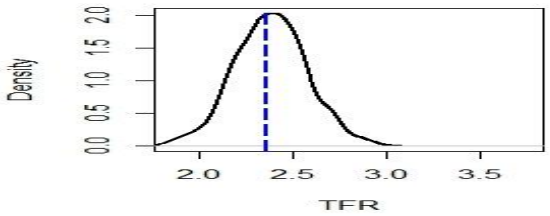

Figure 4.Mean and 95% Confidence Interval of both TFR Estimators for Kerala

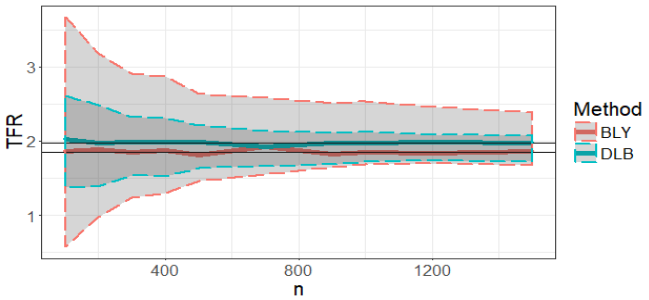

Figure 5.Mean and 95% Confidence Interval of both TFR Estimators for Maharashtra

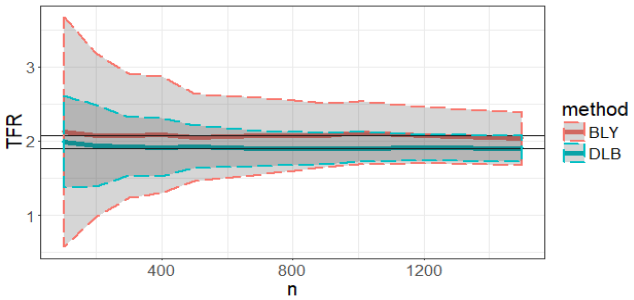

Figure 6.Mean and 95% Confidence Interval of both TFR Estimators for Uttar Pradesh