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Fertility Estimation of Jammu and Kashmir based on Birth Order Statistics

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ABSTRACT

Fertility is one of the vital determinants of population pattern and is also significant in resource planning and development. For small areas, fertility estimates are valuable to analyze demographic change and important for local planning and population projection. When data is sparse or lacking the indirect estimation methodologies of the Total fertility rate (TFR) have provided important techniques through which fertility estimates have been obtained. Using data from Sample Registration System (SRS) this paper gives the estimates of the Total Fertility Rate (TFR) by using the method of regression analysis in which two predictors are used. Two linear regression lines have been obtained between TFR and combined percentage of first and second order births to all births (PFSB) while other between TFR and weighted average of proportions of different birth orders. Both the regression models predict the dependent variable (TFR) significantly well and can be used for future estimation. Employing the method described in this paper gives the trends in fertility of Jammu and Kashmir for the period of 2004-2015. The observed as well as estimated TFR of Jammu and Kashmir shows a continuous decline and had reached below replacement mark (2.1 children per woman).

Keywords: Birth Order, Estimation, Fertility, Jammu and Kashmir, Regression Analysis.

I INTRODUCTION

Fertility is one of the vital determinants of population pattern and is also significant in resource planning and development. Fertility is affected by a complex set of socio-economic, political, biological, legal and psychological factors. Therefore, social scientists and researchers have developed, and calibrated theories of fertility suited to their disciplinary approaches. Fertility changes can be determined by studying measures of fertility such as Crude Birth Rate (CBR) and Total Fertility Rate (TFR) as well as by birth order distribution and age pattern of fertility. Better estimates of fertility can be obtained by examining the total fertility rate (TFR) because it is not affected by the age structure of the population. Generally, Fertility is the average number of children born to a woman during her complete reproductive period.

Fertility is the principal components of population dynamics that determine the size and structure of the population of a country [1]. For understanding, short-term shifts in population age structure and related growth dynamics estimates of population fertility characteristics are of critical importance [2-4]. In developing countries, there are no consistent reproducible methods for estimating trends in fertility rates based on different data sources that assess the uncertainty of the estimates. The literature on fertility estimation methods focuses on the development of indirect estimation techniques [5-9]. By reconciling information from recent fertility (in the last year or years) with lifetime fertility, these techniques deal with bias caused by recall lapse errors, omissions of births (especially soon after birth), and misinterpretation of the reference period in retrospective estimates of fertility rates. Recent fertility is adjusted rather than the full retrospective birth histories extending back 25 years [10-13]. Fertility estimation methods can often require substantial modeling effort and a clear understanding of how survey data is formulated [14–20], TFR estimates based on regression methods often require only the application of a set of coefficients to indicator variables [21-23]. Regression-based methods, such as the Bogue-Palmore procedure, rely upon the powerful least-squares criteria to predict TFR considering symptomatic indicators [21–26]. According to the classic idea of the age pattern of fertility, there are fundamental differences in patterns, by parity and hence age, between populations in natural and controlled fertility regimes: in natural fertility populations fertility declines slowly with age and starts to drop sharply only after age group (35-39) as the population of women who endure fecund reduces rapidly [27]. Indirect methods are generally used to estimate the total fertility rate (TFR) through the birth history and own-children method. The own-children method suggested by [28], contains reverse survival technique (15 years) for estimating age-specific fertility rate (ASFR) from a cross-sectional survey. Another indirect technique for estimation of TFR is proximate determinants model, which is a simple but resourceful method of measuring the relative effects of the proximate determinants of fertility in each population. [29-30].In Nigeria, Fertility was measured by using children ever born (CEB) and fitted into multi-factors additive Poisson regression models. Model with minimum deviance was designated and was used to predict CEB by the woman [31]. TFR of Bangladesh has been determined by using Bongarts model, estimating the four indices associated with this model which shows that TFR of Bangladesh for 2011 is very close to 2.1, which is the replacement level of fertility [32]. In this study estimation of TFR had been obtained by using the regression method.

As per the estimates of National Family Health Survey (NFHS) total fertility rate (TFR) of Jammu and Kashmir continuously goes on decreasing. The first phase of NFHS was not conducted in Kashmir division. NFHS-2 (1998-99) gives the estimate of total fertility rate as 2.7 (children per woman), NFHS-3 (2005-06) estimated the total fertility rate as 2.4 (children per woman) and NFHS-4 (2015-16) gives the current estimate of total fertility rate as

2.0 (children per woman) is below the replacement level [33]. Sample Registration System gives the latest report of fertility estimate which puts the Jammu and Kashmir much below replacement level as 1.6 children per woman in 2015.

II DATA AND METHODOLOGY

The secondary data for the present study has been taken from Sample Registration Systems (SRS). The combined percentage of the first and second order births and estimates of the total fertility rates from SRS has been used to obtain the relationship between the two. A regression equation has been developed by taking a combined percentage of first and second order births (PFSB) as an independent variable and total fertility rate as a dependent variable [34]. It can be symbolically represented as:

$$TFR = a + bx + e \text{ .... (1)}$$

Where a and b are constant and coefficients respectively, and "x" is the combined percentage of the first and second order births to all births.

Also in the present study another predictor variable, weighted average of proportions of different birth orders is used to obtain the estimate of TFR by using regression analysis [35]. This predictor can be mathematically written as:

$$X = P_1 + 2P_2 + 3P_3 + 4P_{4+}$$

where, P_1, P_2, P_3 and P_{4+} are the proportions of first, second, third, fourth and above order of births respectively. It can be symbolically written as:

$$TFR = a + bx + e \text{ .... (2)}$$

Where a and b are constant and coefficients respectively, and "x" is the proportion of different birth orders.

To prove that there is a significant relationship between dependent and independent variables, we set up a null hypothesis to the models described above:

H_0 : b =0 (i.e, slope =0) against

H_1: b≠0 (i.e, slope ≠0)

If we find that the slope of the regression line is significantly different from zero then we will conclude that there is a significant relationship between the dependent and independent variables.

The test statistic under H_0 is given by:

$$|t| = \frac{b}{s_b} \sim T\ (n-2)$$

The acceptance or rejection of the null hypothesis for corresponding degrees of freedom at 5% level of significance has been decided after comparing the calculated and tabulated values by using SPSS v.16.0

III ANALYSIS OF DATA FOR THE STATE OF JAMMU AND KASHMIR

Consider a linear regression equation to gratitude the distribution of total fertility rate (TFR) which is as follows:

$$TFR = a + bx + e$$

When the line of regression between TFR and the combined percentage of first and second order births to all births is drawn for the period of 2004-2015 of Jammu and Kashmir considering SRS data, its equation is found to be:

$$TFR = 4.728 - 0.038x \quad \ldots\ldots\ldots.. (3)$$

$$R^2 = 0.72$$

When the line of regression between TFR and weighted average of proportions of different birth orders is drawn for J&K from 2004 to 2015, its equation is found to be:

$$TFR = 0.6 + 0.071x \quad \ldots\ldots\ldots\ldots(4)$$

$$R^2 = 0.759$$

Here the value of R^2 is slightly better than that of previous one. The estimate of TFR by using the above equations is shown in Table 1.1.

IV RESULTS AND DISCUSSION

The observed and the estimated TFR with the help of regression equations by using the data of SRS is shown in table 1.1. It has been shown in table 1.2 that the linear regression analysis suggests that change in the percentage of the first and second order births explains 72% change (R^2 =0.72) in the total fertility rate while the value of R^2 (0.759) obtained by changing the weighted average of proportion of different birth orders represents 75% change is slightly higher than previous one shown in table 1.3. To check the model adequacy it is essential that the fitted regression model should satisfy the important tests.

For model (3)

Since p-value = 0.0004 < 0.05 = α (or $|t|$ = 5.06 > 2.22 = t_{crit}) we reject the null hypothesis, and conclude that the slope of regression coefficient (b) is different from zero (see table 1.4).

For model (4)

Since p-value = 0.0002 < 0.05 = α (or $|t|$ = 5.60 > 2.22 = t_{crit}) we reject the null hypothesis, and conclude that the slope of regression coefficient (b) is different from zero (see table 1.5).

Here for both models calculated value of |t| at 10 degrees of freedom is greater than the critical value at 5% level of significance so null hypothesis is rejected and we can say that there is a linear relationship between dependent and independent variables described in the regression model (3) and (4). Table 1.6 and 1.7 indicates that both the regression models predict the dependent variable significantly well. Here $P<0.05$ proves that the regression models statistically significantly predicts the Total Fertility Rate (TFR) (i.e., it is a good fit for the data).

Overall both the equations show the continuous decline of TFR of Jammu and Kashmir during the period 2004-2015 as shown by the observed TFR. It has been shown in Table 1.1 that TFR increases from 2.1 (children per woman) in 2004 to 2.3 (children per woman) in 2007 after it continuously declines from 2.2 (children per woman) in 2008 to 1.6 (children per woman) in 2015.

Fig. 2.1 shows the annual trend line of observed and estimated TFR of Jammu and Kashmir which shows the downward trend. The estimated values of TFR obtained from this study by using two predictors (combined percentage of first and second order births to all births and weighted average of proportions of different birth orders) also shows downward trend like observed estimates of TFR. The study shows that fertility of Jammu and Kashmir has been reached below replacement level (2.1 children per woman). As per the estimates given by SRS Jammu and Kashmir is the only Muslim state that has shown the remarkable results to stabilize the population. Except at birth, the state tops the country life expectancy at all ages and the fertility on the other hand continuously goes on decreasing. Due to low fertility, fewer children are born and with time large numbers of adults move into the older age groups. The inevitable consequences of low fertility are changes in the age structure of a population and population aging. In the long term, population ageing is not the only major outcome of determined low fertility. An old age structure provides the momentum for a decline in population, just as a young population provides the momentum for accelerated population growth [36]. Between the onset of fertility replacement and the beginning of zero natural increase, a typical population will tend to become greyer, its median age will rise, and elderly proportion will rise. Younger age-groups move up the age pyramid, the middle and older cohorts are expanded in particular and population-ageing is a direct consequence [37].

In J&K one of the main cause of fertility decline is late marriage, as per the report of SRS 2016 the mean age of fertility is 31.7years (Urban =31.7years and rural =31.6years). Much like developed countries the choice of having fewer children among educated women also contributed a lot to fertility reduction in J&K. According to the figures, the TFR of women with the education graduate and above is a mere 1.2, being second lowest in entire India [38]. Different explanations have been proposed by social scientists for the fall of fertility to below-replacement level (2.1 children per woman) or to lowest-low (1.3 children per woman) fertility levels. In many developed countries postponement of marriage and childbearing is one of the main factors pushing fertility to the lowest end [39-40]. There are three factors that affect the timing of fertility decisions: women's earning, men's earning and the proportion of women in the labor force. The demand for children increases with an increase in the husband's wages while wife's wages have the opposite effect, Increases in women's wages serve to lower fertility [41]. Some studies show that modernization and social development process radically to reduce fertility in developing countries [42].

V FIGURES AND TABLES

Table 1.1: Estimated total fertility rate using the two predictors for (J&K SRS data)

Year	Estimated TFR from		Observed TFR	%1&2 order births	Weighted mean
	%1&2 order births	Weighted mean			
2004	2.1	2.2	2.1	67.9	22.6
2005	2.3	2.1	2.2	63.1	22.5
2006	2.3	2.1	2.3	63.8	22.4
2007	2.2	2.2	2.3	66.1	22.7
2008	2.1	2	2.2	68.9	20.5
2009	2	1.9	2.2	70.2	19.8
2010	1.9	2	2	71.8	20.1
2011	2	1.9	1.9	70.9	19.4
2012	1.9	1.9	1.9	74.3	19.3
2013	1.8	2	1.9	75.0	20.4
2014	2	1.8	1.7	71.4	17
2015	1.6	1.5	1.6	81.4	12.9

Table 1.2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
3	0.848[a]	0.720	0.692	0.1278

a. Predictors: (Constant), PFSB

Table 1.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
4	0.871[a]	0.759	0.735	0.1185

a. Predictors: (Constant), weighted mean

Table 1.4: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
3	(Constant)	4.728	0.535		8.842	.000
	PFSB	-0.038	0.008	-0.848	-5.067	.000

a. Dependent Variable: TFR

Table 1.5: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
4	(Constant)	0.600	0.256		2.340	.041
	Weighted mean	0.071	0.013	0.871	5.609	.000

a. Dependent Variable: TFR

Table 1.6: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	0.419	1	0.419	25.671	.000[a]
	Residual	0.163	10	0.016		
	Total	0.582	11			

a. Predictors: (Constant), PFSB

b. Dependent Variable: TFR

Table 1.7: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
4	Regression	0.442	1	0.442	31.456	.000[a]
	Residual	0.141	10	0.014		
	Total	0.582	11			

a. Predictors: (Constant), weighted mean

b. Dependent Variable: TFR

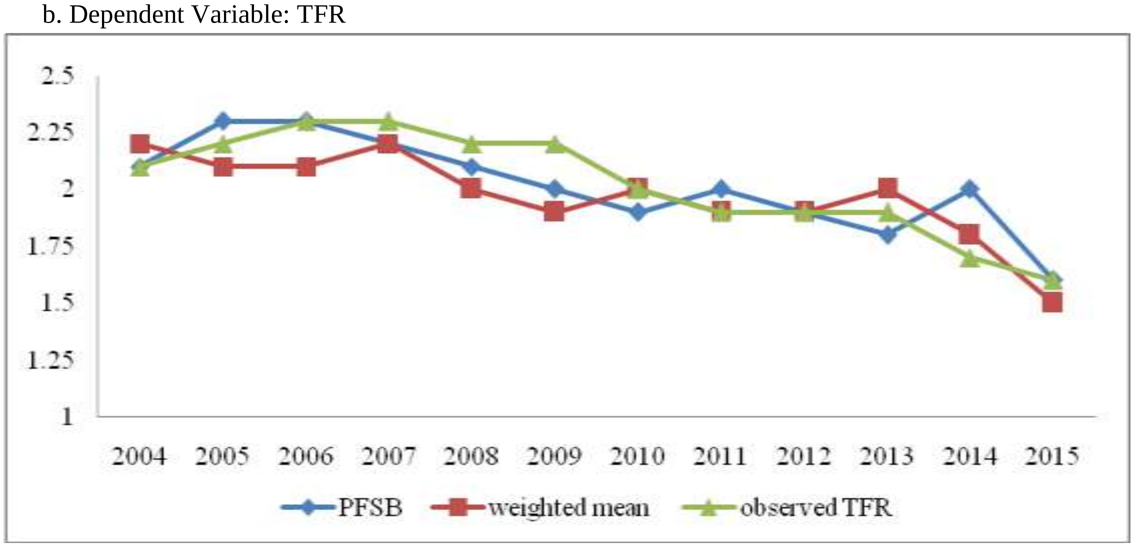

Fig. 2.1: Annual trend line of observed and estimated TFR

VI CONCLUSION

In the introduction, it has been explained that there are several methods of estimation of fertility. Some of them contain mortality factor and some are mathematical in nature with a higher number of parameters. It is difficult to estimate fertility by taking into consideration all these parameters. Thus the study concludes that all the above suggested predictors in both the regression equations seem to be capable of providing good estimates of TFR requiring fewer data. The study also shows that fertility of Jammu and Kashmir continuously goes on diminishing and had reached below replacement level.

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