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Research Note

RELATIONSHIP BETWEEN COALE'S METHOD AND REVERSE SURVIVAL METHOD-A CRITICAL COMPARISON

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Abstract

The relationship between Coale's method and Reverse Survival method has been investigated in this article. Since Coale's method produces estimates which are found to be approximately equal to that of reverse survival method, it is useful to determine a constant multiplier to make Coale's estimates equal to that of the reverse survival method. In this effort, the west model life tables have been used and the constant multipliers for males and females have been found. The male's and female's multipliers are 1.0054 and 1.0083 respectively. It is interesting to note that when the estimates based on Coale's method are known, the estimates based on the reverse survival method can be obtained for both the sexes by using the common multiplier 1.01.

I. INTRODUCTION

Coale's method is found to be useful in estimating fertility of people in developing countries. The estimates based on this method are approximately equal to that of the reverse survival method (Venkatacharya 1990). The author carried out two approximations to make the estimates equal to that of the reverse survival method, and found that the estimates based on the second approximations are equal to that of the reverse survival method (BR). Since the approximation process involves a lot of calculations, it would be relatively easier to obtain those estimates based on a multiplier, which are expected to be equal to that of the reverse survival method. In order to obtain a multiplier, an investigation on the relationship between these two methods has been carried out. The two methods are outlined below.

II. DATA REQUIREMENT

For the application of this method, BR is needed, but for the estimation of BR, $_{15}$*is* needed. However, BR and l_s are taken from another source (Ahmed, 1997). It may be pointed out that for the estimation of BR, P(15), proportions for males and females under 15 years of age and P65+, proportions over 65 years of age for males and females are also needed. These proportions are calculated from 1961, 1974, 1981 censuses and from the estimated and projected results. Further it may be pointed that P(15) has been found to be seriously affected by age reporting errors or completeness of coverage (The Committee on Population, 1981). The study also suggested that the adjustments for undercounts in population censuses of Bangladesh can not be regarded as accurate because of some matching problems (Bangladesh,

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1977) found between the census and the PEC households reported in the 1974 PEC (Post Enumeration Check) and also because 1961 PEC provided estimates an over count of 1.5 percent, while another study (Rabbani *et al.*, 1984) suggested an under count of 8.62 percent. However, the ratio between P65+ and P(15) is little affected by under-enumeration (Ahmed, 1997).

To estimate l_5 we need data on children ever born and children surviving, which are available at national level for 1974 from BRSFM, 1974 (BRSFM, 1977), for 1982 from the BBS Sample Registration System and 1991 census. For other years, l_5 needs to be estimated by the regression method using P (15) and P65+ from the censuses, sample surveys, etc.

The models

Coale's method

$b_c = b_s \exp[7.5(r - r_s)]$

Where:

b_c = the adjusted birth rate

b_s = the birth rate of the stable model located corresponding to P (15) and l_5

r = the rates of increase of the study population and these rates can be obtained from two consecutive censuses

r_s = the rates of increase of the selected stable populations

It is evident that in order to use Coale's method, we need the proportions of population of both sexes under the age of 15, P (15) and the probability of survival from birth to age 5, l_5 to match these with stable model. Since b_c is based on P (15) and l_5, the birth rates can be viewed as the form of reverse survival of population that provides birth rate estimates during the 15 years preceding the recent census (UN, 1983).

Reverse Survival method

$BR = P(15)/[{}_{15}L_0\ (t - 7.5)\exp(-7.5r)]$

$= P(15)\exp(7.5r) / {}_{15}L_0$,

where ${}_{15}L_0\ (t - 7.5)$ = the person years lived under 15 years of age in a life table whose value corresponds to l_5 and t represents the time of the recent census

The method becomes

$BR = P(15)\exp(7.5r) / {}_{15}L_0$

where l_0 is taken as unity and (t-7.5) for ${}_{15}L_0$ is ignored.

${}_{15}L_0 = u + vl_5 = 0.365 + 14.599l_5$ (Venkatacharya, 1990)

The above equation becomes

${}_{15}L_0 = u + v\{a + b(P65+/P(15)) + c(P65+/P(15))^2\}$, (Ahmed, 1997)

where $l_5 = a + b(P65+/P(15)) + c(P65+/P(15))^2$

Where:

a, b and c are constants

P65+/P(15) = ratio of the proportions in the west model stable populations

The equation for l_5 has been proposed by Ahmed (1997). He investigated the relationship between l_5 and P(15) and l_5 and P65+ in the west model life tables (Coale and Demeny, 1966) and found that the former ones are strongly negatively correlated (r = -0.9703). But the later ones are strongly positively correlated (r = 0.974). Then the relationship between l_5 and P65+/P(15) was established.

The equation has been worked for five r values and found that R^2 varies from 0.995 to 1.00 and RMS is zero in all cases.

III. RESULTS AND DISCUSSIIN

The relationship between Coale's method and Reverse Survival

The relationship between Coale's method and Reverse Survival method can be expressed as:

$$b_c = BR\left[\frac{b_s}{P(15)}\exp(-7.5r_s)_{15}L_0\right]$$

$$= BR\left[\frac{b_s}{P(15)}\exp(-7.5r_s)\,(u + vl_5)\right]$$

$$= \mathbf{BR \times y} \qquad [3.1]$$

Where:

$$y = \frac{b_s}{P(15)}\exp(-7.5r_s)\,(u + vl_5)$$

Formulas for ${}_{15}L_0$ and l_5 are shown in section 3.2.

However, y can be expressed with reference to the levels of West Stable Population Model as:

$$y = a + bL + cL^2 \qquad [3.2]$$

where *a, b and c are constants*

L=levels of the West Population Model Life tables

Finally the equation [3.1] can be expressed as

$$b_c = BR \times (a + bL + cL^2) \qquad [3.3]$$

The coefficients of the above equation [3.2] vary according to r in the west model life tables. The coefficients for males and females have been found out for four r(r=0.015, r= 0.02, r = 0.025, r = 0.03) and the results are presented below in Table 1. The values of the coefficients are calculated for various values of r corresponding to various years through interpolation for males and females separately. The results are shown below in Table 1.

Table 1. West Model Life Table

	Males			
	r values			
Constants	0.015	0.020	0.025	0.030
a	0.878734	0.979739	0.973977	0.969414
b	0.001560	0.001878	0.002266	0.002276
c	-0.000047	-0.000053	-0.000065	-0.000058
r-sqr	0.952726	0.965352	0.990741	0.974621
rms	0.0000008	0.0000011	0.0000004	0.0000015
	Females			
	r values			
Constants	0.015	0.02	0.025	0.03
a	0.986303	0.981318	0.976447	0.970658
b	0.001370	0.001740	0.002120	0.002320
c	-0.000043	-0.000051	-0.000064	-0.000064
r-sqr	0.918000	0.969000	0.976000	0.979000
rms	0.0000010	0.0000007	0.0000007	0.0000011

Applications

In order to apply the equation [3.2], we need the levels to be estimated and this is done through interpolation corresponding to l_5. The estimation has been covered for the period from 1961 – 2000. The estimated values of l_1 for both males and females are shown in the Table 2. How l_5 values are estimated provided in the formula section. In this article l_5 values are taken from another research paper (Ahmed, 1997).

For the estimation of birth rates only the constants are used and these are estimated corresponding to the observed r values. The r values are calculated from the census results, the BBS sample registration results and the BBS projected values. These values are taken from another research paper (Ahmed, 1997) and they are shown in the Appendix (Table A1 and Table A2).

Table 2. Estimated levels corresponding to l_5, Bangladesh, 1961-2000

	Males		Females	
Years	l_5	Levels	l_5	Levels
1961	0.7306	10.24	0.6943	7.84
1974	0.7498	10.99	0.7355	9.45
1981	0.9099	18.56	0.8334	13.70
1985	0.8908	17.50	0.7784	11.20
1987	0.8250	14.16	0.7445	9.79
1990	0.8758	16.69	0.8096	12.60
2000	0.8589	15.81	0.8084	12.55

Data source of l_5: Ahmed, (1997)

In the equation [3.3], b_c for males and females are calculated and shown in Tables 3 and 4. The estimating equation [3.3] needs BR for b_c to be estimated. The BR values are taken from another research paper (Ahmed, 1997). The formula for the estimation of BR is given in section 3.2. The y values are found to be less than one, indicating that the birth rates based on Coale method are slightly less than the BR estimates. But when BR is known, it is possible to estimate b_c. In this respect, the median of y values are used as the multipliers. The male and female multipliers are found to be 0.9947 and 0.9918 respectively. BR is obtained by dividing the b_c values by the median multipliers, which are 1.0054 and 1.0083 for males and females respectively. The same procedure has been used for both males and females. The median based estimates of BR values are found to be equal to the previous estimates. The median based estimated values and approximate values of b_c and BR are shown in Tables 3 and 4.

Table 3. Calculations of male birth rates, Bangladesh, 1961-2000, based on the regression, median and the approximate value

Male birth rates							
			Estimated values			Approximate values	
Years	y	BR	b_c =BR* y	b'_c =BR* y_m	BR= b'_c *1/y_m	BR= b'_c *1.01	b''_c = BR*0.99
1961	0.99187	45.3	44.9	45.1	45.3	45.5	44.8
1974	0.99118	46.2	45.8	46.0	46.2	46.4	45.7
1981	0.99473	39.8	39.6	39.6	39.8	40.0	39.4
1985	0.99500	39.6	39.4	39.4	39.6	39.8	39.2
1987	0.99466	40.9	40.7	40.7	40.9	41.1	40.5
1990	0.99457	35.4	35.2	35.2	35.4	35.6	35.0
2000	0.99631	31.3	31.2	31.1	31.3	31.4	31.0
Median	0.9947						
1/Median	1.0054						

b'_c = estimates based on median of y values
b''_c =estimates based on approximated median of y values
y =values estimated by the regression method
y_m= median value of y values
/ indicates division
* indicates multiplication

Table 4. Calculations of female birth rates, Bangladesh, 1961-2000, based on the regression, median and the approximate values of b_c and BR.

Female birth rates							
				Estimated values		Approximate values	
Years	y	BR	b_c =BR* y	b'_c =BR* y_m	BR= b'_c *1/y_m	BR= b'_c *1.01	b''_c = BR*0.99
1961	0.9918	54.2	53.8	53.8	54.2	54.3	53.7
1974	0.9900	52.2	51.7	51.8	52.2	52.2	51.7
1981	0.9911	48.8	48.4	48.4	48.8	48.8	48.3
1985	0.9926	49.3	48.9	48.9	49.3	49.4	48.8
1987	0.9911	50.6	50.1	50.2	50.6	50.6	50.1
1990	0.9934	42.3	42.0	42.0	42.3	42.4	41.9
2000	0.9947	36.6	36.4	36.3	36.6	36.8	36.2
Median	0.9918						
1/median	1.0083						

b'_c = estimates based on median of y values
b''_c = estimates based on approximated median of y values
y = values estimated by the regression method
y_m = median value of y values
/ indicates division
* indicates multiplication

Note that when the median multipliers are considered up to 2 decimal places, both of them becomes the same which is 1.01.The BR values are also estimated again using the common multiplier and the results are found to be consistent (Table 3 and Table 4).

The approximated values of BR and b_c are found to be consistent.

CONCLUSION

The application of the above technique suggests that b_c based estimates of birth rates are approximately equal to BR. But it is possible to derive estimates of birth rates based on Coale model which becomes equal to BR using the approximation method, which method is found to involve a lot of calculations. In order to avoid this, the present method is found to be useful. Another point to note is that consistent estimates of male and female birth rates are possible to obtain by using the same multiplier.

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Appendix

Table A1. Estimated values of constants corresponding to r (Males), Bangladesh, 1961-2000

Years	r	a	b	c
1961	0.018	0.93934	0.00175	-0.00005
1974	0.026	0.97306	0.00227	-0.00006
1981	0.027	0.97215	0.00227	-O.OOOOG
1985	0.026	0.97306	0.00227	-0.00006
1987	0.022	0.97743	0.00203	-0.00006
1990	0.024	0.97513	0.00219	-0.00006
2000	0.021	0.97859	0.00196	-0.00005

Table A2. Estimated values of constants corresponding to r (Females), Bangladesh, 1961-200

Years	r	a	b	c
1961	0.02	0.981318	0.001740	-0.000051
1974	0.026	0.975289	0.002160	-0.000064
1981	0.029	0.971816	0.002280	-0.000064
1985	0.024	0.977421	0.002044	-0.000062
1987	0.025	0.976447	0.002120	-0.000064
1990	0.024	0.977421	0.002044	-0.000062
2000	0.021	0.980344	0.001816	-0.000054