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Estimation of Cohort Nuptiality from Data at Two Successive Censuses—Application of Coale's Model to Indian Data

Introduction

THIS paper describes a longitudinal approach to the study of cohort nuptiality behaviour. An attempt has been made to discern the nuptiality pattern of cohorts from the cross-sectional data on marital status in order to see whether or not cohort nuptiality is changing. The data from two successive censuses have been utilized to examine the nuptiality behaviour of cohorts. The reported nuptiality experience of cohorts is completed using the uniformity in the age pattern of proportions ever-married observed elsewhere by Ansley Coale, three parameters of the model a_0, K and C and by the utilization of computer program EMPROPS developed specially for the purpose.

Coale's observation of uniformities in the age patterns of marriage introduces an important approach to summarizing age schedules of proportion ever-married in different populations. He has found that the first marriage frequencies observed in number of diverse societies conform to a curve of common shape after proper rescaling. An examination of different curves of the ever-married proportion suggested that curves were similar in shape differing only in the age at which marriage begins, the duration of the age span within which the marriages occur, and the ultimate proportion ever-married reached in the population.

Three parameters a_0, K and C together with the standard nuptiality schedule are sufficient to fit observed patterns. The parameters can be explained as: a_0 the lowest age at which a noticeable proportion in the population (more precisely in a cohort) enter into first marriage; K, the tempo at which the marriages takes place relative to standard pattern and C, which is the ultimate ever-married proportion reached in the population. The values of a_0 and K relate the observed time schedule of first marriages to the time schedule used in defining the standard pattern; and with a specification of these values, the marriage exprience of any cohort can be represented. The classical indices characterizing nuptiality schedules such as the mean age at marriage yield rather unsatisfactory results since they do not allow for the specification of the age at which nuptiality starts nor for the tempo at which the nuptiality schedule proceeds. Therefore, Coale's parameter a_0 and especially K are indispensable in the study of different patterns of nuptiality transition.

The method as proposed by Coale for estimating the nuptiality parameters is based on two sets of ratios which can be utilized for obtaining values of a_0, K and C of an actual cohort. The problem arises when data are not available for an actual cohort. Then the option is to utilize the census data on the assumption that census represents the experience of an actual cohort. The standard schedule which represents the common pattern of nuptiality underlines the assumption that the cohort is not subject to mortality and migration. While the assumptions regarding mortality and migration may not be so strong, the assumption that census data represents experience of an actual cohort may seriously affect the results. It is for this reason that an attempt has been made in this study to provide a possible solution. The data on marital distribution from two successive censuses are taken for cohorts whose first marriages had already begun and a methodology has been proposed to complete the nuptiality experience of these incomplete cohorts.

Data and Methodology

The methodology used here is based on identifying the exact combination of a_0 and K for cohort that would yield the observed values of ever-married proportions. If the values of a_0 and K appropriate for each cohort are determined using an iteration process which has been explained elsewhere then other marriage indices can be easily estimated using the standard schedule. In this work, the nuptiality parameters of two most recent cohorts have been computed and changes in cohort nuptiality have been examined The two cohorts, which have been taken for study are described thereafter. The proportion of ever-married in the age group 10-14 at first census and the same proportion in age group 20-24 at the later census held after ten years pertain to same cohort. This cohort has been designated as cohort no. 1, which is the most recent or the youngest cohort

TABLE 1—COHORT NUPTIALITY INDICES FOR FEMALES IN DIFFERENT STATES AND AREAS COMPUTED THROUGH THE PROPOSED TECHNIQUE FOR TOTAL INDIA

States / Areas	Cohort No. 2 (Elder Cohort)			Cohort No. 2 (Younger Cohort)		
	a_0	K	SMAM	a_0	K	SMAM
1. India States	8.8	0.623	15.85	8.8	0.656	16.21
2. Kcrala	12.0	0.738	20.40	12.0	0.821	21.00
3. Tamilnadu	12.5	0.523	18.45	12.0	0.607	18.80
4. Assam	10.4	0.645	17.75	11.2	0.655	18.65
5. Mysore	9.1	0.627	16.22	9.8	0.636	17.06
6. West Bengal	7.1	0.682	14.85	8.5	0.725	16.73
7. Jammu & Kashmir	9.4	0.561	15.80	10.1	0.582	16.66
8. Maharashtra	7.8	0.658	15.31	8.9	0.657	16.36
9. Orissa	9.8	0.555	16.13	10.9	0.483	16.35
10. Andhra Pradesh	8.4	0.548	14.64	9.0	0.554	15.30
11. Uttar Pradesh	7.3	0.581	13.94	8.0	0.572	14.51
12. Bihar	7.9	0.500	13.59	8.3	0.510	14.31
13. Rajasthan	80	0.515	13.86	8.5	0.498	14.16
14. Madhya Pradesh	7.3	0.470	12.64	8.3	0.510	14.07
15. Pondicherry	11.0	0.623	18.09	11.5	0.646	18.85
16. Tripura	8.4	0.658	15.84	9.7	0.690	17.54
17. Himachal Pradesh	8.4	0.564	14.81	9.6	0.594	16.35

as regards to experience of first marriages. The second cohort, which has been designated as cohort No. 2, corresponds to the persons belonging to age group 15-19 at the first census and 25-29 at the next census held after a decade.

To locate the appropriate values of a_0 and K for any cohort, a series of age-schedules of ever-married proportion were generated from the standard. For the purpose of generating age-schedules of ever-married proportion from the standard, the range of a_0 and K is determined on the basis of country or region for which analysis is made. In the present study in which input data are taken from Indian censuses, values for a_0 vary from 5 to 14 each time increased by 1 year. For each family of a_0 an age-schedule of proportion ever-married was computed with values of K varying from 0.3 to 1,2. The value of K was increased by 0.1 each time, until the maximum value of 1.2 was attained. So, in each family of a_0, 10 age-schedules of ever-married proportion were computed from the standard. In all, 10 families of a_0, each consisting of 10 age schedules of ever-married proportion were generated. An examination of the series of age schedules of ever-married proportion generated, indicates that with an increase in the values of a_0 and K, the value of ever-married proportion decreases. But, for a fixed value of ever-married proportion, an increase in a_0 corresponds to decrease in the value of K, Thus, standard pattern follows an inverse relationship between the values of a_0 and K for a fixed value of ever-married proportion in a particular age group. This relationship has been utilised in finding the exact combination of a_0 and for a particular case.

Now, we want to estimate a_0 and K for cohort No. 1 and cohort No. 2, from the census data on ever-married proportion available from two censuses. First, we take cohort No. 1 for estimating the values of a_0 and K. Suppose, we have P_1 which the value of ever-married proportion in the age group 10-14 and P_2 in the age group 20-24 from two censuses. The iteration is made with these two values P_1 and P_2 in the generated standard schedule. For each value of a_0, two appropriate values of K, one corresponding to P_1 and other corresponding to P_2 are obtained. These values are plotted on a graph (See graph No \b) with a_0 on horizontal and K on vertical axis. If the difference between these two values of K is zero for a particular value of a_0, then this combination of a_0 and K will be the values which we are looking for. This will be the situation when K is identical for both the inputs P_1 and P_2 as for any cohort the value of K is unique. The process of locating a_0 and K can be seen very clearly by plotting iterated values of K on graph. We find an intersection of two lines, and this intersection point is the exact location where the two iterated values of K are identical for a particular value of a_0. The values of a_0 and K can be read directly from the graph and an age-schedule of ever-married proportion compared from these values of a_0 and K will yield the same values of ever-married proportion with which iteration was done. The age-schedule of ever-married proportion thus computed, has been plotted on graph l(*a*), which shows that nuptiality curve passes exactly through the two inputs and yields the appropriate values of a_0 and K. To simplify this exercise, a computer program EMPROPS was developed to identify the exact values of the combination of a_0 with K. The only input data are the

TABLE 2—COHORT NUPTIALITY INDICES FOR FEMALES IN DIFFERENT STATES AND AREAS COMPUTED THROUGH THE PROPOSED TECHNIQUE FOR RURAL INDIA

States/Areas	Cohort No. 2 (Eider Cohort)			Cohort No. 1 (Younger Cohort)		
	a_0	K	SMAM	a_0	K	SMAM
1. India	8.5	0.600	15.30	8.9	0.588	15.59
States						
2. Kerala	12.0	0.722	20.24	12.0	0.809	20.92
3. Tamil Nadu	12.5	0.510	18.30	12.0	0.569	18.37
4. Assam	10.6	0.625	17.67	11.2	0.639	18.47
5. Mysore	9.1	0.576	15.66	10.1	0.552	16.35
6. West Bengal	7.1	0.552	13.38	8.7	0.612	15.67
7. Jammu & Kashmir	8.9	0.551	15.23	9.3	0.590	16.01
8. Maharashtra	7.5	0.572	13.97	8.6	0.571	15.09
9. Orissa	9.8	0.553	16.11	10.8	0.476	16.27
10. Andhra Fradesb	8.3	0.520	14.24	8.9	0.519	14.81
11. Uttar Pradesh	7.5	0.520	13.47	8.1	0.518	13.99
12. Bihar	7.6	0.505	13.34	8.5	0.489	14.13
13. Rajasthan	7.6	0.520	13.50	8.2	0.497	13.85
14. Madhya Pradesh	7.0	0.416	11.73	8.4	0.456	13.63
15. Pondicherry	11.8	0.509	17.55	12.2	0.508	17.99
16. Tripura	8.5	0.612	15.49	9.8	0.629	17.04
17. Himachal Pradesh	8.3	0.551	14.57	9.7	0.551	16.06

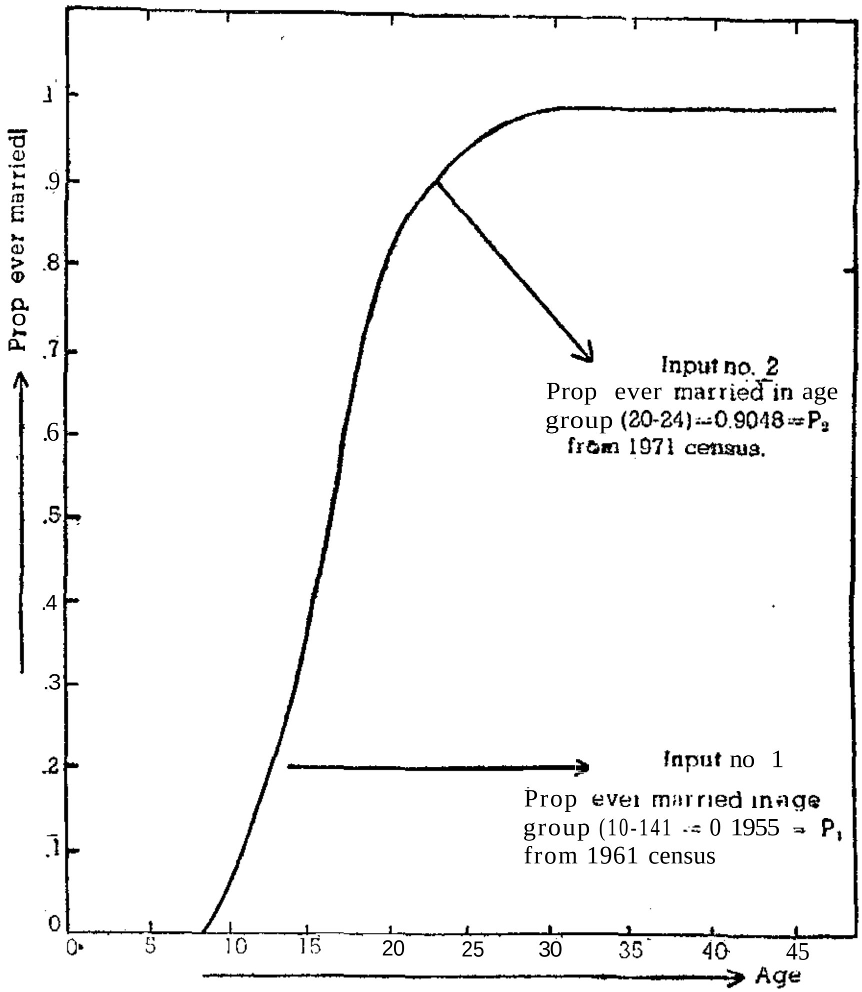
values of ever-married proportion in the relevant age groups from two successive censuses. This methodology has been applied to Indian data from 1961 and 1971 censuses and nuptiality parameters were computed for various states and areas. This was again computed for rural and urban areas separately.

TABLE 3—COHORT NUPTIALITY INDICES FOR FEMALES IN DIFFERENT STATES AND AREAS COMPUTED THROUGH THE PROPOSED TECHNIQUE FOR URBAN INDIA

States/Areas	*Cohort No. 2 (Elder Cohort)*			*Cohort No. 1 (Younger Cohort)*		
	a_0	*K*	*SMAM*	a_0	*K*	*SMAM*
1. **India**	10.5	3.651	17.98	10.1	0.784	18.59
States						
2. **Kerala**	12.0	0.799	21.19	12.0	0.862	21.80
3. Tamil Nadu	12.1	0.592	18.79	12.2	0.657	19.67
4, **Assam**	10.7	0.712	18.8	11.8	0.732	20.14
5. Mysore	9.9	0.705	17.96	10.4	0.757	18.97
6. **West Bengal**	10.1	0.785	19.01	10.3	0:828	19.72
7. **Jammu** & Kashmir	10.0	0.698	17.94	10.5	0.758	19.12
8. **Maharashtra**	10,4	0.690	18.25	10.3	0.763	18.96
9. **Orissa**	9.8	0.576	16.39	11.0	0.554	17.30
10. **Andhra** Pradesh	9.1	0.627	16.22	10.0	0.631	17.17
11. Uttar Pradesh	10.4	0.605	17.24	10.0	0.681	17.57
12. Bihar	9.1	0.584	15.17	9.2	0.609	16.09
13. **Rajasthan**	8.6	0.583	15.18	8.9	0.602	15.80
14. Madhya Pradesh	9.0	0.579	15.58	9.4	0.633	16.62
15. Pondichetry	11.1	0.742	19.50	11.9	0.702	19.92
16. Tripura	10.1	0.807	19.22	10.2	0.956	21.09
17. **Himachal** Pradesh	11.2	0.654	1S.66	11.5	0.747	19.96

Analysis of Results

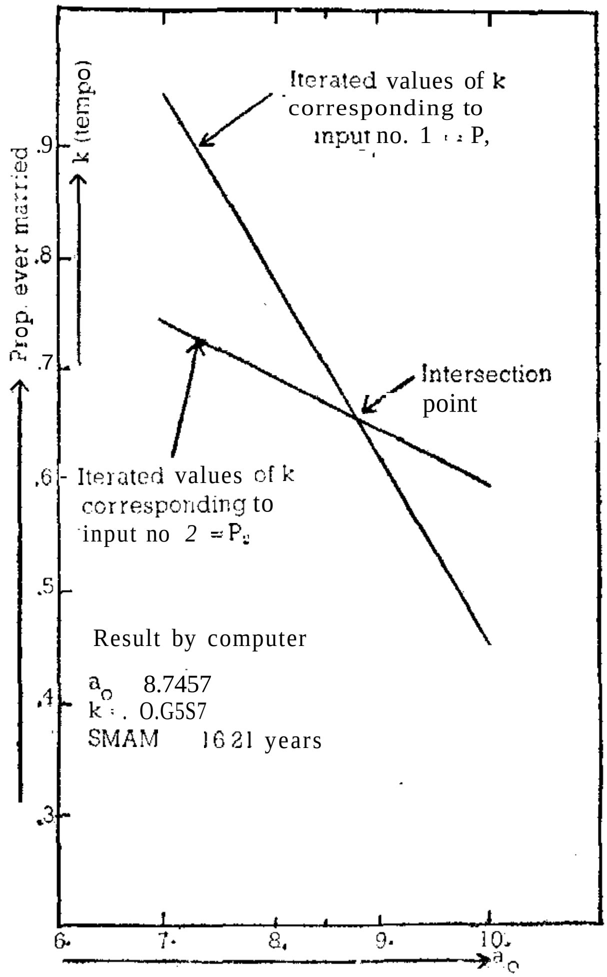
An overall observation of the results obtained gives a clear indication that cohort nuptiality behaviour is changing and the cohort mean age at marriage



Graph 1(*a*).

is rising all over the country. Though, the increase in cohort SMAM is not very significant in some areas, the trend is remarkable. The **marriage** pattern among different regions are quite diverse. The rural-urban patterns show a varied picture of widening and bridging in the rural-urban gap.

For the country as a whole the cohort mean age at marriage has increased from 15.85 years to 16.21 years, with an early entry into marital union (a_0) of 8.75 years **remaining** unchanged and the tempo of moving into such unions (*K*) rising from 0.6234 to 0.6567, relative to the standard pattern. The mean age at marriage for rural females shows an improvement from 15.3 years to 15.6



Graph *l(b)*.

years. The parameters a_0 moves from 8.5 years to 8.9 years and the tempo *K* falls from 0.6 to 0.588. The results for urban females indicate that the cohort mean age at marriage has risen from 18 years to 18.6 years, producing an increase of 0.6 years which is twice the increase among rural females. In this case, a_0 moves from 10.1 years to 10.5 years and *K* from 0.6571 to 0.7477.

The nuptiality differentials between states indicate a diverse pattern. Among the four centrally located states of the country—Uttar Pradesh, Bihar, Rajasthan and Madhya Pradesh, the nuptiality pattern seems to be quite homogenous with an early onset (a_0) and a rapid tempo (K) of moving into marital unions. The state of Andhra Pradesh exhibits to some extent a similar trend. The state of Maharashtra, West Bengal and Himachal Pradesh though entering early in marital unions have a comparatively slow *tempo*. Kerala is an interesting example with its late entry and quite a slow tempo, when both a_0 and K characteristics are combined, it exhibits the highest cohort SMAM. The nuptiality pattern among the rural areas are more or less similar to those seen for the total figure of the country. The variations seem to be an even earlier onset and more rapid tempo of moving into the marital unions. But, the nuptiality trend in urban areas indicate a quite different situation. It is observed that there is a general tendency of late entry and slow tempo of moving into nuptial unions. It is quite interesting to find that urban areas of all the states have cohort SMAM above 15 years, a feature which is not seen in the rural areas.

The figures obtained for cohort SMAM indicate the highest estimate in the case of Kerala and the lowest for Madhya Pradesh. The state of Maharashtra in the west, Jammu and Kashmir and Himachal Pradesh in the north; Assam, West Bengal, Orissa and Tripura in the east; all the southern states Kerala, Tamil Nadu, Mysore, Pondicherry barring Andhra Pradesh have higher cohort SMAM than the national average. The four centrally located states: Uttar Pradesh, Bihar, Rajasthan and Madhya Pradesh have lower cohort SMAM than the national average. There has been a general increase in cohort SMAM by 0.5 years and above among the various states, barring few. In rural-urban sectors, the urban cohort SMAMs are significantly higher than the rural cohort SMAMs.

Validity of Methodology and Reliability of Estimates

Estimates of SMAM were also computed through Hajnal's and Agarwala's method to test the validity and reliability of our estimates. An analysis of results obtained from the three techniques suggest that there is a certain ordering among the estimates, as noted below :

(1) The estimates of Agarwala's SMAM tend to be higher than the 1971 Hajnal's estimate of SMAM (see Table 4).
(2) The 1971 Hajnal's estimate tend to be higher than the estimates obtained for cohort no. 1.
(3) The estimates for cohort no. 1 tend to be higher than the 1961 Hajnal's estimates.
(4) The 1961 Hajnal's estimates tend to be higher than the estimates obtained for cohort no. 2.

To understand the relationship among the estimates, a simulation exercise was done in which, six cases were examined with rising age at marriage over

TABLE 4— SMAMs COMPUTED FOR DIFFERENT STATES AND AREAS (TOTAL INDIA) BY APPLYING THREE TECHNIQUES

States/Areas	*SMAMs Computed by the Three Methods*				
	1961-71 (Agarwala's)	*1971 (Hajnal's)*	*Cohort No. 1 (Proposed technique)*	*1961 (Hajnal's)*	*Cohort No. 3 (Proposed technique)*
1. **India**	17.27	17.17	16.21	15.85	15.85
States					
2. Kerala	21.00	21.00	21.00	19.98	20.40
3. Tamil Nadu	19.60	19.58	18.80	18.32	18.45
4. Assam	18.88	18.78	18,65	18.53	17.75
5. West Bengal	18.13	17.92	17.06	15.88	16.22
6. Mysore	17.95	17.81	16.73	16.33	14.85
7. Jammu & Kashmir	17.96	17.76	16.66	16.01	15.80
8. Maharashtra	17.67	17.55	16.36	15.74	15.31
9. Orissa	17.41	17.31	16.35	16.35	16.13
10. Andhra Pradesh	16.31	16.23	15.30	15.13	14.64
11. Uttar Pradesh	15.46	15.45	14.51	14.43	13.94
12. Bihar	15.40	15.29	14.31	14.23	13.59
13. Rajasthan	15.14	15.09	14.16	14.22	13.86
14. Madhya Pradesh	15.03	15.00	14.07	13.88	12.64
15. Pondicherry	19.35	19.34	18.85	17.98	18.09
16. Tripura	18.34	18.34	17.54	16.22	15.84
17. Himachal Pradesh	17.91	17.67	16.35	15.56	14.81

time but each case with a different nuptiality change. Each case consists of ten cohorts. The oldest cohort belong to persons born during the period 1911-15, and the youngest to persons born during 1956-61. In each case, the value of a_0

for the oldest cohort was set as 6 years, and then, increased 1 year every decade. The value of K was computed when mean age at marriage and a_0 were set for each cohort. The inputs are summarised in Table 5. For each case, ever-married

TABLE 5—INPUTS FOR SIMULATION UNDER VARYING CONDITIONS OP RISE IN MARRIAGE AGE

Cohorts	*Case (i)*			*Case (ii)*			Cose (*iii*)		
	SMAM	a_0	*k*	*SMAM*	a_0	*k*	*SMAM*	a_0	*k*
1.	14.0	6	0.7036	14.0	6	0.7036	15.0	6	0.7916
2.	14.5	6	0.7476	14.2	6	0.7212	15.0	6	0.7916
3.	15.0	7	0.7036	14.4	7	0.6508	15.0	7	0.7036
4.	15.5	7	0.7476	14.6	7	0.6684	15.0	7	0.7036
5.	16.0	8	0.7036	14.8	8	0.59SI	15.0	8	0.6157
6.	16.5	8	0.7476	15.0	8	0.6157	15.0	8	0.6157
7.	17.0	9	0.7036	15.2	9	0,5453	15.0	9	0.5277
8.	17.5	9	0.7476	15.4	9	0.5629	15.0	9	0.5277
9.	18.0	10	0.7036	15.6	10	0.4925	15.0	10	0.4398
10.	18.5	10	0.7476	15.8	10	0.5101	15.0	10	0.4398

Cohorts	*Case (iv)*			*Case (v)*			*Case (vi)*		
	SMAM	a_0	*k*	*SMAM*	a_0	*k*	*SMAM*	a_0	*k*
\.	11.0	6	0.4398	10.5	6	0.3958	10.55	6	0,4002
2.	12.0	6	0.5277	11.5	6	0.4837	11.69	6	0.5004
3.	13.0	7	0:5277	12.0	7	0.4398	12.69	7	0.5004
4.	14.0	7	0.6157	12.5	7	0.4837	13.83	7	0.600?
5.	15.0	8	0.6157	13.5	8	0.4837	14.83	8	0.6007
6.	16.0	8	0.7036	14.0	8	0.5277	15.97	8	0.7009
7.	17.0	9	0.7036	14.5	9	0.4837	16,97	9	0.7009
8.	18.0	9	0.7916	15.5	9	0.5717	18.10	9	0.8004
9.	19.0	10	0.7916	16.0	10	0.5277	19.10	10	0.8004
10.	20.0	10	0.8795	16.5	10	0.5717	20.24	10	0.9006

proportions in different age groups were computed for all the ten cohorts from the standard schedule. Hajnal's and Agarwala's estimates for SMAM were then computed from the complement of ever-married proportion for the two census dates (1961 and 1971) and for the intercensal period, respectively. The SMAM*s are tabulated in Table 6 and Case no. (1) has been illustrated through Fig, 1.

TABLE 6—RESULTS FROM SIMULATION EXERCISE AND INPUT COHORT SMAMs

	Cohorts	*Case* (i)	*Case (ii)*	*Case (iii)*	*Case (iv)*	*Case (v)*	*Case (vi)*
	1.	14.0	14.0	15.0	11.0	10.5	10.55
	2,	14.5	14.2	15.0	12.0	11.5	11.69
	3.	15.0	14.4	15.0	13.0	12.0	12.69
Input	4.	15.5	14.6	15.0.	14,0	12.5	13:83
Cohorts	5.	16.0	14.8	15,0	15.0	13.5	14.83
from	6.	16.5	15.0	15.0	16.0	14.0	15.97
1911	7. Cohort No, 2	17.0	15.2	15.0	17.0	14.5	16.97
To	8. Cohort No. I	17.5	15.4	15.0	18.0	15.5	18.10
1971	9.	18.0	15.6	15.0	19.0	16.0	19.10
	10.	18,5	15.8	15.0	20.0	16,5	20.24
Hajnal's (1961)		17.03	15.35	15.15	16.89	14.88	16.87
Hajnal's (1971)		17.96	15,74	15.12	18.58	16.08	18.65
Agarwala's (1961-71)		18.05	15.78	15.15	18.66	16.10	18.70

The results from the simulation exercise yield an identical pattern to Chat observed earlier in our estimates. The relationship observed among our estimates are thus quite consistent with the relationship that one would expect in a situation where marriage ages are rising.

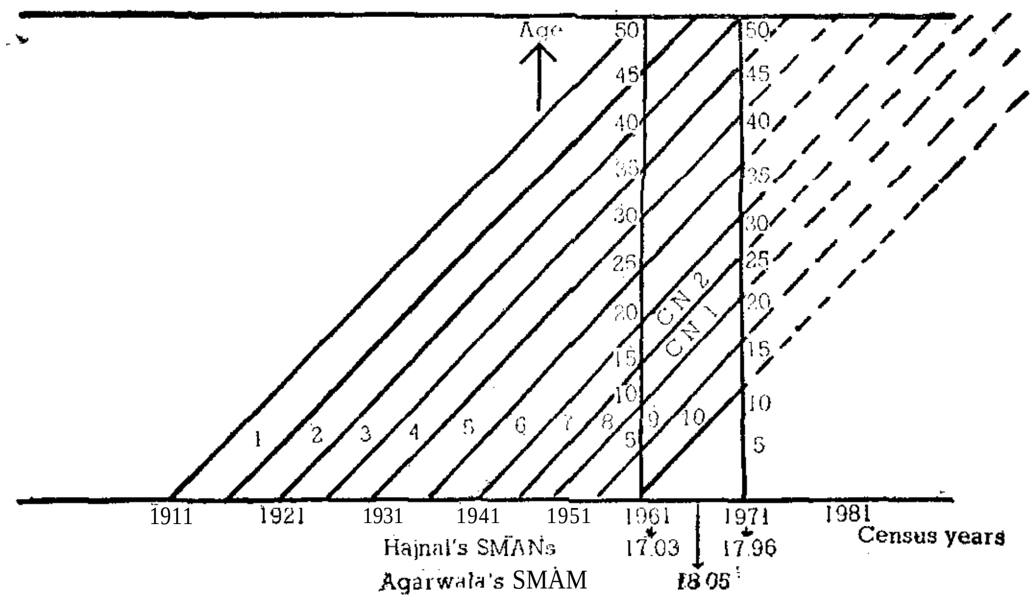


Fig. 1. Case (i) has been illustrated through **this** figure.

Reliability of Estimates

Deficiencies in the data can hamper the estimates to some extent. Any Comprehensive study on nuptiality requires in the first place good data regarding proportions single. The Indian censuses provide marital status distribution by sex and age. It is believed that in India, age reporting is very poor and there is heaping at ages ending in multiple of zero and five. So a very great precision in our *results* with the data from Indian censuses *is* not claimed. But as there is no reason to believe that age reporting by marital status is any more unreliable than other figures available in the censuses. Fairly good idea of cohort mean age at marriage can certainly be obtained from our estimates on a very legitimate assumption that error in reporting at both the censuses is of the same general order.

The errors in reporting can conceal the actual figure for proportion single or there could be some variation or fluctuation from the actual figure which can bias the estimates. The extent of bias in the estimates has been examined by taking **different** cases where the actual data has been subjected to variations from **0.1**% to 5%. The **SMAMs** were computed for each case and has been tabulated in Table 7. The result from this table indicates that if there is **1%** variation in basic data then the bias in the estimates of SMAM ranges from 0.12 years to 0.16 years and if there is 5% variation in the data then bias in the **estimates** become quite significant.

TABLE 7—VALUE OF SMAMs WHEN BASIC DATA ARE SUBJECTED TO DIFFERENT VARIATIONS

Case No.	Input Data	Basic Data	Data with 0.1% Variation	Data with 0.5% Variation	Data with 1% Variation	Data with 5% Variation
	Input 1 (10-14)	0.1955	0.1953	0.1945	0.1935	0.1837
1.	Input 2 (20-24)	0.904S	0.9039	0.9003	0.8958	0.8596
	SMAMs	16.21	16.22	16.28	16.36	16.97
	Input 1 (10-14)	0.2237	0.2235	0.2226	0.2215	0.2125
2.	Input 2 (20-24)	0.9316	0.9307	0.9269	0.9223	0.8850
	SMAMs	15.59	15,60	15.67	15.75	16.40
	Input 1 (10-14)	0.0699	0.0698	0.0696	0.0692	0.0664
3.	Input 2 (20-24)	0.8096	0.8088	0.8056	0.8015	0.7691
	SMAMs	18.59	18.60	18.65	18.71	19.21

The methodology used to compute estimates for cohort no. 1 and cohort no. 2 requires an estimation of the values of C. Since, marriage is virtually universal in India, we can set the value of C equal to about 0.99. In the present study the value of C was estimated as .996 after examining the past data and some trial calculations. To study the effect of C on the estimates of SMAM, some cases were examined and the results are given in Table 8. The results from Table 8 show that the impact of varying values of C on the estimates of SMAM is not significant. The differences between SMAMs computed with $C = 0.99$ and $C = 0.999$ ranges from 0.09 years to 0.22 years. The largest and smallest variation is SMAM ranges from 0.03 years to 0.15 years when SMAMs are computed with $C = 0.996$. Hence, the variations in C at such high levels does not produce any significant change in the estimates of SMAM, and thus, an estimated value of C which is close to the ultimate ever-married proportions reached in that population would not bias the estimates.

Conclusion

The present work describes a methodology which translates the reported

TABLE 8—VALUES OF SMAMs WHEN C IS SUBJECTED TO DIFFERENT VARIATIONS

No.	*Value of C*	*Case (i)*	*Case (ii)*	*Case (in)*	*Case (iv)*	*Case (v)*	*Case (vi)*
1.	0.9900	16.11	15.49	18.51	15.91	15.45	17.91
2.	0.9930	16.16	15.54	18.55	15.88	15.37	17.94
3.	0.9960	16.21	15,59	18.59	15.85	15.30	17.98
4.	0.9990	16.25	15.64	18.62	15.82	15.23	18.01
Differences between highest and lowest SMAMs.		0.14	0.15	0.11	0.09	0.22	0.10
Largest variation when C= 0.996		0.10	0.10	0.08	0.06	0.15	0.07
Smallest variation when C = 0.996		0.04	0,05	0.03	0.03	0.07	0.03

marital experience of cohorts from two successive censuses, into indices of nuptiality i.e. a_0, k and SMAM. This has been applied to data from two successive Indian Censuses and nuptiality parameters for 17 states and other areas have been computed. The results obtained are quite convincing and suggest a high degree of conformity with the basic pattern.

The results of this study reveal that cohort nuptiality is changing all over the country and there has been a consistent rise in age at marriage for females. The increase in age at marriage has been quite significant for the states which already had lower ages at marriage in their older cohorts. The highest estimate of cohort mean age at marriage is obtained for Kerala and the lowest for Madhya Pradesh. The female marriage pattern in central India appears to be relatively homogenous with both early onset (a_0) and a rapid tempo *(k)* of entrance into marriage unions. The southern states of the country with the exception of Andhra Pradesh, exhibit a later pattern of marriage with comparatively higher a_0 and K than the other states. In the context of this regional pattern, Kerala is an interesting example with its very slow tempo and higher value of a_0. When both a_0 and K characteristics are combined than Kerala exhibits the highest cohort SMAM among all the regions.

It seems that it is quite possible to study the cohort behaviour as regards nuptiality through cross-sectional data on distributions by marital status which are readily available from censuses. Cohort analysis studies the fundamental changes in behaviour but needs a recording of demographic events extending over a life span and refers to past experience, whereas period analysis shows how a population changes from one point to other. The two points of view are not contradictory, but arc in fact complementary. The most serious problem in making longitudinal analysis usually arises due to the absence of marriage registration system in many countries. The present study on the longitudinal behaviour of nuptial phenomenon from cross-sectional data provides a possible solution.

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APPENDIX I

To illustrate iteration an example is given below. We have data for cohort No. 1 from the two censuses as follows:

(*a*) Input No. 1 — Proportion ever-married in age group 10-14
= 0.1955 from 1961 census = P_1

(*b*) Input No. 2 = Proportion ever-married in age group 20-24
= 0.9048 from 1971 census = P_2

Now, we start looking in the families of a_0 to find out which age Schedules of proportion ever-married bracket the input values. It is observed that for the family with a_0 = 7 when k = 0.9 and k = 1.0 the proportion ever-married brackets the input value for age group 10-14. The same family, but with k = 0.7 and k = 0.8, brackets the input value for age group 20-24, as shown below.

Parameters	*Age Groups*	*Prop. E. M.*
a_0 = 7.000	10-14	.3480
C = .996	15-19	.7522
k = .700	20-24	.9218
	25-29	.9744
	30-34	.9960
	35-39	.9960
	40-44	.9960
	45-49	.9960

Parameters	*Age Groups*	*Prop. E. M.*
a_0 = 7.000	10-14	.2737
C = .996	15-19	.6719
k = .800	20-24	.8791
	25-29	.9552
	30-34	.9834
	35-39	.9960
	40-44	.9960
	45-49	.9960

The input value for age group 20-24 is bracketed by these values. By iteration the value of k is found to be 0.7420.

Parameters	*Age Groups*	*Prop. E. M.*
a_0 = 7.000	10-14	.2175
C = .996	15-19	.5941
k = .900	20-24	.8298
	25-29	.9309
	30-34	.9707
	35-39	.9883
	40-44	.9960
	45-49	.9960

Parameters	*Age Groups*	*Prop. E. M.*
a_0 = 7.000	10-14	.1748
C = .996	15-19	.5216
k = 1.000	20-24	.7768
	25-29	.9009
	30-34	.9550
	35-39	.9795
	40-44	.9910
	45-49	.9960

The input value for age group 10-14 is bracketed by these values (.2175 and .1748). By iteration the value of k is found to be 0.9480.

We proceed by looking at the family with $a_0 = 8$ years, and it is found that the age schedules described by $k = 0.7$ and k — 0.8 bracket the input value for age group 10-14; and in the same family of a_0 with $k = 0.6$ and k — 0.7, bracket the input value for age group 10-24 as shown below.

Parameters	*Age Groups*	*Prop. E. M.*
$a_0 = 8.000$	10-14	.3153
$C = .996$	15-19	.7790
$k = .600$	20-24	.9421
	25-29	.9845
	30-34	.9960
	35-39	.9960
	40-44	.9960
	45-49	.9960

The input value for ago group 20-24 is bracketed by these values. By iteration the value of k is found to be 0.6926.

Parameters	*Age Groups*	*Prop. E, M.*
$a_0 = 8.000$	10-14	.2395
$C = .996$	15-19	.6905
$k = .700$	20-24	.9015
	25-29	.9679
	30-34	.9900
	35-39	.9960
	40-44	.9960
	45-49	.9960

The input value for age group 10-14 is bracketed by these values. By iteration the value of k is found to be 0.7769.

Parameters	*Age Groups*	*Prop. E. M.*
$a_0 = 8.000$	10-14	.1843
$C = .996$	15-19	.6040
$k = .800$	20-24	.8518
	25-29	.9457
	30-34	.9796
	35-39	.9960
	40-44	.9960
	45-49	.9960

Looking **further** in **the** same way at **the** family with a_0 = 9 years, age **schedules** **described** by k — 0.6 and k = 0.7 bracket both the input values, shown as **follows:**

Parameters	*Age Groups*	*Prop. E. M.*
a_0 = 9.000	10-14	,2053
C = .996	15-19	,7130
k = .600	20-24	.9245
	25-29	.9797
	30-34	.9960
	35-39	.9960
	40-44	,9960
	45-49	.9960

The input value for age group 10-14 is bracketed by these values. By iteration the value of k is found to be **0.6157.**

The input value for age group 20-24 is bracketed by these values. By iteration the value of k is found to be 0.6431.

Parameters	*Age Groups*	*Prop. E. M.*
a_0 = 9.000	10-14	.1514
C = .996	**15-19**	**.6160**
k = ,700	20-24	.8757
	25-29	.9600
	30-34	.9873
	35-39	.9960
	40-44	.9960
	45-49	.9960

In the family of $a_0 = 10$, we find that age schedules described by $k = 0.4$ and $k = 0.5$ bracket the input value of age group 10-14; and with $k = 0.5$ and $k = 0.6$ bracket the other input value.

Parameters	*Age Groups*	*Prop. E. M.*
$a_0 = 10.000$	10-14	.2520
$C = .996$	15-19	.8488
$k = .400$	20-24	.9793
	25-29	.9960
	30-34	.9960
	35-39	.9960
	40-44	.9960
	45-49	.9960

The input value for age group 10-14 is bracketed by these values. By iteration the value of k is found to be 0.4521.

Parameters	*Age Groups*	*Prop. E. M.*
$a_0 = 10.000$	10-14	.1711
$C = .996$	15-19	.7408
$k = .500$	20-24	.9475
	25-29	.9960
	30-34	.9960
	35-39	.9960
	40-44	.9960
	45-49	.9960

The input value for age group 20-24 is bracketed by these values. By iteration the value of k is found to be 0.5953.

Parameters	*Age Groups*	*Prop. E. M.*
$a_0 = 10.000$	10-14	.1190
$C = .996$	15-19	.6308
$k = .600$	20-24	.9013
	25-29	.9734
	30-34	.9960
	35-39	.9960
	40-44	.9960
	45-49	.9960

At this point, it is observed that the iterated value of K for age group 10-14 has gone below the iterated value of K for age group 20-24. This is seen clearly by plotting the iterated values of K for each family of a_0 on Graph 1(6). We find an intersection of two lines, and this intersection point is the exact location where the two values of K are identical. The values of a_0 and K can be read directly from the graph and an age schedule of prop. ever-married computed from the values of a_0 and K will conform that the p.e.m. in age group 10-14 and in age group 20-24 are exactly equal to input no. 1 and input no. 2 respectively. This age schedule of p.e.m. has been plotted on Graph 1(a). The computer program EMPROPS has been specifically developed to simplyfy this task of locating the combination of a_0 and K.