A MODEL FOR THE STUDY OF NUPTIALITY

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1. Introduction

Until recently nuptiality studies have received little attention compared with other demographic fields, especially mortality and fertility which are taken as " true demographic phenomena". On the other hand, although nuptiality is not contributing directly to population change, it is the first step in the process of family formation. Accordingly, it plays a significant role in determining fertility levels (and thus population growth rates) in countries where most births take place within marriage. This relationship is clearly formulated within the framework specifying the intermediate variables affecting fertility, which was suggested by many domographers (Davis and Blake (1956) ; Yaukey (1973); Bongaarts (1978)) aiming at investigating nuptiality variables in order to identify policies that might control population growth.

This growing concern motivated scientific research aimed at providing suitable information about the levels and patterns of nuptiality. Mathematical models simulating this marriage experience, of different countries, is one of the important approaches in that direction, especially when they reflect the relationship between the quantity of marriage and the age distribution of first marriages.

The aim of this paper is to present a simple demographic model for nuptiality and examine its applicability to Egyptian data.

BASIC NUPTIALITY MODELS

Two basic types of variables are affecting the first marriage experience of any country, namely, demographic variables (age structure and its relation to the age at which marriage starts, proportions marrying,....) and social variables which are generally related to norms of life (entry to the marriage pool, entry to the state of marriage, time spent before actual marriage,....). Various models differ in that respect according to their main scope of interest, although they should reflect the interrelationships between both types of variablrs. At the same time, they should clarify the dynamic changes in marriage conditions on the basis of yearly data.

Models to simulate the pattern of first marriages were recently presented by Coale (1971). According to his findings, the curve representing the proportions of women ever-married, by single years of age, has the same functional form in various countries. It may, however, differ from one country to another, in the age at which marriage begins (origin), the steepness with which first marriage increases (horizontal scale) and finally, the ultimate proportion ever-married (vertical scale). Consequently, on the basis of the Swedish data 1965-1969, Coale calculated standard tables of first marriage frequencies, proportions ever-married and years of exposure. All these tables are related to a specified proportion of women who will ultimately marry.

The experience of any cohort of women can be related to the standard pattern. If G_s (X) is the standard proportion ever-married (X) years after marriage begins, then this proportion at age (a), for any cohort is :

$$G(a) = C.\ G_s\ (\ (a-a_o)/k) \qquad (1)$$

where

C is a factor determined by the ultimate proportion ever-married .

a_o is the age at which marriage begins

k is the time scale factor with which mariage is compressed in comparison to the standard tables.

The standard risk of first marriage[1], among those who ultimately ever marry, r (a), was also formulated by Coale and represented by a Gompertz type function in the form:

$$r\ (a) = (0.174/k)\ \exp\ (\ (-4.411).\ \exp\ (\ (-0.309/k)\ (a-a_o)\ )\ ) \qquad (2)$$

(1) Defined by relating the number of first marriages at each age to persons eligible of first marriage, i.e. those who are single.

In a later attempt, Coale and McNeil (1972) developed the above mentioned relational model and emphasized social concepts attached to model's variables. A normal distribution curve is used to represent the age distribution of girls first becoming marriageable (entering the marriage pool), and three exponentially distributed delays are used to represent the time spent form the previous date until first meeting the eventual husband, then until engagement and from that date to actual marriage.

The formula used to calculate the first marriage rates, a closed form analytical expression, was;

$$g\ (a) = (0.19456/k)\ \mathrm{Exp}\ (\ (/0.174/k)(a-a_o-6.06k)\ \mathrm{Exp}\ (-0.2881/k)(a-a_o-6.06k)))\ (3)$$

Where a, a_o and k follow the same definitions presented earlier. It should be noted, however, that the first marriage rates used in this case are estimated by relating the number of first marriages at each age to the total number of females regardless of marital status[1]. The proportion ever-married can, then, be calculated by integration.

Consequently, appropriate estimates at a_o (location) and K (scale), which are extracted from the population experience were only used in order to determine specified patterns of first marriage. The ultimate proportion ever-married (c) is omitted and needs to be seperately estimated.

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(1) They are equivalent to the birth order rates.

Another social oriented model was presented by Feeny (1972). He accepted the idea that any individual decides to marry in two stages. Firstly, a decision to enter the marriage pool, and secondly delays between readiness for marriage and the actual marriage. He developed a model in which a woman's age first marriage can be taken as the sum of two components represented by convolution functions (related to the previous stages), namely a normal function and an exponential function respectively. The expression used was:

$$g(x) = \int_{x}^{x+1} f(a,m,s,t,p)\, da$$

where:

g (x), the proportion expected to marry between exact age x, x+1.

m the mean-age when entering the marriage pool.

s the standard deviation of ages entering the marriage pool.

t the mean-waiting time in the marriage pool.

p the proportion never entering the marriage pool.

Feeny fitted his model to observed age patterns of first marriage in selected cohorts of the United States white females.

Another model was presented by Hernes (1972). It is based on the idea that entry into first marriage, for any member of a cohort, is subject to two forces. The first, is the social pressure to get married and the second is the decline in the capacity of those cohort members to marry with growing age. He considered a Gompertz-type function to represent this process and formulated this model as follows:

$$K.G^{B^x} = \frac{P_{(x)}}{1-p_{(x)}} \qquad (4)$$

where:

$P_{(x)}$ the proportion married at age x

$K = P_o / (G(1-p_o))$

P_o the percentage married at age (14)

$\text{Log } G = A/\text{Log } B$

A the parameter representing the marriage capacity or marriageability

B the parameter representing the deterioration in marriageability with growing age.

Accordingly, Hernes's model is dependent on three parameters, namely K,G and B which are the Gompertz parameters. The model was successfully tested with the U.S.A. data.

Brass (1974) suggested the Gompertz function as a possible candidate for representing the marriage experience. This conclusion was the result of comparing Coale curves to the Murphy and Nagnur fertility model. By excluding the proportion ultimately marrying, Brass reduced the model to two parameters in the form:

$$\text{Log}_e \left(-\log_e M(x)/K\right) = \alpha + B \log_e \left(-\log_e \overset{*}{M}(x)/K\right) \quad (5)$$

where

$M(x)$ the proportion married by age x

K the fixed constant towards which it tends for long larger x.

$M^*_{(x)}$ the proportion married extracted from Coale standard.

This log log relational model gave good results when examined for England and Wales. This model, however, assumes that the Coale's empirical system representing the marriage experience is exact.

THE PROPOSED MODEL

The examination of all previous models shows that entry into first marriage can be mathematically represented by an exponential type function and preferably by a Gompertz type-function. However, the functions used earlier were complicated and the finding of a simple model, with clear demographic interpretation for its parameters, would be of great importance in improving the understanding of the nuptiality experience in different nations.

The Gompertz function was introduced in 1825 and used to describe the force of mortality. Recently it was used by many demographers to describe the fertility experience and gave satisfactory results. One of the problems, from the projectional point of view, is the possibility of having erratic values in the fitting process at the tail of the curve (Murphy and Nagnur, 1972), especially in developping countries where data are vulnerable to serious errors.

With regard to nuptiality statistics, this problem is less important in developping countries with early pattern of marriage. Accordingly, a simple Gompertz-type function is an acceptable formula for modelling the pattern of first marriage.

If we consider y(x) as representing the age-specific first marriage rate[1] at age (x), thus for a closed cohort Y (x) would be the proportion ever-married at that exact age and it is possible to formulate the model as:

$$Y\ (x) = K.G.^{B^{x-x_o}}$$

where

K the ultimate proportion expected to be married

(1) The equivalent of the birth order rate as mentioned earlier in section 11.

G the proportion ever-married achieved at x_o

B the shape of the first marriage curve

X_o: the age at which a sizeable ratio is married or the age at which marriage starts.

This model has the shape of a non-symmetrical "S" with a lower "0" asymptote and an upper asymptote "K". It is based on three parameters K,G and B. The estimation of these parameters in this case, can be simply carried out using partial totals of nuptiality experience related to selected ages (Wunsch, 1966) or by using the given nuptiality values at three selected points x_o. x_1 and x_2 (Martin,1967), chosen such that:

$$X_2 - X_1 = X_1 - X_o = r > 0$$

Beside simplicity, the main advantage of this model is its built-intechnique to estimate the final level of marriage (ultimate proportion ever-married) and the possibility of relating its value to the changes in the age of starting marriage and the pace of first marriage represented by the shape of the first marriage curve. The model also, can be translated to a relational model and lend itself to Computer handling. It is also possible to reduce the parameters of this model through the elimination of K, the expected ultimate proportion ever-married.

APPLICATION OF THE MODEL TO EGYPTIAN DATA

The model is basically formulated within the context of a closed cohort. Such data are not available for Egypt and accordingly we shall use reported distribution of female first marriage by age of bride. These data are published annually since 1935 , in five-years age groups only. Studies had shown their completeness with regard to their total number (Farrag, 1957). However, mis-reporting of age which is a general characteristic of the Egyptian data, may affect published statistics and distort the distribution of first marriages. In spite of these difficulties, we selected the data published in 1960 and 1970 to test the model. Table (1) presents the basic data.

Table (1)

Female First Marriages, the Age-Specific First Marriage Rates Per 1000 Woman

Age Groups	1960			1970		
	No.	%	A.S.F.M.	No.	%	A.S.F.M.
20	147,225	65,1	119	163,907	60,8	103
20- 24	59,605	26,4	56	82,257	30,5	61
25- 29	14,146	6,3	15	16,550	6,1	14
30- 34	2,715	1,2	3	3,981	1,5	4
35- 39	1,216	,5	2	1,306	,5	1
40- 44	,491	,2	1	,756	,3	1
45- 49	,310	,1	1	,462	,2	...
Total *	225,979	99,8		269,768	99,9	

* Including those over age 50.

Table (1) shows that Egypt follows the traditional or non-European pattern of nuptiality characterized by early and universal marriage leading to a very high proportion ultimately marrying. By age 20, between 61-65% of all first marriages were carried out. Column three presents the Age-Specific First Marriage Rates calculated as described in the previous section. These rates were adopted to the use of age groups and accumulated to yield the observed proportions ever-married at various exact ages. They are presented in Table (2).

Table (2)

Observed and Estimated Proportions Ever-Married Per One Woman and the Percentage

Exact Age	1960			1970		
	Observed	Estimated	Difference %	Observed	Estimated	Difference %
20	.595	.595	0	.515	.515	0
25	.875	.851	4	.820	.776	5
30	.950	.927	2	.890	.877	1
35	.965	.965	0	.910	.910	0
40	.975	.978	-0.3	.915	.920	-0.5
45	.980	.983	-0.3	.920	.923	-0.3
50	.985	.985	0	.924	.924	o

To estimate the parameters of the models, the proportions ever-married at exact ages 20, 35 and 50 (i.e.r =15) were used. The value of these parameters are given in Table (3).

Table (3)

Estimated value of the parameters B,C K for 1960 and 1970

Parameters	1960	1970
B	.810	0.787
G	.604	0.557
K	.986	0.924

The value of B determine the shape of the proportions ever-married curve and consequently the first marriage curve. It is a very sensitive parameter and the estimated values indicate a large of change in the pattern of marriage between 1960 and 1970. This change is related to the value of the ultimate proportion ever-married which decreased by about 6% during the considered period. With regard to G, it is obvious from Table (2), that it represents the proportion of ever-married achicved at exact age 20.

The estimated parameters were fitted to the proposed Gompertz model to calculate the proportions ever-married. These values are also presented in Table (2). The method used in the process of estimating the model's parameters forces the curve to pass through the three selected points. For other points, the difference is very small and it might be related to the expected mis-statement of ages. This deficiency would probably be in direction of reporting lower ages, especially for those between ages 20 to 35. Generally, these results allow us to accept the proposed Gompertz model as representing the nuptiality experience of Egypt. It should also be tested with the data of other countries.

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