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SOME DEMOGRAPHIC DETERMINANTS OF AVERAGE HOUSEHOLD SIZE: AN ANALYTIC APPROACH

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Abstract—Descriptions of non-nuclear family systems in terms of rules of residence imply large and complex households, yet such households are not encountered as modal or average for large populations. Demographic factors, in particular high mortality, have been suggested as possible explanations for the apparent discrepancy. The purpose of this paper is to investigate the influence of demographic variables (viz., mortality, fertility, age at marriage) on average household size under different family systems—nuclear, extended and stem. The approach used has been applied by Coale to stationary populations. It has here been modified to apply to stable populations. The results indicate that under all family systems, average household size is positively correlated with fertility, life expectancy, and average age at marriage. Households under nuclear and stem family systems never exceed 10 persons on average. By contrast, under extended family systems, when mortality is low and fertility is high, average household size reaches levels seldom if ever observed in reality, e.g., 25 persons per household. Large households under the extended family system also tend to be fairly complex, often containing 5 or more adults. A number of modifications in the model would make for greater fit between model and real family systems. A more fruitful approach would involve the simulation of household formation and development.

Descriptions of non-nuclear family systems in terms of their characteristic rules of residence often seem to imply very large and complex households. For example, in a classic patriarchal family system, a household containing a father, his wife, two married sons, and their wives and children would number ten or more persons. Such large households are seldom encountered as modal or average, however. A recent compilation of census materials reported in the U.N. *Demographic Yearbook* showed no bona fide case of a national average household size larger than six (Burch, 1967, pp. 353–355, esp. Tables 1, 2, and 3).

Several explanations have been offered for this discrepancy between the ideal and the actual. Lang (1946) has stressed economic limitations on household size and composition, arguing that only the better-off segments of any society can realize the ideal, because only they have the required land, housing and other material goods.

Hsu (1943) has stressed the social psychological difficulties of maintaining large, complex households, and argued that relatively few male or female heads will have the social and administrative skill to hold these households together in the face of centrifugal forces (e.g., mother-in-law or sister-in-law problems).

Others have stressed demographic limitations, pointing out in particular the role of high mortality in hindering realization of the ideal household form. Some quantitative data on this point were presented by Collver (1963) in his study of the Indian family life-cycle. The idea is developed at length by Levy (1965) in a theoretical essay in which he argues that actual family structures have been rather similar in societies of all times and places, regardless of the structural ideals. The central notion in this approach is that high mortality makes the joint survival of siblings or of three or more generations in direct line of descent for one sex (or other survival contingencies needed to elaborate complex household structures) relatively rare events.

Little systematic work has been done to investigate the relations of demographic variables to household size and structure. (But see Brown, 1951, pp. 380–394. An elaborate simulation approach is described in Orcutt, Greenberger, Korbel and Rivlin, 1961, but so far as I know it has not been utilized to study the kinds of questions raised in this paper.) Recent work by Coale suggests a fruitful approach to the problem, however. In a brief technical note appended to Levy's essay, Coale presents a life table technique for showing the variation in average household size for different family systems, defined in terms of rules of residence, in a stationary population with high fertility and high mortality ($e_0 = 20$ years; crude birth and death rates = 50 per 1,000). He finds that for the family system involving maximum extension of households, average household size is 75 percent larger than for the nuclear family system under the same demographic conditions (Coale, 1965, pp. 64–67, esp. Table 1).

The purpose of this paper is to extend Coale's model to stable populations as well as stationary, in order to show the variation in average household size by family system, for different levels and combinations of mortality and fertility, and for different average ages at marriage. In addition, the model will be used to shed some light on variations in the structure as well as the size of households, by examining the average number of adults per household as well as the average number of all persons (adults and children).

The paper comprises three sections: 1) description of the Coale model and of the modifications needed to apply it to stable populations; 2) presentation of the main conclusions as to the effects of varying rules of residence, fertility, mortality and age at marriage on family composition, as these are given by the model; 3) a discussion of the adequacy of the model as a representation of real family systems, and of needed or possible modifications.

Description of the Model for Stationary and Stable Populations

Calculations made by Coale and in the present paper involve several general assumptions which should be mentioned at this point. First, all calculations relate either to stationary or stable populations, in the full technical sense. (The stationary population model assumes unchanging age-specific birth and death rates which yield an unchanging age structure and total population size, i.e., the growth rate is zero. A stable population model involves assumptions of unchanging fertility, mortality and age structure, but allows the growth rate to vary over a wide range. See Barclay, 1958, pp. 131–134 for a brief explanation.) Second, the treatment is in terms of female populations only; total household size (i.e., males and females) is taken as twice that for females, a rough approximation. Third, all females are assumed to marry. Fourth, all marriages take place exactly at the average age at marriage, and all births take place at the average age of child-bearing. Fifth, once a woman becomes a household head, she does not relinquish that status despite advanced age.

The general approach is to calculate age-specific headship rates (proportions of females who are household heads by age group) as functions of the family system, mortality, age at marriage, mean age at childbearing, and fertility. These headship rates are applied to the appropriate population age distribution (stationary or stable) to calculate the number of heads. The total population size divided by the number of heads gives average size of household.

Coale defines four different family systems in terms of residence rules. Each of these is described below, along with the computational procedure used in the stationary and stable cases.

I. *Nuclear Family.*

Every woman marries at the average age at marriage ($\bar{N}$) and thereupon establishes her own household. In other words all women at or above the average age at marriage are household heads. For the stationary case, average household size ($\bar{H}$) is simply $T_0/T_{\bar{N}}$, where T is the ordinary life table function and $\bar{N}$ is the average age at marriage. For the stable case, $\bar{H}$ is $P(\text{total})/P(\bar{N}$ and over), where P refers to age groups in the stable population. It will be noted that for this model, $\bar{H}$ is a function of age structure and of the average age at marriage.

II. *Extended Family with Foster Mothers.*

Every woman marries at the average age at marriage, but continues to live with her own mother or a foster mother the same age as her own mother (who is assigned her if her own mother dies before the daughter reaches the marriage age). The daughter does not establish her own household until her mother (or foster mother) has died. In both stationary and stable populations, the proportion *not* maintaining their own household at age $\bar{N}$ is 1.00, by definition. At age $\bar{N} + X$, the proportion not maintaining their own household is $l_{\bar{A}+\bar{N}+X}/l_{\bar{A}+\bar{N}}$, where l is the life table function, $\bar{A}$ is the average age at childbearing and $\bar{N}$ the average age at marriage. (In the present calculations $\bar{A}$ is constant at 30 years. For a discussion of connected problems, see below). In other words, at the time of marriage every woman is living with her mother (or foster mother), who is $\bar{A}$ years older than she. The proportion remaining in the parental household five years later is the proportion whose mothers or foster mothers survive over that interval of age. The headship rates calculated in this fashion are then applied to the stationary or stable age distribution. It will be noted that in this case, the headship rates are functions of age at marriage, mean age at childbearing, and of mortality. Thus, $\bar{H}$ is a function of age structure, age at marriage, age at childbearing, and of mortality.

III. *Extended Family Without Foster Mothers.*

Every woman marries at the average age at marriage. If her own mother has died, she immediately sets up her own household; if her own mother is still living, she remains in her mother's household until her mother dies. No foster mothers are involved. In the stationary and stable cases, the proportion *not* maintaining their own household at the average age at marriage ($\bar{N}$) is $l_{\bar{A}+\bar{N}}/l_{\bar{A}}$, where $\bar{A}$ is the average age at childbearing. In general at age $\bar{N} + X$, the proportion not maintaining their own households is $l_{\bar{A}+\bar{N}+X}/l_{\bar{A}}$. In other words, the probability that a woman will not head her own household at any age from age $\bar{N}$ on is the probability that her own mother will survive to that age. In this, as in the previous case, the headship rates are functions of mean age at marriage and at childbearing and of mortality.

IV. *Stem Family.*

Every woman marries at the average age at marriage. If her mother is dead, she immediately sets up her own household. If her mother is alive, she or one of her sisters remains in the mother's household until the death of the mother. The remaining sisters set up new households immediately upon marriage. The proportion not maintaining their own households at age $\bar{N}$ is the product of three factors: 1) the proportion of mothers surviving to age $\bar{A} + \bar{N}$ (i.e., the mothers' age at the time of their daughters' marriages); 2) the proportion of families having at least one daughter surviving to age $\bar{N}$; 3) the reciprocal of the average number of daughters surviving to age $\bar{N}$ in families having at least one. Factor #1 is the same, age for age, as that computed in case III above.

Factor #2 is $1.0 - \alpha$, where α is the proportion of families with no daughters surviving to $\bar{N}$. In the stationary case, α is $(1 - l_{\bar{N}}/l_0)^{l_0/l_{\bar{A}}}$. The expression in parentheses gives the probability of dying by age $\bar{N}$. The exponent is the average number of daughters born per mother. α is thus the combined probability of all daughters dying before age $\bar{N}$. $1.0 - \alpha$ is the probability that at least one will survive to that age. In the stable case, $l_0/l_{\bar{A}}$ is replaced by the gross reproduction rate (GRR), to give the number of daughters born per mother on average.

Factor #3 in the stationary case is $(l_{\bar{N}}/l_{\bar{A}})/(1 - \alpha)$. $l_{\bar{N}}/l_{\bar{A}}$ gives the number of daughters reaching age $\bar{N}$ per family. Dividing this by $(1.0 - \alpha)$ gives the average number reaching the age at marriage in families having at least one reaching that age.

Factor #3 in the stable case is GRR $(l_{\bar{N}}/l_0)/(1 - \alpha)$. GRR $(l_{\bar{N}}/l_0)$ gives the average number of daughters surviving to marriage age in all families. This factor divided by $1.0 - \alpha$ gives the average number surviving to marriage in families having at least one surviving daughter.

For the stable case, then, the proportion of women not maintaining their own households at any given age equals the proportion from case III above multiplied by the product of factors #2 and #3, or $[(1 - \alpha)^2 \times l_0]/\text{GRR} \times l_{\bar{N}}$, which is constant over all ages for given ages at marriage and at childbearing and levels of fertility and mortality. In case IV, average household size bears a very complex relation to demographic factors; it is a function of the mean age at marriage and at childbearing, the level of fertility and of mortality, and age composition of the population.

Results

For each of the family systems described above, calculations have been made of the average number of persons per household and of the average number of adults per household for various levels of fertility, mortality and age at marriage. Fertility levels are GRR's of 1, 2, 3 and 4. Mortality levels are e_0's of 20, 40, 60, and 77.5. Age at marriage is taken as 15, 20 and 25. The stable populations used in the calculations are from the model West female series given by Coale and Demeny (1966). (Life table functions are also model West female, with l_{100} assumed to be zero, and l_x for 85, 90, and 95 obtained by linear interpolation.)

Average age at childbearing has been kept constant at 30 years throughout. This involves two difficulties that should be mentioned. First, the stable population models used assume average age at childbearing to be 29, not 30, so that there is a small bias in the calculations. Second, although the average age at childbearing does not vary widely in actual fact, still the models would be more realistic were $\bar{A}$ varied over at least a small range. In particular, there is some inconsistency in combining very high fertility with a late average age at marriage, without assuming also a higher average age at childbearing. In this first approach to the problem, it seemed reasonable to accept these inconsistencies rather than to get involved in considerably more complicated computation. In any case, the errors involved would not seem to affect our major conclusions.

Table 1 gives the average size of household for each family system for different combinations of fertility and mortality. In the nuclear family, it is clear that household size remains within moderate bounds under any of the demographic conditions given. To a lesser extent this is true also of the stem family. In both cases, $\bar{H}$ is well under ten, and pretty much in line with values observed in actual populations—for large populations, these seldom if ever exceed 7. In extended family systems (cases II and III), however, household size becomes extremely large when fertility and life expectancy are both high. About $\frac{1}{3}$ of the values in Table 1 exceed 10. Such values have been observed, so far as I know, only for certain regions of tropical African nations, although these cases involve problems relating to census definitions of *household*.

On the empirical level, the calculations tend to support two generalizations regarding demographic aspects of family structure. First, populations with high fertility, relatively low mortality and moderate household size (e.g., 5 or under) are operating under an actual family system that involves considerable departure from an extended family ideal. Were the extended family pattern being adhered to consistently, the average household size would be much larger than observed. Second, in populations with high fertility and extended family ideals, the decline in mortality creates powerful pressures at the household level for departures from or modifications of the extended family system or for the control of fertility. By powerful pressures, we mean the doubling or even tripling of average household size as mortality declines from very high to very low levels. (These findings are in general accord with the original hypothesis of Levy, 1965, esp. p. 56.)

TABLE 1.—Average Household Size in Stable Population Under Different Family Systems, by Mortality and Fertility Level (age at marriage = 20 years)

Mortality and fertility levels	Nuclear	Extended, foster mothers: Allowed	Extended, foster mothers: Not allowed	Stem
e_0 = 20				
GRR =				
1.0 . . .	2.4	3.2	2.8	2.6
2.0 . . .	3.0	4.6	3.8	3.3
3.0 . . .	3.6	6.0	4.7	4.1
4.0 . . .	4.2	7.6	5.6	4.8
e_0 = 40				
GRR =				
1.0 . . .	2.6	4.0	3.6	3.2
2.0 . . .	3.4	6.5	5.4	4.3
3.0 . . .	4.2	9.4	7.2	5.2
4.0 . . .	5.0	12.4	9.2	6.0
e_0 = 60				
GRR =				
1.0 . . .	2.7	4.8	4.4	4.1
2.0 . . .	3.6	8.7	7.5	5.1
3.0 . . .	4.5	13.2	10.9	5.8
4.0 . . .	5.4	18.2	14.4	6.6
e_0 = 77.5				
GRR =				
1.0 . . .	2.7	5.6	5.4	5.4
2.0 . . .	3.7	11.2	10.7	5.5
3.0 . . .	4.6	18.4	17.2	6.2
4.0 . . .	5.6	26.9	24.9	7.0

Note: Figures are average number of females per household in the female stable population multiplied by 2.

The theoretical effect of extended family systems on household size, however, even when mortality is high, is not negligible, as is brought out in Table 2. With a GRR of 3 and an e_0 of 40, for instance, household size in case III is 73 percent greater than in the nuclear system; in case II, household size is more than twice as large as in the nuclear system.

It is also apparent from Table 2 that the impact of an extended family system tends to increase separately with fertility and with life expectancy, and is greatest when very high fertility and low mortality are combined. The reasons for this are clear. High fertility yields a large proportion of children in the population, none of whom become household heads, and thus

TABLE 2.—Average Household Size Under Stem and Extended Family Systems Relative to Size Under Nuclear System, by Mortality and Fertility Level
(nuclear system = 100)

Mortality and fertility levels	Nuclear	Extended, foster mothers: Allowed	Extended, foster mothers: Not allowed	Stem
e_0 = 20				
GRR =				
1.0 . . .	100	131	116	105
2.0 . . .	100	151	124	111
3.0 . . .	100	167	130	113
4.0 . . .	100	181	135	114
e_0 = 40				
GRR =				
1.0 . . .	100	156	138	122
2.0 . . .	100	193	158	128
3.0 . . .	100	224	173	125
4.0 . . .	100	249	184	120
e_0 = 60				
GRR =				
1.0 . . .	100	181	166	153
2.0 . . .	100	240	208	140
3.0 . . .	100	290	239	128
4.0 . . .	100	334	264	122
e_0 = 77.5				
GRR =				
1.0 . . .	100	208	203	200
2.0 . . .	100	305	292	150
3.0 . . .	100	396	373	133
4.0 . . .	100	480	445	125

inflates average household size. Low mortality increases the probability that a married adult will remain in her parental home, and similarly increases household size.

Under a stem family system, the relations are more complicated and somewhat different. Household size increases uniformly with fertility and life expectancy, as is apparent in Table 1. But the size of the stem family household *relative* to that in the nuclear system (see Table 2) tends to decline with higher fertility when life expectancy is relatively high. This is due to the fact that with a larger *number* of daughters surviving well into the adult years, the *proportion* remaining in the parental home declines.

Demographic interest attaches to the question of the relative influence of fertility and of mortality on household size under the different family systems. Some light can be shed on these problems by Tables 3 and 4, although the results there depend to some extent on the range of values chosen. In the nuclear family system, it is clear that fertility is the more important factor affecting household size. This is because under the nuclear model, $\bar{H}$ is dependent only on age at marriage and age structure (but not on the survivorship of one's parents), and it is well established that fertility has a more powerful influence on age structure than does mortality.

In the extended family systems, the relative effects of fertility and mortality seem roughly similar, with a slight edge to fertility over the ranges included in Tables 3 and 4. In the stem family system (case IV), once again the picture is mixed, but with mortality seeming to

TABLE 3.—Relative Size of Households for Different Fertility Levels, for Each Mortality Level and Family System
(GRR of 1.0 = 100 for each e_0 level)

Mortality and fertility levels	Nuclear	Extended, foster mothers: Allowed	Extended, foster mothers: Not allowed	Stem
e_0 = 20				
GRR =				
1.0 . . .	100	100	100	100
2.0 . . .	124	143	133	130
3.0 . . .	148	189	166	159
4.0 . . .	172	266	199	186
e_0 = 40				
GRR =				
1.0 . . .	100	100	100	100
2.0 . . .	131	162	151	137
3.0 . . .	162	233	203	165
4.0 . . .	192	307	257	189
e_0 = 60				
GRR =				
1.0 . . .	100	100	100	100
2.0 . . .	135	179	169	124
3.0 . . .	169	272	245	142
4.0 . . .	203	376	325	162
e_0 = 77.5				
GRR =				
1.0 . . .	100	100	100	100
2.0 . . .	137	201	197	102
3.0 . . .	174	330	318	115
4.0 . . .	210	484	458	130

have a slightly greater influence, particularly at high levels of fertility.

Perhaps the most important general conclusion to emerge from these calculations is the strong independent effect of fertility on average household size, a point that has not been emphasized in previous discussions of the topic. The reason for this is clear analytically from the models. Fertility has a strong influence on the proportion of the total population who are children (say, under 15) most of whom are nonheads of households under any family system, and on the proportion who are adults, and thus are candidates for household headship by virtue of their age. In brief, household size is strongly influenced by age structure.

The fact that household size reflects the relative number of children in a population suggests computation of a different household measure, one that gives at least a rough index of the complexity of households. The index used here is simply the average number of adults per household, where an adult is taken as anyone 15 years or older. Table 5 shows how this measure varies with fertility and mortality for the four family systems.

It shows that in nuclear and stem family systems, households tend to remain relatively simple in composition, as well as relatively small, under almost any conditions of mortality and fertility. Only in a few instances for the stem family and never for the nuclear family does the number of adults per household

TABLE 4.—Relative Size of Households for Different Mortality Levels, for Each Fertility Level and Family System
(e_0 of 20 = 100 for each GRR level)

Fertility and mortality levels	Nuclear	Extended, foster mothers: Allowed	Extended, foster mothers: Not allowed	Stem
GRR = 1.0				
e_0 =				
20 . . .	100	100	100	100
40 . . .	106	126	126	123
60 . . .	110	151	157	159
77.5 . .	109	173	192	208
GRR = 2.0				
e_0 =				
20 . . .	100	100	100	100
40 . . .	112	143	143	129
60 . . .	119	189	199	151
77.5 . .	121	244	284	164
GRR = 3.0				
e_0 =				
20 . . .	100	100	100	100
40 . . .	116	155	154	127
60 . . .	125	218	231	142
77.5 . .	128	304	367	150
GRR = 4.0				
e_0 =				
20 . . .	100	100	100	100
40 . . .	118	163	162	126
60 . . .	130	240	256	139
77.5 . .	134	356	441	146

TABLE 5.—Average Number of Adults (Persons 15 and Over) per Household, by Family System and Fertility and Mortality Level
(age at marriage = 20 years)

Mortality and fertility levels	Nuclear	Extended, foster mothers: Allowed	Extended, foster mothers: Not allowed	Stem
e_0 = 20				
GRR =				
1.0 . . .	2.1	2.8	2.5	2.2
2.0 . . .	2.2	3.4	2.8	2.5
3.0 . . .	2.4	3.9	3.1	2.7
4.0 . . .	2.4	4.4	3.3	2.8
e_0 = 40				
GRR =				
1.0 . . .	2.2	3.4	3.0	2.6
2.0 . . .	2.3	4.5	3.7	3.0
3.0 . . .	2.4	5.4	4.2	3.0
4.0 . . .	2.5	6.3	4.7	3.0
e_0 = 60				
GRR =				
1.0 . . .	2.2	3.9	3.6	3.3
2.0 . . .	2.3	5.6	4.9	3.3
3.0 . . .	2.5	7.2	5.9	3.2
4.0 . . .	2.6	8.6	6.9	3.2
e_0 = 77.5				
GRR =				
1.0 . . .	2.2	4.5	4.4	4.4
2.0 . . .	2.3	7.2	6.8	3.5
3.0 . . .	2.5	9.8	9.2	3.3
4.0 . . .	2.6	12.5	11.5	3.2

Note: Figures are the average number of adult females per household in the female stable population multiplied by 2.

exceed 3. On average this means less than two married couples per household. In the extended family systems, by contrast, the large households are also extremely complex in the sense that they would contain (for certain levels of fertility and mortality) 5 or more adults and presumably 2 or more married couples.

Up until now, all calculations have assumed an average age at marriage of 20 years. What effect does variation of age at marriage have on household size? First of all, it should be noted that the interrelations mentioned above are largely independent of age at marriage. That is, roughly the same substantive conclusions would have emerged had Tables 1 through 5 assumed an average age at marriage of 15 or 25, instead of 20.

As for the direct effect of age at marriage on household size, within the limitations of the model, it would seem that later marriage yields larger households on average (assuming later marriage does not result in lower fertility). This is the case for almost all family systems, and all combinations of fertility and mortality. There are some exceptions for the stem family system when mortality and fertility both are low, but the differences are small, and the lack of sufficient refinements in the model would suggest that they not be emphasized.

Discussion

The above comments deal with the interrelations of household and demographic variables within the context of the model. How adequate are they as descriptions of these interrelations in the real world? To answer this question at least in part, it will be helpful to mention two kinds of limitations in the model as presented. The first are unrealistic assumptions that could be modified by changes in computational details. The second are limitations inherent in the basic approach used. The latter suggest the need for basically different analytic approaches to the problem.

In the first category, we can mention the following problems:

1. Whereas the model assumes universal marriage, in reality appreciable proportions of women never marry. The extent of non-marriage is thought to vary with family system, being slight in societies with extended family ideals, and relatively large in societies with nuclear or stem family systems. Since some proportion of permanent spinsters would remain in their parents' home, this non-marriage would tend to reduce the number of household heads and thus to increase average household size. The re-working of the models to build in appropriate assumptions regarding proportions married for each family system probably would have the net effect of reducing the size differences between extended and non-extended forms. If the assumptions regarding proportions married were introduced age for age, this would have the additional effect of relaxing the assumption that all marriage takes place at the average age at marriage.

2. In the above models, the proportion of women with their own households reaches 1.0 by age group 70–74 and remains at that level for age groups 75–79 and 80 and over. This assumption is unrealistic on two counts. First, the level of these headship rates is almost certainly too high. It is unlikely that empirical headship rates come close to 1.0 for any age-sex group under any family system. Second, the shape of the age-specific headship curve is incorrect. Empirical curves tend to reach a maximum in late adult years (in the 50's or 60's for males, a decade or so later for females) and then decline at the oldest ages. Some modifications of the model to take this into account would be feasible. Their net effect would be to increase the average size of household under all family systems.

3. The calculations presented above have been based on female stable populations. For most family systems, it probably would be more realistic, though more difficult practically, to compute household size using male stable population parameters. The effect of using male rather than female stable population is difficult to assess in advance. The later age at marriage would tend to increase household size. But the later average age at childbearing would tend to decrease the probability that a man's father would survive to any given age of the son, and to increase the number of heads in the son's generation, thus tending to decrease average household size.

Other shortcomings of our results would require a different approach. For instance, the models deal with stable conditions, and are not necessarily adequate as descriptions of changes in household size concomitant with demographic changes such as secular declines in mortality. For this purpose, it would be necessary to modify the calculations considerably so that they might be applied in the context of quasi-stable population models, or in the context of population projections.

A more basic shortcoming of the present approach is the limited detail of the household measures derived. It would be desirable to have more descriptive measures (such as number of married couples per household), distributions as well as averages, and descriptions of changes in size and composition over the family life cycle (e.g., by age of head of household). The generation of such detailed information would be best accomplished by a simulation of household formation and dissolution.

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