Chapter III

METHODS NOT USING HEADSHIP RATE

SIMPLE HOUSEHOLD-TO-POPULATION RATIO METHOD

Mainly because of the paucity of cross-tabulated census or sample survey data on household and family heads, it is not possible with developing countries to make an elaborate projection of households and families which takes into account the various factors affecting their future growth and structural changes. In those countries, it is frequently necessary to resort to population census data for estimating the future rate of growth of households. A crude estimate is obtained by taking the rate of growth of total households to be equal to the rate of growth of the population, or, similarly, by taking the same ratio of the number of households to the total population and applying it to the future population projections already prepared. This method clearly assumes that the average size of household remains constant during the projection period. It should be noted, however, that in many countries, the number of households may grow at a considerably different rate from that of the total population,[1] thus invalidating the general use of such a constant ratio method. A growth rate different from that for the population may therefore be used for households.

A better estimate of the future number of households may be obtained either (*a*) by calculating the rate of growth of the adult population of, for instance, 18 years and over, or between 20 and 65 or 25 and 70 years old, from the base year to the year of the projections, then applying this rate of growth to the number of households at the base year; (*b*) by applying the ratio between the number of households at the base year and the adult population for the same year, to the future adult population for the year of the projections, since household formation is usually confined to this section of the population.[2] As was seen, the number of persons in this kind of broad age group is little affected by the assumed trend of either fertility or mortality during the periods for which most projections are made, and hence it introduces relatively few errors to the projected population figures.[3] In the absence of data required for more refined methods, a frequently used method for estimating the future number of households is the application to the projected population total of a constant or changing ratio of the number of households to the adult population.

In geographical subdivisions such as provinces, states or cities, the demand for household and family projections has recently increased, but available basic demographic statistics on households and families are much more limited than for the nation as a whole and, for this reason, projections by more refined methods may not be directly possible. In such circumstances, the above-mentioned type of simple ratio method may be employed, and the ratio may be extrapolated by modified exponential, logistic or other mathematical curves.[4]

An example of how to project households, using the ratio of the number of households to the population aged 20–64, will be shown below. Venezuela is the sample country here. Venezuela took two post-war censuses, in 1950 and 1961, from which data on both the age composition of the population and the number of households are available. The basic figures are as follows:

Year	*Number of households*	*Population aged 20–64*	*Ratio of the number of households to population aged 20–64*
1950	903 175	2 286 975	0.39492
1961	1 372 275	3 234 775	0.42423

The official population projections by five-year age group are readily available for the years 1965, 1970 and 1975.[5] Multiplication of the future projections of population for ages 20–64 by the future estimated ratio of the number of households to the population aged 20–64 will yield the projections of the number of households.

One important question is whether the ratio of the number of households to the population aged 20–64 will change in the future and, if so, in what way. From 1950 to

[1] This has clearly been seen in recent years in countries like Japan, where urban-rural migration has been swift and substantial in volume, and the nuclearization of the family has become a common phenomenon. From 1955 to 1960, the population growth rate in Japan was 0.91 per cent per annum, whereas the rate of growth of households was 2.84 per cent. From 1960 to 1965, the population growth rate was 1.02 per annum, whereas the rate of growth of households was 3.12 per cent. Eleven developed countries for which long-term data are available show continuous secular declines in average size of household, indicating that the growth of households has been faster than that of the population.

[2] Jacob S. Siegel, "Demographic information required for housing programmes with special reference to Latin America", revised version of a paper prepared for the Latin American Seminar on Housing Statistics and Programmes, held at Copenhagen in 1962, p. 42.

[3] H. V. Muhsam, "Population data and analyses needed in assessing present and future housing requirements", paper prepared for the United Nations Seminar on Evaluation and Utilization of Population Census Data in Asia and the Far East, held at Bombay, 20 June to 8 July 1960.

[4] Linear extrapolation can also be done, but it normally gives unrealistically high figures as the number of years increases.

[5] Gobierno de Venezuela, Dirección General de Estadística y Censos Nacionales, Oficina de Análisis Demográfico, *Proyección de la Población de Venezuela* (Caracas, 1963).

1961 the ratio increased from 0.39492 to 0.42423. The question arises as to whether the increase in the ratio will or can continue further. In this connexion, some of the countries whose historical experience may throw light on the future course of this index for Venezuela may be examined here.

For this purpose, five developed countries are selected, Canada, Denmark, Japan, Sweden and the United States of America, for which trends in the number of households and the age composition of the population are available for sufficiently long periods of time. An examination of long-range trends in this ratio would make it possible to assess an interrelationship between the change in the ratio and the tempo of demographic transition and modernization and to estimate future levels of the ratio. Sweden provides numbers of households since 1860, Canada since 1871, the United States of America since 1890, Denmark since 1901 and Japan since 1920. Numbers of households and population aged 20–64 for these countries are shown in table 4.

From table 4, which shows the trends of the five countries, the following points may be drawn:

(*a*) Although there were some fluctuations, secular increasing trends are clear in each of the five countries.

TABLE 4. HISTORICAL TRENDS IN THE RATIO OF THE NUMBER OF HOUSEHOLDS TO THE POPULATION AGED 20–64: SWEDEN, CANADA, UNITED STATES OF AMERICA, DENMARK AND JAPAN

Sweden			
Year	*Number of households (in thousands)*	*Population aged 20–64 (in thousands)*	*Ratio of number of households to population aged 20–64*
1860	892.5	2 011.3	0.44374
1870	1 017.3	2 144.7	0.47433
1880	1 152.3	2 356.4	0.48901
1900	1 368.3	2 555.1	0.53552
1910	1 471.6	2 792.7	0.52695
1920	1 607.3	3 121.7	0.51488
1930	1 743.3	3 492.5	0.49916
1945	2 361.8	4 125.2	0.57253
1950	2 385.1	4 253.7	0.56071
1960	2 581.2	4 354.8	0.59273
1965	2 777.7	4 537.4	0.61218

Canada			
Year	*Number of households (in thousands)*	*Population aged 20–64 (in thousands)*	*Ratio of number of households to population aged 20–64*
1871	622.7	1 562.6	0.39850
1881	800.4	1 961.2	0.40812
1891	900.1	2 299.8	0.39138
1901	1 058.4	2 696.0	0.39258
1911	1 483.0	3 809.2	0.38932
1921	1 897.1	4 539.8	0.41788
1931	2 275.2	5 478.9	0.41527
1941	2 706.1	6 420.3	0.42149
1951	3 409.3	7 614.5	0.44774
1956	3 923.6	9 222.6	0.42543
1961	4 554.7	8 449.3	0.53906
1966	5 180.5	10 045.9	0.51568

United States of America			
Year	*Number of households (in thousands)*	*Population aged 20–64 (in thousands)*	*Ratio of number of households to population aged 20–64*
1890	12 690.2	31 324.2	0.40512
1900	15 964.0	39 135.7	0.40791
1910	20 255.6	49 381.7	0.41018
1920	24 351.7	57 666.8	0.42228
1930	29 904.7	68 490.7	0.43662
1940	34 948.7	77 344.4	0.45186
1950	42 857.3	86 663.9	0.49452
1960	53 021.1	94 034.0	0.56385

Denmark			
Year	*Number of households (in thousands)*	*Population aged 20–64 (in thousands)*	*Ratio of number of households to population aged 20–64*
1901	556.7	1 216.5	0.45762
1911	649.4	1 390.0	0.46719
1921	794.8	1 710.7	0.46461
1930	940.5	1 994.0	0.47166
1940	1 158.1	2 295.2	0.50457
1950	1 330.8	2 472.7	0.53820
1960	1 544.4	2 560.8	0.60309
1965	1 663.3	2 676.4	0.62147

Japan			
Year	*Number of households (in thousands)*	*Population aged 20–64 (in thousands)*	*Ratio of number of households to population aged 20–64*
1920	11 101.1	26 910.0	0.41253
1925	11 879.2	28 641.5	0.41475
1930	12 582.0	31 000.8	0.40586
1935	13 378.1	33 574.9	0.39846
1940	14 218.9	35 202.3	0.40392
1950	16 580.1	41 090.1	0.40351
1955	17 959.9	46 103.7	0.38955
1960	20 656.2	50 693.5	0.40747
1965	24 081.8	56 076.1	0.42945

(*Source notes next page*)

Ratios have been increasing and are highly likely to continue to do so in the near future.

(*b*) In Sweden and the United States of America and especially in Denmark, the ratio exceeded the level of 50 per cent and even of 60 per cent. It is considered that a host of social and economic factors influenced such tendencies. Particularly in the case of Sweden, where the ratio had already reached the level of about 50 per cent at the beginning of the century, the increase may have been caused to a considerable extent by the process of aging due to the current fertility decline and to the emigration of the young working population from Sweden at the end of the nineteenth century and the beginning of the twentieth century.[6] A quick analysis of the ratios of the number of households to the population aged 20–64 for the five countries suggests that it would be realistic to assume that Venezuela may in the future reach the level of 50 per cent.

(*c*) A J- shaped or U-shaped curve seen in the figures for both Canada and Japan indicates interesting demographic and economic features of a very rapidly changing society. The population in the society is first subject to a mortality decline, causing a relative increase in non-head population in the age group 20–64, thus leading to an initial appreciable decline in the ratio of the number of households to the population aged 20–64. The population is later subject to a process of undoubling of households promoted by urban-rural migration, improvement in the housing shortage and so on, and thus the ratio is raised. Canada changed its definition of the term household in the 1951 census from that of the housekeeping unit to that of the housing (dwelling) unit, but as is evident in table 4, the effect of this appears to be insignificant in the J-shaped swing of the trend. Among developing countries, for example, the Republic of Korea has shown a similar J-shaped curve in the household-to-population ratio from 1950 to 1966, as shown below.

Year	*Number of households (in thousands)*	*Population aged 20–64 (in thousands)*	*Ratio of the number of households to population aged 20–64*
1955	3 801.9	9 508.5	0.39984
1960	4 378.0	11 029.0	0.39695
1966	5 191.5	12 810.1	0.40527

SOURCE

Heads for 1955: United Nations, *Demographic Yearbook, 1963*, pp. 708–709;

Heads for 1960: The card file in the Statistical Office of the United Nations;

Heads for 1966: The Bank of Korea, *Economic Statistics Yearbook, 1970* (Seoul, 1970), p. 9;

Population: United Nations, *Demographic Yearbook* for various years.

In view of the above observations concerning other countries, it is assumed that the ratio of the number of households to the population aged 20–64 for Venezuela will further continue to increase. On the basis of this hypothesis, an application is made of a modified exponential curve to the situation in Venezuela for which the ratio of the number of heads over the population aged 20–

[6] The Swedish statistics show that the number of emigrants as well as the excess of emigration over immigration became noticeably large after around 1880. The trend of this large outflow of presumably working-age population continued until about 1915, and then gradually tapered off; see Sweden, Statistiska Centralbyrån, *Historisk Statistik för Sverige*, table B.17, pp. 64–65. Denmark experienced somewhat similar tendencies in emigration, though on a much smaller scale and in a less distinct way, in the early twentieth century; see Denmark, Det Statistiske Department, *Befolkningsudvikling og Sundhedsforhold, 1901–1960*, table 30, p. 117. This was because the headship rate, in other words, the ratio of the number of heads of households to the population in the corresponding sex-age group, is normally lower in the younger than in the older working-age population, so that the emigration of a relatively smaller proportion of the younger age group would produce a larger ratio of the number of heads over the population aged from 20 to 64. At the same time, it is generally considered that, even in those early periods, younger people tended to have their own households separate from their parents, and older people tended to retain their headship by separating from their sons and daughters.

SOURCES:

Sweden

Households for 1860–1950: Statistiska Centralbyrån, *Historisk Statistik för Sverige, I: Befolkning, 1720–1950* (Stockholm, 1955), p. 34, table A.24.

Households for 1960: United Nations, *Demographic Yearbook, 1962*, pp. 410–411, table 12.

Population for 1860–1950: Statistika Centralbyrån, op. cit., p. 22, table A.16.

Population for 1960: United Nations, *Demographic Yearbook, 1962*, pp. 178–179, table 5.

Canada

Households for 1871–1931: Dominion Bureau of Statistics, *Seventh Census of Canada, 1931, Volume I: Population Summary* (Ottawa, 1936), p. 1396, table 106.

Households for 1941: Dominion Bureau of Statistics, *Eighth Census of Canada, 1931, Volume V: Dwellings, Households and Families* (Ottawa, 1947), table 1, p. 2.

Households for 1951–1961: Dominion Bureau of Statistics, *1961 Census of Canada*, Series 2.1, *Households and Families*, Bulletin 2.1 (Ottawa, 1963), p. 1-1.

Population for 1871–1931: Dominion Bureau of Statistics, *Seventh Census of Canada, Vol. I*, table 8, p. 387 and table 9, pp. 388–389.

Population for 1941, 1951, 1956 and 1961: Dominion Bureau of Statistics, *1961 Census of Canada*, Series 1.2, Bulletin 1.2-2 (Ottawa, 1962), table 20, pp. 20-1-2.

United States of America

Households for 1890–1950: Conrad Taeubner and Irene B. Taeuber, *The Changing Population of the United States*, Census Monograph Series (New York, John Wiley and Sons, Inc., 1958), table 54, p. 173.

Households for 1960: United States Bureau of the Census, *United States of America Census of Population: 1960, Vol. I: Characteristics of Population*, Part 1, "United States summary" (Washington, D.C. United States Government Printing Office, 1964), table 62, pp. 1–175.

Population for 1890–1950: United States Bureau of the Census, *United States Census of Population: 1950, Vol. II: Characteristics of Population*, Part 1, "United States summary" (Washington, D.C., United States of America Government Printing Office, 1953), table 39, pp. 1–93.

Population for 1960: United States Bureau of the Census, *United States Census of Population: 1960, Vol. I*, part 1, table 65, pp. 1–99.

Denmark

Households for 1901–1960: Denmark Det Statistiske Department, *Befolkningsudvikling og Sundhedsforhold, 1901–1960* (Copenhagen, 1966), Statistiske Undersøgelser Nr. 19, table 6.

Population for 1901–1960: *ibid.*, table 8, pp. 58–61.

Japan

Households for 1920–1950: Japan Bureau of Statistics, Office of the Minister, *Showa 25-nen Kokusei Chosa Hokokusho (Population census of 1950), Volume 8: Final Report*, table 16.1, p. 218.

Households for 1955: United Nations, *Demographic Yearbook, 1962*, pp. 404–405.

Households for 1960: Japan Bureau of Statistics, Office of the Prime Minister, *Showa 35-nen Kokusei Chosa Hokokusho (1960 Population Census of Japan), Volume 3: All Japan*, part 1, table 16, p. 452.

Households for 1965: Japan Bureau of Statistics, Office of the Prime Minister, *Showa 40-nen Kokusei Chosa Hokokusho (1965 Population census of Japan), Volume 3: Whole Japan*, part 1, "Age, sex, etc.", table 9, pp. 382–383.

Population for 1920–1960: Japan Bureau of Statistics, Office of the Prime Minister, *Showa 35-nen Kokusei Chosa Hokokusho (Population census of Japan, 1960), Nihon no Jinko (Population of Japan)* (Tokyo, 1963), table 20, pp. 340–345.

Population for 1965: Japan Bureau of Statistics, *Showa 40-nen Kokusei Chosa Hokokusho, Volume 3*, table 2, p. 78.

TABLE 5. AN EXAMPLE OF PROJECTING HOUSEHOLDS FOR VENEZUELA BY USING THE RATIO OF THE NUMBER OF HOUSEHOLDS TO THE POPULATION AGED 20–64

(1) Year (t)	(2) $\frac{t-1950}{11}$	(3) (2) × $\bar{1}$.9784362	(4) Antilog (3)	(5) (4) × 0.60508	(6) 1 − (5) *Estimated ratio for future years*	(7) *Population projection for ages 20–64 (in thousands)*	(8) (6) × (7) *Projections of households (in thousands)*
1965	1.36364	$\bar{1}$.9705947	0.93453	0.56547	0.43453	3 638	1 581
1970	1.81818	$\bar{1}$.9607931	0.91368	0.55285	0.44715	4 241	1 896
1975	2.27273	$\bar{1}$.9509913	0.89329	0.54051	0.45949	5 036	2 314

64 is available only for the two time-points of 1950 and 1961. Estimates of the ratio for the future years are made in the following formula:[7]

$$(E:1)\ h_t = 1 - (1 - h_{1950}) \times \left(\frac{1 - h_{1961}}{1 - h_{1950}}\right)^{\frac{(t-1950)}{11}}.$$

Where h_t denotes the ratio of total households to the population aged 20–64 in year t; h_{1950} denotes the said ratio in 1950 as obtained from the 1950 census; and h_{1961} denotes the ratio in 1961 as obtained from the 1961 census. The value of "11" (eleven) in $\frac{(t-1950)}{11}$ as the power in the equation means the number of years from 1950 to 1961.

The steps for computing h_t for the years 1965, 1970 and 1975 are shown below:

First, find the value of $\frac{(1 - h_{1961})}{(1 - h_{1950})}$

$$\frac{1 - h_{1961}}{1 - h_{1950}} = \frac{1 - 0.42423}{1 - 0.39493} = \frac{0.57577}{0.60508} = 0.95156$$

Then, obtain the logarithm of 0.95156
$\log 0.95156 = \bar{1}.9784362$

After having obtained the above value, find the values of $\frac{(t-1950)}{11}$ for 1965, 1970 and 1975 and multiply them by $\bar{1}$.9784362. The rest of the process of computation is made clear in the steps shown in table 5. Column (7) gives the United Nations population projections for age groups 20–64. The projected numbers of households for Venezuela by this ratio method are shown in column (8).

The limitation of the simple households-to-population ratio is obvious. In the first place, no matter how elaborate the technique of curve-fitting for projections, a simple ratio method lacks the dimension of structural change in the population, thus limiting the possibility of predicting the future number, size and composition of households. Secondly, this simple ratio method does not provide any of the several desirable types of by-products relating to the characteristics of households and families. For example, a future distribution of heads of household by sex and age may be wanted for many purposes, in addition to projections of the total number of households. It can be obtained as the by-product of calculation by the headship rate method, but the simple ratio method naturally cannot produce such a derivative. Furthermore, more refined procedures allow for alternative possibilities resulting from possible variations in the crucial factors affecting changes in the number of households and families, and hence permit some evaluation of the results in terms of the components which made up the final totals.[8]

LIFE-TABLE METHOD: THE BROWN–GLASS–DAVIDSON MODELS

S. P. Brown made for the United Kingdom a model distribution of the families in a hypothetical stationary population by sex, age and marital status, on the basis of the 1947 British Social Survey data.[9] Ruth Glass and F. G. Davidson used Brown's family distribution model for projecting future distributions of households and housing needs.[10]

Brown's calculation of a model distribution of stationary population by family units was actually based on two types of hypothetical population distribution, a stationary population distribution by sex, age and marital status, and a distribution of the number of married couples, widows and widowers, by number of children. Table 6 shows the stationary population distribution by sex, age and marital status that would ultimately be reached if the 1947 experiences of the United Kingdom in mortality and nuptiality were to continue, and births were to occur in the numbers required to maintain the over-all population at a constant level.

From table 6, it is possible to determine the number of families by size in the hypothetical stationary population of 100,000 persons, making the following assumptions: (*a*) that any child marrying before age 25 would move from his or her parents to form a new family unit; (*b*) that, on reaching age 25 without marrying, children would normally leave home and that the number of unmarried

[7] The formula in its general form was taken from the United States Bureau of the Census, "Illustrative projections of the number of households and families: 1960 to 1980", *Current Population Reports — Population Characteristics*, Series P-20, No. 90 (September 29, 1958), p. 9.

[8] Jacob S. Siegel, op. cit., p. 42.

[9] S. P. Brown, "Analysis of a hypothetical stationary population by family units — a note on some experimental calculations", *Population Studies* (London), vol. IV, No. 4 (March 1951), pp. 380–394.

[10] Ruth Glass and F. G. Davidson, "Household structure and housing needs", *Population Studies* (London), vol. IV, No. 4 (March 1951), pp. 395–420.

TABLE 6. THE BROWN MODEL OF STATIONARY POPULATION BY SEX, AGE AND MARITAL STATUS FOR THE UNITED KINGDOM

Age group	Men				Women			
	Single	*Married*	*Widowers*	*Total*	*Single*	*Married*	*Widows*	*Total*
0–4	3 718	—	—	3 718	3 547	—	—	3 547
5–9	3 668	—	—	3 368	3 508	—	—	3 508
10–14	3 646	—	—	3 646	3 491	—	—	3 491
15–19	3 608	12	—	3 620	3 354	116	—	3 470
20–24	3 007	570	2	3 579	2 195	1 236	5	3 436
25–29	1 580	1 941	10	3 531	847	2 534	15	3 396
30–34	832	2 632	19	3 483	408	2 914	33	3 355
35–39	585	2 815	28	3 428	293	2 947	72	3 312
40–44	490	2 826	42	3 358	247	2 874	139	3 260
45–49	437	2 763	56	3 256	222	2 743	225	3 190
50–54	397	2 626	81	3 104	203	2 536	352	3 091
55–59	358	2 406	118	2 882	189	2 225	540	2 954
60–64	315	2 087	172	2 574	173	1 833	751	2 757
65–69	262	1 673	232	2 167	152	1 362	954	2 468
70–74	201	1 196	272	1 669	125	857	1 074	2 056
75–79	133	721	252	1 106	93	406	1 020	1 519
80–84	69	327	180	576	56	125	745	926
85–89	27	109	87	223	26	22	385	433
90 and over	8	28	33	69	11	2	161	174
All ages	23 341	24 732	1 584	49 657	19 140	24 732	6 471	50 343

SOURCE: S. P. Brown, "Analysis of a hypothetical stationary population by family units — a note on some experimental calculations", *Population Studies* (London), vol. IV, No. 4 (March 1951), p. 392.

Note: the distribution of unmarried children under 25 is assumed to be as follows:

Children of married couples	29 587
Children of widows	1 980
Children of widowers	505
Orphans	100
Illegitimate children	1 570
TOTAL	33 742

children above that age continuing to reside with their parents would be roughly counterbalanced by the number below that age who ceased to live in the parental home for reasons other than marriage.[11]

Sizes of families, according to the above two assumptions, were determined by three sets of hypothetical population distributions, showing the numbers of unmarried children under age 25 separately for married couples, widows and widowers, using data from the 1946 British Family Census.[12] On the basis of these data, adjustments were made to convert the population distribution by number of children born into that by number of children living in the family and unmarried under age 25. The resultant table (table 7) of family distribution in a stationary population of 100,000 is clearly a hypothetical distribution of families, indicating a state which would ultimately be reached by the interactions of the various demographic factors of mortality, fertility, marriage and divorce.

Glass and Davidson maintained that it is unlikely that families and households would ever be identical, as not all unmarried adults or widowed people would be able or willing to live on their own. They might join other families, as relatives, boarders or domestic servants, and thus "households", as distinct from "families", would be formed. The previously shown distribution of biological families and the survivors of such families, and of single persons over the age of 25, represents, therefore, the upper limit of household formation.[13] Because of these assumptions, and because of the age structure of the stationary population of 100,000 persons, there is an extraordinarily high proportion of one-person and two-person families (62.0 per cent of all families),[14] a large total of separate families and a very small average size of family (2.4 persons per family).[15] Such figures do not provide a realistic picture of households as distinct from family structure. For the purpose of estimating housing needs, additional considerations would have to be introduced.

In order to obtain a more realistic picture of the household structure as distinct from the family structure, it is necessary to consider how many and which of the one-person families should be redistributed among other families, and to which families they would most likely be attached. One-person families were reallocated according to their 1947 distribution by their relationship to the households with which they lived;[16] the result is shown in table 8, example A. This is a more realistic estimate in the long run. In addition, Glass and Davidson prepared an alternative conversion, allowing for a considerable amount

[11] S. P. Brown, op. cit., p. 386.

[12] Many other kinds of special data for the marriage cohort were also taken from the British Family Census. S. P. Brown, op. cit., p. 385.

[13] Ruth Glass and F. G. Davidson, op. cit., pp. 395–396.

[14] It should be noted here that Brown's concept of "family" is different from that of the United Nations; for example, he regards one-person households as one-person families.

[15] Ruth Glass and F. G. Davidson, op. cit., p. 396.

[16] According to Glass and Davidson, those data were obtained from the report of the Government Social Survey (now part of the new Office of Population Censuses and Surveys) on *The British Household*, by P. G. Gray, based on a national sample inquiry carried out in 1947.

TABLE 7. THE BROWN MODEL OF STATIONARY POPULATION BY FAMILY UNIT FOR THE UNITED KINGDOM

Persons in family unit	*Age group (wife, widow, widower or single person over 25)*						
	Under 25	*25–34*	*35–44*	*45–54*	*55–64*	*65 and over*	*All ages*
1 b	3	3 696	1 683	1 473	2 053	6 435	15 343
2 a	741	1 405	891	1 384	2 668	2 626	9 715
b	4	26	93	227	388	111	849
3 a	460	2 043	1 926	1 878	1 047	118	7 472
b	—	15	63	151	127	12	368
4 a	120	1 174	1 466	1 162	269	20	4 211
b	—	5	25	58	30	—	118
5 a	28	457	515	374	44	5	1 423
b	—	2	19	39	18	—	78
6 a	3	218	508	273	21	2	1 025
b	—	—	6	10	—	—	16
7 or more a	—	151	515	209	9	2	886
b	—	—	7	15	—	—	22
All sizes: a	1 352	5 448	5 821	5 280	4 058	2 773	34 732
b	7	3 744	1 896	1 973	2 616	6 558	16 794
a + b	1 359	9 192	7 717	7 253	6 674	9 331	41 526
Total persons in above family units	3 511	22 261	25 516	21 219	13 391	12 432	98 330

SOURCE: S. P. Brown, op. cit., p. 394.
Note: the balance of the total population of 100,000 persons consists of 100 orphans and 1,570 unmarried illegitimate children under age 25.

[a] With married couples.
[b] Without married couples.

TABLE 8. THE BROWN–GLASS–DAVIDSON MODEL OF HYPOTHETICAL POPULATION; COMPARISON OF FAMILY AND HOUSEHOLD DISTRIBUTION FOR THE UNITED KINGDOM

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Household distribution					
	Original family distribution, families			*Example A, households*[a]			*Example B, households*[b]		
Number of persons per household	*Number*	*Percentage*	*Number of persons in each group*	*Number*	*Percentage*	*Persons*	*Number*	*Percentage*	*Persons*
1	15 343	37.0	15 343	8 269	23.6	8 269	3 459	11.2	3 459
2	10 564	25.4	21 128	9 223	26.4	18 446	8 349	27.0	16 698
3	7 840	18.9	23 520	7 416	21.2	22 248	8 635	27.9	25 905
4	4 329	10.4	17 316	5 237	15.0	20 948	5 221	16.9	20 884
5	1 501	3.6	7 505	2 241	6.4	11 205	2 345	7.6	11 725
6 or more	1 949	4.7	13 518	2 616	7.4	18 884	2 944	9.4	21 329
TOTAL	41 526	100.0	98 330[c]	35 002	100.0	100 000	30 953	100.0	100 000
Average household size (persons)			2.37			2.86			3.23
Percentage of households containing members other than immediate family		0.0			10.0–16.0			18.0–25.0	

SOURCE: Ruth Glass and F. G. Davidson, "Household structure and housing needs", *Population Studies* (London), vol. IV, No. 4 (March 1951), p. 398.
[a] A potential and perhaps, in the long run, more realistic future distribution of population within households by size.
[b] A probable and realistic future distribution in the short run.
[c] The balance of the total population of 100,000 persons — 100 orphans and 1,570 unmarried illegitimate children under age 25 — had not been allocated to families in the original distribution.

of doubling-up in households, as shown in table 8, example B. This estimate is probable in the short run, but realistic only for the present. In the first type of estimation, the members of nuclear-family households comprise 84.0 per cent of the population in households, and one-person households comprise 8.3 per cent. The alternative, on the other hand, shows 85.0 per cent as nuclear-family households and only 3.4 per cent as one-person households. At the same time, the first type of estimation derived directly from the Brown model without any doubling-up, consists of 83.0 per cent as nuclear-family households and 15.3 per cent as one-person households, the remaining 1.7 per cent being orphans and illegitimate children.[17]

Although Glass and Davidson did not give projections using actual figures, it is possible to obtain household projections by a simple method of prorating the projected

[17] Ruth Glass and F. G. Davidson, op. cit., p. 398.

TABLE 9. COMPUTATIONS OF HOUSEHOLD PROJECTIONS FOR THE UNITED KINGDOM ON THE BASIS OF THE BROWN–GLASS–DAVIDSON MODEL OF STATIONARY POPULATION AND HOUSEHOLD DISTRIBUTION, 1970 AND 1980

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			1970 projections				1980 projections	
Number of persons per household	Number of stationary population, example B	Number of stationary households, example B	Population (2) × 56 614 000[a] / 100 000	Households (3) × 56 614 000[a] / 100 000	Number of stationary population, example A	Number of stationary households, example A	Population (6) × 60 686 000[b] / 100 000	Households (7) × 60 686 000[b] / 100 000
			(in thousands)				(in thousands)	
1	3 459	3 459	1 958	1 958	8 269	8 269	5 018	5 018
2	16 698	8 349	9 453	4 727	18 446	9 223	11 194	5 597
3	25 905	8 635	14 666	4 889	22 248	7 416	13 501	4 500
4	20 884	5 221	11 823	2 956	20 948	5 237	12 713	3 178
5	11 725	2 345	6 638	1 328	11 205	2 241	6 800	1 360
6 or more	21 329	2 944	12 075	1 667	18 884	2 616	11 460	1 588
TOTAL	100 000	30 953	56 614	17 525	100 000	35 002	60 686	21 241
Average household size			3.23				2.86	

SOURCE: figures in columns (2), (3), (6) and (7) are based on table 8.

[a] Population projection for the United Kingdom, 1970, according to projection II published by the Organisation for Economic Co-operation and Development.

[b] Population projection for 1980, according to projection II.

total population by the stationary distribution of both population and households, as shown in table 9, columns (4), (5), (8) and (9). According to the report of the Organisation for Economic Co-operation and Development (OECD) on projections of European populations,[18] assuming net immigration, declining mortality and increasing fertility, projections for the United Kingdom give 56,614,000 households for 1970 and 60,686,000 for 1980. The application of the stationary distribution of both population and households as given in table 8, using the values of example B for 1970 and those of example A for 1980, results in the computation of projections of numbers of households and their members as shown in table 9. It should be noticed that average household sizes are naturally the same as those for the model household distributions.

Disadvantages in the life-table approach will be evident without much elaboration. First, this type of estimation of household and family distribution has no direct correspondence with the population projections by sex and age readily available for the United Kingdom. In general, population projections by sex and age can be made more easily and perhaps more reliably than those of numbers of households and families and other sectional population projections. Hence, the use of readily available population projections as the basis for household projections would be a labour-saving and more reliable way to meet the complex problems of the sectional projections.

Secondly, in Glass and Davidson's assumptions, when families were converted into households, allowance was made only for doubling-up involving one-person households and not for doubling-up among multiple-person households. Further, if this model were applied to other countries, doubling-up among multi-person households would still be recognized as important and widely prevalent in developing countries. It would be too simplistic to assume that there is no doubling-up among multi-person households in those countries.

Thirdly, in this life-table approach, it is necessary to go through so many stages of complicated computations, drawing upon so many different sources of detailed data regarding mortality, fertility, nuptiality, divorce, household formation, and so on, that the computational processes may be subject to much greater cumulated error. Even aside from the complexities in the methodological steps and procedures and the enormous amount of computational labour required, this method could hardly be used for developing countries where such elaborate types of statistical information are generally not available in a reliable form.

Fourthly, when projections are made on the basis of the stationary distribution of population and households as shown in table 9, the question inevitably arises whether the same stationary distribution of population and households by number of persons per household can appropriately be applied for future years. Even though — as stated by Glass and Davidson — the distribution and composition of the biological families in a hypothetical stationary population computed by Brown were very similar in age and sex structure to what is likely to exist in England and Wales in 1971,[19] there will be, of course, no guarantee of a similar population structure in later years and the chances are even more remote that there will be any close similarity in the household structure by number of persons per household.

In spite of the disadvantages referred to above, however, this type of life-table approach is theoretically a very interesting example of a demographic method of household projection, mobilizing advanced demographic techniques and substantive knowledge to shed light on a relatively unexplored field of family and household formation and dissolution. By this method, an estimation is made to obtain both an upper and lower limit of the projections, providing a theoretical range of projections between the

[18] Organisation for Economic Co-operation and Development, *Demographic Trends, 1965–1980, in Western Europe and North America* (Paris, 1966), Supplement: "Country reports".

[19] Ruth Glass and F. G. Davidson, op. cit., p. 395.

potential and short-term probable number of households. Perhaps some of the factors involved in computation are much less likely to be influenced by social and cultural, than by demographic factors, so that it might be easy to apply a series of demographic models for these factors. As will be indicated later, since the schedules of headship rates to be applied to developing countries might in effect over-emphasize the experience of the developed countries, further development of this type of demographic approach might supplement the method using the model headship rate. As seen in table 9 another merit of this life-table approach is that it can make projections of households by size of membership. As stated in part one, there has been a growing concern among government agencies and private enterprises over household and family projections by size.

VITAL STATISTICS METHOD

Theoretically, the cohort approach takes the "stock-flow" framework for projections of the number of households and families, highlighting the dynamic aspects of formation, growth and dissolution of households and families. This approach, however, has never actually been practised for household and family projections, for the reasons explained at the beginning of this chapter. In the demography of manpower, a multiple decrement table of working life can serve as a useful tool in the cohort approach for labour force projections.[20] On the other hand, in the demography of households and families, the similar idea of a "family life table" to show important phases of family formation, growth and dissolution, by age or by marriage duration of family head, has never really been validated. Such a table would show, at the same time, the average number of members of a family in each stage of family life. Without such a family life table, it would certainly be difficult to make any elaborate cohort approach to projections of households and families.

Wolfgang Illing made a "vital statistics" approach to household and family projections.[21] In this method, he dealt with the projection of families of married couples and then transformed these into households. This method has certain merits. First and foremost, family formation and dissolution can be related to changes affecting individual members such as marriages, divorces, and deaths in time-series trends, and the patterns of each can be studied separately. Accordingly, unlike other methods, by which projections are made only for the total stock of families and the net balance between the number of family formations and dissolutions, this method can provide information on the future trends of the various components.

The stock of families (F_t) at the end of a given year t may be summarized by the following balancing equation:

$$(E:2) \qquad F_t = F_0 + \sum_{j=1}^{t} (M_j - D_j^m - S_j + N_j^m)$$

where F_0 is designated as the stock of families at a given base year 0, M the sum of marriages, D^m deaths of married

[20] Harold Wool, *Tables of Working Life: Length of Working Life for Men* (United States Bureau of Labor Statistics, Washington, D.C., 1950), bulletin No. 1001; Stuart Garfinkle, *Tables of Working Life of Women* (United States Bureau of Labor Statistics, Washington, D.C., 1957), bulletin No. 1204.

[21] Wolfgang Illing, *Population, Family, Household and Labor Force Growth to 1980* (Ottawa, Economic Council of Canada, September 1967), Staff Study No. 19, pp. 49–69. A similar study was made by the Netherlands Central Bureau of Statistics. See, Centraal Bureau voor de Statistiek, *Statistische en Econometrische Onderzoekingen* (The Hague, 1959), p. 130.

TABLE 10. ESTIMATED NET FAMILY FORMATION FOR CANADA, 1950–1966
(In thousands)

(1) Year	(2) Marriages	(3) Net immigration of married females	(4) Deaths of married persons	(5) Divorces	(6) Net family formation	(7) Adjustment	(8) Number of families as of end of year
1950							3 264.0
1951	128.4	27.1	54.9	5.3	93.6	−1.7	3 357.6
1952	128.5	24.3	55.2	5.6	90.0	−2.0	3 447.6
1953	131.0	24.2	56.3	6.2	90.8	−1.9	3 538.4
1954	128.6	21.2	55.8	5.9	86.2	−1.9	3 624.6
1955	128.0	11.6	57.3	6.1	74.6	−1.6	3 699.2
1956	132.7	21.7	58.7	6.0	88.4	−1.3	3 787.6
1957	133.2	59.5	61.2	6.7	120.6	−4.2	3 908.2
1958	131.5	18.4	61.1	6.3	81.3	−1.2	3 989.5
1959	132.5	13.1	63.4	6.5	74.9	−0.8	4 064.4
1960	130.3	21.1	64.5	7.0	78.6	−1.3	4 143.0
1961	128.5	2.2	65.5	6.6	58.5	−0.1	4 201.5
1962	129.4	0.3	66.9	6.7	56.1	—	4 257.6
1963	131.1	4.3	68.4	7.7	59.3	—	4 316.9
1964	138.1	11.8	69.3	8.6	72.0	—	4 388.9
1965	145.5	18.7	70.0	9.0	85.2	—	4 474.1
1966[a]	155.3	26.6	71.4	10.0	100.5	—	4 574.6

SOURCE: Wolfgang M. Illing, *Population, Family, Household and Labor Force Growth to 1980* (Ottawa, Economic Council of Canada, September 1967), Staff Study No. 19, p. 67.

[a] 1966 census results not available when these estimates were prepared.

TABLE 11. PROJECTED NET FAMILY FORMATION FOR CANADA, 1967–1980
(In thousands)

(1) Year	(2) Marriages	(3) Net immigration of married females[a]	(4) Deaths of married persons	(5) Divorces	(6) Net family formation[a]	(7) Number of families as of end of year
1967	159.2	16.5	73.5	10.0	92.2	4 666.8
1968	167.0	16.5	74.9	10.0	98.7	4 765.5
1969	174.9	16.5	76.0	10.2	105.2	4 870.7
1970	182.8	16.5	77.4	10.6	111.3	4 982.0
1971	190.2	16.5	78.9	10.9	116.9	5 098.9
1972	197.4	16.5	80.3	11.2	122.4	5 221.3
1973	204.1	16.5	81.6	11.5	127.5	5 348.8
1974	210.6	16.5	83.5	11.8	131.8	5 480.6
1975	216.6	16.5	85.0	12.2	135.9	5 616.5
1976	222.2	16.5	86.6	12.5	139.6	5 756.1
1977	227.1	16.5	88.2	12.8	142.6	5 898.7
1978	232.2	16.5	89.9	13.2	145.6	6 044.3
1979	236.7	16.5	91.7	13.6	147.9	6 192.2
1980	240.7	16.5	93.7	14.0	149.5	6 341.7

SOURCE: Illing, op. cit., p. 68.
[a] Figures based on the average annual net immigration assumption of 70,000 persons to 1980, subject to considerable year-to-year fluctuations. For example, 1967 figure likely to be somewhat higher than indicated here.

TABLE 12. ESTIMATED AND PROJECTED HOUSEHOLDS FOR CANADA, 1950–1980
(As of end of year; in thousands)

(1) Year	(2) Families	(3) Households		(5)
		Family[a]	Non-family	Total
	Estimated			
1950	3 264	2 951	457	3 407
1951	3 358	3 029	469	3 497
1952	3 448	3 127	474	3 601
1953	3 538	3 224	482	3 705
1954	3 625	3 320	495	3 815
1955	3 699	3 403	512	3 915
1956	3 788	3 496	532	4 028
1957	3 908	3 623	555	4 178
1958	3 990	3 710	581	4 291
1959	4 064	3 796	609	4 405
1960	4 143	3 886	640	4 526
1961	4 202	3 962	672	4 634
1962	4 258	4 023	707	4 731
1963	4 317	4 092	743	4 835
1964	4 389	4 170	779	4 948
1965	4 474	4 259	814	5 074
1966	4 575	4 364	850	5 214
	Projected			
1967	4 667	4 462	882	5 344
1968	4 766	4 565	914	5 480
1969	4 871	4 676	946	5 622
1970	4 982	4 793	976	5 769
1971	5 099	4 915	1 007	5 922
1972	5 221	5 044	1 037	6 081
1973	5 349	5 178	1 067	6 245
1974	5 481	5 316	1 097	6 414
1975	5 617	5 459	1 128	6 587
1976	5 756	5 612	1 158	6 770
1977	5 899	5 763	1 188	6 951
1978	6 044	5 911	1 218	7 129
1979	6 192	6 062	1 248	7 310
1980	6 342	6 215	1 278	7 493

SOURCE: Illing, op. cit., p. 69.
[a] Total families, excluding those not maintaining a household.

persons, S divorces, and N^m net immigration of families respectively in year t.[22]

Table 10 shows illustrative estimates of net family formation for the years 1950–1966 according to the above equation, and table 11 gives projections in the same way for the years 1967–1980. As the components of change, marriages, deaths, divorces and net immigration are separately projected. Marriages, being regarded as the most important of all, are projected by applying the constant rate of marriage by sex and age to the corresponding population projections. The future magnitude of net immigration of married females was kept constant after 1967 inclusive.

The total of these four components is converted into the number of households by the following formula:

$$(E:3) \qquad H_t = \frac{h_t}{1 - n_t} F_t$$

where h_t is the ratio of the number of family households to the number of families, and n_t the ratio of non-family to total households.[23] Table 12 shows projections of households for the years 1967–1980 by the above conversion formula, together with the estimates for the years 1950–1966. Column (2) shows the stock of families, F_t, and column (5) shows the total number of households converted, H_t.

The 1941–1961 censuses provide data on the relationship between family households and families. The ratio between the two series (a rising one, as progressively more families are willing or able to set up their own households) was estimated annually by intercensal interpolation up to 1961, and was projected to 1980. The ratio was estimated to increase from 0.943 in 1961 to 0.980 in 1980. This is based on the assumption that further increases in living standards and the construction of suitable housing will enable all but a small residual proportion of total families to establish their own households.[24]

This approach is, of course, not free from methodological and practical limitations. First, methodologically, the above conversion from the number of families to that of households was not made specifically by sex and age, and hence, it does not take into consideration sex-age differentials in the relationship between family and household. Secondly, for practical reasons, it is again difficult to apply this method to other countries, particularly to developing ones, since complete and accurate marriage and divorce statistics are unavailable in most of those countries. Illing's method is an interesting and assiduous approach, but, like the Brown–Glass–Davidson models in the previous section, it has no correspondence to and no utilization of the already available population projections by sex and age, which can be prepared with more accuracy and facility under normal circumstances.

Finally, Illing's approach is not really a stock-flow model of formation and dissolution of family or household. It is concerned with inflows and outflows of individual vital events relating to family formation, namely with individual marriages, divorces, deaths and migrations. Although some marriages automatically create additional households and some deaths among family members immediately result in the dissolution of families, such factors do not necessarily constitute actual inflows and outflows of families and households as such.

[22] Illing, op cit., p. 52.
[23] *Ibid.*, p. 57.
[24] *Ibid.*, p. 57.