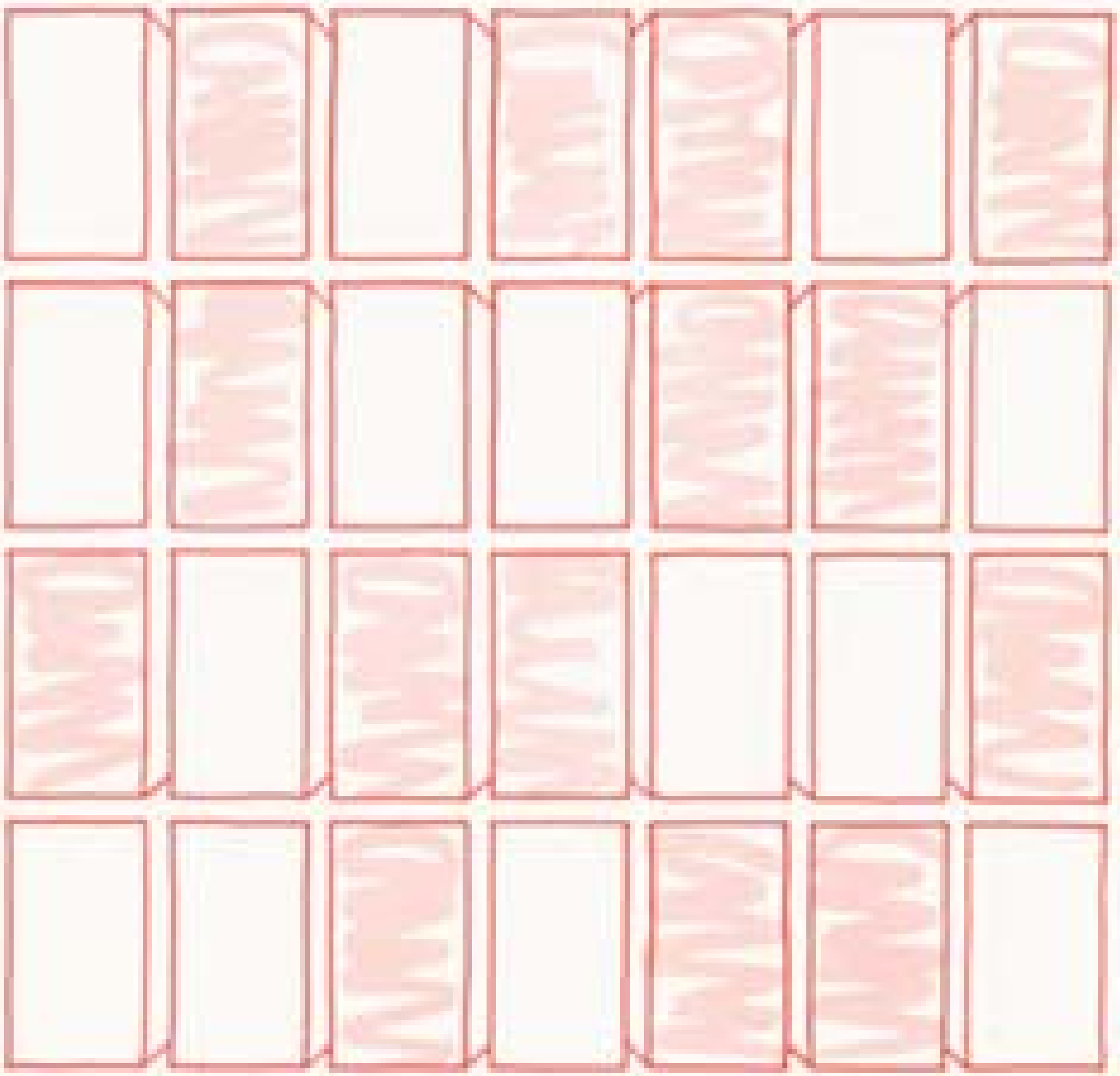
MortPak-

The United Nations Software Package for Mortality Measurement

Batch-oriented Software for the Mainframe Computer



United Nations

Department of International Economic and Social Affairs

ST/ESA/SER.R/78

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United Nations New York, 1988

NOTE

Symbols of United Nations documents are composed of capital letters combined with figures.

ST/ESA/SER.R/78

Printed in the United States of America

Preface

The present volume contains the working manual for MORTPAK, a software package for demographic measurement in developing countries, with special emphasis on mortality measurement. MORTPAK includes 16 applications in the areas of life-table and stable-population construction, graduation of mortality data, indirect mortality estimation, indirect fertility estimation, and other indirect procedures for evaluating age distributions and the completeness of censuses. The package incorporates developed techniques that take advantage of the United Nations model life tables and generalized stable-population equations.

The present document is one of two produced by the United Nations providing such software. It contains a batch-oriented interface which is designed for mainframe computer users but which nevertheless is easily installed on a microcomputer. An earlier publication, entitled MORTPAK-LITE - The United Nations Software Package for Mortality Measurement. Interactive Software for the IBM-PC and Compatibles,* includes identical demographic applications using software and data entry devised specifically for the microcomputer.

The Population Division of the Department of International Economic and Social Affairs of the United Nations Secretariat has long conducted demographic estimation and projection activities at the country level, incorporating methodological advances in the construction of model life tables, for example. As a by-product of these activities, an extensive body of computer software has been developed for the internal use of the Population Division. These computer programs have often been written in a way that permits easy transfer to facilities outside the Population Division. The Population Projection Program of the Population Division is probably the most well-known of these computer programs. It has been well documented (most recently in ESA/P/WP.77) and is used throughout the world. The present publication adds to the list of Population Division software and complements the Projection Program by providing a storehouse of techniques for demographic estimation.

MORTPAK has already been well tested and is now widely used for analysis of developing country data and in developing country institutions. For this, the Population Division would like to thank its colleagues from the Software and Support for Population Data Processing Project of the Department of Technical Co-operation for Development, who tested the package, trained demographic researchers in its use, and provided feedback on ways to improve its accessibility and relevance. We are also grateful to Eduardo Arriaga, who provided early versions of the FORTRAN coding for the FERTCB and FERTPF

* To be issued as a United Nations publication.

programs, The main program - subroutine design of MORTPAK, as well as the program MATCH - has its origins in the United States Census Bureau package, Computer Programs for Demographic Analysis (Arriaga, Anderson and Heligman, 1976). These origins are also gratefully acknowledged.

The Population Division would be pleased to receive comments on experiences in using MORTPAK that would enhance the international usefulness of future software development activities. For information about obtaining the MORTPAK software, please write to the Director, Population Division, United Nations, New York, NY 10017, USA.

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I. INTRODUCTION:

DEMOGRAPHIC PROCEDURES AND COMPUTER ASPECTS

This volume presents a set of 16 computer programs for undertaking demographic analyses in developing countries, including empirical and model life-table construction, graduation of mortality data, mortality and fertility estimation, and evaluation of census coverage and age distributions.

The package as presented here has been constructed for batch-type input data, that is, the necessary input data are entered into the machine by typing "card images" of certain numbers into designated columns. This input approach is usual for mainframe computer work environments. Nevertheless, these programs are easily downloaded onto microcomputers and will generally run without problems. In addition to this volume, a companion volume is also being issued, which describes a version of this software constructed specifically for the microcompter (MORTPAK-LITE: The United Nations Software Package for Mortality Measurement, Interactive Software for the IBH-PC and Compatibles). The most important difference between the two packages is that the microcomputer version includes a worksheet-style, full screen data entry procedure that reduces dependence on a manual and takes advantage of the interactive capabilities of the microcomputer.

A. The procedures

The 16 applications included have been selected by the Population Division as useful for evaluating demographic data from censuses and surveys and preparing reliable estimates of demographic parameters. These applications incorporate techniques for evaluation and estimation of demographic data, particularly those techniques that incorporate the United Nations model life-table system (United Nations, 1982) and generalized stable population equations (Preston and Coale, 1982).

Table 1, at the end of this chapter, presents a brief description of the applications, categorized according to their major functions: life-table and stable population construction, graduation of mortality data, indirect mortality estimation, indirect fertility estimation, and other indirect estimation procedures. The primary type of input data is also indicated. The package emphasizes mortality estimation, reflecting the larger number of techniques available and the further advanced mortality estimation is compared to that of other demographic components. (Of the nine chapters in the United Nations manual on Indirect Techniques for Demographic Estimation (United Nations, 1983), five are dedicated solely, and two partially, to mortality analysis.)

The LIFTB and STABLE programs calculate empirical life tables and stable populations respectively based on age-specific mortality rates, plus, in the latter case, an intrinsic growth rate. The life-table method used is based on the approach of Greville (1943), which permits calculation of age-specific separation factors based on the age pattern [trend] of the mortality rates themselves. It is, hence, potentially more accurate than methods which assume constant separation factors, and more robust, under developing country circumstances, than methods which estimate separation factors based on population age distributions. Although fertility decline is rendering calculation of stable populations less applicable for many countries, for others fertility has changed little and stable population analysis remains useful for evaluation of age distributions and rough approximation of birth and death rates.1/ In addition, the STABLE program is useful for static simulation of the effects of changed growth rates and/or mortality rates on age distribution.

The applications UATCH, COMPAR and BESTFT construct model life tables and compare or graduate empirical data with respect to a model life table. The procedure UATCH not only generates any United Nations or Coale and Demeny model life table but also enables the entering of a user-designated mortality pattern which then can be adjusted to correspond to any desired level. This user-designated model may be a pattern from a third model life-table system such as the Brass standard (Brass and others, 1968) but, perhaps, most importantly can be an age pattern of mortality for a particular country. In the latter case a demographer can generate a model life-table system specific for a country of interest by using WATCH to construct a series of life tables at different levels of life expectancy, all consistent with the country's average pattern. Comparison of an empirical set of age-specific mortality rates to model life-table patterns, through COMPAR, aids the demographer in the choice of a model life table. However, as data quality improves, the demographer will wish to retain as many characteristics of the original data as possible. COMPAR is then very useful for examining deviations of empirical mortality patterns from the models due to either true differences in age patterns or to data errors. Similarly, BESTFT offers the opportunity to graduate observed age-specific mortality rates with respect to a model life table (standard), either to smooth a series of observed rates or to estimate consistent rates for age groups in which data are lacking.

The procedures UNABR and ICM graduate mortality rates in traditional age grouping into single-year values; UNABR considers the entire age range and ICM under age 10 only. The procedures are of immediate use when undertaking single-year population projections or special studies of specific age groups such as the school-age population or the elderly.

1/ However, for countries whose fertility decline is recent and mortality change has not greatly altered the adult age distribution, STABLE could be useful for evaluating age distributions and studying population dynamics among adults.

The remaining programs all relate to indirect estimation of demographic parameters. The five procedures of CEBCS, ORPHAN, WIDOW, COUBIN and BENHR are mortality-specific. CEBCS provides estimates of infant and child mortality based on data of children ever born and children surviving tabulated either by age of mother or duration of her marriage. ORPHAN and WIDOW carry out variations of the maternal orphanhood or widowhood techniques to estimate levels of adult mortality. The procedure COUBIN "combines** early age mortality estimates (perhaps produced by CEBCS) with adult mortality estimates (perhaps produced by ORPHAN and WIDOW) and produces a full, consistent life table. The technique BENHR is an application of the Bennett-Horiuchi (1981) technique; it exploits the generalized stable population equation to estimate the completeness of death registration using population age distributions from two censuses and intercensal registered deaths.

Two fertility estimation techniques are included. FERTCB estimates age-specific fertility rates based on tabulations of average number of children ever born by age of woman. The essential methodology was developed by G. Uortara (1949). The variation included here was proposed by Arriaga (1983); it has the advantage of providing estimates of fertility change over time. In the same 1983 article, Arriaga presented an extension of the P/F technique originally developed by Brass (Brass and others, 1968). The Arriaga extension, presented in FERTPF, allows the demographer to estimate fertility at two points in time under conditions of fertility change. Children ever born data and the pattern of age-specific fertility are necessary from two enumerations when fertility has not been constant.

CENCT and PRESTO provide techniques for evaluating relative coverage and age recording in censuses, as well as estimates of intercensal mortality and fertility. CENCT provides an estimate of the coverage of one census relative to another and hence is an important first step before applying other estimation techniques which assume consistency in coverage between two censuses (such as BENHR and PRESTO). Based on two populations, tabulated by age, and the appropriate model life table, PRESTO enacts the "integrated method^w^ developed by Preston (1983), providing consistent estimates of the birth rate, life expectancy and intercensal age distributions.

B. Computer aspects

The computer software is written in FORTRAN IV for the IBM System/34. This version of FORTRAN is compatible with nearly all existent FORTRAN compilers. The programs will operate on a computer with relatively small memory; in the case of a microcomputer, 256K RAM is sufficient. One change in the FORTRAN source listings that is likely to be necessary is the assigned unit numbers for input and output. These programs use unit 5 for input and unit 6 for output. The unit numbers are specified by NREAD = 5 and NPRNT = 6 statements near the beginning of each program to ease the changing of unit numbers to conform to the computer facility's requirements.

If the programs are downloaded to a microcomputer, additional small modifications will probably be necessary. First, OPEN statements will be needed in the main programs to assign identifying unit numbers to the input and output data sets. The current assignments are as indicated above. Secondly, CHARACTER statements will need to be added to indicate that the variable is of CHARACTER (A format) and the number of bytes needed.

Chapter II contains the documentation for each procedure. This includes program description, required data, input entry instructions, and an illustrative example. Chapter III is intended for programmers and contains detailed computer information about the program subroutines and their argument strings. Chapter IV contains source listings of all the programs.

Table 1. Listing of procedures

Major function		Primary type of input data
LIFE-TABLE AND STABLE POPULATION CONSTRUCTION		
LIFTB	Construction of a life table based on a set of age-specific central death rates or age-specific probabilities of dying.	Age-specific mortality data
STABLE	Calculation of a stable age distribution based on a set of age-specific central death rates or age-specific probabilities of dying and the intrinsic rate of natural increase.	Age-specific mortality data
MODEL LIFE-TABLE CONSTRUCTION		
MATCH	Calculation and printing of United Nations, Coale-Demeny or user-designated model life tables corresponding to given levels of mortality. As the user-designated model can be a mortality pattern specific to a certain population, HATCH can generate a country-specific model life-table system.	Model life table entry point
COMPAR	Comparison of an empirical set of age-specific central death rates or age-specific probabilities of dying to all United Nations and Coale-Demeny model life-table patterns, and printing of indices of similarity.	Age-specific mortality data

Table 1. (continued)

Major function		Primary type of input data
BESTFT	Finding the one, two or three component United Nations model life table which best fits one or more probabilities of dying given as input.	Age-specific mortality data
GRADUATION OF MORTALITY DATA		
UNABR	Graduation of a set of age-specific probabilities of dying in age groups 0-1, 1-5, 5-10, ..., producing a smooth set of values and an estimated unabridged life table.	Age-specific mortality data
ICM	Estimation of single-year probabilities of dying for ages under five from probabilities of dying in age groups 0-1, 1-5 and 5-10.	Age-specific mortality data
INDIRECT MORTALITY ESTIMATION		
CEBCS	Indirect estimation of early age mortality from data on the average number of children ever born and the average number of children surviving, tabulated by either age group of mother or by duration of her marriage.	Survival of kin
ORPHAN	Indirect estimation of female adult mortality from tabulations on proportion of population with mothers still alive by age group of respondents.	Survival of kin
WIDOW	Indirect estimation of male and female adult mortality from data on proportion of the ever-married population whose first spouse is still living tabulated by age of respondent.	Survival of kin
COMBIN	Calculation of a **model" life table from an estimate of life expectancy at age 20 combined with an estimate of survivorship to age one, survivorship to age five, or both.	Model life table entry point
BENHR	Estimation of completeness of adult death registration based on population age distributions from two censuses and registered deaths by age for the intercensal period.	Population and deaths by age

Table 1. (continued)

Major function		Primary type of input data
INDIRECT FERTILITY ESTIMATION		
FERTCB	Estimation of age-.specific fertility rates from data on children ever born tabulated by age of mother recorded at either one or, optionally, two points in time.	Lifetime fertility
FERTPF	Estimation of age-specific fertility rates from data on children ever born tabulated by age of mother and the age pattern of fertility, recorded at either one or two points in time.	Lifetime and current fertility
OTHER INDIRECT ESTIMATION PROCEDURES		
CENCT	Estimation of completeness of one census relative to a second census from population age distributions from two censuses and either assumption of a United Nations or Coale-Demeny model life table or provision of registered deaths or death rates by age for the intercensal period.	Population by age
PRESTO	Provides integrated estimates of intercensal mortality, fertility and age distribution based on recorded age distributions from two censuses and assumption of a United Nations, Coale-Demeny or user-designated model life-table pattern.	Population by age

II. USER GUIDE: DESCRIPTION OF THE PROCEDURES, DATA REQUIRED AND INPUT INSTRUCTIONS

The present chapter contains, for each of the 16 procedures, a description of the procedure, data required and input instructions, and an example with sample input and sample output. For the classification of procedures according to their major functions, see table 1. For ease of reference, procedures are presented in alphabetical order.

Name of procedure: BENHR

Purpose of procedure. Estimates the completeness of adult death registration based on population age distributions from two censuses and registered deaths by age for the intercensal period.

Description of technique. Bennett and Horiuchi (1981) have shown that in a closed population the observed age distribution of deaths can be used in combination with two population age distributions and an age-specific growth rate factor to calculate the completeness of death registration above a certain age x, the age beyond which death registration can be assumed to be equally complete. The growth rate factors are calculated from age-specific intercensal population growth rates. The method, essentially, estimates completeness of death registration by using the growth-rate-transformed registered deaths to generate an independent estimate of the average intercensal population at an age above x; the ratio of this figure to that calculated from the two observed censuses provides an estimate of completeness of death registration above age x. The technique, therefore, provides a series of estimates of completeness of death registration due to the possibility of varying x from age 5 through the maximum age. If the two population censuses are equally complete, if death registration is equally complete for all ages above 5, and if there is no bias in age statement, this series will provide a more or less constant set of figures for completeness of death registration. Variance from a "constant" set of figures indicates that one or more of the above conditions does not hold. (Some systematic patterns of departures from constancy may reflect violations of particular assumptions and thus suggest appropriate directions for correcting the data (see Preston and others, 1980).)

The computer program calculates the median of the series of estimates and assumes this median is the best estimate of death registration completeness. This best estimate is then used to calculate an adjusted set of age-specific death rates and life expectancies for ages 5 and above. The entire procedure is carried out by the subroutine BENHR.

The method requires a preliminary estimate of life expectancy for the oldest age entered for the population age distribution. (For example, if the population age distribution has 80+ as the oldest age group entered, a preliminary estimate of life expectancy at age 80 is required.) This life expectancy is estimated within the computer program using a set of regression equations which relate life expectancy at age a to the ratio of registered deaths for age group 60 and over to registered deaths for age group 5 and over. These regressions were estimated from a set of data points simulated from stable populations generated from male and female model life tables from the United Nations General Pattern of life expectancy at birth varying from 35 years to 75 years, at one-year intervals, in conjunction with intrinsic growth rates varying from .015 to .035, at intervals of .005. The regression equations are

$$e(60) = 9.345 + 12.403\ D_{60+}/D_{5+}$$

$$e(65) = 7.535 + 10.072\ D_{60+}/D_{5+}$$

$$e(70) = 6.049 + 7.918\ D_{60+}/D_{5+}$$

$$e(75) = 4.890 + 5.965\ D_{60+}/D_{5+}$$

$$e(80) = 4.060 + 4.162\ D_{60+}/D_{5+}$$

$$e(85) = 3.379 + 2.836\ D_{60+}/D_{5+}$$

where e(a) is life expectancy at age a, and D_{60+}/D_{5+} is the ratio of intercensal registered deaths for age group 60+ to age group 5+.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A heading of up to 72 characters to be printed above the calculated table.
MONTH1	Indicates the month that the first census was taken (1 = January, 2 = February, ..., 12 = December).
IYEAR1	The year the first census was taken; for example, 1970.
MONTH2	Indicates the month that the second census was taken (1 = January, 2 = February, ..., 12 = December).
IYEAR2	The year the second census was taken; for example, 1970.
NVAL	Indicates the number of age groups given for the populations (POP1 and POP2) and for the registered deaths (DEATHS). NVAL must be between 13 and 18.
POP1	The population by age for the first census. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.

Mnemonic	Definition and comments
POP2	The population by age for the second census. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.
DEATHS	Registered deaths for the intercensal period. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.

<u>Data input</u>. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	MONTH1	1-2	Data must be punched to end in column 2.
	IYEAR1	4-7	The year must be punched to 4 digits; for example, 1970.
	MONTH2	9-10	Data must be punched to end in column 10.
	IYEAR2	12-15	The year must be punched to 4 digits; for example, 1970.
	NVAL	17-18	Data should be punched to end in column 18.
3	POP1	1-8	For age group 0-5. Decimal point should be punched in column 8.
		9-16	For age group 5-10. Decimal point should be punched in column 16.

Card	Mnemonic	Columns	Special comments
		17-24	For age group 10-15. Decimal point should be punched in column 24.
		. . .	
		65-72	For age group 40-45. Decimal point should be punched in column 72.
4	POP1	1-8	For age group 45-50. Decimal point should be punched in column 8.
		. . .	
		25-32	For age group 60-65. Decimal point should be punched in column 32.
		33-40	For age group 65-70. Decimal point should be punched in column 40. Leave blank if fewer values are given.
		41-48	For age group 70-75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49-56	For age group 75-80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57-64	For age group 80-85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65-72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.
5	POP2	1-8	For age group 0-5. Decimal point should be punched in column 8.
		9-16	For age group 5-10. Decimal point should be punched in column 16.

Card	Mnemonic	Columns	Special comments
		17–24	For age group 10–15. Decimal point should be punched in column 24.
		. . .	
		65–72	For age group 40–45. Decimal point should be punched in column 72.
6	POP2	1–8	For age group 45–50. Decimal point should be punched in column 8.
		. . .	
		25–32	For age group 60–65. Decimal point should be punched in column 32.
		33–40	For age group 65–70. Decimal point should be punched in column 40. Leave blank if fewer values are given.
		41–48	For age group 70–75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49–56	For age group 75–80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57–64	For age group 80–85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65–72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.
7	DEATHS	1–8	For age group 0–5. Decimal point should be punched in column 8.
		9–16	For age group 5–10. Decimal point should be punched in column 16.

Card	Mnemonic	Columns	Special comments
		17-24	For age group 10-15. Decimal point should be punched in column 24.
		.	
		.	
		.	
		65-72	For age group 40-45. Decimal point should be punched in column 72.
8	DEATHS	1-8	For age group 45-50. Decimal point should be punched in column 8.
		.	
		.	
		.	
		25-32	For age group 60-65. Decimal point should be punched in column 32.
		33-40	For age group 65-70. Decimal point should be punched in column 40. Leave blank if fewer values are given.
		41-48	For age group 70-75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49-56	For age group 75-80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57-64	For age group 80-85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65-72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.

Example

In the following example, estimated completeness of death registration and adjusted life expectancies for a hypothetical female population are calculated and printed. To calculate the completeness of death registration, e(80) was estimated to be 5.481 years (see footnote 1 in the sample output). It is used for calculation purposes only and not intended as the actual life expectancy at age 80. Footnote 2 indicates that death registration is 0.682 per cent complete; this value is used to adjust the death rates. These adjusted death rates are then used to calculate the life table.

FORTRAN Coding Form

PROGRAM | PROGRAMMER | DATE | PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | PAGE OF | CARD ELECTRO NUMBER

STATEMENT NUMBER | CONT. | FORTRAN STATEMENT | card number

```
HYPOTHETICAL FEMALES                                                        1
 6  1960   6  1970  17                                                      2
   65043.    52724.    45317.    39773.    34949.    30625.    26497.    22783.    19417.    3
   16461.    13799.    11385.     8989.     6641.     4381.     2498.     1382.              4
   79061.    64082.    55587.    48819.    42776.    37229.    32211.    27704.    23626.    5
   20095.    16903.    13853.    10963.     8113.     5364.     3051.     1682.              6
   30018.     4284.     1968.     1833.     1859.     1884.     1897.     1872.     1762.    7
    1627.     1698.     1897.     2193.     2470.     2541.     2155.     2348.              8
```

ICC.7 (6-60)

ESTIMATED COMPLETENESS OF DEATH REGISTRATION AND ADJUSTED LIFE EXPECTANCY (APPLICATION OF BENNETT-HORIUCHI TECHNIQUE)

HYPOTHETICAL FEMALES

AGE	POPULATION		GROWTH RATE	INTERCENSAL DEATHS		COMPLETENESS (1) OF DEATH REGISTRATION	ADJUSTED LIFE TABLE (2)	
	JUN 1960	JUN 1970		NUMBER	RATE		DEATH RATES	APPROX E(X)
0- 5	65043.	79061.	0.01952	30018.	.04186	...	.06136	...
5-10	52724.	64082.	0.01951	4284.	.00737	0.708	.01080	51.3
10-15	45317.	55587.	0.02043	1968.	.00392	0.680	.00575	49.0
15-20	39773.	48819.	0.02049	1833.	.00416	0.681	.00610	45.4
20-25	34949.	42776.	0.02021	1859.	.00481	0.679	.00705	41.7
25-30	30625.	37229.	0.01953	1885.	.00558	0.677	.00818	38.1
30-35	26497.	32211.	0.01953	1897.	.00649	0.677	.00952	34.6
35-40	22783.	27704.	0.01956	1872.	.00745	0.678	.01092	31.2
40-45	19417.	23626.	0.01962	1762.	.00823	0.680	.01206	27.8
45-50	16461.	20095.	0.01995	1627.	.00895	0.682	.01311	24.3
50-55	13799.	16903.	0.02029	1698.	.01112	0.683	.01630	20.8
55-60	11385.	13853.	0.01962	1897.	.01511	0.684	.02214	17.4
60-65	8983.	10963.	0.01992	2193.	.02210	0.685	.03239	14.1
65-70	6641.	8113.	0.02002	2470.	.03365	0.688	.04933	11.1
70-75	4381.	5364.	0.02024	2541.	.05242	0.691	.07684	8.6
75-80	2498.	3051.	0.02000	2155.	.07806	0.694	.11443	6.4
80+	1382.	1682.	0.01965	2348.	.15400	...	.22575	4.4
TOTAL	402658.	491119.	0.01986	64307.				

(1) FOR CALCULATION PURPOSES, E(80) ASSUMED EQUAL TO 5.481
(2) BASED ON MEDIAN COMPLETENESS OF 0.682

Name of procedure: BESTFT

<u>Purpose of procedure</u>. To find the one-, two-, or three-component United Nations model life table which best fits one or more probabilities of dying ($_nq_x$ values) given as input.

<u>Description of technique</u>. Using least squares criteria, the United Nations model life table of a given pattern is found which best fits one or more $_nq_x$ values given as input. Simply the procedure is one of graduation with respect to a standard. When only one $_nq_x$ value is given, this program presents results identical to that of the program MATCH. The one-component model life table (i.e., those presented in United Nations, 1982, annex I) is presented, as well as the adjusted two- and three-component tables. However, at least two $_nq_x$ values must be given for estimation of the two-component table and at least three values for the three-component table. In place of the United Nations model, an alternative model supplied by the user can be given as input and the best fit of the empirical data to that model will be calculated. The calculations are carried out by the subroutine BESTFT (for a more detailed description of the methodology, see United Nations, 1982, chap. IV).

<u>Data required</u>. The following information is required for running the main program:

Mnemonic	Definition and comments
$LABEL_1$	A data description of up to 40 characters, to be included in the heading at the top of the page of output.
NSEX	Indicates whether the life table refers to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females.
NREG	Indicates the model life-table pattern to be used. The codes are: 0 = empirical age pattern 1 = UN Latin American model 2 = UN Chilean 3 = UN South Asian 4 = UN Far East Asian 5 = UN General

Mnemonic	Definition and comments
	If NREG = 0, the user is supplying the average pattern of mortality to be used as a model (see AVE below). The United Nations principal component equations are then used to adjust this pattern to the desired mortality level.
$LABEL_2$	This variable is used only if NREG above equals zero (user is supplying the model). It names the model supplied by the user and is printed in the table heading.
QXMX	The empirical set of $_nq_x$ values. The values are given only for those age groups (0-1, 1-5, 5-10, ...) available. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1. Data must be given for a minimum of 1 age group and a maximum of 18 (i.e., a full set from 0-1 to 80-85).
AVE	This variable is used only if NREG above equals zero. It consists of model $_nq_x$ values supplied by the user. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, $_nq_x$ values must be given through age group 60-65; as a maximum through age group 80-85.

<u>Data input</u>. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	$LABEL_1$	1-40	
2	NSEX	1	
	NREG	3	
	$LABEL_2$	20-51	
3	QXMX	1-6	For age group 0-1. Decimal point must be punched.

Card	Mnemonic	Columns	Special comments
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		22-27	For age group 10-15. Decimal point must be punched.
		29-34	For age group 15-20. Decimal point must be punched.
		36-41	For age group 20-25. Decimal point must be punched.
		43-48	For age group 25-30. Decimal point must be punched.
		50-55	For age group 30-35. Decimal point must be punched.
		57-62	For age group 35-40. Decimal point must be punched.
		64-69	For age group 40-45. Decimal point must be punched.
4	QXMX	1-6	For age group 45-50. Decimal point must be punched.
		8-13	For age group 50-55. Decimal point must be punched.
		15-20	For age group 55-60. Decimal point must be punched.
		22-27	For age group 60-65. Decimal point must be punched.
		29-34	For age group 65-70. Decimal point must be punched.
		36-41	For age group 70-75. Decimal point must be punched.
		43-48	For age group 75-80. Decimal point must be punched.

Card	Mnemonic	Columns	Special comments
		50-55	For age group 80-85. Decimal point must be punched.
	(Two cards must be included for the QXMX values. Available QXMX values must be punched in the appropriate columns; where QXMX values are not available the columns should be left blank. See sample input data for example.)		
5	AVE	1-6	For age group 0-1. Decimal point must be punched. This card is omitted if NREG does not equal zero.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		. . .	
		64-69	For age group 40-45. Decimal point must be punched.
6	AVE	1-6	For age group 45-50. Decimal point must be punched. This card is omitted if NREG does not equal zero.
		. . .	
		22-27	For age group 60-65. Decimal point must be punched.
		29-34	For age group 65-70. Decimal point must be punched. Leave blank if fewer values are given.
		36-41	For age group 70-75. Decimal point must be punched. Leave blank if fewer values are given.

Card	Mnemonic	Columns	Special comments
		43-48	For age group 75-80. Decimal point must be punched. Leave blank if fewer values are given.
		50-55	For age group 80-85. Decimal point must be punched. Leave blank if fewer values are given.

Example

In the following, three examples of the application of BESTFT are given for a hypothetical female population. In the first data set, a set of $_nq_x$ values for age groups 0-1, 1-5, ..., 75-80 are read in and the best fitting one-, two-, and three-component United Nations South Asian models are calculated. In the second example, an infant mortality rate (IMR) only is read in and the Latin American pattern with the same IMR is calculated. In the third example, mortality probabilities for age groups 0-1, 35-40, 40-45, and 45-50 only are read in and the best one-, two- and three-component fits to the Brass African Standard supplied by the user are calculated.

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC		PAGE OF
PROGRAMMER	DATE		PUNCH		CARD ELECTRO NUMBER*

FORTRAN STATEMENT — Card number

```
HYPOTHETICAL FEMALES (DATA SET 1)                                         1
2 3                                                                       2
.11856 .09301 .02970 .01687 .02066 .02531 .02866 .03173 .03560 .03986    3
.04466 .05829 .07924 .12069 .18452 .28516 .41943                          4
HYPOTHETICAL FEMALES (DATA SET 2)                                         1
2 1                                                                       2
.02800                                                                    3
                                                                          4
HYPOTHETICAL FEMALES (DATA SET 3)                                         1
2 0                      BRASS AFRICAN STANDARD                           2
.22000                                                   .04500 .06200    3
.08300                                                                    4
.11980 .10668 .04591 .01866 .03151 .04264 .04410 .04628 .05223 .06155    5
.07751 .10204 .13522 .19042 .25857 .36975 .49333 .59211                  6
```

ICC.7 (0-801)

CALCULATION OF ONE, TWO AND THREE COMPONENT FITS TO HYPOTHETICAL FEMALES (DATA SET 1)
DATA FOR THE FEMALE SEX USING AS A MODEL THE UNITED NATIONS SOUTH ASIAN PATTERN

AGE	EMPIRICAL Q(X,N) VALUES	PREDICTED Q(X,N) VALUES BASED ON		
		ONE COMPONENT	TWO COMPONENTS	THREE COMPONENTS
0	0.11856	0.15081	0.13660	0.11630
1	0.09301	0.12532	0.11306	0.11762
5	0.02970	0.02903	0.02972	0.02858
10	0.01687	0.01241	0.01255	0.01212
15	0.02066	0.01789	0.01808	0.02156
20	0.02531	0.02172	0.02219	0.02866
25	0.02866	0.02326	0.02370	0.02856
30	0.03173	0.02711	0.02723	0.02990
35	0.03560	0.03094	0.03093	0.03217
40	0.03986	0.03684	0.03675	0.03268
45	0.04466	0.04722	0.04751	0.04086
50	0.05829	0.07047	0.07127	0.05831
55	0.07924	0.10648	0.10846	0.08933
60	0.12069	0.16109	0.16385	0.13325
65	0.18452	0.22930	0.23604	0.20792
70	0.28516	0.32583	0.33853	0.32127
75	0.41943	0.44648	0.46405	0.45320
80	.....	0.55791	0.58670	0.61509

CALCULATION OF ONE, TWO AND THREE COMPONENT FITS TO HYPOTHETICAL FEMALES (DATA SET 2)
DATA FOR THE FEMALE SEX USING AS A MODEL THE UNITED NATIONS LATIN AMERICAN PATTERN

AGE	EMPIRICAL Q(X,N) VALUES	PREDICTED Q(X,N) VALUES BASED ON: ONE COMPONENT	TWO COMPONENTS	THREE COMPONENTS
0	0.02800	0.02800		
1	.....	0.00817		
5	.....	0.00206		
10	.....	0.00112		
15	.....	0.00139		
20	.....	0.00193		
25	.....	0.00266		
30	.....	0.00360		
35	.....	0.00538		
40	.....	0.00802		
45	.....	0.01209		
50	.....	0.01810		
55	.....	0.02878		
60	.....	0.04714		
65	.....	0.08119		
70	.....	0.13077		
75	.....	0.19539		
80	.....	0.31882		

CALCULATION OF ONE, TWO AND THREE COMPONENT FITS TO HYPOTHETICAL FEMALES (DATA SET 3)
DATA FOR THE FEMALE SEX USING AS A MODEL THE USER SUPPLIED PATTERN OF BRASS AFRICAN STANDARD

AGE	EMPIRICAL Q(X,N) VALUES	PREDICTED Q(X,N) VALUES BASED ON ONE COMPONENT	TWO COMPONENTS	THREE COMPONENTS
0	0.22000	0.13147	0.21866	0.21962
1	.....	0.12537	0.19593	0.15391
5	.....	0.05470	0.03806	0.03671
10	.....	0.02226	0.01669	0.01581
15	.....	0.03778	0.02831	0.02121
20	.....	0.05109	0.03583	0.02489
25	.....	0.05230	0.03778	0.02842
30	.....	0.05433	0.04351	0.03586
35	0.04500	0.06022	0.05074	0.04464
40	0.06200	0.06944	0.06088	0.06404
45	0.08300	0.08590	0.07293	0.08102
50	.....	0.11160	0.09325	0.11056
55	.....	0.14627	0.11832	0.14149
60	.....	0.20355	0.16865	0.20501
65	.....	0.27299	0.21208	0.24340
70	.....	0.38590	0.28569	0.30881
75	.....	0.51018	0.37826	0.39951
80	.....	0.60576	0.40212	0.39539

Name of procedure: CEBCS

<u>Purpose of procedure</u>. To estimate early age mortality from data on the average number of children ever born and the average number of children surviving, tabulated either by age group of mother or by duration of her marriage.

<u>Description of technique</u>. Brass (Brass and others, 1968) has shown that the probability of dying between birth and age a (denoted as q(a)) can be estimated as $q(a) = {}_5M_x \cdot {}_5D_x$ where ${}_5D_x$ refers to the proportion of children dead to women in age group (x, x+5) and ${}_5M_x$ is an age-specific factor, called a multiplier, which depends on indices of the age pattern of fertility. Under this system, the proportion of children dead for women in age groups 15-20, 20-25, 25-30, ..., 45-50 are used to calculate q(a) for values of a equal to 1, 2, 3, 5, 10, 15 and 20, respectively. Sullivan (1972) later showed that the same type of relationship holds when data are tabulated by duration of marriage. In this case, durations of marriage for 0-5 years, 5-10 years, ..., 30-35 years correspond to q(a) for ages 2, 3, 5, 10, 15, 20 and 25 respectively. Through simulations, regression equations have been developed which relate the multipliers ${}_5M_x$ to indices of the fertility schedule. Nine separate sets of regression equations have been estimated, the first five for each of the United Nations models (see Palloni and Heligman, 1985) and the last four for each of the Coale and Demeny models (the Trussell regressions, see United Nations, 1983). Through a second set of simulations, regression equations have also been developed, from the same set of independent variables, which estimate the time reference to which these q(a) values refer. The independent variables that estimate the q(a) values, as well as the time references, are calculated from the input data to the main program. In addition to the proportion of dead children by age group or marital duration of woman, variables needed are the ratio of average number of children ever born for women in the first age or marital duration group to that in the second age or marital duration group (PAR1), the ratio of average number of children ever born for women in the second group to that in the third group (PAR2), and the mean age of mother at childbearing in the population (AGE). The last variable is used only for calculations based on the United Nations models; an approximate estimate of AGE is produced by the procedures FERTCB and FERTPF. The procedure is performed by subroutine CEBCS; subroutine MATCH calculates estimates of the infant mortality rate (${}_1q_0$), the probability of dying between ages 1 and 5 (${}_4q_1$), and the life expectancy at birth, which corresponds to the q(a) values within each model life-table pattern (both sexes combined).

<u>Data required</u>. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be included in the heading at the top of the page of output.
MONTH	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December).
NYEAR	The year of the enumeration.
NOPT	Indicates whether the data are tabulated by age group of mother (NOPT = 1), or by duration of her marriage (NOPT = 2).
AGE	Mean age of mother at childbearing in the population. This variable is only used when NOPT = 1.
CEB	The average number of children ever born to a woman. If NOPT = 1, the data are given by age groups (15-20, 20-25, ..., 45-50); if NOPT = 2, the data are given by duration of marriage (0-5 years, 5-10 years, ..., 30-35 years).
CS	The average number of children surviving per woman, either by her age group (NOPT = 1), or by duration of her marriage (NOPT = 2).

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	MONTH	1-2	Data should be punched to end in column 2.
	NYEAR	4-7	The year should be punched to four digits, for example, 1970.
	NOPT	9	

Card	Mnemonic	Columns	Special comments
	AGE	11-15	Value should be punched with the decimal point in column 13. Only used if NOPT = 1; leave blank if NOPT = 2.
3	CEB	1-5	For age group 15-20 (NOPT = 1), or marital duration group 0-5 years (NOPT = 2).
		7-11	For age group 20-25 (NOPT = 1), or marital duration group 5-10 years (NOPT = 2).
		13-17	For age group 25-30 (NOPT = 1), or marital duration group 10-15 years (NOPT = 2).
		. . .	
		37-41	For age group 45-50 (NOPT = 1), or marital duration group 30-35 years (NOPT = 2).
4	CS	1-5	For age group 15-20 (NOPT = 1), or marital duration group 0-5 years (NOPT = 2).
		7-11	For age group 20-25 (NOPT = 1), or marital duration group 5-10 years (NOPT = 2).
		13-17	For age group 25-30 (NOPT = 1), or marital duration group 10-15 years (NOPT = 2).
		. . .	
		37-41	For age group 45-50 (NOPT = 1), or marital duration group 30-35 years (NOPT = 2).

Example

In the following example, mortality data are given for two hypothetical populations. In the first data set, the children ever born and children surviving are given by age group of mother. In the second data set, the data are tabulated by duration of marriage. The coded input and resulting output appear as follows:

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE OF
PROGRAMMER	DATE		PUNCH	CARD ELECTRO NUMBER*

STATEMENT NUMBER / CONT. / FORTRAN STATEMENT	card number
HYPOTHETICAL POPULATION (DATA SET 1)	1
1 1974 1 26.00	2
0.154 1.129 2.562 4.008 5.237 5.956 6.243	3
0.138 0.999 2.240 3.477 4.432 4.946 5.013	4
HYPOTHETICAL POPULATION (DATA SET 2)	1
8 1970 2	2
0.242 1.506 3.165 4.504 5.569 6.019 6.154	3
0.214 1.306 2.700 3.794 4.596 4.806 4.779	4

ICC.7 (6-66)

INDIRECT ESTIMATION OF EARLY AGE MORTALITY FOR HYPOTHETICAL POPULATION (DATA SET 1)

ENUMERATION OF JAN 1974 — PROBABILITY OF DYING BEFORE AGE X

AGE OF WOMAN	CHILDREN BORN	CHILDREN SURVIVING	PROPORTION DEAD	AGE X	UN (PALLONI-HELIGMAN EQUATIONS) LAT AM	CHILEAN	SO ASIAN	FAR EAST	GENERAL	COALE-DEMENY (TRUSSELL EQUATIONS) WEST	NORTH	EAST	SOUTH
15-20	0.154	0.138	.104	1	.106	.117	.106	.106	.106	.115	.113	.116	.110
20-25	1.129	0.999	.115	2	.124	.126	.125	.122	.123	.123	.118	.123	.123
25-30	2.562	2.240	.126	3	.130	.130	.129	.127	.127	.127	.122	.127	.129
30-35	4.008	3.477	.132	5	.133	.134	.135	.132	.132	.135	.132	.134	.136
35-40	5.237	4.432	.154	10	.156	.154	.157	.153	.155	.159	.162	.159	.161
40-45	5.956	4.946	.170	15	.165	.167	.170	.164	.165	.173	.177	.173	.174
45-50	6.243	5.013	.197	20	.193	.193	.196	.190	.193	.199	.201	.199	.199

AVERAGE AGE AT CHILDBEARING = 26.00

CORRESPONDING MORTALITY INDICES

INFANT MORTALITY RATE

AGE OF WOMAN	REFERENCE DATE	UN (PALLONI-HELIGMAN EQUATIONS) LAT AM	CHILEAN	SO ASIAN	FAR EAST	GENERAL	REFERENCE DATE	COALE-DEMENY (TRUSSELL EQUATIONS) WEST	NORTH	EAST	SOUTH
15-20	DEC 1972	.106	.117	.106	.106	.106	JAN 1973	.115	.113	.116	.110
20-25	OCT 1971	.098	.113	.099	.100	.100	NOV 1971	.102	.093	.107	.099
25-30	APR 1970	.093	.110	.094	.095	.095	JAN 1970	.097	.086	.105	.097
30-35	MAR 1968	.087	.108	.091	.091	.090	OCT 1967	.094	.082	.103	.095
35-40	SEP 1965	.092	.117	.097	.095	.096	APR 1965	.101	.087	.113	.103
40-45	DEC 1962	.093	.122	.101	.095	.097	AUG 1962	.103	.088	.117	.105
45-50	JUL 1959	.101	.130	.110	.098	.103	AUG 1959	.109	.092	.126	.112

CHILD MORTALITY RATE

AGE OF WOMAN	REFERENCE DATE	UN (PALLONI-HELIGMAN EQUATIONS) LAT AM	CHILEAN	SO ASIAN	FAR EAST	GENERAL	REFERENCE DATE	COALE-DEMENY (TRUSSELL EQUATIONS) WEST	NORTH	EAST	SOUTH
15-20	DEC 1972	.071	.033	.063	.059	.061	JAN 1973	.061	.086	.041	.063
20-25	OCT 1971	.061	.031	.056	.053	.055	NOV 1971	.050	.064	.037	.050
25-30	APR 1970	.056	.029	.052	.049	.050	JAN 1970	.047	.057	.035	.047
30-35	MAR 1968	.051	.028	.048	.045	.046	OCT 1967	.045	.054	.035	.045
35-40	SEP 1965	.056	.033	.054	.049	.051	APR 1965	.050	.058	.040	.054
40-45	DEC 1962	.056	.035	.058	.049	.051	AUG 1962	.051	.059	.042	.057
45-50	JUL 1959	.064	.039	.068	.051	.058	AUG 1959	.056	.063	.047	.065

LIFE EXPECTANCY AT BIRTH

AGE OF WOMAN	REFERENCE DATE	UN (PALLONI-HELIGMAN EQUATIONS) LAT AM	CHILEAN	SO ASIAN	FAR EAST	GENERAL	REFERENCE DATE	COALE-DEMENY (TRUSSELL EQUATIONS) WEST	NORTH	EAST	SOUTH
15-20	DEC 1972	52.8	54.8	56.7	45.8	51.3	JAN 1973	51.0	48.7	55.1	55.6
20-25	OCT 1971	55.1	55.7	58.3	47.5	52.9	NOV 1971	53.6	53.2	56.6	58.3
25-30	APR 1970	56.4	56.2	59.4	48.6	54.3	JAN 1970	54.6	54.9	57.0	59.1
30-35	MAR 1968	57.8	56.6	60.2	49.9	55.4	OCT 1967	55.1	55.8	57.2	59.5
35-40	SEP 1965	56.5	54.8	58.7	48.7	54.1	APR 1965	53.8	54.7	55.7	57.5
40-45	DEC 1962	56.3	54.0	57.8	48.7	53.9	AUG 1962	53.3	54.5	55.0	56.8
45-50	JUL 1959	54.3	52.2	55.8	48.1	52.3	AUG 1959	52.2	53.6	53.5	55.1

INDIRECT ESTIMATION OF EARLY AGE MORTALITY FOR HYPOTHETICAL POPULATION (DATA SET 2)

ENUMERATION OF AUG 1970					PROBABILITY OF DYING BEFORE AGE X								
					UNITED NATIONS MODELS (PALLONI-HELIGMAN EQUATIONS)					COALE-DEMENY MODELS (TRUSSELL EQUATIONS)			
DURATION OF MARRIAGE	CHILDREN BORN	CHILDREN SURVIVING	PROPORTION DEAD	AGE X	LAT AM	CHILEAN	SO ASIAN	FAR EAST	GENERAL	WEST	NORTH	EAST	SOUTH
0- 5	0.242	0.214	.116	2	.149	.144	.150	.141	.147	.143	.143	.140	.148
5-10	1.506	1.306	.133	3	.151	.147	.151	.147	.149	.145	.144	.144	.149
10-15	3.165	2.700	.147	5	.164	.157	.164	.160	.162	.158	.159	.156	.161
15-20	4.504	3.794	.158	10	.178	.171	.176	.175	.177	.174	.182	.172	.176
20-25	5.569	4.596	.175	15	.195	.189	.192	.196	.195	.196	.204	.192	.195
25-30	6.019	4.806	.202	20	.225	.209	.218	.234	.228	.231	.237	.224	.227
30-35	6.154	4.779	.223	25	.251	.252	.240	.267	.255	.259	.259	.250	.252

CORRESPONDING MORTALITY INDICES

DURATION OF MARRIAGE	REFERENCE DATE	UNITED NATIONS MODELS (PALLONI-HELIGMAN EQUATIONS) LAT AM	CHILEAN	SO ASIAN	FAR EAST	GENERAL	REFERENCE DATE	COALE-DEMENY MODELS (TRUSSELL EQUATIONS) WEST	NORTH	EAST	SOUTH
INFANT MORTALITY RATE											
0- 5	AUG 1968	.115	.127	.117	.114	.117	JUL 1969	.117	.111	.121	.116
5-10	NOV 1967	.105	.124	.108	.108	.109	MAR 1968	.109	.100	.117	.108
10-15	JUL 1966	.103	.125	.107	.107	.107	JUN 1966	.109	.097	.119	.107
15-20	OCT 1964	.103	.128	.107	.106	.107	JUN 1964	.110	.096	.121	.109
20-25	AUG 1962	.107	.136	.112	.110	.111	SEP 1962	.116	.100	.129	.115
25-30	DEC 1959	.114	.139	.121	.115	.118	DEC 1960	.125	.107	.142	.123
30-35	OCT 1956	.117	.151	.126	.115	.120	MAR 1958	.128	.107	.147	.126
CHILD MORTALITY RATE											
0- 5	AUG 1968	.081	.038	.075	.067	.072	JUL 1969	.062	.084	.044	.071
5-10	NOV 1967	.069	.036	.065	.061	.063	MAR 1968	.056	.072	.042	.061
10-15	JUL 1966	.067	.037	.064	.059	.061	JUN 1966	.056	.069	.043	.060
15-20	OCT 1964	.066	.038	.064	.059	.061	JUN 1964	.056	.067	.044	.062
20-25	AUG 1962	.071	.042	.069	.062	.065	SEP 1962	.061	.071	.049	.069
25-30	DEC 1959	.079	.044	.079	.068	.072	DEC 1960	.069	.078	.055	.080
30-35	OCT 1956	.082	.052	.085	.067	.074	MAR 1958	.071	.079	.058	.084
LIFE EXPECTANCY AT BIRTH											
0- 5	AUG 1968	50.6	52.8	54.3	43.9	48.8	JUL 1969	50.7	49.2	54.3	53.9
5-10	NOV 1967	53.2	53.5	56.4	45.5	50.9	MAR 1968	52.1	51.6	55.0	56.1
10-15	JUL 1966	53.7	53.3	56.6	45.8	51.3	JUN 1966	52.2	52.3	54.7	56.3
15-20	OCT 1964	53.8	52.6	56.6	46.0	51.4	JUN 1964	52.1	52.6	54.3	55.8
20-25	AUG 1962	52.8	51.2	55.5	45.1	50.4	SEP 1962	50.9	51.7	53.1	54.4
25-30	DEC 1959	51.0	50.5	53.5	43.7	48.7	DEC 1960	49.2	50.2	51.2	52.3
30-35	OCT 1956	50.3	48.2	52.4	43.8	48.2	MAR 1958	48.8	50.2	50.5	51.6

Name of procedure: CENCT

<u>Purpose of procedure</u>. Estimation of completeness of one census relative to a second census from population age distributions from two censuses and either assumption of a United Nations or Coale-Demeny model life table or provision of registered deaths or death rates by age for the intercensal period.

<u>Description of technique</u>. Hill (1987) has shown that in any population closed to migration, the following equation holds for an intercensal period:

$$\frac{N(a)}{N(a+)} - r(a+) = \frac{1}{t} \ln \frac{1}{K} + \frac{K^{\frac{1}{2}}}{C} \frac{D(a+)}{N(a+)}$$

where N(a) and N(a+) are the number of person years lived at exact age a, and at ages a and over, respectively, during an intercensal period, r(a+) is the cumulative age-specific growth rate, D(a+) is registered intercensal deaths for ages a and over, t is the length of the intercensal period, K is completeness of the second census enumeration relative to the first, and C is completeness of death registration during the intercensal period. Values of K and C are assumed to be invariant with age.

In practice, N(a) and N(a+) are calculated from census population age-sex counts, as

$$N(a) = t \cdot ({}_5P1_{a-5} \cdot {}_5P1_a \cdot {}_5P2_{a-5} \cdot {}_5P2_a)^{\frac{1}{4}}$$

and

$$N(a+) = t\,(P1_{a+} \cdot P2_{a+})^{\frac{1}{2}}$$

where P1 and P2 refer to the population counts at the first and second census respectively. The cumulative age-specific growth rate is calculated as

$$r(a+) = \frac{1}{t} \ln (P2_{a+}/P1_{a+})$$

The equation follows directly from Martin's (1980) generalization of the Brass growth-balance equation. The equation indicates that the ratio of intercensal deaths to the intercensal population is linearly related to a measure easily calculated from two population censuses. The intercept of the fitted line allows calculations of the coverage of the second census count relative to that of the first census ($K = e^{It}$ where I is the intercept). The value of K can therefore be considered a multiplicative adjustment factor. When applied to the first census, it produces consistency in coverage to the second census. The computer program estimates the intercept through ordinary least squares regression. (It should be noted that the value of K, along with the value of the slope, provides an estimate of the completeness of death registration.)

Intercensal deaths can be provided in either of two ways. As one option a United Nations, Coale-Demeny or user-designated model life table, considered appropriate to the intercensal period, is provided and the computer program estimates intercensal deaths from the life table central death rates and the two population age distributions. In the second option, absolute numbers of deaths by age for the intercensal period are given as input.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
$LABEL_1$	A data description of up to 40 characters, to be included in the heading at the top of the page of output.
MONTH1	Indicates the month that the first census was taken (1 = January, 2 = February, ..., 12 = December).
IYEAR1	The year the first census was taken; for example, 1970.
MONTH2	Indicates the month that the second census was taken (1 = January, 2 = February, ..., 12 = December).
IYEAR2	The year the second census was taken; for example, 1970.
NVAL	Indicates the number of age groups given for the populations (POP1 and POP2) and for the registered deaths (DEATHS), if given. NVAL must be between 14 and 18.
NOPT	Indicates the type of mortality data given as input. If NOPT=1, a model life table is selected. If NOPT=2, intercensal deaths by age are given.

Mnemonic	Definition and comments
NSEX	Indicates whether the life table refers to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females.
NREG	This variable is used only if NOPT = 1. NREG indicates the model life-table pattern to be used. The codes are: 0 = empirical age pattern 1 = UN Latin American model 2 = UN Chilean 3 = UN South Asian 4 = UN Far East Asian 5 = UN General 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South

The following variables, NPARM, NAGE and CMP, indicate the life-table column, age group and level of the model life table to be chosen. These variables are used only if NOPT = 1.

NPARM	NPARM indicates the life-table column: 1 = ${}_nm_x$, 2 = ${}_nq_x$, 3 = l_x, 4 = e_x. This variable is used only if NOPT = 1.
NAGE	NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l_2, l_3 or l_4. This variable is used only if NOPT = 1.
CMP	CMP indicates the mortality value being matched. For example, if a model life table is chosen with l_5 = 90000., then NPARM = 3, NAGE = 5 and CMP = 90000.. This variable is used only if NOPT = 1.
$LABEL_2$	This variable is used only if NREG above equals zero and NOPT above equals 1. It is a name for the model supplied by the user and is included in the table heading.
POP1	The population by age for the first census. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.

Mnemonic	Definition and comments
POP2	The population by age for the second census. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.
AVE	This variable is used only if NREG above equals zero and NOPT above equals 1. It consists of model $_nq_x$ values supplied by the user. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, $_nq_x$ values must be given through age group 60-65; as a maximum, through age group 80-85. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.
DEATHS	This variable is used only if NOPT above equals 2. These values are the registered deaths for the intercensal period. Data are given for age groups 0-5, 5-10, ... , up through the last age group available. The number of age groups must be consistent with NVAL.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	$LABEL_1$	1-72	
2	MONTH1	1-2	Data must be punched to end in column 2.
	IYEAR1	4-7	The year must be punched to 4 digits; for example, 1970.
	MONTH2	9-10	Data must be punched to end in column 10.
	IYEAR2	12-15	The year must be punched to 4 digits; for example, 1970.
	NVAL	17-18	Data should be punched to end in column 18.

Card	Mnemonic	Columns	Special comments
3	NOPT	1	
	NSEX	3	
	NREG	5	Leave blank if NOPT = 2.
	NPARM	7	Leave blank if NOPT = 2.
	NAGE	9-10	Data should be punched to end in column 10. Leave blank if NOPT = 2.
	CMP	12-17	The decimal point should be punched. Leave blank if NOPT = 2.
	$LABEL_2$	22-53	Leave blank if NREG does not equal zero.
4	POP1	1-8	For age group 0-5. Decimal point should be punched in column 8.
		9-16	For age group 5-10. Decimal point should be punched in column 16.
		17-24	For age group 10-15. Decimal point should be punched in column 24.
		. . .	
		65-72	For age group 40-45. Decimal point should be punched in column 72.
5	POP1	1-8	For age group 45-50. Decimal point should be punched in column 8.
		. . .	
		25-32	For age group 60-65. Decimal point should be punched in column 32.
		33-40	For age group 65-70. Decimal point should be punched in column 40. Leave blank if fewer values are given.

Card	Mnemonic	Columns	Special comments
		41-48	For age group 70-75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49-56	For age group 75-80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57-64	For age group 80-85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65-72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.
6	POP2	1-8	For age group 0-5. Decimal point should be punched in column 8.
		9-16	For age group 5-10. Decimal point should be punched in column 16.
		17-24	For age group 10-15. Decimal point should be punched in column 24.
		. . .	
		65-72	For age group 40-45. Decimal point should be punched in column 72.
7	POP2	1-8	For age group 45-50. Decimal point should be punched in column 8.
		. . .	
		25-32	For age group 60-65. Decimal point should be punched in column 32.
		33-40	For age group 65-70. Decimal point should be punched in column 40. Leave blank if fewer values are given.

Card	Mnemonic	Columns	Special comments
		41-48	For age group 70-75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49-56	For age group 75-80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57-64	For age group 80-85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65-72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.
8	AVE	1-6	For age group 0-1. Decimal point must be punched. This card is omitted if NREG does not equal zero or NOPT equals two.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		. . .	
		64-69	For age group 40-45. Decimal point must be punched.
9	AVE	1-6	For age group 45-50. Decimal point must be punched. This card is omitted if NREG does not equal zero or NOPT equals 2.
		. . .	
		22-27	For age group 60-65. Decimal point must be punched.

Card	Mnemonic	Columns	Special comments
		29-34	For age group 65-70. Decimal point must be punched. Leave blank if fewer values are given.
		36-41	For age group 70-75. Decimal point must be punched. Leave blank if fewer values are given.
		43-48	For age group 75-80. Decimal point must be punched. Leave blank if fewer values are given.
		50-55	For age group 80-85. Decimal point must be punched. Leave blank if fewer values are given.
10	DEATHS	1-8	For age group 0-5. Decimal point should be punched in column 8. This card is omitted if NOPT=1.
		9-16	For age group 5-10. Decimal point should be punched in column 16.
		17-24	For age group 10-15. Decimal point should be punched in column 24.
		. . .	
		65-72	For age group 40-45. Decimal point should be punched in column 72.
11	DEATHS	1-8	For age group 45-50. Decimal point should be punched in column 8. This card is omitted if NOPT = 1.
		. . .	
		25-32	For age group 60-65. Decimal point should be punched in column 32.
		33-40	For age group 65-70. Decimal point should be punched in column 40. Leave blank if fewer values are given.

Card	Mnemonic	Columns	Special comments
		41-48	For age group 70-75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49-56	For age group 75-80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57-64	For age group 80-85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65-72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.

Examples

In the following examples, the completeness of enumeration of the June 1960 census relative to the June 1970 census for a hypothetical female population is estimated. Three examples are presented. In all three the population data are identical, but in each case intercensal cohort deaths are provided in a different way. In the first example the intercensal mortality pattern for the population is assumed to be similar to that of Coale and Demeny's north region, with a life expectancy at birth of 43 years. Intercensal cohort deaths are then estimated from this life table's survival rates in conjunction with the two census age distributions. In the second example, mortality data are given as the absolute number of deaths by age. In conjunction with the population figures cohort deaths are estimated. In the third example, rather than assuming that the intercensal mortality pattern is similar to a published model life-table system, it is assumed that the mortality pattern is similar to that of a neighbouring country. The level of intercensal mortality (as indexed by an infant mortality rate of .11856) is also assumed to be identical to that of the neighbouring country.

The results of the first two examples indicate that the two censuses are equally complete (adjustment factors are between .99 and 1.0) so the recorded population growth rate of 2.0 per cent per annum is approximately correct. The third example indicates that the second census is relatively undercounted by between 3 and 4 per cent and the true intercensal growth rate is 2.3-2.4 per cent per annum. It is of importance, however, to note that the data points in the third example show a slight systematic curvature, which may indicate an inconsistency between the mortality pattern given as input and the recorded population age distributions.

FORTRAN Coding Form

PROGRAM | PROGRAMMER | DATE | PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | PAGE OF | CARD ELECTRO NUMBER

STATEMENT NUMBER | FORTRAN STATEMENT | Card number

```
HYPOTHETICAL FEMALES, DATA SET 1                                            1
06 1960 06 1970 17                                                          2
1 2 7 4 00 43.000                                                           3
 65043.  52724.  45317.  39773.  34949.  30625.  26497.  22783.  19417.     4
 16461.  13799.  11385.   8983.   6641.   4381.   2478.   1382.             5
 79061.  64082.  55587.  48819.  42776.  37229.  32211.  27704.  23626.     6
 20095.  16903.  13853.  10963.   8113.   5364.   3051.   1682.             7
HYPOTHETICAL FEMALES, DATA SET 2                                            1
06 1960 06 1970 17                                                          2
2 2                                                                         3
 65043.  52724.  45317.  39773.  34949.  30625.  26497.  22783.  19417.     4
 16461.  13799.  11385.   8983.   6641.   4381.   2498.   1382.             5
 79061.  64082.  55587.  48819.  42776.  37229.  32211.  27704.  23626.     6
 20095.  16903.  13853.  10963.   8113.   5364.   3051.   1682.             7
 30018.   4284.   1968.   1833.   1859.   1885.   1897.   1872.   1762.     8
  1627.   1698.   1897.   2193.   2470.   2541.   2155.   2348.             9
HYPOTHETICAL FEMALES, DATA SET 3                                            1
06 1960 06 1970 17                                                          2
1 2 0 2 00 .11856     NEIGHBORING COUNTRY                                   3
 65043.  52724.  45317.  39773.  34949.  30625.  26497.  22783.  19417.     4
 16461.  13799.  11385.   8983.   6641.   4381.   2498.   1382.             5
 79061.  64082.  55587.  48819.  42776.  37229.  32211.  27704.  23626.     6
 20095.  16903.  13853.  10963.   8113.   5364.   3051.   1682.             7
.11856 .09301 .02970 .01687 .02066 .02531 .02866 .03173 .03560 .03986       8
.04466 .05829 .07924 .12069 .18452 .28516 .41943                            9
```

ICC.7 10-001

ESTIMATE OF RELATIVE CENSUS COVERAGE FOR HYPOTHETICAL FEMALES, DATA SET 1

MODEL LIFE TABLE:
PATTERN NORTH
SEX FEMALE
MATCHED PARAMETER E(0) = 43.00000

CHARACTERISTICS OF POPULATION

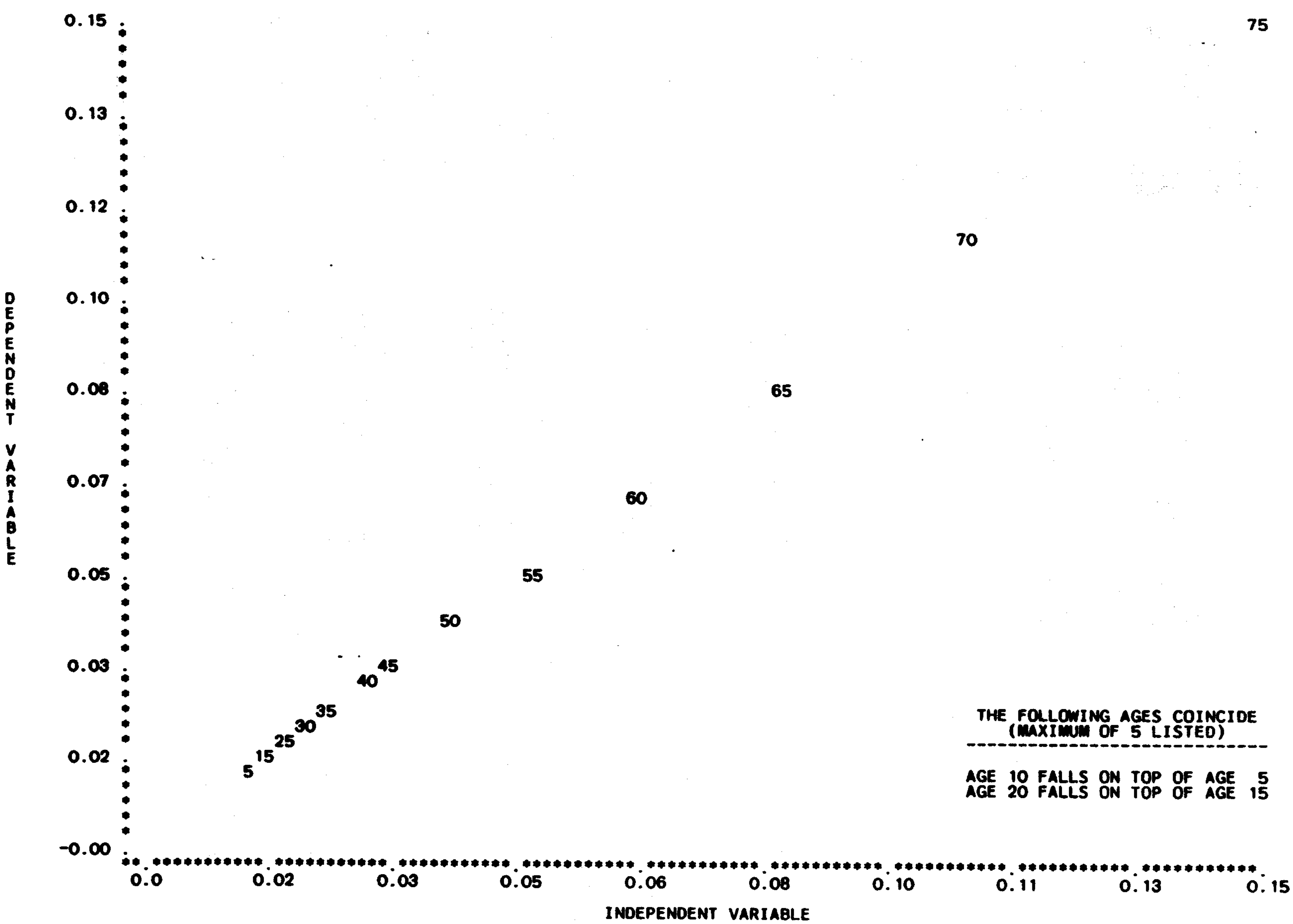
AGE GROUP	POPULATION JUN 1960	POPULATION JUN 1970	GROWTH RATE	INTERCENSAL DEATHS NUMBER	INTERCENSAL DEATHS RATE
0- 5	65043.	79061.	0.01952	42994.	.05996
5-10	52724.	64082.	0.01951	6221.	.01070
10-15	45317.	55587.	0.02043	2850.	.00568
15-20	39773.	48819.	0.02049	2653.	.00602
20-25	34949.	42776.	0.02021	2701.	.00699
25-30	30625.	37229.	0.01953	2741.	.00812
30-35	26497.	32211.	0.01953	2760.	.00945
35-40	22783.	27704.	0.01956	2724.	.01084
40-45	19417.	23626.	0.01962	2560.	.01195
45-50	16461.	20095.	0.01995	2373.	.01305
50-55	13799.	16903.	0.02029	2476.	.01621
55-60	11385.	13853.	0.01962	2760.	.02198
60-65	8983.	10963.	0.01992	3194.	.03219
65-70	6641.	8113.	0.02002	3601.	.04906
70-75	4381.	5364.	0.02024	3695.	.07623
75-80	2498.	3051.	0.02000	3183.	.11531
80+	1382.	1682.	0.01965	3033.	.19896
TOTAL	402658.	491119.	0.01986		

REGRESSION POINTS

AGE X	INDEPENDENT VARIABLE	DEPENDENT VARIABLE
5	0.01328	0.01469
10	0.01375	0.01431
15	0.01529	0.01561
20	0.01714	0.01761
25	0.01929	0.02000
30	0.02184	0.02263
35	0.02488	0.02572
40	0.02864	0.02954
45	0.03358	0.03453
50	0.04046	0.04147
55	0.04997	0.05123
60	0.06329	0.06458
65	0.08203	0.08357
70	0.10853	0.11056
75	0.14507	0.15086

AGE RANGE	REGRESSION RESULTS: SLOPE	INTERCEPT	MEAN SQUARE ERROR (X 100,000)	NUMBER OF SIGN CHANGES	DEMOGRAPHIC ESTIMATES: COMPLETENESS OF SECOND CENSUS RELATIVE TO FIRST	ADJUSTED GROWTH RATE	COMPLETENESS OF DEATHS RELATIVE TO FIRST CENSUS
5-60	1.0128	0.0005	0.00779	6	0.9949	0.02037	0.9848
10-60	1.0177	0.0003	0.00145	6	0.9970	0.02016	0.9811
15-60	1.0178	0.0003	0.00163	6	0.9971	0.02015	0.9810
5-65	1.0126	0.0005	0.00708	6	0.9949	0.02037	0.9850
10-65	1.0157	0.0003	0.00151	4	0.9965	0.02021	0.9828
15-65	1.0156	0.0004	0.00168	4	0.9965	0.02021	0.9829
5-70	1.0136	0.0005	0.00657	6	0.9951	0.02035	0.9842
10-70	1.0155	0.0004	0.00138	4	0.9965	0.02021	0.9830
15-70	1.0155	0.0004	0.00151	4	0.9964	0.02022	0.9830

HYPOTHETICAL FEMALES, DATA SET 1



ESTIMATE OF RELATIVE CENSUS COVERAGE FOR HYPOTHETICAL FEMALES, DATA SET 2

MORTALITY PATTERN:

AGE GROUP	0- 5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45
DEATHS	30018.	4284.	1968.	1833.	1859.	1885.	1897.	1872.	1762.
AGE GROUP	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80+	
DEATHS	1627.	1698.	1897.	2193.	2470.	2541.	2155.	2348.	

CHARACTERISTICS OF POPULATION

AGE GROUP	POPULATION JUN 1960	POPULATION JUN 1970	GROWTH RATE	INTERCENSAL DEATHS NUMBER	INTERCENSAL DEATHS RATE
0- 5	65043.	79061.	0.01952	30018.	.04186
5-10	52724.	64082.	0.01951	4284.	.00737
10-15	45317.	55587.	0.02043	1968.	.00392
15-20	39773.	48819.	0.02049	1833.	.00416
20-25	34949.	42776.	0.02021	1859.	.00481
25-30	30625.	37229.	0.01953	1885.	.00558
30-35	26497.	32211.	0.01953	1897.	.00649
35-40	22783.	27704.	0.01956	1872.	.00745
40-45	19417.	23626.	0.01962	1762.	.00823
45-50	16461.	20095.	0.01995	1627.	.00895
50-55	13799.	16903.	0.02029	1698.	.01112
55-60	11385.	13853.	0.01962	1897.	.01511
60-65	8983.	10963.	0.01992	2193.	.02210
65-70	6641.	8113.	0.02002	2470.	.03365
70-75	4381.	5364.	0.02024	2541.	.05242
75-80	2498.	3051.	0.02000	2155.	.07806
80+	1382.	1682.	0.01965	2348.	.15400
TOTAL	402658.	491119.	0.01986		

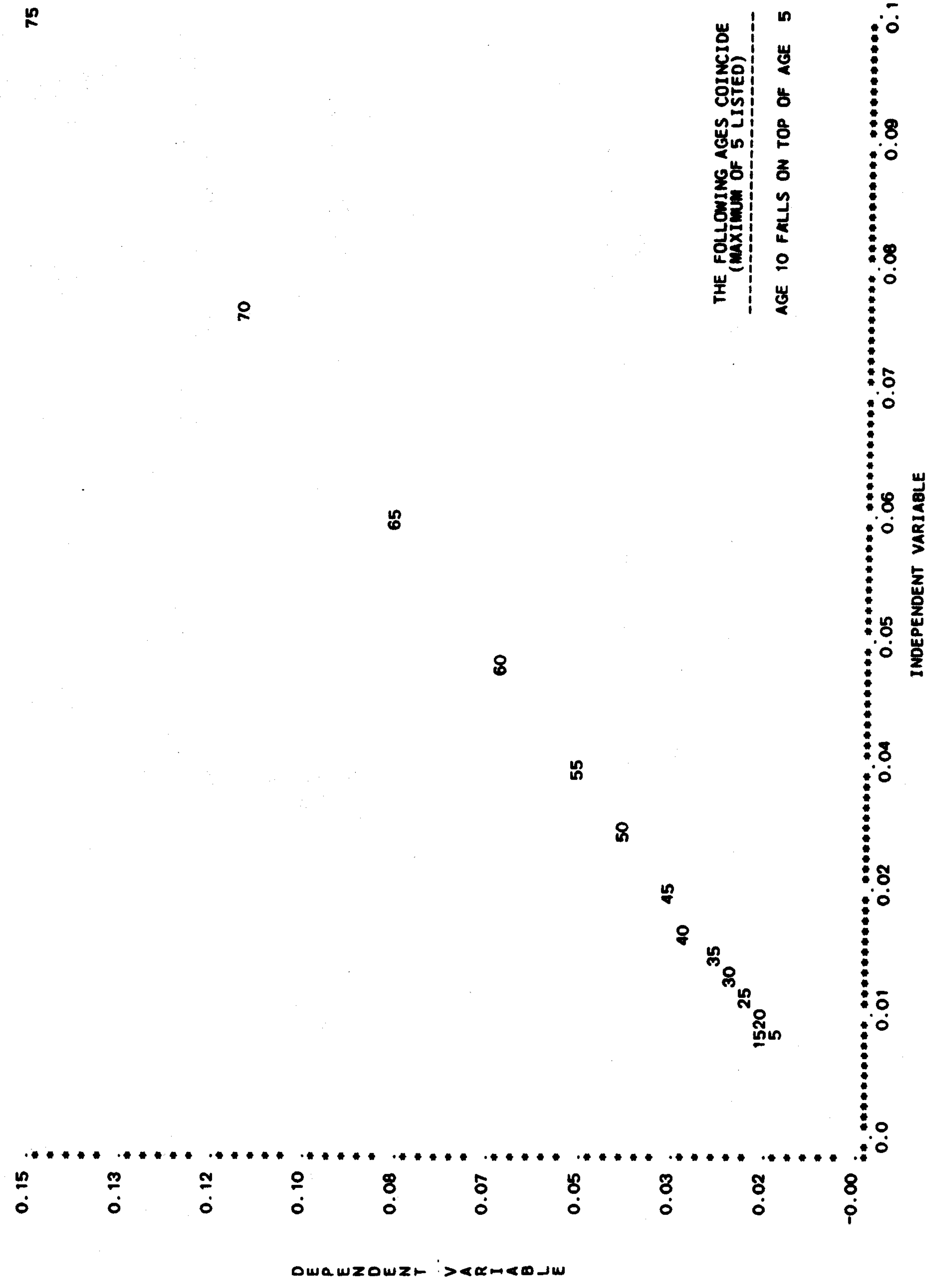
REGRESSION POINTS

AGE X	INDEPENDENT VARIABLE	DEPENDENT VARIABLE
5	0.00919	0.01469
10	0.00953	0.01431
15	0.01059	0.01561
20	0.01188	0.01761
25	0.01338	0.02000
30	0.01516	0.02263
35	0.01729	0.02572
40	0.01992	0.02954
45	0.02338	0.03453
50	0.02822	0.04147
55	0.03492	0.05123
60	0.04435	0.06458
65	0.05775	0.08357
70	0.07713	0.11056
75	0.10508	0.15086

REGRESSION RESULTS / DEMOGRAPHIC ESTIMATES

AGE RANGE	SLOPE	INTERCEPT	MEAN SQUARE ERROR (X 100,000)	NUMBER OF SIGN CHANGES	COMPLETENESS OF SECOND CENSUS RELATIVE TO FIRST	ADJUSTED GROWTH RATE	COMPLETENESS OF DEATHS RELATIVE TO FIRST CENSUS
5-60	1.4420	0.0008	0.00789	3	0.9925	0.02061	0.6909
10-60	1.4485	0.0006	0.00248	3	0.9945	0.02041	0.6885
15-60	1.4479	0.0006	0.00275	3	0.9943	0.02043	0.6887
5-65	1.4360	0.0009	0.00807	3	0.9915	0.02071	0.6934
10-65	1.4398	0.0007	0.00408	3	0.9929	0.02057	0.6921
15-65	1.4389	0.0007	0.00433	3	0.9926	0.02060	0.6924
5-70	1.4262	0.0010	0.01158	3	0.9897	0.02090	0.6975
10-70	1.4282	0.0009	0.00954	3	0.9907	0.02080	0.6969
15-70	1.4272	0.0010	0.00980	3	0.9902	0.02085	0.6972

HYPOTHETICAL FEMALES, DATA SET 2



ESTIMATE OF RELATIVE CENSUS COVERAGE FOR HYPOTHETICAL FEMALES, DATA SET 3

MODEL LIFE TABLE:
PATTERN — EMPIRICAL TABLE: NEIGHBORING COUNTRY
SEX — FEMALE
MATCHED PARAMETER — Q(0) = 0.11856

MORTALITY PATTERN FROM

AGES	0- 1	1- 5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80
Q(X,N)	.11856	.09301	.02970	.01687	.02066	.02531	.02866	.03173	.03560	.03986	.04466	.05829	.07924	.12069	.18452	.28516	.41943

CHARACTERISTICS OF POPULATION

AGE GROUP	POPULATION JUN 1960	POPULATION JUN 1970	GROWTH RATE	INTERCENSAL DEATHS NUMBER	INTERCENSAL DEATHS RATE
0- 5	65043.	79061.	0.01952	33979.	.04738
5-10	52724.	64082.	0.01951	3505.	.00603
10-15	45317.	55587.	0.02043	1708.	.00340
15-20	39773.	48819.	0.02049	1839.	.00417
20-25	34949.	42776.	0.02021	1982.	.00513
25-30	30625.	37229.	0.01953	1963.	.00581
30-35	26497.	32211.	0.01953	1883.	.00645
35-40	22763.	27704.	0.01956	1821.	.00725
40-45	19417.	23626.	0.01962	1742.	.00813
45-50	16461.	20095.	0.01995	1661.	.00913
50-55	13799.	16903.	0.02029	1832.	.01199
55-60	11385.	13853.	0.01962	2068.	.01647
60-65	8983.	10963.	0.01992	2540.	.02560
65-70	6641.	8113.	0.02002	2970.	.04047
70-75	4381.	5364.	0.02024	3211.	.06624
75-80	2498.	3051.	0.02000	2937.	.10638
80+	1382.	1682.	0.01965	2990.	.19611
TOTAL	402658.	491119.	0.01986		

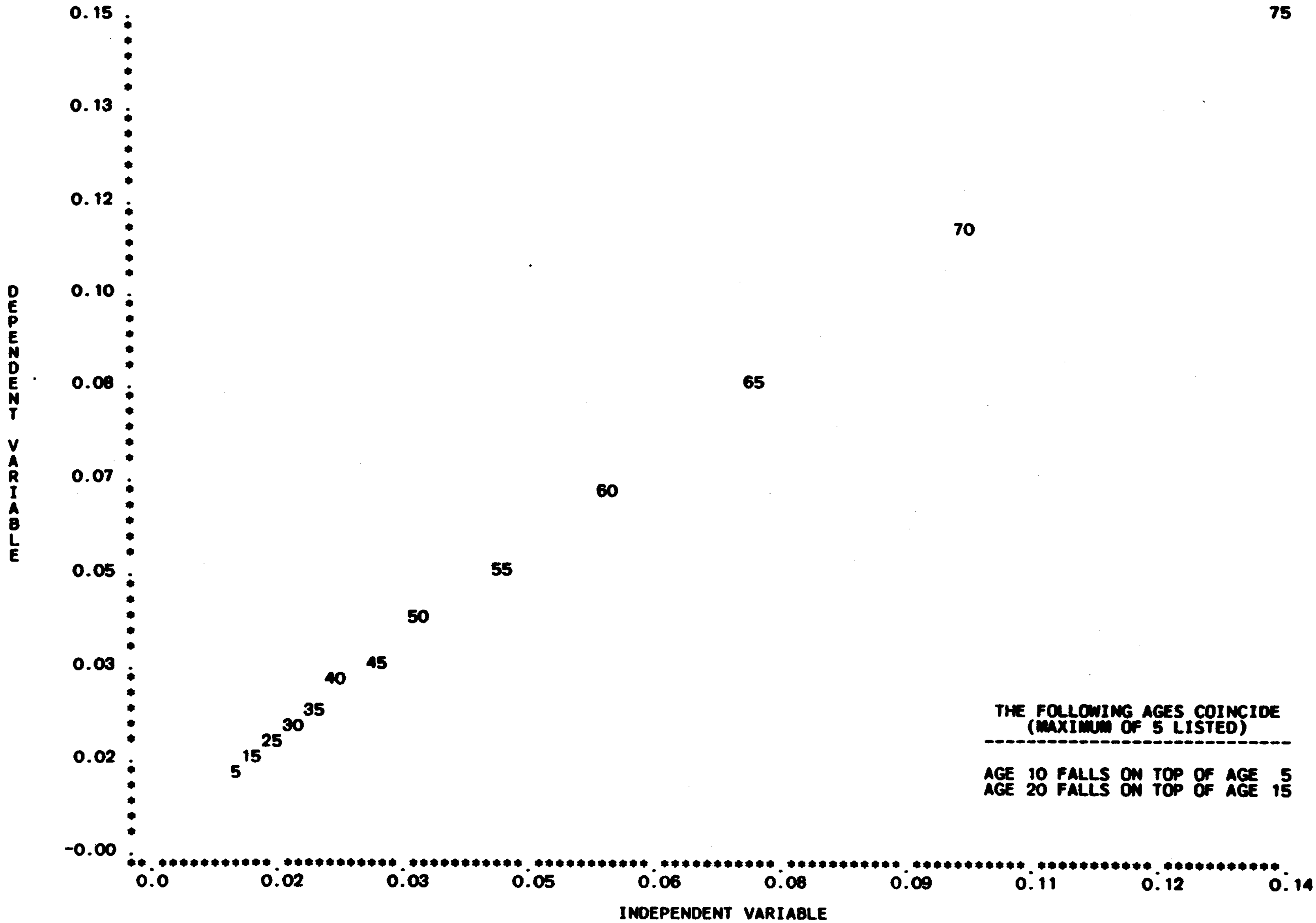
REGRESSION POINTS

AGE X	INDEPENDENT VARIABLE	DEPENDENT VARIABLE
5	0.00983	0.01469
10	0.01053	0.01431
15	0.01188	0.01561
20	0.01342	0.01761
25	0.01518	0.02000
30	0.01731	0.02263
35	0.01998	0.02572
40	0.02339	0.02954
45	0.02791	0.03453
50	0.03420	0.04147
55	0.04291	0.05123
60	0.05549	0.06458
65	0.07350	0.08357
70	0.10005	0.11056
75	0.13830	0.15086

REGRESSION RESULTS / DEMOGRAPHIC ESTIMATES

AGE RANGE	SLOPE	INTERCEPT	MEAN SQUARE ERROR (X 100,000)	NUMBER OF SIGN CHANGES	COMPLETENESS OF SECOND CENSUS RELATIVE TO FIRST	ADJUSTED GROWTH RATE	COMPLETENESS OF DEATHS RELATIVE TO FIRST CENSUS
5-60	1.1175	0.0031	0.02080	3	0.9698	0.02292	0.8813
10-60	1.1222	0.0029	0.01749	3	0.9716	0.02275	0.8783
15-60	1.1189	0.0030	0.01728	3	0.9703	0.02287	0.8804
5-65	1.1010	0.0034	0.02988	3	0.9667	0.02325	0.8930
10-65	1.1032	0.0033	0.03011	3	0.9677	0.02314	0.8917
15-65	1.1001	0.0034	0.02880	3	0.9663	0.02329	0.8935
5-70	1.0797	0.0039	0.06058	3	0.9621	0.02373	0.9084
10-70	1.0803	0.0038	0.06561	3	0.9624	0.02369	0.9081
15-70	1.0775	0.0040	0.06279	3	0.9607	0.02387	0.9097

HYPOTHETICAL FEMALES, DATA SET 3



Name of procedure: COMBIN

Purpose of procedure. Calculates a "model" life table from an estimate of life expectancy at age 20 combined with an estimate of survivorship to age 1, survivorship to age 5, or both.

Description of technique. The procedure adjusts a designated United Nations or Coale and Demeny model life table to incorporate the child and adult survivorship values given as input. Age-specific probabilities of dying (${}_nq_x$ values) consistent with these survivorship values are determined separately for ages 20 and over and for ages under 20. For ages 20 and over, ${}_5q_x$ values from the designated model life-table pattern and life expectancy at age 20 are accepted. These ${}_5q_x$ values are calculated through the subroutine MATCH.

The method of calculating age-specific mortality rates under age 20 depends upon the form of the input data. In the "complete" case, survivorship to both age 1 (i.e., l_1) and age 5 (i.e., l_5) are given, allowing straightforward calculation of ${}_1q_0$ and ${}_4q_1$. Given ${}_1q_0$ and the value of ${}_5q_{20}$ calculated above, the subroutine BESTFT is called to provide interpolated values of ${}_5q_5$, ${}_5q_{10}$ and ${}_5q_{15}$ (based on the second component fit to the designated model). Next ${}_4q_1$ and ${}_5q_{20}$ are used in an identical way to provide a second set of interpolated values of ${}_5q_5$, ${}_5q_{10}$ and ${}_5q_{15}$. The average of these two sets of values is accepted. If only l_5 is given, then subroutine MATCH is used to calculate ${}_1q_0$ and ${}_4q_1$ values which are consistent with the l_5 value and the designated model. Then ${}_5q_5$, ${}_5q_{10}$ and ${}_5q_{15}$ are calculated as mentioned previously. If only l_1 is given, the subroutine BESTFT is used to calculate interpolated values for ${}_4q_1$, ${}_5q_5$, ${}_5q_{10}$ and ${}_5q_{15}$, given ${}_1q_0$ and ${}_5q_{20}$.

With the complete set of ${}_nq_x$ values, the subroutine LIFTB is used. The entire procedure is carried out within the subroutine COMBIN.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be printed at the top of the page of output.
NSEX	Indicates whether the male or female population is being considered. NSEX = 1 indicates males; NSEX = 2 indicates females.
NREG	Indicates the model life-table pattern to be used. The codes are: 1 = UN Latin American 2 = UN Chilean 3 = UN South Asian 4 = UN Far East Asian 5 = UN General 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South
E20	Life expectancy at age 20 in the population under study.
SL1	The probability of surviving to age 1 (times 100,000) in the population under study.
SL5	The probability of surviving to age 5 (times 100,000) in the population under study.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	NSEX	1	
	NREG	3	

Card	Mnemonic	Columns	Special comments
	E20	5-10	The decimal point must be punched in column 7.
	SL1	12-17	Either SL1, SL5 (below), or both must be given. If SL1 is not given, leave these columns blank.
	SL5	19-24	Either SL1 (above), SL5, or both must be given. If SL5 is not given, leave these columns blank.

Examples

In the following examples, data are given for a hypothetical population with a life expectancy at age 20 of 50 years. In the first data set, the Latin American pattern is combined with a value of l_5 of 78000. In the second example, a value of l_1 of 85000 is also given.

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE OF
PROGRAMMER	DATE		PUNCH	CARD ELECTRO NUMBER

STATEMENT NUMBER | CONT. | FORTRAN STATEMENT | card number

```
HYPOTHETICAL FEMALES (DATA SET 1)                                          1
2 1 50.000          78000.                                                 2
HYPOTHETICAL FEMALES (DATA SET 2)                                          1
2 1 50.000 85000. 78000.                                                   2
```

ICC.7 (6-66)

HYPOTHETICAL FEMALES (DATA SET 1)

UNITED NATIONS MODEL LIFE TABLE FOR THE LATIN AMERICAN
PATTERN OF THE FEMALE SEX TRANSFORMED TO BE CONSISTENT
WITH E(20)= 50.000 AND I(5)= 78000.

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)	T(X)	E(X)	A(X,N)
0	.13353	.12286	100000.	12286.	92014.	.83447 /A/	5354403.	53.544	0.350
1	.02987	.11074	87714.	9714.	325220.	.92873 /B/	5262389.	59.995	1.361
5	.00258	.01283	78000.	1001.	387497.	.98999	4937168.	63.297	2.500
10	.00143	.00714	76999.	550.	383620.	.99184	4549671.	59.087	2.500
15	.00194	.00965	76449.	738.	380489.	.98878	4166051.	54.494	2.619
20	.00259	.01286	75711.	973.	376219.	.98563	3785562.	50.000	2.599
25	.00320	.01590	74738.	1188.	370813.	.98243	3409343.	45.617	2.580
30	.00391	.01939	73550.	1426.	364296.	.97835	3038529.	41.313	2.579
35	.00487	.02405	72124.	1735.	356409.	.97371	2674233.	37.078	2.573
40	.00583	.02874	70389.	2023.	347041.	.96776	2317824.	32.929	2.575
45	.00740	.03635	68366.	2485.	335852.	.95833	1970783.	28.827	2.594
50	.00984	.04809	65881.	3169.	321856.	.94232	1634931.	24.816	2.617
55	.01431	.06921	62713.	4340.	303291.	.91571	1313075.	20.938	2.633
60	.02152	.10238	58373.	5976.	277727.	.87274	1009784.	17.299	2.635
65	.03388	.15672	52396.	8212.	242384.	.80888	732056.	13.971	2.613
70	.05204	.23091	44185.	10203.	196059.	.72699	489672.	11.082	2.563
75	.07714	.32357	33982.	10995.	142534.	.61812	293613.	8.640	2.510
80	.11825	.45322	22986.	10418.	88102.	.41685 /C/	151079.	6.573	2.425
85	.19957	.....	12569.	12569.	62977.	.....	62977.	5.011	5.011

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(80+,5)=T(85)/T(80)

HYPOTHETICAL FEMALES (DATA SET 2)

UNITED NATIONS MODEL LIFE TABLE FOR THE LATIN AMERICAN
PATTERN OF THE FEMALE SEX TRANSFORMED TO BE CONSISTENT
WITH E(20)= 50.000. I(1)= 85000. AND I(5)= 78000.

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)	T(X)	E(X)	A(X,N)
0	.16620	.15000	100000.	15000.	90250.	.82355 /A/	5349092.	53.491	0.350
1	.02177	.08235	85000.	7000.	321527.	.94103 /B/	5258842.	61.869	1.361
5	.00259	.01284	78000.	1002.	387495.	.99000	4937315.	63.299	2.500
10	.00143	.00712	76998.	548.	383620.	.99186	4549819.	59.090	2.500
15	.00193	.00962	76450.	736.	380497.	.98879	4166200.	54.496	2.620
20	.00259	.01286	75714.	974.	376234.	.98563	3785702.	50.000	2.600
25	.00320	.01590	74741.	1188.	370827.	.98243	3409468.	45.617	2.580
30	.00391	.01939	73552.	1426.	364310.	.97835	3038642.	41.313	2.579
35	.00487	.02405	72127.	1735.	356422.	.97371	2674332.	37.078	2.573
40	.00583	.02874	70392.	2023.	347054.	.96776	2317910.	32.929	2.575
45	.00740	.03635	68369.	2485.	335864.	.95833	1970856.	28.827	2.594
50	.00984	.04809	65884.	3169.	321868.	.94232	1634991.	24.816	2.617
55	.01431	.06921	62715.	4341.	303302.	.91571	1313124.	20.938	2.633
60	.02152	.10238	58375.	5976.	277738.	.87274	1009821.	17.299	2.635
65	.03388	.15672	52398.	8212.	242393.	.80888	732083.	13.971	2.613
70	.05204	.23091	44186.	10203.	196067.	.72699	489690.	11.082	2.563
75	.07714	.32357	33983.	10996.	142539.	.61812	293624.	8.640	2.510
80	.11825	.45322	22987.	10418.	88106.	.41685 /C/	151085.	6.573	2.425
85	.19957	.....	12569.	12569.	62979.	.....	62979.	5.011	5.011

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(80+,5)=T(85)/T(80)

Name of procedure: COMPAR

Purpose of procedure. Compares empirical set of age-specific central death rates (${}_nm_x$ values) or age-specific probabilities of dying (${}_nq_x$ values) to all United Nations and Coale-Demeny model life-table patterns and prints out indices of similarity.

Description of technique. For each age-specific ${}_nm_x$ or ${}_nq_x$ value given as input (for age groups 0-1, 1-5, 5-10, 10-15, ...), the corresponding life expectancy at birth in each of the five United Nations models and four Coale-Demeny models is found (by calling subroutine COMPAR which calls the subroutine MATCH) and printed out. For each model, a series of life expectancies which are more or less constant by age indicates that the empirical mortality pattern is similar to that model. Indices of goodness of fit for age groups 0 to 10, 10 and over, and 0 and over are calculated by subroutine COMPAR and printed out. The first index used is

$$I = \sum_{a}^{b} |{}_nE_x - M|/N,$$

where a and b indicate the lower and upper age groups being considered, ${}_nE_x$ indicates the life expectancy at birth in the model which corresponds to the mortality rate in age group (x, x+n), M indicates the median of the ${}_nE_x$ within the range (a, b), and N is the number of age groups within the range. Indices are printed out for age ranges 0 to 10, 10 and over, and 0 and over. The second index printed out is the difference between the median within the age range 0 to 10 and the median within the age range 10 and over. In all cases the lower the value of the index, the better the fit to the model.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be included in the heading at the top of the page of output.

Mnemonic	Definition and comments
NFIN	The ending age of the last closed age group. For example if the last mortality value available is $_5m_{80}$ or $_5q_{80}$, NFIN would take the value 85. The minimum value for NFIN is 65 (referring to age group 60-65). The maximum value is 85 (referring to age group 80-85), although only values through 75-80 are used in calculations.
NTYPE	Indicates whether $_nq_x$ or $_nm_x$ values are being given as input. If $_nq_x$ values are used, NTYPE = 1; if $_nm_x$ values are used, NTYPE = 2.
NSEX	Indicates whether the $_nm_x$ or $_nq_x$ values refer to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females.
QXMX	The age-specific mortality data themselves. No matter whether $_nq_x$ or $_nm_x$ values are used as input, the values are input in the same way. For ages 5 and over the values must be given for five-year age groups. For ages under 5 they are given for age groups 0-1 and 1-5. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	NFIN	1-3	Value must be punched to end in column 3.
	NTYPE	5	
	NSEX	7	

Card	Mnemonic	Columns	Special comments
3	QXMX	1-6	For age group 0-1. Decimal point must be punched.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		. . .	
		64-69	For age group 40-45. Decimal point must be punched.
4	QXMX	1-6	For age group 45-50. Decimal point must be punched.
		. . .	
	(Values of QXMX must be given through the age group indicated by NFIN above, in the same format as in card 3.)		

Example

In the following example, a set of $_nq_x$ values for a hypothetical female population is read in. Data are supplied for age groups 0-1, 1-5, 5-10, ..., up to 75-80. The empirical data are shown, by the output, to be most similar to that of the Coale-Demeny North region. This was determined by observing that its average deviation from the median for all age groups is 1.9, the lowest value of all regions. However, if only the childhood ages are under consideration (ages 0 to 10), then the United Nations General pattern is better, with an average deviation of only 0.4.

FORTRAN Coding Form

	card number
HYPOTHETICAL FEMALES	1
080 1 2	2
.11856 .09301 .02970 .01687 .02066 .02531 .02866 .03173 .03560 .03986	3
.04466 .05829 .07924 .12069 .18452 .28516 .41943	4

ICC-7 (6-66)

COMPARISON OF MODEL AGE PATTERNS OF MORTALITY WITH THOSE OF HYPOTHETICAL FEMALES

AGE GROUP	EMPIRICAL Q(X,N)	IMPLIED LIFE EXPECTANCY AT BIRTH: UNITED NATIONS MODELS					COALE-DEMENY MODELS			
		LATIN AM.	CHILEAN	SO. ASIAN	FAR EAST	GENERAL	WEST	NORTH	EAST	SOUTH
0- 1	.11856	47.9	55.3	53.8	42.1	46.8	50.1	47.3	54.8	53.3
1- 5	.09301	50.0	40.4	51.7	39.1	46.0	45.2	48.7	44.2	51.2
5-10	.02970	47.5	37.4	45.9	39.4	45.6	43.1	53.6	43.1	45.2
10-15	.01687	45.8	42.8	40.7	44.3	46.5	49.8	53.7	43.6	45.4
15-20	.02066	48.0	48.4	43.8	52.3	50.3	52.2	51.9	46.4	48.3
20-25	.02531	50.3	50.9	43.7	54.2	52.1	53.2	51.3	48.0	49.0
25-30	.02866	51.2	51.6	42.4	55.4	52.4	53.3	51.8	48.8	48.5
30-35	.03173	52.2	52.7	43.2	55.9	53.3	53.7	52.6	49.0	47.4
35-40	.03560	53.1	53.4	43.2	57.1	53.7	53.8	53.1	49.1	46.7
40-45	.03986	53.3	54.6	44.3	58.7	54.5	54.1	53.8	48.9	46.0
45-50	.04466	55.2	57.3	47.9	62.1	57.2	55.8	53.7	50.7	46.0
50-55	.05829	55.0	57.6	52.2	63.9	58.5	57.0	53.3	52.2	46.8
55-60	.07924	56.1	59.0	56.3	65.3	60.0	57.3	52.7	54.6	47.5
60-65	.12069	54.4	57.4	57.5	64.3	58.9	56.4	51.0	55.0	49.2
65-70	.18452	53.2	56.9	56.6	62.6	57.6	54.1	50.1	56.0	49.9
70-75	.28516	48.8	52.1	54.3	58.9	54.6	51.7	48.1	56.2	51.5
75-80	.41943	42.4	46.4	51.1	54.0	50.9	49.5	46.3	57.1	53.7
AVERAGE ABSOLUTE DEVIATION FROM MEDIAN										
AGES 0 TO 10 :		0.8	6.0	2.7	1.0	0.4	2.3	2.1	3.9	2.7
AGES 10 AND OVER:		3.0	3.7	5.3	4.5	3.0	1.8	1.6	3.4	1.7
AGES 0 AND OVER:		3.1	4.8	5.1	6.6	3.8	2.8	1.9	3.8	2.1
MEDN(0-10)-MEDN(10+)		-4.8	-12.6	5.6	-18.5	-8.1	-8.5	-3.6	-5.7	3.4

Name of procedure: FERTCB

Purpose of procedure. Estimation of age-specific fertility rates from data on children ever born tabulated by age of mother recorded at either one or, optionally, two points in time.

Description of technique. Mortara (1949) has shown that, under conditions of constant fertility, age-specific fertility rates can be calculated from recorded data on children ever born by age of woman. Simply,

$$f_x = CEB_{x+1} - CEB_x$$

where f_x is the fertility rate for women in age group (x, x+1) and CEB_x is the recorded average number of children ever born for women exact age x. Graduation is necessary to estimate average numbers of children ever born for women at exact age x from the usual recorded data on average numbers of children ever born in five-year age groups (x, x+5). Arriaga (1983) proposes a ninth-degree polynomial for this graduation; he also outlines the steps for calculation of fertility rates for conventional five-year age groups from the single-year f_x values (see steps (iv) and (v) in the following paragraph).

Arriaga (1983) also showed how the method can be extended to the case of changing fertility when children ever born data are available at two points in time. The proposal of Arriaga is (i) to obtain average number of children ever born for women exact age x at the time of the first and second enumeration [$CEB_x(t_1)$ and $CEB_x(t_2)$] through graduation by a ninth degree polynomial, on the data on children ever born in five-year age groups recorded in each enumeration; (ii) to estimate children ever born at exact age x for the year after the first census [$CEB_x(t_1+1)$] and the year before the second census [$CEB_x(t_2-1)$] by linear interpolation between $CEB_x(t_1)$ and $CEB_x(t_2)$ for every age x; (iii) to calculate single-year age-specific fertility rates for the one-year period following the first census as $f_x^1 = CEB_{x+1}(t_1+1) - CEB_x(t_1)$ and for the one-year period preceding the second census as $f_x^2 = CEB_{x+1}(t_2) - CEB_x(t_2-1)$; (iv) to ensure that the age-specific fertility rates at older ages decrease monotonically and exponentially to zero at age 50, adjust the estimated single-year age-specific fertility rates at ages 40 and over by assuming that $f_x^i = f_{39} + (1 - f_{39})^{(x-39)/11} - 1$; and, finally, (v) to calculate age-specific fertility rates in conventional five-year age groups for each time period by taking the arithmetic average of the single-year age-specific fertility rates within each five-year age group.

The procedure also generates an estimate of the mean age of mother at childbearing in the population. The mean age is calculated based on the estimated age-specific fertility rates and the 1985 age distribution of the female population for all less developed countries combined according to the United Nations medium variant projections.

A full description of the Mortara and Arriaga approaches for estimating age-specific fertility rates from recorded children ever born data is given in Arriaga (1983). The procedures are carried out by the subroutine FERTIL.

<u>Data required</u>. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be included in the heading at the top of the page of output.
NYRS	The number of enumerations for which children ever born (CEB) data are given. NYRS = 1 indicates CEB data for one point in time; NYRS = 2 indicates CEB data for two points in time.
MONTH1	Indicates the month of the first enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR1	The year of the first enumeration.
MONTH2	Indicates the month of the second enumeration (1 = January, 2 = February, ..., 12 = December). This variable is used only if NYRS = 2.
IYEAR2	The year of the second enumeration. This variable is used only if NYRS = 2.
CEB1	The average number of children ever born per woman at the time of the first enumeration. Data are given for age groups 15-20, 20-25, ..., 45-50.
CEB2	The average number of children ever born per woman at the time of the second enumeration. Data are given for age groups 15-20, 20-25, ..., 45-50. This variable is used only if NYRS = 2.

<u>Data input</u>. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	NYRS	1	
	MONTH1	3-4	Data should be punched to end in column 4.
	IYEAR1	6-9	The year should be punched to four digits, for example, 1970.
	MONTH2	11-12	Data should be punched to end in column 12. Leave blank if NYRS = 1.
	IYEAR2	14-17	The year should be punched to four digits, for example, 1970. Leave blank if NYRS = 1.
3	CEB1	1-5	For age group 15-20.
		7-11	For age group 20-25.
		13-17	For age group 25-30.
		19-23	For age group 30-35.
		25-29	For age group 35-40.
		31-35	For age group 40-45.
		37-41	For age group 45-50.
4	CEB2	1-5	For age group 15-20. Card 4 is omitted if NYRS = 1.
		7-11	For age group 20-25. Card 4 is omitted if NYRS = 1.
		13-17	For age group 25-30. Card 4 is omitted if NYRS = 1.
		19-23	For age group 30-35. Card 4 is omitted if NYRS = 1.

Card	Mnemonic	Columns	Special comments
		25-29	For age group 35-40. Card 4 is omitted if NYRS = 1.
		31-35	For age group 40-45. Card 4 is omitted if NYRS = 1.
		37-41	For age group 45-50. Card 4 is omitted if NYRS = 1.

Example

In the following example, data on children ever born in five-year age groups are available for a hypothetical population from enumerations during July 1970 and May 1976. The Arriaga approach is used to estimate age-specific fertility rates for July 1970 - July 1971 and May 1975 - May 1976. The coded input and resulting output appear as follows:

FORTRAN Coding Form

FORTRAN STATEMENT | Card number

```
HYPOTHETICAL POPULATION                                               1
2 07 1970 05 1976                                                     2
0.154 1.129 2.562 4.008 5.237 5.956 6.243                             3
0.131 0.788 2.306 3.707 4.975 5.615 5.993                             4
```

APPLICATION OF ARRIAGA'S APPROACHES FOR ESTIMATION OF AGE SPECIFIC FERTILITY RATES FOR STUDY OF HYPOTHETICAL POPULATION

BASED ON CHILDREN EVER BORN FOR TWO POINT(S) IN TIME (ARRIAGA-ARRETX)

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)
JUL 1970 TO JUL 1971		
15-19	0.154	0.0960
20-24	1.129	0.2397
25-29	2.562	0.2462
30-34	4.008	0.2259
35-39	5.237	0.1521
40-44	5.956	0.0759
45-49	6.243	0.0278
MEAN AGE OF FERTILITY:		27.73
TOTAL FERTILITY RATE:		5.32
MAY 1975 TO MAY 1976		
15-19	0.131	0.0840
20-24	0.988	0.2180
25-29	2.306	0.2314
30-34	3.707	0.2275
35-39	4.975	0.1526
40-44	5.615	0.0681
45-49	5.993	0.0250
MEAN AGE OF FERTILITY:		27.97
TOTAL FERTILITY RATE:		5.03

Name of procedure: FERTPF

__Purpose of procedure__. Estimation of age-specific fertility rates from data on children ever born tabulated by age of mother and the age pattern of fertility, recorded at either one or, optionally, two points in time.

__Description of technique__. Recorded age-specific fertility rates often underestimate the true level of fertility owing to omission of events from civil registration systems or surveys or misunderstanding of the length of the reference period in survey questions on births during a previous period. Because of reference period errors, age-specific fertility rates calculated from surveys are also occasionally overestimated. Brass (Brass and others, 1968) developed a method, commonly known as the P/F method, for evaluating and adjusting these recorded fertility rates by comparing the recorded rates to data on average number of children ever born tabulated by five-year age group of woman. The P/F approach assumes that fertility has been constant in the past, that the pattern (although, of course, not the level) of the recorded age-specific fertility rates (denoted ASFP) is correct, and that the level of lifetime fertility for the younger cohorts of women provided by the children ever born data (CEB) are correct. Brass simply cumulated and graduated the recorded ASFP data to be in the form of children ever born data. Under the assumption of constant fertility, these transformed data (denoted ${}_nF_x$) are comparable to the recorded children ever born data (${}_nCEB_x$). The ratios of ${}_nCEB_x / {}_nF_x$ for the younger age groups provide possible adjustment factors to be applied to the recorded fertility rates.

Arriaga (1983) later modified the method and extended it to the case of changing fertility. Rather than transforming the recorded ASFP figures to CEB-type figures, he suggested transforming the recorded CEB data into estimates of age-specific fertility (by the method outlined in the program FERTCB). These two sets of age-specific fertility rates are then cumulated by age, and the ratios of these cumulated figures provided possible adjustment factors. According to Arriaga (1983, pp. 7-8), this modification not only has analytical and diagnostic advantages but also leads to extension of the method to conditions of changing fertility. If the children ever born (CEB) and fertility pattern data (ASFP) are available from two enumerations, age-specific fertility rates can be estimated for the one-year period following the first enumeration and the one-year period preceding the second enumeration, by the method described in FERTCB. The estimated age-specific fertility rates can then be compared to the recorded ASFP data to provide adjustment factors in the same way as is done for the constant fertility (one set of data) approach.

The procedure also generates an estimate of the mean age of mother at childbearing in the population. The mean age is calculated based on the estimated age-specific fertility rates and the 1985 age distribution of the female population for all less developed countries combined according to the United Nations medium variant projections.

A full description of the Brass and Arriaga approaches for estimating age-specific fertility rates from recorded children ever born data and the age pattern of fertility is given in Arriaga (1983). The procedures are carried out by the subroutine FERTIL .

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be included in the heading at the top of the page of output.
NYRS	The number of enumerations for which children ever born (CEB) data are given. NYRS = 1 indicates CEB data for one point in time; NYRS = 2 indicates CEB data for two points in time.
MONTH1	Indicates the month of the first enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR1	The year of the first enumeration.
NTAB1	Indicates how the fertility pattern (ASFP1) from the first enumeration is tabulated. NTAB1 = 1 indicates the fertility pattern is tabulated by age of mother at time of birth of the child; NTAB1 = 2 indicates the fertility pattern is tabulated by age of mother at the date of enumeration.
MONTH2	Indicates the month of the second enumeration (1 = January, 2 = February, ..., 12 = December). This variable is used only if NYRS = 2.
IYEAR2	The year of the second enumeration. This variable is used only if NYRS = 2.
NTAB2	Indicates how the fertility pattern (ASFP2) from the second enumeration is tabulated. NTAB2 = 1 indicates the fertility pattern is tabulated by age of mother at time of birth of the child; NTAB2 = 2 indicates the fertility pattern is tabulated by age of mother at the date of enumeration.
CEB1	The average number of children ever born per woman at the time of the first enumeration. Data are given for age groups 15-20, 20-25, ..., 45-50.

Mnemonic	Definition and comments
ASFP1	The age specific fertility pattern at the time of the first enumeration. Data may be given as recorded age-specific fertility rates or as the proportionate age distribution of fertility. Data are given for age groups 15-20, 20-25, ..., 45-50,
CEB2	The average number of children ever born per woman at the time of the second enumeration. Data are given for age groups 15-20, 20-25, ..., 45-50. This variable is used only if NYRS = 2.
ASFP2	The age specific fertility pattern at the time of the second enumeration. Data may be given as recorded age-specific fertility rates or as the proportionate age distribution of fertility. Data are given for age groups 15-20, 20-25, ..., 45-50,

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	NYRS	1	
	MONTH1	3-4	Data should be punched to end in column 4.
	IYEAR1	6-9	The year should be punched to four digits, for example, 1970.
	NTAB1	11	
	MONTH2	13-14	Data should be punched to end in column 12. Leave blank if NYRS = 1.
	IYEAR2	16-19	The year should be punched to four digits, for example, 1970. Leave blank if NYRS = 1.
	NTAB2	21	Leave blank if NYRS = 1.

Card	Mnemonic	Columns	Special comments
3	CEB1	1-5	For age group 15-20.
		7-11	For age group 20-25.
		13-17	For age group 25-30.
		19-23	For age group 30-35.
		25-29	For age group 35-40.
		31-35	For age group 40-45.
		37-41	For age group 45-50.
4	ASFP1	1-5	For age group 15-20. Decimal point should be in column 1.
		7-11	For age group 20-25. Decimal point should be in column 7.
		13-17	For age group 25-30. Decimal point should be in column 13.
		19-23	For age group 30-35. Decimal point should be in column 19.
		25-29	For age group 35-40. Decimal point should be in column 25.
		31-35	For age group 40-45. Decimal point should be in column 31.
		37-41	For age group 45-50. Decimal point should be in column 37.
5	CEB2	1-5	For age group 15-20. Card 5 is omitted if NYRS = 1.
		7-11	For age group 20-25. Card 5 is omitted if NYRS = 1.
		13-17	For age group 25-30. Card 5 is omitted if NYRS = 1.

Card	Mnemonic	Columns	Special comments
		19-23	For age group 30-35. Card 5 is omitted if NYRS = 1.
		25-29	For age group 35-40. Card 5 is omitted if NYRS = 1.
		31-35	For age group 40-45. Card 5 is omitted if NYRS = 1.
		37-41	For age group 45-50. Card 5 is omitted if NYRS = 1.
6	ASFP2	1-5	For age group 15-20. Decimal point should be in column 1. Card 6 is omitted if NYRS = 1.
		7-11	For age group 20-25. Decimal point should be in column 7. Card 6 is omitted if NYRS = 1.
		13-17	For age group 25-30. Decimal point should be in column 13. Card 6 is omitted if NYRS = 1.
		19-23	For age group 30-35. Decimal point should be in column 19. Card 6 is omitted if NYRS = 1.
		25-29	For age group 35-40. Decimal point should be in column 25. Card 6 is omitted if NYRS = 1.
		31-35	For age group 40-45. Decimal point should be in column 31. Card 6 is omitted if NYRS = 1.
		37-41	For age group 45-50. Decimal point should be in column 37. Card 6 is omitted if NYRS = 1.

Example

In the following example, data on children ever born and recorded fertility rates in five-year age groups are available for a hypothetical population from an enumeration of July 1970. The Arriaga/Brass approach is used to adjust the recorded age-specific fertility rates to provide "corrected" fertility estimates for July 1970. The recorded age-specific fertility rates were tabulated by age of mother at the time of the birth of the child. The results imply that the recorded fertility underestimated actual fertility by about 14 per cent and the true total fertility rate is about 6.7 births per woman. The coded input and resulting output appear as follows:

FORTRAN Coding Form

Statement number	FORTRAN STATEMENT	Card number
HYPOT	HETICAL POPULATION	1
1 07	1970 1	2
0.154	1.129 2.562 4.008 5.237 5.956 6.243	3
.1020	.2170 .2590 .2410 .1760 .1300 .0400	4

ICC.7 10-68

APPLICATION OF ARRIAGA'S APPROACHES FOR ESTIMATION OF AGE SPECIFIC FERTILITY RATES FOR STUDY OF HYPOTHETICAL POPULATION

BASED ON CHILDREN EVER BORN FOR ONE POINT(S) IN TIME AND THE AGE PATTERN(S) OF FERTILITY (BRASS)

AGE GROUPS	CHILDREN EVER BORN (C.E.B.)	FERTILITY CONSISTENT WITH C.E.B. (A.S.F.R.)	FERTILITY PATTERN BY AGE AT SURVEY DATE	FERTILITY PATTERN BY AGE AT BIRTH OF CHILD	CUMULATION OF		ADJUSTMENT FACTORS	AGE SPECIFIC FERTILITY RATES BASED ON ADJUSTMENT FACTOR FOR THE AGE GROUP		
					A.S.F.R.	FERTILITY PATTERN BY AGE AT BIRTH		20-25	25-30	20-30
JUL 1970										
				RECORDED						
15-20	0.154	0.1012	XXXXX	0.1020	0.1012	0.1020	0.9926	0.1174	0.1162	0.1168
20-25	1.129	0.2659	XXXXX	0.2170	0.3672	0.3190	1.1509	0.2498	0.2471	0.2484
25-30	2.562	0.2911	XXXXX	0.2590	0.6583	0.5780	1.1389	0.2981	0.2950	0.2965
30-35	4.008	0.2764	XXXXX	0.2410	0.9347	0.8190	1.1412	0.2774	0.2745	0.2759
35-40	5.237	0.1982	XXXXX	0.1760	1.1328	0.9950	1.1385	0.2026	0.2004	0.2015
40-45	5.956	0.1094	XXXXX	0.1300	1.2423	1.1250	1.1042	0.1496	0.1481	0.1488
45-50	6.243	0.0396	XXXXX	0.0400	1.2819	1.1650	1.1003	0.0460	0.0456	0.0458
MEAN AGE OF FERTILITY:		28.30		28.53						
TOTAL FERTILITY RATE:		6.41		5.83				6.70	6.63	6.67

Name of procedure: ICM

Purpose of procedure. Estimates single-year probabilities of dying ($_1q_x$ values) for ages under 5 from probabilities of dying in age groups 0-1, 1-5 and 5-10.

Description of technique. Estimates of single-year mortality under age 5 are generated using the three-parameter interpolation formula

$$\ln(-\ln {}_1q_x) = \ln(-\ln t_1) + t_3 \cdot \ln(x + t_2)$$

where x is the age and t_1, t_2 and t_3 are chosen so that the interpolation equation is consistent with given values of $_1q_0$, $_4q_1$ and $_5q_5$.

The equation was chosen after observation that in a wide range of countries, $\ln(-\ln {}_1q_x)$ values were linearly related to ln x for ages 1 through 7 or 8 years. The addition of the parameter t_2 brought infant mortality in line with the linear relationship (Heligman and Pollard, 1980). Probabilities of dying ($_1q_x$) by single years of age for ages under 5 are presented along with the corresponding number of survivors at each age (l_x). The procedure is carried out by the subroutine ICM.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A heading of up to 72 characters, to be printed at the top of the page of output.
QXMX	The empirical set of $_nq_x$ values, for age groups 0-1, 1-5, and 5-10. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	QXMX	1-6	For age group 0-1. Decimal point must be punched.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.

Example

In the following example, probabilities of dying (${}_nq_x$ values) for ages 0-1, 1-5 and 5-10 are given as input and interpolated ${}_1q_x$ values and corresponding l_x values for ages 0, 1, 2, 3 and 4 are calculated and printed.

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE OF
PROGRAMMER	DATE		PUNCH	CARD ELECTRO NUMBER

STATEMENT NUMBER (1–5)	CONT. (6)	FORTRAN STATEMENT (7–72)	Card number (73–80)
HYPOT	H	ETICAL POPULATION	1
.1350	0	.12000 .01500	2

ICC.7 (6–60)

HYPOTHETICAL POPULATION

INPUT DATA:

```
Q(0-1)  = .13500
Q(1-5)  = .12000
Q(5-10) = .01500
```

ESTIMATED SINGLE YEAR MORTALITY:

```
Q(0-1) = .13500        I(1) = 86500.
Q(1-2) = .06340        I(2) = 81016.
Q(2-3) = .03290        I(3) = 78351.
Q(3-4) = .01817        I(4) = 76927.
Q(4-5) = .01050        I(5) = 76120.
```

INTERPOLATION PARAMETERS:

```
T(1) = 0.22352
T(2) = 1.56461
T(3) = 0.64805
```

Name of procedure: LIFTB

__Purpose of procedure__. Construction of a life table based on a set of age-specific central death rates ($_nm_x$ values) or age-specific probabilities of dying ($_nq_x$ values).

__Description of technique__. Based on a given set of $_nm_x$ or $_nq_x$ values for age groups 0-1, 1-5, 5-10, ..., up to the last closed age group available (maximum of 95-100 is allowed, value for the final open age group is not given), an abridged life table is constructed. The usual life table columns are calculated, labelled on the computer output and defined, as follows:

AGE: the initial age of the age interval (x, x+n) where x is the initial age and n is the length of the interval. The interval length is five years, with the exception of infancy (one year), early childhood years (four-year age group) and last interval (open ended);

M(X,N): central death rate for the age interval (x, x+n). Usual notation is $_nm_x$;

Q(X,N): probability of an individual age x dying before the end of the age interval (x, x+n). Usual notation is $_nq_x$;

I(X): number of survivors at age x in a life table with radix (starting population) of 100,000 persons. Usual notation is l_x;

D(X,N): number of deaths in age interval (x, x+n). Usual notation is $_nd_x$;

L(X,N): number of person-years lived in age interval (x, x+n). Usual notation is $_nL_x$;

S(X,N): the proportion of the life table population in age group (x, x+n) who are alive n year later. Usual notation is $_nS_x$;

T(X): number of person-years lived at ages x and older. Usual notation is T_x;

E(X): expectation of life at age x. Usual notation is e_x;

A(X,N): average number of years lived in the age interval (x, x+n) by those dying during that age interval. Usual notation is $_na_x$.

The procedure for constructing the life table from the $_nm_x$ or $_nq_x$ values is based on a method developed by Greville (1943). To complete the life table the $_nq_x$ values are extrapolated until no survivors remain, by fitting a Makeham function through the last six $_nq_x/(1 - {_nq_x})$ values available (United Nations, 1982, p. 31). The procedure is carried out by the subroutine LIFTB.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
NPG	If a series of life tables is being calculated and if NPG = 1, two life tables will be printed on each page. If NPG = 0, only one life table will be printed per page.
LABEL	A heading of up to 72 characters, to be printed above the calculated life table.
NFIN	The ending age of the last closed age group. For example if the last mortality value available is $_5m_{80}$, or $_5q_{80}$, NFIN would take the value 85. The minimum value allowed for NFIN is 65 (referring to age group 60-65) and the maximum value is 100 (referring to age group 95-100).
NTYPE	Indicates whether $_nq_x$ or $_nm_x$ values are being given as input. If $_nq_x$ values are used, NTYPE = 1; if $_nm_x$ values are used, NTYPE = 2.
NSEX	Indicates whether the life table refers to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females. This variable is used for calculating the first two separation factors ($_1a_0$ and $_4a_1$).
QXMX	The age-specific mortality data themselves. No matter whether $_nq_x$ or $_nm_x$ values are used as input, the values are input in the same way. For ages 5 and over the values must be given for five year age groups. For ages under 5 they are given for age groups 0-1 and 1-5. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	NPG	1	
2	LABEL	1-72	
3	NFIN	1-3	Value must be punched to end in column 3.
	NTYPE	5	
	NSEX	7	
4	QXMX	1-6	For age group 0-1. Decimal point should be punched.
		8-13	For age group 1-5. Decimal point should be punched.
		15-20	For age group 5-10. Decimal point should be punched.
		. . .	
		64-69	For age group 40-45. Decimal point should be punched.
5	QXMX	1-6	For age group 45-50. Decimal point should be punched.
		8-13	For age group 50-55. Decimal point should be punched.
		15-20	For age group 55-60. Decimal point should be punched.
		22-27	For age group 60-65. Decimal point should be punched.

Card	Mnemonic	Columns	Special comments
		29-34	For age group 65-70. Decimal point should be punched. Leave blank if NFIN is less than 70.
		. . .	
		64-69	For age group 90-95. Decimal point should be punched. Leave blank if NFIN is less than 95.
6	QXMX	1-6	For age group 95-100. Decimal point should be punched. Card 6 is omitted if NFIN is less than 100.

A series of life tables can be calculated by inserting additional sets of data cards, beginning with card 2, i.e., the label card. Card 1 should appear only once in the data stream as it refers to all sets of data following.

Example

In the following example, a set of mortality data for a hypothetical female population is to be processed and a life table constructed and printed. Mortality probabilities, i.e., ${}_nq_x$ values, are given for age groups up to 75-80.

The coded input and sample output would appear as follows:

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC		PAGE OF
PROGRAMMER	DATE		PUNCH		CARD ELECTRO NUMBER*

```
STATEMENT NUMBER | CONT. | FORTRAN STATEMENT                                                  | card number
1
HYPOTHETICAL FEMALES                                                                          1
080 1 2                                                                                       2
.11856 .09301 .02970 .01687 .02066 .02531 .02866 .03173 .03560 .03986                         3
.04465 .05829 .07924 .01269 .18452 .28516 .41943                                              4
                                                                                              5
```

HYPOTHETICAL FEMALES

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)	T(X)	E(X)	A(X,N)
0	.12846	.11856	100000.	11856.	92294.	.84647 /A/	4999723.	49.997	0.350
1	.02477	.09301	88144.	8198.	330941.	.93044 /B/	4907430.	55.675	1.361
5	.00603	.02970	79946.	2374.	393793.	.97662	4576489.	57.245	2.500
10	.00340	.01687	77571.	1309.	384585.	.98157	4182696.	53.921	2.500
15	.00417	.02066	76263.	1576.	377495.	.97702	3798111.	49.803	2.577
20	.00513	.02531	74687.	1890.	368820.	.97295	3420616.	45.799	2.558
25	.00581	.02866	72797.	2086.	358843.	.96983	3051796.	41.922	2.536
30	.00645	.03173	70710.	2244.	348016.	.96640	2692953.	38.084	2.532
35	.00725	.03560	68467.	2437.	336322.	.96232	2344937.	34.249	2.533
40	.00813	.03986	66029.	2632.	323649.	.95809	2008616.	30.420	2.531
45	.00913	.04466	63397.	2831.	310084.	.94926	1684967.	26.578	2.562
50	.01199	.05829	60566.	3530.	294350.	.93235	1374882.	22.701	2.598
55	.01647	.07924	57036.	4520.	274439.	.90215	1080532.	18.945	2.624
60	.02560	.12069	52516.	6338.	247585.	.85045	806094.	15.349	2.634
65	.04047	.18452	46178.	8521.	210557.	.76996	558509.	12.095	2.614
70	.06624	.28516	37657.	10738.	162121.	.65469	347951.	9.240	2.563
75	.10638	.41943	26919.	11291.	106139.	.42884 /C/	185831.	6.903	2.480
80	.19611	.....	15628.	15628.	79691.	.....	79691.	5.099	5.099

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(75+,5)=T(80)/T(75)

Name of procedure: MATCH

Purpose of procedure. Calculates and prints out United Nations, Coale-Demeny or user-designated model life tables corresponding to given levels of mortality. As the user-designated model can be a mortality pattern specific to a certain population, MATCH can generate a country-specific model life-table system.

Description of technique. The user must designate the model pattern (any of the five United Nations, four Coale-Demeny patterns or an external model supplied by the user) and sex desired. The United Nations principal component equations (United Nations, 1982, p. 8) or Coale-Demeny regression equations (Coale-Demeny, 1966, p. (21)) are then used with an iterative procedure to find the model corresponding to a given level of mortality. The iterative procedure is described in United Nations, 1982 (pp. 22-23). However, because of potential extrapolation problems, model life tables are calculated only when life expectancy at birth is between 20 and 80 years. The mortality level is specified by the user by designating a mortality value for one of four life-table functions (${}_nm_x$, ${}_nq_x$, l_x or e_x) for any one of the age groups. The iterative procedure is carried out by the subroutine MATCH, which calls the subroutines LIFTB and, when necessary, ICM for construction of the model life table itself. The model life table is presented as computer output; the life-table columns are as given in the description of the main program LIFTB in this chapter.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
$LABEL_1$	A data description of up to 40 characters, to be included in the heading at the top of the page of output.
NSEX	Indicates whether the life table refers to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females.
NREG	Indicates the model life-table pattern to be used. The codes are: 0 = empirical age pattern 1 = UN Latin American model

Mnemonic	Definition and comments
	2 = UN Chilean 3 = UN South Asian 4 = UN Far East Asian 5 = UN General 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South If NREG = 0, the user is supplying the average pattern of mortality to be used as a model (see AVE below). The United Nations principal component equations are then used to adjust this pattern to the desired mortality level.
$LABEL_2$	This variable is used only if NREG above equals zero. It is a name for the model supplied by the user and is included in the table heading.
The following variables, NPARM, NAGE, CMP, CMP2 and RNGE, indicate the life-table column, age group and level(s) of the model life table(s) to be chosen.	
NPARM	NPARM indicates the life-table column: 1 = $_nm_x$, 2 = $_nq_x$, 3 = l_x, 4 = e_x.
NAGE	NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l_2, l_3 or l_4.
CMP CMP2 RNGE	CMP indicates the mortality value being matched. When a series of model life tables is desired, values for CMP2 and RNGE must also be given. In this case, CMP will be the mortality value for the first model life table, CMP2 for the final model table, and RNGE the increment. A maximum of 50 tables can be requested through the CMP2-RNGE option. For example, if a series of model life tables is desired in which e_5 varies from 40 to 60 years at five-year intervals, we would code NPARM = 4, NAGE = 5, CMP = 40.0, CMP2 = 60.0 and RNGE = 5.0.
AVE	This variable is used only if NREG above equals zero. It consists of model $_nq_x$ values supplied by the user. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, $_nq_x$ values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	$LABEL_1$	1-40	
2	NSEX	1	
	NREG	3	
	$LABEL_2$	20-51	
3	NPARM	1	
	NAGE	3-4	Value must be punched to end in column 4.
	CMP	6-11	Decimal point must be punched.
	CMP2	13-18	Decimal point must be punched.
	RNGE	20-25	Decimal point must be punched.
4	AVE	1-6	For age group 0-1. Decimal point must be punched. This card is omitted if NREG does not equal zero.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		. . .	
		64-69	For age group 40-45. Decimal point must be punched.
5	AVE	1-6	For age group 45-50. Decimal point must be punched. This card is omitted if NREG does not equal zero.

Card	Mnemonic	Columns	Special comments
		. . .	
		22-27	For age group 60-65. Decimal point must be punched.
		29-34	For age group 65-70. Decimal point must be punched. Leave blank if fewer values are given.
		36-41	For age group 70-75. Decimal point must be punched. Leave blank if fewer values are given.
		43-48	For age group 75-80. Decimal point must be punched. Leave blank if fewer values are given.
		50-55	For age group 80-85. Decimal point must be punched. Leave blank if fewer values are given.

Example

In the following example, model life tables are calculated corresponding to three different sets of input data. In the first set of data, a United Nations model life table for the Latin American pattern, females, corresponding to an infant mortality rate of 150 infant deaths per 1,000 live births is requested. In the second data set, a North region Coale and Demeny female model life table with a life expectancy at age 5 of 55 years is requested. In the third data set, a set of $_nq_x$ values supplied by the user based on a neighbouring country is given, and the first component vector of the United Nations models is used to adjust them to correspond to a life expectancy at birth of 65 years.

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE OF
PROGRAMMER	DATE		PUNCH	CARD ELECTRO NUMBER

```
STATEMENT  CONT  FORTRAN STATEMENT                                              Card number
HYPOTHETICAL COUNTRY (DATA SET 1)                                                         1
21                                                                                        2
200 .15000                                                                                3
HYPOTHETICAL COUNTRY (DATA SET 2)                                                         1
27                                                                                        2
405 55.000                                                                                3
HYPOTHETICAL COUNTRY (DATA SET 3)                                                         1
20                NEIGHBORING COUNTRY                                                     2
400 65.000                                                                                3
.11856 .09301 .02970 .01687 .02066 .02531 .02866 .03173 .03560 .03986                     4
.04466 .05829 .07924 .12069 .18452 .28516 .41943                                          5
```

ICC.7 (8-60)

UNITED NATIONS MODEL LIFE TABLE FOR THE LATIN AMERICAN
PATTERN OF THE FEMALE SEX WITH A VALUE OF Q(O)= 0.15000
FOR THE STUDY OF HYPOTHETICAL COUNTRY (DATA SET 1)

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)	T(X)	E(X)	A(X,N)
0	.16621	.15000	100000.	15000.	90250.	.79041 /A/	3937158.	39.372	0.350
1	.04355	.15624	85000.	13280.	304954.	.88664 /B/	3846908.	45.258	1.361
5	.00936	.04571	71720.	3278.	350404.	.96511	3541954.	49.386	2.500
10	.00477	.02355	68442.	1612.	338179.	.97258	3191550.	46.632	2.500
15	.00673	.03313	66830.	2214.	328905.	.96009	2853372.	42.696	2.631
20	.00956	.04673	64616.	3019.	315780.	.94959	2524466.	39.069	2.582
25	.01098	.05343	61597.	3291.	299863.	.94306	2208686.	35.857	2.532
30	.01246	.06044	58306.	3524.	282788.	.93660	1908823.	32.738	2.519
35	.01365	.06600	54782.	3615.	264859.	.93313	1626036.	29.682	2.497
40	.01406	.06792	51166.	3475.	247149.	.92859	1361177.	26.603	2.501
45	.01582	.07613	47691.	3631.	229500.	.91673	1114028.	23.359	2.534
50	.01935	.09238	44060.	4070.	210391.	.89357	884528.	20.075	2.565
55	.02626	.12347	39990.	4937.	187998.	.85564	674137.	16.858	2.580
60	.03688	.16925	35052.	5933.	160860.	.79956	486139.	13.869	2.572
65	.05377	.23749	29120.	6916.	128617.	.72162	325279.	11.170	2.544
70	.07815	.32668	22204.	7254.	92812.	.62460	196662.	8.857	2.490
75	.11186	.43374	14950.	6485.	57971.	.51396	103850.	6.946	2.412
80	.15688	.55213	8466.	4674.	29795.	.35058 /C/	45879.	5.419	2.318
85	.23573	.....	3792.	3792.	16084.	.....	16084.	4.242	4.242

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(80+,5)=T(85)/T(80)

COALE & DEMENY MODEL LIFE TABLE FOR THE NORTH
PATTERN OF THE FEMALE SEX WITH A VALUE OF E(5)= 55.00000
FOR THE STUDY OF HYPOTHETICAL COUNTRY (DATA SET 2)

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)		T(X)	E(X)	A(X,N)
0	.12211	.11313	100000.	11313.	92647.	.85041	/A/	4840565.	48.406	0.350
1	.02528	.09481	88687.	8408.	332560.	.92473	/B/	4747919.	53.535	1.361
5	.00834	.04083	80279.	3277.	393202.	.96828		4415358.	55.000	2.500
10	.00449	.02222	77002.	1711.	380731.	.97710		4022156.	52.235	2.500
15	.00485	.02396	75291.	1804.	372014.	.97410		3641425.	48.365	2.539
20	.00570	.02810	73486.	2065.	362378.	.96974		3269411.	44.490	2.553
25	.00661	.03250	71421.	2321.	351414.	.96504		2907034.	40.703	2.548
30	.00765	.03754	69100.	2594.	339127.	.95980		2555620.	36.984	2.543
35	.00877	.04291	66506.	2854.	325493.	.95455		2216493.	33.328	2.534
40	.00963	.04798	63652.	3054.	310698.	.94996		1891000.	29.708	2.524
45	.01083	.05274	60598.	3196.	295150.	.94126		1580302.	26.078	2.547
50	.01370	.06628	57402.	3805.	277812.	.92384		1285152.	22.389	2.582
55	.01844	.08828	53597.	4732.	256654.	.89387		1007340.	18.795	2.605
60	.02725	.12795	48866.	6253.	229415.	.84353		750686.	15.362	2.615
65	.04202	.19083	42613.	8132.	193518.	.76693		521271.	12.233	2.596
70	.06586	.28347	34481.	9774.	148416.	.66302		327752.	9.505	2.546
75	.10104	.40242	24707.	9943.	98402.	.45130	/C/	179337.	7.259	2.472
80	.18242	.....	14764.	14764.	80935.	.....		80935.	5.482	5.482

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(75+,5)=T(80)/T(75)

USER SUPPLIED MODEL LIFE TABLE FOR THE NEIGHBORING COUNTRY
PATTERN OF THE FEMALE SEX WITH A VALUE OF E(0)= 65.00000
FOR THE STUDY OF HYPOTHETICAL COUNTRY (DATA SET 3)

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)	T(X)	E(X)	A(X,N)
0	.06937	.06593	100000.	6593.	95041.	.92152 /A/	6500001.	65.000	0.248
1	.00837	.03278	93407.	3061.	365720.	.97554 /B/	6404960.	68.570	1.417
5	.00199	.00991	90346.	895.	449491.	.99217	6039240.	66.846	2.500
10	.00115	.00573	89451.	513.	445972.	.99388	5589750.	62.490	2.500
15	.00135	.00671	88938.	596.	443242.	.99260	5143778.	57.835	2.571
20	.00164	.00815	88342.	720.	439964.	.99101	4700536.	53.209	2.577
25	.00198	.00986	87622.	864.	436008.	.98930	4260572.	48.625	2.570
30	.00234	.01163	86757.	1009.	431342.	.98699	3824564.	44.083	2.577
35	.00294	.01458	85748.	1250.	425732.	.98347	3393222.	39.572	2.593
40	.00376	.01863	84498.	1575.	418696.	.97929	2967490.	35.119	2.590
45	.00469	.02317	82924.	1921.	410023.	.97255	2548794.	30.737	2.608
50	.00662	.03260	81002.	2641.	398769.	.96091	2138771.	26.404	2.636
55	.00963	.04710	78361.	3691.	383180.	.93973	1740002.	22.205	2.662
60	.01588	.07660	74671.	5720.	360087.	.90100	1356822.	18.171	2.680
65	.02684	.12629	68951.	8708.	324437.	.83654	996735.	14.456	2.667
70	.04622	.20824	60243.	12545.	271404.	.73960	672298.	11.160	2.623
75	.07708	.32436	47698.	15472.	200729.	.49930 /C/	400894.	8.405	2.559
80	.16100	.....	32227.	32227.	200165.	.....	200165.	6.211	6.211

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(75+,5)=T(80)/T(75)

Name of procedure: ORPHAN

Purpose of procedure. To estimate female adult mortality from tabulations on proportion of population with mothers still alive by age group of respondents.

Description of technique. Brass and Hill (1973) have shown that the proportion of population with mother still alive can be used to generate estimates of adult female mortality. Hill and Trussell (1977) later proposed an estimation equation of the form

$$_{n}l_{25} = a(n) + b(n)\ AGE + c(n)\ _{5}S_{n-5}$$

where $_{n}l_{25}$ is the life-table probability of female survival from age 25 to age 25+n, AGE is the mean age of childbearing for women in the population, $_{5}S_{n-5}$ is the proportion of the population in age group (n-5, n) with mother still alive, and a(n), b(n) and c(n) are age-specific constants (presented by Hill and Trussell in tabular form). (An approximate estimate of AGE is produced by the procedures FERTCB and FERTPF.) In practice, only values of n varying from 20 to 50 are used, corresponding to age groups of respondents 15-20, 20-25, 25-30, ..., 45-50 and probabilities of female survival from age 25 to 45, 25 to 50, ..., 25 to 75. The constants a(n), b(n) and c(n) were estimated by Hill and Trussell through regression procedures on simulated data which were in turn based on the Coale-Demeny model life tables. Palloni and Heligman (1985), using the identical formulations, later presented revised constants based on each of the five patterns underlying the United Nations models. In sum, then, a choice of six sets of estimating equations are available, one based on the Coale and Demeny models and five based on the United Nations models. Through a second set of simulations, Palloni and Heligman also developed a set of regression equations which estimate the time reference to which the $_{n}l_{25}$ values refer. These regression equations are based on the United Nations General pattern of mortality but appear to apply equally well to all of the United Nations patterns, as well as the Coale and Demeny based pattern. The independent variables, which are calculated from the input data, necessary for calculating these time references are: the ratio of average number of children ever born for women in age group 15-20 to that in age group 20-25 (PAR1), the ratio of average number of children ever born for women in age group 20-25 to that in age group 25-30 (PAR2), and the mean age of childbearing among women in the population (AGE). The procedure is performed by subroutine ORPHAN; this subroutine also calculates estimates of the life expectancy at birth and at age 20 which correspond to the $_{n}l_{25}$ values within each model life-table pattern.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be included in the heading at the top of the page of output.
MONTH	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December).
NYEAR	The year of the enumeration; for example, 1970.
AGE	The mean age of mother at childbearing in the population.
SNOR	The proportion of population with mother still alive. Data are given for age groups 15-20, 20-25, ..., up to 45-50.
CEB	The average number of children ever born to a woman. Data are given for age groups 15-20, 20-25 and 25-30.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	MONTH	1-2	Data must be punched to end in column 2.
	NYEAR	4-7	The year should be punched to four digits; for example, 1970.
	AGE	9-13	Value should be punched with the decimal point in column 11.
3	SNOR	1-5	For age group 15-20. Decimal point should be in column 1.

Card	Mnemonic	Columns	Special comments
		7-11	For age group 20-25. Decimal point should be in column 7.
		13-17	For age group 25-30. Decimal point should be in column 13.
		. . .	
		37-41	For age group 45-50. Decimal point should be in column 37.
4	CEB	1-5	For age group 15-20. Decimal point should be in column 2.
		7-11	For age group 20-25. Decimal point should be in column 8.
		13-17	For age group 25-30. Decimal point should be in column 14.

Example

In the following example, estimates of adult female mortality and corresponding life expectancies for a hypothetical population are calculated and printed. The average age at childbearing is 26.00 and the proportion of the population with mother still alive is given for age groups 15-20, 20-25, ..., up to 45-50. To calculate the reference dates, the average number of children ever born for age groups 15-20, 20-25 and 25-30 are given.

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC		PAGE OF
PROGRAMMER	DATE		PUNCH		CARD ELECTRO NUMBER*

STATEMENT NUMBER	CONT.	FORTRAN STATEMENT	card number
HYPOT	H	ETICAL POPULATION	1
10 198	4	20.00	2
.9439		.9101 .8491 .7801 .6862 .5567 .4096	3
0.114		1.002 2.523	4

ICC.7 (6-66)

ORPHANHOOD ESTIMATES OF ADULT FEMALE MORTALITY FOR HYPOTHETICAL POPULATION

DATE OF SURVEY = OCT 1984
AVERAGE AGE AT CHILDBEARING = 26.00
CHILDREN EVER BORN:
AGES 15-20 = 0.114
AGES 20-25 = 1.002
AGES 25-30 = 2.523

PROBABILITY OF SURVIVING FROM AGE 25 TO AGE X

AGE GROUP OF RESPONDENT	PROPORTION NOT ORPHANED	AGE X	UNITED NATIONS MODELS (PALLONI-HELIGMAN EQUATIONS) LATIN AM.	CHILEAN	SO. ASIAN	FAR EAST	GENERAL	COALE-DEMENY MODEL (HILL-TRUSSELL EQUATION)
15-20	.9439	45	.9402	.9386	.9415	.9404	.9385	.9355
20-25	.9101	50	.9046	.9051	.9095	.9079	.9038	.9015
25-30	.8491	55	.8444	.8449	.8460	.8458	.8460	.8414
30-35	.7801	60	.7735	.7726	.7738	.7734	.7737	.7741
35-40	.6862	65	.6765	.6726	.6728	.6669	.6741	.6805
40-45	.5567	70	.5336	.5303	.5264	.5202	.5309	.5440
45-50	.4096	75	.3691	.3674	.3594	.3579	.3647	.3805

CORRESPONDING LIFE EXPECTANCIES

AGE GROUP OF RESPONDENT	REFERENCE DATE	UNITED NATIONS MODELS (PALLONI-HELIGMAN EQUATIONS) LATIN AM.	CHILEAN	SO. ASIAN	FAR EAST	GENERAL	COALE-DEMENY MODELS (HILL-TRUSSELL EQUATIONS) WEST	NORTH	EAST	SOUTH
LIFE EXPECTANCY AT AGE TWENTY										
15-20	NOV 1975	52.9	52.2	50.5	51.3	51.7	51.4	52.7	50.7	51.5
20-25	NOV 1973	52.0	51.7	50.0	51.1	51.1	50.8	51.8	50.1	50.6
25-30	DEC 1971	50.3	50.2	48.7	49.9	49.9	49.4	50.1	48.6	48.8
30-35	AUG 1970	49.5	49.6	48.6	49.7	49.3	48.9	49.2	48.2	47.9
35-40	FEB 1969	48.8	48.9	48.6	49.0	48.7	48.5	48.4	48.0	47.5
40-45	DEC 1968	47.4	47.8	48.0	47.8	47.6	47.4	47.1	47.5	46.8
45-50	XXXX	46.1	46.6	47.4	46.7	46.5	46.4	46.1	47.2	46.5
LIFE EXPECTANCY AT BIRTH										
15-20	NOV 1975	65.3	64.6	58.6	67.0	65.0	65.8	66.6	62.8	60.8
20-25	NOV 1973	63.7	63.9	57.6	66.8	64.0	64.6	64.8	61.5	58.8
25-30	DEC 1971	60.7	61.4	54.6	65.1	62.0	61.9	61.2	58.2	55.0
30-35	AUG 1970	59.2	60.3	54.4	64.7	61.0	60.9	59.2	57.3	53.2
35-40	FEB 1969	57.8	59.1	54.5	63.7	60.0	59.8	57.3	56.7	52.1
40-45	DEC 1968	55.2	57.2	53.0	62.0	58.0	57.6	54.5	55.5	50.6
45-50	XXXX	52.6	55.1	51.7	60.3	56.0	55.6	52.2	54.8	50.1

Name of procedure: PRESTO

Purpose of procedure. Provides integrated estimates of intercensal mortality, fertility and age distribution based on recorded age distributions from two censuses and assumption of a United Nations, Coale-Demeny or user-designated model life-table pattern.

Description of technique. Preston (1983) has demonstrated a simple method for estimating intercensal mortality, fertility and age distributions in a closed population based on two recorded census age distributions and assumption of a model life-table pattern. The method is referred to as the "integrated method" because it combines Brass's one-parameter logit mortality system (Brass and others, 1968) with the generalized stable population equation (Preston and Coale, 1982).

The one-parameter (α) Brass system relates a chosen model life table (referred to as the standard) to any other life table within the same model life-table system according to the equation

$$\left[\frac{1 - p(a)}{p(a)}\right] = e^{\alpha} \left[\frac{1 - p_s(a)}{p_s(a)}\right] \qquad (1)$$

where $p_s(a)$ is the probability of surviving to age a in the model life table, p(a) is the corresponding value for any other life table within the same system, and α is a parameter.

The generalized stable population equation applies to any closed population and relates the current age distribution to current levels of mortality, fertility and age-specific growth rates. Namely,

$$c(a) = be^{-\int_0^a r(x)dx} p(a) \qquad (2)$$

where c(a) is the proportion of the population aged a, b is the crude birth rate, r(x) is the growth rate of persons age x, and p(a) is the probability of survival to age a.

If we assume that p(a) in equation (1) describes the current life table for the population described by equation (2), we can solve equation (1) for p(a), substitute into equation (2) and after further manipulation,

$$\frac{e^{-\int_0^a r(x)dx}}{c(a)} = \frac{1}{b} + \frac{e^{\alpha}}{b}\left[\frac{1 - p_s(a)}{p_s(a)}\right]$$

As estimates of p(5), the probability of surviving to age 5, are generally available from children ever born/children surviving tabulations (see CEBCS), the above equation can be refined as

$$\frac{p(5)\ e^{-\int_0^a r(x)dx}}{c(a)} = \frac{1}{b} + \frac{e}{b}\left[\frac{1 - {}_5p_s(a)}{{}_5p_s(a)}\right] \qquad (3)$$

where $a \geq 5$ and ${}_5p_s(a)$ indicates that the radix of the life table is unity at age 5. The variable on the left-hand side of equation (3) can be estimated, on an intercensal basis, from the age distributions in two censuses. With choice of life table from a model life-table pattern (either a United Nations, Coale-Demeny or user-designated pattern) appropriate to the country under study, the quantity in brackets on the right-hand side can be calculated and the left-hand side of equation (3) can be regressed on the right-hand side. The regression minimizes the sum of squared relative differences between observed and predicted values. The estimated regression parameters provide estimates of the demographic parameters during the intercensal period: the reciprocal of the intercept equals the crude birth rate and e^{α} adjusts the chosen model life table to the correct level. From introduction of the estimated intercensal birth rate (b) and survival function [p(a)] into equation (2), the "correct" intercensal age distribution is obtained. This correct intercensal age distribution can be compared with an average of the recorded age distribution for an analysis of errors in age recording in the censuses.

The required input is therefore the population age distributions from two censuses, a model life table to be used as the standard, and estimates of survivorship to age 5 and age 1 for the intercensal period. The last datum permits refined calculation of a life table beginning at age 0; it does not affect calculated crude birth rates, life expectancy at age 5 or the estimated intercensal age distribution. Up to nine regressions are calculated (depending on the number of age groups available), providing nine separate sets of estimates. The regressions vary according to the range of ages used; the initial age is 5, 10 or 15 and the terminal age is 60, 65 or 70.

For more information about this technique, see Preston (1983).

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
$LABEL_1$	A data description of up to 40 characters, to be included in the heading at the top of the page of output.
MONTH1	Indicates the month that the first census was taken (1 = January, 2 = February, ..., 12 = December).
IYEAR1	The year the first census was taken; for example, 1970.
MONTH2	Indicates the month that the second census was taken (1 = January, 2 = February, ..., 12 = December).
IYEAR2	The year the second census was taken; for example, 1970.
NVAL	Indicates the number of age groups given for the populations POP1 and POP2. NVAL must have a value ranging from 14 to 18.
PSTAR1	Probability of surviving from birth to age 1 in the country being studied. Its purpose is to allow the printing of a life table beginning with age 0.
PSTAR5	Probability of surviving from birth to age 5 in the country being studied.
NSEX	Indicates whether the life table refers to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females.
NREG	Indicates the model life-table pattern to be used. The codes are: 0 = empirical age pattern 1 = UN Latin American model 2 = UN Chilean 3 = UN South Asian 4 = UN Far East Asian 5 = UN General 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South If NREG = 0, the user is supplying the average pattern of mortality to be used as a model (see AVE below).

Mnemonic	Definition and comments
	The following variables, NPARM, NAGE and CMP, indicate the life-table column, age group and level of the model life table to be chosen.
NPARM	NPARM indicates the life-table column: 1 = $_nm_x$, 2 = $_nq_x$, 3 = l_x, 4 = e_x.
NAGE	NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l_2, l_3 or l_4.
CMP	CMP indicates the mortality value being matched. For example, if a model life table is chosen with l_5 = 90000, then NPARM = 3, NAGE = 5 and CMP = 90000.
$LABEL_2$	This variable is used only if NREG above equals zero. It is a name for the model supplied by the user and is included in the table heading.
POP1	The population by age for the first census. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.
POP2	The population by age for the second census. Data are given for age groups 0-5, 5-10, ... , up through the last open age group available. The number of age groups must be consistent with NVAL.
AVE	This variable is used only if NREG above equals zero. It consists of model $_nq_x$ values supplied by the user. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, $_nq_x$ values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

<u>Data input</u>. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	$LABEL_1$	1-40	
2	MONTH1	1-2	Data must be punched to end in column 2.
	IYEAR1	4-7	The year must be punched to 4 digits; for example, 1970.
	MONTH2	9-10	Data must be punched to end in column 10.
	IYEAR2	12-15	The year must be punched to 4 digits; for example, 1970.
	NVAL	17-18	Data should be punched to end in column 18.
	PSTAR1	20-25	Decimal point should be punched to end in column 25.
	PSTAR5	27-32	Decimal point should be punched to end in column 32.
3	NSEX	1	
	NREG	3	
	NPARM	5	
	NAGE	7-8	Data should be punched to end in column 8.
	CMP	10-15	Decimal point should be punched.
	$LABEL_2$	20-51	Leave blank if NREG does not equal 0.
4	POP1	1-8	For age group 0-5. Decimal point should be punched in column 8.
		9-16	For age group 5-10. Decimal point should be punched in column 16.
		17-24	For age group 10-15. Decimal point should be punched in column 24.

Card	Mnemonic	Columns	Special comments
		.	
		.	
		.	
		65–72	For age group 40-45. Decimal point should be punched in column 72.
5	POP1	1–8	For age group 45–50. Decimal point should be punched in column 8.
		.	
		.	
		.	
		25–32	For age group 60–65. Decimal point should be punched in column 32.
		33–40	For age group 65–70. Decimal point should be punched in column 40. Leave blank if fewer values are given.
		41–48	For age group 70–75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49–56	For age group 75–80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57–64	For age group 80–85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65–72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.
6	POP2	1–8	For age group 0–5. Decimal point should be punched in column 8.
		9–16	For age group 5–10. Decimal point should be punched in column 16.
		17–24	For age group 10–15. Decimal point should be punched in column 24.

Card	Mnemonic	Columns	Special comments
		. . .	
		65-72	For age group 40-45. Decimal point should be punched in column 72.
7	POP2	1-8	For age group 45-50. Decimal point should be punched in column 8.
		. . .	
		25-32	For age group 60-65. Decimal point should be punched in column 32.
		33-40	For age group 65-70. Decimal point should be punched in column 40. Leave blank if fewer values are given.
		41-48	For age group 70-75. Decimal point should be punched in column 48. Leave blank if fewer values are given.
		49-56	For age group 75-80. Decimal point should be punched in column 56. Leave blank if fewer values are given.
		57-64	For age group 80-85. Decimal point should be punched in column 64. Leave blank if fewer values are given.
		65-72	For age group 85+. Decimal point should be punched in column 72. Leave blank if fewer values are given.
8	AVE	1-6	For age group 0-1. Decimal point must be punched. Card 8 is omitted if NREG is greater than zero.
		8-13	For age group 1-5. Decimal point must be punched. Card 8 is omitted if NREG is greater than zero.

Card	Mnemonic	Columns	Special comments
		15-20	For age group 5-10. Decimal point must be punched. Card 8 is omitted if NREG is greater than zero.
		. . .	
		64-69	For age group 40-45. Decimal point must be punched. Card 8 is omitted if NREG is greater than zero.
9	AVE	1-6	For age group 45-50. Decimal point must be punched. Card 9 is omitted if NREG is greater than zero.
		. . .	
		22-27	For age group 60-65. Decimal point must be punched. Card 9 is omitted if NREG is greater than zero.
		29-34	For age group 65-70. Decimal point must be punched. Leave blank if fewer values are given. Card 9 is omitted if NREG is greater than zero.
		36-41	For age group 70-75. Decimal point must be punched. Leave blank if fewer values are given. Card 9 is omitted if NREG is greater than zero.
		43-48	For age group 75-80. Decimal point must be punched. Leave blank if fewer values are given. Card 9 is omitted if NREG is greater than zero.
		50-55	For age group 80-85. Decimal point must be punched. Leave blank if fewer values are given. Card 9 is omitted if NREG is greater than zero.

Example

In the following example, the integrated procedure is carried out for a hypothetical female population based on census enumerations of June 1960 and June 1970. The age pattern of mortality for the adult years is assumed to be that of Coale-Demeny North region, with the approximate level of mortality assumed to be consistent with a life expectancy at birth of 50 years. Based on external analyses, early age survivorship has been determined to have values of l_1 = 90,000 and l_5 = 85,000 based on a radix of 100,000 persons at birth. Nine regressions have been carried out and all give similar results since all data points seem to appear on a fairly straight line (see figure in sample output). However, the mean square relative errors and number of sign changes in the pattern of residuals (see the "regression results" section of the sample output) indicate that the fit based on age group 10-60 may be slightly better than the others and the demographic parameters for that regression should be chosen. Comparison of the adjusted and enumerated censuses indicates that the recorded censuses have a slightly younger age distribution than the true.

FORTRAN Coding Form

PROGRAM | PUNCHING INSTRUCTIONS | GRAPHIC | PAGE OF
PROGRAMMER | DATE | PUNCH | CARD ELECTRO NUMBER

STATEMENT NUMBER | FORTRAN STATEMENT | Card number

```
HYPOTHETICAL FEMALES                                                        1
06 1960 06 1970 17 90000. 85000.                                            2
2 7 4 00 50.000                                                             3
 65043.  52724.  45317.  39773.  34949.  30625.  26497.  22783.  19417.     4
 16461.  13799.  11385.   8983.   6641.   4381.   2498.   1382.             5
 79061.  64082.  55587.  48819.  42776.  37229.  32211.  27704.  23626.     6
 20095.  16903.  13853.  10963.   8113.   5364.   3051.   1682.             7
```

ICC.7 (6-66)

INTEGRATED ESTIMATES OF DEMOGRAPHIC PARAMETERS FOR HYPOTHETICAL FEMALES

CHOSEN MODEL LIFE TABLE:
PATTERN NORTH
SEX FEMALE
MATCHED PARAMETER E(0) = 50.00000
ASSOCIATED VALUES I(1)= 89385.; I(5)= 81699.; E(0)= 50.00; E(5)= 55.93

CHOSEN SURVIVORSHIP TO AGE 1: 90000.
CHOSEN SURVIVORSHIP TO AGE 5: 85000.

CHARACTERISTICS OF POPULATION

AGE GROUP	POPULATION JUN 1960	POPULATION JUN 1970	GROWTH RATE
0- 5	65043.	79061.	0.01952
5-10	52724.	64082.	0.01951
10-15	45317.	55587.	0.02043
15-20	39773.	48819.	0.02049
20-25	34949.	42776.	0.02021
25-30	30625.	37229.	0.01953
30-35	26497.	32211.	0.01953
35-40	22783.	27704.	0.01956
40-45	19417.	23626.	0.01962
45-50	16461.	20095.	0.01995
50-55	13799.	16903.	0.02029
55-60	11385.	13853.	0.01962
60-65	8983.	10963.	0.01992
65-70	6641.	8113.	0.02002
70-75	4381.	5364.	0.02024
75-80	2498.	3051.	0.02000
80+	1382.	1682.	0.01965
TOTAL	402658.	491119.	0.01986

CALCULATION OF INDEPENDENI 'ND DEPENDENT VARIABLES FOR REGRESSION

AGE X	PROPORTION OF POPULATION AT EXACT AGE X	GROWTH RATE ADJUSTMENT FACTOR	LIFE TABLE SURVIVORS AT EXACT AGE X	REGRESSION POINTS: INDEPENDENT VARIABLE	REGRESSION POINTS: DEPENDENT VARIABLE
5	0.02904	.90702	81699.	0.0	26.55173
10	0.02429	.82273	78668.	0.03853	28.78797
15	0.02115	.74285	77048.	0.06037	29.85361
20	0.01856	.67050	75311.	0.08483	30.70057
25	0.01625	.60606	73303.	0.11455	31.70068
30	0.01413	.54968	71046.	0.14995	33.07688
35	0.01218	.49855	68529.	0.19218	34.77937
40	0.01043	.45211	65758.	0.24242	36.83521
45	0.00888	.40986	62758.	0.30181	39.24744
50	0.00750	.37096	59604.	0.37071	42.06644
55	0.00623	.33517	55810.	0.46390	45.73982
60	0.00502	.30385	51074.	0.59962	51.44039
65	0.00384	.27505	44767.	0.82499	60.90679
70	0.00268	.24885	36485.	1.23927	78.84313
75	0.00165	.22489	26411.	2.09340	116.18531

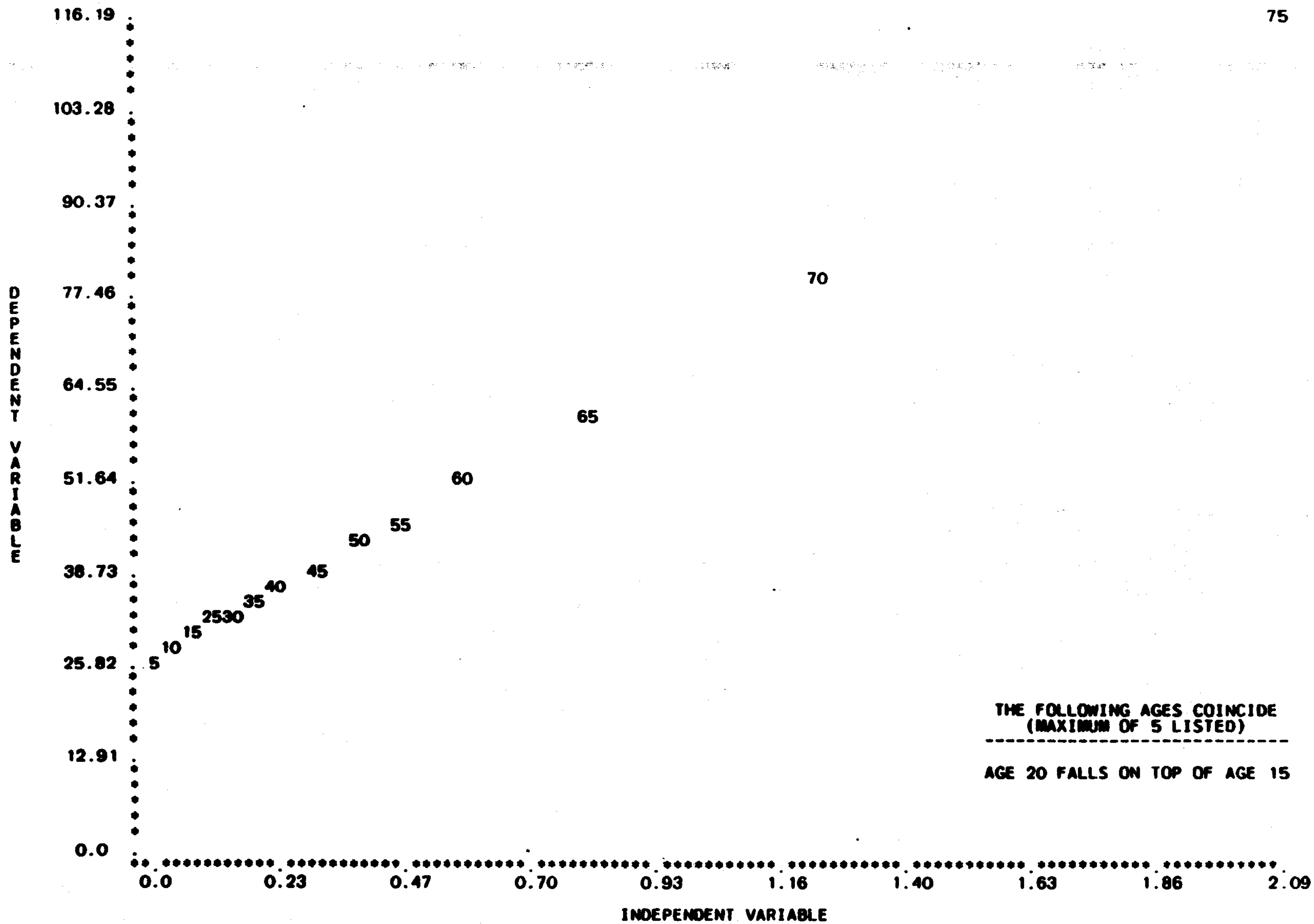
REGRESSION RESULTS

AGE RANGE	SLOPE	INTERCEPT	MEAN SQUARE RELATIVE ERROR	NUMBER OF SIGN CHANGES
5-60	40.59	27.04	0.00006	3
10-60	39.97	27.23	0.00001	5
15-60	39.99	27.22	0.00002	5
5-65	40.78	27.02	0.00006	3
10-65	40.36	27.17	0.00002	3
15-65	40.41	27.15	0.00002	3
5-70	41.20	26.96	0.00007	3
10-70	40.94	27.07	0.00004	3
15-70	41.03	27.03	0.00005	3

ESTIMATES OF DEMOGRAPHIC PARAMETERS

BIRTHS	CRUDE BIRTH RATE	CRUDE DEATH RATE	LIFE EXPECTANCY: BIRTH	LIFE EXPECTANCY: AGE 5
16446.	0.03698	0.01712	47.49	50.69
16331.	0.03672	0.01686	47.75	50.99
16335.	0.03673	0.01687	47.74	50.98
16460.	0.03701	0.01715	47.43	50.62
16367.	0.03680	0.01694	47.61	50.83
16379.	0.03683	0.01697	47.59	50.81
16497.	0.03710	0.01724	47.29	50.45
16427.	0.03694	0.01708	47.41	50.59
16451.	0.03699	0.01713	47.37	50.55

HYPOTHETICAL FEMALES



OBSERVED AND ADJUSTED INTERCENSAL AGE DISTRIBUTION AND RATIOS FOR HYPOTHETICAL FEMALES MODEL: NORTH

	REGRESSION POINTS	0- 5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80+
OBSERVED		.161	.131	.113	.099	.087	.076	.066	.056	.048	.041	.034	.028	.022	.017	.011	.008	.003
	5-60	.155	.132	.115	.100	.087	.076	.066	.056	.048	.041	.034	.028	.022	.016	.011	.006	.004
	10-60	.155	.132	.114	.100	.087	.076	.066	.057	.048	.041	.034	.028	.022	.017	.011	.006	.004
ADJUSTED	15-60	.155	.132	.114	.100	.087	.076	.066	.057	.048	.041	.034	.028	.022	.017	.011	.006	.004
	5-65	.156	.132	.115	.100	.087	.076	.066	.056	.048	.041	.034	.028	.022	.016	.011	.006	.004
	10-65	.155	.132	.115	.100	.087	.076	.066	.057	.048	.041	.034	.028	.022	.017	.011	.006	.004
	15-65	.155	.132	.115	.100	.087	.076	.066	.056	.048	.041	.034	.028	.022	.017	.011	.006	.004
	5-70	.156	.133	.115	.100	.087	.076	.066	.056	.048	.041	.034	.028	.022	.016	.011	.006	.004
	10-70	.156	.133	.115	.100	.087	.076	.066	.056	.048	.041	.034	.028	.022	.016	.011	.006	.004
	15-70	.156	.133	.115	.100	.087	.076	.066	.056	.048	.041	.034	.028	.022	.016	.011	.006	.004
	5-60	1.037	.987	.984	.988	.995	1.000	1.000	1.001	.999	1.000	1.002	1.005	1.004	1.002	.989	.973	.833
	10-60	1.041	.990	.986	.989	.995	1.000	.999	.999	.996	.996	.998	.999	.996	.993	.977	.959	.819
RATIO OF	15-60	1.041	.990	.986	.989	.995	1.000	.999	.999	.996	.996	.998	.999	.997	.993	.977	.960	.820
OBSERVED	5-65	1.036	.987	.984	.987	.994	1.000	1.000	1.001	1.000	1.001	1.004	1.006	1.006	1.005	.992	.977	.837
TO	10-65	1.039	.989	.985	.988	.995	1.000	1.000	1.000	.998	.998	1.000	1.002	1.000	.998	.983	.967	.827
ADJUSTED	15-65	1.039	.989	.985	.988	.995	1.000	1.000	1.000	.998	.999	1.001	1.003	1.001	.999	.984	.968	.828
	5-70	1.034	.985	.982	.987	.994	1.000	1.001	1.002	1.001	1.003	1.006	1.010	1.010	1.010	.998	.984	.844
	10-70	1.036	.986	.983	.987	.994	1.000	1.000	1.001	1.000	1.001	1.004	1.007	1.007	1.006	.993	.978	.838
	15-70	1.035	.986	.983	.987	.994	1.000	1.001	1.002	1.001	1.002	1.005	1.008	1.008	1.007	.995	.980	.840

	REGRESSION POINTS	0-5	5-15	15-50	50-65	65+
OBSERVED		.161	.244	.473	.085	.037
	5-60	.155	.247	.475	.085	.038
	10-60	.155	.246	.475	.085	.038
ADJUSTED	15-60	.155	.246	.475	.085	.038
	5-65	.156	.247	.475	.084	.038
	10-65	.155	.247	.475	.085	.038
	15-65	.155	.247	.475	.085	.038
	5-70	.156	.248	.475	.084	.038
	10-70	.156	.247	.475	.084	.038
	15-70	.156	.247	.475	.084	.038
	5-60	1.037	.986	.996	1.004	.975
	10-60	1.041	.988	.996	.998	.964
RATIO OF	15-60	1.041	.988	.996	.998	.964
OBSERVED	5-65	1.036	.985	.997	1.005	.978
TO	10-65	1.039	.987	.996	1.001	.970
ADJUSTED	15-65	1.039	.987	.996	1.001	.971
	5-70	1.034	.984	.997	1.009	.985
	10-70	1.036	.985	.997	1.006	.979
	15-70	1.035	.985	.997	1.007	.981

Name of procedure: STABLE

Purpose of procedure. Calculates a stable age distribution based on a set of age-specific central death rates ($_nm_x$ values) or age-specific probabilities of dying ($_nq_x$ values) and the intrinsic rate of natural increase.

Description of technique. Based on a given set of $_nm_x$ or $_nq_x$ values for age groups 0-1, 1-5, 5-10, ..., up to an open age group (maximum of 100 and over), an abridged life table is constructed and printed (see LIFTB). Using the person-years column ($_nL_x$) from this life table (including the extrapolated values through age 125 calculated by LIFTB) and the intrinsic rate of natural increase (r) given as input, the stable age distribution is calculated and printed along with the proportion of the population under each age and the intrinsic birth and death rates. Calculation formulas are presented in United Nations, 1982a (p. ix). The stable age distribution and stable parameters are calculated by the subroutine STABLE.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A heading of up to 72 characters, to be printed above the calculated life table.
NFIN	The ending age of the last closed age group. For example, if the last mortality value available is $_5m_{80}$, or $_5q_{80}$, NFIN would take the value 85. The minimum value allowed for NFIN is 65 (referring to age group 60-65); the maximum value is 100 (referring to age group 95-100).
NTYPE	Indicates whether $_nq_x$ or $_nm_x$ values are being given as input. If $_nq_x$ values are used, NTYPE = 1; if $_nm_x$ values are used, NTYPE = 2.
NSEX	Indicates whether the life table refers to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females.

Mnemonic	Definition and comments
R	The intrinsic rate of natural increase. R is read in on a "unit basis" so, for example, a 3 per cent annual growth rate is designated as .0300.
QXMX	The empirical set of ${}_nq_x$ or ${}_nm_x$ values. The values must be given for five-year age groups for ages 5 and over and for age groups 0-1 and 1-5 under age 5. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	NFIN	1-3	Value must be punched to end in column 3.
	NTYPE	5	
	NSEX	7	
	R	9-13	Decimal point should be punched in column 9.
3	QXMX	1-6	For age group 0-1. Decimal point must be punched.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		. . .	

Card	Mnemonic	Columns	Special comments
		64-69	For age group 40-45. Decimal point must be punched.
4	QXMX	1-6	For age group 45-50. Decimal point must be punched.
		.	
		.	
		.	
	(Values of QXMX must be given through the age group indicated by NFIN above and in the same format as the QXMX values given in card 3. An additional (fifth) card must be added if NFIN = 100.)		

Example

In the following example, the life-table stable age distribution and intrinsic vital rates is calculated and printed, corresponding to a given set of ${}_nq_x$ values (up through age group 75-80) and a rate of natural increase of 3 per cent for a hypothetical female population.

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC		PAGE OF
PROGRAMMER	DATE		PUNCH		CARD ELECTRO NUMBER*

STATEMENT NUMBER (1–5)	CONT. (6)	FORTRAN STATEMENT (7–72)	IDENTIFICATION SEQUENCE (73–80)
HYPOT	H	ETICAL FEMALES	1
080 1		2 .0300	2
.1185	6	.09301 .02970 .01687 .02066 .02531 .02866 .03173 .03560 .03986	3
.0446	6	.05829 .07924 .12069 .18452 .28516 .41943	4

HYPOTHETICAL FEMALES

AGE	M(X,N)	Q(X,N)	I(X)	D(X,N)	L(X,N)	S(X,N)	T(X)	E(X)	A(X,N)
0	.12846	.11856	100000.	11856.	92294.	.84647 /A/	4999723.	49.997	0.350
1	.02477	.09301	88144.	8198.	330941.	.93044 /B/	4907430.	55.675	1.361
5	.00603	.02970	79946.	2374.	393793.	.97662	4576489.	57.245	2.500
10	.00340	.01687	77571.	1309.	384585.	.98157	4182696.	53.921	2.500
15	.00417	.02066	76263.	1576.	377495.	.97702	3798111.	49.803	2.577
20	.00513	.02531	74687.	1890.	368820.	.97295	3420616.	45.799	2.558
25	.00581	.02866	72797.	2086.	358843.	.96983	3051796.	41.922	2.536
30	.00645	.03173	70710.	2244.	348016.	.96640	2692953.	38.084	2.532
35	.00725	.03560	68467.	2437.	336322.	.96232	2344937.	34.249	2.533
40	.00813	.03986	66029.	2632.	323649.	.95809	2008616.	30.420	2.531
45	.00913	.04466	63397.	2831.	310084.	.94926	1684967.	26.578	2.562
50	.01199	.05829	60566.	3530.	294350.	.93235	1374882.	22.701	2.598
55	.01647	.07924	57036.	4520.	274439.	.90215	1080532.	18.945	2.624
60	.02560	.12069	52516.	6338.	247585.	.85045	806094.	15.349	2.634
65	.04047	.18452	46178.	8521.	210557.	.76996	558509.	12.095	2.614
70	.06624	.28516	37657.	10738.	162121.	.65469	347951.	9.240	2.563
75	.10638	.41943	26919.	11291.	106139.	.42884 /C/	185831.	6.903	2.480
80	.19611	.....	15628.	15628.	79691.	.....	79691.	5.099	5.099

/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF BIRTH TO AGE GROUP 0-4 = L(0,5)/500000
/B/ VALUE GIVEN IS FOR S(0,5)=L(5,5)/L(0,5)
/C/ VALUE GIVEN IS S(75+,5)=T(80)/T(75)

CORRESPONDING STABLE AGE DISTRIBUTION

AGE GROUP	PROPORTION OF POPULATION IN INDICATED AGE GROUP
0- 1	0.04216
1- 5	0.14026
5-10	0.14582
10-15	0.12257
15-20	0.10355
20-25	0.08708
25-30	0.07292
30-35	0.06087
35-40	0.05063
40-45	0.04194
45-50	0.03458
50-55	0.02826
55-60	0.02268
60-65	0.01761
65-70	0.01289
70-75	0.00854
75-80	0.00481
80+	0.00282

AGE	PROPORTION OF POPULATION UNDER INDICATED AGE
1	0.04216
5	0.18242
10	0.32824
15	0.45081
20	0.55437
25	0.64145
30	0.71437
35	0.77525
40	0.82588
45	0.86782
50	0.90240
55	0.93066
60	0.95334
65	0.97094
70	0.98383
75	0.99237
80	0.99718

INTRINSIC VITAL RATES:

BIRTH RATE = 0.04637
DEATH RATE = 0.01637
GROWTH RATE = 0.0300

Name of procedure: UNABR

Purpose of procedure. Graduates a set of age-specific probabilities of dying ($_nq_x$ values) in age groups 0-1, 1-5, 10-15, ..., producing a smooth set of $_nq_x$ values and estimated single-year probabilities of dying and survivors.

Description of technique. The mortality probabilities in age groups 0-1, 1-5, 5-10, 10-15, ..., are graduated by use of an eight-parameter formula (Heligman and Pollard, 1980) for the age curve of mortality:

$$_1q_x = A^{(x + B)^C} + D^{-E(\ln x - \ln F)^2} + \frac{GH^x}{1 + GH^x}$$

where $_1q_x$ is the probability of someone exact age x dying before exact age x + 1, and A, B, ..., H are parameters to be estimated. The parameters are estimated by least squares criteria, minimizing the sum of squares of the proportional differences of the fitted from the observed mortality probabilities, after regrouping into age groups 0-1, 1-5, 5-10, 10-15, ... The least squares fitting criterion produces a smoothed set of $_nq_x$ values and single-year $_1q_x$ values which aggregate to the smoothed $_nq_x$ values. The fit is usually very good and this procedure appears to provide excellent fits for the additional life-table columns also.

The output presents the $_nq_x$ values, by age group, given as input (labelled "OBSERVED"), the graduated $_nq_x$ values from the interpolation formula (labelled "FITTED"), and the deviations (absolute and proportional) of the two sets. This allows the user to see the extent of graduation. The unabridged life table itself is presented as $_1q_x$, $_1m_x$ values, and l_x and e_x values for single years of age 0-92. The estimated values of the parameters A, ..., H are also given. The entire procedure is carried out by subroutine UNABR.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A heading, up to 72 characters, to be printed at the top of the page of output.
QXMX	The empirical set of ${}_nq_x$ values. The values must be given for those age groups 0-1, 1-5, 5-10, ... As a minimum, ${}_nq_x$ values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	
2	QXMX	1-6	For age group 0-1. Decimal point must be punched.
		8-13	For age group 1-5. Decimal point must be punched.
		15-20	For age group 5-10. Decimal point must be punched.
		. . .	
		64-69	For age group 40-45. Decimal point must be punched.
3	QXMX	1-6	For age group 45-50. Decimal point must be punched.
		. . .	

Card	Mnemonic	Columns	Special comments
		22-27	For age group 60-65. Decimal point must be punched.
		29-34	For age group 65-70. Decimal point must be punched. Leave blank if fewer values are given.
		36-41	For age group 70-75. Decimal point must be punched. Leave blank if fewer values are given.
		43-48	For age group 75-80. Decimal point must be punched. Leave blank if fewer values are given.
		50-55	For age group 80-85. Decimal point must be punched. Leave blank if fewer values are given.

Example

In the following example a set of mortality probabilities in conventional age groups is given as input and an unabridged life table (in the form of single year ${}_1q_x$ and l_x values) is calculated and printed out. The mortality probabilities are given for age groups 0-1, 1-5, 5-10, up through 70-75.

The coded input and sample output would appear as follows:

FORTRAN Coding Form

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC		PAGE OF
PROGRAMMER	DATE		PUNCH		CARD ELECTRO NUMBER

STATEMENT NUMBER	CONT	FORTRAN STATEMENT	Card number
		HYPOTHETICAL POPULATION	1
		.03500 .00600 .00350 .00290 .00570 .00765 .01120 .01350 .01575 .01825	2
		.02750 .03500 .05500 .08500 .12500 .18500	3

ICC.7 (8-66)

GRADUATED ABRIDGED AND UNABRIDGED LIFE TABLES FOR HYPOTHETICAL POPULATION

AGE	OBSERVED Q(X)	FITTED Q(X)	DIFFERENCE	RATIO
0	.03500	.03500	-.00000	1.00
1	.00600	.00606	.00006	1.01
5	.00350	.00334	-.00016	0.95
10	.00290	.00310	.00020	1.07
15	.00570	.00510	-.00060	0.89
20	.00765	.00824	.00059	1.08
25	.01120	.01104	-.00016	0.99
30	.01350	.01320	-.00030	0.98
35	.01575	.01552	-.00023	0.99
40	.01825	.01920	.00095	1.05
45	.02750	.02565	-.00185	0.93
50	.03500	.03660	.00160	1.05
55	.05500	.05441	-.00059	0.99
60	.08500	.08244	-.00256	0.97
65	.12500	.12521	.00021	1.00
70	.18500	.18837	.00337	1.02

AGE	M(X,N)	Q(X,N)	I(X)	E(X)	AGE	M(X,N)	Q(X,N)	I(X)	E(X)	AGE	M(X,N)	Q(X,N)	I(X)	E(X)
0	.03588	.03500	100000	69.80	31	.00258	.00257	92761	43.48	62	.01707	.01692	76324	17.55
1	.00246	.00246	96500	71.32	32	.00266	.00265	92522	42.59	63	.01863	.01846	75033	16.84
2	.00153	.00153	96262	70.49	33	.00274	.00274	92276	41.70	64	.02035	.02014	73647	16.15
3	.00115	.00115	96115	69.60	34	.00282	.00282	92024	40.82	65	.02223	.02198	72164	15.47
4	.00094	.00094	96004	68.68	35	.00291	.00291	91764	39.93	66	.02429	.02399	70578	14.81
5	.00080	.00080	95914	67.74	36	.00301	.00301	91497	39.05	67	.02654	.02619	68884	14.16
6	.00071	.00071	95837	66.80	37	.00312	.00311	91222	38.16	68	.02901	.02859	67080	13.53
7	.00065	.00065	95769	65.84	38	.00323	.00323	90938	37.28	69	.03171	.03121	65162	12.91
8	.00060	.00060	95707	64.89	39	.00336	.00336	90645	36.40	70	.03466	.03407	63128	12.31
9	.00058	.00058	95649	63.93	40	.00351	.00350	90340	35.52	71	.03788	.03718	60977	11.73
10	.00057	.00057	95594	62.96	41	.00367	.00367	90024	34.64	72	.04141	.04057	58710	11.16
11	.00057	.00057	95540	62.00	42	.00386	.00385	89694	33.77	73	.04526	.04426	56328	10.61
12	.00060	.00060	95485	61.03	43	.00406	.00405	89348	32.90	74	.04947	.04827	53835	10.08
13	.00065	.00065	95427	60.07	44	.00429	.00428	88986	32.03	75	.05406	.05264	51236	9.57
14	.00071	.00071	95365	59.11	45	.00455	.00454	88605	31.17	76	.05907	.05737	48539	9.07
15	.00080	.00080	95297	58.15	46	.00484	.00483	88203	30.31	77	.06452	.06251	45755	8.59
16	.00090	.00090	95221	57.20	47	.00516	.00515	87778	29.45	78	.07047	.06807	42895	8.13
17	.00101	.00101	95136	56.25	48	.00552	.00550	87326	28.60	79	.07695	.07410	39975	7.69
18	.00114	.00113	95039	55.30	49	.00592	.00590	86845	27.76	80	.08400	.08062	37012	7.26
19	.00126	.00126	94932	54.37	50	.00636	.00634	86333	26.92	81	.09167	.08766	34028	6.86
20	.00140	.00140	94812	53.43	51	.00685	.00683	85785	26.09	82	.10001	.09525	31046	6.47
21	.00153	.00153	94679	52.51	52	.00740	.00737	85199	25.26	83	.10906	.10342	28088	6.09
22	.00166	.00166	94535	51.59	53	.00800	.00797	84571	24.45	84	.11889	.11222	25183	5.74
23	.00179	.00178	94378	50.67	54	.00867	.00863	83897	23.64	85	.12954	.12166	22357	5.40
24	.00191	.00190	94209	49.76	55	.00940	.00936	83173	22.84	86	.14108	.13178	19637	5.08
25	.00202	.00202	94030	48.86	56	.01021	.01016	82395	22.05	87	.15356	.14261	17049	4.78
26	.00213	.00212	93840	47.95	57	.01110	.01104	81558	21.27	88	.16704	.15417	14618	4.49
27	.00223	.00222	93641	47.05	58	.01208	.01201	80658	20.50	89	.18160	.16648	12364	4.22
28	.00232	.00232	93433	46.16	59	.01316	.01307	79689	19.75	90	.19729	.17958	10306	3.96
29	.00241	.00241	93216	45.26	60	.01434	.01424	78648	19.00	91	.21418	.19346	8455	3.71
30	.00249	.00249	92992	44.37	61	.01564	.01552	77528	18.27	92	.23233	.20815	6819	3.48

PARAMETERS: A= 0.00241 B= 0.00582 C= 0.11399 D= 0.00146 E= 3.12042 F= 30.56661 G= 0.00006 H= 1.09592

Name of procedure: WIDOW

<u>Purpose of procedure</u>. Indirect estimation of male and female adult mortality from data on proportion of the ever-married population whose first spouse is still living tabulated by age of respondent and assumption of a United Nations or Coale-Demeny model life-table pattern.

<u>Description of technique</u>. Hill (1977) has shown that the proportion of the ever-married male population whose first wife is still alive can be used to estimate female mortality, and, in parallel, the proportion of the ever-married female population whose first husband is still alive can be used to estimate male mortality. Hill and Trussell (1977) later proposed estimation equations of the form

$$_{n}l^{f}_{20} = a(n) + b(n)\ A_m + c(n)A_f + d(n)_5S^m_n$$

for estimating female mortality from data reported by ever-married males, and

$$_{n}l^{m}_{20} = a(n) + b(n)\ A_m + c(n)A_f + d(n)_5S^f_{n-5}$$

for estimating male mortality from data reported by ever-married females, where $_{n}l^{m}_{20}$ ($_{n}l^{f}_{20}$) is the life-table probability of male (female) survival from age 20 to age 20+n, A_m (A_f) is the singulate mean age at marriage for the male (female) population, $_5S^m_n$ ($_5S^f_n$) is the proportion of the male (female) population in age group (n, n-5) whose first spouse is still alive, and a(n), b(n), c(n) and d(n) are age-specific constants (presented by Hill and Trussell in tabular form). For male respondents, only values of n varying from 5 to 35 are used, corresponding to age groups of male respondents 25-30, 30-35, 35-40, ..., 55-60 and probabilities of female survival from age 20 to 25, 20 to 30, ..., 20 to 55. For female respondents, only values of n varying from 5 to 40 are used, corresponding to age groups of female respondents 20-25, 25-30, 30-35, ..., 55-60 and probabilities of male survival from age 20 to 25, 20 to 30, ..., 20 to 60. The constants a(n), b(n), c(n) and d(n) were estimated by Hill and Trussell through regression procedures on simulated data which were in turn based on the Coale-Demeny model life tables. No parallel estimating equations based on the United Nations models have yet been developed. Through a second set of simulations, Brass and Bamgboye (1981) developed a set of equations which estimate the time reference to which the $_{n}l_{20}$ values refer. The independent variables necessary for calculating these time references are identical to those used for calculating the survivorship estimates. The procedure is performed by the subroutine WIDOW; this subroutine also calculates estimates of the life expectancy at birth and at age 20 which correspond to the ${}_{n}l_{20}$ values within each of the United Nations and Coale-Demeny model life table patterns.

Data required. The following information is required for running the main program:

Mnemonic	Definition and comments
LABEL	A data description of up to 72 characters, to be included in the heading at the top of the page of output.
MONTH	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December).
NYEAR	The year of the enumeration; for example, 1970.
NSEX	Indicates the sex of the respondent. If NSEX = 1, then the respondents are males and the life table refers to females. If NSEX = 2, then the respondents are females and the life table refers to males.
SMAMM	The singulate mean age at marriage for males.
SMAMF	The singulate mean age at marriage for females.
PNW	The proportion of population whose spouse is still alive. Data are given for age groups 20-25, 25-30, ..., up to 55-60. When NSEX = 1, the value for age group 20-25 is not needed.

Data input. The required data should be punched onto cards according to the following format:

Card	Mnemonic	Columns	Special comments
1	LABEL	1-72	

Card	Mnemonic	Columns	Special comments
2	MONTH	1-2	Data must be punched to end in column 2.
	NYEAR	4-7	The year should be punched to four digits; for example, 1970.
	NSEX	9	
	SMAMM	11-15	Value should be punched with the decimal point in column 13.
	SMAMF	17-21	Value should be punched with the decimal point in column 19.
3	PNW	1-5	For age group 20-25. Decimal point should be in column 1. When NSEX = 1, the value for this age group is not used by the technique, so columns 1-5 may be left blank.
		7-11	For age group 25-30. Decimal point should be in column 7.
		13-17	For age group 30-35. Decimal point should be in column 13.
		. . .	
		43-47	For age group 55-60. Decimal point should be in column 43.

Example

In the following example, estimates of adult female mortality and corresponding life expectancies for a hypothetical population are calculated and printed. The data are from a survey taken in March 1982. The tabulations necessary are the male population's responses to the question of survival of first spouse, as male widowhood provides estimates of female mortality and vice-versa. The singulate mean age at marriage is estimated as 27.21 for males and 20.54 for females. The proportion of the male population whose first wife is still alive is given for age groups 20-25, 25-30, ..., up to 55-60. It should be noted, however, that in the case of male respondents the data for age group 20-25 is not used, so columns 1-5 on card 3 could have been left blank, and its value does not appear on the output.

FORTRAN Coding Form

FORTRAN STATEMENT — Card number

```
HYPOTHETICAL POPULATION, MALE RESPONDENTS                                   1
03 1982 1 27.21 20.54                                                       2
.9965 .9903 .9840 .9691 .9433 .9053 .8418 .7639                             3
```

ICC.7 (6-66)

WIDOWHOOD ESTIMATES OF ADULT FEMALE MORTALITY -- HYPOTHETICAL POPULATION, MALE RESPONDENTS

DATE OF SURVEY = MAR 1982

SINGULATE MEAN AGE AT MARRIAGE:
MALES = 27.21
FEMALES = 20.54

AGE GROUP OF RESPONDENT	PROPORTION MALES NOT WIDOWED	PROBABILITY OF AN ADULT FEMALE SURVIVING FROM AGE 20 TO AGE X: AGE X	HILL-TRUSSELL EQUATION
25-30	.9903	25	.9876
30-35	.9840	30	.9770
35-40	.9691	35	.9584
40-45	.9433	40	.9272
45-50	.9053	45	.8835
50-55	.8418	50	.8121
55-60	.7539	55	.7144

CORRESPONDING FEMALE LIFE EXPECTANCIES

AGE GROUP OF RESPONDENT	REFERENCE DATE	UNITED NATIONS MODELS					COALE-DEMENY MODELS			
		LATIN AM.	CHILEAN	SO. ASIAN	FAR EAST	GENERAL	WEST	NORTH	EAST	SOUTH
FEMALE LIFE EXPECTANCY AT AGE TWENTY										
25-30	JAN 1982	50.2	49.6	48.8	48.1	49.5	50.4	52.0	49.8	51.2
30-35	OCT 1979	51.4	50.8	49.5	49.5	50.6	51.3	53.0	50.7	52.1
35-40	AUG 1977	50.9	50.3	48.8	49.0	50.0	50.7	52.1	50.0	51.2
40-45	APR 1975	49.7	49.0	47.5	47.8	48.8	49.3	50.5	48.7	49.6
45-50	JAN 1973	48.4	47.8	46.1	46.6	47.4	47.9	48.9	47.2	47.9
50-55	JAN 1971	46.1	45.7	44.1	44.9	45.3	45.7	46.3	44.9	45.2
55-60	JAN 1969	43.7	43.5	42.3	43.2	43.2	43.4	43.6	42.5	42.5
FEMALE LIFE EXPECTANCY AT BIRTH										
25-30	JAN 1982	60.5	60.3	54.8	62.4	61.3	63.9	65.2	60.8	60.2
30-35	OCT 1979	62.8	62.3	56.5	64.4	63.2	65.6	67.3	62.8	62.0
35-40	AUG 1977	61.8	61.4	55.0	63.7	62.2	64.3	65.4	61.3	60.2
40-45	APR 1975	59.5	59.3	51.9	61.8	60.0	61.6	62.0	58.2	56.8
45-50	JAN 1973	56.9	57.1	48.8	60.1	57.6	58.7	58.6	54.8	53.2
50-55	JAN 1971	52.7	53.6	44.3	57.5	54.0	54.0	52.9	49.2	47.3
55-60	JAN 1969	48.1	49.8	40.3	54.9	50.2	49.1	46.9	43.6	41.5

III. TECHNICAL INFORMATION FOR PROGRAMMERS

MORTPAK has been developed in a main program-subroutine style. A main program corresponding to each of the 16 applications has been written. The purpose of the main program is solely to read in the data required for the application and to call the subroutine which performs all calculations and prints out the results. Subroutines may call other subroutines. The advantage of this approach is twofold. First, coding is reduced since algorithms (such as LIFTB's) which are required for many applications need not be repeated; the subroutines including that algorithm can just be called. Secondly, this approach allows demographers/programmers to write their own main programs combining these subroutines in ways useful to a particular purpose at hand.

The purpose of the present chapter is to provide, in an easy-to-access way, the information necessary for incorporating these subroutines into other calling programs. Specifically, it provides information on the "call structure" of each subroutine; input and output variables in the argument strings, including dimension, data type, definition and codes.

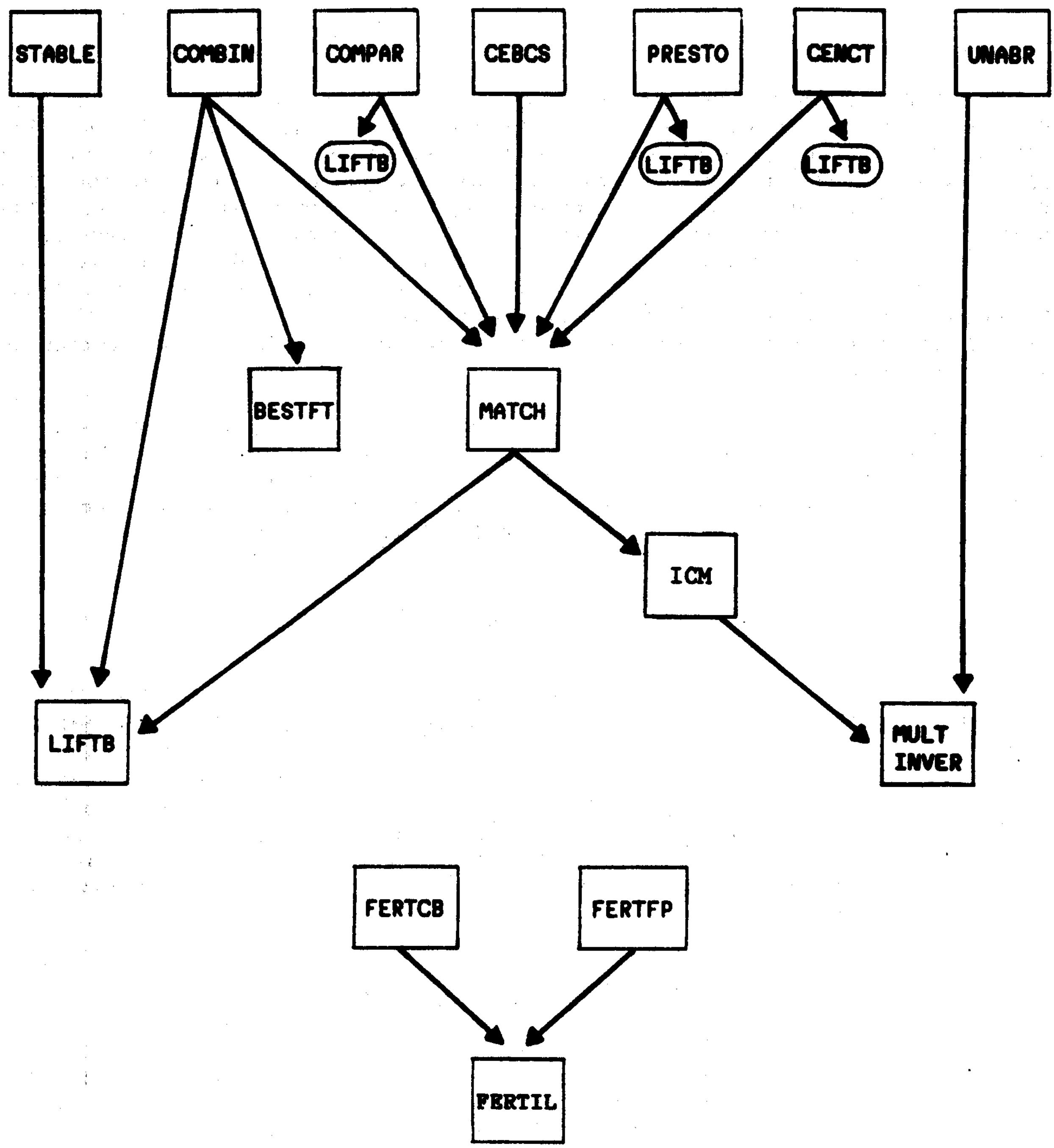
A. Call structure

The following chart presents the subroutine call structure. The MORTPAK package contains 17 subroutines. Each application, except FERTCB and FERTPF, corresponds to a subroutine of the same name which performs calculations and, when necessary, calls other subroutines. The FERTCB and FERTPF applications share the subroutine FERTIL. In addition, two utility subroutines, MULT and INVER, are provided for matrix multiplication and inversion. As an illustrative example for reading the diagram, the subroutine PRESTO calls the subroutines LIFTB and MATCH; MATCH, in turn, calls LIFTB and ICM, and ICM calls MULT and INVER.

B. Dictionary of variables

This section catalogues all the variables in the argument string into three categories: parameters, demographic data - input variables, demographic data - output variables. Within each category variables are listed in alphabetical order. Table 2 permits the programmer to see readily the definition and code restrictions of each variable and note whether there are any slight definitional or coding differences among the subroutines. The table illustrates in a clear way the relatively few pieces of information necessary for applying the broad range of techniques included in MORTPAK.

Diagram I. Subroutine call structure



Note: Independent subroutines: BENHR, ORPHAN and WIDOW.

All the subroutines use double precision for the real variables. The variables are double precisioned through an IMPLICIT REAL*8 (A-H,O-Z) statement. All calling programs should hence include the identical IMPLICIT statement. To transform the programs to single precision, the IMPLICIT statements should be removed from all main programs and subprograms and IBM functions changed to their single precision equivalent. IBM functions used by MORTPAK are DLOG, DSQRT, DABS, DSIGN and DEXP.

Table 2. Dictionary of parameters and variables

Parameters	Definition/code
CMP NPARM NAGE	The parameters NPARM, NAGE and CMP are used together to set the level of a chosen model life table. NPARM indicates the life-table column: 1 = m(x,n), 2 = q(x,n), 3 = l(x), 4 = e(x). NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l(2), l(3) or l(4). CMP indicates the life-table value being matched. For example, if a model life table is desired in which life expectancy at age 5 equals 62.5, we would code NPARM = 4, NAGE = 5 and CMP = 62.5. These variables appear in CENCT, MATCH and PRESTO.
CMP2 RNGE	These variables are used only by subroutine MATCH in conjunction with the NPARM-NAGE-CMP combination just defined. It is used when a series of model life tables is desired; otherwise these values must be set to zero. In this case, CMP will be the life-table value of the first model life table, CMP2 the value for the final model life table, and RNGE the increment. A maximum of 50 tables can be requested through the CMP2-RNGE option. CMP2 may be greater than or less than CMP. The direction of the increment is determined by the relation of CMP and CMP2; the size of the increment is determined by the absolute value of RNGE (i.e., DABS(RNGE)). For example, if a series of model life tables is desired in which the infant mortality varies from .160 to .080 at an increment of .02, we would code NPARM = 2, NAGE = 0, CMP = .160, CMP2 = .080 and RNGE = .02.
IYEAR1 IYEAR2	For programs that include enumerations at two dates, these variables are the year the first and second censuses were taken. For example, IYEAR1 = 1965 and IYEAR2 = 1975. These variables are used in subroutines BENHR, CENCT, FERTIL and PRESTO.

Table 2. (cont.)

Parameters	Definition/code
LABEL	An array containing 72 characters (18A4 format), used for printing all or part of a heading at the top of a page of output. In some subroutines, the LABEL array is separated into two parts. The first 40 characters are used to label the output just described. The remaining 32 characters are used as a secondary label to describe a user-defined model (i.e., the array AVE). This variable LABEL is used by all the subroutines; the "two-part" LABEL is used by BESTFT, CENCT, MATCH and PRESTO.
MONTH	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December). This variable is used in subroutines CEBCS, ORPHAN and WIDOW.
MONTH1 MONTH2	For programs that include enumerations at two dates, these variables indicate the month that the first and second censuses were taken (1 = January, 2 = February, ..., 12 = December). These variables are used in subroutines BENHR, CENCT, FERTIL and PRESTO.
NAGE	See CMP.
NFIN	The ending age of the last closed age group. For example, if the last mortality value available is m(80,5) or q(80,5), NFIN would take the value 85. The minimum value allowed for NFIN is 65 (referring to age group 60-65) and the maximum value is 100 (referring to age group 95-100). An exception is COMPAR; the maximum value is 85 (referring to age group 80-85). The subroutines that use this variable are LIFTB, STABLE and COMPAR.
NOPT	This variable indicates the option number for subroutine CEBCS or CENCT. However, its meaning is different in each subroutine. In CEBCS, if NOPT = 1, then the age group of the mother is being used. If NOPT = 2, then the duration of marriage is used. In CENCT, if NOPT = 1, then a model life table is used to calculate the deaths. If NOPT = 2, then the deaths are given as input.
NPARM	<See CMP>.
NPAT	Age-specific fertility rates can be estimated from children ever born data only (the FERTCB main program) or from children ever born data in conjunction with the age pattern of fertility (the FERTPF main program). For the subroutine FERTIL, this parameter determines whether the FERTCB or FERTPF version of this

Table 2. (cont.)

Parameters	Definition/code
	fertility estimation technique is being used. If NPAT = 0, then the input variables necessary for FERTCB are needed. If NPAT = 1, then the variables for FERTPF are needed.
NPG	If a series of life tables is being calculated and if NPG = 1, two life tables will be printed on each page. If NPG = 0, only one life table will be printed per page. This variable is only used by LIFTB.
NPLT	This variable controls the printing of the output table. Its purpose is to permit greater flexibility in output presentation. This variable is used by subroutines LIFTB, STABLE, MATCH, BESTFT, UNABR, ICM and COMBIN. A generalized idea of the code follows. The specific meaning depends on the subroutine in question. For specific details, refer to section C, Subroutine argument strings.
	0: The subroutine prints the entire output.
	1: The subroutine will not perform form feed and part of the heading might not be printed.
	2: The subroutine will not print an output table nor a heading. Error messages are printed. Results are available through the argument string.
	3: Identical to code 2, except only a subset of the error messages are printed.
	4: This code is identical to code 3, but in addition only partial calculations are performed. This was desirable when it was necessary to save execution time when all results were not needed.
NREG	Indicates the model life-table pattern to be used. If NREG = 0, the user is supplying the average pattern of mortality to be used as a model (see array AVE). The remaining codes are: 1 = UN Latin American model, 2 = UN Chilean model, 3 = UN South Asian model, 4 = UN Far East Asian model, 5 = UN General model, 6 = Coale-Demeny West, 7 = Coale-Demeny North, 8 = Coale-Demeny East and 9 = Coale-Demeny South. This variable is used by BESTFT, CENCT, COMBIN, MATCH and PRESTO. Although the code definitions are consistent from subroutine to subroutine, not all regions are available for all the subroutines. Please check section C, Subroutine argument strings, for detailed information.

Table 2. (cont.)

Parameters	Definition/code
NSEX	Indicates whether the data refer to the male or female sex. NSEX = 1 indicates males; NSEX = 2 indicates females. NSEX is used by BESTFT, CENCT, COMBIN, COMPAR, LIFTB, MATCH, PRESTO, STABLE and WIDOW.
NTAB1	Indicates how the fertility pattern (ASFP1) from the first enumeration is tabulated. NTAB1 = 1 indicates that the fertility pattern is tabulated by age of mother at time of birth of the child; NTAB1 = 2 indicates the fertility pattern is tabulated by age of mother at the date of enumeration. This variable is used in subroutine FERTIL only when NPAT=1 (as with the main program FERTPF).
NTAB2	Indicates how the fertility pattern (ASFP2) from the second enumeration is tabulated. NTAB2 = 1 indicates that the fertility pattern is tabulated by age of mother at time of birth of the child; NTAB2 = 2 indicates the fertility pattern is tabulated by age of mother at the date of enumeration. This variable is used in subroutine FERTIL only when NPAT = 1 (as with the main program FERTPF).
NTYPE	Indicates whether q(x,n) or m(x,n) values are given as input. If q(x,n) values are used, NTYPE=1; if m(x,n) values are used, NTYPE = 2. The subroutines that use this variable are LIFTB, STABLE and COMPAR.
NVAL	Indicates the number of age groups given for the populations (POP1 and POP2) and for the registered deaths (DEATHS) if given. For BENHR, NVAL must be between 13 and 18, elsewhere NVAL must be between 14 and 18. This variable is used by BENHR, CENCT and PRESTO.
NYEAR	The year of the enumeration; for example, 1970. This variable is used by CEBCS, ORPHAN and WIDOW.
NYRS	The number of enumerations for which children ever born (CEB) data are given. NYRS = 1 indicates CEB data for one point in time; NYRS = 2 indicates CEB data for two points in time. This variable is used by subroutine FERTIL only.
RNGE	<see CMP2>.

Table 2. (cont.)

Demographic data

Input variables	Definition/code
AGE	The average age of mother at childbearing. This variable is used in CEBCS and ORPHAN. In CEBCS, this variable is only defined when data are tabulated by age group of mother. Note that an estimate of AGE is provided as output by the subroutine FERTIL, although it does not appear in the FERTIL argument string.
ASFP1 ASPF2	The age-specific fertility pattern at the time of the first and second enumeration. Data may be given as recorded age-specific fertility rates or as the proportionate age distribution of fertility. Data are given for age groups 15-20, 20-25, ..., 45-50. These variables are used in subroutine FERTIL only when NPAT=1 (for procedure FERTPF).
AVE	This variable consists of model life-table q(x,n) values supplied by the user. It is defined only if NREG equals zero. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, q(x,n) values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per person" basis, each value must be in the interval 0 to 1. The variable AVE is used in subroutines BESTFT, CENCT, MATCH and PRESTO.
CEB	The average number of children ever born to a woman. If data are tabulated by age group of mother, the data are given for age groups 15-20, 20-25, ..., 45-50; if data are given by duration of marriage, then the groups are 0-5 years, 5-10 years, ..., 30-35 years. This variable is used in CEBCS and ORPHAN, but ORPHAN only accepts data tabulated by age group of mother.
CEB1 CEB2	For programs that include enumerations at two dates, CEB1 and CEB2 represent the average number of children ever born per woman at the time of the first and second enumerations. Data are given for age groups 15-20, 20-25, ..., up through 45-50. CEB2 is used only if NYRS = 2. These variables are used in subroutine FERTIL only.
CS	The average number of children surviving per woman, either by her age group (NOPT = 1), or by duration of her marriage (NOPT = 2). This variable is used by subroutine CEBCS only.

Table 2. (cont.)

Input variables	Definition/code
DEATHS	Registered deaths for the intercensal period. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL. This variable is used in BENHR and CENCT, although it is defined in CENCT only if NOPT = 2.
E20	Life expectancy at age 20 in the population under study. This variable is used in subroutine COMBIN only.
PNW	The proportion of respondents whose spouses are still alive. Data are given for age groups 20-25, 25-30, ..., up through 55-60. When NSEX = 1, the value for age group 20-25 is not needed. This variable is used by subroutine WIDOW only.
POP1 POP2	The population by age for the first and second censuses. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL. These variables appear in subroutines BENHR, CENCT and PRESTO.
PSTAR1	Probability of surviving from birth to age 1 in the country being studied. This variable is used only in subroutine PRESTO.
PSTAR5	Probability of surviving from birth to age 5 in the country being studied. This variable is used only in subroutine PRESTO.
QXMX	The age-specific mortality rates themselves. No matter whether q(x,n) or m(x,n) values are used as input, the values are input in the same way. For ages 5 and over the values must be given for five-year age groups. For ages under 5 they are given for age groups 0-1 and 1-5. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1. This array is dimensioned to 101 in the subroutines LIFTB and STABLE. In LIFTB and STABLE, age x is indexed to x+1 in array QXMX. In these subroutines, the data correspond to an abridged life table, so that only indexes of 1, 2, 6, 11, 16, ..., NFIN+1 are defined. Values past NFIN+1 are not defined. The array is dimensioned to 18 in the subroutines COMPAR, BESTFT, UNABR and ICM. In these subroutines, QXMX(1) corresponds to age 0, QXMX(2) to age 1, QXMX(3) to age 5 etc. See section C, Subroutine argument strings for detailed information.
R	The intrinsic rate of natural increase. R is read in on a "unit basis" so, for example, a 3 per cent annual growth rate is designated as .0300. This variable is used by subroutine STABLE only.

Table 2. (cont.)

Input variables	Definition/code
SL1	The probability of surviving to age 1 (times 100,000) in the population under study. This variable is used in subroutine COMBIN only.
SL5	The probability of surviving to age 5 (times 100,000) in the population under study. This variable is used in subroutine COMBIN only.
SMAMM	The singulate mean age at marriage for males. This variable is used by subroutine WIDOW only.
SMAMF	The singulate mean age at marriage for females. This variable is used by subroutine WIDOW only.
SNOR	The proportion of population with mother still alive. Data are given for age groups 15-20, 20-25, ..., up to 45-50. This variable is used by subroutine ORPHAN only.

Table 2. (cont.)

Demographic data

Output variables	Definition/code
ARRAY	The output life table is stored in an array named ARRAY. Use the statement DIMENSION ARRAY(101,9) in your calling program. This array appears in the argument strings of COMBIN, COMPAR, LIFTB and MATCH, but is created only by LIFTB. The purpose of ARRAY is to be able to do calculations and/or print results in a form different from that available from LIFTB. The first parameter refers to the age group. A value of x for the first parameter refers to age x-1. The second parameter is the column number of the output table. For example, ARRAY(11,8) contains the life expectancy at age 10. Note that LIFTB produces an abridged life table so that only values of the first parameter equal to 1, 2, 6, 11, 16, ..., NFIN+1 are defined. Values past NFIN+1 are not defined. The definitions of the column numbers are:

Column number	Variable name
1	m(x,n)
2	q(x,n)
3	l(x)
4	d(x,n)
5	L(x,n)
6	S(x,n)
7	T(x)
8	e(x)
9	a(x,n)

ASFR	This variable is a 7 X 2 array containing the output age-specific fertility rates consistent with CEB. The first parameter corresponds to the seven age groups 15-20, 20-25, ..., 45-50. The second parameter corresponds to the number of the enumeration (either 1 or 2), but cannot exceed the value given by NYRS. This variable appears only in the argument string of subroutine FERTIL.
C	This variable is the resultant stable age distribution, calculated as the proportion of population in age groups 0-1, 1-5, 5-10, up to and including the open age group indicated by NFIN. This variable appears in the argument string of STABLE only.

Table 2. (cont.)

Output variables	Definition/code
CENCMP	This variable is a 3 X 3 array indicating the completeness of the second census relative to the first. Each of the elements of the array corresponds to different beginning and ending age groups for the linear regression. The first parameter indicates the beginning age of the regression, where 1 = age 5, 2 = age 10 and 3 = age 15. The second parameter indicates the ending age of the regression, where 1= age 60, 2 = age 65 and 3 = age 70. This variable appears in the argument string of CENCT only.
CF	These are the predicted q(x,n) values calculated by subroutine BESTFT. They were calculated for one, two and three component fits. This variable is dimensioned to (3 X 18). The first parameter indicates the number of components fit. The second parameter indicates the age group and is coded as 1 = 0-1, 2 = 1-5, 3 = 5-10, 4 = 10-15, 5 = 15-20, ..., up through 18 = 80-85.
DTHCMP	This variable is a 3 X 3 array indicating the completeness of the death registration relative to the first census. Each of the elements of the array corresponds to different beginning and ending age groups for the linear regression. The first parameter indicates the beginning age of the regression, where 1 = age 5, 2 = age 10 and 3 = age 15. The second parameter indicates the ending age of the regression, where 1= age 60, 2 = age 65 and 3 = age 70. This variable appears in the argument string of CENCT only.
GOF	This variable is a 3 X 9 array, and indicates the goodness of fit of observed mortality rates with each of the nine model life-table patterns. It is the average difference between the life expectancy at birth and the median life expectancy for the ages indicated by the first parameter. The first parameter is coded as: 1: ages 0 to 10 2: ages 10 and over 3: all ages (0 and over) The second parameter corresponds to the model life-table pattern. The codes are: 1 = UN Latin American model, 2 = UN Chilean model, 3 = UN South Asian model, 4 = UN Far East Asian model, 5 = UN General model, 6 = Coale-Demeny West, 7 = Coale-Demeny North, 8 = Coale-Demeny East and 9 = Coale-Demeny South. Note that the second parameter has the same codes as NREG. This variable appears in the argument string of COMPAR only.

Table 2. (cont.)

Output variables	Definition/code
Q	This array is dimensioned Q(125). This variable is the resultant q(x,1) values in single years. The parameter refers to the age. A value of x for the parameter refers to age x-1. Although age groups 0 through 92 are printed, ages 0 through 120 are available through this array. Therefore, the parameter may contain any value in the range of 1 through 121. This variable is in the argument string for UNABR.
SLX	This variable is the resultant number of survivors at age x, with a radix of 100,000 persons. The parameter refers to the age. A value of x for the parameter refers to age x-1. Only ages 0 through 5 are calculated by ICM. Therefore, the parameter is dimensioned to 6 in ICM and may contain any value in the range of 1 through 6. In UNABR, this array is dimensioned to 125 and only ages 0 through 92 are printed. Ages 0 through 121 are available through array SLX in UNABR, therefore the parameter may contain any value in the range of 1 through 122. This variable is in the argument string for ICM and UNABR.

C. Subroutine argument strings

This section presents, subroutine by subroutine, the variables in the argument strings in order of appearance. Table 3 lists for each subroutine the variable name, array dimension, data type and detailed coding instructions. The variable list here is more inclusive and comprehensive than that presented in chapter II. First, table 3 includes output variables as well as input variables. Secondly, it contains input codes which are not relevant to the main programs but are necessary to transfer intermediate demographic results between subroutines.

Table 3. Subroutine argument string definitions

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine BENHR
LABEL	18	A4	An array containing 72 characters (18A4 format), used for printing part of the heading at the top of the page of output.
MONTH1	SV	Integer	Indicates the month of the first enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR1	SV	Integer	The year of the first enumeration; for example, 1965.
MONTH2	SV	Integer	Indicates the month of the second enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR2	SV	Integer	The year of the second enumeration; for example, 1975.
NVAL	SV	Integer	Indicates the number of age groups given for the populations (POP1 and POP2) and for the registered deaths (DEATHS). The value of NVAL must be between 13 and 18.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine BENHR</u> (cont.)
POP1	18	Real	The population by age for the first census. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.
POP2	18	Real	The population by age for the second census. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.
DEATHS	18	Real	Registered deaths for the intercensal period. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine BESTFT
LABEL	18	A4	An array containing 72 characters (18A4 format), used for printing part of the heading at the top of the page of output. In BESTFT, the array LABEL is separated into two parts. The first 40 characters are used to label the output just described. The remaining 32 characters are used as a secondary label to describe a user-defined model (i.e. the array AVE).
NSEX	SV	Integer	Indicates whether the model life-table pattern is of the male or female sex. 1: males 2: females
NREG	SV	Integer	Indicates the model life-table pattern to be used. The codes are: 0 = User supplied empirical age pattern 1 = UN Latin American model 2 = UN Chilean model 3 = UN South Asian model 4 = UN Far East Asian model 5 = UN General model
QXMX	18	Real	Age-specific mortality rates for any age group(s) 0-1, 1-5, 5-10, 10-15, up to the age group 80-85. For ages 5 and over the values are for five-year age groups. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1. Data must be given for a minimum of 1 age group and a maximum of 18 (i.e., a full set from 0-1 to 80-85). The age groups entered need not be contiguous.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine BESTFT</u> (cont.)
AVE	18	Real	This variable consists of model life table q(x,n) values supplied by the user. It is defined only if NREG equals zero. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, q(x,n) values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per person" basis, each value must be in the interval 0 to 1. If the last age group defined is prior to 80-85, the remaining values of the array must be set to zero.
CF	3,18	Real	These are the predicted q(x,n) values. They are calculated for one, two and three component fits. The first parameter indicates the number of components fit. The second parameter indicates the age group and is coded as 1 = 0-1, 2 = 1-5, 3 = 5-10, 4 = 10-15, 5 = 15-20, ..., up through 18 = 80-85.
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed and no heading is printed. 2: The subroutine prints neither the output table nor the heading. Error messages are printed.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine CEBCS
LABEL	18	A4	A label of up to 72 characters of information to be printed as part of the heading at the top of the page of output.
MONTH	SV	Integer	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December).
NYEAR	SV	Integer	The year of the enumeration; for example, 1970.
NOPT	SV	Integer	This variable indicates the option number. If NOPT=1 then the age group of the mother is being used. If NOPT=2, then the duration of marriage is used.
CEB	7	Real	The average number of children ever born to a woman. If data are tabulated by age group of mother, the data are given for age groups 15-20, 20-25, ..., 45-50; if data are given by duration of marriage, then the groups are 0-5 years, 5-10 years, ..., 30-35 years.
CS	7	Real	The average number of children surviving per woman, either by her age group (NOPT = 1), or by duration of her marriage (NOPT = 2).
AGE	SV	Real	The average age of mother at childbearing. This variable is only defined when data are tabulated by age group of mother. Note that an estimate of AGE is provided as output by the subroutine FERTIL, although it does not appear in the FERTIL argument string.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine CENCT
LABEL	18	A4	An array containing 72 characters (18A4 format), used for printing part of the heading at the top of the page of output. The array LABEL is separated into two parts. The first 40 characters are used to label the output just described. The remaining 32 characters are used as a secondary label to describe a user-defined model (i.e. the array AVE).
MONTH1	SV	Integer	Indicates the month of the first enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR1	SV	Integer	The year of the first enumeration; for example, 1965.
MONTH2	SV	Integer	Indicates the month of the second enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR2	SV	Integer	The year of the second enumeration; for example, 1965.
NVAL	SV	Integer	Indicates the number of age groups given for the populations (POP1 and POP2) and for the registered deaths (DEATHS) if given. The value of NVAL must be between 14 and 18.
NOPT	SV	Integer	This variable indicates the option number. If NOPT=1, then a model life table is used to calculate the deaths. If NOPT=2, then the deaths are given as input.
NSEX	SV	Integer	Indicates whether the model life-table pattern is of the male or female sex. 1: males 2: females
NREG	SV	Integer	This variable is used only if NOPT=1. NREG indicates the model life table pattern to be used. The codes are:

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine CENCT (cont.) 0 = User-supplied empirical age pattern 1 = UN Latin American model 2 = UN Chilean model 3 = UN South Asian model 4 = UN Far East Asian model 5 = UN General model 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South.
NPARM	SV	Integer	This variable is used only if NOPT=1. NPARM indicates the life-table column: 1 = m(x,n) 2 = q(x,n) 3 = l(x) 4 = e(x).
NAGE	SV	Integer	This variable is used only if NOPT=1. NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l(2), l(3) or l(4).
CMP	SV	Real	This variable is used only if NOPT=1. CMP indicates the life table value being matched.
POP1	18	Real	The population by age for the first census. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.
POP2	18	Real	The population by age for the second census. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine CENCT (cont.)
AVE	18	Real	This variable consists of model life table q(x,n) values supplied by the user. It is defined only if NOPT equals one and NREG equals zero. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, q(x,n) values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per person" basis, each value must be in the interval 0 to 1. If the last age group defined is prior to 80-85, the remaining values of the array must be set to zero.
DEATHS	18	Real	This variable is used only if NOPT=2. These values are the registered deaths for the intercensal period. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.
DTHCMP	3,3	Real	This variable indicates the completeness of death registration relative to the first census. Each of the elements of the array corresponds to different beginning and ending age groups for the linear regression. The first parameter indicates the beginning age of the regression, where 1 = age 5, 2 = age 10 and 3 = age 15. The second parameter indicates the ending age of the regression, where 1 = age 60, 2 = age 65 and 3 = age 70.
CENCMP	3,3	Real	This variable indicates the completeness of the second census relative to the first. Each of the elements of the array corresponds to different beginning and ending age groups for the linear regression. The first parameter indicates the beginning age of the regression, where 1 = age 5, 2 = age 10 and 3 = age 15. The second parameter indicates the ending age of the regression, where 1 = age 60, 2 = age 65 and 3 = age 70.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine COMBIN</u>
LABEL	18	A4	An array containing 72 characters (18A4 format), used for printing part of the heading at the top of the page of output.
NSEX	SV	Integer	Indicates whether the model life-table pattern is of the male or female sex. 1: males 2: females
NREG	SV	Integer	Indicates the model life-table pattern to be used. The codes are: 1 = UN Latin American model 2 = UN Chilean model 3 = UN South Asian model 4 = UN Far East Asian model 5 = UN General model 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South.
E20	SV	Real	Life expectancy at age 20 in the population under study.
SL1	SV	Real	The probability of surviving to age 1 (times 100,000) in the population under study.
SL5	SV	Real	The probability of surviving to age 5 (times 100,000) in the population under study.
ARRAY	101,9	Real	The output life table created by subroutine LIFTB is stored in an array named ARRAY. Use the statement <u>DIMENSION ARRAY(101,9)</u> in your calling program. The first parameter refers to the age group. A value of x for the first parameter refers to age x-1. The second parameter is the column number of the output table. For example, ARRAY(11,8) contains the life expectancy at age 10. Note that LIFTB

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine COMBIN</u> (cont.)
			produces an abridged life table so that only values of the first parameters equal to 1, 2, 6, 11, 16, ..., NFIN+1 are defined. Values past NFIN are not defined. NFIN equals 85 for United Nations model life tables and 80 for Coale and Demeny model life tables. The definitions of the column numbers are: Column number — Variable name 1 — m(x,n) 2 — q(x,n) 3 — l(x) 4 — d(x,n) 5 — L(x,n) 6 — S(x,n) 7 — T(x) 8 — e(x) 9 — a(x,n)
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed and no heading is printed. 2: The subroutine prints neither the output table nor LABEL. Error messages are printed but warning messages are not.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine COMPAR</u>
LABEL	18	A4	LABEL is read using 18A4 format and may contain up to 72 characters of information to be printed as part of the heading above the output table.
NFIN	SV	Integer	Ending age of last closed age group. Minimum value is 65 and maximum is 85.
NTYPE	SV	Integer	Identifies input data stored in array QXMX. 1: q(x,n) 2: m(x,n)
NSEX	SV	Integer	Indicates whether the model life-table pattern being compared is of the male or female sex. 1: males 2: females
QXMX	101	Real	Age-specific mortality rates for age groups 0-1, 1-5, 5-10, 10-15, up to the age group (NFIN-5,NFIN). For ages 5 and over the values are for five year age groups. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1. If NTYPE = 1, then QXMX(x+1) = q(x,n); if NTYPE = 2, then QXMX(x+1) = m(x,n)
ARRAY	101,9	Real	The output life table created by subroutine LIFTB is stored in an array named ARRAY. Use the statement <u>DIMENSION ARRAY(101,9)</u> in your calling program. The first parameter refers to the age group. A value of x for the first parameter refers to age x-1. The second parameter is the column number of the output table. For example, ARRAY(11,8) contains the life expectancy at age 10. Note that LIFTB produces an abridged life table so that only values of the first parameters equal to 1, 2, 6, 11, 16, ..., NFIN+1 are defined. Values past NFIN are not defined. The definitions of the column numbers are:

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine COMPAR (cont.)
			Column number — Variable name 1 — m(x,n) 2 — q(x,n) 3 — l(x) 4 — d(x,n) 5 — L(x,n) 6 — S(x,n) 7 — T(x) 8 — e(x) 9 — a(x,n)
GOF			This variable is a 3 X 9 array, and indicates the goodness of fit of observed mortality rates with each of the nine model life-table patterns. It is the average difference between the life expectancy at birth and the median life expectancy for the ages indicated by the first parameter. The first parameter is coded as: 1: ages 0 to 10 2: ages 10 and over 3: all ages (0 and over) The second parameter corresponds to the model life-table pattern. The codes are: 1 = UN Latin American model 2 = UN Chilean model 3 = UN South Asian model 4 = UN Far East Asian model 5 = UN General model 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South. Note that the codes for the second parameter are consistent with the variable NREG found in other subroutines.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine FERTIL
LABEL	18	A4	A label of up to 72 characters of information to be printed as part of the heading at the top of the page of output.
NYRS	SV	Integer	The number of enumerations for which children ever born (CEB) data are given. NYRS = 1 indicates CEB data for one point in time; NYRS = 2 indicates CEB data for two points in time.
NPAT	SV	Integer	Age-specific fertility rates can be estimated from children ever born data only (the FERTCB main program) or from children ever born data in conjunction with the age pattern of fertility (the FERTPF main program). For the subroutine FERTIL, this parameter determines whether the FERTCB or FERTPF version of this fertility estimation technique is being used. If NPAT = 0, then the input variables necessary for FERTCB are needed. If NPAT = 1, then the variables for FERTPF are needed.
MONTH1	SV	Integer	Indicates the month of the first enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR1	SV	Integer	The year of the first enumeration; for example, 1965.
NTAB1	SV	Integer	Indicates how the fertility pattern (ASFP1) from the first enumeration is tabulated. NTAB1 = 1 indicates that the fertility pattern is tabulated by age of mother at time of birth of the child; NTAB1 = 2 indicates the fertility pattern is tabulated by age of mother at the date of enumeration. This variable is used only when NPAT=1 (as with the main program FERTPF).
MONTH2	SV	Integer	Indicates the month of the second enumeration (1 = January, 2 = February, ..., 12 = December).

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine FERTIL</u> (cont.)
IYEAR2	SV	Integer	The year of the second enumeration; for example, 1975.
NTAB2	SV	Integer	Indicates how the fertility pattern (ASFP2) from the second enumeration is tabulated. NTAB2 = 1 indicates that the fertility pattern is tabulated by age of mother at time of birth of the child; NTAB2 = 2 indicates the fertility pattern is tabulated by age of mother at the date of enumeration. This variable is used only when NPAT=1 (as with the main program FERTPF).
CEB1	7	Real	The average number of children ever born per woman at the time of the first enumeration. Data are given for age groups 15-20, 20-25, ..., up through 45-50.
ASFP1	7	Real	The age-specific fertility pattern at the time of the first enumeration. Data may be given as recorded age-specific fertility rates or as the proportionate age distribution of fertility. Data are given for age groups 15-20, 20-25, ..., 45-50. These variables are defined only when NPAT=1 (for procedure FERTPF).
CEB2	7	Real	The average number of children ever born per woman at the time of the second enumeration. Data are given for age groups 15-20, 20-25, ..., up through 45-50. CEB2 is defined only if NYRS = 2.
ASFP2	7	Real	The age-specific fertility pattern at the time of the second enumeration. Data may be given as recorded age-specific fertility rates or as the proportionate age distribution of fertility. Data are given for age groups 15-20, 20-25, ..., 45-50. These variables are defined only when NPAT=1 (for procedure FERTPF) and NYRS = 2.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine FERTIL</u> (cont.)
ASFR	7,2	Real	This variable contains the resultant age-specific fertility rates consistent with CEB. The first parameter corresponds to the seven age groups 15-20, 20-25, ..., 45-50. The second parameter corresponds to the number of the enumeration (either 1 or 2), but cannot exceed the value given by NYRS.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine ICM
LABEL	18	A4	A label of up to 72 characters of information to be printed at the top of the page of output.
QXMX	18	Real	An empirical set of q(x,n) values for age groups 0-1, 1-5, 5-10. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.
SLX	6	Real	This variable is the resultant number of survivors at age x, with a radix of 100,000 persons. The parameter refers to age. A value of x for the parameter refers to age x-1. Therefore, only values for ages 0 through 5 are calculated and are available through array SLX.
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed and no label is printed. 2: The subroutine prints neither the output table nor the heading. Error messages are printed.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine LIFTB</u>
NPG	SV	Integer	0: one life table printed per page. 1: two life tables printed per page.
LABEL	18	A4	LABEL is read using 18A4 format and may contain up to 72 characters of information to be printed above the output table.
NFIN	SV	Integer	Ending age of last closed age group. Minimum value is 65 and maximum is 100.
NTYPE	SV	Integer	Identifies input data stored in array QXMX. 1: q(x,n) 2: m(x,n)
NSEX	SV	Integer	The sex of the population used for calculating the first two separation factors (a(0,1) and a(1,4)). 1: males 2: females
QXMX	101	Real	Age-specific mortality rates for age groups 0-1, 1-5, 5-10, 10-15, up to the age group (NFIN-5,NFIN). For ages 5 and over the values are for five-year age groups. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1. If NTYPE=1, then QXMX(x+1)=q(x,n); if NTYPE=2, then QXMX(x+1)=m(x,n)
ARRAY	101,9	Real	The output life table created by subroutine LIFTB is stored in an array named ARRAY. Use the statement <u>DIMENSION ARRAY(101,9)</u> in your calling program. The first parameter refers to the age group. A value of x for the first parameter refers to age x-1. The second parameter is the column number of the output table. For example, ARRAY(11,8) contains the life expectancy at age 10. Note that LIFTB

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine LIFTB</u> (cont.)
			produces an abridged life table so that only values of the first parameters equal to 1, 2, 6, 11, 16, ..., NFIN+1 are defined. Values past NFIN are not defined. The definitions of the column numbers are:

Column number	Variable name
1	m(x,n)
2	q(x,n)
3	l(x)
4	d(x,n)
5	L(x,n)
6	S(x,n)
7	T(x)
8	e(x)
9	a(x,n)

Variable used	Array dimensions	Data type	Code for argument string
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed and LABEL is not printed. 2: The subroutine prints neither the output table nor LABEL. Error messages are printed but warning messages are not.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine MATCH</u>
LABEL	18	A4	An array containing 72 characters (18A4 format), used for printing part of the heading at the top of the page of output. In MATCH, the array LABEL is separated into two parts. The first 40 characters are used to label the output just described. The remaining 32 characters are used as a secondary label to describe a user-defined model (i.e., the array AVE).
NSEX	SV	Integer	Indicates whether the model life-table pattern is of the male or female sex. 1: males 2: females
NREG	SV	Integer	Indicates the model life-table pattern to be used. The codes are: 0 = User-supplied empirical age pattern 1 = UN Latin American model 2 = UN Chilean model 3 = UN South Asian model 4 = UN Far East Asian model 5 = UN General model 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South.
NPARM	SV	Integer	NPARM indicates the life-table column: 1 = m(x,n) 2 = q(x,n) 3 = l(x) 4 = e(x).
NAGE	SV	Integer	NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l(2), l(3) or l(4).

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine MATCH (cont.)
CMP	SV	Real	CMP indicates the life-table value being matched.
CMP2	SV	Real	This variable is used when a series of model life tables is desired; otherwise this value must be set to zero. CMP2 is the value for the final model life table. A maximum of 50 tables can be requested through the CMP2-RNGE option. CMP2 may be greater than or less than CMP. The direction of the increment (RNGE) is determined by the relation of CMP and CMP2.
RNGE	SV	Real	This variable is used when a series of model life tables is desired; otherwise this value must be set to zero. RNGE is the increment for CMP. A maximum of 50 tables can be requested through the CMP2-RNGE option. The direction of the increment is determined by the relation of CMP and CMP2; the size of the increment is determined by the absolute value of RNGE (i.e., DABS(RNGE)).
AVE	18	Real	This variable consists of model life-table q(x,n) values supplied by the user. It is defined only if NREG equals zero. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, q(x,n) values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per person" basis, each value must be in the interval 0 to 1. If the last age group defined is prior to 80-85, the remaining values of the array must be set to zero.
ARRAY	101,9	Real	The output life table created by subroutine LIFTB is stored in an array named ARRAY. Use the statement DIMENSION ARRAY(101,9) in your calling program. The first parameter refers to the age group. A value of x for the first parameter refers to age x-1. The second parameter is the column number of the output

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine MATCH (cont.)
			table. For example, ARRAY(11,8) contains the life expectancy at age 10. Note that LIFTB produces an abridged life table so that only values of the first parameters equal to 1, 2, 6, 11, 16, ..., NFIN+1 are defined. Values past NFIN are not defined. The definitions of the column numbers are: Column number — Variable name 1 — m(x,n) 2 — q(x,n) 3 — l(x) 4 — d(x,n) 5 — L(x,n) 6 — S(x,n) 7 — T(x) 8 — e(x) 9 — a(x,n)
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed. 2: The subroutine prints neither the output table nor LABEL. Error messages are printed but warning messages are not. 3: Identical to code 2, except only a subset of the error messages is printed. 4: This code is identical to code 3, but in addition only q(x,n) values are calculated (i.e., column 2 of ARRAY). This is desirable when it is necessary to save execution time when many calls to MATCH are made.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine ORPHAN</u>
LABEL	18	A4	A label of up to 72 characters of information to be printed as part of the heading at the top of the page of output.
MONTH	SV	Integer	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December).
NYEAR	SV	Integer	The year of the enumeration; for example, 1970.
AGE	SV	Real	The average age of mother at childbearing. Note that an estimate of AGE is provided as output by the subroutine FERTIL, although it does not appear in the FERTIL argument string.
SNOR	7	Real	The proportion of population with mother still alive. Data are given for age groups 15-20, 20-25, ..., up to 45-50.
CEB	7	Real	The average number of children ever born to a woman. Data are tabulated by age group of mother, and are given for age groups 15-20, 20-25, ..., 45-50.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine PRESTO
LABEL	18	A4	An array containing 72 characters (18A4 format), used for printing part of the heading at the top of the page of output. The array LABEL is separated into two parts. The first 40 characters are used to label the output just described. The remaining 32 characters are used as a secondary label to describe a user-defined model (i.e., the array AVE).
MONTH1	SV	Integer	Indicates the month of the first enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR1	SV	Integer	The year of the first enumeration; for example, 1965.
MONTH2	SV	Integer	Indicates the month of the second enumeration (1 = January, 2 = February, ..., 12 = December).
IYEAR2	SV	Integer	The year of the second enumeration; for example, 1975.
NVAL	SV	Integer	Indicates the number of age groups given for the populations (POP1 and POP2). The value of NVAL must be between 14 and 18.
PSTAR1	SV	Real	Probability of surviving from birth to age 1 in the country being studied.
PSTAR5	SV	Real	Probability of surviving from birth to age 5 in the country being studied.
NSEX	SV	Integer	Indicates whether the model life-table pattern is of the male or female sex. 1: males 2: females
NREG	SV	Integer	Indicates the model life-table pattern to be used. The codes are:

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine PRESTO (cont.)
			0 = User-supplied empirical age pattern 1 = UN Latin American model 2 = UN Chilean model 3 = UN South Asian model 4 = UN Far East Asian model 5 = UN General model 6 = Coale-Demeny West 7 = Coale-Demeny North 8 = Coale-Demeny East 9 = Coale-Demeny South.
NPARM	SV	Integer	NPARM indicates the life-table column: 1 = m(x,n) 2 = q(x,n) 3 = l(x) 4 = e(x).
NAGE	SV	Integer	NAGE indicates the age group of interest: 0 = age group 0-1, 1 = 1-5, 5 = 5-10, 10 = 10-15, ..., 80 = 80-85. When NPARM = 3 (and only when NPARM = 3), NAGE may also take on the values 2, 3 or 4 to indicate matching on l(2), l(3) or l(4).
CMP	SV	Real	CMP indicates the life-table value being matched.
POP1	18	Real	The population by age for the first census. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.
POP2	18	Real	The population by age for the second census. Data are given for age groups 0-5, 5-10, ..., up through the last open age group available. The number of age groups must be consistent with NVAL.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			<u>Subroutine PRESTO</u> (cont.)
AVE	18	Real	This variable consists of model life table q(x,n) values supplied by the user. It is defined only if NREG equals zero. The values must be given for age groups 0-1, 1-5, 5-10, ... As a minimum, q(x,n) values must be given through age group 60-65; as a maximum through age group 80-85. As these data are read in on a "per person" basis, each value must be in the interval 0 to 1. If the last age group defined is prior to 80-85, the remaining values of the array must be set to zero.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine STABLE
LABEL	18	A4	LABEL is read using 18A4 format and may contain up to 72 characters of information to be printed above the output table.
R	SV	Real	The intrinsic rate of natural increase. R is read in on a "unit basis" so, for example, a 3 per cent annual growth rate is designated as .0300.
NFIN	SV	Integer	Ending age of last closed age group. Minimum value is 65 and maximum is 100.
NTYPE	SV	Integer	Identifies input data stored in array QXMX. 1: q(x,n) 2: m(x,n)
NSEX	SV	Integer	The sex of the population used for calculating the first two separation factors (a(0,1) and a(1,4)). 1: males 2: females
QXMX	101	Real	Age-specific mortality rates for age groups 0-1, 1-5, 5-10, 10-15, up to the age group (NFIN-5,NFIN). For ages 5 and over the values are for five-year age groups. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1. If NTYPE = 1, then QXMX(x+1) = q(x,n); if NTYPE = 2, then QXMX(x+1) = m(x,n).
C	22	Real	This variable is the resultant stable age distribution, calculated as the proportion of population in age groups 0-1, 1-5, 5-10, up to and including the open age group indicated by NFIN.
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed and LABEL is not printed. 2: The subroutine prints neither the output table nor LABEL. Error messages are printed but warning messages are not.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine UNABR
LABEL	18	A4	A label of up to 72 characters of information to be printed as part of the heading at the top of the page of output.
QXMX	18	Real	An empirical set of q(x,n) values. The values must be given for age groups 0-1, 1-5, 5-10, 10-15, up through a minimum of age group 60-65; as a maximum through age group 80-85. For ages 5 and over the values are for five-year age groups. As these data are read in on a "per-person" basis, each value must be in the interval 0 to 1.
Q	125	Real	This variable is the resultant q(x,1) values in single years. The array's parameter refers to age. A value of x for the parameter refers to age x-1. Although age groups 0 through 92 are printed, ages 0 through 120 are available through this array. Parameter values 122 through 125 are not defined.
SLX	125	Real	This variable is the resultant number of survivors at age x, with a radix of 100,000 persons. The parameter refers to age. A value of x for the parameter refers to age x-1. Only ages 0 through 92 are printed, although ages 0 through 121 are available through array SLX. Parameter values 123 through 125 are not defined.
NPLT	SV	Integer	This variable controls the printing of the output table. 0: The subroutine prints the entire output. 1: The subroutine will not perform form feed and no heading is printed. 2: The subroutine prints neither the output table nor the heading. Error messages are printed.

Table 3. (cont.)

Variable used	Array dimensions	Data type	Code for argument string
			Subroutine WIDOW
LABEL	18	A4	A label of up to 72 characters of information to be printed as part of the heading at the top of the page of output.
MONTH	SV	Integer	Indicates the month of the enumeration (1 = January, 2 = February, ..., 12 = December).
NYEAR	SV	Integer	The year of the enumeration; for example, 1970.
NSEX	SV	Integer	Indicates whether the data refer to male or female respondents. NSEX=1: respondents are males and the life table refers to females. NSEX=2: respondents are females and the life table refers to males.
SMAMM	SV	Real	The singulate mean age at marriage for males.
SMAMF	SV	Real	The singulate mean age at marriage for females.
PNW	8	Real	The proportion of respondents whose spouses are still alive. Data are given for age groups 20-25, 25-30, ..., up through 55-60. When NSEX = 1, the value for age group 20-25 is not needed.

IV. SOURCE LISTINGS

A. Main programs

BENHR

```
C++BENHR   SUBROUTINES USED:  BENHR ONLY
C************************************************************************
C***                           MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C************************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),POP1(18),POP2(18),DEATHS(18)
      NREAD=5
   90 READ(NREAD,1,END=99) (LABEL(I),I=1,18)
    1 FORMAT(18A4)
      READ(NREAD,11) MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL
   11 FORMAT(I2,1X,I4,1X,I2,1X,I4,1X,I2)
      READ(NREAD,2) (POP1(I),I=1,18),(POP2(I),I=1,18),(DEATHS(I),I=1,18)
    2 FORMAT(9F8.0,5(/9F8.0))
      CALL BENHR(LABEL,MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,POP1,POP2,
     & DEATHS)
      GO TO 90
   99 STOP
      END
```

BESTFT

```
C++BESTFT   SUBROUTINES USED: BESTFT ONLY
C************************************************************************
C***                           MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C************************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),QXMX(18),AVE(18),CF(3,18)
      NREAD=5
      NPRNT=6
      NPLT=0
   10 READ(NREAD,3,END=999) (LABEL(I),I=1,10)
    3 FORMAT(10A4)
      READ(NREAD,1) NSEX,NREG,(LABEL(I),I=11,18)
    1 FORMAT(I1,1X,I1,16X,8A4)
      READ(NREAD,2)(QXMX(I),I=1,18)
    2 FORMAT(F6.0,9(1X,F6.0)/F6.0,9(1X,F6.0))
      IF(NREG.EQ.0) READ(NREAD,2)(AVE(I),I=1,18)
      CALL BESTFT(LABEL,NSEX,NREG,QXMX,AVE,CF,NPLT)
      GO TO 10
  999 STOP
      END
```

CEBCS

```
C++CEBCS   SUBROUTINES USED: CEBCS,MATCH,LIFTB,ICM,MULT,INVER
C************************************************************************
C***                               MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C************************************************************************
C     AT THIS TIME, CPU=10.2 SEC FOR IBM 3081 AND 40 SEC. FOR
C     IBM 4381. ADJUST JOB CARD ACCORDINGLY.
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),CEB(7),CS(7)
      NREAD=5
      NPRNT=6
    1 READ(NREAD,3,END=99) (LABEL(I),I=1,18)
    3 FORMAT(18A4)
      READ(NREAD,6) MONTH,NYEAR,NOPT,AGE
    6 FORMAT(I2,1X,I4,1X,I1,1X,F5.0)
      READ(NREAD,4) (CEB(I),I=1,7)
    4 FORMAT(7(F5.0,1X))
      READ(NREAD,4) (CS(I),I=1,7)
      CALL CEBCS(LABEL,MONTH,NYEAR,NOPT,AGE,CEB,CS)
      GO TO 1
   99 STOP
      END
```

CENCT

```
C++CENCT  SUBROUTINES USED:  CENCT,MATCH,LIFTB,ICM,MULT,INVER
C************************************************************************
C***                               MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C************************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),POP1(18),POP2(18),AVE(18),DEATHS(18)
      DIMENSION DTHCMP(3,3),CENCMP(3,3)
      NREAD=5
   90 READ(NREAD,1,END=99) (LABEL(I),I=1,10)
    1 FORMAT(10A4)
      READ(NREAD,2) MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL
    2 FORMAT(I2,1X,I4,1X,I2,1X,I4,1X,I2)
      READ(NREAD,3) NOPT,NSEX,NREG,NPARM,NAGE,CMP,(LABEL(I),I=11,18)
    3 FORMAT(I1,1X,I1,1X,I1,1X,I1,1X,I2,1X,F6.0,4X,8A4)
      READ(NREAD,4) (POP1(I),I=1,18),(POP2(I),I=1,18)
    4 FORMAT(9F8.0,3(/9F8.0))
      IF(NOPT.EQ.1.AND.NREG.EQ.0) READ(NREAD,5) (AVE(I),I=1,18)
    5 FORMAT(F6.0,9(1X,F6.0)/F6.0,9(1X,F6.0))
      IF(NOPT.EQ.2) READ(NREAD,6)(DEATHS(I),I=1,18)
    6 FORMAT(9F8.0/9F8.0)
      CALL CENCT(LABEL,MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,NOPT,NSEX,
     & NREG,NPARM,NAGE,CMP,POP1,POP2,AVE,DEATHS,DTHCMP,CENCMP)
      GO TO 90
   99 STOP
      END
```

COMBIN

```
C++COMBIN   SUBROUTINES USED: COMBIN,BESTFT,MATCH,LIFTB
C***********************************************************************
C***                           MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),ARRAY(101,9)
      NREAD=5
      NPRNT=6
      NPLT=0
   98 READ(NREAD,3,END=99) (LABEL(I),I=1,18)
    3 FORMAT(18A4)
      READ(NREAD,1) NSEX,NREG,E20,SL1,SL5
    1 FORMAT(I1,1X,I1,1X,F6.0,1X,F6.0,1X,F6.0)
      CALL COMBIN(LABEL,NSEX,NREG,E20,SL1,SL5,ARRAY,NPLT)
      GO TO 98
   99 STOP
      END
```

COMPAR

```
C++COMPAR   SUBROUTINES USED: COMPAR,MATCH,LIFTB,ICM,MULT,INVER
C***********************************************************************
C***                           MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION QXMX(101),LABEL(18),ARRAY(101,9),GOF(3,9)
      NREAD=5
      NPRNT=6
  100 READ(NREAD,4,END=999)(LABEL(I),I=1,18)
    4 FORMAT(18A4)
      READ(NREAD,3) NFIN,NTYPE,NSEX
    3 FORMAT(I3,1X,I1,1X,I1)
      READ(NREAD,2)(QXMX(I),I=1,2),(QXMX(I),I=6,NFIN,5)
    2 FORMAT(10(F6.0,1X))
      CALL COMPAR(LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,GOF)
      GO TO 100
  999 STOP
      END
```

FERTCB

```
C++FERTCB   SUBROUTINES USED: FERTIL ONLY
C*********************************************************************
C***                          MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),CEB1(7),CEB2(7),ASFP1(7),ASFP2(7),ASFR(7,2)
      NREAD=5
      DATA NPAT,NTAB1,NTAB2/0,0,0/
      DATA ASFP1,ASFP2/14*0.0/
   10 READ(NREAD,11,END=99) (LABEL(I),I=1,18)
   11 FORMAT(18A4)
      READ(NREAD,22) NYRS,MONTH1,IYEAR1,MONTH2,IYEAR2
   22 FORMAT(I1,1X,I2,1X,I4,1X,I2,1X,I4)
      READ(NREAD,33) (CEB1(I),I=1,7)
   33 FORMAT(F5.0,6(1X,F5.0))
      IF(NYRS.EQ.1) GO TO 100
      READ(NREAD,33) (CEB2(I),I=1,7)
  100 CALL FERTIL(LABEL,NYRS,NPAT,MONTH1,IYEAR1,NTAB1,MONTH2,IYEAR2,
     & NTAB2,CEB1,ASFP1,CEB2,ASFP2,ASFR)
      GO TO 10
   99 STOP
      END
```

FERTPF

```
C++FERTPF   SUBROUTINES USED: FERTIL ONLY
C*********************************************************************
C***                          MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),CEB1(7),CEB2(7),ASFP1(7),ASFP2(7),ASFR(7,2)
      NREAD=5
      NPAT=1
   10 READ(NREAD,11,END=99) (LABEL(I),I=1,18)
   11 FORMAT(18A4)
      READ(NREAD,22) NYRS,MONTH1,IYEAR1,NTAB1,MONTH2,IYEAR2,NTAB2
   22 FORMAT(I1,1X,I2,1X,I4,1X,I1,1X,I2,1X,I4,1X,I1)
      READ(NREAD,33) (CEB1(I),I=1,7)
   33 FORMAT(F5.0,6(1X,F5.0))
      READ(NREAD,44) (ASFP1(I),I=1,7)
   44 FORMAT(F5.0,6(1X,F5.0))
      IF(NYRS.EQ.1) GO TO 100
      READ(NREAD,33) (CEB2(I),I=1,7)
      READ(NREAD,44) (ASFP2(I),I=1,7)
  100 CALL FERTIL(LABEL,NYRS,NPAT,MONTH1,IYEAR1,NTAB1,MONTH2,IYEAR2,
     & NTAB2,CEB1,ASFP1,CEB2,ASFP2,ASFR)
      GO TO 10
   99 STOP
      END
```

ICM

```
C++ICM   SUBROUTINES USED: ICM,MULT,INVER
C***********************************************************************
C***                              MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),QXMX(18),SLX(6)
      NREAD=5
      NPRNT=6
      NPLT=0
 100  READ(NREAD,2,END=999) (LABEL(I),I=1,18)
   2  FORMAT(18A4)
      READ(NREAD,4)(QXMX(I),I=1,3)
   4  FORMAT (F6.0,1X,F6.0,1X,F6.0)
      CALL ICM(LABEL,QXMX,SLX,NPLT)
      GO TO 100
 999  STOP
      END
```

LIFTB

```
C++LIFTB   SUBROUTINES USED: LIFTB ONLY
C***********************************************************************
C***                              MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION QXMX(101),LABEL(18),ARRAY(101,9)
      NREAD=5
      NPRNT=6
      NPLT=0
      READ(NREAD,5) NPG
    5 FORMAT(I1)
  100 READ(NREAD,4,END=999) (LABEL(I),I=1,18)
    4 FORMAT(18A4)
      READ(NREAD,1) NFIN,NTYPE,NSEX
    1 FORMAT(I3,1X,I1,1X,I1)
      READ(NREAD,2) (QXMX(I),I=1,2),(QXMX(I),I=6,NFIN,5)
    2 FORMAT(10(F6.0,1X))
      CALL LIFTB(NPG,LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,NPLT)
      GO TO 100
  999 STOP
      END
```

MATCH

```
C++MATCH   SUBROUTINES USED: MATCH,LIFTB,ICM,MULT,INVER
C*********************************************************************
C***                          MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),AVE(18),ARRAY(101,9)
      NREAD=5
      NPRNT=6
      NPLT=0
   98 READ(NREAD,3,END=99) (LABEL(I),I=1,10)
    3 FORMAT(10A4)
      READ(NREAD,1) NSEX,NREG,(LABEL(I),I=11,18)
    1 FORMAT(I1,1X,I1,16X,8A4)
      READ(NREAD,883) NPARM,NAGE,CMP,CMP2,RNGE
  883 FORMAT(I1,1X,I2,1X,F6.0,1X,F6.0,1X,F6.0)
      IF(NREG.EQ.0)READ(NREAD,2)(AVE(I),I=1,18)
    2 FORMAT(F6.0,9(1X,F6.0)/F6.0,9(1X,F6.0))
      CALL MATCH(LABEL,NSEX,NREG,NPARM,NAGE,CMP,CMP2,RNGE,AVE,ARRAY,
     & NPLT)
      GO TO 98
   99 STOP
      END
```

ORPHAN

```
C++ORPHAN   SUBROUTINES USED:  ORPHAN ONLY
C*********************************************************************
C***                          MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),CEB(7),SNOR(7)
      NREAD=5
      NPRNT=6
    1 READ(NREAD,3,END=99) (LABEL(I),I=1,18)
    3 FORMAT(18A4)
      READ(NREAD,6) MONTH,NYEAR,AGE
    6 FORMAT(I2,1X,I4,1X,F5.0)
      READ(NREAD,2) (SNOR(I),I=1,7)
    2 FORMAT(7(F5.0,1X))
      READ(NREAD,4) (CEB(I),I=1,3)
    4 FORMAT(7(F5.0,1X))
      CALL ORPHAN(LABEL,MONTH,NYEAR,AGE,SNOR,CEB)
      GO TO 1
   99 STOP
      END
```

PRESTO

```
C++PRESTO   SUBROUTINES USED: PRESTO,MATCH,LIFTB,ICM,MULT,INVER
C***********************************************************************
C***                             MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),POP1(18),POP2(18),AVE(18)
      NREAD=5
   90 READ(NREAD,1,END=99) (LABEL(I),I=1,10)
    1 FORMAT(10A4)
      READ(NREAD,11) MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,PSTAR1,PSTAR5
   11 FORMAT(I2,1X,I4,1X,I2,1X,I4,1X,I2,1X,F6.0,1X,F6.0)
      READ(NREAD,5) NSEX,NREG,NPARM,NAGE,CMP,(LABEL(I),I=11,18)
    5 FORMAT(I1,1X,I1,1X,I1,1X,I2,1X,F6.0,4X,8A4)
      READ(NREAD,2) (POP1(I),I=1,18),(POP2(I),I=1,18)
    2 FORMAT(9F8.0/9F8.0/9F8.0/9F8.0)
      IF(NREG.EQ.0) READ(NREAD,12) (AVE(I),I=1,18)
   12 FORMAT(F6.0,9(1X,F6.0)/F6.0,9(1X,F6.0))
      CALL PRESTO(LABEL,MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,PSTAR1,PSTAR5,
     & NSEX,NREG,NPARM,NAGE,CMP,POP1,POP2,AVE)
      GO TO 90
   99 STOP
      END
```

STABLE

```
C++STABLE   SUBROUTINES USED: STABLE,LIFTB
C***********************************************************************
C***                             MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION QXMX(101),LABEL(18),C(22)
      NREAD=5
      NPRNT=6
      NPLT=0
  100 READ(NREAD,4,END=999) (LABEL(I),I=1,18)
    4 FORMAT(18A4)
      READ(NREAD,1) NFIN,NTYPE,NSEX,R
    1 FORMAT(I3,1X,I1,1X,I1,1X,F5.0)
      READ(NREAD,2) (QXMX(I),I=1,2),(QXMX(I),I=6,NFIN,5)
    2 FORMAT(10(F6.0,1X))
      CALL STABLE(LABEL,R,NFIN,NTYPE,NSEX,QXMX,C,NPLT)
      GO TO 100
  999 STOP
      END
```

UNABR

```
C++UNABR   SUBROUTINES USED: UNABR,MULT,INVER
C*********************************************************************
C***                            MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),QXMX(18),Q(125),SLX(125)
      NREAD=5
      NPRNT=6
      NPLT=0
  100 READ(NREAD,2,END=999) (LABEL(I),I=1,18)
    2 FORMAT(18A4)
      READ(NREAD,4)(QXMX(I),I=1,18)
    4 FORMAT(F6.0,9(1X,F6.0)/F6.0,9(1X,F6.0))
      CALL UNABR(LABEL,QXMX,Q,SLX,NPLT)
      GO TO 100
  999 STOP
      END
```

WIDOW

```
C++WIDOW   SUBROUTINES USED: WIDOW ONLY
C*********************************************************************
C***                            MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),PNW(8)
      NREAD=5
      NPRNT=6
   90 READ(NREAD,3,END=99) (LABEL(I),I=1,18)
    3 FORMAT(18A4)
      READ(NREAD,6) MONTH,NYEAR,NSEX,SMAMM,SMAMF
    6 FORMAT(I2,1X,I4,1X,I1,1X,F5.0,1X,F5.0)
      READ(NREAD,2) (PNW(I),I=1,8)
    2 FORMAT(F5.0,7(1X,F5.0))
      CALL WIDOW(LABEL,MONTH,NYEAR,NSEX,SMAMM,SMAMF,PNW)
      GO TO 90
   99 STOP
      END
```

B. Subroutines

BENHR

```
      SUBROUTINE BENHR(LABEL,MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,POP1,POP2,
     & DEATHS)
C***********************************************************************
C***                              MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),POP1(18),POP2(18),DEATHS(18),DTH(18),MON(12)
      DIMENSION IAGE(18),R(18),POP5(18),SRT(18),E0(18)
      DIMENSION POPAH(18),POP5H(18),COMP(18),SMLX(18),AM(18),ADJM(18)
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     & 'OCT','NOV','DEC'/
      DATA XSI/0.1/
      NPRNT=6
      N=NVAL
      IF(N.GT.18.OR.N.LT.13) GO TO 800
      IF(MONTH1.GT.12.OR.MONTH1.LT.1) GO TO 802
      IF(MONTH2.GT.12.OR.MONTH2.LT.1) GO TO 802
      DO 123 I=1,18
      POP5H(I)=0.0
      DTH(I)=DEATHS(I)
  123 CONTINUE
      YRS=IYEAR2-IYEAR1+(MONTH2-MONTH1)/12.0
      DO 10 I=1,18
      IAGE(I)=5*(I-1)
   10 CONTINUE
      NM1=N-1
      NM2=N-2
      NM3=N-3
      TPOP1=0.0
      TPOP2=0.0
      TDTH=0.0
      DO 6 I=1,N
      R(I)=DLOG(POP2(I)/POP1(I))/YRS
      TPOP1=TPOP1+POP1(I)
      TPOP2=TPOP2+POP2(I)
      TDTH=TDTH+DTH(I)
      POP5(I)=YRS*DSQRT(POP1(I)*POP2(I))
      AM(I)=DTH(I)/POP5(I)
    6 CONTINUE
      TGR=DLOG(TPOP2/TPOP1)/YRS
      D60=0.0
      D5=0.0
      DO 77 I=2,N
      D5=D5+DTH(I)
      IF(I.LE.12) GO TO 77
```

```
      D60=D60+DTH(I)
   77 CONTINUE
      RATIO=D60/D5
      IF(N.EQ.13) EA=9.345+12.403*RATIO
      IF(N.EQ.14) EA=7.535+10.072*RATIO
      IF(N.EQ.15) EA=6.049+7.918*RATIO
      IF(N.EQ.16) EA=4.890+5.965*RATIO
      IF(N.EQ.17) EA=4.060+4.162*RATIO
      IF(N.EQ.18) EA=3.379+2.836*RATIO
      POPAH(N)=DTH(N)*(DEXP(R(N)*EA)-(R(N)*EA)**2/6.0)
      DO 40 I=1,NM1
      IDX=N-I
      IDX1=IDX+1
      TMP=DEXP(2.5*R(IDX))
      POPAH(IDX)=POPAH(IDX1)*TMP**2+DTH(IDX)*TMP
   40 CONTINUE
      DO 41 I=1,12
      POP5H(I)=2.5*(POPAH(I)+POPAH(I+1))
   41 CONTINUE
      IF(NM1.LT.13) GO TO 44
      E5XSI=DEXP(5.0*XSI)
      DO 42 I=13,NM1
      AMU=XSI*(DLOG(POPAH(I+1)/POPAH(I))+5.0*R(I))/(1.0-E5XSI)
      SUM=0.0
      DO 43 J=1,6
      WT=1.0
      IF(J.EQ.1.OR.J.EQ.6) WT=0.5
      XMA=J-1
      SUM=SUM+WT*DEXP(-XMA*R(I))*DEXP(AMU*(1.0-DEXP(XMA*XSI))/XSI)
   43 CONTINUE
      POP5H(I)=POPAH(I)*SUM
   42 CONTINUE
   44 DO 47 I=2,NM1
      COMP(I)=(POP5H(I-1)+POP5H(I))/(POP5(I-1)+POP5(I))
      SRT(I-1)=COMP(I)
   47 CONTINUE
      DO 48 ILP=1,NM3
      NSTP=NM2-ILP
      DO 48 I=1,NSTP
      IF(SRT(I).LE.SRT(I+1)) GO TO 48
      TMP=SRT(I)
      SRT(I)=SRT(I+1)
      SRT(I+1)=TMP
   48 CONTINUE
      ICHK=MOD(NM2,2)
      IPTR=NM1/2
      IF(ICHK.EQ.0) AMEDN=(SRT(IPTR)+SRT(IPTR+1))/2.0
      IF(ICHK.EQ.1) AMEDN=SRT(IPTR)
      DO 50 I=1,N
      ADJM(I)=AM(I)/AMEDN
   50 CONTINUE
C     NOTE: SMLX(1) AND EO(1) ARE NOT CALCULATED AND NOT PRINTED.
```

```
      SMLX(2)=1.0
      DO 51 I=3,N
      SMLX(I)=SMLX(I-1)*DEXP(-5.0*ADJM(I-1))
   51 CONTINUE
      TVAL=SMLX(N)/ADJM(N)
      EO(N)=TVAL/SMLX(N)
      DO 52 I=1,NM2
      IDX=N-I
      TVAL=TVAL+2.5*(SMLX(IDX)+SMLX(IDX+1))
      EO(IDX)=TVAL/SMLX(IDX)
   52 CONTINUE
      WRITE(NPRNT,71) (LABEL(II),II=1,18)
   71 FORMAT('1'//5X,'ESTIMATED COMPLETENESS OF DEATH REGISTRATION ',
     & 'AND ADJUSTED LIFE EXPECTANCY (APPLICATION OF BENNETT-HORIUCHI ',
     & 'TECHNIQUE)',7(/),5X,18A4)
      WRITE(NPRNT,4) MON(MONTH1),IYEAR1,MON(MONTH2),IYEAR2
    4 FORMAT(/5X,120('-')/23X,'POPULATION',28X,'INTERCENSAL DEATHS',
     & 4X,'COMPLETENESS (1)  ADJUSTED LIFE TABLE (2)'/7X,'AGE',
     & 6X,22('-'),8X,'GROWTH',8X,20('-'),5X,'OF DEATH',7X,
     & 25('-')/16X,A3,I5,6X,A3,I5,9X,'RATE',9X,'NUMBER',9X,'RATE',
     & 4X,'REGISTRATION',5X,'DEATH RATES   APPROX E(X)'/5X,120('-')/)
      WRITE(NPRNT,73) POP1(1),POP2(1),R(1),DTH(1),AM(1),ADJM(1)
   73 FORMAT(6X,'0- 5',2F14.0,F14.5,F14.0,7X,F6.5,10X,'...',10X,
     & F6.5,10X,'...')
      DO 30 I=2,NM1
      WRITE(NPRNT,3) IAGE(I),IAGE(I+1),POP1(I),POP2(I),R(I),DTH(I),
     & AM(I),COMP(I),ADJM(I),EO(I)
    3 FORMAT(5X,I2,'-',I2,2F14.0,F14.5,F14.0,7X,F6.5,F13.3,10X,F6.5,
     & F13.1)
   30 CONTINUE
      WRITE(NPRNT,5) IAGE(N),POP1(N),POP2(N),R(N),DTH(N),
     & AM(N),ADJM(N),EO(N)
    5 FORMAT(5X,I2,'+',2X,2F14.0,F14.5,F14.0,7X,F6.5,10X,'...',10X,
     & F6.5,F13.1)
      WRITE(NPRNT,37) TPOP1,TPOP2,TGR,TDTH
   37 FORMAT(/5X,'TOTAL',2F14.0,F14.5,F14.0)
      WRITE(NPRNT,38) IAGE(N),EA,AMEDN
   38 FORMAT(///5X,'(1) FOR CALCULATION PURPOSES, E(',I2,') ASSUMED ',
     & 'EQUAL TO',F7.3/5X,'(2) BASED ON MEDIAN COMPLETENESS OF',F6.3)
      GO TO 99
  800 WRITE(NPRNT,801) (LABEL(I),I=1,18),NVAL
  801 FORMAT('1'/5X,'*** ERROR IN BENHR FOR DATA SET ',18A4/5X,
     &'NUMBER OF AGE GROUPS SHOULD BE BETWEEN 13 AND 18, BUT NVAL =',I3)
      GO TO 99
  802 WRITE(NPRNT,803) (LABEL(I),I=1,18),MONTH1,MONTH2
  803 FORMAT('1'/5X,'*** ERROR IN BENHR FOR DATA SET ',18A4/5X,
     & 'THE MONTH MUST BE AN INTEGER VALUE FROM 1 TO 12.',
     & //5X,'MONTH1 =',I4/5X,'MONTH2 =',I4)
   99 RETURN
      END
```

BESTFT

```
      SUBROUTINE BESTFT(LABEL,NSEX,NREG,QXMX,AVE,CF,NPLT)
C***********************************************************************
C***                           MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),QXMX(18),AVE(18),CF(3,18)
      DIMENSION NAGE(18),R(18),EMP(18),
     & S(18),VEC(3,18),GAL1(18),GAL2(18),GAL3(18),SVEC1(18),SVEC2(18)
      DIMENSION SVEC3(18),BAL1(18),BAL2(18),BAL3(18),AVX(18)
      DIMENSION VEC1(36),VEC2(36),VEC3(36),A1(3),A2(3),A3(3),D(3)
      DIMENSION EMP1(36),EMP2(36),EMP3(36),EMP4(36),EMP5(36)
      DIMENSION ASEX(2),AREG1(6),AREG2(6)
      DATA ASEX/'  MALE   ',' FEMALE '/
      DATA AREG1/' EMPIRIC',' LATIN A',' CHILEAN',' SOUTH A',' FAR EAS',
     &' GENERAL'/
      DATA AREG2/'AL      ','MERICAN ','        ','SIAN    ','TERN    ',
     &'        '/
      DATA VEC1/.23686,.36077,.33445,.30540,.28931,.28678,.27950,.28023,
     &.26073,.23626,.20794,.17804,.15136,.13217,.12243,.11457,.10445,
     $.08878,.18289,.31406,.31716,.30941,.32317,.32626,.30801,.29047,
     $.25933,.22187,.19241,.17244,.15729,.14282,.12711,.11815,.11591,
     $.09772/
      DATA VEC2/-.46007,-.68813,.06414,.12479,.24384,.10713,.06507,
     $.03339,.02833,.06473,.08705,.10620,.11305,.09467,.10809,.14738,
     $.21037,.30918,-.51009,-.52241,.08947,.03525,.03132,.07843,.06762,
     $.00482,-.01409,-.02178,.01870,.04427,.08201,.08061,.15756,.24236,
     $.30138,.50530/
      DATA VEC3/.09331,-.29269,-.47139,-.17403,.10715,.28842,
     $.33620,.33692,.21354,.15269,.06569,.00045,-.03731,-.10636,-.11214,
     $-.22258,-.19631,-.38123,.23944,-.11117,.07566,.06268,-.26708,
     $-.39053,-.28237,-.14277,-.05923,.18909,.24773,.33679,.34121,
     $.38290,.26731,.14442,.09697,-.13377/
      DATA EMP1/-1.12977,-1.49127,-2.13005,-2.40748,-2.21892,-2.01157,
     $-1.93591,-1.86961,-1.76133,-1.64220,-1.49651,-1.34160,-1.15720,
     $-.96945,-.74708,-.52259,-.29449,-.04031,-1.22452,-1.45667,
     $-2.13881,-2.46676,-2.31810,-2.14505,-2.03883,-1.93924,-1.83147,
     $-1.74288,-1.62385,-1.47924,-1.28721,-1.07443,-.83152,-.59239,
     $-.35970,-.08623/
      DATA EMP2/-1.04722,-1.81992,-2.42430,-2.52487,-2.24491,-2.02821,
     $-1.90923,-1.78646,-1.66679,-1.52497,-1.37807,-1.21929,-1.03819,
     $-.84156,-.63201,-.42070,-.21110,+.01163,-1.12557,-1.82378,
     $-2.52319,-2.63933,-2.38847,-2.20417,-2.09701,-1.99128,-1.87930,
     $-1.75744,-1.61558,-1.45886,-1.26115,-1.05224,-.80346,-.58202,
     $-.35093,-.10587/
      DATA EMP3/-.97864,-1.24228,-2.01695,-2.44280,-2.35424,-2.27012,
     $-2.16833,-2.05942,-1.90053,-1.71213,-1.51120,-1.28493,-1.08192,
     $-.84671,-.62964,-.40229,-.19622,-.00129,-0.97055,-1.15424,
     $-1.93962,-2.36857,-2.19082,-2.09358,-2.04788,-1.95922,-1.87311,
```

```
     $-1.76095,-1.61425,-1.39012,-1.15515,-0.90816,-.68011,-.43231,
     $-.17489,0.05948/
      DATA EMP4/-1.53473,-2.15035,-2.61442,-2.66392,-2.42326,-2.23095,
     $-2.15279,-2.05765,-1.89129,-1.68244,-1.47626,-1.23020,-1.02801,
     $-.77148,-.54696,-.32996,-.11911,0.10572,-1.42596,-1.95200,
     $-2.55653,-2.68018,-2.33095,-2.15952,-2.03377,-1.94554,-1.82299,
     $-1.69084,-1.52189,-1.33505,-1.13791,-0.93765,-.72718,-.50916,
     $-.28389,-.01285/
      DATA EMP5/-1.27638,-1.78957,-2.35607,-2.55527,-2.34263,-2.16193,
     $-2.09109,-2.00215,-1.86781,-1.70806,-1.52834,-1.33100,-1.12934,
     $-.91064,-.68454,-.45685,-.23002,0.00844,-1.35963,-1.77385,
     $-2.39574,-2.64549,-2.44766,-2.28991,-2.18850,-2.08535,-1.97231,
     $-1.84731,-1.69291,-1.50842,-1.30344,-1.08323,-.84402,-.59485,
     $-.34158,-.06493/
      NPRNT=6
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 803
      IF(NREG.LT.0.OR.NREG.GT.5) GO TO 803
      DO 79 I=1,18
   79 AVX(I)=AVE(I)
      DO 80 I=1,18
      NAGE(I)=5*(I-2)
      IKOD=18*(NSEX-1)+I
      VEC(1,I)=VEC1(IKOD)
      VEC(2,I)=VEC2(IKOD)
      VEC(3,I)=VEC3(IKOD)
      IF(NREG.EQ.1) EMP(I)=EMP1(IKOD)
      IF(NREG.EQ.2) EMP(I)=EMP2(IKOD)
      IF(NREG.EQ.3) EMP(I)=EMP3(IKOD)
      IF(NREG.EQ.4) EMP(I)=EMP4(IKOD)
      IF(NREG.EQ.5) EMP(I)=EMP5(IKOD)
      IF(QXMX(I).LT.0.0.OR.QXMX(I).GE.1.0) GO TO 800
      IF(NREG.GE.1)AVX(I)=DEXP(2.0*EMP(I))/(1.0+DEXP(2.0*EMP(I)))
   80 CONTINUE
      NAGE(1)=0
      NAGE(2)=1
      DO 81 I=1,18
      NMAX=19-I
      IF(AVX(NMAX).NE.0.0) GO TO 82
   81 CONTINUE
      NMAX=0
   82 IF(NMAX.LT.14) GO TO 806
      GAMMA1=0.0
      GAMMA2=0.0
      GAMMA3=0.0
      ALPHA1=0.0
      ALPHA2=0.0
      ALPHA3=0.0
      BETA1=0.0
      BETA2=0.0
      BETA3=0.0
      NCTR=0
      DO 10 I=1,NMAX
```

```
      IF(AVX(I).LE.0.0.OR.AVX(I).GE.1.0) GO TO 800
      IF(NREG.EQ.0)EMP(I)=0.50*DLOG(AVX(I)/(1.0-AVX(I)))
      GAL1(I)=VEC(1,I)*VEC(1,I)
      GAL2(I)=VEC(2,I)*VEC(2,I)
      GAL3(I)=VEC(3,I)*VEC(3,I)
      BAL1(I)=VEC(1,I)*VEC(2,I)
      BAL2(I)=VEC(1,I)*VEC(3,I)
      BAL3(I)=VEC(2,I)*VEC(3,I)
      IF(QXMX(I).EQ.0.0) GO TO 10
      NCTR=NCTR+1
      R(I)=0.5*DLOG(QXMX(I)/(1.0-QXMX(I)))
      S(I)=R(I)-EMP(I)
      SVEC1(I)=S(I)*VEC(1,I)
      SVEC2(I)=S(I)*VEC(2,I)
      SVEC3(I)=S(I)*VEC(3,I)
      GAMMA1=GAMMA1+GAL1(I)
      GAMMA2=GAMMA2+GAL2(I)
      GAMMA3=GAMMA3+GAL3(I)
      ALPHA1=ALPHA1+SVEC1(I)
      ALPHA2=ALPHA2+SVEC2(I)
      ALPHA3=ALPHA3+SVEC3(I)
      BETA1=BETA1+BAL1(I)
      BETA2=BETA2+BAL2(I)
      BETA3=BETA3+BAL3(I)
   10 CONTINUE
      B1=BETA1
      B2=BETA2
      B3=BETA3
      G2=GAMMA2
      G3=GAMMA3
      IF(NCTR.GE.3) NCTR=3
      NTEMP=4-NCTR
      DO 60 I=NTEMP,3
      IC=4-I
      IF(IC.EQ.1.OR.IC.EQ.2) GAMMA3=1.0
      IF(IC.EQ.1.OR.IC.EQ.2) BETA2=0.0
      IF(IC.EQ.1.OR.IC.EQ.2) BETA3=0.0
      IF(IC.EQ.1) BETA1=0.0
      IF(IC.EQ.1) GAMMA2=1.0
      D(IC)=GAMMA1*GAMMA2*GAMMA3-GAMMA3*BETA1*BETA1-GAMMA2*BETA2*BETA2-G
     &AMMA1*BETA3*BETA3+2.0*BETA1*BETA2*BETA3
      A1(IC)=ALPHA1*(GAMMA2*GAMMA3-BETA3*BETA3)+ALPHA2*(BETA2*BETA3-BETA
     &1*GAMMA3)+ALPHA3*(BETA1*BETA3-BETA2*GAMMA2)
      A1(IC)=A1(IC)/D(IC)
      A2(IC)=ALPHA1*(BETA2*BETA3-BETA1*GAMMA3)+ALPHA2*(GAMMA1*GAMMA3-BET
     &A2*BETA2)+ALPHA3*(BETA1*BETA2-BETA3*GAMMA1)
      A2(IC)=A2(IC)/D(IC)
      A3(IC)=ALPHA1*(BETA1*BETA3-BETA2*GAMMA2)+ALPHA2*(BETA1*BETA2-BETA3
     &*GAMMA1)+ALPHA3*(GAMMA1*GAMMA2-BETA1*BETA1)
      A3(IC)=A3(IC)/D(IC)
      A2(1)=0.0
      A3(1)=0.0
```

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      A3(2)=0.0
      DO 60 J=1,NMAX
      CF(IC,J)=EMP(J)+A1(IC)*VEC(1,J)+A2(IC)*VEC(2,J)+A3(IC)*VEC(3,J)
   60 CF(IC,J)=DEXP(2.0*CF(IC,J))/(1.0+DEXP(2.0*CF(IC,J)))
      NREG1=NREG+1
      IF(NPLT.EQ.2) GO TO 99
      IF(NPLT.EQ.1) GO TO 97
      IF(NREG.NE.0) WRITE(NPRNT,1)(LABEL(I),I=1,10),ASEX(NSEX),
     & AREG1(NREG1),AREG2(NREG1)
    1 FORMAT('1'/////15X,'CALCULATION OF ONE, TWO AND THREE COMPONENT ',
     & 'FITS TO ',10A4/15X,'DATA FOR THE',A8,'SEX USING AS A MODEL ',
     & 'THE UNITED NATIONS',2A8,'PATTERN')
      IF(NREG.EQ.0) WRITE(NPRNT,71)(LABEL(I),I=1,10),ASEX(NSEX),
     & (LABEL(I),I=11,17)
   71 FORMAT('1'/////15X,'CALCULATION OF ONE, TWO AND THREE COMPONENT ',
     & 'FITS TO ',10A4/15X,'DATA FOR THE',A8,'SEX USING AS A MODEL ',
     & 'THE USER SUPPLIED PATTERN OF ',7A4)
   97 WRITE(NPRNT,720)
  720 FORMAT(/////65X,'PREDICTED Q(X,N) VALUES BASED ON'/57X,
     & 48('-')/31X,'EMPIRICAL',21X,'ONE',15X,'TWO',15X,'THREE'/10X,
     & 'AGE',16X,'Q(X,N) VALUES',16X,'COMPONENT',9X,'COMPONENTS',
     & 9X,'COMPONENTS'/9X,5('-'),14X,15('-'),5X,3(9X,'----------'))
      DO 30 J=1,NMAX
      IF(QXMX(J).NE.0.0)WRITE(NPRNT,721)NAGE(J),QXMX(J),
     & (CF(K,J),K=1,NCTR)
  721 FORMAT(6X,I6,16X,F11.5,8X,3(8X,F11.5))
      IF(QXMX(J).EQ.0.0)WRITE(NPRNT,725)NAGE(J),(CF(K,J),K=1,NCTR)
  725 FORMAT(6X,I6,22X,'.....',8X,3(8X,F11.5))
   30 CONTINUE
      GO TO 99
  800 WRITE(NPRNT,801) (LABEL(J),J=1,10),(QXMX(J),J=1,18)
  801 FORMAT('1'/5X,'*** ERROR IN BESTFT FOR DATA SET ',10A4/5X,'INPUT',
     &' VALUE(S) IS OUTSIDE THE RANGE OF ZERO AND ONE.'/5X,'NOTE: ',
     & 'QXMX CAN EQUAL 0.0 WHEN DATA NOT AVAILABLE FOR THAT AGE GROUP.'
     &//5X,'PLEASE CHECK INPUT QXMX VALUES:'/5X,10F8.5/5X,10F8.5)
      IF(NREG.EQ.0) WRITE(NPRNT,802)(AVX(J),J=1,18)
  802 FORMAT(/5X,'PLEASE CHECK INPUT AVE VALUES:'/5X,10F8.5/5X,10F8.5)
      GO TO 99
  803 WRITE(NPRNT,804) (LABEL(J),J=1,10),NSEX,NREG
  804 FORMAT('1'/5X,'*** ERROR IN BESTFT FOR DATA SET ',10A4/5X,'INPUT',
     & ' ERROR IN AT LEAST ONE OF THE FOLLOWING PARAMETERS:'/
     & 5X,'NSEX MUST BE 1 OR 2.          ',3X,'NSEX=',I3/
     & 5X,'NREG MUST BE BETWEEN 0 AND 5.',3X,'NREG=',I3)
      GO TO 99
  806 WRITE(NPRNT,807) (LABEL(J),J=1,10),NMAX
  807 FORMAT('1'/5X,'*** ERROR IN BESTFT FOR DATA SET ',10A4/5X,
     & 'AT LEAST 14 CONSECUTIVE INPUT VALUES FOR AVE ARE REQUIRED, ',
     & 'BUT ONLY',I3,' WERE SUPPLIED.')
   99 RETURN
      END
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CEBCS

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      SUBROUTINE CEBCS(LABEL,MONTH,NYEAR,NOPT,AGE,CEB,CS)
C***********************************************************************
C***                              MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),CEB(7),CS(7),D(7),QI(9,7),AMR(9,7),CMR(9,7),
     & EAB(9,7),AK(9,7),SMLXC(9,7),NAGE(2,7),NX(7),HEAD(3,2),MON(12),
     & AVE(18),ARRAY(101,9),TSTAR(2,7),IYR(2,7),IMN(2,7),IGL(9,7)
      DIMENSION JGL(9,7),Q080(9),Q180(9)
      DATA HEAD/' ',' AGE OF',' WOMAN','DURATION','   OF','MARRIAGE'/
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     &           'OCT','NOV','DEC'/
      DATA IBL,IGT,ILT/' ','GT','LT'/
      DATA CMP2,RNGE,ITHREE/0.0,0.0,3/
      DATA Q080/0.016,0.017,0.017,0.008,0.012,0.003,0.007,0.005,0.019/
      DATA Q180/0.003,0.001,0.003,0.001,0.002,0.000,0.001,0.000,0.001/
      NPRNT=6
      DO 10 I=1,7
      IF(CS(I).LT.0.0) GO TO 800
      IF(CEB(I).LT.CS(I)) GO TO 800
      IF(CEB(I).GT.10.0) GO TO 800
   10 CONTINUE
      IF(NOPT.LT.1.OR.NOPT.GT.2) GO TO 802
      IF(MONTH.LT.1.OR.MONTH.GT.12) GO TO 804
      IF(NOPT.EQ.1) NTMP=10
      IF(NOPT.EQ.2) NTMP=-5
      DO 20 I=1,7
      N=5*I+NTMP
      NAGE(1,I)=N
      NAGE(2,I)=N+5
      IF(I.GT.3) GO TO 21
      NX(I)=I
      GO TO 20
   21 NX(I)=5*(I-3)
   20 CONTINUE
      IF(NOPT.NE.2) GO TO 15
      NX(1)=2
      NX(2)=3
      DO 16 I=3,7
   16 NX(I)=5*(I-2)
   15 A=CEB(1)/CEB(2)
      B=CEB(2)/CEB(3)
      DO 25 I=1,7
   25 D(I)=1.0-CS(I)/CEB(I)
      IF(NOPT.EQ.2) GO TO 26
C     (*) INPUT DATA BASED ON AGE OF MOTHER
C     (1) CALCULATION OF MULTIPLIERS FOR LATIN AMERICAN PATTERN
      AK(1,1)=0.6892-1.6937*A+0.6464*B+0.0106*AGE
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      AK(1,2)=1.3625-0.3778*A-0.2892*B-0.0041*AGE
      AK(1,3)=1.0877+0.1097*A-0.2986*B+0.0024*AGE
      AK(1,4)=0.7500+0.0532*A-0.1106*B+0.0115*AGE
      AK(1,5)=0.5605+0.0222*A+0.0170*B+0.0171*AGE
      AK(1,6)=0.5024+0.0028*A+0.0048*B+0.0180*AGE
      AK(1,7)=0.5326+0.0052*A+0.0256*B+0.0168*AGE
C     (2) CALCULATION OF MULTIPLIERS FOR CHILEAN PATTERN
      AK(2,1)=0.8274-1.5854*A+0.5949*B+0.0097*AGE
      AK(2,2)=1.3129-0.2457*A-0.2329*B-0.0031*AGE
      AK(2,3)=1.0632+0.0196*A-0.1996*B+0.0021*AGE
      AK(2,4)=0.8236+0.0293*A-0.0684*B+0.0081*AGE
      AK(2,5)=0.6895+0.0068*A+0.0032*B+0.0119*AGE
      AK(2,6)=0.6098-0.0014*A+0.0166*B+0.0141*AGE
      AK(2,7)=0.5615+0.0040*A+0.0073*B+0.0159*AGE
C     (3) CALCULATION OF MULTIPLIERS FOR SOUTH ASIAN PATTERN
      AK(3,1)=0.6749-1.7580*A+0.6805*B+0.0109*AGE
      AK(3,2)=1.3716-0.3652*A-0.2966*B-0.0041*AGE
      AK(3,3)=1.0899+0.0299*A-0.2887*B+0.0024*AGE
      AK(3,4)=0.7694+0.0548*A-0.0934*B+0.0108*AGE
      AK(3,5)=0.6156+0.0231*A+0.0298*B+0.0149*AGE
      AK(3,6)=0.6077+0.0040*A+0.0573*B+0.0141*AGE
      AK(3,7)=0.6952+0.0018*A+0.0306*B+0.0109*AGE
C     (4) CALCULATION OF MULTIPLIERS FOR FAR EASTERN PATTERN
      AK(4,1)=0.7194-1.3143*A+0.5432*B+0.0093*AGE
      AK(4,2)=1.2671-0.2996*A-0.2105*B-0.0029*AGE
      AK(4,3)=1.0668+0.0017*A-0.2424*B+0.0019*AGE
      AK(4,4)=0.7833+0.0307*A-0.1103*B+0.0098*AGE
      AK(4,5)=0.5765+0.0068*A-0.0202*B+0.0165*AGE
      AK(4,6)=0.4115+0.0014*A+0.0083*B+0.0213*AGE
      AK(4,7)=0.3071+0.0111*A+0.0129*B+0.0251*AGE
C     (5) CALCULATION OF MULTIPLIERS FOR GENERAL PATTERN
      AK(5,1)=0.7210-1.4686*A+0.5746*B+0.0095*AGE
      AK(5,2)=1.3155-0.3360*A-0.2475*B-0.0034*AGE
      AK(5,3)=1.0768+0.0109*A-0.2695*B+0.0021*AGE
      AK(5,4)=0.7682+0.0439*A-0.1090*B+0.0105*AGE
      AK(5,5)=0.5769+0.0176*A+0.0038*B+0.0165*AGE
      AK(5,6)=0.4845+0.0034*A+0.0036*B+0.0187*AGE
      AK(5,7)=0.4760+0.0071*A+0.0246*B+0.0189*AGE
C     (6) CALCULATION OF MULTIPLIERS FOR WEST REGION
      AK(6,1)=1.1415-2.7070*A+0.7663*B
      AK(6,2)=1.2563-0.5381*A-0.2637*B
      AK(6,3)=1.1851+0.0633*A-0.4177*B
      AK(6,4)=1.1720+0.2341*A-0.4272*B
      AK(6,5)=1.1865+0.3080*A-0.4452*B
      AK(6,6)=1.1746+0.3314*A-0.4537*B
      AK(6,7)=1.1639+0.3190*A-0.4435*B
C     (7) CALCULATION OF MULTIPLIERS FOR NORTH REGION
      AK(7,1)=1.1119-2.9287*A+0.8507*B
      AK(7,2)=1.2390-0.6865*A-0.2745*B
      AK(7,3)=1.1884+0.0421*A-0.5156*B
      AK(7,4)=1.2046+0.3037*A-0.5656*B
      AK(7,5)=1.2586+0.4236*A-0.5898*B
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      AK(7,6)=1.2240+0.4222*A-0.5456*B
      AK(7,7)=1.1772+0.3486*A-0.4624*B
C     (8) CALCULATION OF MULTIPLIERS FOR EAST REGION
      AK(8,1)=1.1461-2.2536*A+0.6259*B
      AK(8,2)=1.2231-0.4301*A-0.2245*B
      AK(8,3)=1.1593+0.0581*A-0.3479*B
      AK(8,4)=1.1404+0.1991*A-0.3487*B
      AK(8,5)=1.1540+0.2511*A-0.3506*B
      AK(8,6)=1.1336+0.2556*A-0.3428*B
      AK(8,7)=1.1201+0.2362*A-0.3268*B
C     (9) CALCULATION OF MULTIPLIERS FOR SOUTH REGION
      AK(9,1)=1.0819-3.0005*A+0.8689*B
      AK(9,2)=1.2846-0.6181*A-0.3024*B
      AK(9,3)=1.2223+0.0851*A-0.4704*B
      AK(9,4)=1.1905+0.2631*A-0.4487*B
      AK(9,5)=1.1911+0.3152*A-0.4291*B
      AK(9,6)=1.1564+0.3017*A-0.3958*B
      AK(9,7)=1.1307+0.2596*A-0.3538*B
      GO TO 30
C     (*) INPUT DATA BASED ON DURATION OF MARRIAGE
C     (1) CALCULATION OF MULTIPLIERS FOR LATIN AMERICAN PATTERN
   26 AK(1,1)=1.3181-0.5453*A+0.1286*B
      AK(1,2)=1.2464-0.3530*A-0.1163*B
      AK(1,3)=1.3198+0.0770*A-0.4608*B
      AK(1,4)=1.3941+0.3370*A-0.6712*B
      AK(1,5)=1.3930+0.3187*A-0.6875*B
      AK(1,6)=1.3909+0.2328*A-0.6543*B
      AK(1,7)=1.4128+0.2505*A-0.6893*B
C     (2) CALCULATION OF MULTIPLIERS FOR CHILEAN PATTERN
      AK(2,1)=1.2632-0.4131*A+0.0952*B
      AK(2,2)=1.1890-0.2239*A-0.0950*B
      AK(2,3)=1.2208+0.0062*A-0.3192*B
      AK(2,4)=1.2647+0.2204*A-0.4584*B
      AK(2,5)=1.2978+0.2222*A-0.5239*B
      AK(2,6)=1.3550-0.2103*A-0.6008*B
      AK(2,7)=1.4281+0.2706*A-0.7246*B
C     (3) CALCULATION OF MULTIPLIERS FOR SOUTH ASIAN PATTERN
      AK(3,1)=1.3265-0.5606*A+0.1333*B
      AK(3,2)=1.2502-0.3447*A-0.1149*B
      AK(3,3)=1.3083+0.0845*A-0.4369*B
      AK(3,4)=1.3496+0.3121*A-0.5962*B
      AK(3,5)=1.3150+0.2675*A-0.5503*B
      AK(3,6)=1.2677+0.1567*A-0.4392*B
      AK(3,7)=1.2406+0.1403*A-0.3974*B
C     (4) CALCULATION OF MULTIPLIERS FOR FAR EASTERN PATTERN
      AK(4,1)=1.2419-0.4122*A+0.0965*B
      AK(4,2)=1.1939-0.2840*A-0.0943*B
      AK(4,3)=1.2656+0.0485*A-0.3892*B
      AK(4,4)=1.3675+0.2775*A-0.6303*B
      AK(4,5)=1.4486+0.3317*A-0.7957*B
      AK(4,6)=1.5633+0.3588*A-0.9649*B
      AK(4,7)=1.6638+0.4525*A-1.1344*B
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C     (5) CALCULATION OF MULTIPLIERS FOR GENERAL PATTERN
      AK(5,1)=1.2941-0.4986*A+0.1173*B
      AK(5,2)=1.2265-0.3248*A-0.1078*B
      AK(5,3)=1.2964+0.0648*A-0.4301*B
      AK(5,4)=1.3809+0.3099*A-0.6492*B
      AK(5,5)=1.4056+0.3186*A-0.7115*B
      AK(5,6)=1.4352+0.2661*A-0.7328*B
      AK(5,7)=1.4732+0.2991*A-0.7947*B
C     (6) CALCULATION OF MULTIPLIERS FOR WEST REGION
      AK(6,1)=1.2584-0.4683*A+0.1080*B
      AK(6,2)=1.1841-0.3006*A-0.0892*B
      AK(6,3)=1.2446+0.0131*A-0.3555*B
      AK(6,4)=1.3353+0.1157*A-0.5245*B
      AK(6,5)=1.3875-0.0193*A-0.5472*B
      AK(6,6)=1.4227-0.1954*A-0.5127*B
      AK(6,7)=1.4432-0.1977*A-0.5339*B
C     (7) CALCULATION OF MULTIPLIERS FOR NORTH REGION
      AK(7,1)=1.2615-0.5340*A+0.1252*B
      AK(7,2)=1.1957-0.4103*A-0.0930*B
      AK(7,3)=1.3067-0.0103*A-0.4618*B
      AK(7,4)=1.4701+0.1763*A-0.7268*B
      AK(7,5)=1.5039+0.0039*A-0.7071*B
      AK(7,6)=1.4798-0.2487*A-0.5582*B
      AK(7,7)=1.4373-0.2317*A-0.5047*B
C     (8) CALCULATION OF MULTIPLIERS FOR EAST REGION
      AK(8,1)=1.2299-0.3998*A+0.0910*B
      AK(8,2)=1.1611-0.2451*A-0.0797*B
      AK(8,3)=1.2036+0.0171*A-0.2992*B
      AK(8,4)=1.2773+0.1015*A-0.4276*B
      AK(8,5)=1.3014-0.0219*A-0.4195*B
      AK(8,6)=1.3160-0.1630*A-0.3751*B
      AK(8,7)=1.3287-0.1523*A-0.3925*B
C     (9) CALCULATION OF MULTIPLIERS FOR SOUTH REGION
      AK(9,1)=1.3103-0.5856*A+0.1367*B
      AK(9,2)=1.2309-0.3463*A-0.1073*B
      AK(9,3)=1.2774+0.0336*A-0.3987*B
      AK(9,4)=1.3493+0.1366*A-0.5403*B
      AK(9,5)=1.3592-0.0315*A-0.4944*B
      AK(9,6)=1.3532-0.1978*A-0.4099*B
      AK(9,7)=1.3498-0.1663*A-0.4131*B
   30 DO 31 I=1,9
      DO 31 J=1,7
      QI(I,J)=AK(I,J)*D(J)
   31 SMLXC(I,J)=(1.0-QI(I,J))*100000.0
      DO 40 NREG=1,9
      DO 40 I=1,7
      IGL(NREG,I)=IBL
      JGL(NREG,I)=IBL
      IF(QI(NREG,I).GT.0.001) GO TO 48
      AQ0=Q080(NREG)
      AQ1=Q180(NREG)
      GO TO 47
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   48 NAGEGR=NX(I)
      CMP=SMLXC(NREG,I)
      CALL MATCH(LABEL,1,NREG,3,NAGEGR,CMP,CMP2,RNGE,AVE,ARRAY,ITHREE)
      AQ0=ARRAY(1,2)
      AQ1=ARRAY(2,2)
      AE0=ARRAY(1,8)
      CALL MATCH(LABEL,2,NREG,3,NAGEGR,CMP,CMP2,RNGE,AVE,ARRAY,ITHREE)
      AQ0=(1.05*AQ0+ARRAY(1,2))/2.05
      AQ1=(1.05*AQ1+ARRAY(2,2))/2.05
      AE0=(1.05*AE0+ARRAY(1,8))/2.05
      IF(AE0.GE.20.0) GO TO 41
      IGL(NREG,I)=ILT
      JGL(NREG,I)=IGT
      AE0=19.98
      GO TO 42
   41 IF(AE0.LE.80.0) GO TO 42
   47 IGL(NREG,I)=IGT
      JGL(NREG,I)=ILT
      AE0=80.02
   42 AMR(NREG,I)=AQ0
      EAB(NREG,I)=AE0
      CMR(NREG,I)=AQ1
   40 CONTINUE
      IF(NOPT.EQ.2) GO TO 43
C     (*) INPUT DATA BASED ON AGE OF MOTHER
C     (1) UNITED NATIONS MODELS
      TSTAR(1,1)=1.2136+0.9740*A-0.5247*B
      TSTAR(1,2)=1.7025+4.1569*A-0.1232*B
      TSTAR(1,3)=1.8360+2.8632*A+3.5220*B
      TSTAR(1,4)=2.1882-2.6521*A+9.1691*B
      TSTAR(1,5)=2.9682-10.3053*A+15.3161*B
      TSTAR(1,6)=4.6526-16.6920*A+19.8534*B
      TSTAR(1,7)=7.1425-18.3021*A+22.4168*B
C     (2) COALE-DEMENY MODELS
      TSTAR(2,1)=1.0970+5.5628*A-1.9956*B
      TSTAR(2,2)=1.3062+5.5677*A+0.2962*B
      TSTAR(2,3)=1.5305+2.5528*A+4.8962*B
      TSTAR(2,4)=1.9991-2.4261*A+10.4282*B
      TSTAR(2,5)=2.7632-8.4065*A+16.1787*B
      TSTAR(2,6)=4.3468-13.2436*A+20.1990*B
      TSTAR(2,7)=7.5242-14.2013*A+20.0162*B
      GO TO 50
C     (*) INPUT DATA BASED ON DURATION OF MARRIAGE
C     (1) UNITED NATIONS MODELS
   43 TSTAR(1,1)=2.0219-0.0732*A-0.0119*B
      TSTAR(1,2)=2.2402+3.6178*A-0.2111*B
      TSTAR(1,3)=1.3013+3.4958*A+4.7043*B
      TSTAR(1,4)=-0.8950-2.8421*A+15.1546*B
      TSTAR(1,5)=-2.6971-10.3558*A+25.9914*B
      TSTAR(1,6)=-1.8148-12.7146*A+30.4876*B
      TSTAR(1,7)=-0.8001-12.2269*A+34.8030*B
C     (2) COALE-DEMENY MODELS
```

```
      TSTAR(2,1)=1.0349+1.3714*A-0.3390*B
      TSTAR(2,2)=1.6654+4.5855*A+0.0233*B
      TSTAR(2,3)=1.2109+3.3291*A+5.1402*B
      TSTAR(2,4)=-0.5370-1.7679*A+14.6370*B
      TSTAR(2,5)=-2.4694-3.9194*A+23.0999*B
      TSTAR(2,6)=-2.2107+1.3059*A+24.4479*B
      TSTAR(2,7)=1.7815+5.0415*A+20.6725*B
   50 AYR=NYEAR
      AMON=MONTH-0.5
      CEN=AYR+AMON/12.0
      DO 51 I=1,2
      DO 51 J=1,7
      RDT=CEN-TSTAR(I,J)
      IYR(I,J)=RDT
      AMON=RDT-IYR(I,J)
      AMON=12.0*AMON+1.0
      IMON=AMON
      IF(IMON.LT.1) IMON=1
      IF(IMON.GT.12) IMON=12
      IMN(I,J)=MON(IMON)
   51 CONTINUE
      WRITE(NPRNT,70) (LABEL(I),I=1,18)
   70 FORMAT('1',12X,'INDIRECT ESTIMATION OF EARLY AGE MORTALITY FOR ',
     & 18A4)
      WRITE(NPRNT,71) MON(MONTH),NYEAR
   71 FORMAT(///3X,'ENUMERATION OF ',A4,I4,52X,'PROBABILITY OF DYING ',
     & 'BEFORE AGE X')
      WRITE(NPRNT,73) (HEAD(I,NOPT),I=1,3)
   73 FORMAT(3X,6('-'),3X,29('-'),3X,3('-'),3X,45('-'),3X,33('-')/
     & 2X,A8,52X,'UNITED NATIONS MODELS',22X,'COALE-DEMENY MODELS'/
     & 2X,A8,7X,'CHILDREN',6X,'PROPORTION',3X,'AGE',12X,'(PALLONI-',
     & 'HELIGMAN EQUATIONS)',17X,'(TRUSSELL EQUATIONS)'/2X,A8,4X,'BORN',
     & 2X,'SURVIVING',5X,'DEAD',7X,'X',4X,'LAT AM   CHILEAN  SO ASIAN',
     & 2X,'FAR EAST  GENERAL',4X,'WEST',4X,'NORTH',5X,'EAST',4X,
     & 'SOUTH'/3X,6('-'),3X,29('-'),3X,3('-'),3X,45('-'),3X,33('-'))
      DO 74 J=1,7
      WRITE(NPRNT,75) (NAGE(I,J),I=1,2),CEB(J),CS(J),D(J),NX(J),
     & (QI(NREG,J),NREG=1,9)
   75 FORMAT(3X,I2,'-',I2,1X,2F10.3,5X,F4.3,6X,I2,1X,5(5X,F4.3),2X,
     & 4(5X,F4.3))
   74 CONTINUE
      IF(NOPT.EQ.1) WRITE(NPRNT,771) AGE
  771 FORMAT(/2X,'AVERAGE AGE AT CHILDBEARING =',F6.2)
      IF(NOPT.EQ.2) WRITE(NPRNT,772)
  772 FORMAT(1X)
      WRITE(NPRNT,76) (HEAD(I,NOPT),I=1,3)
   76 FORMAT(////62X,'CORRESPONDING MORTALITY INDICES'/2X,8('-'),
     & 7X,57('-'),7X,44('-')/2X,A8,29X,'UNITED NATIONS MODELS',38X,
     & 'COALE-DEMENY MODELS'/2X,A8,8X,'REFERENCE',9X,'(PALLONI-HELIGM',
     & 'AN EQUATIONS)',17X,'REFERENCE',7X,'(TRUSSELL EQUATIONS)'/2X,A8,
     & 10X,'DATE',4X,'LAT AM   CHILEAN  SO ASIAN  FAR EAST  ',
     & 'GENERAL',10X,'DATE',6X,'WEST',4X,'NORTH',5X,'EAST',4X,'SOUTH'/
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   & 2X,8('-'),7X,57('-'),7X,44('-'))
    WRITE(NPRNT,77)
 77 FORMAT(/2X,'INFANT MORTALITY RATE'/)
    DO 78 J=1,7
    WRITE(NPRNT,79) (NAGE(I,J),I=1,2),IMN(1,J),IYR(1,J),
   & (JGL(NREG,J),AMR(NREG,J),NREG=1,5),IMN(2,J),IYR(2,J),
   & (JGL(NREG,J),AMR(NREG,J),NREG=6,9)
 79 FORMAT(3X,I2,'-',I2,10X,A4,I4,1X,A3,F4.3,4(2X,A3,F4.3),11X,A4,
   & I4,1X,A3,F4.3,3(2X,A3,F4.3))
 78 CONTINUE
    WRITE(NPRNT,84)
 84 FORMAT(/2X,'CHILD MORTALITY RATE'/)
    DO 85 J=1,7
    WRITE(NPRNT,86) (NAGE(I,J),I=1,2),IMN(1,J),IYR(1,J),
   & (JGL(NREG,J),CMR(NREG,J),NREG=1,5),IMN(2,J),IYR(2,J),
   & (JGL(NREG,J),CMR(NREG,J),NREG=6,9)
 86 FORMAT(3X,I2,'-',I2,10X,A4,I4,1X,A3,F4.3,4(2X,A3,F4.3),11X,A4,
   & I4,1X,A3,F4.3,3(2X,A3,F4.3))
 85 CONTINUE
    WRITE(NPRNT,80)
 80 FORMAT(/2X,'LIFE EXPECTANCY AT BIRTH'/)
    DO 81 J=1,7
    WRITE(NPRNT,82) (NAGE(I,J),I=1,2),IMN(1,J),IYR(1,J),
   & (IGL(NREG,J),EAB(NREG,J),NREG=1,5),IMN(2,J),IYR(2,J),
   & (IGL(NREG,J),EAB(NREG,J),NREG=6,9)
 82 FORMAT(3X,I2,'-',I2,10X,A4,I4,1X,A3,F4.1,4(2X,A3,F4.1),11X,A4,
   & I4,1X,A3,F4.1,3(2X,A3,F4.1))
 81 CONTINUE
    GO TO 99
800 WRITE(NPRNT,801) LABEL,CEB,CS
801 FORMAT('1'/5X,'*** ERROR IN CEBCS FOR DATA SET ',18A4/5X,'INPUT ',
   & 'VALUE(S) FOR CEB OR CS IS OUTSIDE THE RANGE OF ZERO AND TEN'/5X,
   & 'OR CS IS GREATER THAN CEB IN AT LEAST ONE OF THE AGE GROUPS.'/
   & 5X,'PLEASE CHECK INPUT VALUES:'//5X,'CEB ',7F8.4/5X,'CS  ',7F8.4)
    GO TO 99
802 WRITE(NPRNT,803) LABEL,NOPT
803 FORMAT('1'/5X,'*** ERROR IN CEBCS FOR DATA SET ',18A4/5X,
   & 'THE VALUE FOR NOPT MUST BE EITHER 1 OR 2, BUT NOPT =',I3)
    GO TO 99
804 WRITE(NPRNT,805) LABEL,MONTH
805 FORMAT('1'/5X,'*** ERROR IN CEBCS FOR DATA SET ',18A4/5X,
   & 'THE MONTH MUST BE AN INTEGER VALUE FROM 1 TO 12, BUT ',
   & 'MONTH =',I4)
 99 RETURN
    END
```

CENCT

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      SUBROUTINE CENCT(LABEL,MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,NOPT,
     & NSEX,NREG,NPARM,NAGE,CMP,POP1,POP2,AVE,DEATHS,DTHCMP,CENCMP)
C***********************************************************************
C***                            MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      INTEGER*2 IGRAPH(55,55)
      DIMENSION LABEL(18),POP1(18),POP2(18),AVE(18),DEATHS(18)
      DIMENSION DTHCMP(3,3),CENCMP(3,3),AM(19)
      DIMENSION ARRAY(101,9),IAGE(19),MON(12),IAGE01(19)
      DIMENSION CEN1(18),CEN2(18),R(18)
      DIMENSION XTMP(18),YTMP(18)
      DIMENSION REG1(10),REG2(10),LDV(55)
      DIMENSION ASEX(2),ICOL(4),NSC(3,3)
      DIMENSION ASLOPE(3,3),BINTER(3,3),AGR(3,3)
      DIMENSION EMS(3,3)
      DIMENSION NUM(10),NBUF(110),XPRT(10),IPT(5,2)
      DIMENSION XVAL(25),YVAL(25)
      DATA NUM/'1','2','3','4','5','6','7','8','9','0'/
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     & 'OCT','NOV','DEC'/
      DATA XVAL(1),YVAL(1),RNGE/0.0D0,0.0D0,0.0D0/
      DATA LDV/18*' ','D','E','P','E','N','D','E','N','T',' ','V','A',
     & 'R','I','A','B','L','E',19*' '/
      DATA  REG1/' EMPIRIC',' LATIN A',' CHILEAN',' SOUTH A',' FAR EAS',
     &' GENERAL',' WEST   ',' NORTH  ',' EAST   ',' SOUTH  '/
      DATA  REG2/'AL TABLE','MERICAN ','        ','SIAN    ','TERN    ',
     &'        ','        ','        ','        ','        '/
      DATA ASEX/' MALE   ',' FEMALE '/,ICOL/'M','Q','I','E'/
      DATA IBL/' '/,IDOT/'.'/,ISTAR/'*'/,IDASH/'-'/,IPLUS/'+'/
      DATA IDASH/'-'/,IPLUS/'+'/
      NPRNT=6
      CMP2=0.0
      RNGE=0.0
      NP=2
      N=NVAL
      NM1=N-1
      IF(N.GT.18.OR.N.LT.14) GO TO 800
      IF(MONTH1.LT.1.OR.MONTH1.GT.12) GO TO 808
      IF(MONTH2.LT.1.OR.MONTH2.GT.12) GO TO 808
      IF(IYEAR2.LT.IYEAR1) GO TO 812
      IF(NOPT.NE.1.OR.NREG.NE.0) GO TO 84
      DO 81 I=1,18
      NAVE=19-I
      IF(AVE(NAVE).NE.0.0) GO TO 82
   81 CONTINUE
   82 IF(NAVE.LT.14) GO TO 806
      DO 1 I=1,NAVE
```

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      IF(AVE(I).LE.0.0.OR.AVE(I).GE.1.0) GO TO 814
    1 CONTINUE
   84 IF(NOPT.NE.1) GO TO 223
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 804
      IF(NPARM.LT.1.OR.NPARM.GT.4) GO TO 804
      IF(NREG.LT.0.OR.NREG.GT.9) GO TO 804
  223 YRS=IYEAR2-IYEAR1+(MONTH2-MONTH1)/12.0
      DO 126 I=1,19
      IAGE01(I)=5*(I-2)
  126 IAGE(I)=5*(I-1)
      IAGE01(1)=0
      IAGE01(2)=1
      TP1=0.0
      TP2=0.0
      DO 123 I=1,18
      CEN1(I)=POP1(I)
  123 CEN2(I)=POP2(I)
      DO 6 I=1,N
      TP1=TP1+POP1(I)
      TP2=TP2+POP2(I)
    6 CONTINUE
      TGR=DLOG(TP2/TP1)/YRS
      IF(NOPT.NE.1) GO TO 505
C---- WHEN NOPT=1, MODEL LIFE TABLE IS USED
      CALL MATCH(LABEL,NSEX,NREG,NPARM,NAGE,CMP,CMP2,RNGE,AVE,ARRAY,NP)
      E0=ARRAY(1,8)
      IF(E0.GT.80.05.OR.E0.LT.19.95) GO TO 810
      NMAX=N
      IF(NREG.GE.6) NMAX=17
      IF(NREG.LE.5) NMAX=18
      IF(NREG.EQ.0) NMAX=NAVE
      IF(NMAX.GE.N) GO TO 24
      SP1=0.0
      SP2=0.0
      DO 23 L=NMAX,N
      SP1=SP1+POP1(L)
   23 SP2=SP2+POP2(L)
      CEN1(NMAX)=SP1
      CEN2(NMAX)=SP2
      N=NMAX
      NM1=N-1
   24 AM(1)=(ARRAY(1,4)+ARRAY(2,4))/(ARRAY(1,5)+ARRAY(2,5))
      DO 560 I=2,NM1
      INDX=5*I-4
      AM(I)=ARRAY(INDX,1)
  560 CONTINUE
      SDX=0.0
      SLX=0.0
      DO 561 I=N,NMAX
      INDX=5*I-4
      SDX=ARRAY(INDX,4)
      SLX=ARRAY(INDX,5)
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```
  561 CONTINUE
      AM(N)=SDX/SLX
      DO 588 I=1,N
      DEATHS(I)=AM(I)*YRS*DSQRT(POP1(I)*POP2(I))
  588 CONTINUE
C     IF LIFE TABLE OPEN AGE GROUP AND POPULATION OPEN AGE GROUP
C     DON'T MATCH, IT MIGHT BE NECESSARY TO ADD BACKWARDS
      GO TO 530
  505 IF(NOPT.NE.2) GO TO 802
C---- WHEN NOPT=2, DEATHS ARE USED
      DO 506 I=1,N
      AM(I)=DEATHS(I)/(YRS*DSQRT(POP1(I)*POP2(I)))
  506 CONTINUE
  530 CONTINUE
      NREG1=NREG+1
      WRITE(NPRNT,718) (LABEL(I),I=1,10)
  718 FORMAT('1',11X,'ESTIMATE OF RELATIVE CENSUS COVERAGE FOR ',10A4)
      NREGP1=NREG+1
      IF(NOPT.EQ.1.AND.NREG.NE.0) WRITE(NPRNT,711) REG1(NREGP1),
     & REG2(NREGP1),ASEX(NSEX),ICOL(NPARM),NAGE,CMP
  711 FORMAT(///12X,'MODEL LIFE TABLE:'/15X,'PATTERN',19X,2A8/15X,
     & 'SEX',23X,A8/15X,'MATCHED PARAMETER',10X,A1,'(',I2,') = ',F11.5)
      IF(NOPT.EQ.1.AND.NREG.EQ.0)WRITE(NPRNT,712) REG1(NREGP1),
     & REG2(NREGP1),(LABEL(I),I=11,18),ASEX(NSEX),ICOL(NPARM),NAGE,CMP
  712 FORMAT(///12X,'MODEL LIFE TABLE:'/15X,'PATTERN',19X,
     & 2A8,':  ',8A4/15X,'SEX',23X,A8/15X,'MATCHED PARAMETER',
     & 10X,A1,'(',I2,') = ',F11.5)
      IF(NOPT.EQ.2)WRITE(NPRNT,730) (IAGE(I),IAGE(I+1),I=1,9),(DEATHS
     & (I),I=1,9),(IAGE(I),IDASH,IAGE(I+1),I=10,NM1),IAGE(N),IPLUS
  730 FORMAT(////10X,'MORTALITY PATTERN:'//10X,'AGE GROUP',9(5X,I2,'-',
     & I2)/10X,'DEATHS',3X,9F10.0//10X,'AGE GROUP',9(5X,I2,A1,I2))
      IF(NOPT.EQ.2) WRITE(NPRNT,731) (DEATHS(I),I=10,N)
  731 FORMAT(10X,'DEATHS',3X,9F10.0)
      IF(NOPT.EQ.1.AND.NREG.EQ.0) WRITE(NPRNT,732)
     & (LABEL(I),I=11,18),(IAGE01(I),IDASH,IAGE01(I+1),I=1,NAVE)
  732 FORMAT(//1X,'MORTALITY PATTERN FROM ',8A4//1X,'AGES   ',
     & 18(I4,A1,I2))
      IF(NOPT.EQ.1.AND.NREG.EQ.0) WRITE(NPRNT,734) (AVE(I),I=1,NAVE)
  734 FORMAT(1X,'Q(X,N)',18(1X,F6.5))
      M1=MON(MONTH1)
      WRITE(NPRNT,716)  MON(MONTH1),IYEAR1,MON(MONTH2),IYEAR2
  716 FORMAT(///25X,'CHARACTERISTICS OF POPULATION'/5X,
     & 69('-'),8X,32('-')/93X,
     & 'REGRESSION POINTS'/7X,'AGE',9X,'POPULATION',11X,
     & 'GROWTH',9X,'INTERCENSAL DEATHS',10X,'AGE',4X,
     & 23('-')/6X,'GROUP',3X,20('-'),7X,'RATE',9X,20('-'),10X,'X',
     & 5X,'INDEPENDENT',2X,'DEPENDENT'/
     & 14X,A3,I5,4X,A3,I5,20X,'NUMBER',9X,'RATE',19X,
     & 'VARIABLE',4X,'VARIABLE'/5X,69('-'),8X,32('-')/)
      DO 20 I=1,N
      R(I)=DLOG(CEN2(I)/CEN1(I))/YRS
   20 CONTINUE
```

```
      SUMP1=CEN1(N)
      SUMP2=CEN2(N)
      SUMD=DEATHS(N)/YRS
      SUMP=(CEN1(N)*CEN2(N))**0.5
      DO 40 I=2,NM1
      IDX=N-I+1
      SUMD=SUMD+DEATHS(IDX)/YRS
      SUMP=SUMP+(CEN1(IDX)*CEN2(IDX))**0.5
      XVAL(IDX)=SUMD/SUMP
      BDAY=(CEN1(IDX-1)*CEN2(IDX-1)*CEN1(IDX)*CEN2(IDX))**0.25/5.0
      SUMP1=SUMP1+CEN1(IDX)
      SUMP2=SUMP2+CEN2(IDX)
      YVAL(IDX)=BDAY/SUMP-DLOG(SUMP2/SUMP1)/YRS
   40 CONTINUE
      NM2=NM1-1
      DO 30 I=1,NM2
      J=I+1
      WRITE(NPRNT,3) IAGE(I),IAGE(J),CEN1(I),CEN2(I),R(I),
     & DEATHS(I),AM(I),IAGE(J),XVAL(J),YVAL(J)
    3 FORMAT(5X,I2,'-',I2,2F12.0,F12.5,3X,F12.0,6X,F6.5,10X,I2,2X,
     & 2F12.5)
   30 CONTINUE
      WRITE(NPRNT,4) IAGE(NM1),IAGE(N),CEN1(NM1),CEN2(NM1),R(NM1),
     & DEATHS(NM1),AM(NM1)
    4 FORMAT(5X,I2,'-',I2,2F12.0,F12.5,3X,F12.0,6X,F6.5)
      WRITE(NPRNT,5) IAGE(N),CEN1(N),CEN2(N),R(N),DEATHS(N),AM(N)
    5 FORMAT(5X,I2,'+',2X,2F12.0,F12.5,3X,F12.0,6X,F6.5)
      WRITE(NPRNT,37) TP1,TP2,TGR
   37 FORMAT(/5X,'TOTAL',2F12.0,F12.5)
C     REGRESSION STARTS HERE
      NAGS=15
      IF(NM1.LT.NAGS) NAGS=NM1
      NAGS=NAGS-12
      DO 900 IAG2=1,NAGS
      DO 900 IAG1=2,4
      IFIN=IAG2+12
      NPTS=IFIN-IAG1+1
      DO 50 I=IAG1,IFIN
      XTMP(I-IAG1+1)=XVAL(I)
   50 YTMP(I-IAG1+1)=YVAL(I)
      SUMX=0.0
      SUMY=0.0
      SUMXX=0.0
      SUMYY=0.0
      CROSP=0.0
      FN=NPTS
      DO 220 J=1,NPTS
      SUMX=SUMX+XTMP(J)
      SUMY=SUMY+YTMP(J)
      SUMXX=SUMXX+XTMP(J)*XTMP(J)
      SUMYY=SUMYY+YTMP(J)*YTMP(J)
      CROSP=CROSP+XTMP(J)*YTMP(J)
```

```
  220 CONTINUE
      SX=(FN*SUMXX-SUMX*SUMX)
      SY=(FN*SUMYY-SUMY*SUMY)
      AVAL=(FN*CROSP-SUMX*SUMY)/SX
      BVAL=(SUMY*SUMXX-SUMX*CROSP)/SX
C     RVAL=(FN*CROSP-SUMX*SUMY)/DSQRT(SX*SY)
      SUMSQ=0.0
      DO 330 J=1,NPTS
  330 SUMSQ=SUMSQ+(AVAL*XTMP(J)+BVAL-YTMP(J))**2
      TMP=NPTS-2
C     MEAN SQUARE ERROR
      EMS(IAG1-1,IAG2)=100000.0*SUMSQ/TMP
      ICTR=0
      DIFF=0
      DO 897 I=2,NM1
      DIFFP=DIFF
      DIFF=YVAL(I)-AVAL*XVAL(I)-BVAL
      IF(I.EQ.2) GO TO 897
      TMP=DIFF*DIFFP
      IF(TMP.LT.0.0) ICTR=ICTR+1
  897 CONTINUE
      NSC(IAG1-1,IAG2)=ICTR
      ASLOPE(IAG1-1,IAG2)=AVAL
      BINTER(IAG1-1,IAG2)=BVAL
  900 CONTINUE
      WRITE(NPRNT,701)
  701 FORMAT(///31X,'REGRESSION RESULTS',34X,'DEMOGRAPHIC ESTIMATES',
     & /2X,9('-'),7X,46('-'),6X,49('-')/44X,'MEAN SQUARE',2X,'NUMBER',
     & 8X,'COMPLETENESS OF',5X,'ADJUSTED',5X,'COMPLETENESS OF'/
     & 2X,'AGE RANGE',9X,'SLOPE',6X,'INTERCEPT',7X,'ERROR',5X,
     & 'OF SIGN',8X,'SECOND CENSUS',7X,'GROWTH',6X,'DEATHS RELATIVE'/
     & 44X,'(X 100,000)',2X,'CHANGES',6X,'RELATIVE TO FIRST',6X,'RATE',
     & 7X,'TO FIRST CENSUS'/2X,9('-'),7X,46('-'),6X,49('-'))
      DO 710 I2=1,NAGS
      DO 710 I1=1,3
      I3=I1+1
      I4=I2+12
      TMP=YRS*BINTER(I1,I2)
      CENCMP(I1,I2)=1.0/DEXP(TMP)
      DTHCMP(I1,I2)=DSQRT(CENCMP(I1,I2))/ASLOPE(I1,I2)
      TMP=TP2/(TP1*CENCMP(I1,I2))
      AGR(I1,I2)=DLOG(TMP)/YRS
      WRITE(NPRNT,702) IAGE(I3),IAGE(I4),ASLOPE(I1,I2),BINTER(I1,I2),
     & EMS(I1,I2),NSC(I1,I2),CENCMP(I1,I2),AGR(I1,I2),DTHCMP(I1,I2)
  702 FORMAT(4X,I2,'-',I2,2X,2F14.4,F14.5,I8,7X,F12.4,5X,F12.5,4X,F12.4)
  710 CONTINUE
C     PRINT GRAPH FOLLOWS
      DO 781 J=1,55
      DO 781 I=1,55
  781 IGRAPH(I,J)=0
      WRITE(NPRNT,9) LABEL
    9 FORMAT('1 ',18A4//)
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```
      M=0
      XMIN=0.0
      XMAX=XVAL(2)
      DO 12 I=2,NM1
      IF(XVAL(I).GT.XMAX) XMAX=XVAL(I)
   12 CONTINUE
      YMIN=0.0
      YMAX=YVAL(2)
      DO 15 I=2,NM1
      IF(YVAL(I).GT.YMAX) YMAX=YVAL(I)
   15 CONTINUE
      DO 300 I=2,NM1
      NAGR=5*(I-1)
      PX=(XVAL(I)-XMIN)/(XMAX-XMIN)
      PY=(YVAL(I)-YMIN)/(YMAX-YMIN)
      IX=54.0*PX+0.5
      IX=IX+1
      IY=54.0*PY+0.5
      IY=55-IY
      IF(IY.LT.1.OR.IY.GT.55) GO TO 921
      IF(IX.LT.1.OR.IX.GT.55) GO TO 921
      ITMP=IGRAPH(IY,IX)
      IF(ITMP.EQ.0) GO TO 34
      M=M+1
      IF(M.GE.6) GO TO 300
      IPT(M,1)=NAGR
      IPT(M,2)=ITMP
      GO TO 300
  921 WRITE(NPRNT,922) NAGR
  922 FORMAT(30X,'--- WARNING --- POINT ',I2,' FALLS OUTSIDE THE ',
     &'GRAPH.')
      GO TO 300
   34 IGRAPH(IY,IX)=NAGR
  300 CONTINUE
      YCTR=YMAX
      DO 400 I=1,55
      DO 500 J=1,55
      JP2=J*2
      JP1=JP2-1
      ITMP=IGRAPH(I,J)
   51 N2=MOD(ITMP,10)
      IF(N2.EQ.0) N2=10
      N1=ITMP/10
      IF(N1.EQ.0) N1=10
      NA1=NUM(N1)
      NA2=NUM(N2)
      IF(N1.EQ.10) NA1=IBL
      IF(N2.EQ.10.AND.N1.EQ.10) NA2=IBL
      NBUF(JP1)=NA1
      NBUF(JP2)=NA2
  500 CONTINUE
      ITMP=MOD(I,6)
```

```
      IF(ITMP.EQ.1) GO TO 60
      IF(I.LE.45) GO TO 57
      IF(M.EQ.0) GO TO 57
      IF(I.EQ.46) WRITE(NPRNT,550) LDV(I),(NBUF(K),K=1,80)
  550 FORMAT(4X,A1,10X,'*',80A1,2X,'THE FOLLOWING AGES COINCIDE')
      IF(I.EQ.47) WRITE(NPRNT,551) LDV(I),(NBUF(K),K=1,80)
  551 FORMAT(4X,A1,10X,'*',80A1,5X,'(MAXIMUM OF 5 LISTED)')
      IF(I.EQ.48) WRITE(NPRNT,552) LDV(I),(NBUF(K),K=1,80)
  552 FORMAT(4X,A1,10X,'*',80A1,1X,29('-'))
      IF(I.LE.48) GO TO 400
      ICN=I-49
      IF(ICN.GT.M) GO TO 57
      WRITE(NPRNT,553) LDV(I),(NBUF(K),K=1,80),IPT(ICN,1),IPT(ICN,2)
  553 FORMAT(4X,A1,10X,'*',80A1,1X,'AGE ',I2,' FALLS ON TOP OF AGE ',I2)
      GO TO 400
   57 WRITE(NPRNT,52) LDV(I),(NBUF(K),K=1,110)
   52 FORMAT(4X,A1,10X,'*',110A1)
      GO TO 400
   60 WRITE(NPRNT,661) LDV(I),YCTR,(NBUF(K),K=1,110)
  661 FORMAT(4X,A1,F9.2,' .',110A1)
      YCTR=YCTR-(YMAX-YMIN)/9.0
  400 CONTINUE
      DO 70 I=1,110
   70 NBUF(I)=ISTAR
      DO 774 J=2,110,12
  774 NBUF(J)=IDOT
      WRITE(NPRNT,775)(NBUF(K),K=1,110)
  775 FORMAT(15X,'*',110A1)
      XCTR=XMIN
      DO 773 I=1,10
      XPRT(I)=XCTR
  773 XCTR=XCTR+(XMAX-XMIN)/9.0
      WRITE(NPRNT,74)(XPRT(K),K=1,10)
   74 FORMAT(8X,10(2X,F10.2)//62X,'INDEPENDENT VARIABLE')
      GO TO 99
  800 NFIN=5*N-5
      WRITE(NPRNT,801) (LABEL(I),I=1,10),NFIN
  801 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',10A4/5X,
     &'FINAL OPEN AGE GROUP MUST BE BETWEEN 65+ AND 85+, BUT'/5X,
     & 'A FINAL OPEN AGE GROUP OF ',I3,'+ IS GIVEN.')
      GO TO 99
  802 WRITE(NPRNT,803) (LABEL(I),I=1,10),NOPT
  803 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',10A4/5X,
     & 'TO INDICATE WHETHER "DEATHS" ARE ESTIMATED BY A MODEL LIFE ',
     & 'TABLE OR'/5X,'GIVEN AS INTERCENSAL DEATHS, TYPE IN 1 OR 2 ',
     & 'ONLY. A',I3,' IS ENTERED.')
      GO TO 99
  804 WRITE(NPRNT,805) (LABEL(I),I=1,10),NSEX,NREG,NPARM
  805 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',10A4/5X,
     & 'INPUT ERROR IN AT LEAST ONE OF THE FOLLOWING PARAMETERS:'//
     & 5X,'SEX MUST BE 1 OR 2. SEX =',I4/5X,'MODEL LIFE TABLE PATTERN ',
     & 'MUST BE BETWEEN 0 AND 9. THE CODE ENTERED IS',I4/5X,
```

```
   & 'MODEL LIFE TABLE COLUMN IS INDICATED BY A VALUE BETWEEN 1 ',
   & 'AND 4. THE CODE ENTERED IS',I4)
     GO TO 99
806 WRITE(NPRNT,807) (LABEL(I),I=1,10),NAVE
807 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',10A4/5X,
   &'AT LEAST 14 CONSECUTIVE INPUT Q(X,N) VALUES FOR THE USER '/5X,
   & 'DEFINED MODEL ARE REQUIRED, (I.E., THROUGH AGE GROUP 60-65), ',
   & 'BUT ONLY ',I3,' WERE GIVEN.')
     GO TO 99
808 WRITE(NPRNT,809) (LABEL(I),I=1,18),MONTH1,MONTH2
809 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',18A4/5X,
   & 'THE MONTH MUST BE AN INTEGER VALUE FROM 1 TO 12, BUT THE'/5X,
   & 'MONTH FOR THE FIRST ENUMERATION IS ',I3,' AND THE SECOND ',
   & 'ENUMERATION IS ',I3)
     GO TO 99
810 WRITE(NPRNT,811) (LABEL(I),I=1,18)
811 FORMAT(////5X,'*** ERROR IN CENCT FOR DATA SET ',18A4/5X,
   & 'CALCULATION OF MODEL LIFE TABLE WAS NOT SUCCESSFUL AND NO TABLE',
   & ' WAS PRINTED.'/5X,'PLEASE CHECK INPUT DATA FOR POSSIBLE ERROR.')
     GO TO 99
812 WRITE(NPRNT,813) (LABEL(I),I=1,18),IYEAR1,IYEAR2
813 FORMAT(////5X,'*** ERROR IN CENCT FOR DATA SET ',18A4/5X,
   & 'THE YEAR OF THE SECOND ENUMERATION CANNOT BE LESS THAN THE ',
   & 'YEAR OF THE FIRST ENUMERATION.'/5X,'FIRST ENUMERATION',
   & '  - ',I4/5X,'SECOND ENUMERATION - ',I4)
     GO TO 99
814 WRITE(NPRNT,815) (LABEL(I),I=1,18),(AVE(I),I=1,N)
815 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',18A4/5X,'INPUT',
   & ' USER DEFINED MODEL Q(X,N) VALUES MUST BE BETWEEN 0 AND 1. ',
   & 'MODEL Q(X,N) VALUES ENTERED ARE:'/2(/1X,10F8.5))
     GO TO 99
822 WRITE(NPRNT,823) (LABEL(I),I=1,10)
823 FORMAT('1'/5X,'*** ERROR IN CENCT FOR DATA SET ',10A4/5X,
   & 'QUALITY OF INPUT DATA INSUFFICIENT TO PRODUCE ',
   & 'MEANINGFUL TABLE.')
 99 RETURN
    END
```

COMBIN

```
      SUBROUTINE COMBIN(LABEL,NSEX,NREG,E20,SL1,SL5,ARRAY,NPLT)
C*********************************************************************
C***                          MORTPAK                               ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),ARRAY(101,9),AVE(18),QXMX(101),QMOD(101),Q(18)
      DIMENSION ASEX(2),AREG1(10),AREG2(10),AVX(18),CF(3,18),ALBL(2)
      DIMENSION PRN(18),R(18),EMP(18),BLBL(2)
      DATA ASEX/'  MALE  ',' FEMALE '/
      DATA ALBL/'UNITED N','COALE & '/
      DATA BLBL/'ATIONS  ','DEMENY  '/
      DATA AREG1/' EMPIRIC',' LATIN A',' CHILEAN',' SOUTH A',' FAR EAS',
     &' GENERAL',' WEST    ',' NORTH   ',' EAST    ',' SOUTH   '/
      DATA AREG2/'AL      ','MERICAN ','        ','SIAN    ','TERN    ',
     &'        ','        ','        ','        ','        '/
      DATA CMP2,RNGE,NTYPE,NPG,IONE,ITW/0.0,0.0,1,1,1,2/
      DATA Q/18*0.0/
      NPRNT=6
      IF(SL1.LT.0.0.OR.SL1.GT.99999.0) GO TO 800
      IF(SL5.LT.0.0) GO TO 800
      DIFF=SL1-SL5
      IF(DIFF.LT.1.0.AND.SL1.NE.0.0) GO TO 800
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 803
      IF(NREG.LT.1.OR.NREG.GT.9) GO TO 803
      NREG1=NREG+1
      NREGC=NREG
      IF(NREG.GE.6) NREGC=0
      NPARM=4
      NAGE=20
      CALL MATCH(LABEL,NSEX,NREG,NPARM,NAGE,E20,CMP2,RNGE,AVE,ARRAY,ITW)
      E0=ARRAY(1,8)
      IF(E0.GT.80.05.OR.E0.LT.19.95) GO TO 810
      IF(NREG.LE.5) NFIN=85
      IF(NREG.LE.5) GO TO 7
      NFIN=80
      AVX(1)=ARRAY(1,2)
      AVX(2)=ARRAY(2,2)
      DO 6 I=3,17
      INDX=5*I-9
    6 AVX(I)=ARRAY(INDX,2)
      AVX(18)=0.0
    7 QMOD(1)=ARRAY(1,2)
      QMOD(2)=ARRAY(2,2)
      DO 10 I=6,NFIN,5
      QMOD(I)=ARRAY(I,2)
      QXMX(I)=QMOD(I)
   10 CONTINUE
      Q(6)=QMOD(21)
```

```
      IF(SL1.EQ.0.0) GO TO 20
      IF(SL5.EQ.0.0) GO TO 30
      Q0=1.0-SL1/100000.0
      Q1=1.0-SL5/(100000.0*(1.0-Q0))
      GO TO 40
   20 IF(SL5.EQ.0.0) GO TO 808
      NPARM=3
      NAGE=5
      CALL MATCH(LABEL,NSEX,NREG,NPARM,NAGE,SL5,CMP2,RNGE,AVE,ARRAY,ITW)
      E0=ARRAY(1,8)
      IF(E0.GT.80.05.OR.E0.LT.19.95) GO TO 810
      Q0=ARRAY(1,2)
      Q1=ARRAY(2,2)
      GO TO 40
   30 Q0=1.0-SL1/100000.0
      Q(1)=Q0
      Q(2)=0.0
      CALL BESTFT(LABEL,NSEX,NREGC,Q,AVX,CF,ITW)
      QXMX(1)=Q0
      QXMX(2)=CF(2,2)
      QXMX(6)=CF(2,3)
      QXMX(11)=CF(2,4)
      QXMX(16)=CF(2,5)
      GO TO 50
   40 Q(1)=Q0
      Q(2)=0.0
      CALL BESTFT(LABEL,NSEX,NREGC,Q,AVX,CF,ITW)
      SVQ05=CF(2,3)
      SVQ10=CF(2,4)
      SVQ15=CF(2,5)
      Q(1)=0.0
      Q(2)=Q1
      CALL BESTFT(LABEL,NSEX,NREGC,Q,AVX,CF,ITW)
      QXMX(1)=Q0
      QXMX(2)=Q1
      QXMX(6)=(SVQ05+CF(2,3))/2.0
      QXMX(11)=(SVQ10+CF(2,4))/2.0
      QXMX(16)=(SVQ15+CF(2,5))/2.0
   50 IF(NPLT.EQ.0) WRITE(NPRNT,51) (LABEL(I),I=1,18)
   51 FORMAT('1'/4X,18A4)
      IF(NPLT.GE.2) GO TO 99
      LS=1
      IF(NREG.GE.6) LS=2
      WRITE(NPRNT,52) ALBL(LS),BLBL(LS),AREG1(NREG1),AREG2(NREG1),
     & ASEX(NSEX)
   52 FORMAT(//33X,A8,A7,'MODEL LIFE TABLE FOR THE',2A8/
     & 33X,'PATTERN OF THE',A8,'SEX TRANSFORMED TO BE CONSISTENT')
      IF(SL1.NE.0.0.AND.SL5.NE.0.0) WRITE(NPRNT,53) E20,SL1,SL5
   53 FORMAT(33X,'WITH E(20)=',F7.3,', I(1)=',F7.0,' AND I(5)=',F7.0/
     & ///)
      IF(SL1.EQ.0.0) WRITE(NPRNT,54) E20,SL5
   54 FORMAT(33X,'WITH E(20)=',F7.3,' AND I(5)=',F7.0////)
```

```
      IF(SL5.EQ.0.0) WRITE(NPRNT,55) E20,SL1
   55 FORMAT(33X,'WITH E(20)=',F7.3,' AND I(1)=',F7.0////)
      CALL LIFTB(NPG,LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,IONE)
      GO TO 99
  800 WRITE(NPRNT,801) (LABEL(J),J=1,10),SL1,SL5
  801 FORMAT('1'/5X,'*** ERROR IN COMBIN FOR DATA SET ',10A4/5X,'INPUT',
     & ' SL1 OR SL5 OUTSIDE THE RANGE OF 0 AND 99999.0'/5X,
     & 'NOTE: SL5 MUST ALSO BE LESS THAN SL1 BY AT LEAST 1.0'//5X,
     & 'PLEASE CHECK INPUT VALUES:'/5X,'SL1=',F8.0/5X,'SL5=',F8.0)
      GO TO 99
  803 WRITE(NPRNT,804) (LABEL(J),J=1,10),NSEX,NREG
  804 FORMAT('1'/5X,'*** ERROR IN COMBIN FOR DATA SET ',10A4/5X,'ERROR',
     & ' DETECTED IN AT LEAST ONE OF THE FOLLOWING INPUT VARIABLES:'//
     & 5X,'NSEX SHOULD BE 1 OR 2.          ',3X,'NSEX =',I3/
     & 5X,'NREG SHOULD BE BETWEEN 1 AND 9.',3X,'NREG =',I3)
      GO TO 99
  808 WRITE(NPRNT,809) (LABEL(J),J=1,10)
  809 FORMAT('1'/5X,'*** ERROR IN COMBIN FOR DATA SET ',10A4/5X,
     & 'NO DATA WAS SUPPLIED FOR EITHER SL1 OR SL5.')
      GO TO 99
  810 WRITE(NPRNT,811) (LABEL(I),I=1,18)
  811 FORMAT(////5X,'*** ERROR IN COMBIN FOR DATA SET ',18A4/5X,
     & 'CALCULATION OF MODEL LIFE TABLE WAS NOT SUCCESSFUL AND NO TABLE',
     & ' WAS PRINTED.'/5X,'PLEASE CHECK INPUT DATA FOR POSSIBLE ERROR.')
   99 RETURN
      END
```

COMPAR

```
      SUBROUTINE COMPAR(LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,GOF)
C***********************************************************************
C***                           MORTPAK                               ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),QXMX(101),ARRAY(101,9),GOF(3,9),AVE(18),
     & IAGE(101),MSG(9),EXAB(18,9),NQM(2),SRT(18),Q(101)
      DIMENSION DIFMED(9)
      DATA NPLT,NPG/2,0/,NQM/'Q','M'/
      DATA MSGBL,MSGLT,MSGGT/'  ','LT','GT'/
      DATA CMP2,RNGE,ITHREE/0.0,0.0,3/
      NPRNT=6
C     EVEN IF NFIN > 80, THE OUTPUT TABLE IS LIMITED TO AGE GROUP 75-80,
C     BECAUSE THE COALE-DEMENY MODELS HAVE AN NFIN OF 80.
      IF(NFIN.LT.65.OR.NFIN.GT.100) GO TO 800
      IF(NTYPE.LT.1.OR.NTYPE.GT.2) GO TO 800
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 800
      DO 1 I=1,2
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
    1 CONTINUE
      DO 2 I=6,NFIN,5
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
    2 CONTINUE
      IAGE(1)=0
      IAGE(2)=1
      NM1=2
      DO 3 I=6,NFIN,5
      NM1=NM1+1
    3 IAGE(NM1)=I-1
      NMAX=NM1+1
      IAGE(NMAX)=NFIN
      WRITE(NPRNT,70) (LABEL(I),I=1,18)
   70 FORMAT('1','COMPARISON OF MODEL AGE PATTERNS OF MORTALITY ',
     & 'WITH THOSE OF ',18A4)
      WRITE(NPRNT,73) NQM(NTYPE)
   73 FORMAT(////57X,'IMPLIED LIFE EXPECTANCY AT BIRTH'/3X,7('-'),
     & 3X,10('-'),3X,53('-'),3X,41('-')/5X,'AGE',6X,'EMPIRICAL',18X,
     & 'UNITED NATIONS MODELS',30X,'COALE-DEMENY MODELS'/4X,'GROUP',
     & 6X,A1,'(X,N)',
     & 6X,'LATIN AM.  CHILEAN   SO. ASIAN   FAR EAST   GENERAL',6X,
     & 'WEST',6X,'NORTH',7X,'EAST',6X,'SOUTH'/3X,7('-'),3X,10('-'),3X,
     & 53('-'),3X,41('-')/)
      IF(NTYPE.EQ.1) GO TO 4
      CALL LIFTB(NPG,LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,NPLT)
    4 DO 44 I=1,101
      IF(NTYPE.EQ.1) Q(I)=QXMX(I)
      IF(NTYPE.EQ.2) Q(I)=ARRAY(I,2)
   44 CONTINUE
```

```
      NAGR=NM1
      IF(NAGR.GT.17) NAGR=17
      DO 100 IA=1,NAGR
      NAGE=IAGE(IA)
      CMP=Q(NAGE+1)
      DO 5 NREG=1,9
    5 MSG(NREG)=MSGBL
      DO 110 NREG=1,9
      CALL MATCH(LABEL,NSEX,NREG,2,NAGE,CMP,CMP2,RNGE,AVE,ARRAY,ITHREE)
      EO=ARRAY(1,8)
      IF(EO.LT.20.0) MSG(NREG)=MSGLT
      IF(EO.LT.20.0) EO=19.99
      IF(EO.GT.80.0) MSG(NREG)=MSGGT
      IF(EO.GT.80.0) EO=80.01
      EXAB(IA,NREG)=EO
  110 CONTINUE
      WRITE(NPRNT,75) IAGE(IA),IAGE(IA+1),QXMX(NAGE+1),
     & (MSG(NREG),EXAB(IA,NREG),NREG=1,9)
   75 FORMAT(3X,I2,'-',I2,7X,F6.5,1X,5(5X,A2,F4.1),4(5X,A2,F4.1))
  100 CONTINUE
      DO 7130 NREG=1,9
 7130 DIFMED(NREG)=0.0
      DO 130 ISM=1,3
      IFV=1
      IF(ISM.EQ.2) IFV=4
      ILV=NAGR
      IF(ISM.EQ.1) ILV=3
      NVAL=ILV-IFV+1
      NVALM1=NVAL-1
      DO 120 NREG=1,9
      DO 121 IA=1,NVAL
      INDX=IA+IFV-1
  121 SRT(IA)=EXAB(INDX,NREG)
      DO 122 ILP=1,NVALM1
      NSTP=NVAL-ILP
      DO 122 I=1,NSTP
      IF(SRT(I).LE.SRT(I+1)) GO TO 122
      TMP=SRT(I)
      SRT(I)=SRT(I+1)
      SRT(I+1)=TMP
  122 CONTINUE
      ICHK=MOD(NVAL,2)
      IPTR=(NVAL+1)/2
      IF(ICHK.EQ.0) AMEDN=(SRT(IPTR)+SRT(IPTR+1))/2.0
      IF(ICHK.EQ.1) AMEDN=SRT(IPTR)
      IF(ISM.EQ.1) DIFMED(NREG)=DIFMED(NREG)+AMEDN
      IF(ISM.EQ.2) DIFMED(NREG)=DIFMED(NREG)-AMEDN
      SUM=0.0
      DO 123 IA=1,NVAL
  123 SUM=SUM+DABS(AMEDN-SRT(IA))
      GOF(ISM,NREG)=SUM/NVAL
  120 CONTINUE
```

```
130 CONTINUE
    WRITE(NPRNT,125) ((GOF(ISM,NREG),NREG=1,9),ISM=1,3)
125 FORMAT(/2X,'AVERAGE ABSOLUTE DEVIATION FROM MEDIAN'/
   & 5X,'AGES 0 TO 10     :',5(6X,F5.1),4(6X,F5.1)/
   & 5X,'AGES 10 AND OVER:',5(6X,F5.1),4(6X,F5.1)/
   & 5X,'AGES  0 AND OVER:',5(6X,F5.1),4(6X,F5.1))
    WRITE(NPRNT,788) (DIFMED(NREG),NREG=1,9)
788 FORMAT(/2X,'MEDN(0-10)-MEDN(10+)',5(6X,F5.1),4(6X,F5.1))
    GO TO 99
800 WRITE(NPRNT,801) LABEL,NFIN,NTYPE,NSEX
801 FORMAT('1'/5X,'*** ERROR IN COMPAR FOR DATA SET ',18A4/5X,'ERROR',
   & ' DETECTED IN AT LEAST ONE OF THE FOLLOWING INPUT VARIABLES:'//
   & 5X,'NFIN SHOULD BE BETWEEN 65 AND 100.',3X,'NFIN  = ',I4/
   & 5X,'NTYPE SHOULD BE 1 OR 2.          ',3X,'NTYPE = ',I4/
   & 5X,'NSEX SHOULD BE 1 OR 2.           ',3X,'NSEX  = ',I4)
    GO TO 99
802 WRITE(NPRNT,803) LABEL,(QXMX(I),I=1,2),(QXMX(I),I=6,NFIN,5)
803 FORMAT('1'/5X,'*** ERROR IN COMPAR FOR DATA SET ',18A4/5X,'INPUT',
   & ' Q(X) OR M(X) VALUE(S) IS OUTSIDE THE RANGE OF ZERO AND ONE.'/
   & 5X,'PLEASE CHECK INPUT QXMX VALUES:'/3(/1X,9F8.5))
 99 RETURN
    END
```

FERTIL

```
      SUBROUTINE FERTIL(LABEL,NYRS,NPAT,MONTH1,IYEAR1,NTAB1,MONTH2,
     & IYEAR2,NTAB2,CEB1,ASFP1,CEB2,ASFP2,ASFR)
C***********************************************************************
C***                          MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
C-----------------------------------------------------------------------
C     IF NTAB = 1 THEN DATA TABULATED BY MOTHERS AGE AT BIRTH OF CHILD
C     IF NTAB = 2 THEN DATA TABULATED BY MOTHERS AGE AT SURVEY DATE
C-----------------------------------------------------------------------
      DIMENSION LABEL(18),CEB1(7),ASFP1(7),CEB2(7),ASFP2(7),ASFR(7,2)
      DIMENSION CB5(7,2),CB1(36,4),NTAB(2),MSG(2),WEIT(7),
     & ASFP(7,2),ASFPB(7,2),ASFR1(36,2),MONTH(2),IYEAR(2),
     & CFR(7,2),TFR(5,2),AGE(2,2),FACTR(7,2),AVFTR(2),MREC(2,2),
     & FR(7,3,2),CFP(7,2),CO(10),MON(12),MTAB(3,2),KREDIT(4,4)
      DATA WEIT/.22151,.19095,.16010,.14183,.11155,.09177,.08229/
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     & 'OCT','NOV','DEC'/
      DATA MTAB/' REC','ORDE','D   ','CALC','ULAT','ED  '/
      DATA MREC/'    ','    ','RECO','RDED'/
      DATA MSG/'ONE','TWO'/
      DATA KREDIT/'(MOR','TARA',')   ','    ','(ARR','IAGA','-ARR',
     & 'ETX)','(BRA','SS) ','    ','    ','(ARR','IAGA','-BRA','SS) '/
      NPRNT=6
      IF(NYRS.LT.1.OR.NYRS.GT.2) GO TO 800
      IF(NPAT.LT.0.OR.NPAT.GT.1) GO TO 800
      IF(MONTH1.LT.1.OR.MONTH1.GT.12) GO TO 800
      DO 771 I=1,7
      IF(CEB1(I).LE.0.0) GO TO 804
  771 CONTINUE
      IF(NPAT.EQ.0) GO TO 773
      IF(NTAB1.LT.1.OR.NTAB1.GT.2) GO TO 808
      DO 772 I=1,7
      IF(ASFP1(I).LE.0.0.OR.ASFP1(I).GE.1.0) GO TO 814
  772 CONTINUE
  773 IF(NYRS.EQ.1) GO TO 780
      IF(IYEAR2.LE.IYEAR1) GO TO 800
      IF(MONTH2.LT.1.OR.MONTH2.GT.12) GO TO 800
      DO 774 I=1,7
      IF(CEB2(I).LE.0.0) GO TO 804
  774 CONTINUE
      IF(NPAT.EQ.0) GO TO 780
      IF(NTAB2.LT.1.OR.NTAB2.GT.2) GO TO 810
      DO 775 I=1,7
      IF(ASFP2(I).LE.0.0.OR.ASFP2(I).GE.1.0) GO TO 814
  775 CONTINUE
  780 MONTH(1)=MONTH1
      MONTH(2)=MONTH2
```

```
      IYEAR(1)=IYEAR1
      IYEAR(2)=IYEAR2
      NTAB(1)=NTAB1
      NTAB(2)=NTAB2
      DO 7 I=1,7
      CB5(I,1)=CEB1(I)
      CB5(I,2)=CEB2(I)
      ASFP(I,1)=ASFP1(I)
      ASFP(I,2)=ASFP2(I)
    7 CONTINUE
      DO 15 K=1,NYRS
      C1=CB5(1,K)
      C2=CB5(2,K)
      C3=CB5(3,K)
      C4=CB5(4,K)
      C5=CB5(5,K)
      C6=CB5(6,K)
      C7=CB5(7,K)
      CO(1)=1.2472688288D0*C1-0.4647620726D0*C2+0.2727665790D0*C3
     & -0.1646628054D0*C4+0.0785565273D0*C5-0.0266677231D0*C6
     & +0.0051381904D0*C7
      CO(2)=-27.8361521571D0*C1+10.7773416188D0*C2-6.4372299129D0*C3
     & +3.9154231953D0*C4-1.8758692369D0*C5+.6385232342D0*C6
     & -0.1232339379D0*C7
      CO(3)=201.3456739922D0*C1-84.187553834D0*C2+52.0969507556D0*C3
     & -32.1762176417D0*C4+15.5487279453D0*C5-5.3217323014D0*C6
     & +1.0306075405D0*C7
      CO(4)=-545.5843605024D0*C1+266.176719251D0*C2-176.9530538465D0*C3
     & +112.7546329844D0*C4-55.4545341674D0*C5+19.1945576324D0*C6
     & -3.7433821805D0*C7
      CO(5)=738.8635966655D0*C1-404.8277600480D0*C2+294.6192295602D0*C3
     & -196.3905565099D0*C4+99.1931329034D0*C5-34.9362275367D0*C6
     & +6.8885853512D0*C7
      CO(6)=-566.2687279004D0*C1+336.7155450624D0*C2-265.4335830746D0*C3
     & +186.4795944975D0*C4-97.4690375677D0*C5+35.1449563363D0*C6
     & -7.0359349469D0*C7
      CO(7)=257.1264180100D0*C1-162.1042199955D0*C2+136.3077201825D0*C3
     & -100.7518461996D0*C4+54.7452637952D0*C5-20.3199954373D0*C6
     & +4.1485820123D0*C7
      CO(8)=-68.5408888977D0*C1+45.1039613351D0*C2-39.9138955745D0*C3
     & +30.8640973745D0*C4-17.4418956191D0*C5+6.6910226396D0*C6
     & -1.3991808412D0*C7
      CO(9)=9.9067208388D0*C1-6.7323228160D0*C2+6.2034253060D0*C3
     & -4.9859401603D0*C4+2.9237922920D0*C5-1.1611202073D0*C6
     & +0.2496295790D0*C7
      CO(10)=-0.5989156702D0*C1+0.417163089D0*C2-0.3969786867D0*C3
     & +0.3296456446D0*C4-0.1998847206D0*C5+0.0821368375D0*C6
     & -0.0181924237D0*C7
      INDX=3*K-2
      DO 54 J=1,36
      POINT=CO(1)
      XVAL=J/10.0
```

```
      DO 12 I=2,10
      POINT=POINT+CO(I)*XVAL**(I-1)
   12 CONTINUE
      CB1(J,INDX)=POINT
   54 CONTINUE
   15 CONTINUE
      IF(NYRS.NE.2) GO TO 27
      YD=(IYEAR(2)-IYEAR(1))+(MONTH(2)-MONTH(1))/12.0
      DO 20 I=1,36
      CB1(I,2)=(1.0-1.0/YD)*CB1(I,1)+(1.0/YD)*(CB1(I,4))
      CB1(I,3)=(1.0/YD)*CB1(I,1)+(1.0-1.0/YD)*CB1(I,4)
   20 CONTINUE
      DO 21 I=1,35
      ASFR1(I,1)=CB1(I+1,2)-CB1(I,1)
      ASFR1(I,2)=CB1(I+1,4)-CB1(I,3)
   21 CONTINUE
      GO TO 29
   27 DO 28 I=1,35
      ASFR1(I,1)=CB1(I+1,1)-CB1(I,1)
   28 CONTINUE
C     ADJUST THE FERTILITY RATES FROM AGE 40 TO 50
   29 XEX=1.0/11.0
      DO 333 J=1,NYRS
      TMP=DABS(ASFR1(25,J))
      BET=1.0-(1.0-TMP)**XEX
      DO 332 I=26,36
      XXE=I-25.0
      ASFR1(I,J)=TMP+((1.0-BET)**XXE)-1.0
  332 CONTINUE
  333 CONTINUE
      DO 62 J=1,NYRS
      DO 67 I=1,7
   67 ASFR(I,J)=0.0
      DO 60 I7=1,7
      DO 60 I5=1,5
      IK=5*(I7-1)+I5
      ASFR(I7,J)=ASFR(I7,J)+ASFR1(IK,J)/5.0
   60 CONTINUE
   62 CONTINUE
      DO 22 I=1,NYRS
      CFR(1,I)=ASFR(1,I)
      DUM=ASFR(1,I)*WEIT(1)
      XA=17.5*ASFR(1,I)*WEIT(1)
      DO 24 J=2,7
      DUM=DUM+ASFR(J,I)*WEIT(J)
      CFR(J,I)=CFR(J-1,I)+ASFR(J,I)
   24 XA=XA+ASFR(J,I)*(12.5+5DO*J)*WEIT(J)
      TFR(1,I)=CFR(7,I)*5.0
   22 AGE(1,I)=XA/DUM
      IF(NPAT.LE.0) GO TO 566
C-----ASFP IS BY AGE AT BIRTH OR AGE AT SURVEY DATE (DEPENDING ON NTAB)
C-----ASFPB IS THE AGE SPECIFIC FERTILITY PATTERN AT BIRTH ONLY
```

```
      DO 210 I=1,NYRS
      IF(NTAB(I).EQ.1) GO TO 220
      UTFR=0.0
      DO 232 J=1,7
  232 UTFR=UTFR+ASFP(J,I)
      UTFR=5.0*UTFR
      SB1=ASFP(2,I)*(0.031+(2.287*ASFP(1,I) +0.114*ASFP(2,I))/UTFR)
      SB2=ASFP(3,I)*(0.068+(0.999*ASFP(2,I) -0.233*ASFP(3,I))/UTFR)
      SB3=ASFP(4,I)*(0.094+(1.219*ASFP(3,I) -0.977*ASFP(4,I))/UTFR)
      SB4=ASFP(5,I)*(0.120+(1.139*ASFP(4,I) -1.531*ASFP(5,I))/UTFR)
      SB5=ASFP(6,I)*(0.162+(1.739*ASFP(5,I) -3.592*ASFP(6,I))/UTFR)
      SB6=ASFP(7,I)*(0.270+(3.454*ASFP(6,I)-21.497*ASFP(7,I))/UTFR)
      ASFPB(1,I)=ASFP(1,I)+SB1
      ASFPB(2,I)=ASFP(2,I)-SB1+SB2
      ASFPB(3,I)=ASFP(3,I)-SB2+SB3
      ASFPB(4,I)=ASFP(4,I)-SB3+SB4
      ASFPB(5,I)=ASFP(5,I)-SB4+SB5
      ASFPB(6,I)=ASFP(6,I)-SB5+SB6
      ASFPB(7,I)=ASFP(7,I)-SB6
      GO TO 210
  220 DO 221 J=1,7
  221 ASFPB(J,I)=ASFP(J,I)
  210 CONTINUE
      DO 30 I=1,NYRS
      CFP(1,I)=ASFPB(1,I)
      DUM=ASFPB(1,I)*WEIT(1)
      XA=17.5*ASFPB(1,I)*WEIT(1)
      DO 32 J=2,7
      XA=XA+ASFPB(J,I)*(12.5 + 5D0*J)*WEIT(J)
      DUM=DUM+ASFPB(J,I)*WEIT(J)
   32 CFP(J,I)=CFP(J-1,I)+ASFPB(J,I)
      TFR(2,I)=CFP(7,I)*5.0
   30 AGE(2,I)=XA/DUM
      DO 40 I=1,NYRS
      DO 42 J=1,7
   42 FACTR(J,I)=CFR(J,I)/CFP(J,I)
      AVFTR(I)=(FACTR(2,I)+FACTR(3,I))/2.0
      TFR(3,I)=TFR(2,I)*FACTR(2,I)
      TFR(4,I)=TFR(2,I)*FACTR(3,I)
      TFR(5,I)=TFR(2,I)*AVFTR(I)
      DO 63 J=1,7
      FR(J,1,I)=ASFPB(J,I)*FACTR(2,I)
      FR(J,2,I)=ASFPB(J,I)*FACTR(3,I)
      FR(J,3,I)=ASFPB(J,I)*AVFTR(I)
   63 CONTINUE
   40 CONTINUE
  566 WRITE(NPRNT,300) (LABEL(J),J=1,18)
  300 FORMAT('1',9X,'APPLICATION OF ARRIAGA''S APPROACHES FOR ESTIMAT',
     & 'ION OF AGE SPECIFIC FERTILITY RATES FOR STUDY OF'/15X,18A4)
      INDX=2*NPAT+NYRS
      IF(NPAT.GE.1) WRITE(NPRNT,301) MSG(NYRS),(KREDIT(J,INDX),J=1,4)
  301 FORMAT(/////2X,'BASED ON CHILDREN EVER BORN FOR ',A4,
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   & 'POINT(S) IN TIME AND THE AGE PATTERN(S) OF FERTILITY',1X,4A4)
    IF(NPAT.GE.1) WRITE(NPRNT,130)
130 FORMAT(2X,128('-')/25X,'FERTILITY',4X,'FERTILITY',3X,'FERTILITY',
   & 7X,'CUMULATION OF',23X,'AGE SPECIFIC FERTILITY'/14X,
   & 'CHILDREN',3X,'CONSISTENT',4X,'PATTERN',5X,'PATTERN',4X,21('-'),
   & 18X,'RATES BASED ON ADJUSTMENT'/5X,'AGE',8X,'EVER',8X,'WITH',7X,
   & 'BY AGE',6X,'BY AGE',16X,'FERTILITY',3X,'ADJUSTMENT',6X,
   & 'FACTOR FOR THE AGE GROUP'/4X,'GROUPS',6X,'BORN',7X,'C.E.B.',5X,
   & 'AT SURVEY',3X,'AT BIRTH',4X,'A.S.F.R.',3X,'PATTERN BY',4X,
   & 'FACTORS',3X,33('-')/14X,'(C.E.B.)',3X,'(A.S.F.R.)',5X,
   & 'DATE',6X,'OF CHILD',14X,'AGE AT BIRTH',16X,'20-25',7X,'25-30',
   & 7X,'20-30'/2X,128('-'))
    IF(NPAT.LE.0) WRITE(NPRNT,302) MSG(NYRS),(KREDIT(J,INDX),J=1,4)
302 FORMAT(/////26X,'BASED ON CHILDREN EVER BORN FOR ',A4,
   & 'POINT(S) IN TIME',1X,4A4)
    IF(NPAT.LE.0) WRITE(NPRNT,530)
530 FORMAT(///44X,34('-')/67X,'FERTILITY'/
   & 56X,'CHILDREN',3X,'CONSISTENT'/47X,'AGE',8X,
   & 'EVER',8X,'WITH'/46X,'GROUPS',6X,'BORN',7X,'C.E.B.'/56X,
   & '(C.E.B.)',3X,'(A.S.F.R.)'/44X,34('-'))
    DO 500 I=1,NYRS
    IYR1=IYEAR(I)-I+1
    IYR2=IYEAR(I)-I+2
    IF(I.EQ.2) WRITE(NPRNT,555)
555 FORMAT(///)
    IF(NPAT.LE.0) GO TO 501
    INDX=MONTH(I)
    ITAB=NTAB(I)
    IF(NYRS.EQ.1) WRITE(NPRNT,131) MON(INDX),IYR1,
   & (MREC(K,ITAB),K=1,2),(MTAB(K,ITAB),K=1,3)
131 FORMAT(/2X,A3,1X,I4//25X,12X/25X,11X,2X,2A4,3X,3A4/)
    IF(NYRS.EQ.2) WRITE(NPRNT,132) MON(INDX),IYR1,MON(INDX),IYR2,
   & (MREC(K,ITAB),K=1,2),(MTAB(K,ITAB),K=1,3)
132 FORMAT(/2X,A3,1X,I4,' TO ',A3,1X,I4//25X,12X/25X,
   & 11X,2X,2A4,3X,3A4/)
    DO 65 K=1,7
    KA1=5*K+10
    KA2=KA1+5
    IF(NTAB(I).EQ.2) WRITE(NPRNT,140) KA1,KA2,CB5(K,I),ASFR(K,I),
   & ASFP(K,I),ASFPB(K,I),CFR(K,I),CFP(K,I),FACTR(K,I),
   & (FR(K,L,I),L=1,3)
140 FORMAT(4X,I2,'-',I2,F12.3,9F12.4)
    IF(NTAB(I).EQ.1) WRITE(NPRNT,141) KA1,KA2,CB5(K,I),ASFR(K,I),
   & ASFPB(K,I),CFR(K,I),CFP(K,I),FACTR(K,I),(FR(K,L,I),L=1,3)
141 FORMAT(4X,I2,'-',I2,F12.3,F12.4,7X,'XXXXX',7F12.4)
 65 CONTINUE
    WRITE(NPRNT,160) AGE(1,I),AGE(2,I)
160 FORMAT(/2X,'MEAN AGE OF CHILDBEARING:',F6.2,12X,F12.2)
    WRITE(NPRNT,150) (TFR(L,I),L=1,5)
150 FORMAT(2X,'TOTAL FERTILITY RATE: ',F9.2,12X,F12.2,36X,3F12.2)
    GO TO 500
501 INDX=MONTH(I)
```

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      IF(NYRS.EQ.1) WRITE(NPRNT,152) MON(INDX),IYR1
  152 FORMAT(/55X,A3,1X,I4////)
      IF(NYRS.EQ.2) WRITE(NPRNT,153) MON(INDX),IYR1,MON(INDX),IYR2
  153 FORMAT(/49X,A3,1X,I4,' TO ',A3,1X,I4////)
      DO 565 K=1,7
      KA1=5*K+10
      KA2=KA1+5
      WRITE(NPRNT,540) KA1,KA2,CB5(K,I),ASFR(K,I)
  540 FORMAT(46X,I2,'-',I2,F12.3,11F12.4)
  565 CONTINUE
      WRITE(NPRNT,560) AGE(1,I)
  560 FORMAT(/44X,'MEAN AGE OF CHILDBEARING:',F6.2)
      WRITE(NPRNT,550) TFR(1,I)
  550 FORMAT(44X,'TOTAL FERTILITY RATE: ',F9.2)
  500 CONTINUE
      GO TO 99
  800 WRITE(NPRNT,801) LABEL,NYRS,NPAT,MONTH1,IYEAR1
  801 FORMAT('1'/5X,'*** ERROR IN FERTIL FOR DATA SET ',18A4/5X,'ERROR',
     & ' DETECTED IN AT LEAST ONE OF THE FOLLOWING INPUT VARIABLES:'//
     & 5X,'NYRS SHOULD BE 1 OR 2.             ',3X,'NYRS   =',I4/
     & 5X,'NPAT SHOULD BE 0 OR 1.             ',3X,'NPAT   =',I4//
     & 5X,'MONTH1 SHOULD BE BETWEEN 1 AND 12.',3X,'MONTH1 =',I4/
     & 5X,'IF NYRS=2, COMPARE WITH IYEAR2.   ',3X,'IYEAR1 =',I4)
      IF(NYRS.EQ.2) WRITE(NPRNT,802) MONTH2,IYEAR2
  802 FORMAT(/5X,'MONTH2 SHOULD BE BETWEEN 1 AND 12.',3X,'MONTH2 =',I4/
     & 5X,'IYEAR2 MUST BE GREATER THAN IYEAR1.',2X,'IYEAR2 =',I4)
      GO TO 99
  804 WRITE(NPRNT,805) LABEL,CEB1
  805 FORMAT('1'/5X,'*** ERROR IN FERTIL FOR DATA SET ',18A4//5X,'INPU',
     & 'T CEB VALUES MUST BE GREATER THAN ZERO:'//5X,'CEB1 ',4X,7F8.4)
      IF(NYRS.EQ.2) WRITE(NPRNT,806) CEB2
  806 FORMAT(5X,'CEB2 ',4X,7F8.4)
      GO TO 99
  808 WRITE(NPRNT,809) LABEL,NTAB1
  809 FORMAT('1'/5X,'*** ERROR IN FERTIL FOR DATA SET ',18A4/5X,
     & 'NTAB1 MUST HAVE A VALUE OF 1 OR 2, BUT NTAB1 =',I3)
      GO TO 99
  810 WRITE(NPRNT,811) LABEL,NTAB2
  811 FORMAT('1'/5X,'*** ERROR IN FERTIL FOR DATA SET ',18A4/5X,
     & 'NTAB2 MUST HAVE A VALUE OF 1 OR 2, BUT NTAB2 =',I3)
      GO TO 99
  814 WRITE(NPRNT,815) LABEL,ASFP1
  815 FORMAT('1'/5X,'*** ERROR IN FERTIL FOR DATA SET ',18A4//
     & 5X,'INPUT AGE SPECIFIC FERTILITY PATTERN VALUES MUST BE ',
     & 'GREATER THAN ZERO AND LESS THAN ONE:'//5X,'ASFP1',4X,7F8.4)
      IF(NYRS.EQ.2) WRITE(NPRNT,816) ASFP2
  816 FORMAT(5X,'ASPF2',4X,7F8.4)
   99 RETURN
      END
```

ICM

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      SUBROUTINE ICM(LABEL,QXMX,SLX,NPLT)
C***********************************************************************
C***                            MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),QXMX(18),SLX(6)
      DIMENSION T(8),QS(6),TP(8),TN(8),PFPT(8,18),PFPTLN(8)
      DIMENSION GRAD(8),GAUSS(8,8),CINV(8,8)
      DIMENSION GSSC(8,8),GRADS(8),DELT(8),GSSI(8,8)
      DIMENSION GSS1(8,8),DELT1(8),F(21)
      DIMENSION FC(102),PFCPT(8,102)
      DATA EPS,IONE/0.0000001,1/
      NPRNT=6
      K=3
      MAX=99
      DO 81 I=1,3
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 800
   81 CONTINUE
      IF(NPLT.EQ.0) WRITE(NPRNT,32) LABEL
   32 FORMAT(1H1//////20X,18A4/)
C     T IS INITIAL ESTIMATES OF PARAMETERS
      T(1)=2.9
      T(2)=0.2
      T(3)=0.3
      RE2=2.0
      ALN2=DLOG(RE2)
C---- BEGINNING OF NON-LINEAR REGRESSION
      DO 110 I=1,K
  110 TN(I)=T(I)
      J=0
      SP10=1000.0
  200 CONTINUE
      J=J+1
      MJ=MOD(J,10)
      IF(MJ.NE.2) GO TO 649
      STT=DABS(SP10-SN)
      SNT=SN*0.00001
      IF(STT.LT.SNT)GO TO 999
      SP10=SN
  649 SP=SN
      DO 634 I=1,K
  634 TP(I)=TN(I)
      H=2.0
      DO 150 I=1,35
      IF(J.EQ.1) GO TO 300
      H=H/2.0
      DO 120 L=1,K
  120 TN(L)=TP(L)+H*DELT(L)
```

```
      IF (TN(1).LE.0.0) GO TO 140
      IF (TN(2).LE.0.0) GO TO 140
C-------------------------------------------
C     WHEN CONVERGED, H*DELT CAN BE SO SMALL THAT TN(L)=TP(L) FOR ALL L.
C     IF TN(L)=TP(L), THEN NO NEED TO CALCULATE SN BECAUSE SN=SP
      DO 121 L=1,K
      IF(TN(L).NE.TP(L)) GO TO 300
  121 CONTINUE
      GO TO 140
C-------------------------------------------
  300 CONTINUE
      DO 117 IJ=1,10
      A=IJ-1
      FC(IJ)=DEXP(-TN(1)*(A+TN(2))**TN(3))
  117 CONTINUE
      DO 118 IJ=1,3
  118 F(IJ)=1.0
      F(1)=FC(1)
      DO 122 KJ=2,5
  122 F(2)=F(2)*(1.0-FC(KJ))
      F(2)=1.0-F(2)
      DO 119 KJ=6,10
  119 F(3)=F(3)*(1.0-FC(KJ))
      F(3)=1.0-F(3)
      SN=0.0
      DO 20 IJ=1,3
   20 SN=SN+(QXMX(IJ)-F(IJ))**2
      IF(J.EQ.1) GO TO 130
      IF (SN-SP) 130,140,140
  140 CONTINUE
      IF (J.GE.MAX) GO TO 999
      IF (I.GE.35) GO TO 999
  150 CONTINUE
  130 CONTINUE
      IF (J.GE.MAX) GO TO 999
      DO 30 I=1,10
      A=I-1
      TTT=(A+TN(2))**TN(3)
      TMP=DEXP(-TN(1)*TTT)
      PFCPT(1,I)=-TTT*TMP
      PFCPT(2,I)=-TN(1)*TN(3)*((A+TN(2))**(TN(3)-1.0))*TMP
      PFCPT(3,I)=-TN(1)*TTT*DLOG(A+TN(2))*TMP
   30 CONTINUE
      DO 171 LM=1,K
      PFPT(LM,1)=PFCPT(LM,1)
      PFPT(LM,2)=-(1.0-FC(2))*(1.0-FC(3))*((1.0-FC(4))*(-PFCPT(LM,5))+
     &(1.0-FC(5))*(-PFCPT(LM,4)))-(1.0-FC(4))*(1.0-FC(5))*((1.0-FC(2))*
     &(-PFCPT(LM,3))+(1.0-FC(3))*(-PFCPT(LM,2)))
      PFPT(LM,3)=-(1.0-FC(6))*(1.0-FC(7))*(1.0-FC(8))*((1.0-FC(9))
     &*(-PFCPT(LM,10))+(1.0-FC(10))*(-PFCPT(LM,9)))-(1.0-FC(9))*
     &(1.0-FC(10))*((1.0-FC(6))*(1.0-FC(7))*(-PFCPT(LM,8))+
     &(1.0-FC(8))*((1.0-FC(6))*(-PFCPT(LM,7))+(1.0-FC(7))*
```

```
      &(-PFCPT(LM,6))))
  171 CONTINUE
      DO 50 L=1,K
   50 GRAD(L)=0.0
      DO 40 I=1,3
      DO 40 L=1,K
   40 GRAD(L)=GRAD(L)-2.0*(QXMX(I)-F(I))*PFPT(L,I)
      RE1=1.0
      RE3=174.673
      RE4=-180.218
      DO 60 I=1,K
      DO 60 L=1,K
   60 GAUSS(I,L)=0.0
      DO 70 I=1,3
      DO 71 L=1,K
      PFPTLN(L)=DLOG(DABS(PFPT(L,I)))
   71 CONTINUE
      DO 70 L=1,K
      PT1=PFPTLN(L)
      P1=DSIGN(RE1,PFPT(L,I))
      DO 70 MM=1,K
      PT=ALN2
      PT2=PFPTLN(MM)
      P2=DSIGN(RE1,PFPT(MM,I))
      PT=PT+PT1+PT2
      TST=PT
      IF(TST.GE.174.673) PT=DEXP(RE3)
      IF(TST.LE.-180.218) PT=DEXP(RE4)
      IF(TST.LT.174.673.AND.TST.GT.-180.218) PT=DEXP(PT)
      PT=P1*P2*PT
   70 GAUSS(L,MM)=GAUSS(L,MM)+PT
      DO 80 I=1,K
      DO 80 L=1,K
   80 CINV(I,L)=0.0
      DO 90 I=1,K
   90 CINV(I,I)=1.0/DSQRT(GAUSS(I,I))
      CALL MULT(CINV,GAUSS,K,K,K,GSS1)
      CALL MULT(GSS1,CINV,K,K,K,GSSC)
      CALL MULT(CINV,GRAD,K,K,IONE,GRADS)
      CALL INVER(GSSC,EPS,K,GSSI,IFLAG)
      IF(IFLAG.EQ.1) GO TO 826
      DO 100 I=1,K
      DO 100 L=1,K
  100 GSSI(I,L)=-GSSI(I,L)
      CALL MULT(GSSI,GRADS,K,K,IONE,DELT1)
      CALL MULT(CINV,DELT1,K,K,IONE,DELT)
      GO TO 200
  826 DO 827 I=1,K
  827 DELT(I)=-GRAD(I)
      GO TO 200
  999 CONTINUE
      IF(TP(1).LE.0.00001) J=MAX
```

```
      IF(TP(2).LE.0.00001) J=MAX
      IF(J.GE.MAX) WRITE(NPRNT,1119)
 1119 FORMAT('1',55X,'***WARNING***'/14X,'CONVERGENCE WAS NOT REACHED',
     &' IN COMPLETION OF THE FOLLOWING LIFE TABLE. PLEASE CHECK',
     &' INPUT DATA.')
      DO 160 I=1,K
  160 T(I)=TP(I)
C---- END OF NON-LINEAR REGRESSION
      DO 23 I=1,5
      A=I-1
      IF(I.EQ.1)A=.00000000001
      QS(I)=DEXP(-T(1)*(A+T(2))**T(3))
   23 CONTINUE
      SLX(1)=100000.
      DO 43 J=2,6
   43 SLX(J)=SLX(J-1)*(1.0-QS(J-1))
      T(1)=DEXP(-T(1))
      IF(NPLT.EQ.2) GO TO 99
      WRITE(NPRNT,1)
    1 FORMAT(///////50X,'INPUT DATA:'/50X,11('-')/)
      WRITE(NPRNT,5)(QXMX(I),I=1,3)
    5 FORMAT(50X,'Q(0-1)  = ',F6.5/50X,'Q(1-5)  = ',F6.5/
     &50X,'Q(5-10) = ',F6.5/////40X,'ESTIMATED SINGLE YEAR MORTALITY:'/
     &40X,32('-')/)
      DO 7 I=1,5
      IM1=I-1
      IP1=I+1
      WRITE(NPRNT,3) IM1,I,QS(I),I,SLX(IP1)
    3 FORMAT(40X,'Q(',I1,'-',I1,') = ',F6.5,10X,'I(',I1,') = ',F6.0)
    7 CONTINUE
      WRITE(NPRNT,2) (T(I),I=1,3)
    2 FORMAT(////50X,'INTERPOLATION PARAMETERS:'/50X,25('-')//50X,
     &'T(1) = ',F7.5/50X,'T(2) = ',F7.5/50X,'T(3) = ',F7.5)
      GO TO 99
  800 WRITE(NPRNT,801) (LABEL(I),I=1,18),(QXMX(I),I=1,3)
  801 FORMAT('1'/5X,'*** ERROR IN ICM FOR DATA SET ',18A4/5X,'INPUT ',
     & 'Q(X) VALUE(S) IS OUTSIDE THE RANGE OF ZERO AND ONE.'/5X,
     & 'PLEASE CHECK INPUT QXMX VALUES:',1X,3F9.5)
   99 RETURN
      END
```

INVER

```
      SUBROUTINE INVER(A,EPS,N,B,IFLAG)
C***********************************************************************
C***                          MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
C     THE INVERSE VALUES FOR ARRAY A ARE PLACED INTO ARRAY B.
C     IF CALCULATING THE INVERSE FAILS, THEN IFLAG=1, OTHERWISE IFLAG=0.
      DIMENSION A(8,8),B(8,8),AX(8,8)
      IFLAG=0
      DO 10 J=1,N
      DO 10 I=1,N
   10 AX(I,J)=A(I,J)
      DO 20 I=1,N
      DO 20 J=1,N
      B(I,J)=0.0
      IF(I.EQ.J) B(I,J)=1.0
   20 CONTINUE
C     FIND MAXIMUM AX IN COLUMN K AND ROWS K TO N
      DO 100 K=1,N
      IF(K.GE.N) GO TO 130
      MAX=K
      AMAX=DABS(AX(K,K))
      KP1=K+1
      DO 110 I=KP1,N
      IF (AMAX.GE.DABS(AX(I,K))) GO TO 110
      MAX=I
      AMAX=DABS(AX(I,K))
  110 CONTINUE
      IF(AMAX.LE.EPS) GO TO 98
C     EXCHANGE ROWS MAX AND K
      IF(MAX.EQ.K) GO TO 130
      DO 120 J=1,N
      TMP=AX(MAX,J)
      AX(MAX,J)=AX(K,J)
      AX(K,J)=TMP
      TMP=B(MAX,J)
      B(MAX,J)=B(K,J)
  120 B(K,J)=TMP
  130 TMP=AX(K,K)
C     PERFORM GAUSSIAN ELIMINATION ON MATRICES
      DO 140 J=1,N
      AX(K,J)=AX(K,J)/TMP
  140 B(K,J)=B(K,J)/TMP
      DO 150 I=1,N
      TMP=AX(I,K)
      IF(I.EQ.K) GO TO 150
      DO 160 J=1,N
      AX(I,J)=AX(I,J)-TMP*AX(K,J)
```

```
      B(I,J)=B(I,J)-TMP*B(K,J)
  160 CONTINUE
  150 CONTINUE
  100 CONTINUE
      GO TO 99
   98 IFLAG=1
   99 RETURN
      END
```

LIFTB

```
      SUBROUTINE LIFTB(NPG,LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,NPLT)
C***********************************************************************
C***                           MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),QXMX(101),ARRAY(101,9),QVAL(25),XVAL(6),T(3)
      DIMENSION AM(101),A(101),G(101),XV(6),YV(6)
      DATA KEY/0/
      NPRNT=6
C--------------------------------------
      NCHILD=1
C--------------------------------------
C     IF NCHILD = 1 THEN QXMX 3,4,5 IS SET TO 0.0
      IF(NCHILD.NE.1) GO TO 632
      QXMX(3)=0.0
      QXMX(4)=0.0
      QXMX(5)=0.0
  632 CONTINUE
      IF(NFIN.LT.65.OR.NFIN.GT.100) GO TO 800
      IF(NTYPE.LT.1.OR.NTYPE.GT.2) GO TO 800
      IF(NCHILD.LT.1.OR.NCHILD.GT.2) GO TO 800
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 800
      DO 1 I=1,2
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
    1 CONTINUE
      IF(NCHILD.EQ.1) GO TO 3
      DO 2 I=3,5
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
    2 CONTINUE
    3 DO 4 I=6,NFIN,5
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
    4 CONTINUE
      NEND=NFIN+1
      IF(NPLT.EQ.0) KEY=KEY+1
      IF(NPLT.NE.0) GO TO 603
      IF(MOD(KEY,2).EQ.0.AND.NPG.EQ.1) WRITE(NPRNT,64)(LABEL(I),I=1,18)
   64 FORMAT(///1X,18A4//)
      IF(MOD(KEY,2).NE.0.OR.NPG.NE.1) WRITE(NPRNT,61)(LABEL(I),I=1,18)
   61 FORMAT(1H1,1X,18A4//)
  603 CONTINUE
      GO TO (10,20),NTYPE
   10 DO 100 I=6,NEND,5
  100 ARRAY(I,2)=QXMX(I)
      DO 110 I=1,5
  110 ARRAY(I,2)=QXMX(I)
      ARRAY(NEND,2)=1.0
      A(6)=2.5
      A(11)=2.5
```

```
      NM10=NEND-10
      NM5=NEND-5
      DO 2644 I=16,NM5,5
 2644 A(I)=2.5
      DO 2645 IT=1,20
      DO 2642 I=11,NM5,5
 2642 AM(I)=QXMX(I)/(5.0-(5.0-A(I))*QXMX(I))
      DO 2641 I=16,NM10,5
      AK=DLOG(AM(I+5)/AM(I-5))/10.0
 2641 A(I)=2.5-(25.0/12.0)*(AM(I)-AK)
      A(NM5)=2.5-(25.0/12.0)*(AM(NM5)-AK)
 2645 CONTINUE
      GO TO 30
   20 CONTINUE
      A(6)=2.5
      A(11)=2.5
      NM10=NEND-10
      NM5=NEND-5
      DO 641 I=16,NM10,5
      AK=DLOG(QXMX(I+5)/QXMX(I-5))/10.0
  641 A(I)=2.5-(25.0/12.0)*(QXMX(I)-AK)
      A(NM5)=2.5-(25.0/12.0)*(QXMX(NM5)-AK)
      DO 200 I=6,NFIN,5
  200 ARRAY(I,2)=5.0*QXMX(I)/(1.0+(5.0-A(I))*QXMX(I))
      ARRAY(NEND,2)=1.0
      GO TO (318,418),NSEX
  318 IF(QXMX(1).LT.0.1072)ARRAY(1,2)=((1.0+QXMX(1)-.0425*QXMX(1))-DSQRT
     &((.0425*QXMX(1)-QXMX(1)-1.0)*(.0425*QXMX(1)-QXMX(1)-1.0)-4.0*2.875
     &*QXMX(1)*QXMX(1)))/(2.0*2.875*QXMX(1))
      IF (QXMX(1).GE.0.1072) ARRAY(1,2)=1.0*QXMX(1)/(1.0+.67*QXMX(1))
      GO TO 422
  418 IF(QXMX(1).LT.0.1072)ARRAY(1,2)=((1.0+QXMX(1)-.0500*QXMX(1))-DSQRT
     &((.0500*QXMX(1)-QXMX(1)-1.0)*(.0500*QXMX(1)-QXMX(1)-1.0)-4.0*3.000
     &*QXMX(1)*QXMX(1)))/(2.0*3.000*QXMX(1))
      IF (QXMX(1).GE.0.1072)ARRAY(1,2)=1.0*QXMX(1)/(1.0+.65*QXMX(1))
  422 CONTINUE
      IF (NCHILD.EQ.2)GO TO 40
      GO TO (531,532),NSEX
  531 IF (QXMX(1).LT.0.1072)ARRAY(2,2)=4.0*QXMX(2)/(1.0+(4.0-1.653+3.013
     &*ARRAY(1,2))*QXMX(2))
      IF (QXMX(1).GE.0.1072)ARRAY(2,2)=4.0*QXMX(2)/(1.0+2.648*QXMX(2))
      GO TO 567
  532 IF(QXMX(1).LT.0.1072)ARRAY(2,2)=4.0*QXMX(2)/(1.0+(4.0-1.524+1.627*
     &ARRAY(1,2))*QXMX(2))
      IF (QXMX(1).GE.0.1072)ARRAY(2,2)=4.0*QXMX(2)/(1.0+2.639*QXMX(2))
  567 ARRAY(3,2)=0.0
      ARRAY(4,2)=0.0
      ARRAY(5,2)=0.0
      GO TO 30
   40 ARRAY(2,2)=QXMX(2)/(1.0+0.56*QXMX(2))
      ARRAY(3,2)=QXMX(3)/(1.0+0.53*QXMX(3))
      ARRAY(4,2)=QXMX(4)/(1.0+0.51*QXMX(4))
```

```
      ARRAY(5,2)=QXMX(5)/(1.0+0.50*QXMX(5))
   30 CONTINUE
      ARRAY(1,3)=100000.
      DO 300 I=2,6
      ARRAY(I,3)=ARRAY(I-1,3)*(1.0-ARRAY(I-1,2))
  300 ARRAY(I-1,4)=ARRAY(I-1,3)*ARRAY(I-1,2)
      DO 400 I=11,NEND,5
      ARRAY(I,3)=ARRAY(I-5,3)*(1.0-ARRAY(I-5,2))
  400 ARRAY(I-5,4)=ARRAY(I-5,3)*ARRAY(I-5,2)
      ARRAY(NEND,4)=ARRAY(NEND,3)
      IF(ARRAY(1,2)-0.100) 387,388,388
  388 IF(NSEX.EQ.1) ARRAY(1,5)=0.33*ARRAY(1,3)+.67*ARRAY(2,3)
      IF(NSEX.EQ.2) ARRAY(1,5)=0.35*ARRAY(1,3)+.65*ARRAY(2,3)
      GO TO 391
  387 IF(NSEX.EQ.1)ARRAY(1,5)=(.0425+2.875*ARRAY(1,2))*ARRAY(1,3)+(.9575
     *-2.875*ARRAY(1,2))*ARRAY(2,3)
      IF(NSEX.EQ.2)ARRAY(1,5)=(.0500+3.000*ARRAY(1,2))*ARRAY(1,3)+(.9500
     *-3.000*ARRAY(1,2))*ARRAY(2,3)
  391 CONTINUE
      IF(NCHILD.EQ.2) GO TO 50
      IF(ARRAY(1,2)-0.100) 1387,1388,1388
 1388 IF(NSEX.EQ.1)ARRAY(2,5)=1.352*ARRAY(2,3)+2.648*ARRAY(6,3)
      IF(NSEX.EQ.2)ARRAY(2,5)=1.361*ARRAY(2,3)+2.639*ARRAY(6,3)
      GO TO 1391
 1387 IF(NSEX.EQ.1)ARRAY(2,5)=(1.653-3.013*ARRAY(1,2))*ARRAY(2,3)+
     *(2.347+3.013*ARRAY(1,2))*ARRAY(6,3)
      IF(NSEX.EQ.2)ARRAY(2,5)=(1.524-1.627*ARRAY(1,2))*ARRAY(2,3)+
     *(2.476+1.627*ARRAY(1,2))*ARRAY(6,3)
 1391 CONTINUE
      ARRAY(3,5)=0.0
      ARRAY(4,5)=0.0
      ARRAY(5,5)=0.0
      GO TO 60
   50 ARRAY(2,5)=.44*ARRAY(2,3)+.56*ARRAY(3,3)
      ARRAY(3,5)=.47*ARRAY(3,3)+.53*ARRAY(4,3)
      ARRAY(4,5)=.49*ARRAY(4,3)+.51*ARRAY(5,3)
      ARRAY(5,5)=.50*ARRAY(5,3)+.50*ARRAY(6,3)
   60 CONTINUE
      DO 500 I=6,NFIN,5
  500 ARRAY(I,5)=A(I)*ARRAY(I,3)+(5.0-A(I))*ARRAY(I+5,3)
      IF(NPLT.GE.2) GO TO 1110
      DO 1120 I=46,NFIN,5
      IF(ARRAY(I,2).LT.ARRAY(I-5,2)) GO TO 1130
 1120 CONTINUE
      GO TO 1110
 1130 WRITE(NPRNT,771) LABEL
  771 FORMAT(//5X,'*** WARNING IN LIFTB FOR DATA SET ',18A4/5X,
     & 'MORTALITY RATES AT OLDER AGES DO NOT INCREASE MONOTONICALLY.'/
     & 5X,'PLEASE CHECK INPUT DATA.'//)
 1110 NBEG=NEND-30
      KN=0
      DO 1001 I=NBEG,NFIN,5
```

```
      KN=KN+1
      QVAL(KN)=ARRAY(I,2)/(1.0-ARRAY(I,2))
 1001 XVAL(KN)=I-1
      TMP=(QVAL(5)-QVAL(3))/(QVAL(3)-QVAL(1))
      IF(TMP.LE.0) GO TO 770
      STVAL=TMP**0.1
      TMP=(QVAL(6)-QVAL(4))/(QVAL(4)-QVAL(2))
      IF(TMP.LE.0) GO TO 770
      AAA=TMP**0.1
      STVAL=(STVAL+AAA)/2.0
      GO TO 72
  770 STVAL=1.12
C---- CALCULATION OF NON-LINEAR REGRESSION
   72 DELTA=0.05
      T(3)=STVAL-DELTA
      DO 70 ITER=1,99
      DO 75 I=1,6
      XV(I)=T(3)**XVAL(I)
   75 YV(I)=QVAL(I)
      SUMX=0.0
      SUMY=0.0
      SUMXX=0.0
      CROSP=0.0
      FN=6.0
      DO 76 J=1,6
      SUMX=SUMX+XV(J)
      SUMY=SUMY+YV(J)
      SUMXX=SUMXX+XV(J)*XV(J)
      CROSP=CROSP+XV(J)*YV(J)
   76 CONTINUE
      SX=(FN*SUMXX-SUMX*SUMX)
      T(1)=(SUMY*SUMXX-SUMX*CROSP)/SX
      T(2)=(FN*CROSP-SUMX*SUMY)/SX
      SUMSQ=0.0
      DO 77 J=1,6
   77 SUMSQ=SUMSQ+(T(1)+T(2)*XV(J)-YV(J))**2
      IF(ITER.LE.2) GO TO 78
C     AN EPSILON VALUE OF T(3)/100000.0 SUPPLIES ENOUGH ACCURACY, BUT TO
C     PRODUCE RESULTS IDENTICAL TO NLS, EPS WAS REDUCED. FOR SINGLE
C     PRECISION ARITHMETIC, EPS MAY HAVE TO BE INCREASED (TRY 100000.0).
      EPS=T(3)/500000.0
      DIFF=DABS(T(3)-C1)
      IF(DIFF.LT.EPS) GO TO 79
      DIFF=DABS(T(3)-C2)
      IF(DIFF.LT.EPS) GO TO 79
   78 C3=C2
      C2=C1
      C1=T(3)
      SUM3=SUM2
      SUM2=SUM1
      SUM1=SUMSQ
      IF(ITER.EQ.1) T(3)=STVAL+DELTA
```

```
      IF(ITER.EQ.2) T(3)=STVAL
      IF(ITER.LE.2) GO TO 70
      T(3)=((SUM2-SUM1)*(C3*C3-C2*C2)-(SUM3-SUM2)*(C2*C2-C1*C1))/2.0
      T(3)=T(3)/((SUM2-SUM1)*(C3-C2)-(SUM3-SUM2)*(C2-C1))
      IF(T(3).LT.0.50) T(3)=0.5
      IF(T(3).GT.2.1) T(3)=2.1
   70 CONTINUE
      WRITE(NPRNT,71) LABEL
   71 FORMAT(//5X,'*** WARNING IN LIFTB FOR DATA SET ',18A4/5X,
     & 'CONVERGENCE WAS NOT REACHED IN COMPLETION OF THE FOLLOWING ',
     & 'LIFE TABLE.'/5X,'PLEASE CHECK INPUT DATA.'//)
      GO TO 1017
C---- COEFFICIENTS FOR NON-LINEAR REGRESSION EQUATION WERE CALCULATED.
   79 IF(T(3).GT.1.0.AND.T(3).LT.2.0) GO TO 1017
      WRITE(NPRNT,71) LABEL
 1017 KN=KN+1
      KNP12=KN+13
      IK=NEND-6
      DO 1002 I=KN,KNP12
      IK=IK+5
      QVAL(I)=T(1)+T(2)*T(3)**IK
 1002 QVAL(I)=QVAL(I)/(1.0+QVAL(I))
      IF(NTYPE.EQ.2) AM(KN-1)=QXMX(NM5)
      IF(NTYPE.EQ.1) AM(KN-1)=AM(NM5)
      AM(KNP12+1)=1.0
      DO 1444 I=KN,KNP12
 1444 G(I)=2.5
      DO 1445 IT=1,10
      DO 1102 I=KN,KNP12
      IF(G(I).LE.0.0) G(I)=0.5
 1102 AM(I)=QVAL(I)/(5.0-(5.0-G(I))*QVAL(I))
      DO 1112 I=KN,KNP12
      AK=DLOG(AM(I+1)/AM(I-1))/10.0
 1112 G(I)=2.5-(25.0/12.0)*(AM(I)-AK)
 1445 CONTINUE
      CAPL=0.0
      SMLX=ARRAY(NEND,3)
      DO 1004 I=KN,KNP12
      SMLX1=SMLX*(1.0-QVAL(I))
C     CHECK SMLX1 FOR POSSIBLE UNDERFLOW IN EXTREME CASES.
      IF(SMLX1.LT.0.001) SMLX1=0.0
      ARRAY(5*I-28,5)=G(I)*SMLX+(5.0-G(I))*SMLX1
      ARRAY(5*I-28,1)=AM(I)
      CAPL=CAPL+G(I)*SMLX+(5.0-G(I))*SMLX1
 1004 SMLX=SMLX1
      ARRAY(NEND,5)=CAPL
      ARRAY(NEND,7)=CAPL
      DO 600 I=1,5
      IF (ARRAY(I,5).GE.1.0) ARRAY(I,1)=ARRAY(I,4)/ARRAY(I,5)
      IF (ARRAY(I,5).LT.1.0) ARRAY(I,1)=0.0
  600 CONTINUE
      DO 700 I=6,NEND,5
```

```
 700 ARRAY(I,1)=ARRAY(I,4)/ARRAY(I,5)
     K=NEND-5
     DO 750 I=6,K,5
     J=NEND-I+1
 750 ARRAY(J,7)=ARRAY(J+5,7)+ARRAY(J,5)
     DO 900 I=1,5
     J=6-I
 900 ARRAY(J,7)=ARRAY(J+1,7)+ARRAY(J,5)
     SUM=0.0
     DO 887 I=1,5
 887 SUM=SUM+ARRAY(I,5)
     ARRAY(1,6)=SUM/500000.0
     ARRAY(2,6)=ARRAY(6,5)/SUM
     KM10=NEND-10
     DO 888 I=6,KM10,5
 888 ARRAY(I,6)=ARRAY(I+5,5)/ARRAY(I,5)
     ARRAY(K,6)=ARRAY(NEND,7)/ARRAY(K,7)
     DO 1000 J=1,5
1000 ARRAY(J,8)=ARRAY(J,7)/ARRAY(J,3)
     DO 1100 J=6,NEND,5
1100 ARRAY(J,8)=ARRAY(J,7)/ARRAY(J,3)
     DO 1200 J=6,NFIN,5
1200 ARRAY(J,9)=A(J)
     ARRAY(NEND,9)=1.0/ARRAY(NEND,1)
     ARRAY(3,9)=.47
     ARRAY(4,9)=.49
     ARRAY(5,9)=.50
     IF (ARRAY(1,2)-.100) 1210,1220,1220
1220 IF (NSEX.EQ.1) A(1)=.33
     IF (NSEX.EQ.1) A(2)=1.352
     IF (NSEX.EQ.2) A(1)=.35
     IF (NSEX.EQ.2) A(2)=1.361
     GO TO 1230
1210 IF (NSEX.EQ.1) A(1)=.0425+2.875*ARRAY(1,2)
     IF (NSEX.EQ.1) A(2)=1.653-3.013*ARRAY(1,2)
     IF (NSEX.EQ.2) A(1)=.050+3.00*ARRAY(1,2)
     IF (NSEX.EQ.2) A(2)=1.524-1.627*ARRAY(1,2)
1230 IF (NCHILD.EQ.2) ARRAY(2,9)=.44
     IF (NCHILD.EQ.1) ARRAY(2,9)=A(2)
     ARRAY(1,9)=A(1)
     IF(NPLT.EQ.2) GO TO 99
     WRITE(NPRNT,62)
  62 FORMAT(4X,'AGE',8X,'M(X,N)',7X,'Q(X,N)',8X,'I(X)',8X,'D(X,N)',
    1 7X,'L(X,N)',5X,'S(X,N)',10X,'T(X)',8X,'E(X)',7X,'A(X,N)'/)
     I=1
     J=0
     WRITE(NPRNT,63) J,(ARRAY(I,K),K=1,9)
  63 FORMAT(4X,I3,8X,F6.5,7X,F6.5,6X,F7.0,7X,F6.0,6X,F7.0,5X,F6.5,
    1 ' /A/',3X,F8.0,5X,F6.3,6X,F7.3)
     I=2
     J=1
     WRITE(NPRNT,73) J,(ARRAY(I,K),K=1,9)
```

```
 73 FORMAT(4X,I3,8X,F6.5,7X,F6.5,6X,F7.0,7X,F6.0,6X,F7.0,5X,F6.5,
   1 ' /B/',3X,F8.0,5X,F6.3,6X,F7.3)
    IF (NCHILD.EQ.1) GO TO 620
    DO 630 I=3,5
    J=I-1
    WRITE(NPRNT,65) J,(ARRAY(I,K),K=1,5),(ARRAY(I,K),K=7,9)
 65 FORMAT(4X,I3,8X,F6.5,7X,F6.5,6X,F7.0,7X,F6.0,6X,F7.0,5X,
   1 ' .....',7X,F8.0,5X,F6.3,6X,F7.3)
630 CONTINUE
620 NEND10=NFIN-9
    DO 640 I=6,NEND10,5
    J=I-1
    WRITE(NPRNT,66) J,(ARRAY(I,K),K=1,9)
 66 FORMAT(4X,I3,8X,F6.5,7X,F6.5,6X,F7.0,7X,F6.0,6X,F7.0,5X,F6.5,
   1 7X,F8.0,5X,F6.3,6X,F7.3)
640 CONTINUE
    I=NFIN-4
    J=I-1
    WRITE(NPRNT,74) J,(ARRAY(I,K),K=1,9)
 74 FORMAT(4X,I3,8X,F6.5,7X,F6.5,6X,F7.0,7X,F6.0,6X,F7.0,5X,F6.5,
   1 ' /C/',3X,F8.0,5X,F6.3,6X,F7.3)
    J=NFIN
    WRITE(NPRNT,68) J,ARRAY(NEND,1),(ARRAY(NEND,K),K=3,5),
   & (ARRAY(NEND,K),K=7,9)
 68 FORMAT(4X,I3,8X,F6.5,7X,' .....',6X,F7.0,7X,F6.0,6X,F7.0,5X,
   1 ' .....',7X,F8.0,5X,F6.3,6X,F7.3)
    NFIN5=NFIN-5
    WRITE(NPRNT,69) NFIN5,NFIN,NFIN5
 69 FORMAT(/5X,'/A/ VALUE GIVEN IS FOR SURVIVORSHIP OF 5 COHORTS OF ',
   & 'BIRTH TO AGE GROUP 0-4 = L(0,5)/500000'/5X,'/B/ VALUE GIVEN ',
   & 'IS FOR S(0,5)=L(5,5)/L(0,5)'/5X,'/C/ VALUE GIVEN IS S(',
   & I3,'+,5)=T(',I3,')/T(',I3,')')
    GO TO 99
800 WRITE(NPRNT,801) LABEL,NFIN,NTYPE,NCHILD,NSEX
801 FORMAT('1'/5X,'*** ERROR IN LIFTB FOR DATA SET ',18A4/5X,'ERROR ',
   & 'DETECTED IN AT LEAST ONE OF THE FOLLOWING INPUT PARAMETERS:'/
   & 5X,'NFIN SHOULD BE BETWEEN 65 AND 100.',3X,'NFIN   =',I4/
   & 5X,'NTYPE SHOULD BE 1 OR 2.           ',3X,'NTYPE  =',I4/
   & 5X,'NCHILD SHOULD BE 1 OR 2.          ',3X,'NCHILD =',I4/
   & 5X,'NSEX SHOULD BE 1 OR 2.            ',3X,'NSEX   =',I4)
    GO TO 99
802 WRITE(NPRNT,803) LABEL
803 FORMAT('1'/5X,'*** ERROR IN LIFTB FOR DATA SET ',18A4/5X,'INPUT ',
   & 'Q(X) OR M(X) VALUE(S) IS OUTSIDE THE RANGE OF ZERO AND ONE.'/5X,
   & 'PLEASE CHECK INPUT QXMX VALUES:')
    IF(NCHILD.EQ.1) WRITE(NPRNT,804) (QXMX(I),I=1,2),
   & (QXMX(I),I=6,NFIN,5)
804 FORMAT(/3X,2F9.5,4(/3X,5F9.5))
    IF(NCHILD.EQ.2) WRITE(NPRNT,805) (QXMX(I),I=1,5),
   & (QXMX(I),I=6,NFIN,5)
805 FORMAT(5(/3X,5F9.5))
 99 RETURN
    END
```

MATCH

```
      SUBROUTINE MATCH(LABEL,NSEX,NREG,NPARM,NAGE,CMP,CMP2,RNGE,AVE,
     &ARRAY,NPLT)
C***********************************************************************
C***                          MORTPAK                                ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
C-----------------------------------------------------------------------
C     NOTE: IT IS PERMISSIBLE TO MATCH ON I(2), I(3), I(4). THEY ARE
C     NOT PRINTED, BUT ARE AVAILABLE FROM ARRAY (I.E. ARRAY(AGE+1,3)).
C-----------------------------------------------------------------------
      DIMENSION LABEL(18),AVE(18),ARRAY(101,9),Q(101),AVEX(18),VEC(18)
      DIMENSION VEC1(36),ICOL(4),QXS(18),SL(6),IAGE(18)
      DIMENSION EMP1(36),EMP2(36),EMP3(36),EMP4(36),EMP5(36)
      DIMENSION CD1(68),CD2(68),CD3(68),CD4(68),CD5(68),CD6(68)
      DIMENSION CD7(68),CD8(68),CD(4,17)
      DIMENSION ASEX(2),AREG1(10),AREG2(10),ALBL(2),BLBL(2)
      DATA NFIN80,NTYPE,IONE,ITWO/80,1,1,2/
      DATA ASEX/'  MALE  ',' FEMALE '/,ICOL/'M','Q','I','E'/
      DATA AREG1/' EMPIRIC',' LATIN A',' CHILEAN',' SOUTH A',' FAR EAS',
     &' GENERAL',' WEST   ',' NORTH  ',' EAST   ',' SOUTH  '/
      DATA AREG2/'AL      ','MERICAN ','        ','SIAN    ','TERN    ',
     &'        ','        ','        ','        ','        '/
      DATA ALBL/'UNITED N','COALE & '/
      DATA BLBL/'ATIONS  ','DEMENY  '/
      DATA VEC1/.23686,.36077,.33445,.30540,.28931,.28678,.27950,.28023,
     &.26073,.23626,.20794,.17804,.15136,.13217,.12243,.11457,.10445,
     $.08878,.18289,.31406,.31716,.30941,.32317,.32626,.30801,.29047,
     $.25933,.22187,.19241,.17244,.15729,.14282,.12711,.11815,.11591,
     $.09772/
      DATA EMP1/-1.12977,-1.49127,-2.13005,-2.40748,-2.21892,-2.01157,
     $-1.93591,-1.86961,-1.76133,-1.64220,-1.49651,-1.34160,-1.15720,
     $-.96945,-.74708,-.52259,-.29449,-.04031,-1.22452,-1.45667,
     $-2.13881,-2.46676,-2.31810,-2.14505,-2.03883,-1.93924,-1.83147,
     $-1.74288,-1.62385,-1.47924,-1.28721,-1.07443,-.83152,-.59239,
     $-.35970,-.08623/
      DATA EMP2/-1.04722,-1.81992,-2.42430,-2.52487,-2.24491,-2.02821,
     $-1.90923,-1.78646,-1.66679,-1.52497,-1.37807,-1.21929,-1.03819,
     $-.84156,-.63201,-.42070,-.21110,+.01163,-1.12557,-1.82378,
     $-2.52319,-2.63933,-2.38847,-2.20417,-2.09701,-1.99128,-1.87930,
     $-1.75744,-1.61558,-1.45886,-1.26115,-1.05224,-.80346,-.58202,
     $-.35093,-.10587/
      DATA EMP3/-.97864,-1.24228,-2.01695,-2.44280,-2.35424,-2.27012,
     $-2.16833,-2.05942,-1.90053,-1.71213,-1.51120,-1.28493,-1.08192,
     $-.84671,-.62964,-.40229,-.19622,-.00129,-0.97055,-1.15424,
     $-1.93962,-2.36857,-2.19082,-2.09358,-2.04788,-1.95922,-1.87311,
     $-1.76095,-1.61425,-1.39012,-1.15515,-0.90816,-.68011,-.43231,
     $-.17489,0.05948/
      DATA EMP4/-1.53473,-2.15035,-2.61442,-2.66392,-2.42326,-2.23095,
```

```
     $-2.15279,-2.05765,-1.89129,-1.68244,-1.47626,-1.23020,-1.02801,
     $-.77148,-.54696,-.32996,-.11911,0.10572,-1.42596,-1.95200,
     $-2.55653,-2.68018,-2.33095,-2.15952,-2.03377,-1.94554,-1.82299,
     $-1.69084,-1.52189,-1.33505,-1.13791,-0.93765,-.72718,-.50916,
     $-.28389,-.01285/
      DATA EMP5/-1.27638,-1.78957,-2.35607,-2.55527,-2.34263,-2.16193,
     $-2.09109,-2.00215,-1.86781,-1.70806,-1.52834,-1.33100,-1.12934,
     $-.91064,-.68454,-.45685,-.23002,0.00844,-1.35963,-1.77385,
     $-2.39574,-2.64549,-2.44766,-2.28991,-2.18850,-2.08535,-1.97231,
     $-1.84731,-1.69291,-1.50842,-1.30344,-1.08323,-.84402,-.59485,
     $-.34158,-.06493/
C-----------------------------------------------------------------------
C---- WEST MALE MODEL LIFE TABLE CONSTANTS -----------------------------
C-----------------------------------------------------------------------
      DATA CD1 /
     *    0.63726,    -0.009958,    5.8061,     -0.05338,
     *    0.40548,    -0.006653,    7.1062,     -0.08559,
     *    0.10393,    -0.001662,    5.4472,     -0.06295,
     *    0.07435,    -0.001183,    5.0654,     -0.05817,
     *    0.09880,    -0.001539,    4.8700,     -0.05070,
     *    0.14009,    -0.002183,    5.0677,     -0.05156,
     *    0.15785,    -0.002479,    5.2660,     -0.05471,
     *    0.18260,    -0.002875,    5.3438,     -0.05511,
     *    0.21175,    -0.003312,    5.2792,     -0.05229,
     *    0.25049,    -0.003864,    5.0415,     -0.04573,
     *    0.27894,    -0.004158,    4.6666,     -0.03637,
     *    0.33729,    -0.004856,    4.4506,     -0.02961,
     *    0.38425,    -0.005190,    4.2202,     -0.02256,
     *    0.48968,    -0.006300,    4.1851,     -0.01891,
     *    0.59565,    -0.007101,    4.1249,     -0.01491,
     *    0.73085,    -0.007911,    4.1051,     -0.01161,
     *    0.89876,    -0.008695,    4.1133,     -0.00895/
C-----------------------------------------------------------------------
C---- WEST FEMALE MODEL LIFE TABLE CONSTANTS ---------------------------
C-----------------------------------------------------------------------
      DATA CD2 /
     *    0.53774,    -0.008044,    5.8992,     -0.05406,
     *    0.39368,    -0.006162,    7.4576,     -0.08834,
     *    0.10927,    -0.001686,    6.2018,     -0.07410,
     *    0.08548,    -0.001320,    5.9627,     -0.07181,
     *    0.10979,    -0.001672,    5.9335,     -0.06812,
     *    0.13580,    -0.002051,    5.9271,     -0.06577,
     *    0.15134,    -0.002276,    5.8145,     -0.06262,
     *    0.17032,    -0.002556,    5.6578,     -0.05875,
     *    0.18464,    -0.002745,    5.3632,     -0.05232,
     *    0.19390,    -0.002828,    4.9600,     -0.04380,
     *    0.20138,    -0.002831,    4.5275,     -0.03436,
     *    0.25350,    -0.003487,    4.4244,     -0.03004,
     *    0.31002,    -0.004118,    4.3131,     -0.02554,
     *    0.43445,    -0.005646,    4.3439,     -0.02295,
     *    0.53481,    -0.006460,    4.2229,     -0.01773,
     *    0.69394,    -0.007713,    4.1838,     -0.01376,
     *    0.84589,    -0.008239,    4.1294,     -0.00978/
```

```
C-----------------------------------------------------------------------
C---- NORTH MALE MODEL LIFE TABLE CONSTANTS ----------------------------
C-----------------------------------------------------------------------
      DATA CD3 /
     *   0.54327,   -0.008251,   5.6151,     -0.05022,
     *   0.46169,   -0.007290,   7.2025,     -0.08475,
     *   0.18983,   -0.002974,   6.1947,     -0.07195,
     *   0.09551,   -0.001476,   5.3488,     -0.06047,
     *   0.09666,   -0.001422,   4.5662,     -0.04322,
     *   0.13472,   -0.001968,   4.6970,     -0.04277,
     *   0.14325,   -0.002103,   4.7661,     -0.04372,
     *   0.15280,   -0.002244,   4.7248,     -0.04236,
     *   0.17535,   -0.002589,   4.7568,     -0.04197,
     *   0.20924,   -0.003083,   4.7280,     -0.03986,
     *   0.24673,   -0.003605,   4.6020,     -0.03578,
     *   0.28578,   -0.004016,   4.3499,     -0.02857,
     *   0.36171,   -0.005037,   4.3718,     -0.02682,
     *   0.45849,   -0.006124,   4.2977,     -0.02244,
     *   0.59986,   -0.007677,   4.2858,     -0.01913,
     *   0.82662,   -0.010241,   4.3482,     -0.01710,
     *   1.03681,   -0.011906,   4.3197,     -0.01357/
C-----------------------------------------------------------------------
C---- NORTH FEMALE MODEL LIFE TABLE CONSTANTS --------------------------
C-----------------------------------------------------------------------
      DATA CD4 /
     *   0.47504,   -0.006923,   5.7332,     -0.05133,
     *   0.45025,   -0.006805,   7.6298,     -0.08909,
     *   0.19376,   -0.002928,   7.1271,     -0.08647,
     *   0.10041,   -0.001497,   6.1089,     -0.07192,
     *   0.10126,   -0.001480,   5.4984,     -0.05955,
     *   0.11261,   -0.001618,   5.2649,     -0.05372,
     *   0.13137,   -0.001893,   5.2547,     -0.05236,
     *   0.15448,   -0.002239,   5.3691,     -0.05339,
     *   0.17693,   -0.002566,   5.3186,     -0.05136,
     *   0.18440,   -0.002612,   4.9099,     -0.04261,
     *   0.19440,   -0.002712,   4.6164,     -0.03627,
     *   0.22364,   -0.003011,   4.3673,     -0.02961,
     *   0.30043,   -0.004053,   4.4363,     -0.02858,
     *   0.41033,   -0.005394,   4.4163,     -0.02511,
     *   0.56691,   -0.007187,   4.4030,     -0.02152,
     *   0.77206,   -0.009334,   4.3826,     -0.01784,
     *   0.96175,   -0.010681,   4.3108,     -0.01355/
C-----------------------------------------------------------------------
C---- EAST MALE MODEL LIFE TABLE CONSTANTS -----------------------------
C-----------------------------------------------------------------------
      DATA CD5 /
     *   1.07554,   -0.017228,   6.3796,     -0.06124,
     *   0.55179,   -0.009201,   7.8944,     -0.09934,
     *   0.15292,   -0.002523,   6.4371,     -0.08076,
     *   0.06856,   -0.001096,   5.1199,     -0.05978,
     *   0.10060,   -0.001578,   4.9229,     -0.05182,
     *   0.14725,   -0.002312,   5.1056,     -0.05225,
```

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     *   0.15127,   -0.002381,   5.1036,    -0.05207,
     *   0.17022,   -0.002686,   5.1685,    -0.05244,
     *   0.20786,   -0.003277,   5.1986,    -0.05131,
     *   0.24876,   -0.003868,   5.0221,    -0.04577,
     *   0.28685,   -0.004320,   4.6915,    -0.03697,
     *   0.32623,   -0.004654,   4.3492,    -0.02767,
     *   0.38906,   -0.005243,   4.1849,    -0.02171,
     *   0.49337,   -0.006341,   4.1647,    -0.01842,
     *   0.66168,   -0.008182,   4.2175,    -0.01634,
     *   0.84188,   -0.009644,   4.2171,    -0.01324,
     *   1.03876,   -0.010780,   4.2155,    -0.01035/
C-----------------------------------------------------------------------
C---- EAST FEMALE MODEL LIFE TABLE CONSTANTS --------------------------
C-----------------------------------------------------------------------
      DATA CD6 /
     *   0.78219,   -0.011679,   5.8529,    -0.05064,
     *   0.46584,   -0.007284,   7.2269,    -0.08351,
     *   0.13739,   -0.002136,   6.3204,    -0.07590,
     *   0.07600,   -0.001166,   5.6332,    -0.06684,
     *   0.10067,   -0.001529,   5.5780,    -0.06295,
     *   0.13039,   -0.001973,   5.5872,    -0.06081,
     *   0.15401,   -0.002335,   5.6149,    -0.06004,
     *   0.16941,   -0.002559,   5.4593,    -0.05616,
     *   0.18184,   -0.002718,   5.1881,    -0.05000,
     *   0.18555,   -0.002718,   4.8186,    -0.04209,
     *   0.19407,   -0.002746,   4.4509,    -0.03368,
     *   0.24415,   -0.003376,   4.3702,    -0.02966,
     *   0.34490,   -0.004723,   4.4480,    -0.02807,
     *   0.49585,   -0.006651,   4.4917,    -0.02544,
     *   0.68867,   -0.008874,   4.4702,    -0.02152,
     *   0.88452,   -0.010551,   4.3759,    -0.01640,
     *   1.07727,   -0.011513,   4.2972,    -0.01191/
C-----------------------------------------------------------------------
C---- SOUTH MALE MODEL LIFE TABLE CONSTANTS ----------------------------
C-----------------------------------------------------------------------
      DATA CD7 /
     *   0.61903,   -0.008974,   4.7096,    -0.02980,
     *   0.70613,   -0.011375,   6.3246,    -0.06433,
     *   0.16455,   -0.002674,   5.6400,    -0.06389,
     *   0.07634,   -0.001207,   4.6816,    -0.05008,
     *   0.11449,   -0.001810,   4.9454,    -0.05170,
     *   0.17104,   -0.002693,   5.2748,    -0.05458,
     *   0.17171,   -0.002710,   5.1168,    -0.05152,
     *   0.16483,   -0.002535,   4.8459,    -0.04547,
     *   0.17905,   -0.002734,   4.7660,    -0.04292,
     *   0.20606,   -0.003081,   4.5796,    -0.03738,
     *   0.23208,   -0.003370,   4.3559,    -0.03116,
     *   0.28000,   -0.003917,   4.1918,    -0.02547,
     *   0.35245,   -0.004765,   4.1492,    -0.02193,
     *   0.49465,   -0.006569,   4.2479,    -0.02063,
     *   0.66947,   -0.008608,   4.3069,    -0.01863,
     *   0.89759,   -0.010843,   4.3251,    -0.01552,
     *   1.10111,   -0.011806,   4.2684,    -0.01123/
```

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C-----------------------------------------------------------------------
C---- SOUTH FEMALE MODEL LIFE TABLE CONSTANTS ---------------------------
C-----------------------------------------------------------------------
      DATA CD8 /
     *   0.52069,   -0.007051,   4.5097,    -0.02566,
     *   0.68268,   -0.010453,   5.9815,    -0.05532,
     *   0.17066,   -0.002657,   5.6479,    -0.06136,
     *   0.09000,   -0.001380,   5.1045,    -0.05537,
     *   0.12189,   -0.001851,   5.2384,    -0.05494,
     *   0.15083,   -0.002279,   5.1708,    -0.05171,
     *   0.16073,   -0.002412,   5.0949,    -0.04945,
     *   0.16719,   -0.002505,   4.9291,    -0.04590,
     *   0.17408,   -0.002583,   4.8035,    -0.04280,
     *   0.17278,   -0.002504,   4.4917,    -0.03615,
     *   0.17800,   -0.002513,   4.2693,    -0.03092,
     *   0.22639,   -0.003140,   4.1982,    -0.02717,
     *   0.30167,   -0.004130,   4.2724,    -0.02588,
     *   0.47682,   -0.006501,   4.4242,    -0.02491,
     *   0.67440,   -0.008891,   4.4554,    -0.02190,
     *   0.92943,   -0.011532,   4.4348,    -0.01775,
     *   1.16023,   -0.013009,   4.3542,    -0.01296/
      NPRNT=6
      ARRAY(1,8)=0.0
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 800
      IF(NREG.LT.0.OR.NREG.GT.9) GO TO 800
      IF(NPARM.LT.1.OR.NPARM.GT.4) GO TO 800
      IF(NAGE.LT.0) GO TO 806
      ITST=MOD(NAGE,5)
      IF(NAGE.GT.5.AND.ITST.NE.0) GO TO 806
C     ETINIT IS THE INITIAL ESTIMATED LIFE EXPECTANCY AT AGE TEN.
C     IF CONVERGENCE FAILS FOR REGIONS 6 - 9, THEN EITHER ETINIT NEEDS
C     ADJUSTMENT OR NEEDS TO BE READ IN.
      ETINIT=50.0
      EP=-1.0
      NPARX=NPARM
      CMX=CMP
      CHNG=DABS(RNGE)
      IF(CMP2.LT.CMP) CHNG=-CHNG
      FIN=CMP2+0.01*CHNG
      NPG=0
      LS=1
      IF(NREG.GE.6) LS=2
      IF(NREG.GE.6) NMAX=17
      IF(NREG.LE.5) NMAX=18
      ICLM=ICOL(NPARX)
      IF(NPARX.EQ.4) NPARX=8
      DO 80 I=1,NMAX
      IAGE(I)=5*(I-2)
      IKOD=NMAX*(NSEX-1)+I
      VEC(I)=VEC1(IKOD)
      IF(NREG.EQ.1) AVEX(I)=EMP1(IKOD)
      IF(NREG.EQ.2) AVEX(I)=EMP2(IKOD)
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      IF(NREG.EQ.3) AVEX(I)=EMP3(IKOD)
      IF(NREG.EQ.4) AVEX(I)=EMP4(IKOD)
      IF(NREG.EQ.5) AVEX(I)=EMP5(IKOD)
      IF(NREG.LE.5) GO TO 80
      DO 79 J=1,4
      K=4*(I-1)+J
      IF(NREG.EQ.6.AND.NSEX.EQ.1) CD(J,I)=CD1(K)
      IF(NREG.EQ.6.AND.NSEX.EQ.2) CD(J,I)=CD2(K)
      IF(NREG.EQ.7.AND.NSEX.EQ.1) CD(J,I)=CD3(K)
      IF(NREG.EQ.7.AND.NSEX.EQ.2) CD(J,I)=CD4(K)
      IF(NREG.EQ.8.AND.NSEX.EQ.1) CD(J,I)=CD5(K)
      IF(NREG.EQ.8.AND.NSEX.EQ.2) CD(J,I)=CD6(K)
      IF(NREG.EQ.9.AND.NSEX.EQ.1) CD(J,I)=CD7(K)
      IF(NREG.EQ.9.AND.NSEX.EQ.2) CD(J,I)=CD8(K)
   79 CONTINUE
   80 CONTINUE
      IAGE(1)=0
      IAGE(2)=1
      IF(NREG.NE.0) GO TO 84
      DO 14 I=1,18
   14 AVEX(I)=AVE(I)
      DO 81 I=1,18
      NMAX=19-I
      IF(AVEX(NMAX).NE.0.0) GO TO 82
   81 CONTINUE
   82 IF(NMAX.LT.14) GO TO 804
      DO 83 I=1,NMAX
      IF(AVEX(I).LE.0.0.OR.AVEX(I).GE.1.0) GO TO 802
   83 CONTINUE
      DO 87 I=1,NMAX
   87 AVEX(I)=0.5*DLOG(AVEX(I)/(1.0-AVEX(I)))
   84 NCHK=5*NMAX-5
      IF(NPARM.EQ.2) NCHK=NCHK-5
      IF(NAGE.GT.NCHK) GO TO 806
      NAGE1=NAGE+1
      NREG1=NREG+1
      DO 20 I=1,50
      IF(NPLT.EQ.0) WRITE(NPRNT,111)
  111 FORMAT('1')
      IF(NPLT.GE.2) GO TO 19
      IF(NREG.NE.0) WRITE(NPRNT,11)ALBL(LS),BLBL(LS),AREG1(NREG1),
     & AREG2(NREG1),ASEX(NSEX),ICLM,NAGE,CMX,(LABEL(II),II=1,10)
   11 FORMAT(////25X,A8,A7,'MODEL LIFE TABLE FOR THE',2A8/
     & 25X,'PATTERN OF THE',A8,'SEX WITH A VALUE OF ',A1,'(',I2,')=',
     & F11.5/25X,'FOR THE STUDY OF ',10A4//)
      IF(NREG.EQ.0) WRITE(NPRNT,12) (LABEL(II),II=11,18),ASEX(NSEX),
     & ICLM,NAGE,CMX,(LABEL(II),II=1,10)
   12 FORMAT(////25X,'USER SUPPLIED MODEL LIFE TABLE FOR THE ',8A4/
     & 25X,'PATTERN OF THE',A8,'SEX WITH A VALUE OF ',A1,'(',I2,')=',
     &F11.5/25X,'FOR THE STUDY OF ',10A4//)
   19 IF(NREG.GE.6) GO TO 430
      C=-2.0
```

```
      CN=2.0
      DO 23 JT=1,40
      IF(C.LT.-18.0.AND.NSEX.EQ.1) C=-18.0
      IF(C.LT.-10.6.AND.NSEX.EQ.2) C=-10.6
      IF(C.GT.5.65) C=5.65
      DO 21 J=1,NMAX
      K=IAGE(J)+1
      Q(K)=AVEX(J)+C*VEC(J)
      ETQ=DEXP(2.0*Q(K))
      Q(K)=ETQ/(1.0+ETQ)
   21 CONTINUE
      K=5*NMAX-5
      IF(NPARX.EQ.3) GO TO 561
      IF(NPARX.EQ.2) ARRAY(NAGE1,NPARX)=Q(NAGE1)
      IF(NPARX.EQ.2) GO TO 550
      CALL LIFTB(NPG,LABEL,K,NTYPE,NSEX,Q,ARRAY,ITWO)
      GO TO 550
  561 ARRAY(1,3)=100000.0
      ARRAY(2,3)=ARRAY(1,3)*(1.0-Q(1))
      ARRAY(6,3)=ARRAY(2,3)*(1.0-Q(2))
      IF(NAGE1.LT.11) GO TO 478
      DO 477 II=11,NAGE1,5
  477 ARRAY(II,3)=ARRAY(II-5,3)*(1.0-Q(II-5))
  478 IF(NAGE.LT.2.OR.NAGE.GT.4) GO TO 550
      QXS(1)=Q(1)
      QXS(2)=Q(2)
      QXS(3)=Q(6)
      CALL ICM(LABEL,QXS,SL,ITWO)
      ARRAY(3,3)=SL(3)
      ARRAY(4,3)=SL(4)
      ARRAY(5,3)=SL(5)
  550 E=ARRAY(NAGE1,NPARX)
      TEMP=DABS(E-CMX)/CMX
C  IF CHANGING TO SINGLE PRECISION, 0.000005 MAY HAVE TO BE INCREASED.
      IF(TEMP.LT.0.000005) GO TO 420
      IF(E.EQ.EP) GO TO 420
      IF(JT.NE.1)CN=C-(E-CMX)*(C-CP)/(E-EP)
      CP=C
      EP=E
      C=CN
   23 CONTINUE
      GO TO 425
  430 ET1= 0.0
      ET2= 100.0
      DO 390 JT=1,20
      IF(JT-2) 240,240,250
  240 X=JT*10-15
      C=ETINIT+X
      GO TO 270
  250 CONTINUE
      IF(E02-E01) 260,420,260
  260 C= ET1 + (ET2-ET1) * (CMX-E01) / (E02-E01)
```

```
      IF(C.LT.20.0) C=20.0
      IF(C.GT.99.0) C=99.0
C---- CALCULATION OF Q(X) VALUES
  270 DO 310 J=1,17
      K=IAGE(J)+1
      X= CD(1,J)+CD(2,J)*C
      XP1= CD(3,J)+CD(4,J)*C
      XP= 10.0**XP1/10000.0
      IF (XP-X) 300,310,280
  280 CONTINUE
      IF (C-54.0) 310,310,290
  290 X=XP
      GO TO 310
  300 X= (X+XP) /2.0
  310 Q(K)= X
      K=5*NMAX-5
C---- GENERATE NEW LIFE TABLE AND TEST LIFE EXPECTANCY
      IF(NPARX.EQ.3) GO TO 562
      IF(NPARX.EQ.2) ARRAY(NAGE1,NPARX)=Q(NAGE1)
      IF(NPARX.EQ.2) GO TO 551
      CALL LIFTB(NPG,LABEL,NFIN80,NTYPE,NSEX,Q,ARRAY,ITWO)
      GO TO 551
  562 ARRAY(1,3)=100000.0
      ARRAY(2,3)=ARRAY(1,3)*(1.0-Q(1))
      ARRAY(6,3)=ARRAY(2,3)*(1.0-Q(2))
      IF(NAGE1.LT.11) GO TO 488
      DO 487 II=11,NAGE1,5
  487 ARRAY(II,3)=ARRAY(II-5,3)*(1.0-Q(II-5))
  488 IF(NAGE.LT.2.OR.NAGE.GT.4) GO TO 551
      QXS(1)=Q(1)
      QXS(2)=Q(2)
      QXS(3)=Q(6)
      CALL ICM(LABEL,QXS,SL,ITWO)
      ARRAY(3,3)=SL(3)
      ARRAY(4,3)=SL(4)
      ARRAY(5,3)=SL(5)
  551 TEMP=DABS(CMX-ARRAY(NAGE1,NPARX))/CMX
C  IF CHANGING TO SINGLE PRECISION, 0.000005 MAY HAVE TO BE INCREASED.
      IF(TEMP.LT.0.000005) GO TO 420
C---- CHANGE INTERVAL FOR NEXT INTERPOLATION
      IF(DABS(C-ET1)-DABS(C-ET2)) 370,370,380
  370 ET2=C
      E02=ARRAY(NAGE1,NPARX)
      GO TO 390
  380 ET1=C
      E01=ARRAY(NAGE1,NPARX)
  390 CONTINUE
  425 WRITE(NPRNT,555) (LABEL(II),II=1,10)
  555 FORMAT(//5X,'*** WARNING IN MATCH FOR DATA SET ',10A4/5X,
     & 'ITERATION LIMIT EXCEEDED ATTEMPTING TO INTERPOLATE FOR MODEL ',
     & 'LIFE TABLE'////)
      GO TO 98
```

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 420 CALL LIFTB(NPG,LABEL,K,NTYPE,NSEX,Q,ARRAY,ITWO)
     EO=ARRAY(1,8)
     IF(EO.GT.80.05.OR.EO.LT.19.95) GO TO 808
     IF(NPLT.LT.2) CALL LIFTB(NPG,LABEL,K,NTYPE,NSEX,Q,ARRAY,
    & IONE)
  98 IF(RNGE.EQ.0.0) GO TO 99
     CMX=CMX+CHNG
     IF(CHNG.GT.0.0.AND.CMX.GT.FIN) GO TO 99
     IF(CHNG.LT.0.0.AND.CMX.LT.FIN) GO TO 99
  20 CONTINUE
     WRITE(NPRNT,810) (LABEL(I),I=1,10)
 810 FORMAT('1'/5X,'*** ERROR IN MATCH FOR DATA SET ',10A4/5X,
    & 'EXECUTION STOPPED BECAUSE LIMIT OF 50 CALCULATED LIFE TABLES ',
    & 'PERMITTED.')
     GO TO 99
 800 WRITE(NPRNT,801) (LABEL(I),I=1,10),NSEX,NREG,NPARM
 801 FORMAT('1'/5X,'*** ERROR IN MATCH FOR DATA SET ',10A4/5X,
    & 'INPUT ERROR IN AT LEAST ONE OF THE FOLLOWING PARAMETERS:'//
    & 5X,'NSEX SHOULD BE 1 OR 2.           ',3X,'NSEX  =',I4/
    & 5X,'NREG SHOULD BE BETWEEN 0 AND 9. ',3X,'NREG  =',I4/
    & 5X,'NPARM SHOULD BE BETWEEN 1 AND 4.',3X,'NPARM =',I4)
     GO TO 99
 802 WRITE(NPRNT,803) (LABEL(I),I=1,10),(AVEX(I),I=1,NMAX)
 803 FORMAT('1'/5X,'*** ERROR IN MATCH FOR DATA SET ',10A4/5X,'INPUT ',
    & 'AVE VALUE(S) IS OUTSIDE THE RANGE OF 0 AND 1:'/2(/1X,10F8.5))
     GO TO 99
 804 WRITE(NPRNT,805) (LABEL(I),I=1,10),NMAX
 805 FORMAT('1'/5X,'*** ERROR IN MATCH FOR DATA SET ',10A4/5X,
    & 'AT LEAST 14 CONSECUTIVE INPUT VALUES FOR AVE ARE REQUIRED, ',
    & 'BUT ONLY',I3,' WERE SUPPLIED.')
     GO TO 99
 806 WRITE(NPRNT,807) (LABEL(I),I=1,10),NCHK,NAGE
 807 FORMAT('1'/5X,'*** ERROR IN MATCH FOR DATA SET ',10A4/
    & 5X,'THE MINIMUM VALUE FOR NAGE IS 0 AND THE MAXIMUM VALUE IS',I3,
    & ' FOR THIS TABLE.'/5X,'NAGE MUST BE A MULTIPLE OF 5 WHEN ',
    & 'GREATER THAN AGE 5.'/5X,'NAGE =',I4)
     GO TO 99
 808 IF(NPLT.EQ.2) WRITE(NPRNT,8081)
8081 FORMAT('1')
     IF(NPLT.NE.3) WRITE(NPRNT,809) (LABEL(I),I=1,10),ICLM,NAGE,CMP
 809 FORMAT(//5X,'*** ERROR IN MATCH FOR DATA SET ',10A4/5X,
    & 'REQUESTED PARAMETER RELATES TO A LIFE TABLE WITH A LIFE '/
    & 5X,'EXPECTANCY AT BIRTH OUTSIDE THE RANGE OF 20 YEARS ',
    & 'TO 80 YEARS.'/5X,'NO MODEL LIFE TABLE CALCULATED FOR ',
    & A1,'(',I2,')=',F11.5)
  99 RETURN
     END
```

MULT

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      SUBROUTINE MULT(A,B,NR,NB,NC,C)
C***********************************************************************
C***                              MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
C     (ARRAY C) = (ARRAY A) X (ARRAY B)
      DIMENSION A(8,8),B(8,8),C(8,8)
      DO 100 I=1,NR
      DO 100 J=1,NC
      C(I,J)=0.0
      DO 100 K=1,NB
      C(I,J)=C(I,J)+A(I,K)*B(K,J)
  100 CONTINUE
      RETURN
      END
```

ORPHAN

```
      SUBROUTINE ORPHAN(LABEL,MONTH,NYEAR,AGE,SNOR,CEB)
C*********************************************************************
C***                            MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C*********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),SNOR(7),CEB(7),AE0(7,9),AE20(7,9)
      DIMENSION NAGE(2,7),HEAD(3),MON(12),IGL(7,9)
      DIMENSION ARRAY(101,9),TSTAR(7),IYR(7),IMN(7),ADSURV(9,7)
      DIMENSION UNA00(7,5),UNB00(7,5),UNC00(7,5),UND00(7,5),UNE00(7,5)
      DIMENSION UNA20(7,5),UNB20(7,5),UNC20(7,5),UND20(7,5),UNE20(7,5)
      DIMENSION CDA00(7,4),CDB00(7,4),CDC00(7,4),CDD00(7,4),CDE00(7,4)
      DIMENSION CDA20(7,4),CDB20(7,4),CDC20(7,4),CDD20(7,4),CDE20(7,4)
      DATA AE0,AE20/126*0.0/,TSTAR/7*0.0/
      DATA IBL,IGT,ILT/' ','GT','LT'/
      DATA HEAD/'AGE','GROUP OF','RESPONDE'/
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     &          'OCT','NOV','DEC'/
      DATA UNA00/ 1.58061, 1.23360, 0.91926, 0.59781, 0.21977,-0.20186,
     & -0.67116, 1.36791, 1.05676, 0.76358, 0.44943, 0.12101,-0.26268,
     & -0.64267, 2.29463, 1.88438, 1.42830, 0.93891, 0.40374,-0.15342,
     & -0.70966, 0.98419, 0.68872, 0.39720, 0.10635,-0.23003,-0.54255,
     & -0.85811, 1.39760, 1.07193, 0.75336, 0.41337, 0.05691,-0.34332,
     & -0.78229/
      DATA UNB00/-1.15960,-1.09441,-1.04260,-0.99638,-0.96647,-0.93221,
     & -0.86700,-1.00936,-0.94835,-0.90435,-0.87301,-0.84539,-0.81717,
     & -0.74839,-1.41040,-1.32849,-1.24314,-1.15081,-1.06402,-0.99098,
     & -0.88471,-0.87367,-0.82345,-0.79294,-0.76889,-0.75620,-0.71526,
     & -0.64587,-1.07933,-1.01308,-0.96206,-0.92392,-0.88879,-0.85158,
     & -0.78302/
      DATA UNC00/ 0.12304, 0.10075, 0.07908, 0.06019, 0.04426, 0.04212,
     &  0.05181, 0.09949, 0.07910, 0.05909, 0.04094, 0.03124, 0.03069,
     &  0.04109, 0.17858, 0.16377, 0.14010, 0.11161, 0.08338, 0.06483,
     &  0.06385, 0.07136, 0.05077, 0.03260, 0.02245, 0.01725, 0.02465,
     &  0.03231, 0.11180, 0.09082, 0.06908, 0.04908, 0.03859, 0.03893,
     &  0.04698/
      DATA UND00/-0.00675,-0.00506,-0.00234, 0.00207, 0.00642, 0.01133,
     &  0.01357,-0.00548,-0.00344,-0.00075, 0.00256, 0.00654, 0.00966,
     &  0.01072,-0.01083,-0.01012,-0.00849,-0.00482, 0.00049, 0.00573,
     &  0.00915,-0.00313,-0.00069, 0.00224, 0.00571, 0.00778, 0.00926,
     &  0.00838,-0.00632,-0.00429,-0.00141, 0.00225, 0.00686, 0.01056,
     &  0.01141/
      DATA UNE00/ 94.0, 93.0, 93.0, 94.0, 94.0, 95.0, 96.0, 95.0, 95.0,
     &95.0, 95.0, 96.0, 97.0, 99.0, 95.0, 95.0, 94.0, 94.0, 94.0, 94.0,
     &95.0, 93.0, 93.0, 93.0, 94.0, 94.0, 96.0, 98.0, 93.0, 93.0, 93.0,
     &93.0, 94.0, 95.0, 96.0/
      DATA UNA20/ 1.67035, 1.81970, 1.67429, 0.14593,-0.09924,-0.35746,
     & -0.64867, 1.95976, 1.81978, 0.37652, 0.15280,-0.09400,-0.35445,
     & -0.59952, 0.86203, 0.85216, 1.13795, 1.53283, 1.35202,-0.26216,
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&  -0.49626, 1.99731, 0.52620, 0.29539, 0.04963,-0.18933,-0.41585,
&  -0.61349, 1.78813, 1.83504, 0.37008, 0.11472,-0.11590,-0.37540,
&  -0.66455/
 DATA UNB20/-0.60273,-0.51919,-0.46991,-0.64575,-0.62724,-0.60636,
&  -0.57471,-0.56317,-0.50414,-0.64540,-0.61995,-0.60374,-0.58412,
&  -0.54077,-0.76586,-0.66706,-0.52727,-0.40611,-0.34151,-0.49906,
&  -0.44521,-0.53330,-0.65243,-0.62658,-0.61246,-0.59604,-0.56654,
&  -0.50962,-0.58502,-0.51024,-0.65383,-0.63296,-0.60663,-0.58345,
&  -0.54791/
 DATA UNC20/ 0.10325, 0.09415, 0.08412, 0.03892, 0.02571, 0.01904,
&   0.01756, 0.09766, 0.08728, 0.04696, 0.03259, 0.02105, 0.01590,
&   0.01726, 0.09590, 0.09314, 0.08925, 0.07679, 0.06180, 0.03030,
&   0.02118, 0.08647, 0.04279, 0.02744, 0.01547, 0.01067, 0.01230,
&   0.01653, 0.10047, 0.09063, 0.05048, 0.03384, 0.02376, 0.01887,
&   0.01756/
 DATA UND20/-0.00741,-0.00721,-0.00633,-0.00098, 0.00128, 0.00359,
&   0.00453,-0.00706,-0.00640,-0.00213,-0.00005, 0.00205, 0.00382,
&   0.00435,-0.00732,-0.00695,-0.00727,-0.00701,-0.00557,-0.00127,
&   0.00011,-0.00574,-0.00167, 0.00038, 0.00243, 0.00419, 0.00503,
&   0.00456,-0.00719,-0.00679,-0.00237,-0.00043, 0.00209, 0.00399,
&   0.00429/
 DATA UNE20/153.0,200.0,200.0, 77.0, 77.0, 78.0, 79.0,195.0,200.0,
&78.0, 78.0, 78.0, 79.0, 81.0, 76.0, 88.0,126.0,200.0,200.0, 83.0,
&85.0,200.0, 75.0, 75.0, 75.0, 76.0, 78.0, 81.0,166.0,200.0, 77.0,
&76.0, 77.0, 78.0, 79.0/
 DATA CDA00/ 2.71946, 1.28526, 0.83295, 0.41503,-0.09383,-0.63704,
&  -1.43689, 1.94020, 1.43088, 1.00210, 0.55472, 0.08714,-0.43831,
&  -1.15097, 2.37702, 2.72825, 1.27630, 0.75126, 0.17144,-0.48380,
&  -1.36254, 2.38104, 1.89882, 1.40355, 0.93230, 0.42913,-0.14856,
&  -0.91268/
 DATA CDB00/-1.37258,-1.26184,-1.13047,-1.08642,-1.10484,-1.23535,
&  -1.56234,-1.44174,-1.25538,-1.14767,-1.10026,-1.08750,-1.16782,
&  -1.42253,-1.77254,-1.46553,-1.33037,-1.19387,-1.15536,-1.21073,
&  -1.48067,-1.74647,-1.52215,-1.32064,-1.16308,-1.03612,-1.01365,
&  -1.12734/
 DATA CDC00/ 0.29106, 0.07952, 0.00760,-0.04893,-0.09961,-0.18386,
&  -0.31639, 0.10598, 0.04293,-0.01568,-0.04666,-0.09898,-0.18611,
&  -0.31241, 0.24341, 0.33042, 0.08218, 0.00185,-0.05874,-0.11369,
&  -0.25682, 0.26077, 0.20825, 0.13641, 0.06528, 0.00248,-0.03817,
&  -0.11687/
 DATA CDD00/-0.02186, 0.00143, 0.00974, 0.01474,-0.00950,-0.01700,
&  -0.03358,-0.00117, 0.00608, 0.01108,-0.00011,-0.01795,-0.02614,
&  -0.03958,-0.01513,-0.02675, 0.00257, 0.01444, 0.01571, 0.00803,
&  -0.02326,-0.01988,-0.01400,-0.00676, 0.00239, 0.01513, 0.01986,
&   0.00030/
 DATA CDE00/200.0, 86.0, 85.0, 84.0, 82.0, 82.0, 82.0, 87.0, 87.0,
&86.0, 84.0, 83.0, 83.0, 83.0, 88.0,200.0, 87.0, 86.0, 84.0, 83.0,
&82.0, 88.0, 91.0, 90.0, 89.0, 89.0, 87.0, 84.0/
 DATA CDA20/ 2.05161, 1.84579, 0.13484,-0.11007,-0.42423,-0.90420,
&  -1.51460, 2.05644, 0.44284, 0.19520,-0.04498,-0.26858,-0.78005,
&  -1.22584, 1.46537, 1.88788, 0.25080,-0.04895,-0.33901,-0.81581,
&  -1.45227, 1.30785, 1.91387, 0.31549, 0.03413,-0.25899,-0.58662,
&  -1.23489/
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      DATA CDB20/-0.64256,-0.53807,-0.69979,-0.66218,-0.68142,-0.81644,
     & -1.10869,-0.64895,-0.75247,-0.67797,-0.63775,-0.62218,-0.73935,
     & -0.87314,-0.74918,-0.55748,-0.70574,-0.64274,-0.62234,-0.70962,
     & -0.93671,-0.80623,-0.57953,-0.72196,-0.66172,-0.62235,-0.63015,
     & -0.79834/
      DATA CDC20/ 0.12733, 0.10280, 0.01204,-0.02541,-0.05182,-0.11697,
     & -0.25288, 0.12159, 0.03143,-0.00808,-0.03504,-0.04685,-0.10819,
     & -0.16487, 0.13722, 0.10905, 0.03759,-0.00968,-0.03958,-0.07475,
     & -0.17180, 0.13451, 0.11072, 0.03786,-0.00336,-0.03505,-0.04473,
     & -0.11386/
      DATA CDD20/-0.00950,-0.00744, 0.00442, 0.01129, 0.01508,-0.00331,
     & -0.02944,-0.00855, 0.00194, 0.00727, 0.01163, 0.01564,-0.00404,
     & -0.01401,-0.00995,-0.00845, 0.00004, 0.00688, 0.01452, 0.01007,
     & -0.01288,-0.00913,-0.00832,-0.00036, 0.00484, 0.01157, 0.01589,
     & -0.00275/
      DATA CDE20/200.0,200.0, 68.0, 68.0, 67.0, 64.0, 63.0,200.0, 70.0,
     &70.0, 70.0, 71.0, 66.0, 66.0,116.0,200.0, 70.0, 69.0, 69.0, 66.0,
     &64.0,100.0,200.0, 71.0, 70.0, 70.0, 70.0, 66.0/
      NPRNT=6
      DO 10 I=1,3
      IF(CEB(I).LE.0.0) GO TO 800
      IF(CEB(I).GE.10.0) GO TO 800
   10 CONTINUE
      DO 11 I=1,7
      IF(SNOR(I).LT.0.0) GO TO 800
      IF(SNOR(I).GT.1.0) GO TO 800
   11 CONTINUE
      IF(MONTH.LT.1.OR.MONTH.GT.12) GO TO 802
      DO 20 I=1,7
      N=5*(I+2)
      NAGE(1,I)=N
      NAGE(2,I)=N+5
   20 CONTINUE
C     (*) INPUT DATA BASED ON AGE OF MOTHER
C     (1) CALCULATION OF MULTIPLIERS FOR LATIN AMERICAN PATTERN
      ADSURV(1,1)=-0.2580+1.1289*SNOR(1)+0.0051*AGE
      ADSURV(1,2)=-0.2814+1.0917*SNOR(2)+0.0074*AGE
      ADSURV(1,3)=-0.3429+1.0707*SNOR(3)+0.0107*AGE
      ADSURV(1,4)=-0.4412+1.0639*SNOR(4)+0.0148*AGE
      ADSURV(1,5)=-0.5561+1.0650*SNOR(5)+0.0193*AGE
      ADSURV(1,6)=-0.6558+1.0670*SNOR(6)+0.0229*AGE
      ADSURV(1,7)=-0.6832+1.0519*SNOR(7)+0.0239*AGE
C     (2) CALCULATION OF MULTIPLIERS FOR CHILEAN PATTERN
      ADSURV(2,1)=-0.2918+1.1300*SNOR(1)+0.0063*AGE
      ADSURV(2,2)=-0.3261+1.0957*SNOR(2)+0.0090*AGE
      ADSURV(2,3)=-0.3942+1.0766*SNOR(3)+0.0125*AGE
      ADSURV(2,4)=-0.4910+1.0699*SNOR(4)+0.0165*AGE
      ADSURV(2,5)=-0.5908+1.0682*SNOR(5)+0.0204*AGE
      ADSURV(2,6)=-0.6556+1.0608*SNOR(6)+0.0229*AGE
      ADSURV(2,7)=-0.6374+1.0313*SNOR(7)+0.0224*AGE
C     (3) CALCULATION OF MULTIPLIERS FOR SOUTH ASIAN PATTERN
      ADSURV(3,1)=-0.2277+1.0872*SNOR(1)+0.0055*AGE
```

```
      ADSURV(3,2)=-0.2832+1.0591*SNOR(2)+0.0088*AGE
      ADSURV(3,3)=-0.4000+1.0602*SNOR(3)+0.0133*AGE
      ADSURV(3,4)=-0.5484+1.0716*SNOR(4)+0.0187*AGE
      ADSURV(3,5)=-0.7049+1.0908*SNOR(5)+0.0242*AGE
      ADSURV(3,6)=-0.8026+1.0983*SNOR(6)+0.0276*AGE
      ADSURV(3,7)=-0.7856+1.0751*SNOR(7)+0.0271*AGE
C     (4) CALCULATION OF MULTIPLIERS FOR FAR EASTERN PATTERN
      ADSURV(4,1)=-0.3207+1.1184*SNOR(1)+0.0079*AGE
      ADSURV(4,2)=-0.3849+1.0920*SNOR(2)+0.0115*AGE
      ADSURV(4,3)=-0.4829+1.0841*SNOR(3)+0.0157*AGE
      ADSURV(4,4)=-0.5765+1.0772*SNOR(4)+0.0196*AGE
      ADSURV(4,5)=-0.6421+1.0665*SNOR(5)+0.0222*AGE
      ADSURV(4,6)=-0.6373+1.0377*SNOR(6)+0.0223*AGE
      ADSURV(4,7)=-0.5445+0.9781*SNOR(7)+0.0193*AGE
C     (5) CALCULATION OF MULTIPLIERS FOR GENERAL PATTERN
      ADSURV(5,1)=-0.2715+1.1194*SNOR(1)+0.0059*AGE
      ADSURV(5,2)=-0.3173+1.0875*SNOR(2)+0.0089*AGE
      ADSURV(5,3)=-0.3960+1.0739*SNOR(3)+0.0127*AGE
      ADSURV(5,4)=-0.5031+1.0701*SNOR(4)+0.0170*AGE
      ADSURV(5,5)=-0.6120+1.0709*SNOR(5)+0.0212*AGE
      ADSURV(5,6)=-0.6810+1.0653*SNOR(6)+0.0238*AGE
      ADSURV(5,7)=-0.6592+1.0335*SNOR(7)+0.0231*AGE
C     (6) CALCULATION OF MULTIPLIERS FOR WEST, NORTH, EAST, SOUTH REGION
      ADSURV(6,1)=-0.1798+1.0505*SNOR(1)+0.00476*AGE
      ADSURV(6,2)=-0.2267+1.0291*SNOR(2)+0.00737*AGE
      ADSURV(6,3)=-0.3108+1.0287*SNOR(3)+0.01072*AGE
      ADSURV(6,4)=-0.4259+1.0473*SNOR(4)+0.01473*AGE
      ADSURV(6,5)=-0.5566+1.0818*SNOR(5)+0.01903*AGE
      ADSURV(6,6)=-0.6676+1.1228*SNOR(6)+0.02256*AGE
      ADSURV(6,7)=-0.6981+1.1454*SNOR(7)+0.02344*AGE
      WRITE(NPRNT,70) (LABEL(I),I=1,18)
   70 FORMAT('1',3X,'ORPHANHOOD ESTIMATES OF ADULT FEMALE MORTALITY ',
     & 'FOR ',18A4)
      WRITE(NPRNT,71) MON(MONTH),NYEAR,AGE,(CEB(I),I=1,3)
   71 FORMAT(//2X,'DATE OF SURVEY = ',A4,I4/2X,'AVERAGE AGE AT ',
     & 'CHILDBEARING =',F6.2/2X,'CHILDREN EVER BORN:'/4X,'AGES 15-20 =',
     & F6.3/4X,'AGES 20-25 =',F6.3/4X,'AGES 25-30 =',F6.3)
      WRITE(NPRNT,73)
   73 FORMAT(////57X,'PROBABILITY OF SURVIVING FROM AGE 25 TO AGE X'/
     &  2X,10('-'),3X,10('-'),3X,80('-'),3X,18('-')/2X,'AGE',10X,
     & 'PROPORTION',28X,'UNITED NATIONS MODELS',37X,
     & 'COALE-DEMENY MODEL'/2X,'GROUP OF',8X,'NOT',8X,'AGE X',16X,
     & '(PALLONI-HELIGMAN EQUATIONS)',35X,'(HILL-TRUSSELL'/2X,
     & 'RESPONDENT',4X,'ORPHANED',15X,'LATIN AM.',7X,'CHILEAN',7X,
     & 'SO. ASIAN',7X,'FAR EAST',7X,'GENERAL',9X,'EQUATION)'/2X,10('-'),
     & 3X,10('-'),3X,80('-'),3X,18('-')/)
      DO 74 J=1,7
      NX=5*(J+8)
      WRITE(NPRNT,75) (NAGE(I,J),I=1,2),SNOR(J),NX,(ADSURV(NR,J),NR=1,6)
   75 FORMAT(3X,I2,'-',I2,9X,F5.4,8X,I2,9X,5(F5.4,10X),1X,F5.4)
   74 CONTINUE
      DO 30 I=1,7
```

```
      DO 30 NREG=1,6
      IF(ADSURV(NREG,I).LE.0.02) ADSURV(NREG,I)=0.02
      IF(ADSURV(NREG,I).GE.0.994) ADSURV(NREG,I)=0.994
   30 CONTINUE
      DO 40 I=1,7
      DO 40 NR=1,5
      IGL(I,NR)=IBL
      XV=DLOG(ADSURV(NR,I)/(1.0-ADSURV(NR,I)))
      FCN=UNA00(I,NR)+UNB00(I,NR)*XV+UNC00(I,NR)*XV**2+UND00(I,NR)*XV**3
      AE0(I,NR)=UNE00(I,NR)/(DEXP(FCN)+1.0)
      IF(AE0(I,NR).GE.20.0) GO TO 41
      IGL(I,NR)=ILT
      AE20(I,NR)=19.98
      AE0(I,NR)=19.98
      GO TO 40
   41 IF(AE0(I,NR).LE.80.0) GO TO 42
      IGL(I,NR)=IGT
      AE20(I,NR)=80.02
      AE0(I,NR)=80.02
      GO TO 40
   42 FCN=UNA20(I,NR)+UNB20(I,NR)*XV+UNC20(I,NR)*XV**2+UND20(I,NR)*XV**3
      AE20(I,NR)=UNE20(I,NR)/(DEXP(FCN)+1.0)
   40 CONTINUE
      DO 50 I=1,7
      XV=DLOG(ADSURV(6,I)/(1.0-ADSURV(6,I)))
      DO 50 NREG=6,9
      IGL(I,NREG)=IBL
      NR=NREG-5
      FCN=CDA00(I,NR)+CDB00(I,NR)*XV+CDC00(I,NR)*XV**2+CDD00(I,NR)*XV**3
      AE0(I,NREG)=CDE00(I,NR)/(DEXP(FCN)+1.0)
      IF(AE0(I,NREG).GE.20.0) GO TO 51
      IGL(I,NREG)=ILT
      AE20(I,NREG)=19.98
      AE0(I,NREG)=19.98
      GO TO 50
   51 IF(AE0(I,NREG).LE.80.0) GO TO 52
      IGL(I,NREG)=IGT
      AE20(I,NREG)=80.02
      AE0(I,NREG)=80.02
      GO TO 50
   52 FCN=CDA20(I,NR)+CDB20(I,NR)*XV+CDC20(I,NR)*XV**2+CDD20(I,NR)*XV**3
      AE20(I,NREG)=CDE20(I,NR)/(DEXP(FCN)+1.0)
   50 CONTINUE
      PAR1=CEB(1)/CEB(2)
      PAR2=CEB(2)/CEB(3)
      TSTAR(1)=-105.4+4.49*AGE+0.289*PAR1+3.068*PAR2+121.19*SNOR(1)
     & -4.81*SNOR(1)*AGE
      TSTAR(2)=-72.2+3.28*AGE+0.508*PAR1+3.417*PAR2+90.95*SNOR(2)
     & -3.65*SNOR(2)*AGE
      TSTAR(3)=-46.9+2.33*AGE+0.746*PAR1+3.614*PAR2+68.99*SNOR(3)
     & -2.76*SNOR(3)*AGE
      TSTAR(4)=-18.3+1.26*AGE+0.520*PAR1+2.427*PAR2+44.33*SNOR(4)
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     & -1.77*SNOR(4)*AGE
      TSTAR(5)=14.3+0.11*AGE+0.658*PAR1+1.809*PAR2+3.93*SNOR(5)
     & -0.28*SNOR(5)*AGE
      TSTAR(6)=52.0-1.22*AGE+0.770*PAR1+0.541*PAR2-60.05*SNOR(6)
     & +1.98*SNOR(6)*AGE
      AYR=NYEAR
      AMON=MONTH-0.5
      CEN=AYR+AMON/12.0
      DO 61 J=1,6
      RDT=CEN-TSTAR(J)
      IYR(J)=RDT
      AMON=RDT-IYR(J)
      AMON=12.0*AMON+1.0
      IMON=AMON
      IF(IMON.LT.1) IMON=1
      IF(IMON.GT.12) IMON=12
      IMN(J)=MON(IMON)
   61 CONTINUE
      WRITE(NPRNT,76) (HEAD(I),I=1,3)
   76 FORMAT(////61X,'CORRESPONDING LIFE EXPECTANCIES'/2X,10('-'),4X,
     & 11('-'),4X,53('-'),4X,39('-')/2X,A8,36X,'UNITED NATIONS MODELS',
     & 31X,'COALE-DEMENY MODELS'/2X,A8,7X,'REFERENCE',17X,'(PALLONI-',
     & 'HELIGMAN EQUATIONS)',24X,'(HILL-TRUSSELL EQUATIONS)'/2X,A8,
     & 'NT',7X,'DATE',9X,'LATIN AM.  CHILEAN   SO. ASIAN   FAR EAST',
     & '   GENERAL',6X,'WEST',6X,'NORTH',7X,'EAST',6X,'SOUTH'/
     & 2X,10('-'),4X,11('-'),4X,53('-'),4X,39('-'))
      WRITE(NPRNT,80)
   80 FORMAT(//2X,'LIFE EXPECTANCY AT AGE TWENTY'/)
      DO 81 J=1,6
      WRITE(NPRNT,82) (NAGE(I,J),I=1,2),IMN(J),IYR(J),(IGL(J,NR),
     &AE20(J,NR),NR=1,5),(IGL(J,NR),AE20(J,NR),NR=6,9)
   82 FORMAT(3X,I2,'-',I2,9X,A4,I4,6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
   81 CONTINUE
      WRITE(NPRNT,686) (NAGE(I,7),I=1,2),(IGL(7,NR),
     & AE20(7,NR),NR=1,5),(IGL(7,NR),AE20(7,NR),NR=6,9)
  686 FORMAT(3X,I2,'-',I2,13X,'XXXX',6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
      WRITE(NPRNT,77)
   77 FORMAT(/2X,'LIFE EXPECTANCY AT BIRTH'/)
      DO 78 J=1,6
      WRITE(NPRNT,79) (NAGE(I,J),I=1,2),IMN(J),IYR(J),(IGL(J,NR),
     & AE0(J,NR),NR=1,5),(IGL(J,NR),AE0(J,NR),NR=6,9)
   79 FORMAT(3X,I2,'-',I2,9X,A4,I4,6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
   78 CONTINUE
      WRITE(NPRNT,89) (NAGE(I,7),I=1,2),
     & (IGL(7,NR),AE0(7,NR),NR=1,5),(IGL(7,NR),AE0(7,NR),NR=6,9)
   89 FORMAT(3X,I2,'-',I2,13X,'XXXX',6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
      GO TO 99
  800 WRITE(NPRNT,801) LABEL,SNOR,(CEB(I),I=1,3)
```

```
801 FORMAT('1'/5X,'*** ERROR IN ORPHAN FOR DATA SET ',18A4/5X,
   & 'INPUT VALUE(S) IS OUTSIDE THE SPECIFIED RANGE. PLEASE CHECK:'//
   & 5X,'SNOR (FROM 0 TO  1)',7F8.4/5X,'CEB  (FROM 0 TO 10)',3F8.4)
    GO TO 99
802 WRITE(NPRNT,803) LABEL,MONTH
803 FORMAT('1'/5X,'*** ERROR IN ORPHAN FOR DATA SET ',18A4/5X,
   & 'THE MONTH MUST BE AN INTEGER VALUE FROM 1 TO 12, BUT ',
   & 'MONTH =',I4)
 99 RETURN
    END
```

PRESTO

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      SUBROUTINE PRESTO(LABEL,MONTH1,IYEAR1,MONTH2,IYEAR2,NVAL,PSTAR1,
     & PSTAR5,NSEX,NREG,NPARM,NAGE,CMP,POP1,POP2,AVE)
C***********************************************************************
C***                              MORTPAK                             ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),AVE(18),ARRAY(101,9),IAGE(18),C(18),MON(12)
      DIMENSION CEN1(18),CEN2(18),R(18),SLX(18),EIRX(18),XVAL(18)
      DIMENSION YVAL(18),SLI(18),Q(101),GMP(18),EC(18),XTMP(18)
      DIMENSION REG1(10),REG2(10),X(3),Y(3),LDV(55),H1(9),H2(9)
      DIMENSION POP1(18),POP2(18),ASEX(2),ICOL(4),YTMP(18)
      DIMENSION ASLOPE(4,15),BINTER(4,15),BRTH(4,15),CDR(4,15)
      DIMENSION EMS(4,15),EZERO(4,15),EFIVE(4,15),ALPHA(4,15)
      DIMENSION YPRED(4,15,18),DIFF(4,15,18),GMPOBS(4,15,18),COE(4,15,5)
      DIMENSION ASGR(4,15,18),GOA(4,15,18),IBUF(18),ABUF(18)
      DIMENSION CO(4,15,5),CE(4,15,5),BRTHS(4,15)
      DIMENSION IGRAPH(55,55),NUM(10),NBUF(110),XPRT(10),IPT(5,2)
      DATA NUM/'1','2','3','4','5','6','7','8','9','0'/
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     & 'OCT','NOV','DEC'/
      DATA XVAL(1),YVAL(1),RNGE/0.0,0.0,0.0/
      DATA LDV/18*' ','D','E','P','E','N','D','E','N','T',' ','V','A',
     & 'R','I','A','B','L','E',19*' '/
      DATA  REG1/' EMPIRIC',' LATIN A',' CHILEAN',' SOUTH A',' FAR EAS',
     &' GENERAL',' WEST    ',' NORTH   ',' EAST    ',' SOUTH   '/
      DATA  REG2/'AL      ','MERICAN ','        ','SIAN    ','TERN    ',
     &'        ','        ','        ','        ','        '/
      DATA ASEX/' MALE    ',' FEMALE '/,ICOL/'M','Q','I','E'/
      DATA IBL/' '/,IDOT/'.'/,ISTAR/'*'/
      DATA IDASH/'-'/,IPLUS/'+'/
      DATA H1/2*' ','ADJUSTED',6*' '/,ARAT/'RATIO'/
      DATA H2/2*' ','RATIO OF','OBSERVED','   TO','ADJUSTED',3*' '/
      NPRNT=6
      N=NVAL
      IF(N.GT.18.OR.N.LT.14) GO TO 800
      IF(NREG.LT.0.OR.NREG.GT.9) GO TO 804
      NREG1=NREG+1
      DO 123 I=1,18
      CEN1(I)=POP1(I)
  123 CEN2(I)=POP2(I)
      IF(MONTH1.LT.1.OR.MONTH1.GT.12) GO TO 806
      IF(MONTH2.LT.1.OR.MONTH2.GT.12) GO TO 806
      YRS=IYEAR2-IYEAR1+(MONTH2-MONTH1)/12.0
      CALL MATCH(LABEL,NSEX,NREG,NPARM,NAGE,CMP,CMP2,RNGE,AVE,ARRAY,2)
      E0=ARRAY(1,8)
      IF(E0.GT.80.05.OR.E0.LT.19.95) GO TO 808
      WRITE(NPRNT,71) (LABEL(II),II=1,10)
   71 FORMAT('1',21X,'INTEGRATED ESTIMATES OF DEMOGRAPHIC PARAMETERS ',
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   & 'FOR ',10A4)
     IF(NREG.NE.0) WRITE(NPRNT,711) REG1(NREG1),REG2(NREG1)
 711 FORMAT(///5X,'CHOSEN MODEL LIFE TABLE:'/8X,'PATTERN',12X,2A8)
     IF(NREG.EQ.0) WRITE(NPRNT,712) (LABEL(II),II=11,18)
 712 FORMAT(///5X,'CHOSEN MODEL LIFE TABLE:'/8X,'PATTERN',13X,
   & 'USER SUPPLIED FOR ',8A4)
     WRITE(NPRNT,714) ASEX(NSEX),ICOL(NPARM),NAGE,CMP
 714 FORMAT(8X,'SEX',16X,A8/8X,'MATCHED PARAMETER',3X,A1,
   & '(',I2,') = ',F11.5)
     WRITE(NPRNT,715) ARRAY(2,3),ARRAY(6,3),ARRAY(1,8),ARRAY(6,8)
 715 FORMAT(8X,'ASSOCIATED VALUES',3X,'I(1)=',F7.0,';  ','I(5)=',F7.0,
   & ';  ','E(0)=',1X,F5.2,';  ','E(5)=',1X,F5.2)
     WRITE(NPRNT,72) PSTAR1,PSTAR5
  72 FORMAT(//5X,'CHOSEN SURVIVORSHIP TO AGE 1: ',F7.0/5X,'CHOSEN ',
   & 'SURVIVORSHIP TO AGE 5: ',F7.0)
     WRITE(NPRNT,716)  MON(MONTH1),IYEAR1,MON(MONTH2),IYEAR2
 716 FORMAT(///12X,'CHARACTERISTICS OF POPULATION',15X,'CALCULATION',
   & ' OF INDEPENDENT AND DEPENDENT VARIABLES FOR REGRESSION'/5X,
   & 42('-'),7X,69('-')/62X,'PROPORTION OF',3X,'GROWTH',4X,'LIFE ',
   & 'TABLE',4X,'REGRESSION POINTS'/7X,'AGE',9X,'POPULATION',11X,
   & 'GROWTH',9X,'AGE',6X,'POPULATION',5X,'RATE',5X,'SURVIVORS',2X,
   & 23('-')/6X,'GROUP',3X,20('-'),7X,'RATE',11X,'X',8X,'AT EXACT',
   & 3X,'ADJUSTMENT',3X,'AT EXACT',2X,'INDEPENDENT',2X,'DEPENDENT'/
   & 14X,A3,I5,4X,A3,I5,32X,'AGE X',7X,'FACTOR',6X,'AGE X',6X,
   & 'VARIABLE',4X,'VARIABLE'/5X,42('-'),7X,69('-')/)
     DO 10 I=1,18
     INDX=5*I-4
     SLX(I)=ARRAY(INDX,3)
     IAGE(I)=5*(I-1)
  10 CONTINUE
     IF(NREG.GE.6) SLX(18)=0.0
     IF(NREG.NE.0) GO TO 25
     DO 26 L=1,18
     NMAX=19-L
     IF(AVE(NMAX).NE.0.0) GO TO 22
  26 CONTINUE
  22 NMAX=NMAX+1
     IF(NMAX.GE.N) GO TO 24
     SP1=0.0
     SP2=0.0
     DO 23 L=NMAX,N
     SP1=SP1+CEN1(L)
  23 SP2=SP2+CEN2(L)
     CEN1(NMAX)=SP1
     CEN2(NMAX)=SP2
     N=NMAX
  24 IF(NMAX.LE.18) SLX(NMAX)=0.0
  25 NM1=N-1
     TCEN1=0.0
     TCEN2=0.0
     DO 6 I=1,N
     TCEN1=TCEN1+CEN1(I)
```

```
  6 TCEN2=TCEN2+CEN2(I)
    TGR=DLOG(TCEN2/TCEN1)/YRS
    DO 20 I=1,N
    R(I)=DLOG(CEN2(I)/CEN1(I))/YRS
    IF(I.EQ.1.OR.I.EQ.N) GO TO 20
    XVAL(I)=SLX(2)/SLX(I)-1.0
    IAGE5=I-1
    SUMR=0.0
    DO 21 J=1,IAGE5
 21 SUMR=SUMR+R(J)
    EIRX(I)=DEXP(-5.0*SUMR)
 20 CONTINUE
    IF(N.GE.18) GO TO 29
    NP1=N+1
    DO 28 I=NP1,18
 28 R(I)=R(N)
 29 TMP=5.0*DSQRT(TCEN1*TCEN2)
    DO 40 I=2,NM1
    C(I)=(CEN1(I-1)*CEN2(I-1)*CEN1(I)*CEN2(I))**0.25/TMP
    YVAL(I)=PSTAR5*EIRX(I)/(100000.0*C(I))
 40 CONTINUE
    NM2=NM1-1
    DO 30 I=1,NM2
    J=I+1
    WRITE(NPRNT,3) IAGE(I),IAGE(J),CEN1(I),CEN2(I),R(I),IAGE(J),
   & C(J),EIRX(J),SLX(J),XVAL(J),YVAL(J)
  3 FORMAT(5X,I2,'-',I2,2F12.0,F12.5,9X,I2,3X,F12.5,6X,F6.5,
   & F12.0,2F12.5)
 30 CONTINUE
    WRITE(NPRNT,4) IAGE(NM1),IAGE(N),CEN1(NM1),CEN2(NM1),R(NM1)
  4 FORMAT(5X,I2,'-',I2,2F12.0,F12.5)
    WRITE(NPRNT,5) IAGE(N),CEN1(N),CEN2(N),R(N)
  5 FORMAT(5X,I2,'+',2X,2F12.0,F12.5)
    WRITE(NPRNT,37) TCEN1,TCEN2,TGR
 37 FORMAT(/5X,'TOTAL',2F12.0,F12.5)
    NAGS=15
    IF(NM1.LT.NAGS) NAGS=NM1
    DO 900 IAG2=13,NAGS
    DO 900 IAG1=2,4
    NPTS=IAG2-IAG1+1
    DO 50 I=IAG1,IAG2
    XTMP(I-IAG1+1)=XVAL(I)
 50 YTMP(I-IAG1+1)=YVAL(I)
    NM2=NM1-1
    DO 333 ITER=1,2
    SUMX=0.0
    SUMY=0.0
    SUMXX=0.0
    SUMYY=0.0
    CROSP=0.0
    FN=0.0
    DO 220 J=1,NPTS
```

```
      IF(ITER.EQ.1) WT=1.0/YTMP(J)**2
      IF(ITER.EQ.2) WT=1.0/(AVAL*XTMP(J)+BVAL)**2
      FN=FN+WT
      SUMX=SUMX+XTMP(J)*WT
      SUMY=SUMY+YTMP(J)*WT
      SUMXX=SUMXX+XTMP(J)*XTMP(J)*WT
      SUMYY=SUMYY+YTMP(J)*YTMP(J)*WT
      CROSP=CROSP+XTMP(J)*YTMP(J)*WT
  220 CONTINUE
      SX=(FN*SUMXX-SUMX*SUMX)
      SY=(FN*SUMYY-SUMY*SUMY)
      AVAL=(FN*CROSP-SUMX*SUMY)/SX
      BVAL=(SUMY*SUMXX-SUMX*CROSP)/SX
      SUMSQ=0.0
      DO 330 J=1,NPTS
  330 SUMSQ=SUMSQ+((AVAL*XTMP(J)+BVAL-YTMP(J))/YTMP(J))**2
  333 CONTINUE
      TMP=NPTS-2
C---- MEAN SQUARE ERROR
      EMS(IAG1,IAG2)=SUMSQ/TMP
      BRTH(IAG1,IAG2)=1.0/BVAL
      CDR(IAG1,IAG2)=BRTH(IAG1,IAG2)-TGR
      BRTHS(IAG1,IAG2)=BRTH(IAG1,IAG2)*DSQRT(TCEN1*TCEN2)
      IF(BRTH(IAG1,IAG2)*AVAL.LE.0.0) GO TO 802
      ALPHA(IAG1,IAG2)=DLOG(BRTH(IAG1,IAG2)*AVAL)
      DO 897 I=2,NM1
      YPRED(IAG1,IAG2,I)=AVAL*XVAL(I)+BVAL
      DIFF(IAG1,IAG2,I)=YVAL(I)-YPRED(IAG1,IAG2,I)
  897 CONTINUE
C     PSTAR5 BELOW ASSUMES ORIGINAL AND FINAL TABLE HAVE SAME PSTAR5
C     SLI(I) WILL CONTAIN THE NEW VALUES DEFINED AS I(X)/100000.0
      SLI(2)=PSTAR5/100000.0
      DO 54 I=3,18
      IF(SLX(I).EQ.0.0) NMAX=I-2
      IF(SLX(I).EQ.0.0) GO TO 56
      TMP=ALPHA(IAG1,IAG2)+DLOG(SLX(2)/SLX(I)-1.0)
      SLI(I)=PSTAR5/(100000.0*(DEXP(TMP)+1.0))
   54 CONTINUE
      NMAX=17
   56 Q(1)=1.0-PSTAR1/100000.0
      Q(2)=1.0-PSTAR5/PSTAR1
      DO 55 I=2,NMAX
      INDX=5*I-4
   55 Q(INDX)=1.0-SLI(I+1)/SLI(I)
      NFIN=INDX+4
      CALL LIFTB(0,LABEL,NFIN,1,NSEX,Q,ARRAY,2)
      ASLOPE(IAG1,IAG2)=AVAL
      BINTER(IAG1,IAG2)=BVAL
      EZERO(IAG1,IAG2)=ARRAY(1,8)
      EFIVE(IAG1,IAG2)=ARRAY(6,8)
      NMAX=NMAX+1
      IMAX=5*(NMAX-1)+1
```

```
      NTMP=NMAX-1
      IF(NM1.LT.NTMP) NTMP=NM1
      NOAG=NTMP+1
      IOAG=5*(NOAG-1)+1
      GMPT=0.0
      DO 61 I=1,NOAG
      GMP(I)=DSQRT(CEN1(I)*CEN2(I))
   61 GMPT=GMPT+GMP(I)
      DO 611 I=1,NOAG
  611 GMP(I)=GMP(I)/GMPT
      DO 1122 I=1,18
 1122 EC(I)=0.0
      SUM=-2.3*R(1)
      EC(1)=DEXP(SUM)*(ARRAY(1,5)+ARRAY(2,5))
      NMAX1=NMAX-1
      DO 63 I=2,NMAX1
      SUM=SUM-2.5*(R(I)+R(I-1))
   63 EC(I)=DEXP(SUM)*ARRAY(5*I-4,5)
      SUM=SUM-ARRAY(IMAX,8)*(R(NMAX)+R(NMAX-1))
      EC(NMAX)=DEXP(SUM)*ARRAY(5*NMAX-4,5)
      IF(NOAG.GE.NMAX) GO TO 632
      SUM=0.0
      DO 633 I=NOAG,NMAX
  633 SUM=SUM+EC(I)
      EC(NOAG)=SUM
  632 TOT=0.0
      DO 634 I=1,NOAG
  634 TOT=TOT+EC(I)
      DO 637 I=1,NOAG
  637 EC(I)=EC(I)/TOT
      DO 65 I=1,NOAG
      GMPOBS(IAG1,IAG2,I)=GMP(I)
      ASGR(IAG1,IAG2,I)=EC(I)
      GOA(IAG1,IAG2,I)=GMP(I)/EC(I)
   65 CONTINUE
  900 CONTINUE
      WRITE(NPRNT,701)
  701 FORMAT(///31X,'REGRESSION RESULTS',31X,'ESTIMATES OF DEMOGRAPHIC',
     & ' PARAMETERS'/2X,9('-'),7X,46('-'),6X,55('-')/44X,'MEAN SQUARE',
     & 2X,'NUMBER',20X,'CRUDE',7X,'CRUDE',9X,'LIFE EXPECTANCY'/
     & 2X,'AGE RANGE',9X,'SLOPE',6X,'INTERCEPT',5X,'RELATIVE',4X,
     & 'OF SIGN',7X,'BIRTHS',6X,'BIRTH',7X,'DEATH',8X,17('-')/47X,
     & 'ERROR',5X,'CHANGES',19X,'RATE ',7X,'RATE ',8X,'BIRTH',7X,
     & 'AGE 5'/2X,9('-'),7X,46('-'),6X,55('-'))
      DO 710 I2=13,NAGS
      DO 710 I1=2,4
      NSC=0
      DO 758 I=3,NM1
      TMP=DIFF(I1,I2,I)*DIFF(I1,I2,I-1)
      IF(TMP.LT.0.0) NSC=NSC+1
  758 CONTINUE
      WRITE(NPRNT,702) IAGE(I1),IAGE(I2),ASLOPE(I1,I2),BINTER(I1,I2),
```

```
     & EMS(I1,I2),NSC,BRTHS(I1,I2),BRTH(I1,I2),CDR(I1,I2),
     & EZERO(I1,I2),EFIVE(I1,I2)
  702 FORMAT(4X,I2,'-',I2,2X,2F14.2,F14.5,I8,4X,F12.0,2F12.5,2F12.2)
  710 CONTINUE
      DO 81 J=1,55
      DO 81 I=1,55
   81 IGRAPH(I,J)=0
      WRITE(NPRNT,9) LABEL
    9 FORMAT('1 ',18A4//)
      M=0
      XMIN=0.0
      XMAX=XVAL(2)
      DO 12 I=2,NM1
      IF(XVAL(I).GT.XMAX) XMAX=XVAL(I)
   12 CONTINUE
      YMIN=0.0
      YMAX=YVAL(2)
      DO 15 I=2,NM1
      IF(YVAL(I).GT.YMAX) YMAX=YVAL(I)
   15 CONTINUE
      DO 300 I=2,NM1
      NAGR=5*(I-1)
      PX=(XVAL(I)-XMIN)/(XMAX-XMIN)
      PY=(YVAL(I)-YMIN)/(YMAX-YMIN)
      IX=54.0*PX+0.5
      IX=IX+1
      IY=54.0*PY+0.5
      IY=55-IY
      IF(IY.LT.1.OR.IY.GT.55) GO TO 921
      IF(IX.LT.1.OR.IX.GT.55) GO TO 921
      ITMP=IGRAPH(IY,IX)
      IF(ITMP.EQ.0.OR.ITMP.EQ.IDOT) GO TO 34
      M=M+1
      IF(M.GE.6) GO TO 300
      IPT(M,1)=NAGR
      IPT(M,2)=ITMP
      GO TO 300
  921 WRITE(NPRNT,922) NAGR
  922 FORMAT(30X,'--- WARNING --- POINT ',I2,' FALLS OUTSIDE THE ',
     &'GRAPH.')
      GO TO 300
   34 IGRAPH(IY,IX)=NAGR
  300 CONTINUE
      YCTR=YMAX
      DO 400 I=1,55
      DO 500 J=1,55
      JP2=J*2
      JP1=JP2-1
      ITMP=IGRAPH(I,J)
      IF(ITMP.NE.IDOT) GO TO 51
      NBUF(JP1)=IBL
      NBUF(JP2)=IDOT
      GO TO 500
```

```
   51 N2=MOD(ITMP,10)
      IF(N2.EQ.0) N2=10
      N1=ITMP/10
      IF(N1.EQ.0) N1=10
      NA1=NUM(N1)
      NA2=NUM(N2)
      IF(N1.EQ.10) NA1=IBL
      IF(N2.EQ.10.AND.N1.EQ.10) NA2=IBL
      NBUF(JP1)=NA1
      NBUF(JP2)=NA2
  500 CONTINUE
      ITMP=MOD(I,6)
      IF(ITMP.EQ.1) GO TO 60
      IF(I.LE.45) GO TO 57
      IF(M.EQ.0) GO TO 57
      IF(I.EQ.46) WRITE(NPRNT,550) LDV(I),(NBUF(K),K=1,80)
  550 FORMAT(4X,A1,10X,'*',80A1,2X,'THE FOLLOWING AGES COINCIDE')
      IF(I.EQ.47) WRITE(NPRNT,551) LDV(I),(NBUF(K),K=1,80)
  551 FORMAT(4X,A1,10X,'*',80A1,5X,'(MAXIMUM OF 5 LISTED)')
      IF(I.EQ.48) WRITE(NPRNT,552) LDV(I),(NBUF(K),K=1,80)
  552 FORMAT(4X,A1,10X,'*',80A1,1X,29('-'))
      IF(I.LE.48) GO TO 400
      ICN=I-49
      IF(ICN.GT.M) GO TO 57
      WRITE(NPRNT,553) LDV(I),(NBUF(K),K=1,80),IPT(ICN,1),IPT(ICN,2)
  553 FORMAT(4X,A1,10X,'*',80A1,1X,'AGE ',I2,' FALLS ON TOP OF AGE ',I2)
      GO TO 400
   57 WRITE(NPRNT,52) LDV(I),(NBUF(K),K=1,110)
   52 FORMAT(4X,A1,10X,'*',110A1)
      GO TO 400
   60 WRITE(NPRNT,661) LDV(I),YCTR,(NBUF(K),K=1,110)
  661 FORMAT(4X,A1,F9.2,' .',110A1)
      YCTR=YCTR-(YMAX-YMIN)/9.0
  400 CONTINUE
      DO 70 I=1,110
   70 NBUF(I)=ISTAR
      DO 774 J=2,110,12
  774 NBUF(J)=IDOT
      WRITE(NPRNT,775)(NBUF(K),K=1,110)
  775 FORMAT(15X,'*',110A1)
      XCTR=XMIN
      DO 773 I=1,10
      XPRT(I)=XCTR
  773 XCTR=XCTR+(XMAX-XMIN)/9.0
      WRITE(NPRNT,74)(XPRT(K),K=1,10)
   74 FORMAT(8X,10(2X,F10.2)//62X,'INDEPENDENT VARIABLE')
      IF(NREG.NE.0) WRITE(NPRNT,53) (LABEL(I),I=1,10),REG1(NREG1),
     & REG2(NREG1)
   53 FORMAT('1OBSERVED AND ADJUSTED INTERCENSAL AGE DISTRIBUTION AND ',
     & 'RATIOS FOR ',10A4,1X,'MODEL:',2A8)
      IF(NREG.EQ.0) WRITE(NPRNT,73) (LABEL(I),I=1,14)
   73 FORMAT('1OBSERVED AND ADJUSTED INTERCENSAL AGE DISTRIBUTION AND ',
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     & 'RATIOS FOR ',10A4,1X,'MODEL: ',8A4)
      WRITE(NPRNT,727)
  727 FORMAT(///9X,'REGRESSION',36X,'AGE GROUPS')
      WRITE(NPRNT,79)(IAGE(I-1),IDASH,IAGE(I),I=2,NOAG),IAGE(NOAG),IPLUS
   79 FORMAT(11X,'POINTS',2X,18(1X,I2,A1,I2))
      WRITE(NPRNT,87) (IDASH,I=1,NOAG)
   87 FORMAT(1X,18('-'),18(A1,'-----'))
      WRITE(NPRNT,731) (GMPOBS(I1,I2,I),I=1,NOAG)
  731 FORMAT(1X,'OBSERVED',10X,18(2X,F4.3))
      WRITE(NPRNT,87) (IDASH,I=1,NOAG)
      DO 730 I2=13,NAGS
      DO 730 I1=2,4
      J=3*(I2-13)+(I1-1)
      WRITE(NPRNT,732) H1(J),IAGE(I1),IAGE(I2),(ASGR(I1,I2,I),I=1,NOAG)
  732 FORMAT(1X,A8,3X,I2,'-',I2,2X,18(2X,F4.3))
  730 CONTINUE
      WRITE(NPRNT,87) (IDASH,I=1,NOAG)
      DO 735 I2=13,NAGS
      DO 735 I1=2,4
      J=3*(I2-13)+(I1-1)
      DO 736 I=1,NOAG
      ITMP=GOA(I1,I2,I)+0.0005
      IF(ITMP.EQ.0) IBUF(I)=IBL
      IF(ITMP.GE.1.AND.ITMP.LE.9) IBUF(I)=NUM(ITMP)
      IF(ITMP.GE.10) IBUF(I)=ISTAR
      ATMP=ITMP
      ABUF(I)=GOA(I1,I2,I)-ATMP
      IF(ABUF(I).LE.0.0) ABUF(I)=0.0001
  736 CONTINUE
      ATMP=H2(J)
      IF(NAGS.EQ.13.AND.J.EQ.3) ATMP=ARAT
      WRITE(NPRNT,733) ATMP,IAGE(I1),IAGE(I2),(IBUF(I),ABUF(I),I=1,NOAG)
  733 FORMAT(1X,A8,3X,I2,'-',I2,2X,18(1X,A1,F4.3))
  735 CONTINUE
      WRITE(NPRNT,87) (IDASH,I=1,NOAG)
      DO 740 I2=13,NAGS
      DO 740 I1=2,4
      CO(I1,I2,1)=GMPOBS(I1,I2,1)
      CE(I1,I2,1)=ASGR(I1,I2,1)
      CO(I1,I2,2)=GMPOBS(I1,I2,2)+GMPOBS(I1,I2,3)
      CE(I1,I2,2)=ASGR(I1,I2,2)+ASGR(I1,I2,3)
      CO(I1,I2,3)=0.0
      CE(I1,I2,3)=0.0
      DO 741 I=4,10
      CO(I1,I2,3)=CO(I1,I2,3)+GMPOBS(I1,I2,I)
  741 CE(I1,I2,3)=CE(I1,I2,3)+ASGR(I1,I2,I)
      CO(I1,I2,4)=0.0
      CE(I1,I2,4)=0.0
      DO 742 I=11,13
      CO(I1,I2,4)=CO(I1,I2,4)+GMPOBS(I1,I2,I)
  742 CE(I1,I2,4)=CE(I1,I2,4)+ASGR(I1,I2,I)
      CO(I1,I2,5)=0.0
```

```
      CE(I1,I2,5)=0.0
      DO 743 I=14,NOAG
      CO(I1,I2,5)=CO(I1,I2,5)+GMPOBS(I1,I2,I)
  743 CE(I1,I2,5)=CE(I1,I2,5)+ASGR(I1,I2,I)
  740 CONTINUE
      DO 745 I2=13,NAGS
      DO 745 I1=2,4
      DO 745 I=1,5
      COE(I1,I2,I)=CO(I1,I2,I)/CE(I1,I2,I)
  745 CONTINUE
      WRITE(NPRNT,748)
  748 FORMAT(/////36X,'REGRESSION',27X,'AGE GROUPS'/38X,'POINTS',10X,
     & '0-5',8X,'5-15',7X,'15-50',7X,'50-65',9X,'65+')
      WRITE(NPRNT,88)
   88 FORMAT(28X,77('-'))
      WRITE(NPRNT,751) (CO(I1,I2,I),I=1,5)
  751 FORMAT(28X,'OBSERVED',9X,5(8X,F4.3))
      WRITE(NPRNT,88)
      DO 750 I2=13,NAGS
      DO 750 I1=2,4
      J=3*(I2-13)+(I1-1)
      WRITE(NPRNT,752) H1(J),IAGE(I1),IAGE(I2),(CE(I1,I2,I),I=1,5)
  752 FORMAT(28X,A8,3X,I2,'-',I2,1X,5(8X,F4.3))
  750 CONTINUE
      WRITE(NPRNT,88)
      DO 755 I2=13,NAGS
      DO 755 I1=2,4
      J=3*(I2-13)+(I1-1)
      DO 737 I=1,5
      ITMP=COE(I1,I2,I)+0.0005
      IF(ITMP.EQ.0) IBUF(I)=IBL
      IF(ITMP.GE.1.AND.ITMP.LE.9) IBUF(I)=NUM(ITMP)
      IF(ITMP.GE.10) IBUF(I)=ISTAR
      ATMP=ITMP
      ABUF(I)=COE(I1,I2,I)-ATMP
      IF(ABUF(I).LE.0.0) ABUF(I)=0.0001
  737 CONTINUE
      ATMP=H2(J)
      IF(NAGS.EQ.13.AND.J.EQ.3) ATMP=ARAT
      WRITE(NPRNT,753) ATMP,IAGE(I1),IAGE(I2),(IBUF(I),ABUF(I),I=1,5)
  753 FORMAT(28X,A8,3X,I2,'-',I2,1X,5(7X,A1,F4.3))
  755 CONTINUE
      WRITE(NPRNT,88)
      GO TO 99
  800 WRITE(NPRNT,801) (LABEL(I),I=1,10),N
  801 FORMAT('1'/5X,'*** ERROR IN PRESTO FOR DATA SET ',10A4/5X,
     &'NUMBER OF AGE GROUPS SHOULD BE BETWEEN 14 AND 18, BUT NVAL =',I3)
      GO TO 99
  802 WRITE(NPRNT,803) (LABEL(I),I=1,10)
  803 FORMAT('1'/5X,'*** ERROR IN PRESTO FOR DATA SET ',10A4/5X,
     & 'QUALITY OF INPUT DATA INSUFFICIENT TO PRODUCE ',
     & 'MEANINGFUL TABLE.')
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```
      GO TO 99
  804 WRITE(NPRNT,805) (LABEL(I),I=1,10),NREG
  805 FORMAT('1'/5X,'*** ERROR IN PRESTO FOR DATA SET ',10A4,5X,
     & 'NREG MUST HAVE A VALUE BETWEEN 0 AND 9, BUT NREG =',I3)
      GO TO 99
  806 WRITE(NPRNT,807) (LABEL(I),I=1,18),MONTH1,MONTH2
  807 FORMAT('1'/5X,'*** ERROR IN PRESTO FOR DATA SET ',18A4/5X,
     & 'THE MONTH MUST BE AN INTEGER VALUE FROM 1 TO 12.',
     & //5X,'MONTH1 =',I4/5X,'MONTH2 =',I4)
      GO TO 99
  808 WRITE(NPRNT,809) (LABEL(I),I=1,18)
  809 FORMAT(////5X,'*** ERROR IN PRESTO FOR DATA SET ',18A4/5X,
     & 'CALCULATION OF MODEL LIFE TABLE WAS NOT SUCCESSFUL AND NO TABLE',
     & ' WAS PRINTED.'/5X,'PLEASE CHECK INPUT DATA FOR POSSIBLE ERROR.')
   99 RETURN
      END
```

STABLE

```
      SUBROUTINE STABLE(LABEL,R,NFIN,NTYPE,NSEX,QXMX,C,NPLT)
C************************************************************************
C***                              MORTPAK                            ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C************************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),QXMX(101),C(22)
      DIMENSION ARRAY(101,9),CUM(22),KAGE(23),AM(22),CAPL(22)
      DATA NPG/0/
      NPRNT=6
      IF(NFIN.LT.65.OR.NFIN.GT.100) GO TO 800
      IF(NTYPE.LT.1.OR.NTYPE.GT.2) GO TO 800
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 800
      DO 21 I=1,2
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
   21 CONTINUE
      DO 22 I=6,NFIN,5
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
   22 CONTINUE
      IF(R.GT.1.0) GO TO 804
      NEND=NFIN+1
      CALL LIFTB(NPG,LABEL,NFIN,NTYPE,NSEX,QXMX,ARRAY,NPLT)
      KAGE(1)=0
      KAGE(2)=1
      DO 10 I=3,23
   10 KAGE(I)=5*(I-2)
      AM(1)=ARRAY(1,1)
      AM(2)=ARRAY(2,1)
      CAPL(1)=ARRAY(1,5)
      CAPL(2)=ARRAY(2,5)
      DO 20 I=6,NFIN,5
      K=(I+9)/5
      AM(K)=ARRAY(I,1)
   20 CAPL(K)=ARRAY(I,5)
      N=2+NFIN/5
      NM1=N-1
      POPTOT=0.0
      DO 50 IX=1,NM1
      A1=KAGE(IX)
      A2=KAGE(IX+1)
      A=(A1+A2)/2.0
      C(IX)=DEXP(-R*A)*CAPL(IX)
      POPTOT=POPTOT+C(IX)
   50 CONTINUE
      C(N)=C(NM1)*ARRAY(NFIN-4,6)/(DEXP(5.0*R)-ARRAY(NFIN-4,6))
      POPTOT=POPTOT+C(N)
      DO 60 IX=1,N
   60 C(IX)=C(IX)/POPTOT
      DO 70 IX=1,N
```

```
70 CUM(IX)=0.0
   CUM(1)=C(1)
   DO 90 IX=2,N
90 CUM(IX)=CUM(IX-1)+C(IX)
   BR=100000.0/POPTOT
   DR=BR-R
   IF(NPLT.EQ.2) GO TO 99
   WRITE(NPRNT,12)
12 FORMAT(//40X,'CORRESPONDING STABLE AGE DISTRIBUTION')
   WRITE(NPRNT,11)
11 FORMAT(//26X,'PROPORTION OF POPULATION',
  $34X,'PROPORTION OF POPULATION'/4X,'AGE GROUP',14X,'IN ',
  $'INDICATED AGE GROUP',19X,'AGE',15X,'UNDER INDICATED AGE')
   WRITE(NPRNT,9)
 9 FORMAT(4X,9('-'),13X,24('-'),18X,3('-'),12X,25('-'))
   DO 110 IX=1,NM1
   WRITE(NPRNT,2) KAGE(IX),KAGE(IX+1),C(IX),KAGE(IX+1),CUM(IX)
110 CONTINUE
 2 FORMAT(5X,I2,'-',I2,23X,F7.5,28X,I2,22X,F7.5)
   WRITE(NPRNT,3) KAGE(N),C(N)
 3 FORMAT(5X,I2,'+',25X,F7.5)
   WRITE(NPRNT,4)BR
 4 FORMAT(//18X,'INTRINSIC VITAL RATES:'/18X,22('-')/
  &18X,'BIRTH RATE = ',F7.5)
   WRITE(NPRNT,7)DR
 7 FORMAT(18X,'DEATH RATE = ',F7.5)
   WRITE(NPRNT,1)R
 1 FORMAT(18X,'GROWTH RATE = ',F6.4)
   GO TO 99
800 WRITE(NPRNT,801) LABEL,NFIN,NTYPE,NSEX
801 FORMAT('1'/5X,'*** ERROR IN STABLE FOR DATA SET ',18A4/5X,'ERROR',
   & ' DETECTED IN AT LEAST ONE OF THE FOLLOWING INPUT PARAMETERS:'/
   & 5X,'NFIN SHOULD BE BETWEEN 65 AND 100.',3X,'NFIN  =',I4/
   & 5X,'NTYPE SHOULD BE 1 OR 2.           ',3X,'NTYPE =',I4/
   & 5X,'NSEX SHOULD BE 1 OR 2.            ',3X,'NSEX  =',I4)
    GO TO 99
802 WRITE(NPRNT,803) LABEL,(QXMX(I),I=1,2),(QXMX(I),I=6,NFIN,5)
803 FORMAT('1'/5X,'*** ERROR IN STABLE FOR DATA SET ',18A4/5X,'INPUT',
   & ' Q(X) OR M(X) VALUE(S) IS OUTSIDE THE RANGE OF ZERO AND ONE.'/
   & 5X,'PLEASE CHECK INPUT QXMX VALUES:',3(/4X,10F8.5))
    GO TO 99
804 WRITE(NPRNT,805) LABEL,R
805 FORMAT('1'/5X,'*** ERROR IN STABLE FOR DATA SET ',18A4/5X,'INPUT',
   & ' R CANNOT BE GREATER THAN 1.0 (INDICATING AN ANNUAL GROWTH ',
   & 'RATE OF OVER 100 PERCENT)'/5X,'VALUE INPUTTED FOR R IS',F8.3)
 99 RETURN
    END
```

UNABR

```
      SUBROUTINE UNABR(LABEL,QXMX,Q,SLX,NPLT)
C***********************************************************************
C***                            MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION LABEL(18),QXMX(18),Q(125),SLX(125),EO(125),AM(125)
      DIMENSION X(18),FYQ(18),W(18),TSTAR(8),T(8)
      DIMENSION TP(8),TN(8),PFPT(8,18),GRAD(8),GAUSS(8,8),CINV(8,8)
      DIMENSION GSSC(8,8),GRADS(8),DELT(8),GSSI(8,8),PFPTLN(8)
      DIMENSION GSS1(8,8),DELT1(8),F(21),FC(102),PFCPT(8,102)
      DATA TSTAR/3.11,.496,.315,.00011,1.09,-3.4,22.6,-43.6/
      DATA EPS,IONE/0.0000001,1/
      NPRNT=6
      K=8
      MAX=99
      DO 11 I=1,18
      N=19-I
      IF(QXMX(N).NE.0.0) GO TO 12
   11 CONTINUE
   12 IF(N.LT.14) GO TO 800
      DO 1 I=1,N
      IF(QXMX(I).LE.0.0.OR.QXMX(I).GE.1.0) GO TO 802
    1 CONTINUE
      DO 15 I=3,18
   15 X(I)=5*(I-2)
      X(1)=0.00000000001
      X(2)=1.0
      DO 16 I=1,8
   16 T(I)=TSTAR(I)
      DO 26 I=1,N
   26 W(I)=1.0/(QXMX(I)*QXMX(I))
      WT=W(4)/10.0
      DO 36 I=1,N
   36 W(I)=W(I)/WT
      RE2=2.0
      ALN2=DLOG(RE2)
      IF(NPLT.EQ.0) WRITE(NPRNT,73) (LABEL(I),I=1,18)
   73 FORMAT('1',5X,'GRADUATED ABRIDGED AND UNABRIDGED LIFE TABLES ',
     & 'FOR ',18A4)
C---- BEGINNING OF NON-LINEAR REGRESSION
      DO 110 I=1,K
  110 TN(I)=T(I)
      J=0
      SP10=1000.0
  200 CONTINUE
      J=J+1
      MJ=MOD(J,10)
      IF(MJ.NE.2) GO TO 649
```

```
      STT=DABS(SP10-SN)
      SNT=SN*0.00001
      IF(STT.LT.SNT) GO TO 999
      SP10=SN
  649 SP=SN
      DO 634 I=1,K
  634 TP(I)=TN(I)
      H=2.0
      DO 150 I=1,50
      IF(J.EQ.1) GO TO 300
      H=H/2.0
      DO 120 L=1,K
  120 TN(L)=TP(L)+H*DELT(L)
      IF(TN(1).LE.0.0) GO TO 140
      IF(TN(2).LE.0.0) GO TO 140
      IF(TN(5).LE.1.00005.OR.TN(5).GE.1.5) GO TO 140
C--------------------------------------------
C     WHEN CONVERGED, H*DELT CAN BE SO SMALL THAT TN(L)=TP(L) FOR ALL L.
C     IF TN(L)=TP(L), THEN NO NEED TO CALCULATE SN BECAUSE SN=SP
      DO 121 L=1,K
      IF(TN(L).NE.TP(L)) GO TO 300
  121 CONTINUE
      GO TO 140
C--------------------------------------------
  300 CONTINUE
      DO 117 IJ=1,101
      A=IJ-1
      IF(IJ.EQ.1) A=.00000000001
      TMP=TN(4)*TN(5)**(A)
      FC(IJ)=DEXP(-TN(1)*(A+TN(2))**TN(3))+(TMP)/(1.0+TMP)
      DLA=DLOG(A)
      TPP=TN(6)*DLA*DLA+TN(7)*DLA+TN(8)
      IF (TPP.LT.(-100.0)) TPP=-100.0
      IF (TPP.GE.0.1) SN=1000.0
      IF (TPP.GE.0.1) GO TO 786
      FC(IJ)=FC(IJ)+DEXP(TPP)
  117 CONTINUE
      DO 118 IJ=1,N
  118 F(IJ)=1.0
      DO 123 IJ=5,95,5
      IND=IJ/5+2
      DO 119 KJ=1,5
  119 F(IND)=F(IND)*(1.0-FC(IJ+KJ))
  123 F(IND)=1.0-F(IND)
      F(1)=FC(1)
      DO 122 KJ=2,5
  122 F(2)=F(2)*(1.0-FC(KJ))
      F(2)=1.0-F(2)
      SN=0.0
      DO 20 IJ=1,N
   20 SN=SN+W(IJ)*(QXMX(IJ)-F(IJ))**2
  786 CONTINUE
```

```
      IF(J.EQ.1) GO TO 130
      IF (SN-SP) 130,140,140
  140 CONTINUE
      IF (J.GE.MAX) GO TO 999
      IF (I.GE.50) GO TO 999
  150 CONTINUE
  130 CONTINUE
      IF (J.GE.MAX) GO TO 999
      DO 30 I=1,100
      A=I-1
      IF (I.EQ.1) A=.00000000001
      ATT3=(A+TN(2))**TN(3)
      TMP=DEXP(-TN(1)*ATT3)
      PFCPT(1,I)=-ATT3*TMP
      PFCPT(2,I)=-TN(1)*TN(3)*((A+TN(2))**(TN(3)-1.0))*TMP
      PFCPT(3,I)=-TN(1)*ATT3*DLOG(A+TN(2))*TMP
      T5A=TN(5)**A
      FCN=(1.0+TN(4)*T5A)**2
      PFCPT(4,I)=T5A/FCN
      PFCPT(5,I)=(TN(4)*A*TN(5)**(A-1.0))/FCN
      DLA=DLOG(A)
      TPP=TN(6)*DLA*DLA+TN(7)*DLA+TN(8)
      IF (TPP.LT.(-100.0)) TPP=-100.0
      EXPTPP=DEXP(TPP)
      PFCPT(6,I)=DLA*DLA*EXPTPP
      PFCPT(7,I)=DLA*EXPTPP
      PFCPT(8,I)=EXPTPP
   30 CONTINUE
      DO 171 I=3,N
      L=5*I-9
      DO 171 LM=1,K
  171 PFPT(LM,I)=-(1.0-FC(L))*(1.0-FC(L+1))*(1.0-FC(L+2))*((1.0-FC(L+3))
     &*(-PFCPT(LM,L+4))+(1.0-FC(L+4))*(-PFCPT(LM,L+3)))-(1.0-FC(L+3))*
     &(1.0-FC(L+4))*((1.0-FC(L))*(1.0-FC(L+1))*(-PFCPT(LM,L+2))+
     &(1.0-FC(L+2))*((1.0-FC(L))*(-PFCPT(LM,L+1))+(1.0-FC(L+1))*
     &(-PFCPT(LM,L))))
      DO 172 LM=1,K
      PFPT(LM,1)=PFCPT(LM,1)
  172 PFPT(LM,2)=-(1.0-FC(2))*(1.0-FC(3))*((1.0-FC(4))*(-PFCPT(LM,5))+
     &(1.0-FC(5))*(-PFCPT(LM,4)))-(1.0-FC(4))*(1.0-FC(5))*((1.0-FC(2))*
     &(-PFCPT(LM,3))+(1.0-FC(3))*(-PFCPT(LM,2)))
      DO 50 L=1,K
   50 GRAD(L)=0.0
      DO 40 I=1,N
      DO 40 L=1,K
   40 GRAD(L)=GRAD(L)-2.0*W(I)*(QXMX(I)-F(I))*PFPT(L,I)
      RE1=1.0
      RE3=174.673
      RE4=-180.218
      DO 60 I=1,K
      DO 60 L=1,K
   60 GAUSS(I,L)=0.0
```

```
      DO 70 I=1,N
      ALNW=DLOG(W(I))
      DO 81 L=1,K
      PFPTLN(L)=DLOG(DABS(PFPT(L,I)))
   81 CONTINUE
      DO 70 L=1,K
      PT1=PFPTLN(L)
      P1=DSIGN(RE1,PFPT(L,I))
      DO 70 MM=1,K
      PT=ALN2+ALNW
      PT2=PFPTLN(MM)
      P2=DSIGN(RE1,PFPT(MM,I))
      PT=PT+PT1+PT2
      TST=PT
      IF(TST.GE.174.673) PT=DEXP(RE3)
      IF(TST.LE.-180.218) PT=DEXP(RE4)
      IF(TST.LT.174.673.AND.TST.GT.-180.218) PT=DEXP(PT)
      PT=P1*P2*PT
   70 GAUSS(L,MM)=GAUSS(L,MM)+PT
      DO 80 I=1,K
      DO 80 L=1,K
   80 CINV(I,L)=0.0
      DO 90 I=1,K
   90 CINV(I,I)=1.0/DSQRT(GAUSS(I,I))
      CALL MULT(CINV,GAUSS,K,K,K,GSS1)
      CALL MULT(GSS1,CINV,K,K,K,GSSC)
      CALL MULT(CINV,GRAD,K,K,IONE,GRADS)
      CALL INVER(GSSC,EPS,K,GSSI,IFLAG)
      IF(IFLAG.EQ.1) GO TO 826
      DO 100 I=1,K
      DO 100 L=1,K
  100 GSSI(I,L)=-GSSI(I,L)
  908 CALL MULT(GSSI,GRADS,K,K,IONE,DELT1)
  909 CALL MULT(CINV,DELT1,K,K,IONE,DELT)
      GO TO 200
  826 DO 827 I=1,K
  827 DELT(I)=-GRAD(I)
      GO TO 200
  999 CONTINUE
      IF(TP(1).LE.0.00001) J=MAX
      IF(TP(2).LE.0.00001) J=MAX
      IF(TP(5).LE.1.000055) J=MAX
      IF(TP(5).GE.1.49999) J=MAX
      IF(J.GE.MAX) WRITE(NPRNT,1119)
 1119 FORMAT(/6X,'*** WARNING - CONVERGENCE WAS NOT REACHED',
     &' IN COMPLETION OF THE FOLLOWING LIFE TABLE. PLEASE CHECK',
     &' INPUT DATA. ***')
      DO 160 I=1,K
  160 T(I)=TP(I)
C---- ENDING OF NON-LINEAR REGRESSION
      SLX(1)=100000.0
      DO 71 I=1,121
```

```
      A=I-1
      IF(I.EQ.1) A=.0000000001
      FFF=DEXP(-T(1)*(A+T(2))**T(3))
      DLX=DLOG(A)
      G=(T(6)*DLX*DLX+T(7)*DLX+T(8))
      IF(G.LE.-180.218) G=-180.218
      IF(G.GE.174.673) G=174.673
      G=DEXP(G)
      TMP=T(4)*T(5)**A
      H=TMP/(1.0+TMP)
      Q(I)=FFF+G+H
      SLX(I+1)=SLX(I)*(1.0-Q(I))
   71 CONTINUE
      SUM=0.0
      DO 710 I=95,122
  710 SUM=SUM+SLX(I)
      DO 711 I=1,92
      ICTR=94-I
      SUM=SUM+SLX(ICTR+1)
      EO(ICTR)=0.5+SUM/SLX(ICTR)
      AM(ICTR)=2.0*(SLX(ICTR)-SLX(ICTR+1))/(SLX(ICTR)+SLX(ICTR+1))
  711 CONTINUE
      EO(1)=0.3+(1.2*SLX(2)+SUM)/SLX(1)
      AM(1)=(SLX(1)-SLX(2))/(0.3*SLX(1)+0.7*SLX(2))
      DO 72 I=3,N
      J=X(I)+1.0
   72 FYQ(I)=1.0-SLX(J+5)/SLX(J)
      FYQ(1)=Q(1)
      FYQ(2)=1.0-SLX(6)/SLX(2)
      IF(NPLT.EQ.2) GO TO 99
      WRITE(NPRNT,74)
   74 FORMAT(//32X,'AGE',8X,'OBSERVED Q(X)',4X,'FITTED Q(X)',5X,
     $'DIFFERENCE',7X,'RATIO'/)
      DO 75 I=1,N
      NAGE=X(I)
      DIF=FYQ(I)-QXMX(I)
      RATIO=FYQ(I)/QXMX(I)
      IR=RATIO
      IF(IR.LT.1) WRITE(NPRNT,76) NAGE,QXMX(I),FYQ(I),DIF,RATIO
   76 FORMAT(31X,I4,11X,F6.5,10X,F6.5,9X,F7.5,10X,F4.2)
      IF(IR.GE.1) WRITE(NPRNT,77) NAGE,QXMX(I),FYQ(I),DIF,RATIO
   77 FORMAT(31X,I4,11X,F6.5,10X,F6.5,10X,F6.5,10X,F4.2)
   75 CONTINUE
      WRITE(NPRNT,78)
   78 FORMAT(//3(2X,'AGE   M(X,N)   Q(X,N)',5X,'I(X)',4X,'E(X)',4X)/)
      DO 79 I=1,31
      J=I-1
      K=J+31.0
      L=K+31.0
      IX1=SLX(I)
      IX2=SLX(I+31)
      IX3=SLX(I+62)
```

```
      WRITE(NPRNT,3) J,AM(I),Q(I),IX1,EO(I),K,AM(I+31),Q(I+31),IX2,
     & EO(I+31),L,AM(I+62),Q(I+62),IX3,EO(I+62)
    3 FORMAT(3(3X,I2,3X,F6.5,3X,F6.5,3X,I6,2X,F6.2,4X))
   79 CONTINUE
      AA=DEXP(-T(1))
      DD=DEXP(T(8)-(T(7)*T(7)/(4.0*T(6))))
      EE=-T(6)
      FF=DEXP(-T(7)/(2.0*T(6)))
      WRITE(NPRNT,7) AA,T(2),T(3),DD,EE,FF,T(4),T(5)
    7 FORMAT (//2X,'PARAMETERS:  ','A= ',F8.5,'  B= ',F8.5,'  C= ',
     &F8.5,'  D= ',F8.5,'  E= ',F8.5,'  F= ',F8.5,'  G= ',F8.5,
     &'  H= ',F8.5)
      GO TO 99
  800 WRITE(NPRNT,801) (LABEL(I),I=1,18),N
  801 FORMAT('1'/5X,'*** ERROR IN UNABR FOR DATA SET ',18A4/5X,
     & 'AT LEAST 14 CONSECUTIVE INPUT VALUES FOR QXMX ARE REQUIRED, ',
     & 'BUT ONLY',I3,' WERE SUPPLIED.')
      GO TO 99
  802 WRITE(NPRNT,803) (LABEL(I),I=1,18),(QXMX(I),I=1,N)
  803 FORMAT('1'/5X,'*** ERROR IN UNABR FOR DATA SET ',18A4/5X,'INPUT ',
     & 'Q(X) VALUE(S) IS OUTSIDE THE RANGE OF ZERO AND ONE.'/5X,
     & 'PLEASE CHECK INPUT QXMX VALUES:'/4X,10F8.5/4X,10F8.5)
   99 RETURN
      END
```

WIDOW

```
      SUBROUTINE WIDOW(LABEL,MONTH,NYEAR,NSEX,SMAMM,SMAMF,PNW)
C***********************************************************************
C***                            MORTPAK                              ***
C*** THE UNITED NATIONS SOFTWARE PACKAGE FOR DEMOGRAPHIC MEASUREMENT ***
C***********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION LABEL(18),PNW(8),AE0(8,9),AE20(8,9),NAGE(2,8),MON(12)
      DIMENSION IGL(8,9),TSTAR(8),IYR(8),IMN(8),SURV(8),Z(75)
      DIMENSION ASX(2)
      DIMENSION UNA00(8,5),UNB00(8,5),UNC00(8,5),UND00(8,5),UNE00(8,5)
      DIMENSION UNA20(8,5),UNB20(8,5),UNC20(8,5),UND20(8,5),UNE20(8,5)
      DIMENSION CDA00(8,4),CDB00(8,4),CDC00(8,4),CDD00(8,4),CDE00(8,4)
      DIMENSION CDA20(8,4),CDB20(8,4),CDC20(8,4),CDD20(8,4),CDE20(8,4)
      DIMENSION UNF00(8,5),UNG00(8,5),UNH00(8,5),UNI00(8,5),UNJ00(8,5)
      DIMENSION UNF20(8,5),UNG20(8,5),UNH20(8,5),UNI20(8,5),UNJ20(8,5)
      DIMENSION CDF00(8,4),CDG00(8,4),CDH00(8,4),CDI00(8,4),CDJ00(8,4)
      DIMENSION CDF20(8,4),CDG20(8,4),CDH20(8,4),CDI20(8,4),CDJ20(8,4)
      DATA AE0,AE20/144*0.0/,TSTAR/8*0.0/
      DATA IBL,IGT,ILT/' ','GT','LT'/
      DATA ASX/' MALES   ','FEMALES '/
      DATA MON/'JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP',
     &          'OCT','NOV','DEC'/
      DATA Z/25*0.0,9*0.09,0.091,.092,.093,.095,.099,.104,.109,.115,
     & .122,.130,.139,.149,.160,.171,.182,.193,.205,.218,.231,.245,
     & .259,.274,.289,.305,.321,.338,.356,.374,.392,.411,.431,.452,
     & .473,.495,.518,.542,.568,.595,.622,.650,.678/
      DATA UNA00/ 5.46695, 3.52440, 2.56265, 1.92329, 1.46511, 1.08645,
     &   0.74736, 0.40251, 4.77048, 3.05488, 2.16455, 1.57471, 1.13562,
     &   0.79081, 0.48213, 0.16775, 7.59858, 5.25666, 3.92095, 3.08882,
     &   2.42283, 2.51092, 1.28013, 0.74174, 4.25124, 2.69835, 1.91545,
     &   1.65025, 1.84626, 0.57650, 0.24014,-0.08543, 5.12468, 3.34040,
     &   2.40171, 1.79798, 2.13792, 0.93421, 0.57989, 0.22619/
      DATA UNB00/-2.56971,-1.91620,-1.54851,-1.34393,-1.20603,-1.10883,
     &  -1.04402,-1.00555,-2.16211,-1.62230,-1.28768,-1.10398,-0.98349,
     &  -0.90250,-0.85505,-0.83444,-3.14019,-2.47764,-2.05057,-1.78377,
     &  -1.59346,-1.36148,-1.30536,-1.20392,-2.05357,-1.53460,-1.21471,
     &  -0.98064,-0.74371,-0.81411,-0.75461,-0.72568,-2.39355,-1.81141,
     &  -1.46241,-1.25908,-0.98865,-1.01848,-0.94868,-0.90771/
      DATA UNC00/ 0.34864, 0.25450, 0.19911, 0.16315, 0.13540, 0.11031,
     &   0.08647, 0.06384, 0.27641, 0.20392, 0.15678, 0.12332, 0.09525,
     &   0.07167, 0.05080, 0.03345, 0.39730, 0.32906, 0.27530, 0.24423,
     &   0.22159, 0.28255, 0.16412, 0.12704, 0.27285, 0.20161, 0.15687,
     &   0.14963, 0.13725, 0.07515, 0.05205, 0.03446, 0.31776, 0.23956,
     &   0.18943, 0.15836, 0.19131, 0.10412, 0.07936, 0.05703/
      DATA UND00/-0.02187,-0.01684,-0.01188,-0.01000,-0.00795,-0.00556,
     &  -0.00258, 0.00122,-0.01659,-0.01308,-0.00904,-0.00706,-0.00504,
     &  -0.00256, 0.00032, 0.00343,-0.02113,-0.01940,-0.01715,-0.01495,
     &  -0.01415,-0.02204,-0.01079,-0.00733,-0.01659,-0.01310,-0.00949,
     &  -0.00925,-0.00986,-0.00399,-0.00117, 0.00172,-0.01913,-0.01532,
     &  -0.01156,-0.00968,-0.01408,-0.00571,-0.00274, 0.00095/
```

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DATA UNE00/ 86.0, 88.0, 93.0, 92.0, 92.0, 92.0, 92.0, 92.0, 87.0,
&89.0, 95.0, 94.0, 93.0, 93.0, 93.0, 93.0, 87.0, 88.0, 89.0, 93.0,
&94.0,171.0, 93.0, 92.0, 85.0, 87.0, 93.0,117.0,191.0, 92.0, 92.0,
&92.0, 86.0, 88.0, 92.0, 93.0,184.0, 92.0, 92.0, 92.0/
 DATA UNA20/ 2.56518, 1.75193, 1.62060, 1.94800, 1.85464, 0.36844,
&   0.18071,-0.01507, 2.68534, 1.92181, 1.94461, 2.05829, 1.86277,
&   0.36984, 0.17430,-0.00350, 2.61004, 1.72043, 1.22373, 0.96891,
&   1.02904, 1.62170, 1.58853, 0.14122, 2.50828, 1.74181, 1.65955,
&   2.10327, 1.90357, 0.41523, 0.19637, 0.00209, 2.54534, 1.72768,
&   1.55674, 1.87114, 1.87946, 0.39188, 0.18986, 0.00807/
 DATA UNB20/-1.24121,-0.94480,-0.72067,-0.54910,-0.47412,-0.60731,
&  -0.58511,-0.57935,-1.17987,-0.89682,-0.65382,-0.51645,-0.44516,
&  -0.56552,-0.54907,-0.54341,-1.17896,-0.94338,-0.78102,-0.66864,
&  -0.54658,-0.40873,-0.35848,-0.48793,-1.12025,-0.85828,-0.65059,
&  -0.48912,-0.41908,-0.52087,-0.50188,-0.49556,-1.19966,-0.91807,
&  -0.70670,-0.53742,-0.45367,-0.57310,-0.54983,-0.53750/
 DATA UNC20/ 0.13954, 0.11227, 0.10147, 0.08803, 0.07628, 0.03808,
&   0.02518, 0.01263, 0.12843, 0.10744, 0.09337, 0.07767, 0.06450,
&   0.02571, 0.01309, 0.00405, 0.13269, 0.10589, 0.08371, 0.07111,
&   0.06755, 0.06164, 0.05343, 0.02665, 0.12297, 0.09449, 0.08257,
&   0.07048, 0.05795, 0.02588, 0.01263, 0.00433, 0.13473, 0.10384,
&   0.09265, 0.08128, 0.06962, 0.03552, 0.02197, 0.01129/
 DATA UND20/-0.00800,-0.00610,-0.00593,-0.00574,-0.00505,-0.00125,
&   0.00029, 0.00205,-0.00674,-0.00566,-0.00545,-0.00478,-0.00378,
&  -0.00024, 0.00135, 0.00319,-0.00770,-0.00689,-0.00560,-0.00452,
&  -0.00412,-0.00423,-0.00370,-0.00099,-0.00683,-0.00513,-0.00450,
&  -0.00420,-0.00332,-0.00048, 0.00121, 0.00290,-0.00778,-0.00576,
&  -0.00521,-0.00508,-0.00445,-0.00136, 0.00021, 0.00219/
 DATA UNE20/ 71.0, 81.0,110.0,185.0,200.0, 75.0, 75.0, 75.0, 74.0,
&88.0,141.0,200.0,200.0, 75.0, 75.0, 76.0, 70.0, 71.0, 73.0, 78.0,
&98.0,181.0,200.0, 82.0, 70.0, 77.0,107.0,200.0,200.0, 75.0, 75.0,
&76.0, 70.0, 77.0,101.0,168.0,200.0, 75.0, 75.0, 76.0/
 DATA CDA00/ 6.60705, 4.15307, 2.88995, 2.07109, 1.95238, 1.99356,
&   0.54907, 0.17987, 8.41515, 5.48315, 4.11052, 2.31085, 1.66830,
&   1.17004, 0.76467, 0.36529, 9.06170, 5.94253, 4.27904, 3.17947,
&   2.51848, 2.28497, 1.05832, 0.54036, 7.50392, 4.41999, 3.36349,
&   2.52908, 1.92537, 1.49038, 1.03435, 0.61041/
 DATA CDB00/-3.16505,-2.37838,-1.90917,-1.58745,-1.23201,-0.94576,
&  -1.03226,-0.99875,-4.08706,-2.85804,-2.19453,-1.66528,-1.40734,
&  -1.21525,-1.10137,-1.05203,-4.40590,-3.36286,-2.71360,-2.25920,
&  -1.89169,-1.49195,-1.42858,-1.30663,-4.03787,-2.65882,-2.32255,
&  -1.92555,-1.61186,-1.40136,-1.23972,-1.11978/
 DATA CDC00/ 0.41893, 0.33082, 0.26933, 0.22073, 0.23903, 0.20335,
&   0.04286,-0.01050, 0.71989, 0.56140, 0.45564, 0.17167, 0.11120,
&   0.05340,-0.00288,-0.04127, 0.63200, 0.51551, 0.42539, 0.37131,
&   0.36576, 0.34664, 0.14690, 0.05547, 0.67229, 0.44126, 0.40995,
&   0.32459, 0.24714, 0.20104, 0.13596, 0.06681/
 DATA CDD00/-0.02204,-0.01938,-0.01594,-0.01307,-0.01683,-0.01573,
&   0.00502, 0.01669,-0.04364,-0.03840,-0.03323,-0.00703,-0.00118,
&   0.00590, 0.01529, 0.02008,-0.03482,-0.03191,-0.02687,-0.02382,
&  -0.02587,-0.02881,-0.00495, 0.01384,-0.04468,-0.03247,-0.03471,
&  -0.02866,-0.02015,-0.01439,-0.00781, 0.00384/
```

```
 DATA CDE00/  85.0, 85.0, 87.0, 88.0,135.0,200.0, 86.0, 86.0,200.0,
&200.0,200.0, 88.0, 88.0, 88.0, 88.0, 87.0, 84.0, 84.0, 86.0, 90.0,
&107.0,156.0, 86.0, 86.0, 81.0, 82.0, 82.0, 83.0, 86.0, 90.0, 89.0,
& 89.0/
 DATA CDA20/ 3.60113, 2.13081, 1.38458, 1.03550, 1.17546, 1.73867,
&   0.00346,-0.18514, 4.37870, 3.16883, 2.59277, 2.22104, 1.95353,
&   0.36853, 0.14006,-0.07332, 3.92023, 2.34533, 1.51358, 0.91732,
&   0.54073, 0.59011, 1.60563,-0.11027, 3.38787, 1.96968, 1.27141,
&   0.84591, 0.59343, 1.01118, 1.62948,-0.07124/
 DATA CDB20/-1.89674,-1.42749,-1.12736,-0.88490,-0.62611,-0.44224,
&  -0.61663,-0.58904,-1.66971,-1.18385,-0.91821,-0.72873,-0.58365,
&  -0.68555,-0.61925,-0.58637,-2.23978,-1.69173,-1.37198,-1.07359,
&  -0.86453,-0.63517,-0.39031,-0.58113,-2.04183,-1.54041,-1.21159,
&  -1.01290,-0.82990,-0.57770,-0.41613,-0.60762/
 DATA CDC20/ 0.25143, 0.19683, 0.15583, 0.13094, 0.10763, 0.08167,
&   0.02140,-0.00978, 0.28061, 0.21791, 0.17496, 0.13872, 0.10634,
&   0.03450, 0.00049,-0.02320, 0.34090, 0.27218, 0.22354, 0.16065,
&   0.11527, 0.09347, 0.07147, 0.01134, 0.31649, 0.25346, 0.18593,
&   0.14224, 0.10251, 0.09594, 0.07362, 0.00433/
 DATA CDD20/-0.01411,-0.01247,-0.01009,-0.00838,-0.00744,-0.00600,
&   0.00101, 0.00720,-0.01690,-0.01479,-0.01262,-0.01024,-0.00758,
&   0.00005, 0.00461, 0.00851,-0.02254,-0.02113,-0.01959,-0.01463,
&  -0.01024,-0.00668,-0.00561, 0.00223,-0.02169,-0.02097,-0.01660,
&  -0.01328,-0.00808,-0.00683,-0.00527, 0.00411/
 DATA CDE20/  66.0, 66.0, 68.0, 76.0,108.0,200.0, 68.0, 69.0,200.0,
&200.0,200.0,200.0,200.0, 72.0, 72.0, 72.0, 63.0, 63.0, 63.0, 64.0,
& 66.0, 82.0,200.0, 71.0, 63.0, 63.0, 64.0, 65.0, 69.0,108.0,200.0,
& 71.0/
 DATA UNF00/ 3.97879, 2.71309, 2.01889, 1.56653, 1.26274, 1.00465,
&   0.74990, 0.48044, 3.49435, 2.38295, 1.78027, 1.38147, 1.08977,
&   0.86312, 0.62389, 0.35451, 4.68562, 3.35863, 2.68951, 2.23348,
&   2.68282, 1.56809, 1.21457, 0.78989, 2.95831, 1.95051, 2.25724,
&   1.01637, 0.74621, 0.53097, 0.28804, 0.03558, 3.59712, 2.43752,
&   1.79978, 1.38863, 1.10455, 0.85543, 0.59816, 0.30899/
 DATA UNG00/-1.74714,-1.38111,-1.18575,-1.07373,-1.00923,-0.96760,
&  -0.93941,-0.91618,-1.54591,-1.20768,-1.03252,-0.93447,-0.88036,
&  -0.84135,-0.81953,-0.80881,-1.95258,-1.57987,-1.38601,-1.27927,
&  -1.14211,-1.15839,-1.10207,-1.05198,-1.36279,-1.05596,-0.79300,
&  -0.81220,-0.76828,-0.73895,-0.72903,-0.72161,-1.63369,-1.27885,
&  -1.09541,-0.99242,-0.93189,-0.89269,-0.86666,-0.85218/
 DATA UNH00/ 0.20098, 0.15731, 0.12850, 0.10560, 0.08753, 0.06983,
&   0.05210, 0.03790, 0.17661, 0.13378, 0.10778, 0.08663, 0.06848,
&   0.05278, 0.03690, 0.02331, 0.22873, 0.18372, 0.16395, 0.15041,
&   0.20296, 0.12317, 0.10291, 0.07719, 0.14980, 0.11396, 0.12399,
&   0.06291, 0.04461, 0.02991, 0.01662, 0.01078, 0.18925, 0.14566,
&   0.11781, 0.09597, 0.07856, 0.06128, 0.04394, 0.02900/
 DATA UNI00/-0.01116,-0.00843,-0.00693,-0.00559,-0.00400,-0.00200,
&   0.00058, 0.00463,-0.01017,-0.00726,-0.00573,-0.00436,-0.00301,
&  -0.00079, 0.00168, 0.00457,-0.01259,-0.01031,-0.00885,-0.00841,
&  -0.01357,-0.00700,-0.00477,-0.00165,-0.00810,-0.00582,-0.00739,
&  -0.00252,-0.00094, 0.00151, 0.00398, 0.00678,-0.01080,-0.00780,
&  -0.00630,-0.00495,-0.00337,-0.00135, 0.00134, 0.00457/
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 DATA UNJ00/  89.0, 94.0, 94.0, 93.0, 93.0, 93.0, 93.0, 94.0, 89.0,
& 95.0, 96.0, 95.0, 94.0, 95.0, 95.0, 95.0, 87.0, 90.0, 95.0, 95.0,
&194.0, 94.0, 94.0, 93.0, 90.0, 96.0,200.0, 93.0, 92.0, 93.0, 93.0,
& 94.0, 88.0, 94.0, 94.0, 93.0, 93.0, 93.0, 93.0, 93.0/
 DATA UNF20/ 2.30162, 1.48710, 1.33603, 1.64581, 1.83334, 1.71308,
&   0.25473, 0.06981, 2.30101, 1.51113, 1.43735, 1.91308, 1.84485,
&   0.44765, 0.25404, 0.06049, 2.17815, 1.39720, 0.99848, 0.81019,
&   0.82315, 1.08847, 1.63208, 1.48603, 2.29206, 1.59177, 1.95022,
&   2.01695, 0.58444, 0.40121, 0.20913, 0.01973, 2.26152, 1.46609,
&   1.38286, 1.76882, 1.85141, 1.72778, 0.24138, 0.04319/
 DATA UNG20/-1.17323,-0.90466,-0.71611,-0.55806,-0.48018,-0.44298,
&  -0.60586,-0.59376,-1.15665,-0.88147,-0.68517,-0.52538,-0.46967,
&  -0.60138,-0.58933,-0.58040,-1.15073,-0.92646,-0.78907,-0.69941,
&  -0.61419,-0.51053,-0.40472,-0.36185,-1.12068,-0.82947,-0.60033,
&  -0.49803,-0.60587,-0.58459,-0.57551,-0.56763,-1.16021,-0.88917,
&  -0.69294,-0.53764,-0.47124,-0.43323,-0.59404,-0.58365/
 DATA UNH20/ 0.13490, 0.10278, 0.09531, 0.08824, 0.08013, 0.07270,
&   0.03564, 0.02391, 0.13383, 0.09996, 0.09223, 0.08366, 0.07482,
&   0.04196, 0.02870, 0.01736, 0.13920, 0.11092, 0.09060, 0.07980,
&   0.07741, 0.07635, 0.06953, 0.06059, 0.12639, 0.09526, 0.08833,
&   0.07479, 0.03842, 0.02553, 0.01409, 0.00776, 0.13455, 0.10057,
&   0.09322, 0.08516, 0.07678, 0.06876, 0.03116, 0.01950/
 DATA UNI20/-0.00816,-0.00611,-0.00559,-0.00583,-0.00561,-0.00499,
&  -0.00095, 0.00084,-0.00821,-0.00592,-0.00541,-0.00553,-0.00500,
&  -0.00173,-0.00040, 0.00134,-0.00882,-0.00791,-0.00664,-0.00565,
&  -0.00523,-0.00549,-0.00558,-0.00485,-0.00766,-0.00518,-0.00530,
&  -0.00457,-0.00133, 0.00019, 0.00190, 0.00379,-0.00826,-0.00602,
&  -0.00546,-0.00560,-0.00523,-0.00450,-0.00052, 0.00132/
 DATA UNJ20/ 70.0, 75.0, 95.0,150.0,200.0,200.0, 77.0, 77.0, 70.0,
&76.0,102.0,186.0,200.0, 78.0, 77.0, 77.0, 68.0, 69.0, 71.0, 75.0,
&86.0,116.0,200.0,200.0, 69.0, 81.0,155.0,200.0, 75.0, 75.0, 75.0,
&76.0, 69.0, 74.0, 98.0,164.0,200.0,200.0, 76.0, 76.0/
 DATA CDF00/ 6.43101, 4.17594, 3.05367, 2.51453, 2.41951, 1.05670,
&   0.68773, 0.29443, 8.33097, 5.44280, 4.05297, 3.16239, 1.64403,
&   1.22411, 0.84946, 0.44060, 8.08419, 5.01077, 3.48459, 2.60510,
&   2.00120, 2.47734, 1.09064, 0.62467, 7.59469, 4.60698, 3.30151,
&   2.45089, 1.94701, 1.58589, 1.18351, 0.79762/
 DATA CDG00/-3.12765,-2.41725,-1.92410,-1.52600,-1.20363,-1.19532,
&  -1.08397,-1.05768,-3.96694,-2.79137,-2.08978,-1.62784,-1.35576,
&  -1.20698,-1.12168,-1.08278,-3.96234,-2.91400,-2.28753,-1.88406,
&  -1.63056,-1.31224,-1.27260,-1.15755,-4.01455,-2.79182,-2.26937,
&  -1.82097,-1.56382,-1.38673,-1.23011,-1.09797/
 DATA CDH00/ 0.41926, 0.37109, 0.33364, 0.29693, 0.25894, 0.07852,
&   0.01679,-0.03726, 0.64408, 0.51927, 0.42081, 0.33822, 0.09119,
&   0.03793,-0.01343,-0.04545, 0.57932, 0.45687, 0.35383, 0.28166,
&   0.22470, 0.29933, 0.08543, 0.01171, 0.66261, 0.47537, 0.39777,
&   0.29222, 0.23172, 0.18866, 0.12791, 0.06732/
 DATA CDI00/-0.02135,-0.02086,-0.02085,-0.02063,-0.01985, 0.00071,
&   0.01011, 0.01172,-0.03602,-0.03357,-0.02972,-0.02484, 0.00048,
&   0.00691, 0.01115, 0.00053,-0.03397,-0.03115,-0.02534,-0.01849,
&  -0.01439,-0.02472, 0.00081, 0.01133,-0.04453,-0.03612,-0.03450,
&  -0.02494,-0.01840,-0.01323,-0.00718, 0.00190/
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      DATA CDJ00/  87.0, 96.0,110.0,138.0,200.0, 86.0, 86.0, 84.0,152.0,
     &179.0,200.0,200.0, 87.0, 87.0, 86.0, 84.0, 83.0, 83.0, 84.0, 88.0,
     & 88.0,200.0, 87.0, 86.0, 82.0, 83.0, 83.0, 85.0, 88.0, 91.0, 90.0,
     & 90.0/
      DATA CDF20/ 3.62767, 2.24062, 1.67602, 1.66447, 1.91082, 1.75033,
     &   0.03406,-0.18345, 4.50724, 3.20716, 2.56285, 2.17234, 1.92714,
     &   0.29422, 0.10504,-0.11120, 3.80165, 2.18713, 1.46492, 1.17398,
     &   1.37962, 1.79215, 0.17839,-0.11727, 3.57204, 1.99347, 1.30657,
     &   0.96985, 1.12080, 1.79582, 0.21955,-0.02357/
      DATA CDG20/-1.92811,-1.38311,-1.02947,-0.74723,-0.56754,-0.48462,
     &  -0.67347,-0.64367,-1.70270,-1.19852,-0.90788,-0.71300,-0.58451,
     &  -0.72988,-0.66224,-0.62882,-2.05556,-1.48696,-1.16086,-0.90311,
     &  -0.65957,-0.50546,-0.66896,-0.62555,-2.07894,-1.44161,-1.14003,
     &  -0.93559,-0.71066,-0.51454,-0.67697,-0.62869/
      DATA CDH20/ 0.27197, 0.21968, 0.17859, 0.14209, 0.11343, 0.09258,
     &   0.01558,-0.01814, 0.27815, 0.21691, 0.17283, 0.13773, 0.10932,
     &   0.02508,-0.00652,-0.03046, 0.28651, 0.22027, 0.17934, 0.15069,
     &   0.12375, 0.09953, 0.04175,-0.00359, 0.31123, 0.20956, 0.15918,
     &   0.13077, 0.11954, 0.09846, 0.04041, 0.00406/
      DATA CDI20/-0.01434,-0.01309,-0.01166,-0.01016,-0.00865,-0.00678,
     &   0.00337, 0.00932,-0.01596,-0.01411,-0.01210,-0.00999,-0.00766,
     &   0.00205, 0.00725, 0.01111,-0.01616,-0.01379,-0.01181,-0.01040,
     &  -0.00929,-0.00789,-0.00057, 0.00515,-0.02085,-0.01490,-0.01150,
     &  -0.00889,-0.00837,-0.00757,-0.00080, 0.00405/
      DATA CDJ20/  73.0, 81.0, 94.0,132.0,200.0,200.0, 68.0, 68.0,200.0,
     &200.0,200.0,200.0,200.0, 69.0, 70.0, 70.0, 67.0, 69.0, 73.0, 84.0,
     &123.0,200.0, 71.0, 69.0, 65.0, 67.0, 69.0, 74.0,101.0,200.0, 72.0,
     & 71.0/
      NPRNT=6
      DO 11 I=1,8
      IF(I.EQ.1.AND.NSEX.EQ.1) GO TO 11
      IF(PNW(I).LE.0.0) GO TO 800
      IF(PNW(I).GE.1.0) GO TO 800
   11 CONTINUE
      IF(MONTH.LT.1.OR.MONTH.GT.12) GO TO 802
      IF(NSEX.LT.1.OR.NSEX.GT.2) GO TO 804
      NFRST=1
      IF(NSEX.EQ.1) NFRST=2
      DO 20 I=1,8
      N=5*(I+3)
      NAGE(1,I)=N
      NAGE(2,I)=N+5
   20 CONTINUE
      IF(NSEX.EQ.2) GO TO 27
C     SURVIVORSHIP FROM AGE 20 TO AGE X - FEMALES (MALE RESPONDENTS)
      SURV(1)=0.0
      SURV(2)=-0.0208+0.00052*SMAMF-0.00137*SMAMM+1.0451*PNW(2)
      SURV(3)=-0.2135+0.00104*SMAMF-0.00329*SMAMM+1.2791*PNW(3)
      SURV(4)=-0.1896+0.00162*SMAMF-0.00492*SMAMM+1.2884*PNW(4)
      SURV(5)=-0.1290+0.00236*SMAMF-0.00624*SMAMM+1.2483*PNW(5)
      SURV(6)=-0.0713+0.00340*SMAMF-0.00742*SMAMM+1.2005*PNW(6)
      SURV(7)=-0.0327+0.00502*SMAMF-0.00860*SMAMM+1.1590*PNW(7)
      SURV(8)=-0.0139+0.00749*SMAMF-0.01019*SMAMM+1.1297*PNW(8)
      GO TO 28
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C     SURVIVORSHIP FROM AGE 20 TO AGE X - MALES (FEMALE RESPONDENTS)
   27 SURV(1)=+0.1082-0.00209*SMAMF+0.00072*SMAMM+0.9136*PNW(1)
      SURV(2)=-0.0284-0.00465*SMAMF+0.00157*SMAMM+1.0822*PNW(2)
      SURV(3)=-0.0159-0.00638*SMAMF+0.00253*SMAMM+1.0831*PNW(3)
      SURV(4)=+0.0041-0.00784*SMAMF+0.00395*SMAMM+1.0596*PNW(4)
      SURV(5)=+0.0152-0.00953*SMAMF+0.00611*SMAMM+1.0324*PNW(5)
      SURV(6)=+0.0087-0.01189*SMAMF+0.00925*SMAMM+1.0144*PNW(6)
      SURV(7)=-0.0169-0.01515*SMAMF+0.01353*SMAMM+1.0111*PNW(7)
      SURV(8)=-0.0590-0.01940*SMAMF+0.01880*SMAMM+1.0291*PNW(8)
   28 IF(NSEX.EQ.1) WRITE(NPRNT,70) (LABEL(I),I=1,18)
   70 FORMAT('1',1X,'WIDOWHOOD ESTIMATES OF ADULT FEMALE MORTALITY ',
     & '-- ',18A4)
      IF(NSEX.EQ.2) WRITE(NPRNT,71) (LABEL(I),I=1,18)
   71 FORMAT('1',1X,'WIDOWHOOD ESTIMATES OF ADULT MALE MORTALITY ',
     & '-- ',18A4)
      WRITE(NPRNT,72) MON(MONTH),NYEAR,SMAMM,SMAMF
   72 FORMAT(//2X,'DATE OF SURVEY = ',A4,I4//2X,'SINGULATE MEAN AGE ',
     & 'AT MARRIAGE:'/4X,'MALES    =',F7.2/4X,'FEMALES  =',F7.2)
      IF(NSEX.EQ.1) WRITE(NPRNT,771)
  771 FORMAT(///46X,'PROPORTION',6X,'PROBABILITY OF AN ADULT FEMALE')
      IF(NSEX.EQ.2) WRITE(NPRNT,772)
  772 FORMAT(///46X,'PROPORTION',7X,'PROBABILITY OF AN ADULT MALE')
      WRITE(NPRNT,73) ASX(NSEX)
   73 FORMAT(33X,'AGE GROUP',5X,A8,7X,'SURVIVING FROM AGE ',
     & '20 TO AGE X'/36X,'OF',11X,'NOT',10X,30('-')/33X,'RESPONDENT',
     & 4X,'WIDOWED',8X,'AGE X',3X,'HILL-TRUSSELL EQUATION'/
     & 33X,10('-'),3X,10('-'),6X,30('-')/)
      DO 74 J=NFRST,8
      NX=5*(J+5-NFRST)
      WRITE(NPRNT,75) (NAGE(I,J),I=1,2),PNW(J),NX,SURV(J)
   75 FORMAT(35X,I2,'-',I2,8X,F5.4,11X,I2,12X,F5.4)
   74 CONTINUE
      DO 30 I=NFRST,5
      IF(SURV(I).LE.0.14) SURV(I)=0.14
      IF(SURV(I).GE.0.9997) SURV(I)=0.9997
   30 CONTINUE
      DO 31 I=6,8
      IF(SURV(I).LE.0.14) SURV(I)=0.14
      IF(SURV(I).GE.0.9940) SURV(I)=0.9940
   31 CONTINUE
      DO 40 I=NFRST,8
      J=I-NFRST+1
      XV=DLOG(SURV(I)/(1.0-SURV(I)))
      DO 40 NR=1,5
      IGL(I,NR)=IBL
      IF(NSEX.EQ.2) GO TO 43
C     FEMALE EQUATION (MALE RESPONDENTS)
      FCN=UNF00(J,NR)+UNG00(J,NR)*XV+UNH00(J,NR)*XV**2+UNI00(J,NR)*XV**3
      AE0(I,NR)=UNJ00(J,NR)/(DEXP(FCN)+1.0)
      GO TO 44
C     MALE EQUATION (FEMALE RESPONDENTS)
   43 FCN=UNA00(J,NR)+UNB00(J,NR)*XV+UNC00(J,NR)*XV**2+UND00(J,NR)*XV**3
      AE0(I,NR)=UNE00(J,NR)/(DEXP(FCN)+1.0)
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   44  IF(AE0(I,NR).GE.20.0) GO TO 41
       IGL(I,NR)=ILT
       AE20(I,NR)=19.98
       AE0(I,NR)=19.98
       GO TO 40
   41  IF(AE0(I,NR).LE.80.0) GO TO 42
       IGL(I,NR)=IGT
       AE20(I,NR)=80.02
       AE0(I,NR)=80.02
       GO TO 40
   42  IF(NSEX.EQ.2) GO TO 45
C      FEMALE EQUATION (MALE RESPONDENTS)
       FCN=UNF20(J,NR)+UNG20(J,NR)*XV+UNH20(J,NR)*XV**2+UNI20(J,NR)*XV**3

       AE20(I,NR)=UNJ20(J,NR)/(DEXP(FCN)+1.0)
       GO TO 40
C      MALE EQUATION (FEMALE RESPONDENTS)
   45  FCN=UNA20(J,NR)+UNB20(J,NR)*XV+UNC20(J,NR)*XV**2+UND20(J,NR)*XV**3
       AE20(I,NR)=UNE20(J,NR)/(DEXP(FCN)+1.0)
   40  CONTINUE
       DO 50 I=NFRST,8
       J=I-NFRST+1
       XV=DLOG(SURV(I)/(1.0-SURV(I)))
       DO 50 NREG=6,9
       IGL(I,NREG)=IBL
       NR=NREG-5
       IF(NSEX.EQ.2) GO TO 53
C      FEMALE EQUATION (MALE RESPONDENTS)
       FCN=CDF00(J,NR)+CDG00(J,NR)*XV+CDH00(J,NR)*XV**2+CDI00(J,NR)*XV**3
       AE0(I,NREG)=CDJ00(J,NR)/(DEXP(FCN)+1.0)
       GO TO 54
C      MALE EQUATION (FEMALE RESPONDENTS)
   53  FCN=CDA00(J,NR)+CDB00(J,NR)*XV+CDC00(J,NR)*XV**2+CDD00(J,NR)*XV**3
       AE0(I,NREG)=CDE00(J,NR)/(DEXP(FCN)+1.0)
   54  IF(AE0(I,NREG).GE.20.0) GO TO 51
       IGL(I,NREG)=ILT
       AE20(I,NREG)=19.98
       AE0(I,NREG)=19.98
       GO TO 50
   51  IF(AE0(I,NREG).LE.80.0) GO TO 52
       IGL(I,NREG)=IGT
       AE20(I,NREG)=80.02
       AE0(I,NREG)=80.02
       GO TO 50
   52  IF(NSEX.EQ.2) GO TO 55
C      FEMALE EQUATION (MALE RESPONDENTS)
       FCN=CDF20(J,NR)+CDG20(J,NR)*XV+CDH20(J,NR)*XV**2+CDI20(J,NR)*XV**3
       AE20(I,NREG)=CDJ20(J,NR)/(DEXP(FCN)+1.0)
       GO TO 50
C      MALE EQUATION (FEMALE RESPONDENTS)
   55  FCN=CDA20(J,NR)+CDB20(J,NR)*XV+CDC20(J,NR)*XV**2+CDD20(J,NR)*XV**3
       AE20(I,NREG)=CDE20(J,NR)/(DEXP(FCN)+1.0)
   50  CONTINUE
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      NSTP=1
      IF(NSEX.EQ.2) GO TO 68
C     COALE-DEMENY MODELS  - TIME REFERENCE - FEMALES (MALE RESPONDENTS)
      TSTAR(1)=0.0
      CONST=0.0037*(27.0-SMAMF)
      DO 60 I=2,8
      AGE=5*(I+3)
      TMP=SMAMF+AGE+2.5-SMAMM
      ITMP=TMP
      IF(ITMP.GE.75) GO TO 67
      NSTP=I
      FLPT=TMP-ITMP
      UVAL=0.3333*DLOG(PNW(I))+Z(ITMP)+FLPT*(Z(ITMP+1)-Z(ITMP))+CONST
      TSTAR(I)=(AGE+2.5-SMAMM)*(1.0-UVAL)/2.0
   60 CONTINUE
      GO TO 67
C     COALE-DEMENY MODELS  - TIME REFERENCE - MALES (FEMALE RESPONDENTS)
   68 CONST=0.0037*(27.0-SMAMM)
      DO 66 I=1,8
      AGE=5*(I+4)
      TMP=SMAMM+AGE-2.5-SMAMF
      ITMP=TMP
      IF(ITMP.GE.75) GO TO 67
      NSTP=I
      FLPT=TMP-ITMP
      UVAL=0.3333*DLOG(PNW(I))+Z(ITMP)+FLPT*(Z(ITMP+1)-Z(ITMP))+CONST
      TSTAR(I)=(AGE-2.5-SMAMF)*(1.0-UVAL)/2.0
      IF(TSTAR(I).LT.0.0) TSTAR(I)=0.0
   66 CONTINUE
   67 AYR=NYEAR
      AMON=MONTH-0.5
      CEN=AYR+AMON/12.0
      DO 61 J=NFRST,NSTP
      RDT=CEN-TSTAR(J)
      IYR(J)=RDT
      AMON=RDT-IYR(J)
      AMON=12.0*AMON+1.0
      IMON=AMON
      IF(IMON.LT.1) IMON=1
      IF(IMON.GT.12) IMON=12
      IMN(J)=MON(IMON)
   61 CONTINUE
      IF(NSEX.EQ.1) WRITE(NPRNT,676)
  676 FORMAT(////61X,'CORRESPONDING FEMALE LIFE EXPECTANCIES')
      IF(NSEX.EQ.2) WRITE(NPRNT,678)
  678 FORMAT(////61X,'CORRESPONDING MALE LIFE EXPECTANCIES')
      WRITE(NPRNT,76)
   76 FORMAT(2X,10('-'),4X,11('-'),4X,53('-'),
     & 4X,39('-')/2X,'AGE GROUP',35X,'UNITED NATIONS MODELS',31X,
     & 'COALE-DEMENY MODELS'/5X,'OF',10X,'REFERENCE'/2X,'RESPONDENT',
     & 7X,'DATE',9X,'LATIN AM.  CHILEAN   SO. ASIAN   FAR EAST   ',
     & 'GENERAL',6X,'WEST',6X,'NORTH',7X,'EAST',6X,'SOUTH'/
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     & 2X,10('-'),4X,11('-'),4X,53('-'),4X,39('-'))
      IF(NSEX.EQ.1) WRITE(NPRNT,80)
   80 FORMAT(//2X'FEMALE LIFE EXPECTANCY AT AGE TWENTY'/)
      IF(NSEX.EQ.2) WRITE(NPRNT,680)
  680 FORMAT(//2X'MALE LIFE EXPECTANCY AT AGE TWENTY'/)
      DO 81 J=NFRST,NSTP
      WRITE(NPRNT,82) (NAGE(I,J),I=1,2),IMN(J),IYR(J),(IGL(J,NR),
     &AE20(J,NR),NR=1,5),(IGL(J,NR),AE20(J,NR),NR=6,9)
   82 FORMAT(3X,I2,'-',I2,9X,A4,I4,6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
   81 CONTINUE
      IBEG=NSTP+1
      IF(IBEG.GT.8) GO TO 85

      DO 83 J=IBEG,8
      WRITE(NPRNT,886) (NAGE(I,J),I=1,2),(IGL(J,NR),
     & AE20(J,NR),NR=1,5),(IGL(J,NR),AE20(J,NR),NR=6,9)
  886 FORMAT(3X,I2,'-',I2,13X,'XXXX',6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
   83 CONTINUE
   85 IF(NSEX.EQ.1) WRITE(NPRNT,77)
   77 FORMAT(/2X'FEMALE LIFE EXPECTANCY AT BIRTH'/)
      IF(NSEX.EQ.2) WRITE(NPRNT,677)
  677 FORMAT(/2X'MALE LIFE EXPECTANCY AT BIRTH'/)
      DO 78 J=NFRST,NSTP
      WRITE(NPRNT,79) (NAGE(I,J),I=1,2),IMN(J),IYR(J),(IGL(J,NR),
     & AE0(J,NR),NR=1,5),(IGL(J,NR),AE0(J,NR),NR=6,9)
   79 FORMAT(3X,I2,'-',I2,9X,A4,I4,6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
   78 CONTINUE
      IBEG=NSTP+1
      IF(IBEG.GT.8) GO TO 99
      DO 86 J=IBEG,8
      WRITE(NPRNT,87) (NAGE(I,J),I=1,2),
     & (IGL(J,NR),AE0(J,NR),NR=1,5),(IGL(J,NR),AE0(J,NR),NR=6,9)
   87 FORMAT(3X,I2,'-',I2,13X,'XXXX',6X,A3,F4.1,4(4X,A3,F4.1),4X,
     & A3,F4.1,3(4X,A3,F4.1))
   86 CONTINUE
      GO TO 99
  800 WRITE(NPRNT,801) LABEL,PNW
  801 FORMAT('1'/5X,'*** ERROR IN WIDOW FOR DATA SET ',18A4/5X,
     & 'INPUT PNW VALUES MUST BE BETWEEN 0 AND 1. PLEASE CHECK:'/
     & 5X,8F8.4)
      GO TO 99
  802 WRITE(NPRNT,803) LABEL,MONTH
  803 FORMAT('1'/5X,'*** ERROR IN WIDOW FOR DATA SET ',18A4/5X,
     & 'THE MONTH MUST BE AN INTEGER VALUE FROM 1 TO 12, BUT ',
     & 'MONTH =',I4)
      GO TO 99
  804 WRITE(NPRNT,805) LABEL,NSEX
  805 FORMAT('1'/5X,'*** ERROR IN WIDOW FOR DATA SET ',18A4/5X,
     & 'NSEX MUST HAVE A VALUE OF 1 OR 2, BUT NSEX = ',I4)
   99 RETURN
      END
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