WORKING PAPER 60

A Computer program for constructing spatial demographic accounts (aggregate population): users' manual

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Contents

Abstract

The paper describes how a computer program may be used to construct spatial demographic accounts for a set of regions for an historic or projective period. Reference is made to the papers outlining the methodology. Instructions are given for preparing the deck of cards for input to the computer and a simple example is given. The nature of the program output is outlined and sample output generated from the example input deck is listed. The way in which the printout information may be assembled into an accounts table is specified. Finally, a complete listing of the FORTRAN IV text of the program as established as a file on the Leeds KDF9 disc store is provided.

1. Spatial demographic accounts.

The program enables the user to contruct spatial demographic accounts for regional populations from input data on start of period populations and births, deaths and migrations during the period. The methods and model involved are outlined in P.H. Rees and A.G. Wilson (1973) "Accounts and models for spatial demographic analysis I: aggregate populations," Environment and Planning, 5,1, pp 61-90 and in P.H. Rees and A.G. Wilson (1974) Spatial demographic analysis, monograph in preparation, Chapters 3 through 7.

2. Features of the program.

The program has been written for the Leeds KDF 9 and Leeds 1906 A computers. The KDF 9 version is described here. There is no restriction on the number of regions that may be handled as the program uses dynamic dimensioning. However, with a large number of regions the storage capacity of the KDF 9 may be exceeded with the program in its present state.

The user is required to identify which region, if any, is to be regarded as "the rest of the world". This is necessary because the model equations will differ for this region, and dummy values only (e.g. zeroes) will be read in for the population, the births and the deaths of this region. The program may, however, be run without a rest of the world region if it is considered that the system of regions considered is closed to migration for all practical purposes.

The program may be run in one of two modes: historical or projective.

1. The historical mode requires the input of regional populations at the start of a period, regional birth totals, regional death totals, migration and survival flows, and birth, migration and survival flows for a past period.

2. The projective mode requires the input regional populations at some base point in time, and forecast regional birth rates, death rates, and projected migration and survival flows and birth, migration and survival flows.

3. Input cards.

The following cards or sets of cards need to be prepared when using the program on the KDF 9 computer. If the program is used on another computer system cards specific to that computer will need to be substituted for those described here.

(1) System Control Card I: *JOB Card

Use cards with pre-punched *JOB in columns 1 - 4.

Columns	Entry	Description
1-4	*JOB	Pre-punched
6-18	MPHRSDA--FPU+	Program identifier
19-22	k/dd	Users number k= letter or number dd = decimal number e.g. Q/01 refers to an undergraduate in the Geography Department with the identification number 01.
23-25	/dd	Anticipated running time in minutes, right justified e.g. 01 meaning 1 minute, which should normally be sufficient.
28-33	X10000	Execution storage needed.
35-39	P1000	Number of lines of printing anticipated.

This accesses the program MPHRSDA stored on the KDF 9 disc.

(2) System Control Card 2: the * DATA card.

Use a pre-punched blue card reading *DATA in the first four columns. No further punching is required for this card.

(3) Program Control card (1): Parameter card.

On this card are entered the job specifications for the number of regions involved (N), the mode of analysis (NHP, set to values indicating historical or projective analysis), the number of the rest of the world region (NRW), the maximum number of iterations that the program is to go through (NITMAX) and whether printing of intermediate iterations accounts is to be suppressed or not (NPRINT). Each parameter must be right justified in the field indicated.

Column	Format	Variable Name	Description
1 - 3	I3	N	Number of regions
4 - 6	I3	NHP	Mode of analysis required: NHP < 0 means historical analysis; NHP > 0 means projective analysis
7 - 9	I3	NRW	Index number of the rest of the world region. Normally it will be placed last.
10 - 12	I3	NITMAX	Maximum number of iterations which the program is to go through before stopping.
13 - 15	I3	NPRINT	Parameter indicating whether all iterations should be printed or only some. NPRINT equals 0 means that all iterations are printed. Otherwise only the final iteration is printed.

(4) Title Cards (2)

Enter the title of the job on two cards in any format in Columns 1 - 80 on each card. Normally the title should contain the user's name, the name of the regional system being analysed, and the periods covered.

N.B. If you are punching the cards on a 1906A coded card punch rather than a KDF9 coded card punch avoid the use of punctuation on the title cards.

(5) Demographic data cards

Set (a): the KOLDP or initial population cards.

These will contain the values of the beginning of period population for each region. The format of each card is (10 F 8.0) and the number of cards needed is the smallest integer greater than $(N/10)$. For example, if there were 15 regions, $N/10$ would equal 1.5 and the next largest integer would be 2. A dummy value should be supplied for the population of the rest of the world region even though it will not be used in the calculation.

Set (b): the K (I,J) N surviving migrant cards.

These will contain the values for the number of surviving migrants between regions over the period. Dummy values should be supplied for the K (I,I) flows. The format of each card is (10 F 8.0). There will be N sets of cards each referring to one origin region. Each origin region will contain $^{N}/_{10}$ (evaluated as the next largest integer) cards.

Set (c): the K (N + I,J) or birth and surviving migrant cards.

These will contain the values of the migrant flows between regions of persons born in the period who survive at the end of the period. Dummy values should be supplied for the (N + I,I) or diagonal term. The format of each card will be 10 F 8.0. There will be N sets of cards each referring to one origin region. Each region will contain $^{N}/_{10}$ (evaluated as the lext largest integer) cards.

Set (d): the KTB (I) and KTD (I) or total births and total deaths cards or the B (I) and D (I) or birth rate and death rate cards.

If the accounts analysis is in historical mode, total births and total deaths for the regions should be read in here. If the accounts analysis is in projective mode, forecast birth rates and death rates should be input instead. The NHP parameter on the parameter card will have been set to a number less than 0 for historical analysis, or to a number greater than zero for projective analysis.

The set of cards referring to births will come first and then the set of cards referring to deaths. Each set will consist of $^{N}/_{10}$ (evaluated aa the next largest integer) cards, each with a format of (10 F 8.0) in the case of historical analysis or each with a format of (10 F 8.6) in the case of projective analysis.

(6) Program control card (2): termination card.

This flags the end of the analysis. A zero should be punched in column 1 of the card.

(7) System control card 3: the *ENDJOB card.

This should be placed at the end of the card deck. It consists of*ENDJOB punched punched in the first 7 columns of a card. Pre-punched *ENDJOB cards are available in the racks next to the card punches in the EDP9 data preparation room. This indicates the end of the card deck or job.

4. An example of an input deck.

This example has been prepared using data from Andrei Rogers (1971) Matrix methods in urban and regional analysis Holden - Day, San Francisco, Table 1.1, page 19. The birth, migration and survival flows have been estimated by multiplying the births total for each region by the relevant inter-region migration and survival rates.

Input data table: known flows in the spatial demographic accounts for Islandia, 1950 - 1965.

Regional locations in 1950	Regional location in 1965 NI	CI	SI	Regional location of deaths 1950-1965 NI	CI	SI	Totals
1. Northern Islandia (NI)		36	36				288
2. Central Islandia (NI)	72		36				288
3. Southern Islandia (NI)	72	36					288
Regional locations of births, 1950-1965.							
1. Northern Islandia (NI)		16	16				132
2. Central Islandia (CI)	33		16				132
3. Southern Islandia (SI)	33	16					132
Totals:				108	108	108	

The input card deck

```
*JØBVMPHRSDA--FPU+6/01/02VX10000VP1000                          (1)
*DATA                                                           (2)
003V-1VV0V20VV0                                                 (3)
SPATIAL DEMØGRAPHIC ANALYSIS                                    )  (4)
RØGERS ISLANDIA EXAMPLE (CHAPTER 1, RØGERS,1971)                )
     288     288     288                                        (5)(a)
       0      36      36                                        )
      72       0      36                                        )  (5)(b)
      72      36       0                                        )
       0      16      16                                        )
      33       0      16                                        )  (5)(c)
      33      16       0                                        )
     132     132     132                                        )  (5)(d)
     108     108     108                                        ).
0                                                               (6)
*ENDJØB                                                         (7)
```

Items in the input deck

(1) System control card 1: job identification card.

(2) System control card 2: data link card.

(3) Program control card 1: the parameter card.

(4) The title cards.

(5) (a) The KOLDP or initial population cards.

(5) (b) The K (I,J) or surviving migrant cards.

(5) (c) The K (N + I,J) or birth and surviving migrant cards.

(5) (d) The KTB (I) and KTD (I) or total births and total deaths cards.

(6) Program control card 2: termination card.

(7) System control card 3: end of job card.

Card sequence (3) to (5)(d) may be repeated as many times as is desired.

5. The output.

The following items are printed out.

(1) The title of the job.

(2) The job parameters. Note that no rest of the world region has been specified. All iterations are to be printed.

(3) The input data summarized.

KOLDP - the initial or "old" population of the region.
KSUMMO - the sum of migration and survival out of the region.
KSUMMI - the sum of migration into the region.
KSMBMO - the sum of birth, migration and survival out of the region.
KSMBMI - the sum of birth, migration and survival into the region.
KTB - the total births in the region.
KTD - the total deaths in the region.
K refers to the population.

(4) A list of the variables calculated in the program.

This list is produced for each region at each iteration.

KATRB - population at risk of giving birth.
KATRD - population at risk of dying.
KATRDI - population at risk of dying in region i, having started there.
BRATE - birth rate.
DRATE - death rate
DIRATE - death rate of persons dying in region i, having started there.
KSBMDO - sum of persons born, migrating and dying out of the region.
KSBMDI - sum of persons born, migrating and dying into the region.
KSMMDO - sum of persons migrating and dying out of the region.
KSMMDI - sum of persons migrating and dying into the region.
K (N + I, N + I) - deaths in a region of persons born there.
K (N + I,I) - persons born in a region who survive there.
K (I, N + I) - persons dying in a region, having started there.
K (I,I) - persons surviving in a region, having started there.
KNEWP - the end of the period or "new" population.

(5) The death and migration and death matrix.
This is printed out as a table.

(6) The birth and death and the birth migration and death matrix.

This is printed out as a table.

Where the user has requested that the results of all iterations be printed out, items (4), (5) and (6) will be repeated for each iteration. The results for each iteration are headed by the iteration number.

(7) A message is printed out at the end that indicates that all analyses have been completed.

6. An example of the printout.

In Figure 1 the printout from the input cards listed in Section 4 is reproduced. Alongside each block of the printout is noted the item number as indicated in the description of the output in Section 5 above. Only two iterations of the account based model were needed before the accounts terms converged on a stable solution.

7. Construction of spatial demographic accounts tables from the printout.

The final step of assembling the figures in the printout into an accounts table is left to the users. The following table shows how this may be done in general.

Figure 1. AN EXAMPLE OF THE PRINTOUT.

```
 DAVES* WATFOR

 *JOB MPHRSDAO1FPU*6/01/02          X10000  P5000
 *DATA


SPATIAL DEMOGRAPHIC ANALYSIS  P.H. REES                                    (1)
 ROGERS ISLANDIA EXAMPLE (CHAPTER 4, ROGERS, 1971)

No. OF REGIONS=   3                                                        (2)
 NHP=  1
 REGION   0   IS THE REST OF THE WORLD REGION
 MAX. No. OF ITERATIONS IS  20
 NPRINT=   0

REGION      KOLDP     KSUMM0     KSUMM1     KSMBM0     KSMBM1       KTB       KTD      (3)
   1         288.       72.       144.        33.        66.      132.      108.
   2         288.      108.        72.        49.        33.      132.      108.
   3         288.      108.        72.        49.        33.      132.      108.

 MIGRATION MATRIX
   1          0.       36.        36.
   2         72.        0.        36.
   3         72.       36.         0.

 BIRTH AND MIGRATION MATRIX
   1          0.       16.        16.
   2         33.        0.        16.
   3         33.       16.         0.

 POPULATIONS AT RISK, ACCOUNTS, HISTORICAL CASE                            (4)
                                                                          NIT=1
ITERATION NO.=  1

   1      KATRB=     270.0000      KATRD=     344.2500      KATRDI=     198.0000
          BRATE=       0.4889      DRATE=       0.3137      DIRATE=       0.0000
         KSBMD0=       3.3702      KSBMDI=       5.3878      KSMMD0=      15.4978
         KSMMDI=      24.5106  K(N+I,N+I)=      16.4323  K(N+I,I)=      79.1974
     K(I,N+I)=      61.6693      K(I,I)=     138.8330      KNEWP=     428.0394
   2      KATRB=     216.0000      KATRD=     277.8750      KATRDI=     180.0000
          BRATE=       0.6111      DRATE=       0.3887      DIRATE=       0.0000
         KSBMD0=       4.3790      KSBMDI=       3.3702      KSMMD0=      20.0042
         KSMMDI=      15.4978  K(N+I,N+I)=      18.4146  K(N+I,I)=      59.7064
     K(I,N+I)=      70.7174      K(I,I)=      89.2784      KNEWP=     253.9848
   3      KATRB=     216.0000      KATRD=     277.8750      KATRDI=     180.0000
          BRATE=       0.6111      DRATE=       0.3887      DIRATE=       0.0000
         KSBMD0=       4.3790      KSBMDI=       3.3702      KSMMD0=      20.0042
         KSMMDI=      15.4978  K(N+I,N+I)=      18.4146  K(N+I,I)=      59.7064
     K(I,N+I)=      70.7174      K(I,I)=      89.2784      KNEWP=     253.9848
```

Figure 1 (Continued)

```
 DEATH AND MIGRATION AND DEATH MATRIX
   1        61.6693          7.7489          7.7489
   2        12.2553         70.7174          7.7489
   3        12.2553          7.7489         70.7174

 BD AND BMD MATRIX
   1        16.4323          1.6851          1.6851
   2         2.6939         18.4146          1.6851
   3         2.6939          1.6851         18.4146

 POPULATIONS AT RISK, ACCOUNTS, HISTORICAL CASE

 ITERATION NO.=  2

 CONVERGED ON THIS ITERATION

   1     KATRB=     287.6697     KATRD=     357.2213     KATRDI=     209.5420
         BRATE=       0.4589     DRATE=       0.3023     DIRATE=       0.2943
        KSBMDO=       3.3488     KSBMDI=       5.1844     KSMMDO=      15.3942
        KSMMDI=      23.5472  K(N+I,N+I)=      15.8798  K(N+1,1)=      79.7713
     K(I,N+1)=      63.3879     K(1,1)=     137.2179     KNEWP=     426.9893
   2     KATRB=     223.5126     KATRD=     279.5631     KATRDI=     183.6351
         BRATE=       0.5906     DRATE=       0.3863     DIRATE=       0.3851
        KSBMDO=       4.2890     KSBMDI=       3.3488     KSMMDO=      19.4710
        KSMMDI=      15.3942  K(N+I,N+I)=      18.3280  K(N+1,1)=      59.9053
     K(I,N+1)=      79.9290     K(1,1)=      89.6000     KNEWP=     254.5054
   3     KATRB=     223.5126     KATRD=     279.5631     KATRDI=     183.6351
         DRATE=       0.5906     DRATE=       0.3863     DIRATE=       0.3851
        KSBMDO=       4.2890     KSBMDI=       3.3488     KSMMDO=      19.4710
        KSMMDI=      15.3942  K(N+I,N+I)=      18.3280  K(N+1,1)=      59.9053
     K(I,N+1)=      79.9290     K(1,1)=      89.6000     KNEWP=     254.5054

 DEATH AND MIGRATION AND DEATH MATRIX
   1        63.3879          7.6971          7.6971
   2        11.7739         79.9290          7.6971
   3        11.7739          7.6971         79.9290

 BD AND BMD MATRIX
   1        15.8798          1.6744          1.6744
   2         2.5922         18.3280          1.6744
   3         2.5922          1.6744         18.3280

 READ N=, CARD AT FINISHED ALL SETS OF DATA

 TIME     4.3 SECS

 STORE USED  4240  WORDS
```

(5) NIT=1

(6) NIT=2

(4) NIT=2

(5) NIT=2

(7)

		Regional location at the end of the period. 1 2 ...J ... N	Regional location of deaths in the period. 1 2 ... J ... N	Totals
Regional location at the beginning of the period	1 2 : I : N	K(I,J) figures from "Migration Matrix" K(I,I) figures K(I,J) figures from "Migration Matrix".	K(I,N+J) figures from "Death and Migration and Death Matrix" K(I,N+I) figures K(I,N+J) figures "Death and Migration and Death Matrix"	KOLDP figures
Regional location of birth in the period	1 2 : I : N	K(N+I,J) figures from "Birth and Migration Matrix" K(N+I,I) figures K(N+I,J) figures from "Birth and Migration Matrix"	K(N+I,N+J) figures from "BD and BMD Matrix". K(N+I,N+I) figures K(N+I,N+J) figures from "BD and BMD Matrix"	KTB figures
Totals		KNEWP figures	KTD figures	

For the Islandia example, the final ccounts table is as follows:

Initial states \ Final states	Regional location in 1965			Regional location of deaths 1950 - 1965			Totals
	Northern Islandia NI	Central Islandia CI	Southern Islandia SI	Northern Islandia NI	Central Islandia CI	Southern Islandia SI	
Regional location in 1950							
1.Northern Islandia	138.8330	36	36	61.6693	7.7489	7.7489	288
2.Central Islandia	72	89.2784	36	12.2553	70.7174	7.7489	288
3.Southern Islandia	72	36	89.2784	12.2553	7.7489	70.7174	288
Regional location of births 1950 - 1965							
1.Northern Islandia	79.1974	16	16	16.4323	1.6851	1.6851	132
2.Central Islandia	33	59.7064	16	2.6939	18.4146	1.6851	132
3.Southern Islandia	33	16	59.7064	2.6939	1.6851	18.4146	132
Totals:	428.0304	253.9848	253.9848	108	108	108	

8. The program.

A listing of the computer program used to construct the spatial demographic accounts is given below. The program is written in FORTRAN IV for the KDF9 computor used for undergraduate teaching at the University of Leeds. One feature of the program that may be perculiar to the Leeds KDF9 computer is the use of dynamic dimensions in the DIMENSION statement. If this facility is not available to the user the DIMENSION statement may be altered to fixed dimensions.

References:

P.H. Rees and A.G. Wilson (1973) Accounts and models for spatial demographic analysis 1: aggregate populations Environment and Planning, 5, 1, pp 61-90.

P.H. Rees and A.G. Wilson (1974) Spatial demographic analysis monograph in preparation, Chapters 3 to 7.

A. Rogers (1971) Matrix methods in urban and regional analysis, Holden-Day, San Francisco.

FIGURE 2. A LISTING OF THE S.D.A. PROGRAM (KDF9 Version).

```
DAVES, WATFOR

*JOB NPHRSDA01FPU+6/01/02  C10000
*BIN
      REAL KOLDP,K,KSUMMO,KSUMMI,KSMMDO,KSMMDI,KSMBMO,KSMBMI,KSBMDO,KSBM
     1DI,KTB,KTD,KATRB,KATRD,KATRDI,KO,KNEWP
C THIS RUN IS WITH THE REVISED CHAPTER 7 ESTIMATED FLOWS AND STOCKS
C  READ RUN PARAMETERS
C  N= NUMBER OF REGIONS
C      NHP.LT.0 MEANS HISTORICAL ANALYSIS, NHP.GT.0 MEANS PROJECTION
C      NRW= NUMBER OF THE REST OF THE WORLD REGION
C      NITMAX= MAXIMUM NUMBER OF ITERATIONS
C      NPRINT GT 0 MEANS PRINT ALL ITERATIONS
C      OTHERWISE ONLY FINAL ITERATION PRINTED
  200 READ(5,100) N,NHP,NRW,NITMAX,NPRINT
  100 FORMAT(5I3)
C    ITERATIONS COUNT, NIT
      NIT=0
      NTEST=-1
      DIMENSION KOLDP(N),K(2*N,2*N),KSUMMO(N),KSUMMI(N),KSMMDO(N),KSMMDI
     1(N),KSMBMO(N),KSMBMI(N),KSBMDO(N),KSBMDI(N),KTB(N),KTD(N),B(N),D(N
     2),KATRB(N),KATRD(N),KATRDI(N),DI(N),KO(2*N,2*N),KNEWP(N),TITLE(40)
      IF(N.NE.0) GO TO 199
      WRITE(6,233)
  233 FORMAT(1H1,'READ ZERO CARD AND FINISHED ALL SETS OF DATA')
      GO TO 201
C      READ IN TITLE OF JOB
  199 READ(5,207) (TITLE(I),I=1,40)
  207 FORMAT(20A4/20A4)
C      WRITE OUT TITLE OF JOB
      WRITE(6,208) (TITLE(I),I=1,40)
  208 FORMAT(1H1,20A4/1H ,20A4//)
C      READ DATA
C      OLD POPULATION
      READ(5,102) (KOLDP(I),I=1,N)
  102 FORMAT(10F8.0)
C      SURVIVING MIGRANTS
      DO 1 I=1,N
      READ(5,102) (K(I,J),J=1,N)
    1 CONTINUE
C      N.B. DUMMIES FOR K(I,I)
C      BIRTH AND SURVIVING MIGRATION
      N1=N+1
      N2=2*N
      DO 2 I=N1,N2
      READ(5,102) (K(I,J),J=1,N)
    2 CONTINUE
C      N.B. DUMMIES FOR K(N+I,I)
C      CALCULATE M AND BM SUMS
      DO 3 I=1,N
      KSUMMO(I)=0.0
      KSUMMI(I)=0.0
      KSMBMO(I)=0.0
      KSMBMI(I)=0.0
      DO 4 J=1,N
      KSUMMO(I)=KSUMMO(I)+K(I,J)
      KSUMMI(I)=KSUMMI(I)+K(J,I)
      KSMBMO(I)=KSMBMO(I)+K(N+I,J)
      KSMBMI(I)=KSMBMI(I)+K(N+J,I)
    4 CONTINUE
    3 CONTINUE
      IF(NHP.GT.0)GO TO 5
```

```
C       HISTORICAL ANALYSIS    READ KTB,KTD
        READ(5,102) (KTB(I),I=1,N)
        READ(5,102) (KTD(I),I=1,N)
C       N.B. SET KTB,KTD AS DUMMIES FOR RW ZONE
        GO TO 40
C       PROJECTION.    READ BIRTH AND DEATH RATES
    5   READ(5,103) (B(I),I=1,N)
        READ (5,103) (D(I),I=1,N)
C       N.B.  SET B, D TO DUMMIES FOR RW ZONE
  103   FORMAT(10F8.6)
C       PRINT DATA
   40   WRITE(6,104) N,NHP,NRW,NITMAX,NPRINT
  104   FORMAT(1H ,'NO. OF REGIONS=',1X,I3/1H ,'NHP=',1X,I3/1H ,'REGION',1
       1X,I3,3X,'IS THE REST OF THE WORLD REGION'//1H ,'MAX. NO. OF ITERATI
       2ONS IS',1X,I3/1H ,'NPRINT=',1X,I3//)
        IF(NHP.GT.0) GO TO 41
        WRITE(6,220)
  220   FORMAT(1H ,'REGION',5X,'KOLDP',4X,'KSUMMO',3X,'KSUMMI',3X,'KSMBMO'
       1,3X,'KSMBMI',5X,'KTB',6X,'KTD'//)
        DO 44 I=1,N
        WRITE(6,105)  I,KOLDP(I),KSUMMO(I),KSUMMI(I),KSMBMO(I),KSMBMI(I),K
       1TB(I),KTD(I)
   44   CONTINUE
  105   FORMAT(1H ,I4,4X,7F9.0)
        GO TO 42
   41   WRITE(6,221)
  221   FORMAT(1H ,'REGION',5X,'KOLDP',4X,'KSUMMO',3X,'KSUMMI',3X,'KSMBMO'
       1,3X,'KSMBMI',3X,'BRATE',5X,'DRATE'//)
        DO 45 I=1,N
        WRITE(6,106)  I,KOLDP(I),KSUMMO(I),KSUMMI(I),KSMBMO(I),KSMBMI(I),B
       1(I),D(I)
   45   CONTINUE
  106   FORMAT(1H ,I4,4X,5F9.0,2X,F8.6,2X,F8.6)
   42   WRITE(6,206)
  206   FORMAT(//1H ,'MIGRATION MATRIX')
        DO 43 I=1,N
        WRITE(6,107)  I,(K(I,J),J=1,N)
   43   CONTINUE
  107   FORMAT(1H ,I4,10F8.0)
        WRITE(6,108)
  108   FORMAT(//1H ,'BIRTH AND MIGRATION MATRIX')
        DO 46 I=1,N
        WRITE(6,109)  I,(K(N+I,J),J=1,N)
  109   FORMAT(1H ,I4,10F8.0)
   46   CONTINUE
C       MAIN ITERATIVE LOOP STARTS
    6   NFLAG=1
        NIT=NIT+1
C       STEP 2.  AT RISK POPULATIONS
        DO 7 I=1,N
        IF(NIT.GT.1) GO TO 32
        KSBMDO(I)=0.0
        KSBMDI(I)=0.0
        KSMMDO(I)=0.0
        KSMMDI(I)=0.0
        K(N+I,N+I)=0.0
        KATRB(I)=0.0
        KATRO(I)=0.0
        KATRDI(I)=0.0
        B(I)=0.0
        D(I)=0.0
        DI(I)=0.0
        K(N+I,I)=0.0
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      K(I,N+I)=0.0
      K(I,I)=0.0
      KNEWP(I)=0.0
   31 IF(NHP.LT.0)GO TO 32
C     INITIAL ESTIMATES OF KTB,KTD IN PROJECTION CASE
      KTB(I)=KOLDP(I)*B(I)
      KTD(I)=KOLDP(I)*D(I)
   32 IF(I.EQ.NRW)GO TO 7
      KATRB(I)=KOLDP(I)+0.5*KSUMMI(I)-0.5*KSUMMO(I)-0.5*KTD(I)+0.75*KSMM
     1DI(I)-0.75*KSMMDO(I)+0.5*K(N+I,N+I)+0.5*KSBMDI(I)
      KATRD(I)=KOLDP(I)+0.5*KSUMMI(I)-0.5*KSUMMO(I)-0.5*KTD(I)+0.75*KSMM
     1DI(I)-0.75*KSMMDO(I)+0.25*K(N+I,N+I)+0.625*KSBMDI(I)-0.375*KSBMDO(
     21)+0.50*KTB(I)-0.25*KSMBMO(I)+0.25*KSMBMI(I)
      KATRDI(I)=KOLDP(I)+0.5*KSUMMO(I)-0.5*KTD(I)+0.5*KSMMDI(I)+0.5*K(N+
     11,N+I)+0.5*KSBMDI(I)-0.75*KSMMDO(I)
    7 CONTINUE
C     STEP 3
      IF(NHP.GT.0)GO TO 10
C     HISTORICAL RATES
      DO 11 I=1,N
      IF(I.EQ.NRW)GO TO 11
      B(I)=KTB(I)/KATRB(I)
      D(I)=KTD(I)/KATRD(I)
      IF(NIT.EQ.1)GO TO 11
      DI(I)=K(I,N+I)/KATRDI(I)
   11 CONTINUE
      GO TO 12
C     PROJECTION, TOTAL BIRTHS AND DEATHS
   10 DO 13 I=1,N
      IF(I.EQ.NRW)GO TO 13
      KTB(I)=B(I)*KATRB(I)
      KTD(I)=D(I)*KATRD(I)
   13 CONTINUE
C     STEP 4  CALCULATE MINOR FLOWS
   12 DO 14 I=1,N
      KSBMDO(I)=0.0
      DO 15 J=1,N
      IF(I.EQ.J)GO TO 15
      IF(N+I.EQ.J)GO TO 15
      IF(I.EQ.N+J)GO TO 15
      IF(J.EQ.NRW)GO TO 30
      K(I,N+J)=(0.5*D(J)*K(I,J))/(1.0-0.25*D(J))
      K(N+I,N+J)=(0.25*D(J)*K(N+I,J))/(1.0-0.125*D(J))
      KSBMDO(I)=KSBMDO(I)+K(N+I,N+J)
      GO TO 15
   30 K(I,N+J)=(0.5*D(I)*K(I,J))/(1.0-0.25*D(I))
      K(N+I,N+J)=(0.25*D(I)*K(N+I,J))/(1.0-0.125*D(I))
      KSBMDO(I)=KSBMDO(I)+K(N+I,N+J)
   15 CONTINUE
      IF(I.EQ.NRW)GO TO 14
      K(N+I,N+I)=(0.5*D(I)*(KTB(I)-0.5*KSMBMO(I)-0.75*KSBMDO(I)))/(1.0+0
     1.25*D(I))
   14 CONTINUE
C     CONVERGENCE TESTS
      IF(NIT.EQ.1)GO TO 16
      NTEST=-1
      DO 17 I=1,N
      IF(I.EQ.NRW) GO TO  17
      X=(K(N+I,N+I)-KO(N+I,N+I))/(KO(N+I,N+I))
      IF(X.GT.0.001)GO TO 16
      DO 18 J=1,N
      IF(I.EQ.N+J)GO TO 18
      IF(I.EQ.J)GO TO 18
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      IF(N+I.EQ.J)GO TO 18
      X=(K(I,N+J)*KO(I,N+J))/(KO(I,N+J))
      IF(X.GT.0.001)GO TO 16
      X=(K(N+I,N+J)*KO(N+I,N+J))/(KO(N+I,N+J))
      IF(X.GT.0.001)GO TO 16
   18 CONTINUE
   17 CONTINUE
      NTEST=1
      GO TO 21
C     RESET FOR NEXT ITERATION
   16 DO 19 I=1,N
      KO(N+I,N+I)=K(N+I,N+I)
      DO 20 J=1,N
      IF(I.EQ.J)GO TO 20
      IF(I.EQ.N+J)GO TO 20
      IF(N+I.EQ.J)GO TO 20
      KO(I,N+J)=K(I,N+J)
      KO(N+I,N+J)=K(N+I,N+J)
   20 CONTINUE
   19 CONTINUE
C     STEP 5 ACCOUNTING EQUATIONS
   21 DO 22 I=1,N
      KSBMDI(I)=0.0
      KSMMDI(I)=0.0
      KSMMDO(I)=0.0
      DO 23 J=1,N
      IF(I.EQ.J)GO TO 23
      IF(I.EQ.N+J)GO TO 23
      IF(N+I.EQ.J)GO TO 23
      KSBMDI(I)=KSBMDI(I)+K(N+J,N+I)
      KSMMDI(I)=KSMMDI(I)+K(J,N+I)
      KSMMDO(I)=KSMMDO(I)+K(I,N+J)
   23 CONTINUE
      IF(I.EQ.NPW)GO TO 22
      K(N+I,I)=KTB(I)*KSMBMI(I)=K(N+I,N+I)*KSBMDO(I)
      K(I,N+I)=KTD(I)*KSMMDI(I)=K(N+I,N+I)*KSBMDI(I)
      K(I,I)=KOLDP(I)*KSUMMO(I)=K(I,N+I)*KSMMDO(I)
      KNEWP(I)=K(I,I)*KSUMMI(I)+K(N+I,I)*KSMBMI(I)
   22 CONTINUE
      IF(NIT.LT.NITMAX)GO TO 36
      IF(NTEST.LT.0)GO TO 37
      WRITE(6,110)
  110 FORMAT(1H ,' CONVERGED ON LAST ITERATION')
   37 WRITE(6,120)
  120 FORMAT(1H ,'EXCEEDED MAXIMUM NO. OF ITERATIONS')
      GO TO 48
   36 IF(NTEST.LT.0)GO TO 47
   48 IF(NHP.GT.0)GO TO 50
C     HISTORICAL CASE
      WRITE(6,209)
  209 FORMAT(//1H ,'POPULATIONS AT RISK, ACCOUNTS, HISTORICAL CASE'/)
      WRITE(6,222) NIT
  222 FORMAT(1H ,'ITERATION NO.=',I3/)
      IF(NTEST.EQ.1) GO TO 230
      GO TO 231
  230 WRITE(6,232)
  232 FORMAT(1H ,'CONVERGED ON THIS ITERATION'/)
  231 DO 49 I=1,N
      WRITE(6,111) I,KATRB(I),KATRD(I),KATRDI(I),B(I),D(I),DI(I),KSBMDO(
     1I),KSBMDI(I),KSMMDO(I),KSMMDI(I),K(N+I,N+I),K(N+I,I),K(I,N+I),K(I,
     2I),KNEWP(I)
   49 CONTINUE
  111 FORMAT(1H ,I4,5X,'KATRB=',F13.4,6X,'KATRD=',F13.4,5X,'KATRDI=',F13
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     1,4/9X,'BRATE=',F13.4,6X,'DRATE=',F13.4,5X,'DIRATE=',F13.4/8X,'KSBM
     2D=',F13.4,5X,'KSMMDI=',F13.4,5X,'KSMMDO=',F13.4/8X,'KSMMDI=',F13.
     34,1X,'K(N+1,N+1)=',F13.4,3X,'K(N+1,1)=',F13.4/6X,'K(1,N+1)=',F13.4
     4,5X,'K(1,1)=',F13.4,6X,'KNEWP=',F13.4)
      GO TO 51
      WRITE(6,210)
  210 FORMAT(1H ,'POPULATIONS AT RISK, PROJECTED BIRTHS AND DEATHS, ACCO
     1UNTS, PROJECTION CASE')
   50 DO 52 I=1,N
      WRITE(6,112) I,KATRB(I),KATRD(I),KATRDI(I),KTB(I),KTD(I),DI(I),KSB
     1MDO(I),KSBMDI(I),KSMMDO(I),KSMMDI(I),K(N+1,N+1),K(N+1,I),K(I,N+1),
     2K(I,I),KNEWP(I)
   52 CONTINUE
  112 FORMAT(1H ,I4,5X,'KATRB=',F13.4,6X,'KATRD=',F13.4,5X,'KATRDI=',F13
     1.4/9X,'  KTB=',F13.4,6X,'  KTD=',F13.4,5X,'DIRATE=',F13.4/8X,'KSBM
     2D=',F13.4,5X,'KSBMDI=',F13.4,5X,'KSMMDO=',F13.4/8X,'KSMMDI=',F13.
     34,1X,'K(N+1,N+1)=',F13.4,3X,'K(N+1,1)=',F13.4/6X,'K(1,N+1)=',F13.4
     4,5X,'K(1,1)=',F13.4,6X,'KNEWP=',F13.4)
   51 WRITE(6,113)
  113 FORMAT(//1H ,'DEATH AND MIGRATION AND DEATH MATRIX')
      DO 53 I=1,N
      WRITE(6,114) I,(K(I,N+J),J=1,N)
   53 CONTINUE
  114 FORMAT(1H ,I4,5F13.4/1H ,5F13.4)
      WRITE(6,115)
  115 FORMAT(//1H ,'BD AND BMD MATRIX')
      DO 54 I=1,N
      WRITE(6,114) I,(K(N+I,N+J),J=1,N)
   54 CONTINUE
      IF(NFLAG.LT.0)GO TO 6
      GO TO 200
  201 STOP
   47 IF(NPRINT.LT.0)GO TO 6
      NFLAG=-1
      GO TO 48
      END
*ENDJOB
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