LTCSRMig

Version 5.20

Description

LTCSRMig estimates net migration by 5-year age groups for a subnational population using three methods: the census survival ratio method, the life table survival ratio method, and a composite method that combines the previous two. The workbook produces both forward- and reverse-survived estimates, as well as an average of the two, using each of these three methods for censuses approximately 5 or 10 years apart.

In this workbook, the subarea populations by age and sex from one census are survived to the date of a subsequent census using the survival ratios. The difference—calculated as a residual—between the projected and enumerated populations at the later date serves as an estimate of the net number of migrants during the intercensal period. For the reverse-survival methods, the later population is reverse-survived back to the date of the earlier census. The difference between the expected and enumerated populations is an estimate of the cohort migration. These cohort estimates of intercensal migration are then converted to average annual net numbers of migrants by age and sex.

Migration estimates for children are estimated using child-woman ratios (CWRs) either computed directly from census data or estimated based on intercensal fertility estimates.

Data Required

(1) Two population distributions by age and sex for the total area, 5 or 10 years apart

(2) Two population distributions by age and sex for the desired subarea, 5 or 10 years apart

(3) One life table representative of the intercensal period for the total area

(4) One life table representative of the intercensal period for the subarea

(5) (Optional) Estimated total fertility rate (TFR) for the subarea representative of the intercensal period

Assumptions

(1) The degree of completeness of enumeration in each sex and age group is the same for the subarea as for the whole country.

(2) The degree of completeness of enumeration is similar for the two censuses.

(3) The child-woman ratios (CWR) among migrants are similar to those of the population of the subarea based on census data or estimated based on the intercensal TFR.

Procedures

The census populations and survival ratios are used to derive migration estimates using residual methods. The essence of these methods is that a population is projected forward (or backward) by multiplying (dividing) by a survival ratio to create an expected population for the

other point in time. The expected and observed populations are subtracted from one another to get a residual estimate of migration over the interval.

In order to standardize the age groups to an open-ended age group of 80+ in both censuses for both the total country and the subnational area, any populations with open-ended age groups lower than 80+ are extended using the procedures described in Arriaga (1994). It is assumed that available life tables already extend to age 80+.

(1) The workbook automatically generates the following survival ratios by sex (a total of six sets) based on the input data:

(a) Census survival ratios (CSR), based on the ratio of the national population at the later census divided by the population of same cohort in the earlier census.

$$CSR(s,a)=P(T,s,a,t_2) / P(T,s,a-p,t_1)$$

where:

CSR(s,a) = the census survival ratio for sex s and age group a at the later census

P(T,s,a,t) = total country population for sex s and age group a at time t

t_1 = earlier census date

t_2 = later census date

p = intercensal period = $t_2 – t_1$

a = 5-year age group a to a+4

s = sex (male or female)

(b) Life table survival ratios (LTSR) based on the ratio of the life table ${}_nL_x$ values for age groups that are 5 or 10 years apart (depending on the time between the censuses).

$$LTSR(i,s,a)=L(i,s,a) / L(i,s,a-p)$$

where:

LTSR(i,s,a) = the life table survival ratio for subarea i, sex s, and age group a at the later census

L(i,s,a) = intercensal life table stationary population for area i, sex s, and age group a

(c) Composite survival ratios (ComSR), created by multiplying the census survival ratio by the ratio of the subarea LTSR to the national LTSR.

$$ComSR(i,s,a)=CSR(s,a) * LTSR(i,s,a) / LTSR(T,s,a)$$

where:

ComSR(i,s,a) = composite survival ratio for sex s and age group a at the later census

LTSR(T,s,a) = intercensal life table survival ratio for the total country, sex s, and age group a at the later census

Siegel and Hamilton (1952) and Bogue, Hinze and White (1982:28-29) suggested many years ago that survival ratio-based estimates of net migration for subnational areas could be improved by using a hybrid of census survival and life table survival ratios; that is, by adjusting census survival ratios for differential mortality. One way of doing this, and the method employed in LTCSRMig, is the calculation of a composite set of intercensal survival ratios.[1]

(2) For each forward survival ratio method, the population in an age group for the earlier census is multiplied by the corresponding survival ratio. The result is an expected population for the later year. The difference between the observed population and the expected population for each age/sex group is the estimated cohort migration for the intercensal period.

$$EP(m,i,s,a,t_2) = P(i,s,a-p,t_1) * SR(m,i,s,a)$$
$$FM(m,i,s,a) = P(i,s,a,t_2) – EP(m,i,s,a,t_2)$$

where:

$EP(m,i,s,a,t_2)$ = expected population of area i at time t_2 for sex s and age group a based on method m

P(i,s,a,t) = area i population for sex s and age a at time t

SR(m,i,s,a) = survival ratio for method m, area i, sex s, and age group a at the later census

FM(m,i,s,a) = forward survival migration estimate using method m for area i, sex s, and the cohort in age group a at the later census

(3) For each reverse survival ratio method, the population in an age group for the later census is divided by the corresponding survival ratio. The result is an expected population for the earlier year. The difference between the expected population and the observed population is the estimated cohort migration.

$$EP(m,i,s,a,t_1) = P(i,s,a+p,t_2) / SR(m,i,s,a+p)$$
$$RM(m,i,s,a+p) = EP(m,i,s,a,t_1) - P(i,s,a,t_1)$$

where:

$EP(m,i,s,a,t_1)$ = expected population of area i at time t_1 for sex s and age a based on method m

RM(m,i,s,a+p) = reverse survival migration estimate using method m for area i, sex s, and the cohort in age group a+p at the later census

[1] United Nations (1970:30-32) and Shryock, Siegel and Associates (1971:633-634).

(4) To convert from cohort measures of migration to calendar year measures by age at migration we assume that the estimated cohort migrants are evenly distributed over time and age.

For a 5-year intercensal interval, the average annual net number of migrants is estimated using the following equation (5<=a<=70):

$$AAM(m,s,a)=[M(m,s,a) + M(m,s,a+5)] / 10$$

where:

AAM(m,s,a) = average annual net number of migrants for sex s, and age group a using method m
M(m,s,a) = estimated cohort net migrants using method m for sex s and age group a at time t_2
M(m,s,a+5) = estimated cohort net migrants using method m for sex s and age group a+5 at time t_2
m = method, which can be forward or reverse census, life table, or composite method

For a 10-year intercensal interval, the average annual net number of migrants is estimated using the following equation (10<=a<=65):

$$AAM(m,s,a)=[M(m,s,a) + 2*M(m,s,a+5) + M(m,s,a+10)] / 40$$

(5) For the oldest ages, we solve for the average annual net number of migrants in the open-ended age group and estimate the average annual net migration rate by dividing by the mid-period population by age. That migration rate is then applied to each of the midperiod component age groups to get the average annual numbers in each age group to 80+.

For a 5-year intercensal interval:

$$AAMOR(m,s,75) = \frac{[M(m,s,75)+2*M(m,s,80)]/10}{[P(i,s,75,t_1)+P(i,s,80,t_1)+P(i,s,75,t_2)+P(i,s,80,t_2)]/2}$$

Then for a=75 and 80+

$$AAM(m,s,a)= AAMOR(m,s,75)*[P(i,s,a,t_1)+P(i,s,a,t_2)]/2$$

where:

AAMOR(m,s,a) = average annual net migration rate for sex s, and age a using method m

For a 10-year intercensal interval:

$$AAMOR(m,s,70) = \frac{[M(m,s,70)+ 3*M(m,s,75)+4*M(m,s,80)]/40}{\left[\sum_{t=t1,t2} \sum_{a=70,75,80} P(i,s,a,t)\right]/2}$$

Then for a=70, 75 and 80+

$$AAM(m,s,a)= AAMOR(m,s,70)*[P(i,s,a,t_1)+P(i,s,a,t_2)]/2$$

(6) For ages below the intercensal interval, the average annual net number of migrants is estimated using the selected CWR values as follows for a= 0 (or a=5 only if the intercensal period is 10 years):

$$AAM(m,s,a) = CWR(s,a) * \sum_{x=15+a \text{ to } 40+a} AAM(m,f,x)$$

The CWR values can be the observed CWR values (average of the two censuses):

$$CWR(s,0) = \left[P(i,s,0,t_1)+P(i,s,0,t_2)\right] / \sum_{x=15 \text{ to } 39} \left[P(i,f,x,t_1)+ P(i,f,x,t_2)\right]$$

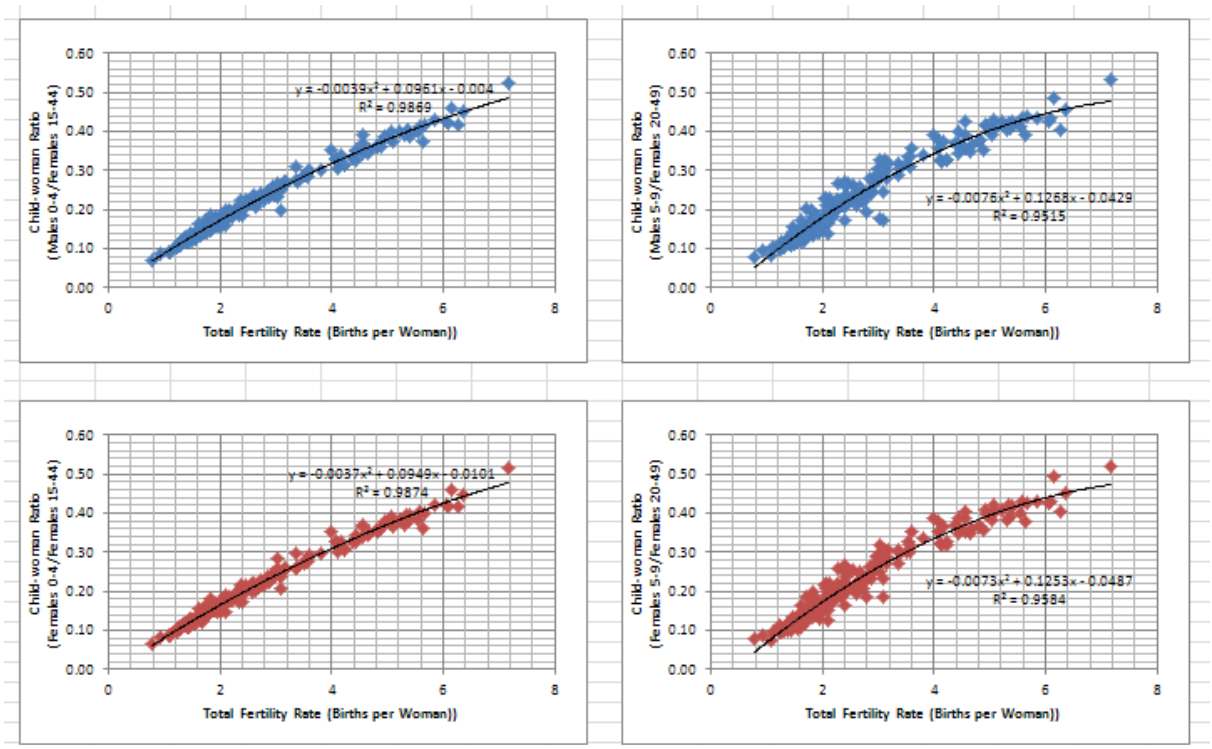
$$CWR(s,5) = \left[P(i,s,5,t_1)+P(i,s,5,t_2)\right] / \sum_{x=20 \text{ to } 44} \left[P(i,f,x,t_1)+ P(i,f,x,t_2)\right]$$

Alternate estimates of CWR can be obtained based on regression equations that relate CWRs to total fertility rates (TFR). The following models were based on estimates for 2012 from the International Data Base (U.S. Census Bureau 2013).

$$CWR(m,0) = -0.0039*TFR^2 + 0.0961*TFR - 0.004$$
$$CWR(f,0) = -0.0037*TFR^2 + 0.0949*TFR - 0.0101$$
$$CWR(m,5) = -0.0076*TFR^2 + 0.1268*TFR - 0.0429$$
$$CWR(f,5) = -0.0073*TFR^2 + 0.1253*TFR - 0.0487$$

Figure 1 shows the data and estimated regression equations underlying the estimation of child-woman ratios based on TFR.

Figure 1. Regressions of Child-Woman Ratios on TFRs



Advantages

(1) The required information is available in most population censuses and other national sources.

(2) If the actual populations do not depart significantly from the assumptions, the results are not greatly affected by age misreporting or by differential completeness of enumeration in the two censuses.

(3) The technique provides an approximate age/sex structure of the migrants.

Limitations

(1) If there is a difference in mortality between national and subnational areas, the CSR method results will be higher or lower than the actual number of migrants (depending on the direction of migration and the relative disparity between the national and subnational levels).[2] The LTSR and composite methods try to adjust for this.

(2) Censuses must be 5 or 10 years apart. If they are not, the census populations should be shifted so the intercensal periods correspond to one of these alternatives. This change may be a source of error.

(3) Only net migrants are estimated, not gross flows of in-migrants and/or out-migrants.

[2] See Bogue, Hinze and White (1982:27).

(4) Migrants are assumed to have migrated in equal numbers within each 5-year age group during the intercensal period. Since this may not be the case, the assumption might affect the accuracy of the age distribution.

(5) The selected child-woman ratios (CWRs) are used to derive child migration by assuming that they are the same for migrants as for the total population. The observed CWRs may be underestimated due to the frequently observed relative undercount of young children.

(6) The estimates based on TFR may also be wrong if fertility has been changing in recent years or the population is subject to high levels of migration. These issues may affect the accuracy of the child migration estimates.

The migration distributions are subject to any errors in the census populations (such as age misreporting and differential net underreporting within and between censuses) and life table input data.

References

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Note

For access to all Subnational Projections Toolkit workbooks and documentation, go to: http://www.census.gov/population/international/software/sptoolkit/