Influence of the mean net migration rate on change in the crude death rate

ABSTRACT.

This article focuses on indirect estimation of the influence of the mean net migration rate on the change in the crude death rate. The Paper includes a concrete application from the indirect estimation presented for Georgia in the period from 1989 to 1994.

1. INTRODUCTION.

In this paper we will try to find how the mean net migration rate influenced change in the crude death rate $\bar{\mu}$.

Decomposing the change in crude death rate $\bar{\mu}$ (Vaupel and Canudas Romo 2002), we assume that we have no data about migration. In the decomposition formula, substituting for age specific growth rate we use the variable r-method (Preston and Coale, 1982; Preston et al., 2001) and by indirect estimation find how the net migration rate influenced the change of crude death rate $\bar{\mu}$.

2. DECOMPOSITION OF THE CRUDE DEATH RATE $\bar{\mu}$

In the following section we shall try to follow the notation originated by Vaupel (1992) and used in Vaupel and Canudas Romo (2000) and (2002).

Let us denote population by $N(a,t)$ and an age-specific mortality rate by $\mu(a,t)$ over age a and time t.

Using $N(a,t)$ as weighting function we can represent average crude death rate $\bar{\mu}$ by following integral over age:

$$\dot{\bar{\mu}} = \frac{\int_0^{\omega} \mu(a,t)N(a,t)da}{\int_0^{\omega} N(a,t)da} \quad ,$$

Where ω is highest age attained.

Let the intensity of population growth be denoted by

$$\rho(a,t) = \frac{dN(a,t)/dt}{N(a,t)} \equiv \acute{N}(a,t). \qquad [1]$$

By a formula for decomposing derivatives of averages (Vaupel and Canudas Romo, 2002), the following equation is hold:

$$\dot{\bar{\mu}} = \bar{\dot{\mu}} + c(\mu, \acute{N}) \, , \qquad [2]$$

where

$$\dot{\bar{\mu}} = \frac{d}{dt}\frac{\int_0^{\omega} \mu(a,t)N(a,t)da}{\int_0^{\omega} N(a,t)da}, \qquad [3]$$

Where $\bar{\dot{\mu}}$, the average change by age is given by

$$\bar{\dot{\mu}} = \frac{\int_0^{\omega} [\frac{\partial}{\partial t}\mu(a,t)]N(a,t)da}{\int_0^{\omega} N(a,t)da} \qquad [4]$$

and where the covariance is given by

$$c(\mu, \acute{N}) = \frac{\int_0^{\omega} \mu(a,t) \acute{N}(a,t) N(a,t) da}{\int_0^{\omega} N(a,t) da} - \frac{\int_0^{\omega} \mu(a,t) N(a,t) da}{\int_0^{\omega} N(a,t) da} \frac{\int_0^{\omega} \acute{N}(a,t) N(a,t) da}{\int_0^{\omega} N(a,t) da} \quad [5]$$

For calculation of integrals using discrete data we used approximate derivatives and instantaneous averages(see note).

3. SUBSTITUTION FOR AGE-SPECIFIC GROWTH RATE.

We can see from [5] that the covariance term depends on the intensity of population growth $\acute{N}(a,t)$. We shall use the variable-r method in demographic estimation as a substitute for the intensity of population growth. When growth rate changes linearly during the time interval, this method uses the geometric mean of population counts at the beginning and end of the period for estimating the mean growth rate and the mean net migration rate $\bar{\iota}$ in the continuous case (Preston and Coale, 1982, Preston et al., 2001). Using the variable-r method the mean growth rate ρ(a+h/2,t+h/2)= $\acute{N}(a + \frac{h}{2}, t + h/2)$ at the mid-point age $a + h/2$ and mid-point time $t + h/2$ can be approximated by sum of two terms:

$$(\acute{N}_a \backslash \bar{\iota}_a) + \bar{\iota}_a,$$

Where only $\bar{\iota}_a$ depends on mean net migration rate.

As for calculation integral in covariance term [5] is used growth rate at mid-point age and mid-point time we can substitute for $\acute{N}(a + \frac{h}{2}, t + h/2)$ approximated sum $(\acute{N}_a \backslash \bar{\iota}_a) + \bar{\iota}_a$. After substitution we can get

$$c(\mu, \acute{N}) = c(\mu, \acute{N}_a \backslash \bar{\iota}_a) + c(\mu, \bar{\iota}_a) \qquad [6]$$

After calculating $c(\mu, \acute{N})$ and $c(\mu, \acute{N}_a \backslash \bar{\iota}_a)$ in [6] we can estimate indirectly influence of mean net migration rate on covariance term $c(\mu, \acute{N})$ and consequently on change of crude death rate.

4. Empirical example

In this section we will try to find how the net migration rate influenced change in the average crude death rate $\bar{\mu}$ in the period from 1989 to 1994 for Georgia. In 1989 there was almost no control over out-migration from Georgia. The State Department of Statistics of Georgia (SDSG) data mainly covers the out-migrants who have left Georgia for permanent residence and have possibly sold their homes and have been removed from the official register. Therefore, the SDSG data regarding out-migration is very inadequate.

Pursuant to some calculations, the negative net migration for the period 1990-1997 is estimated to be 820 thousand (Gugushvili, 1998).

According another estimation, which is based on both certain calculations and sociological-demographic research results, the negative net migration for the period of 1989-1999 amounted to 1189.5 thousand (Tsuladze et al., 2011).

Table 4.1. shows the decomposition of the crude death rate $\bar{\mu}$ from 1989 to 1994 for males in Georgia.

Table 4.1: Annual change of crude death rate $\bar{\mu}$ per thousand from 1989 to 1994 for males in Georgia.

$\bar{\mu}(1994) = 11{,}566$
$\bar{\mu}(1989) = 9{,}648$
$\dot{\bar{\mu}} = 0{,}384$
$\hat{\bar{\mu}} = 0{,}095$
$c(\mu, \acute{N}) = 0{,}287$
$c(\mu, \acute{N}_a \backslash \bar{\iota}_a) = 0{,}077$
$c(\mu, \bar{\iota}_a) = c(\mu, \acute{N}) - c(\mu, \acute{N}_a \backslash \bar{\iota}_a) = 0{,}287 - 0{,}077 = 0{,}21$

source: Based on the Census in 1989 in Georgia and estimations in the Demographic Yearbook of Georgia 2010.

The estimated value of $\dot{\bar{\mu}} = 0{,}384$ calculated from [2] is slightly different from the actual figure of 0,382, the discrepancy arises because discrete data are used to approximate derivatives and instantaneous averages.

After the calculation it became clear that the mean net migration increases the change of crude death rate.

5. Conclusion.

In this paper we presented a substitution for the intensity of growth inside the decomposition formula for the change of crude death rate using the variable r-method. This substitution can also be used successfully in decomposition formulas for the another demographic indicators, which contains intensity of growth in any dimensional case. This substitution is useful when data about migration is not available. In our empirical example for Georgia we demonstrate such a substitution. By calculations we find out that net migration of Georgian males significantly increased the covariance term and consequently the change in the crude death rate for Georgian males from 1984 to 1994.

Note

If data are available for time t and $t+h$, the following approximation is used for the value at the midpoint $t+h$. For the intensity of growth of population

$$\rho(a,t+h/2) = \acute{N}\left(a, t+\frac{h}{2}\right) = \ln\left(\frac{N(a,t+h)}{N(a,t)}\right)/h$$

.

In the same way we use an approximation for the intensity of the crude death rate by age and origin:

$$\acute{\bar{\mu}}\left(a, t+\frac{h}{2}\right) = \ln\left(\frac{\bar{\mu}(a,t+h)}{\bar{\mu}(a,t)}\right)/h$$

The values of the functions at the mid-point $N(a, t+\frac{h}{2})$ and $\bar{\mu}(a, t+\frac{h}{2})$ are estimated by

$$N\left(a, t+\frac{h}{2}\right) = \sqrt{N(a,t)N(a,t+h)}$$

and

$$\bar{\mu}\left(a, t+\frac{h}{2}\right) = \sqrt{\bar{\mu}(a,t)\bar{\mu}(a,t+h)}$$

The derivatives of the functions $N\left(a, t + \frac{h}{2}\right)$ and $\bar{\mu}\left(a, t + \frac{h}{2}\right)$ are estimated by

$$\dot{N}\left(a, t + \frac{h}{2}\right) = \acute{N}\left(a, t + \frac{h}{2}\right) N\left(a, t + \frac{h}{2}\right)$$

and

$$\dot{\bar{\mu}}\left(a, t + \frac{h}{2}\right) = \acute{\bar{\mu}}\left(a, t + \frac{h}{2}\right) \bar{\mu}\left(a, t + \frac{h}{2}\right)$$

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