The role of migration in population aging

ABSTRACT.
This article focuses on indirect estimation of the influence of the mean net migration rate on the change in the mean age. The Paper includes a concrete application from the indirect estimation presented for Australia in the period from 2004 to 2009.

1. Introduction.

Population aging is global phenomenon. Population aging is a shift in the distribution of a country's population towards older ages. This is usually reflected in an increase in the population's mean and median ages, a decline in the proportion of the population composed of children, and a rise in the proportion of the population that is elderly. Population aging is widespread across the world. It is most advanced in the most highly developed countries.

Population aging arises from two (possibly related) demographic effects: increasing longevity and declining fertility.

The rate of population ageing may also be affected by migration. Migration can cause big distortions in age distributions because it is normally concentrated among young adults, and it is sometimes selective. Immigration usually slows down population aging, because immigrants tend to be younger. Areas where substantial numbers of immigrants have settled will have a young age structure, with many children and very few elderly. Conversely, areas from which substantial numbers have emigrated will, in extreme cases, have top-heavy pyramids with an unusually high proportion of the population in older age groups, few young adults and, consequently, few children.

In this paper we will try to find how the mean net migration rate influenced change in the mean age of the population . Decomposing the change in mean age of the population (Vaupel and Canudas Romo 2002), we assume that we have no data about migration. In the decomposition formula, substituting for age specific growth rate (Maglaperidze 2013) 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 in mean age of the population .

In our empirical examples we present the relative contribution of net migration rate to the average annual change in the mean age in Australia for males respectively over time from 2004 to 2009

2. DECOMPOSITION OF THE MEAN AGE $\bar{a}$

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

Let us denote population by $N(a,t)$ and over age a and time t .

Using $N(a,t)$ as weighting function we can represent mean age of population $\bar{a}$ by following integral over age:

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

where ω is highest age attained.

Let the intensity of population growth be denoted by

$$\acute{N}(a,t) \equiv \frac{dN(a,t)/dt}{N(a,t)} \quad . \tag{1}$$

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

$$\dot{\bar{a}} = c\left(a,\acute{N}\right). \tag{2}$$

Where the change in the average, $\dot{\bar{a}}$, is

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

and the covariance is given by

$$c\,(a, \acute{N}) = \frac{\int_0^{\omega} a\acute{N}(a,t)N(a,t)da}{\int_0^{\omega} N(a,t)da} - \frac{\int_0^{\omega} aN(a,t)da}{\int_0^{\omega} N(a,t)da}\frac{\int_0^{\omega} \acute{N}(a,t)N(a,t)da}{\int_0^{\omega} N(a,t)da} \qquad (4)$$

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

We can see from (4) 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 $\bar{i}$ in the continuous case (Preston and Coale 1982; Preston et al. 2001)

Using the variable-r method the mean growth rate $\acute{N}(a+\frac{h}{2}, t+\frac{h}{2})$ at the mid-point age $a+\frac{h}{2}$ and mid-point time $t+\frac{h}{2}$ can be approximated by sum of two terms: $\acute{N}_a\overline{\backslash\iota}_a + \bar{\iota}_a$, where only $\bar{\iota}_a$ depends on mean net migration rate.

As for calculation integral in covariance term (4) is used growth rate at midpoint age and midpoint time we can substitute approximated sum $\acute{N}_a\overline{\backslash\iota}_a + \bar{\iota}_a$. After substitution we can get

$$c(a, \acute{N}) = c(a, \acute{N}_a \backslash \bar{\iota}_a) + c(a, \bar{\iota}_a) \tag{5}$$

Calculating $c(a, \acute{N})$ and $c(a, \acute{N}_a \backslash \bar{\iota}_a)$ in (5) we can estimate indirectly $c(a, \bar{\iota}_a)$ influence of mean net migration rate on covariance term $c(a, \acute{N})$ and consequently on change in mean age.

3. Empirical example

In this section we will try to find how the net migration rate influenced change in the mean age in Australia ,Sweden and Bulgaria for males and females , respectively over time from 2004 to 2009.

Table 3.1. shows the decomposition of the mean age $\bar{a}$ from 2004 to 2009 for males in Australia .

Table 3.1: Annual change of the mean age $\bar{a}$ from 2004 to 2009 for males in Australia.

$\bar{a}(2004) = 36{,}511$

$\bar{a}(2009) = 37{,}068$

$\dot{\bar{a}} = 0{,}111$

$c(a, \acute{N}) = 0{,}111$

$c(a, \acute{N}_a \backslash \bar{\iota}_a) = 0{,}240$

$c(a, \bar{\iota}_a) = c(a, \acute{N}) - c(a, \acute{N}_a \backslash \bar{\iota}_a) = 0{,}111 - 0{,}240 = -0{,}129$

source: Author's calculations described in note , based on Human Mortality Database

The estimated value of $\dot{\bar{a}} = 0{,}111$ calculated from (2) equals to the actual figure of 0,111.

After the calculation it became clear that the mean net migration significantly decreases the change of mean age.

5. Conclusion.

In this paper we presented a substitution for the intensity of growth inside the decomposition formula for the change of the mean age 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 Australia we demonstrate such a substitution. By calculations we find out that net migration of Australian males significantly decreased the covariance term and consequently the change in the mean age of Australian males from 2004 to 2009.

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

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

In the same way we use an approximation for the $\rho\rho$ intensity of mean age:

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

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

$$N\left(a, t + \frac{h}{2}\right) = (N(a, t)N(a, t + h))^{\frac{1}{2}}$$

and

$$\bar{a}\left(t + \frac{h}{2}\right) = (\bar{a}(t)\bar{a}(t + h))^{\frac{1}{2}}$$

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

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

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