

Demographic Structure Estimation by Mortality Rate Alteration

Evgueni A. Haroutunian, Harutyun A. Shahumyan

Institute for Informatics and Automation Problems
of NAS RA and YSU

E-mail: evhar@ipia.sci.am, sharut@freenet.am

Abstract

This article presents a statistical reasonings which allow without essential expenses estimate alterations in a regional population's age and gender structure. On the base of official data on population and mortality of Republic of Armenia in 1990, 1995-1999, we derive the number of population and emigrants for 1995-1999.

Introduction

The present account of population of Armenia is based on results of the last census of 1989 with counting official data of births, deaths and migration of the passed years. According to these sources the permanent population of Armenia was 3804,6 thousand people in 2000. But the real number is considerably smaller. The main reason is that the majority of people leaving temporarily the Republic avoids registration at migration authorities. According to data of Civil Aviation of RA [1] and some sample investigations [2] the number of leaving people is essentially bigger than the number of arrivers. So, it is very important to have corrected data on the quantity of emigrants.

Indirect statistical methods of research on migration are preferable, because they don't demand great expenses. They may be based on demographic, employment, transport and other statistical data.

The Ministry of Statistics, State Register and Analysis of RA and the European Statistics Services have realized sample investigation of RA external migration during 1998-1999. The analysis of questioning of 3600 families from the different regions of Armenia shows that the difference between left and arrived residents during 1991-1998 was about 475 thousand. But according to the General Department of Civil Aviation of RA there are more than 610,4 thousand passengers left the Republic by the airway than arrived during 1992-1998. Although airway was the main bridge between Armenia and other countries in 1992-1998, there are many people who left Armenia by other means of conveyance. Taking it into account and also the emigration during 1991, it is estimated that the number of people left the country during 1991-1998 was about 760-780 thousand.

For definition of the number of emigrated population the following method was suggested [9]. Entertaining the difference between birth rates of RA in 1990 and 1994 (there were

about 30 thousand births in 1994 less than in 1990) and accounting the influence of social-economic situation on births, the number of absent residents in 1994 was estimated about 900-945 thousand.

For reliability of results other factors can be used. An important point is the exactitude of the database. The births' data strictly fixed and they can be accepted as exact. Other factors such as marriages, divorces and mortality are also strictly fixed. But the influences of socio-economic conditions on such factors are different. For example if the number of births decreases with declining of socio-economic conditions, the number of deaths increases.

We present a statistical approach, which allows to estimate a region demographic structure by consideration the alteration of mortality rate. On the base of official data on population and mortality in 1990, 1995, 1996, 1997, 1998 and 1999, we calculate the real number, age and gender structure of population and emigrated population of Armenia in 1995, 1996, 1997, 1998 and 1999.

The Algorithm

Social-economic conditions influence differently on urban and rural population, on male and female, on people of different age groups. For more precise estimation of these influences on mortality we will separate calculations by residence, gender and ages.

We admit the following notations. Let $k = \overline{0, 18}$ are indexes of age groups (Table 1.), s is the gender (1 - male, 2 - female), l is the residence (1 - urban, 2 - rural), t is the year (t_0 - base year, $t_0 + \Delta t$ - estimation year).

Table 1 Indexes of age groups

Ages	0	1-4	5-9	10-14	15-17	18-20	21-24	25-29	30-34	35-39
k	0	1	2	3	4	5	6	7	8	9
Ages	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	
k	10	11	12	13	14	15	16	17	18	

Assortment in the table is done by singularity of some age and gender groups. Thus taking into account the military service, men aged 18-20 are assorted apart.

Denote by $N(k, s, l, t)$ the number of population and by $M(k, s, l, t)$ the number of deaths in the appropriate demographic group.

The frequency of mortality is

$$P(k, s, l, t) = \frac{M(k, s, l, t)}{N(k, s, l, t)} \quad (1)$$

Investigations of demographic data of Armenia show that mortality rate in 1995-1999 increase for the residents aged 55 and above compared with the same data of 1990. It can be explained by aggravation of socio-economic situation in Armenia. But for the younger population the mortality rate essentially decreased. It may be caused by the absence of numerous young residents from the motherland. It is known that the majority of emigrants are young and able to work people. The main part of older population has stayed in the country [2]. So, the official data on residents aged 55 and older ($k = \overline{13, 18}$) can be considered as exact. We will use this circumstance for estimation of influence of social-economic conditions on mortality of other age groups ($k = \overline{0, 12}$).

Using the mortality rate of older population $P'(s, l, t)$, we will find corresponding coefficient $r(s, l, t_0, \Delta t)$ of mortality rate alteration:

$$P'(s, l, t) = \frac{\sum_{k=13}^{18} M(k, s, l, t)}{\sum_{k=13}^{18} N(k, s, l, t)}, \quad (2)$$

$$r(s, l, t_0, \Delta t) = \frac{P'(s, l, t_0 + \Delta t)}{P'(s, l, t_0)}. \quad (3)$$

Using the coefficient $r(s, l, t_0, \Delta t)$, we can estimate the rate of mortality in the year $t_0 + \Delta t$ for other age groups.

$$\tilde{M}(k, s, l, t_0 + \Delta t) = r(s, l, t_0, \Delta t) \frac{M(k, s, l, t_0 + \Delta t)}{N(k, s, l, t_0)} N(k, s, l, t_0 + \Delta t), k = \overline{0, 12} \quad (4)$$

Denote by \hat{N} the estimated number of residents:

$$\hat{N}(k, s, l, t_0 + \Delta t) = \frac{M(k, s, l, t_0 + \Delta t)}{\tilde{M}(k, s, l, t_0 + \Delta t)} N(k, s, l, t_0 + \Delta t), k = \overline{0, 12} \quad (5)$$

Therefore the number of absent residents from the Republic (for given gender, age and residence) is:

$$Q(k, s, l, t_0 + \Delta t) = N(k, s, l, t_0 + \Delta t) - \hat{N}(k, s, l, t_0 + \Delta t), k = \overline{0, 12}. \quad (6)$$

Estimation of the Number of Residents and Emigrants of Armenia in 1995-1999

As a base we take the data of 1990. This data is relatively exact because the last census in Armenia was done in 1989¹.

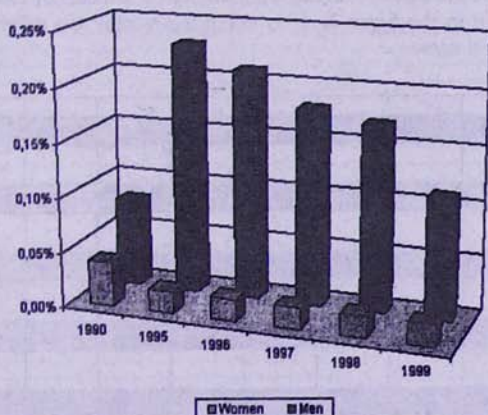


Figure 1 The mortality rates of men and women aged 18-20 in 1990 and 1995-1999.

¹Although it also can't be admitted as absolutely exact because during the census of 1989 the Republic was in a chaotic socio-economic and political situation caused by the complex impact of the Kharabakh resistance and its consequences, as well as the disaster earthquake in Spitak

Having necessary data we present estimation of the number of present and absent residents of Armenia in 1995 ($\Delta t = 5$), in 1996 ($\Delta t = 6$), in 1997 ($\Delta t = 7$), in 1998 ($\Delta t = 8$) and in 1999 ($\Delta t = 9$).

Taking into consideration the political and socio-economic situation of these years we must exclude some gender and age groups. The special interest lies upon men of age 18-20. The above mentioned method is not expedient for this group since besides socio-economical influence military service has its impact on their mortality rate. Comparing the data of 1995, 1996, 1997, 1998 and 1999 with the data of 1990 we see the apparent increase of mortality for men of this age. But for women of the same group the mortality rate even has been decreased (Figure 1). Therefore the described method may be effective for the age 0-54 except men at the age of 18-20. For this group we take the average number of the groups of men aged 15-17 and 21-24.

For estimating the result's reliability interval we must find the maximal and minimal values of the coefficient $r(s, l, t_0, \Delta t)$. The surveys showed that $r(s, l, t_0, \Delta t)$ accepts its maximal value if in the formula 2 the average frequency of mortality taken for people aged 60 and above. Approximately it accepts minimal value for the same data of people aged 65 and above.

The results of these calculations is shown in the table 2.

Table 2 The numbers of the absent population from Armenia in 1995-1999.

Value	1995	1996	1997	1998	1999
Minimum	685000	695000	686000	670000	921000
Maximum	990000	1030000	1000000	997000	1210000
Average	836000	865000	846000	833000	1070000

The numbers of residents and emigrants of Armenia during 1995-1999 is shown in the figure 2.

The demographic structure of emigrated population of Armenia in 1995, 1996, 1997, 1998 and 1999 is described in the figure 3. It is worth mentioning the difference of emigration activity by gender and ages.

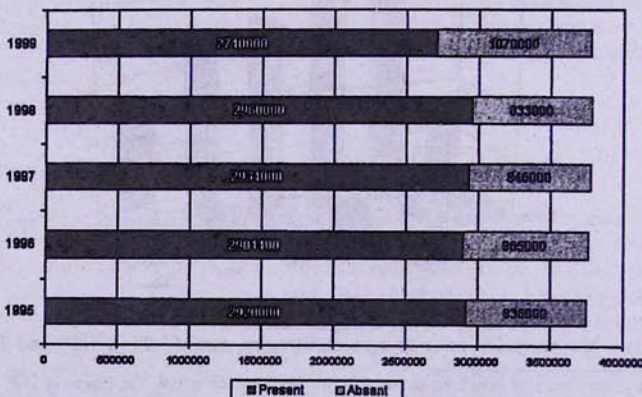


Figure 2 The number of residents and emigrants of Armenia in 1995-1999.

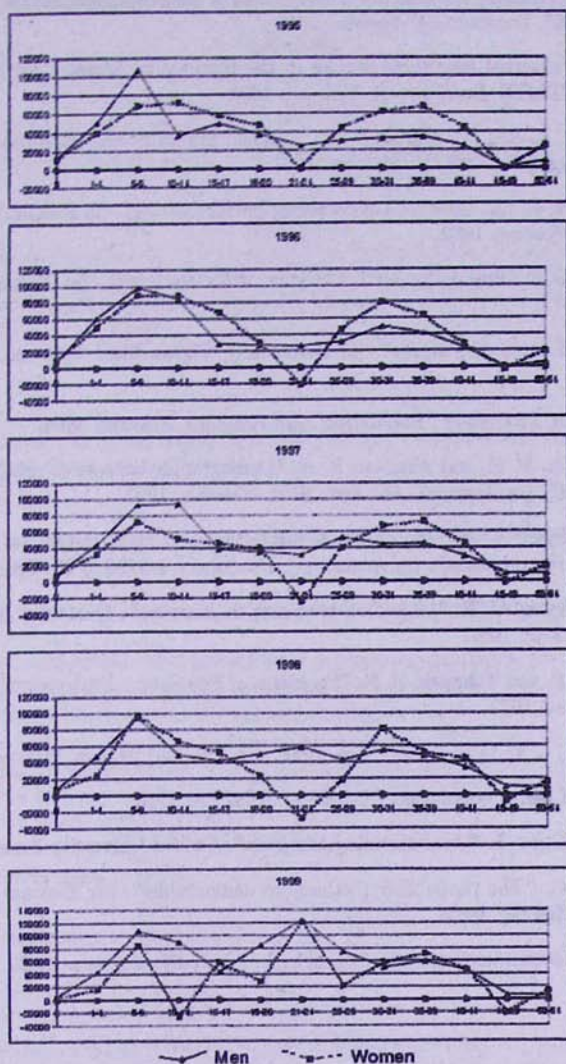


Figure 3 The emigration rates of Armenia by gender and ages in 1995-1999.

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