An attempt to re-estimate recent mortality trends in two Caucasian countries

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Introduction

In the framework of the unfavourable trends observed in the ex-Soviet Union area since the 1960s, it is of particular interest to look at the specific evolution of Caucasian countries, which have always shown mortality levels and trends different from the rest of the Soviet world. To what extent such differences were related to data quality has always been questionable (Kingkade, 2000), but since the Soviet Union split the question has become even more acute. Not only the control of migration flows that characterized the Soviet system collapsed and Caucasian countries were subject to different political conflicts and wars that disrupted many statistical series but it seems that even the current data collection systems for births and deaths have been deteriorating.

After studying long-term trends in mortality and causes of death in Russia (Meslé *et al.*, 1996, 1998, 2003; Shkolnikov *et al.,* 1996), in Ukraine (Meslé and Vallin, 2003) and in the Baltic countries (Hertrich and Meslé, 1999), a specific project was thus undertaken on Caucasian countries. It required, however, to manage a preliminary step aiming to evaluate in what extent political changes and adverse events impacted data available for the recent period specifically, and to try to make better estimates of deaths and births flows, population counts and population distribution by sex and age.

Until the early 2000s population estimates were particularly problematic because of the dramatic changes, especially in migration flows, which occurred after the 1991 USSR split. Since the last Soviet census had been held in 1989, any attempt to estimate mortality rates had become quite questionable. For example according to Badurashvili *et al*. (2001), Georgian male life expectancy could have been of 66.4 years in 1998 instead of 74.2 officially published by the Statistical Office, which means a gap of 7.8 years, and female life expectancy ranged between 75.2 and 82.0, a 6.8-year gap. For the same year, Tsuladze and Maglaperidze (2000) also pointed important differences (5.8 years for males and 6.3 for females). For the year 1999, Yeganyan *et al*. (2001) estimated 1999 Armenian life expectancy levels as 68.7 for males and 75.4 for females instead of 72.5 and 77.2 given by the Statistical Office at that time while in Georgia the discrepancy ranged from 68.8 to 73.8 for males and from 75.6 to 81.0 for females.

Dramatic changes in migration flows soon after the split of the USSR and military conflicts which caused a lot of population displacements make difficult the inter-census population estimates while an obvious deterioration in the birth, death and migration registration led to a growing underestimation of demographic events (Badurashvili and Kapanadze, 2003; Meslé *et al*., 2006). Both countries carried out new censuses at the beginning of the years 2000 (2001 in Armenia and 2002 in Georgia). These new counts have confirmed that official pre-census heavily over-estimated population sizes and provide a much more reliable basis to compute current mortality rates. However, dramatic changes in

migration flows soon after the split of the USSR and military conflicts which caused a lot of population displacements make difficult the inter-census population estimates while an obvious deterioration in the birth, death and migration registration led to a growing underestimation of demographic events (Badurashvili and Kapanadze, 2003; Meslé *et al*., 2006). In both countries statistical offices, together with other institutions, undertook different reforms to try to improve vital statistics.

This paper is an attempt to put together all existing information about population estimates, as well as about under-registration of vital events in Armenia and Georgia, and to select the best possible estimates of population (section 1) and of death numbers (section 2). Finally, new estimates of mortality trends during the last two decades will be discussed.

1. Recent changes in population: reassessment after censuses

Before comparing the various population estimates published before and after new censuses, let us summarize the main causes of disruption.

1.1. Causes of dramatic changes in population numbers

The split of the USSR and the collapse of the Soviet system resulted in two main consequences in terms of population changes: what was internal migration suddenly became international migration and relative peace between minorities imposed by the Soviet power turned out into major local conflicts including wars.

1.1.1 Migration flows across new boarders

Before the split of the USSR, migration between Armenia, or Georgia, and the other republics of the Union was internal migration mainly related to economic development and private purposes, but also strongly regulated by the soviet rules. When the union split, the set of new international boarders changed the situation radically and many people belonging to minorities or suffering of economic difficulties felt locked in the new independent countries and eager to go out. Furthermore, while getting out the international boarders of the former Soviet Union was totally forbidden, a new perspective of emigration towards western countries or Israel was opened. Thus in both Armenia and Georgia, a sharp increase in out-migration occurred in the 1990s. Firstly, many Russians returned to Russia in the first years of independence. The migration out-flow has become even greater after 1991 due to socio-economic crisis and dramatic worsening of life conditions, which have become substantially worse than those in Russia. Later in the 1990s, international migration flows stabilized more or less.

1.1.2 Wars

Armenia was involved in a war with Azerbaijan about Nagorny Karabakh. Troubles started when newly independent Republic of Azerbaijan withdrew the autonomous status, which that territory, mostly populated with Armenian people, used to have inside the former Soviet Republic of Azerbaijan. Armenians living elsewhere in Azerbaijan (mainly in the capital city, Baku) were also subject to different forms of aggression. The started war between Armenia and Azerbaijan resulted in the control by Armenians of the south-western part of the Azerbaijani territory surrounding the Nagorny Karabakh aiming at creating safety zone. Officially, Nagorny Karabakh is now considered by Armenia as an independent state and its population was never included in the Armenian statistics, but it is out of control of Azerbaijan and its population is no longer included in Azerbaijanis statistics, while the statistical status of

south-west Azeri populations is unclear. In brief, the war as such did not affect Armenian population data substantially but the war was also accompanied by important inflows of Armenian refugees who used to live in Azerbaijan especially in Baku.

Direct impact of war was much greater in Georgia. Before USSR split, the socialist Republic of Georgia included two small autonomous republics, Abkhazia and Adjaria, and one autonomous oblast, South Ossetia. Soon after Georgian independence, violent conflicts occurred about Abkhazia and South Ossetia.

On the one hand, the resistance between Ossetians and Georgians on the territory of the former South-Ossetia started as soon as early 1991, has resulted in the military conflict between Ossetians and Georgian troops. South Ossetia finally proclaimed its independence in 1994, when Georgia was dramatically weakened after Abkhazian war and internal political troubles. Until now, a large part of the former South Ossetia (so called "Tzkhinvali region") is out of control of the Georgian government.

On the other hand, after Georgian independence, and after a coup overthrew the first Georgian President Gamsakhourdia, in 1992, Abkhazians decided to re-establish their 1925 constitution[1], an indirect way to proclaim their independence. Georgian troops entered Abkhazia immediately, but, helped by Russian army, Abkhazians re-conquered the capital Sukhumi and most of the territory, while almost all Georgian people fled to Georgia where they are still refugees. In 1993, under strong pressure of Russia, Georgia accepted ceasefire. The war probably resulted in 10,000 deaths and 200,000 refugees about, while total Abkhazian population is now less than 180,000.

1.1.3 Territory changes

Consequently to these events, since the mid-1990s, Georgian Government does no longer control most of Abkhazia and a large part of the former autonomous oblast of South Ossetia. We tried to identify as accurately as possible, the population coverage of the 2002 census. To do it, the non entirely controlled rayons (basic administrative units) have been identified and the presence of each village belonging to these rayons enumerated in the 1989 census has been checked on the list of 2002 census.

The great majority of Abkhazia appears to have been missed by the 2002 census: only a few villages belonging to Gulirifshi rayon were enumerated, i.e. only 1956 inhabitants for all Abkhazia instead of 525 061 in 1989 (Table 1).

While the boundaries of the different Abkhazian rayons remained unchanged, a complete reorganisation of Ossetian territories has been done resulting in completely new rayons mixing former Ossetian rayons with surrounding Georgian rayons. In 1989, the autonomous oblast of South Ossetia was made of 4 rayons (Znauri, Leningori, Tzkhinvali-rayon, and Java), and of Tzkhinvali-city. After resetting, only the territory of Leningori rayon was not changed, while the rayon was has been renamed Akhalgori. Javi rayon lost a large western part of its territory, which was redistributed between the Georgian rayons of Honi and of Sachkheri. Znauri and Tzkhinvali rayons disappeared as such and absorbed by Georgian rayons of Kareli and of Gori, respectively (Figure 1).

[1] A constitution which was giving to Abkhazia a status similar to that of Georgia inside the USSR. It ruled Abkhazia for 6 years before Staline decided, in 1931, to give Abkhazia to the Republic of Georgia.

Table 1.
Population enumerated by 1989 and 2002 censuses in Abkhazia and South Ossetia (1989 territory)

1989		2002	
Rayon or city	Population	*Rayon* or city	Population
Abkhazia			
Sukhumi-city	119,150	Sukhumi-city	0
Sukhumi-rayon	39,516	Sukhumi-rayon	0
Gagra	77,079	Gagra	0
Tkvarcheli	21,744	Tkvarcheli	0
Gali	79,688	Gali	0
Gudauti	57,534	Gudauti	0
Gulirifshi	54,962	Gulirifshi	1,956
Ochamchiri	75,388	Ochamchiri	0
Total Abkhazia	525,061	Total Abkhazia	1,956
South Ossetia			
Znauri	10,189	Kareli (Ossetian part)	1,591
Leningori	12,073	Akhalgori	7,703
Tzkhinvali-city	42,333	Tzkhinvali-city	0
Tzkhinvali-rayon	23,514	Gori (Ossetian part)	13,230
Javi	10,418	Javi	0
		Sachkeri (Ossetian part)	256
		Honi (Ossetian part)	0
Total South Ossetia	99,527	Total South Ossetia	22,780

Figure 1.
Map showing the redistribution of South-Ossetia territory among Georgian Oblast

(Blue and orange lines represents bo rders before suppression of South Ossetia; grey lines indicate the new ones after Java split)

By comparing enumerated population of each village at 1989 and 2002 censuses, a rather accurate reconstitution of the coverage of the 2002 census has been obtained for each of the *rayons* involved (Table 1). It appears that a large part of the former Ossetian territory was missed by the last census. However at least some villages were enumerated in all *rayons*. The total population of these villages accounts for 22,780 inhabitants, which can be compared to the 98,527 enumerated by the 1989 census.

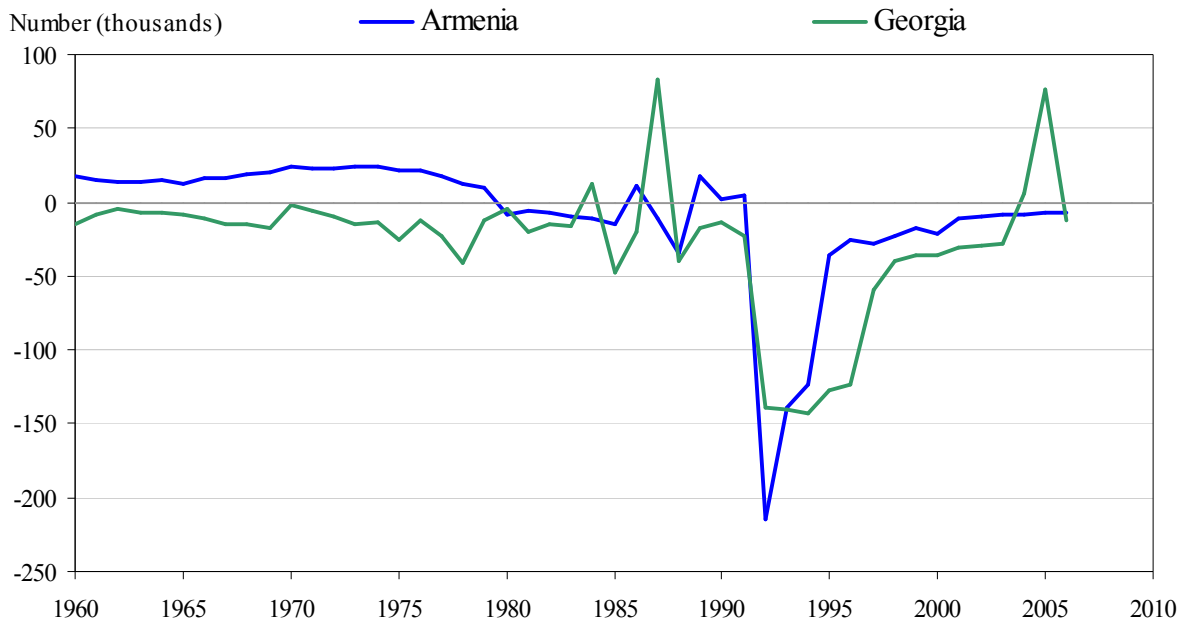
1.2. Population estimates since the last censuses

1.2.1 Collapse of the Soviet migration registration system

Contrary to the traditional Soviet system, which strictly controlled in and out migrations, registration got worse at its end and the new national registration systems failed to capture the scale of these flows. During the Soviet time, outmigration from the USSR was quasi impossible and changing place of residence was subject to out- and in-registration what made possible a rather good statistic of migration flows, especially for in-migrations. The USSR Goskomstat centralized information from local authorities and established a complete matrix of inter-republic migration flows based on entries. With the collapse of the USSR, migration statistics deteriorated for three main reasons: migration outside of the former Union became possible, inter-republic collaboration to produce a general matrix ceased, and the quality of the in- and out-registration fell down. The phenomenon has been particularly acute in Armenia (Karapetyan *et al.*, 1996; Yeganyan, 2000; Yeganyan and Davtyan, 2000) and in Georgia as well (Tsuladze and Badurashvili, 1999). The registration of vital events (births, deaths) also deteriorated (as it will be seen later) but in lesser proportion and with smaller consequences for population estimates.

According to official estimates, during the Soviet time, migration flows were rather regular until the late 1970s, resulting in a balance slightly positive in Armenia and slightly negative in Georgia (Figure 2). During the 1980s, trends became more erratic with a globally negative balance in both countries. It seems that the control of moves already diminished and made official estimates more difficult. In particular, the 1987 peak in Georgia seems unrealistic, without any specific event which could explain them. On the contrary, the huge deficit observed in 1992-94 in Armenia and 1992-96 in Georgia is obviously related to the split of the USSR that resulted in important out-migration (return migration of Russians and political and/or economic migration). More recently, the 2005 Georgian peak is very improbable: no recent events can explain this important in-migration flow.

Figure 2.
Official estimates of migration flows in Armenia and Georgia before and after independence



Sources: Armenia: NSS, 2007; Georgia: Council of Europe, 2005 until 1989 and SDS, 2006 from 1990.

1.2.2. Reassessment of population estimates after 2001 and 2002 censuses

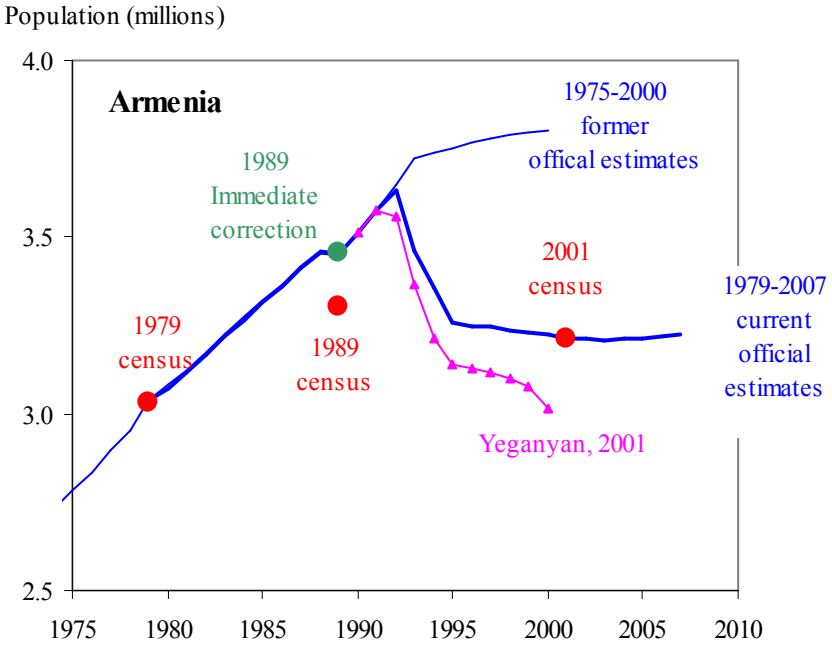
Consequently to all the problems described above, yearly official population estimates diverged more and more above from the reality and age structure became less and less conformed to the actual population distribution until the carrying out of the most recent censuses. New censuses held in 2001 (Armenia) and 2002 (Georgia) allowed statistical offices to reassess inter-census population counts and to assess more reliable estimates for the recent years. Indeed, inter-census estimates were more difficult in Armenia where the 1989 Soviet census was dramatically perturbed by the situation left after the 1988 earthquake. At that time Armenian authorities facing a huge problem of displaced populations asked for postponing the census but they were obliged by the central power to have it in the same time as everywhere in the Soviet Union. Consequently, the census underestimated the population significantly, and a correction was made immediately after, increasing the results from the 3,304,000 enumerated population to 3,450,000. The Armenian statistical office decided to take this corrected value as the first point for the recent reassessment between 1989 and 2001.

Armenia

Figure 3 shows different estimates for population trends in Armenia since 1975: population estimated through the three censuses in 1979, 1989 and 2001; official estimates provided by the National Statistical Service (NSS) before and after the last census; and estimates published by Yeganyan *et al.* (2001). Before the 2001 census, population estimates were based on the corrected 1989 census, vital statistics and migration estimates. There was thus a suspicion of an increasing gap between these estimates and the real number. In 2001, there would have been 3.8 millions of inhabitants according to official statistics (NSS, 2004) compared to only 3 millions estimated by Yeganyan *et al.* (2001), a difference of more than 25%. The main cause of such a divergence was the way to estimate migration flows. While official population estimates relied on migrations registered through a deteriorated system, Yeganyan *et al*. attempted to re-assess migration (Yeganyan, 2000; Yeganyan and Davtyan,

2000). They took into account different sources including surveys (Karapetyan *et al.*, 1996, Yeganyan and Shakhnazaryan, 1999). Finally, the new census gave an intermediate number of 3.2 millions, closer, however to that of Yeganyan *et al*. Following the census, NSS produced new annual population estimates for the period 1989-2001. The readjustment took into account the post-independence emigration wave resulting in a dramatic population fall down from 1992 to 1995. Current population estimates after 2001 are probably less problematic than in the early 1990s, since migration flows are supposed to have stabilized. These new official estimates will be used to compute mortality rates here after.

Figure 3.
Armenian population trends according to different estimates



Sources : Censuses: 1979, 1989, 2001; current official estimates: NSS, 2007; former official estimates before the last census: NSS, 2004; Other estimates: Yeganyan *et al*., 2001.

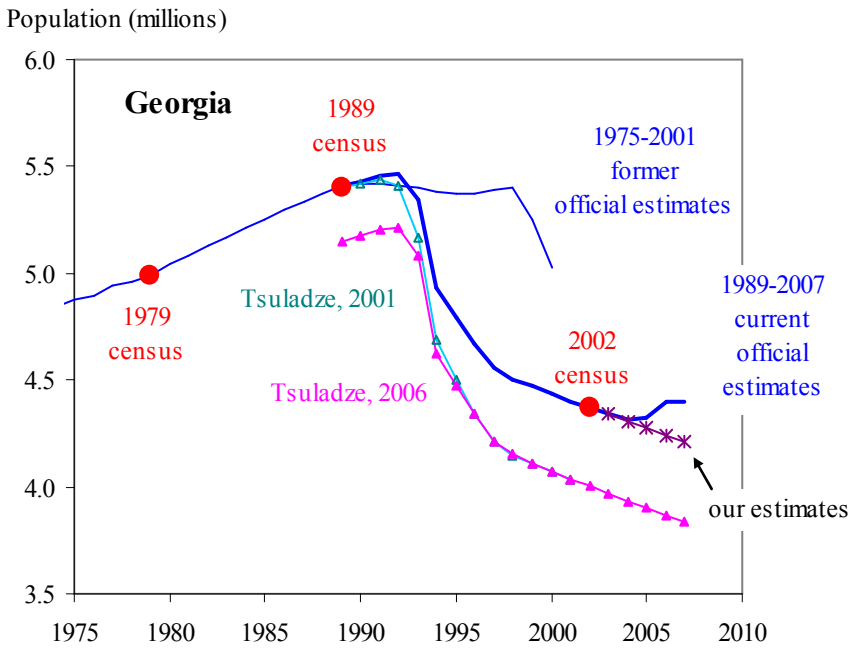
Georgia

In Georgia too, population estimates varied a lot at the eve of the 2002 census (Figure 4). For 2001, official estimates gave 4.9 million inhabitants while Tsuladze proposed 4.0, a difference close to 25% like in Armenia. The gap was even larger in 1999 between 5.4 and 4.1 (30%), but it was somewhat artificial, since the official estimates continued during the 90s to include Abkhazia and Tzkhinvali populations which have been *de facto* out of Georgian population after 1993, while Tsuladze excluded them in 1993 (Tzkhinvali) and 1994 (Abkhazia). Once again, the new census gave an intermediate result : 4.4 million. The new official estimates made after the 2002 census include a short period of continued growth (1989-1992) followed by a dramatic fall combining the loss of Ossetian (1993) and Abkhazian (1994) population and the exceptional post-independence emigration flows (1992-1996).

The 1989-2002 inter-census official estimates will be used here after to compute rates. However, in our opinion, more recent estimates are quite doubtful since they are largely influenced by the artificial peak of in-migration already discussed here above, even if a

positive natural growth rate is taken into consideration. Consequently, we propose new population estimates for 2005-2007 resulting from a linear population trends since 1998.

Figure 4.
Georgian population trends according to different estimates



Sources : Official and Tsuladze estimates are both published in the Demographic Yearbooks of Georgia. Censuses, current official estimates and Tsuladze 2006: Tsuladze *et al*., 2006; former official estimates and Tsuladze 2001: Tsuladze *et al*., 2001.

2. Incomplete birth and death registration

During the last decade of the Soviet time, while death registration seems to have been quite complete for adults; there was an important under-estimation of infant deaths in Caucasian countries (Ksenofontova, 1994; Velkoff and Miller, 1995), probably much more significant than in Russia (Meslé et al., 2003) or in Ukraine (Meslé and Vallin, 2003) where the problem was only related to the definition of live birth. Since independence, however, registration system deteriorated in both Georgia and Armenia, mainly because administrative control of the population felt down but also for other reasons such as the establishment of dues for registration in Georgia[2]. More recently, health and statistical authorities tried to reverse this negative tendency, by implementing recovery measures.

Furthermore, in Georgia Abkhazian and Ossetian conflicts resulted in more specific difficulties. On the one hand, vital statistics no longer cover neither the "Tzkhinvali region" since 1991, nor Abkhazia since 1992. The only possibility to calculate rates is thus to refer to population of Georgia without these territories. On the other hand, in 1993, while mortality climbed up because of the conflict, the civil registration system was perturbed and no regular data are available for that year. Georgian Statistical Office gives only a rough estimation of death numbers.

[2] The amount of dues was rather significant for Georgians people who had to face a hard socio-economic crisis. Since at that time burial might take place without death certificate, especially in rural area of Georgia, many people no longer applied death registration. Registration of birth deteriorated much less but completeness of births statistics was also affected because child benefits for women desapeared.

2.1. The recent reforms to improve civil registration

Armenia

Georgia

A first improvement occurred in Georgia, when, in 1998, fees for birth and death certificates were abolished, first in the capital city Tbilisi, and then everywhere in Georgia, , but people still have to pay medical doctor for issuing the medical certificate they need to register a vital event. Later on, during the 2004-2005 "Rose revolution", in the framework of a general reform of the state, a reorganization of the civil registration system was implemented, setting up an independent Agency, the Georgian Civil Register, to centralize the process of civil registration. This agency is responsible for issuing all civil documents starting from birth certificates, including local and international passports, death certificates and for giving people clear explanations on rules, time-limits and fees. On the one hand, the reform improved the availability and quality of services for Georgians who suffered from corruption, endless waiting list and non-professionalism of former services.

But, on the other hand, the centralisation of services discouraged many people in rural areas and the number of deaths registered in 2005 was 18% less than in 2004. In 2006 it slightly increased, but remained less than before the reform. Consequently, Georgian Statistical Office re-estimated the 2005 number of deaths in rural areas on the basis of the ratio rural/urban observed in 2004. Nevertheless, a positive role was played by advertising campaign about the usefulness of registration and the accessibility of services. Recent official statistics show an increase in the number of registered events, especially births and marriages. In the same time, to try to improve vital statistics, a double collection of data was organized in 2004. The so called "old" (the traditional process of civil registration) was duplicated by a "new" one, based on data available from medical facilities. The comparison between the two sources should result in a better estimate of actual mortality.

2.2. Available data on births and deaths

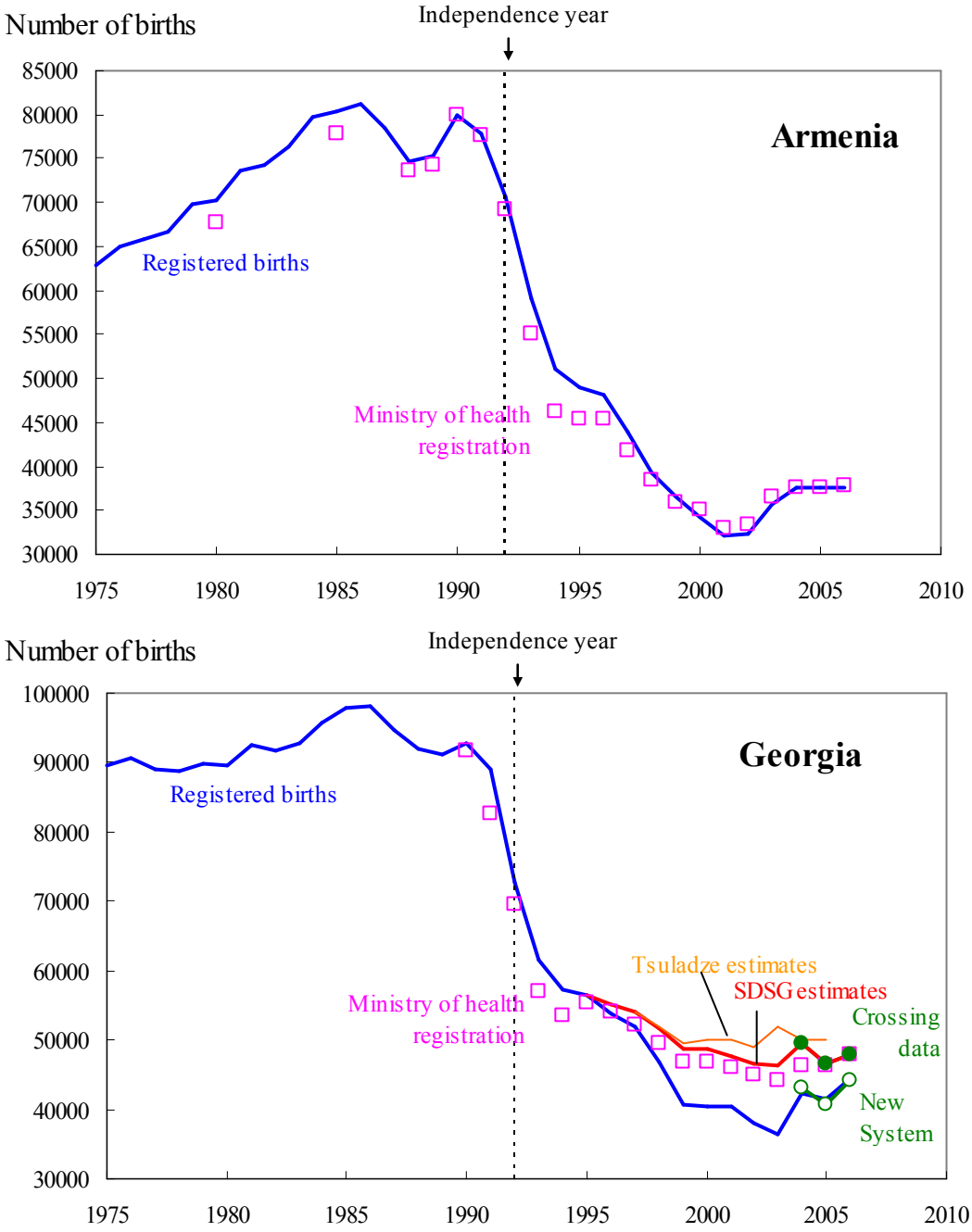
Births

For both countries, several estimates of annual birth numbers are available (Figure 5). In Armenia, and in Georgia as well, both statistical offices and Ministries of Health publish routine annual numbers of births. In addition,, since 1996, the Georgian statistical office has also published corrected estimates, while the new data collection system and its crossing with the old one give slightly different results for the years 2004-2006, and finally, Georgi Tsuladze has published his own yearly estimates since 1998.

In Armenia, Statistical office and Ministry of Heath data are quite similar all along the period, with the exception of the mid 1990s where Ministry of Health estimates are significantly less than Statistical Office estimates.

The situation is quite different in Georgia, where the annual birth counts produced by the Ministry of Health are much higher than those produced by the Statistical Office since the late 1990s. It is the reason why the Statistical Office also published an adjusted series, which is almost the same, but tiny higher, that of Ministry until 2003. Since this year, Statistical Office's adjusted data fully rely on the results of the crossing of the double data collection. It is interesting to note that both old and new systems of that double collection give quite the same total number of births, but births registered by each system are not the same, which explains that crossing data give a significantly higher number of births. Indeed, it is this number that is taken as adjusted number by the Statistical Office.

Figure 5.
Armenian and Georgian available estimates of annual numbers of births



In both countries, the dramatic drop observed around the independence year is obviously due to the similar drop of population above mentioned, which is much more important in Georgia because of territory losses.

The almost perfect coincidence between Statistical Office and Ministry of Health data in Armenia gives the impression that birth registration is quite good and can be used as such. On the contrary, in Georgia, important recent divergences require a different decision. It seems to us that the Statistical Office's adjusted series, which takes in account both recent better

estimates from the Ministry of health and the crossing data since 2004[3], give a solid basis for our further computations.

Deaths

While only one annual death series is available in Armenia, four different estimates can be referred to in Georgia. Indeed, Georgian series of registered deaths published by the Statistical Office are much more perturbed since the Independence than the Armenian one (Figure 6), with a first dramatic drop in 1994-1995 and then a second one in 2005. As for births, the first drop is somewhat related to the population drop, but it is much more pronounced than in Armenia and probably also reflects a deterioration of death registration. Georgian crude data certainly needed more adjustment than Armenian ones. The series adjusted by the Statistical Office from 1989, which is much higher than the registered death series for the 1990s, seems to take into account the first drop, but for the second it fully relies on the crossing data without any correction for the second drop, while Tsuladze series adopted much higher numbers of deaths for the years 2005 and 2006. Before making final decision about these data, let us have a look at crude death rates.

2.3. Crude death rates

Crude death rate series are freed from the total population change effect (Figure 7). Nevertheless, in Armenia a decrease in mortality is still observed in the first years of Independence. It could be related to some deterioration in death registration that was not clear from death series. But the matter is even more dramatic in Georgia when registered deaths only are considered. Death series adjusted by the Statistical Office seems to give a more realistic view for the 1990s. If we take into account the 1993 mortality peak due to the Abkhazian conflict, this correction removes the unexpected hole of 1995-96 by increasing observed mortality rates differently according to time. However, it does not abolish the sharp drop of 2004-2005 as Tsuladze's estimates do.

For all these reasons, it seems to us that further adjustments are needed. But discussing on the global under-registration of deaths is not enough to solve the question. It is very probable that under-registration varies with age. In particular, infant mortality deserves a special attention.

[3] The double data collection experiment started in 2003 but the first year seems to have been incomplete.

Figure 6.
Armenian and Georgian available estimates of annual numbers of deaths

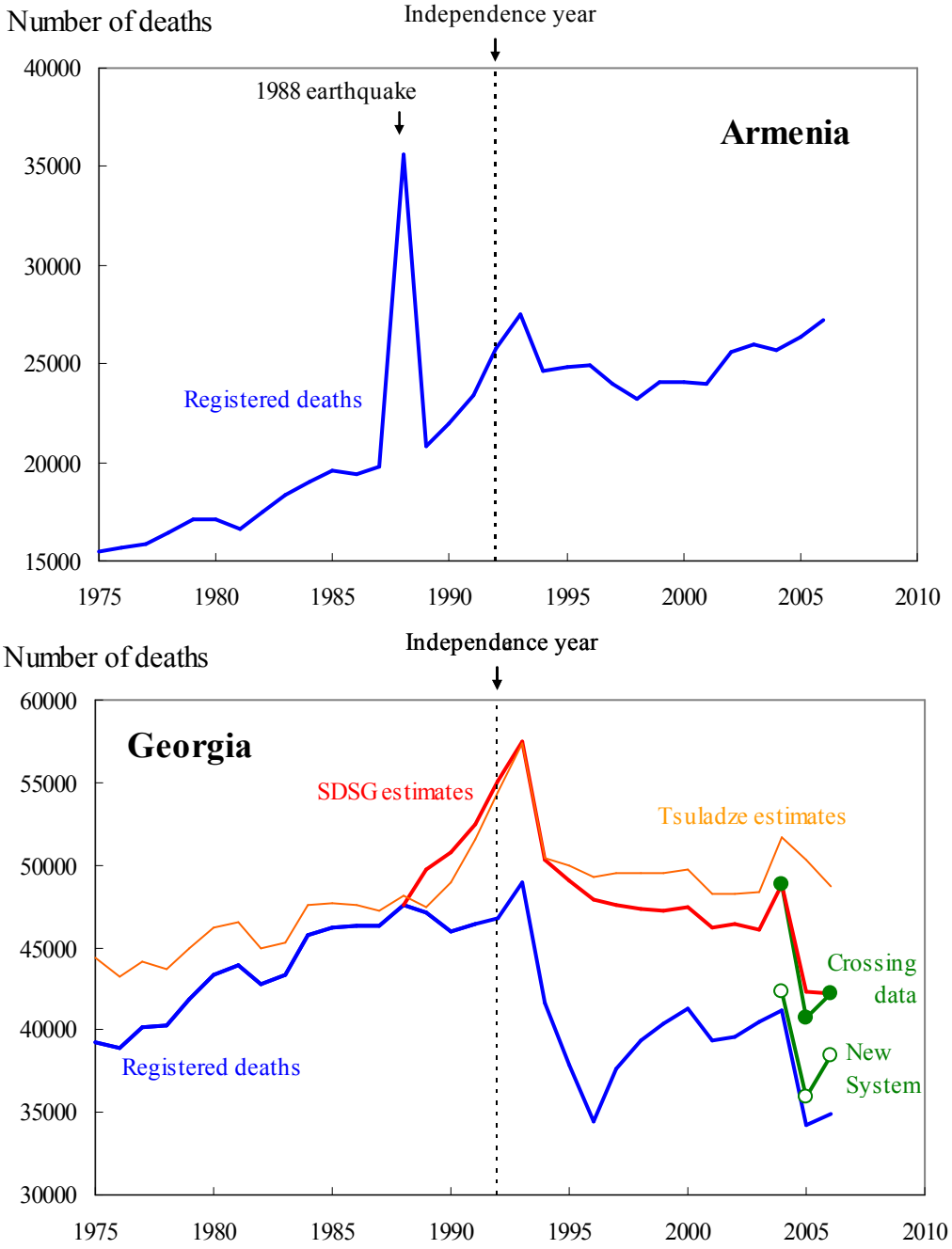
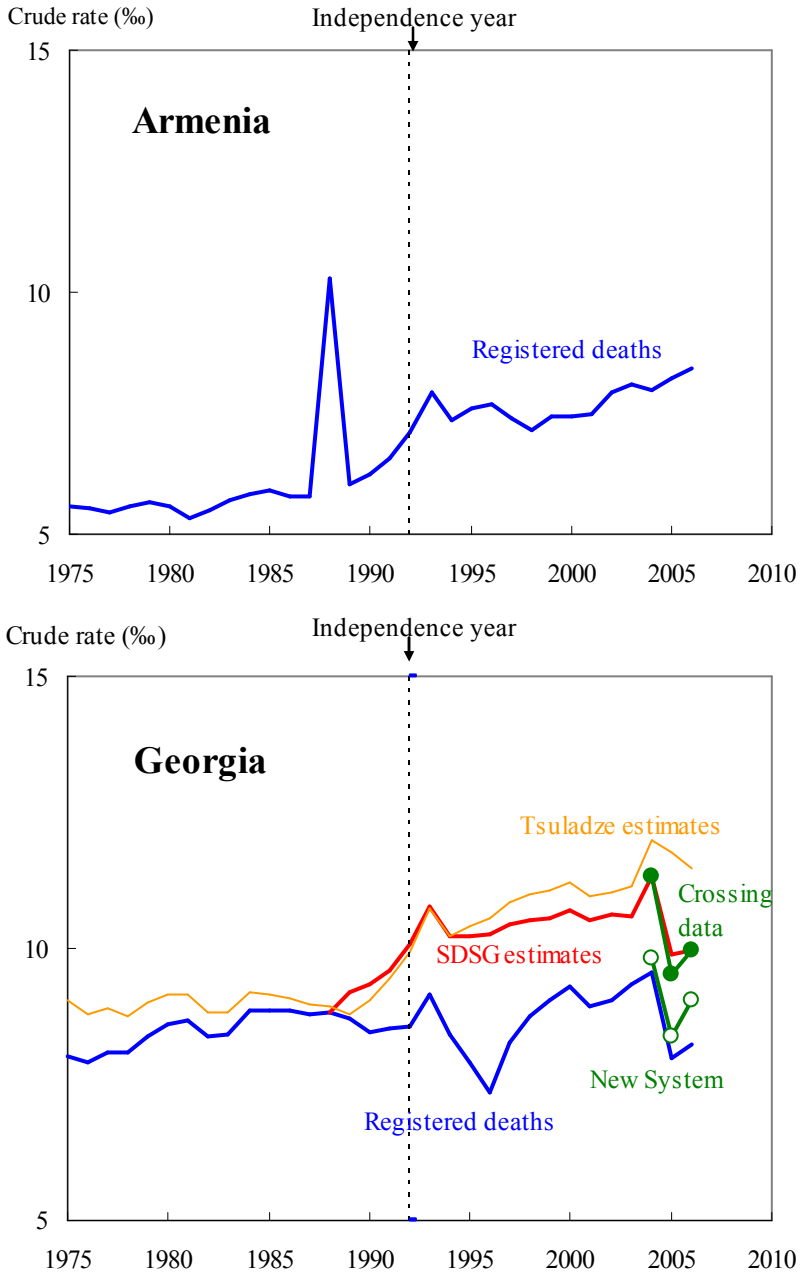


Figure 7.
Armenian and Georgian available estimates of crude death rates



3. Re-estimating infant mortality and life expectancy

3.1. Infant mortality

Not only infant mortality can suffer of specific causes for under-registration, but also sources of information totally independent from the routine registration are available. In Armenia, two Demographic and Health Surveys (DHS) were carried out, in 2000 and in 2005 (NSS *et al.*, 2001; 2006), while Georgia also produced results from two Reproductive and Health Surveys (RHS), very similar to DHS, conducted in 1999 and 2005 (NCDC *et al.*, 2001; 2007).

In Armenia, Ministry of Health data shows infant mortality rates slightly higher than Statistical Office data, which probably means that infant deaths are significantly under-

registered by the civil registration system, but, much more important, both 2000 and 2005 DHS show far higher rates than civil registration system ones. And this is true for all survey indicators (whatever the reference time used). Figure 8 displays three measures from each survey (0-4, 5-9 and 10-14 years before the survey) with their confidence intervals. The two DHS appear to be quite in coherence and indicate a much higher infant mortality than routine observations. They also confirm, however, a steady decrease in infant mortality during the past three decades.

The same situation is observed in Georgia, when rates based on civil registration are compared to surveys. However, for the period 2000-2004 (the five years before survey) the second survey shoes a mean infant mortality rate that is very close to the mean indicator given by Ministry of Health data (a little bit lower) and Statistical Office estimates (a bit higher), close to the 2004 results of the double data collection.

Consequently, to estimate infant mortality rate (IMR), we first assumed that the results of the surveys give a better view on the general levels and trends than current vital statistics. But different biases are linked to such surveys and despite a standardized method, results for a similar period are not systematically the same. In Armenia, for instance, Figure 8 shows that for the period 1996-2000, IMR was estimated at 37 per thousand according to the first DHS compared to 27 according to the second one. Different reasons may be involved in this gap: the sample is not the same in the two surveys, with the carrying out of the last census between them. There are also some classical limits to question women on their past history: problem of memory, underestimation of early neonatal mortality, reliability of the age of their children as well as for those who died (Potter, 1977; Institute for Resource Development, 1990). For these reasons, it is certainly better to rely on estimates based on current statistics to take into account the actual short term changes in infant mortality.

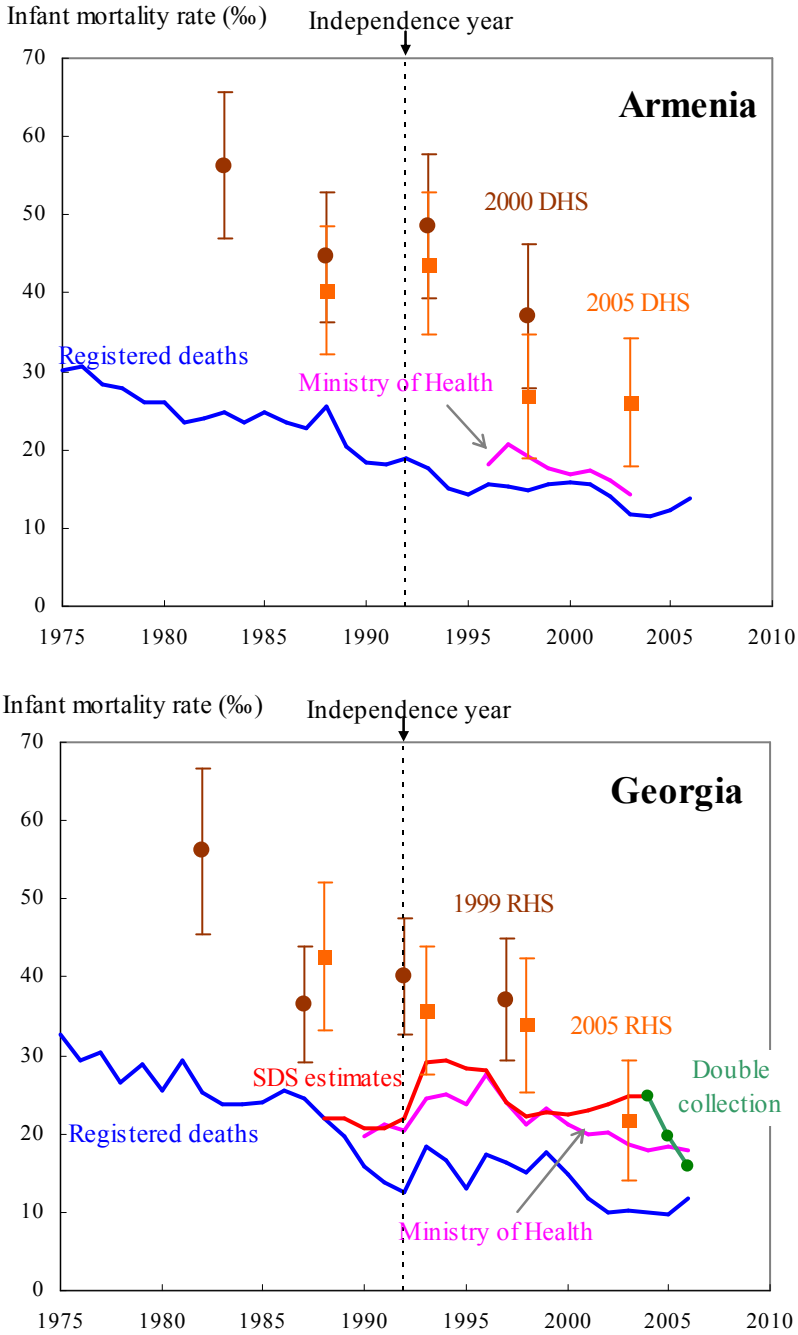
To estimate annual IMR, we proceeded in five steps (details in annex 1). First, we estimated new IMR for the 5-year periods on the basis of a linear regression of the eight points given by the two surveys. Second, we used these five-year estimates to calculate five-year coverage rates of the official IMR[4]. Third, annual coverage rates have been interpolated in between. Fourth, annual IMR has been estimated by applying annual coverage rates to annual official IMR. Fifth, for the most recent years, trends in annual estimated IMR have been extrapolated until 2006.

Figure 9 compares our final estimates of IMR to official IMR. For Armenia, in the last step we assume not only that the general decrease in IMR is going on, but also that an important improvement recently occurred in the civil registration system, which was responsible of the artificial increase observed in official IMR. For Georgia, according to the RHSs, our estimates are very close to official ones for the year 2004. Indeed, the new system of double collection seems to have been the most efficient in 2004 (when data are crossed), it can be assumed that the official IMR for this year is very close to reality[5].

[4] In the case of Armenia, that means civil registration results. In the case of Georgia, it means official estimates based on several sources as indicated above.

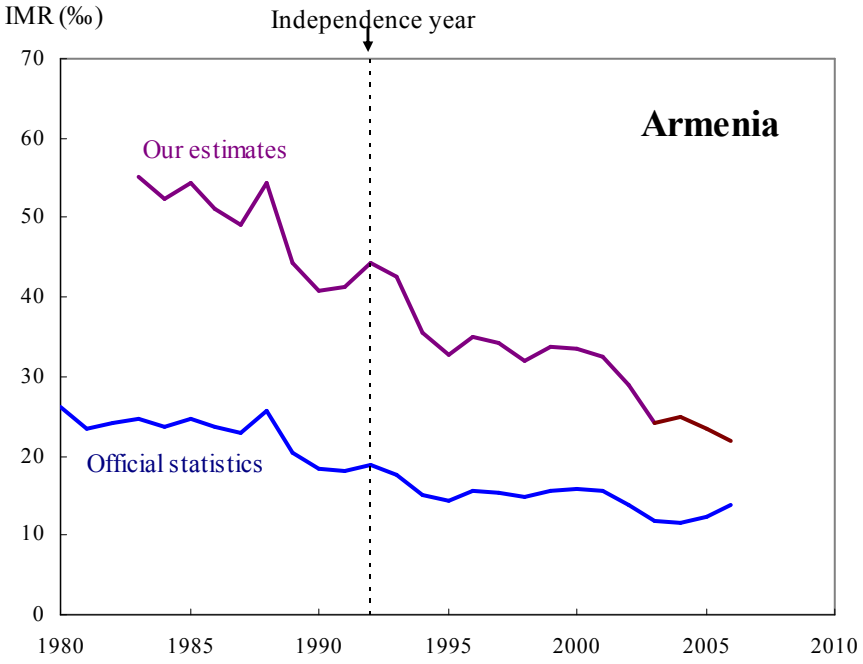
[5] Moreover, for 2005, it has been possible to use the capture-recapture method to estimate the number of events which have not been collected nor by the old system neither by the new one (assuming there is independence between the two sources) and the result backs up our global extrapolation.

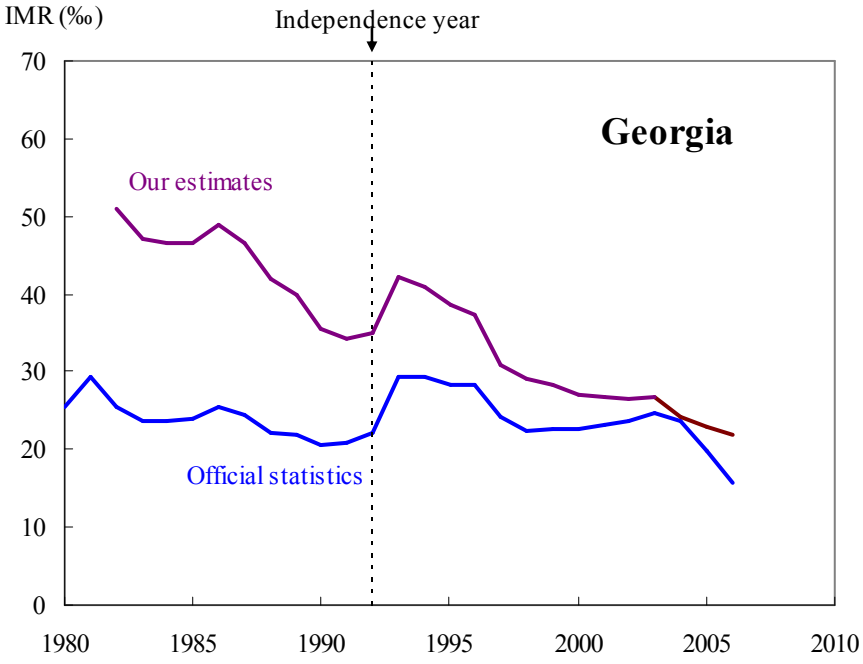
Figure 8.
Armenian and Georgian available estimates of infant mortality death rates



Sources : Armenia: NSS 2006; Ministry of Health 2006, 2000 and 2005 DHS (our calculation for 5-year periods with confident uncertainty). Georgia: Tsuladze *et al*., 2006; 1999 and 2005 RHS (our calculation for 5-years periods with confident uncertainty).

Figure 9.
Infant mortality rates (IMR) in Armenia and Georgia according to official data and our estimates





3.2. Life expectancy at birth

In the absence of clear information about the level of under-registration of deaths after age 1, we can at least take into account reestimated IMR to compute life expectancies that should be better than official ones, even if still overestimated.

Armenia

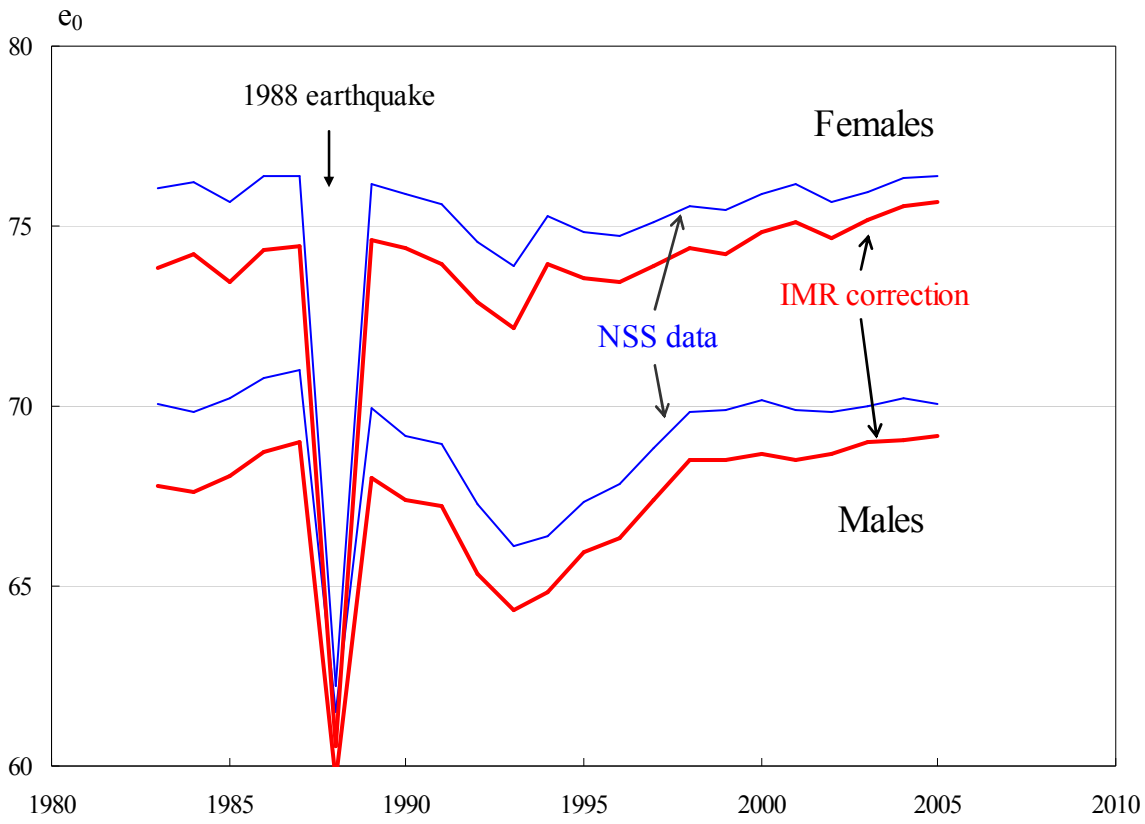
For Armenia (Figure 10), we simply used official data to compute age-specific mortality rates at more than one year. Life tables were then computed on the basis of these age-specific rates plus our IMR estimation.

Female life expectancy would have been of 73.8 in 1983 instead of 76.1 according to official estimates, a gap of 2.3 years. In 2006, with 75.6 years instead of 76.4, 0.8 year of reduction is observed. This is certainly a minimum correction. For males, the correction is a bit larger: 2.5 years in 1983 (67.6 instead of 70.1) and 0.9 in 2006 (69.2 instead of 70.1).

The impact of 1988 earthquake is obviously massive. Life expectancy at birth fell down as low as 59.6 for males and 60.5 for females; sex difference almost vanished because of the greater impact on females than on males.

For females, general trends seem to have been slightly negative from the 1980s to 1993, the lowest level observed, apart from the earthquake, and then, slightly positive from 1993 to 2006. Same changes occurred for males but the down trends were sharper and the up trends changed into a stagnation in the most recent years.

Figure 10.
Armenian life expectancy at birth trends from 1983 according to our estimates

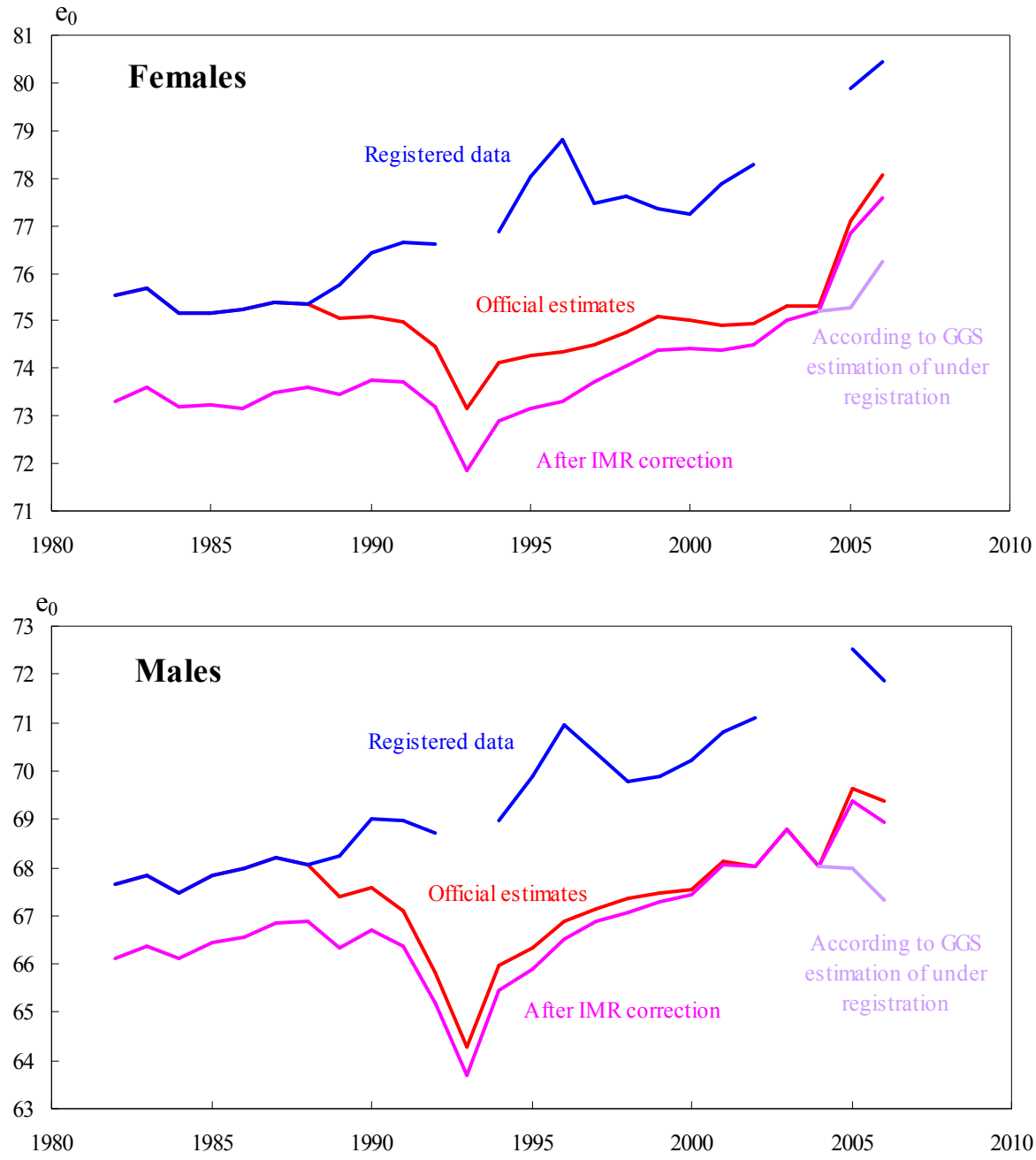


Georgia

In Georgia (Figure 11), we also used official data as the basis for computing age-specific mortality rates at more than one year, but taking into account that they already include an important correction for the last decade. For that reason, our correction of official data varies a lot with time, since official statistics do not propose any correction before 1989,

but our estimates are continuously much lower than life expectancy measured on the basis of registered data[6]. From the latter, our correction is of 1.6 year for males in 1982 (66.1 instead of 67.7) and 2.9 years in 2006 (68.9 instead of 71.8). For females it is of 2.2 years in 1982 (73.3 instead of 75.5) and 2.8 in 2006 (77.6 instead of 80.4). Contrary to Armenia, it is larger in 2006 than in 1982.

Figure 11.
Georgian life expectancy at birth trends from 1983 according to our estimates

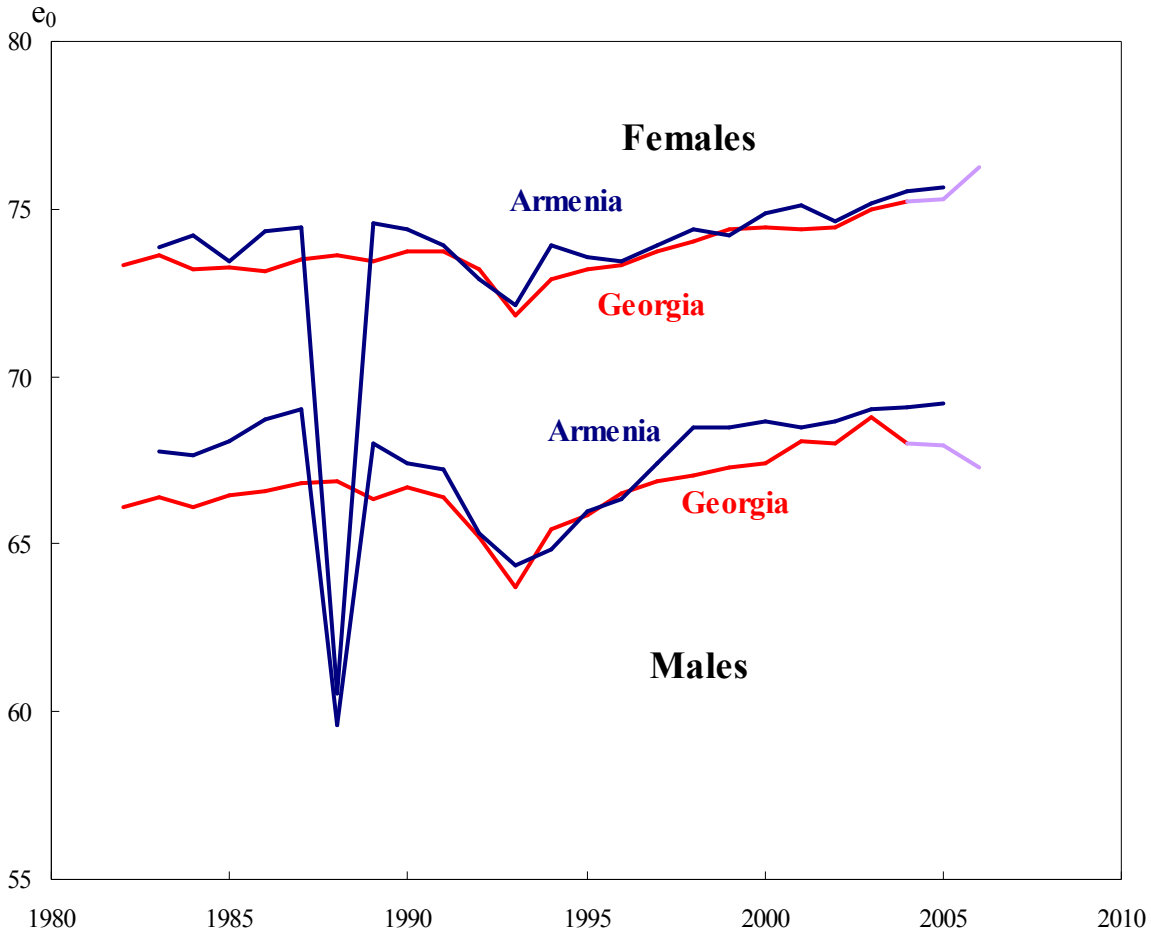


[6] Concerning registered deaths through civil registration, there are missing data in 1993 due to the war but also in 2003 and 2004 due to the establishment of the new system (crossing sources), it was nevertheless possible to have data for the years 2005 and 2006.

General trends are rather similar to Armenian ones, but the initial down trends are less pronounced while the final up-trends are much sharper. However, it is very probable that the latter is exaggerated. We know that registration system significantly deteriorated in 2005. Indeed, according to a special question asked in the 2006 Gender and Generation Survey (GGS) 27 % of deaths over age 1 of the 5-year period preceding the survey would have not been registered. If such a ratio is applied to registered deaths, life expectancy at birth should have been 1.6 year less for both sexes in 2005-2006. For females, such a correction would not change the direction of the recent upward trends. For males, however, it would mean that life expectancy would have declined rather sharply since 2003. Nevertheless, this results is more realistic than the sharp increase obtained when the 2005 deterioration of registration is not taken into account.

Figure 12 compares recent trends thus estimated for Armenia and Georgia (Annex 2). In spite of various differences in the way to adjust crude data, results are quite comparable. Apart from the very specific impact of the 1988 earthquake in Armenia, changes in life expectancy appear to be quite similar in both countries for females. A similarity also appears for males, but with some specific differences. In particular, life expectancy was significantly shorter in Georgia than in Armenia in the mid-1980s, but, furthermore, while Georgian and Armenian life expectancy was quite the same in 2004 they have been strongly diverging for the last 3 years, apparently.

Figure 12.
Georgian and Armenian life expectancy at birth trends since the early 1980s according to our estimates



References

BADURASHVILI Irina, MCKEE Martin, TSULADZE Giorgi, MESLÉ France, VALLIN Jacques and SHKOLNIKOV Vladimir, 2001. – Where there are no data : what has happened to life expectancy in Georgia since 1990 ?, *Public Health*, n° 115, p. 394-400.

INSTITUTE FOR RESOURCE DEVELOPMENT. - 1990. *An Assessment of DHS-I Data Quality*. DHS Methodological Reports, 1. Columbia, Maryland : Institute for Resource Development / Macro Systems, Inc.

KARAPETYAN S.A., EGANYAN R.S., and SHAKHNAZARYAN N.V. 1996. – *Migratsiya naseleniya Armenii za postsovetskiy period (1991-1995)*. [Migration of the Armenian population during the post-Soviet period (1991-1995)]. –Erevan, UNFPA, 31 p.

KATUS Kalev and PUUR Allan (ed.), 2003. – *Unity and diversity of population development: Baltic and South Caucasian regions.* – Tallinn, Estonian Interuniversity Population Research Centre, 353 p. (RU Series D, n° 3).

KINGKADE Ward W., 2000. – *Caucasian old age mortality: the case of Armenia.* – Washington, US Census Bureau, 36 p. (Paper at PAA meeting, Los Angeles, 2000).

KSENOFONTOVA Nantalia Y., 1994. – Trends in infant mortality in the USSR, *in :* Wolfgang LUTZ, Andrei VOLKOV and Serguei SCHERBOV (ed.), *Demographic trendsand patterns in the Soviet Union before 1991,* p. 359-378. – New York, Routledge, 496 p.

MESLÉ France and VALLIN Jacques, 2003. – *Mortalité et causes de décès en Ukraine au XXe siècle.* – Paris, INED, xvi + 396 p. (Les cahiers de l'INED, cahier n° 152).

MESLÉ France, VALLIN Jacques, HERTRICH Véronique, ANDREEV Evgueni and SHKOLNIKOV Vladimir, 2003. – Causes of death in Russia: assessing trends since the 50s, *in :* Irena E. KOTOWSKA and Janina JÓZWIAK (ed.), *Population of Central and Eastern Europe : challenges and opportunities,* p. 389-414. – Warsaw, Statistical Publishing Establishment, 724 p. + CD-Rom.

MESLÉ France, VALLIN Jacques and BADURASHVILI Irina, 2006. – Data quality of population and vital statistics in Caucasian countries in post-soviet period, *in :* Institute for Demography and Social Studies (IDSS) (éd.), *Mortality in countries of the former USSR. Fifteen years after break-up: change or continuity? International seminar, Kiev, 12-14 October 2006, Vol. 2,* p. 6-27. – Kiev, IDSS, CDHE, MPIDR, INED, IUSSP, UNFPA, 302 p.

NATIONAL CENTER FOR DISEASE CONTROL [GEORGIA] *et al*. - 2001. *Reproductive health survey Georgia, 1999 : final report*. - Atlanta : DRH/CDC, *** p.

NATIONAL CENTER FOR DISEASE CONTROL [GEORGIA] *et al*. - 2007. *Reproductive health survey Georgia, 2005 : final report*. - Atlanta : DRH/CDC, 440 p.

NATIONAL STATISTICAL SERVICE [ARMENIA], MINISTRY OF HEALTH [ARMENIA], AND ORC MACRO. 2001. *Armenia Demographic and Health Survey 2000*. Calverton, Maryland: National Statistical Service, Ministry of Health, and ORC Macro, 215 p + appendix.

NATIONAL STATISTICAL SERVICE [ARMENIA], MINISTRY OF HEALTH [ARMENIA], AND ORC MACRO. 2006. *Armenia Demographic and Health Survey 2005*. Calverton, Maryland: National Statistical Service, Ministry of Health, and ORC Macro, 230 p + appendix.

POTTER Joseph H. - 1977. Methods of detecting errors in WFS data: an application to the Fidji Fertility Survey. IUSSP, Mexico City.

TSULADZE Giorgi and BADURASHVILI Irina, 1999. – *The Demographic Yearbook of Georgia 1998.* – Tbilisi, Georgian Centre of Population Research, 92 p.

TSULADZE Giorgi and MAGLAPERIDZE Nika, 2000. – *Demographic yearbook of Georgia. 1999.* – Tbilisi (Georgia), Centre for Social Studies, 90 p.

TSULADZE Giorgi, MAGLAPERIDZE Nika et VADACHKORIA Alexander, 2001. – *Demographic yearbook of Georgia, 2000.* – Tbilissi (Géorgie), Georgian Academy of Sciences, Institute of Demographic and Sociological research, Centre for Social Studies, 100 p.

TSULADZE Giorgi, MAGLAPERIDZE Nika et VADACHKORIA Alexander, 2006. – Demographic Yearbook of Georgia 2005. – Tbilissi (Géorgie), UNFPA, Institute of Demography and Sociology, 200 p.

VELKOFF Victoria A. and MILLER Jane E., 1995. – Trends and differentials in the Soviet Union 1970-90: how much is due to misreporting?, *Population Studies*, vol. 49, n° 2, p. 241-258.

WHO (World Health Organisation), 2008. – *World Health Statistics 2008.* – Geneva, WHO , 110 p. (http://www.who.int/whosis/whostat/EN_WHS08_Full.pdf).

YEGANYAN Ruben S., 2000. – *Demografitcheskiye realii i perspektivi RA na poroge 21-go veka*. [Demographic realities and perspectives of Armenia at threshold of the 21th century]. – Erevan, *** p. (Materials of the scientific seminar "Demography of Armenia between two centuries", Dilijan, 2000).

YEGANYAN Ruben, BADURASHVILI Irina, ANDREEV Evgueni, MESLÉ France SHKOLNIKOV Vladimir and VALLIN Jacques, 2001. – Life expectancy in two Caucasian countries: how much due to overestimated population?, *Demographic Research*, vol. 5, n° 7, p. 217-243.

YEGANYAN Ruben S. and DAVTYAN L.M. 2000. – *Vneshnemigratsionnaya situatsiya Armenii.* [Armenian situation with external migration]. – Erevan, *** p. (Materials of the scientific seminar "Demography of Armenia between two centuries", Dilijan, 2000).

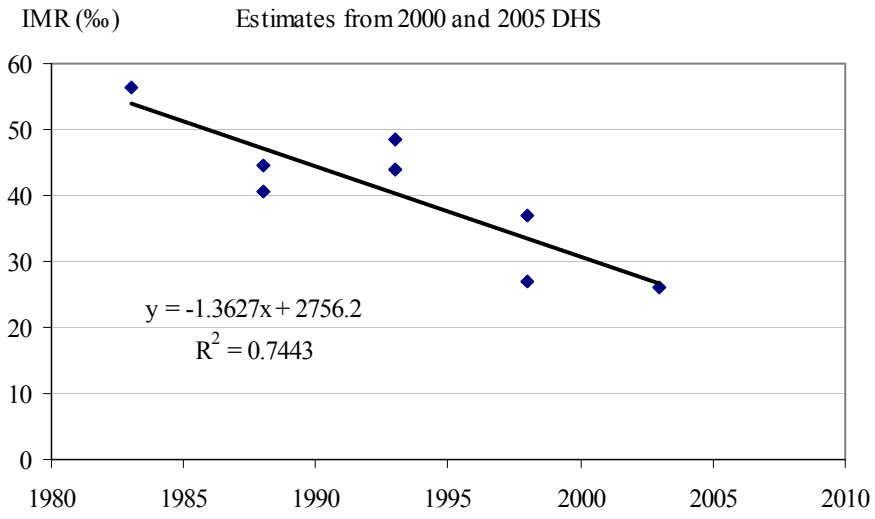
YEGANYAN Ruben S. et SHAKHNAZARYAN N. V., 1999. – *Issledovaniye vneshnemigratsionnikh protsessov RA 1991-1998 [Study of the processes of external migration in Armenia 1991-1998*. – Erevan, Ministry of Statistics and Eurostat, 45 p.

Annex 1. Method for estimating annual infant mortality rates in Armenia and Georgia

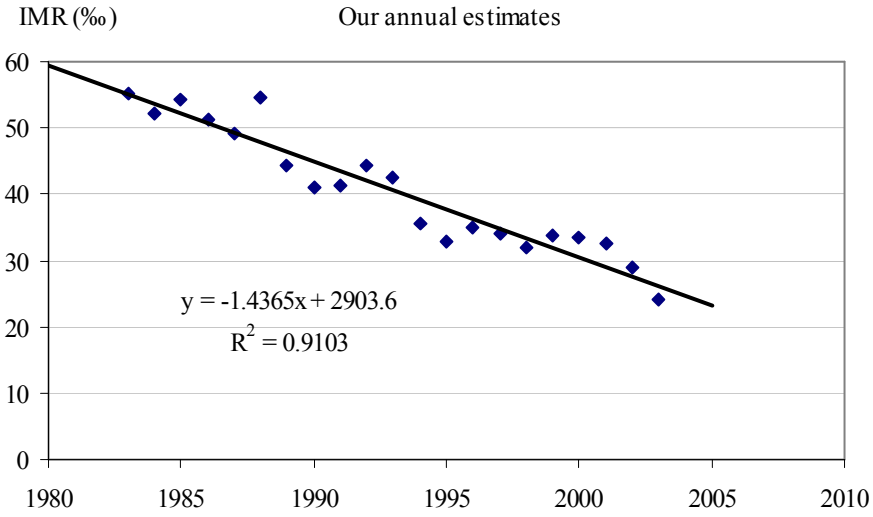
Armenia

Year	IMR Civil registration (1) ‰	IMR 2000 DHS (2) ‰	IMR 2005 DHS (3) ‰	IMR 2000&2005 DHS (4) ‰	5-y periods coverage rate (5) %	Annual coverage rate (6) %	IMR annual estimates (7) ‰
1980	26.2						
1981	23.4						
1982	24.1						
1983	24.7	56.3		54.0	0.44672	0.45	55.2
1984	23.6					0.45	52.3
1985	24.7					0.46	54.3
1986	23.6					0.46	51.2
1987	22.8					0.46	49.1
1988	25.6	44.6	40.5	47.2	0.46947	0.47	54.5
1989	20.4					0.46	44.4
1990	18.3					0.45	40.9
1991	18.0					0.44	41.2
1992	18.9					0.43	44.3
1993	17.8	48.5	43.8	40.3	0.41672	0.42	42.6
1994	15.1					0.43	35.5
1995	14.2					0.43	32.8
1996	15.5					0.44	35.1
1997	15.4					0.45	34.2
1998	14.7	37.0	26.9	33.5	0.46002	0.46	32.0
1999	15.7					0.47	33.7
2000	15.8					0.47	33.5
2001	15.5					0.48	32.6
2002	14.0					0.48	29.0
2003	11.8		26.0	26.7	0.48652	0.49	24.2
2004	11.5					**0.46**	**24.9**
2005	12.3					**0.52**	**23.4**
2006	13.9					**0.63**	**22.0**

a) Column (4) gives estimates for IMR for 5-year periods as resulting from linear regression on the eight points given by the two surveys.



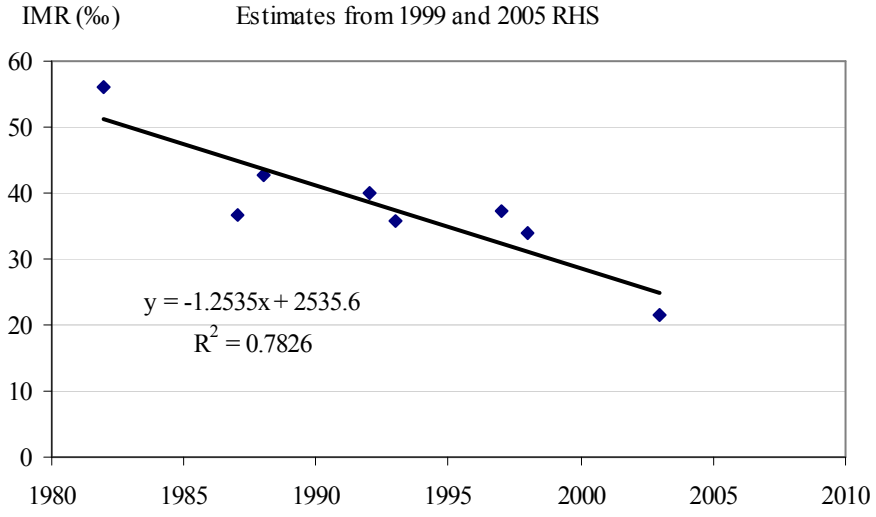
b) Column (5) is the coverage rate computed as the ratio between 5-year civil registration IMR and 5-year estimated IMR (column 4) .
c) Column (6) is annual coverage rate computed by interpolation of the 5-year coverage rate (column 5) (linear progression per year between two estimates).
d) Column (7) gives IMR annual estimates obtained by multiplying civil registration IMR (1) and coverage rate (6).
e) For the last three years (in bold in column 7), the estimates are resulting from a linear progression made from all previous estimates. Then from these last estimates, we deduced the coverage rate.



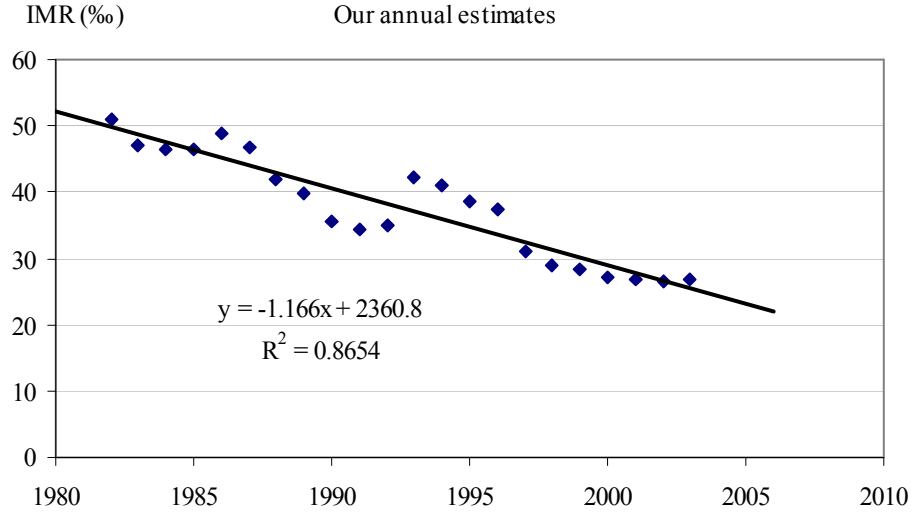
Georgia

Year	IMR Official statistics (1)	IMR 1999 RHS (2)	IMR 2005 RHS (3)	IMR 1999&2005 RHS (4)	5-y periods coverage rate (5)	Annual coverage rate (6)	IMR annual estimates (7)
	‰	‰	‰	‰	‰	‰	‰
1980	25.4						
1981	29.4						
1982	25.4	56.1		51.2	0.50	0.50	50.9
1983	23.8					0.50	47.2
1984	23.7					0.51	46.5
1985	23.9					0.51	46.5
1986	25.5					0.52	49.0
1987	24.5	36.5		44.9	0.53	0.53	46.6
1988	22.0		42.7	43.6	0.53	0.53	42.0
1989	22.0					0.55	39.9
1990	20.6					0.58	35.6
1991	20.8					0.60	34.3
1992	22.0	40.1		38.6	0.63	0.63	34.9
1993	29.2		35.8	37.4	0.69	0.69	42.1
1994	29.3					0.71	41.0
1995	28.4					0.74	38.6
1996	28.2					0.76	37.3
1997	24.1	37.1		32.4	0.78	0.78	31.0
1998	22.3		33.9	31.1	0.77	0.77	29.0
1999	22.7					0.80	28.3
2000	22.5					0.83	27.1
2001	23.1					0.86	26.7
2002	23.6					0.89	26.4
2003	24.8		21.6	24.8	0.93	0.93	26.8
2004	23.8					**0.98**	**24.1**
2005	19.7					**0.86**	**23.0**
2006	15.8					**0.72**	**21.8**

a) Linear regression on the eight points given by the two surveys



e) Linear regression on the annual IMR estimates from 1980 to 2003



Annex 2. Life expectancy at birth in Armenia and Georgia according to our estimates

e_0 (in years)	Armenia			Georgia		
	Male	Female	Total	Male	Female	Total
1982				66.1	73.3	70.0
1983	67.8	73.8	71.0	66.4	73.6	70.3
1984	67.6	74.2	71.1	66.1	73.2	69.9
1985	68.1	73.5	71.0	66.4	73.2	70.1
1986	68.7	74.3	71.7	66.6	73.1	70.1
1987	69.0	74.5	71.9	66.8	73.5	70.4
1988	59.6	60.5	60.3	66.9	73.6	70.4
1989	68.0	74.6	71.4	66.3	73.5	70.1
1990	67.4	74.4	71.0	66.7	73.7	70.4
1991	67.2	73.9	70.7	66.4	73.7	70.2
1992	65.3	72.9	69.2	65.2	73.2	69.3
1993	64.3	72.1	68.3	63.7	71.9	67.8
1994	64.8	73.9	69.4	65.5	72.9	69.3
1995	66.0	73.6	69.8	65.9	73.2	69.6
1996	66.4	73.4	70.0	66.5	73.3	70.0
1997	67.4	73.9	70.7	66.9	73.7	70.4
1998	68.5	74.4	71.5	67.1	74.0	70.7
1999	68.5	74.2	71.4	67.3	74.4	70.9
2000	68.7	74.9	71.8	67.4	74.4	71.0
2001	68.5	75.1	71.9	68.1	74.4	71.4
2002	68.7	74.6	71.7	68.0	74.5	71.4
2003	69.0	75.1	72.2	68.8	75.0	72.0
2004	69.1	75.6	72.4	68.0	75.2	71.6
2005	69.2	75.6	72.5	68.0	75.3	71.7
2006				67.3	76.2	71.8