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Producing reliable mortality estimates in the context of distorted population statistics: the case of Moldova

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Abstract

Background and Aim Despite having a functioning population register, the official demographic indicators in Moldova are seriously biased. The problem arises primarily because the registration of deaths and births covers only the events that occur within the country (the *de facto* population), whereas the population at risk includes Moldovan citizens who live abroad (the *de jure* population). Because the country has high levels of emigration, there are substantial differences between the *de facto* and the *de jure* population numbers. Thus, the nominator-denominator bias must be taken into account in the population statistics. To obtain plausible demographic rates, appropriate corrections of population size have to be made. Our aim is to estimate the size of the *de facto* Moldovan population, and to produce reliable mortality estimates for the longest period possible. **Data and Methods** We rely on official data obtained from various sources. These include mortality data, census counts, and annual population estimates collected from archives or obtained directly from the Moldovan National Bureau of Statistics. Using alternative administrative data sources, we first correct the size of the Moldovan population. We then generate adjusted population estimates. Finally, on the basis of the adjusted population estimates, we produce life tables. All of the calculations are performed using the methodology and programming tools developed within the Human Mortality Database (HMD) Project. **Results** Our corrected population estimates are 18 percent lower than the official figures. The adjusted estimates of life expectancy at birth in 2014 are 64.94 years for males and 73.74 years for females. These figures are, respectively, 2.58 years and 1.65 years lower than the official estimates. Our estimates of the size of the population are consistent with unpublished 2014 population census data. Complete life tables for the period 1970–2014, as well as some other HMD statistics, are provided as supplementary material. **Conclusions** We show that even when there is a serious distortion of population statistics, it is possible to obtain plausible mortality estimates. This issue is highly relevant not just for Moldova, but for other European countries that have also been experiencing problems with the incorrect registration of

migration. To improve the quality of their population estimates, countries will increasingly have to consult alternative administrative data sources.

1. Introduction

It is often assumed that statistical error, which is unavoidable when producing annual population estimates, has a rather minor impact on mortality indicators such as life expectancy at birth. In most cases this assumption is indeed valid. Error caused by the under-registration of out-migration tends to accumulate around the youngest and the most mobile population groups, who also have relatively low mortality. Therefore, error in population estimates has to be extremely high to affect mortality rates.

It is also widely assumed that countries that maintain population registers generally have more accurate population statistics. This notion is, however, based on evidence from the Nordic countries, and from Sweden in particular. Because these countries have long histories of data collection and well-established population registers that have been functioning for several decades, they are able to produce very reliable mortality estimates (Kannisto, 1999; Jdanov et al., 2008). However, simply having a population register does not guarantee that the quality of mortality estimates will be high, especially in countries where a system of population register has only recently been introduced. The quality of the population register depends in large part on the initial conditions under which it was created, such as the level of development of the vital registration system.

Using the official data, we show that despite having a functioning population register, the official demographic indicators in Moldova are seriously biased. The main source of the problem is that the registration of deaths and births covers only events that occur within the country (the *de facto* population), whereas the population at risk includes Moldovan citizens living abroad (the *de jure* population). Because the country has high levels of emigration, the differences between the *de facto* and the *de jure* population numbers are substantial. Thus, the nominator-denominator bias in the population statistics must be taken into account. To obtain plausible demographic rates, appropriate corrections of the population size have to be made. Our aim is to estimate the size of the *de facto* Moldovan population, and to produce reliable mortality estimates for the longest period possible.

This work was conducted within the framework of the Human Mortality Database (HMD) Project¹. This report is organized as follows. First, we start by providing a general description of the statistical system of Moldova, including background information on the history of the population statistics, the data, the completeness of registration, and the territorial coverage. We then describe in detail the system of demographic data collection and processing, and provide information about the available data on population estimates, census counts, and migration. In a separate section of the paper, we explain the main data quality issues. Finally, we describe our method for producing alternative population estimates for Moldova. In a statistical annex to this report, we provide complete life tables for the period 1970–2014, along with the adjusted population estimates upon which the tables were constructed, as well as some other HMD statistics. These data are freely [available for download](#) from the server of the Max Planck Institute for Demographic Research.

2. Organization of population statistics in Moldova

In the 19th century, when Moldova (then called Bessarabia) was a province of the Russian Empire, deaths, births, baptisms, and marriages were registered by the church in special parish registers. The earliest church records in Moldova date back to 1810 (Corlăteanu-Granciuc, 2008). Between 1918 and 1940 Moldova belonged to Romania, and gradually adopted the Romanian death registration system. When Moldova became the Moldavian Soviet Socialist Republic (MSSR) in 1940, the country adopted the Soviet death registration system. After Moldova gained its independence from the USSR in 1991, new rules were introduced. In 1990, Transnistria, a region in the eastern part of the country with a population of around half a million (representing 14 percent of the total population), proclaimed its independence. Although this claim was not recognized by Moldova or by any other country, Transnistria was offered an “autonomous” status by Moldova. This offer was refused, and war broke out in 1992.

In Moldova, the national system of statistics is centralized. The *National Bureau of Statistics [Biroul Național de Statistică]*, which was called the Central Statistical Administration (TCSU) during the Soviet period, is the main body responsible for the

¹ The Human Mortality Database is a joint project of the [Department of Demography at the University of California, Berkeley, USA](#), and at the [Max Planck Institute for Demographic Research in Rostock, Germany](#), available at www.mortality.org.

organization and dissemination of official statistics. Apart from the National Bureau of Statistics (NBS), three ministries and their subordinate institutions are involved in the collection and processing of death and birth certificates:

- The Ministry of Justice, which oversees the Vital Statistics Office;
- The Ministry of Information, Technology, and Communications, which supervises the Center for State Information Resources, which is in turn in charge of the population registries, or “*Registru*”, as described below; and
- The National Center for Health Management, which operates within the Ministry of Health and is responsible for cause-of-death statistics.

The annual population estimates are based on data from population censuses and vital and migration statistics. After World War II, four Soviet censuses were conducted in Moldova: on January 15, 1959; on January 15, 1970; on January 17, 1979; and on January 12, 1989. The first census after independence was conducted on October 5, 2004. For political reasons this census did not cover Transnistria. The most recent Population and Housing Census was conducted in Moldova on May 12, 2014. Like the census of 2004, it did not cover Transnistria.

The Center for State Information Resources “*Registru*” (SE CSIR “*Registru*”), an agency that reports to the Ministry of Information Technology and Communication (MITC), is responsible for the maintenance of the State Population Register (SPR). Created in the mid-1990s, the SPR provides information on all Moldovan citizens, as well as on all foreign citizens and stateless individuals residing in Moldova, either permanently or temporarily. Moldovan citizens remain in the SPR even if they migrate permanently or temporarily to another country. Personal data in the SPR are linked by a personal identification number (IDNP). An IDNP is assigned to each individual upon his or her initial registration (that is, at birth or when identification papers are issued for the first time for a native-born individual, and at first entry for foreigners), and it remains unchanged thereafter. An IDNP is removed from the SPR only in case of death or of permanent departure (in the case of foreigners).

3. Collecting and processing demographic data

The following description is limited to the post-World War II period, with distinctions being made between the Soviet era and the period after independence.

3.1. Coverage and completeness

The statistical offices of the former Soviet republics, including those of the MSSR, conducted annual “*control checks*” of the completeness of death and birth registration. The control check procedure, which was implemented in the Soviet republics after 1948 (Kharkova, 2006), was as follows. In the urban regions, the individual death and birth records were collected at maternity hospitals, maternity units, and hospitals; while in the rural regions these records were retrieved from so-called house registers [*pohozeistvennaia kniga*]. The quality of the records was then assessed according to the corresponding civil status regulations by ZAGS [*Zapis' aktov grazhdanskogo sostoiania*, Registry of Acts of Civil Status]. In the Soviet republics, ZAGS referred to the district administration office responsible for the registration of births, deaths, marriages, divorces, and other events related the legal status of the family members (Andreev, Scherbov and Willekens, 1995). In Moldova, 10% of villages were selected randomly for one control check (TCSU of USSR, 1971).² The selection of villages was made according to the special instructions of the TCSU of the USSR, and those instructions could change from year to year. In rural areas, the completeness of death and birth registration was controlled for a single calendar year, while in urban areas it was controlled for the last quarter of a single year only.

The results of one control check conducted in Moldova in 1971 (TCSU of MSSR, 1972) showed that in urban areas, 6% of births, 5.5% of deaths, and 6.8% of infant deaths were not registered with ZAGS; whereas in rural areas, just 0.2% of births, 0.3% of deaths, and 2.6% of infant deaths were not registered with ZAGS. However, the true extent of infant death under-registration in Moldova before the mid-1970s was much greater than the situation depicted by these official control checks, especially in rural areas. Experts have estimated (Penina, Meslé and Vallin, 2010) that the actual percentages of infant deaths that were not registered in Moldova in 1971 were 42% in

² A 10% sample was drawn in the following republics: Ukraine, Belarus, Lithuania, Moldova, Latvia, Estonia, and Russia (with a few exceptions for Russia). For the other republics the sample size was increased up to 20% (TCSU of USSR, 1971)

rural areas and 33% in urban areas (see *Specific details* in this section). Thus, the official correction coefficients clearly cannot be used to adjust infant mortality data for Moldova for the early Soviet period.

The official vital and migration statistics of Moldova have not covered the Transnistria region since 1997. The mortality series that refer to Moldova include this territory for the years prior to 1997, and exclude it thereafter. The vital statistics in Moldova for the late Soviet period and the period of independence are considered to be complete. An evaluation of the Health Information System in Moldova conducted by the Health Metrics Network in 2007 (Health Metrics Network, 2007) showed that more than 90% of deaths are registered in the vital statistics.

3.2. Death records

Soviet period

Until 1991, the Moldovan vital statistics system was integrated into the USSR-wide registration system. In the Soviet Union, the system of civil registration of vital events was established after the 1917 revolution, when the church registration functions were transferred to newly established district administration offices called ZAGS (Jones and Grupp, 1987). Deaths had to be registered within three days of the event. After a death, the deceased's relatives or close associates were required to obtain a medical death certificate from the responsible medical institution, and to take the certificate to the responsible ZAGS office. In exchange, the relatives of the deceased would receive a civil death certificate that served as both a burial permit and a legal document for inheritance purposes. The ZAGS office would then send the medical death certificate to the regional office of statistics.

In the Soviet Union, a death could be confirmed not only by a medical doctor, but also by a medical assistant [*feldsher*], albeit only in cases not requiring forensic medical examination (e.g., not in cases of violent death or suspected violent death, the death of a child outside of a medical unit, or an abortion performed outside of a medical unit). The death certificate issued by a doctor was referred to as a medical certificate of death [*vrachebnoe svidetelstvo o smerti*], and the certificate issued by a *feldsher* was called a *feldsher* certificate of death [*feldsherskaya spravka o smerti*]. A special death certificate for perinatal deaths (stillbirths after 28 weeks of gestation and deaths of children aged

0-6 days), called the perinatal death certificate [*svidetelstvo o perinatalinoi smerti*], was adopted in the USSR in 1973.

In addition to a civil death certificate, ZAGS issued for each death a record of the death for administrative and statistical purposes called a civil status act [*akt grazhdanskogo sostoiania*]. Two copies were made of this death record³. The first copy was kept at the ZAGS office, while the second copy was sent (together with a medical death certificate) to the district statistical office for data processing.

In the MSSR, the processing of the medical death certificates and of the second copies of civil status forms was centralized at the level of the Central Statistical Administration of the MSSR.

The TCSU of the MSSR tabulated annually the various statistical forms based on the second copies of the civil status acts and the medical death certificates, in accordance with the instructions regularly elaborated by TCSU of the USSR. All of the statistical forms were tabulated manually until 1988, when electronic data processing was introduced. However, from 1974 onward the Soviet authorities no longer published official mortality data by age or by cause of death (Tolts, 2004). Thus, researchers had no access to the archives of Soviet statistical offices until the late 1980s, when the files were made available under Mikhail Gorbachev's *glasnost* and *perestroika* policies.

Post-Soviet period

After Moldova became independent in 1991, the system of death registration remained basically the same. However, the management of vital statistics underwent important changes, especially following the establishment of the State Population Register (SPR) in the mid-1990s. The system of making two copies of each civil status act, which was first introduced in the USSR in the late 1920s, was continued after 1991. Currently, however, these two copies are used for administrative purposes only. In the late 1990s, the NBS adopted a series of statistical forms [*Buletin statistic*] for statistical purposes. These statistical forms are to be completed on the basis of records of births, deaths,

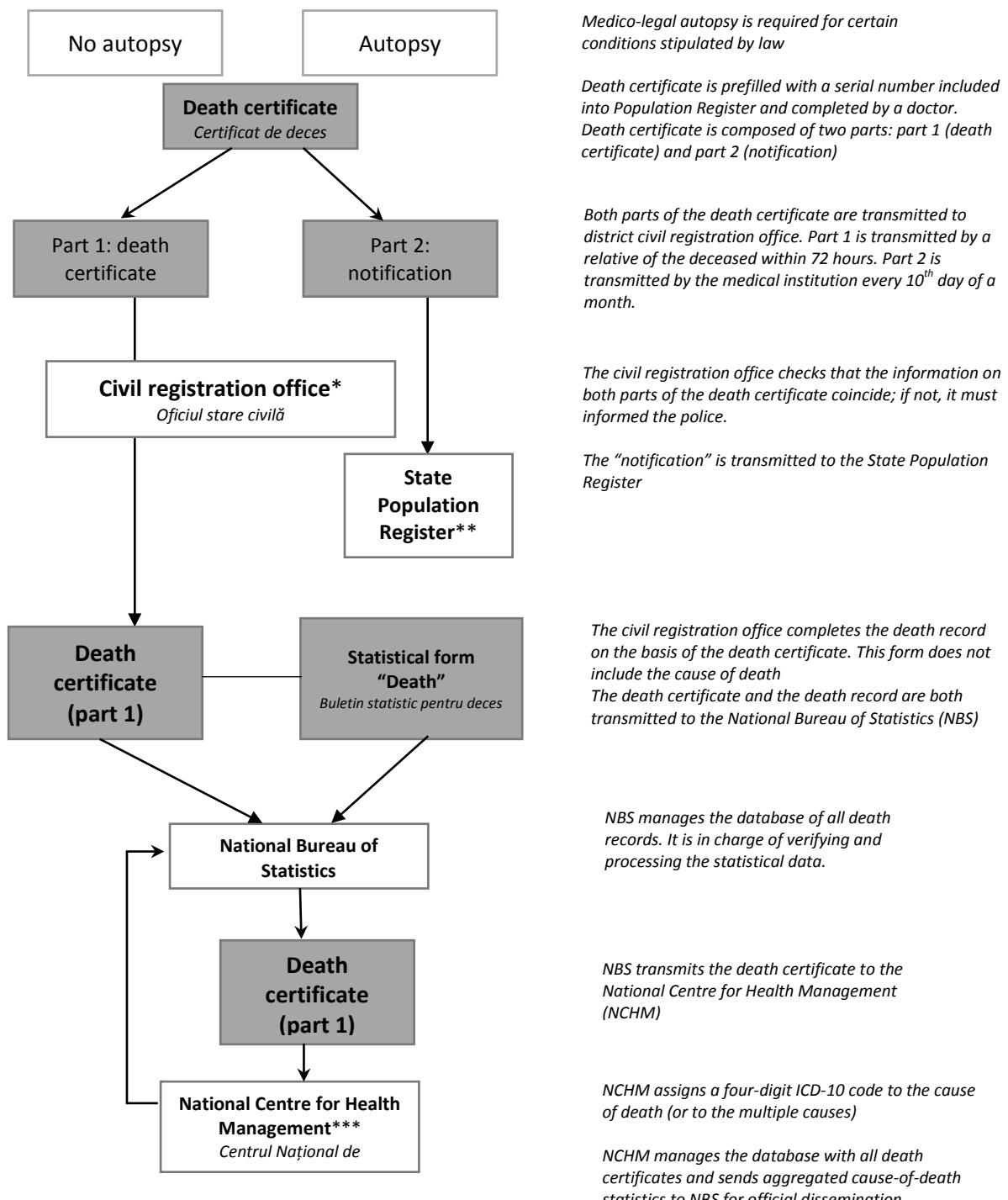
³ The procedure of making two identical copies of a civil status form was adopted in the Soviet Union in 1926 (Jones and Grupp, 1987).

marriages, and divorces.⁴ The forms correspond to vital records, and contain around 25 variables, including the IDNP.

Figure 1 illustrates the circulation of medical death certificates in Moldova. At present, the system for the production of death certificates functions as follows. A medical death certificate is issued by a certified physician after examination of the body. In some cases (e.g., a death in a hospital, a violent death or a suspected violent death) a forensic autopsy is compulsory. The medical death certificate, which is prefilled with a serial number provided by the MITC, includes the deceased's identification number and consists of two parts. One part of the document is given to the relative of the deceased or to the person who declared the death (typically a neighbor or a physician from the medical institution in which the death occurred). This individual must present this part of the document at the civil registration office within three days of the death. In exchange, the individual receives a certificate of the death record. The other part of the medical death certificate (a notification) must be sent to the civil registration office by the physician or the medical institution who certified the death by the 10th day of the month (Ministry of Health of Moldova, Department of Statistics and Sociology and Department of Information Technology, 2004).

At the civil registration office, the medical death certificate presented by the person who has declared the death and the notification received from the medical institution must match. If the information on the two documents coincides, the death is registered. If a discrepancy is found, the civil registration officer must refer the case to the local authorities (i.e., the police) for investigation.

⁴ Four vital registration forms were introduced in Moldova in 1997: one for births (#1), one for deaths (#3), one for marriages (#4), and one for divorces (#5). These forms were reproduced from those used in Romania, except for form #2 (for stillbirths), which is not used in Moldova.



*Ministry of Justice

**Ministry of Information Technology and Communications

***Ministry of Health

Figure 1. Circulation of medical death certificate in Moldova

This procedure is designed to ensure that all deaths are recorded at the civil registration office. The civil registration office sends the information from each “notification” to the MITC within two days for inclusion in the State Register of Population. It also sends the medical death certificate with its associated statistical form (i.e., the death record) to the NBS. The statistical forms are completed with the information included on the medical death certificate, and cover 17 socio-demographic variables. But for reasons of confidentiality, the cause of death listed on the medical death certificate is not added to the statistical forms. The NBS forwards the medical death certificate to the NCHM, which is responsible for coding the cause of death according to the 10th revision of the International Classification of Diseases and Causes of Death; a classification system that has been in use since 1996. The NCHM manages a database that includes all of the medical death certificates, and is responsible for transmitting aggregated cause-of-death statistics to the NBS for publication and dissemination purposes.

A different certificate is used for all deaths that occur within six days of birth. It is called the perinatal death certificate, as it is also used to record stillbirths. The perinatal death certificate must be completed by a forensic pathologist. For each neonatal death, both a birth certificate and a perinatal death certificate must be filed at the civil registration office.

3.3. Birth records

The medical *birth certificate* is prefilled with an identification number from the MITC. The medical birth certificate is composed of two parts: one part is given to the family to be presented at the regional civil registration office within three days, and the other (a notification) is sent to the civil registration office by the medical institution. The medical birth certificate has to be issued by one of the 41 accredited medical institutions. Since 2009, a birth can be registered directly at the medical institution. If a delivery takes place outside of one of these 41 medical institutions, the birth certificate is to be issued within 10 days of the birth, following a medical examination of the mother and the child by a committee composed of three physicians.

The civil registration office sends the medical birth certificate to the NBS, along with an additional statistical form that includes information on 30 socio-demographic variables. When the family registers the birth at the civil registration office by presenting the part of the medical birth certificate issued by the medical institution or the committee, the

information on the document is compared with the information on the notification from the medical institution. If the information from the two sources coincides, the birth is registered. If not, the civil registration office notifies the police of the need for further investigation. The civil registration office then transmits the information (from the notification received from the medical institution) to the SRP within two days.

Before the mid-1970s, the official number of live births in Moldova was greatly underestimated. (see the section on data quality issues for more details). Because the Soviet definition of a live birth was used in the official Moldovan statistics up to 2008, and a new, though still incomplete, definition was implemented starting in 2008; it is clear that the number of births was underestimated until 2008, and may have been underestimated in subsequent years as well.

3.4. Migration statistics

The NBS obtains international migration statistics from two main sources: the State Population Register (SPR) and the Bureau of Migration and Asylum (BMA). Aggregated data on emigrants come from the SPR, whereas the BMA provides data on immigrants and repatriates. The NBS does not have access to individual migration records.

The definition of international migration used in Moldova does not conform to international standards, which are based on the notion of “usual residence”⁵. The national definitions take into account each person’s citizenship. Thus, an emigrant is a citizen of Moldova who leaves the country to reside permanently or temporarily in another country, while an immigrant is a foreign citizen (or a person without citizenship) who has obtained the right to reside permanently or temporarily in Moldova.⁶ The use of these definitions make little sense, as a foreign citizen who has been included in the Moldovan population as an “immigrant” cannot be excluded from the population since he or she is not a Moldovan citizen.

⁵ According to European recommendations, a person is considered to have a usual residence in a specific geographic area if she/he lived in that usual residence for at least 12 months prior to the reference moment. European Union definitions: Regulation (EC) No 862/2007 of the European Parliament and of the Council of 11 July 2007 on Community statistics on migration and international protection and repealing Council Regulation (EEC) No 311/76 on the compilation of statistics on foreign workers <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32007R0862&from=RO>

⁶ <http://statbank.statistica.md/pxweb/Database/EN/02%20POP/POP01/Population.pdf>

The official emigration statistics are based exclusively on the information collected from special deregistration forms. This type of emigration is known as “permanent” or “documented” emigration, and is based on the assumption that the individual has “deregistered” from his/her place of permanent (formal) residence (Vremiș et al., 2012). Meanwhile, Moldovan citizens who live abroad but maintain a permanent residence in the country are considered temporary emigrants even if they have not been back for more than a year. This is called “temporary” or “working” emigration. These citizens are included in the Moldovan population, but their deaths are not reflected in the official vital statistics if they die abroad. Since the early 1990s, the NBS has combined data on “documented” emigrants with vital statistics records to produce annual population estimates (Poalelungi, 2012). Because such large numbers of Moldovan citizens have emigrated, this practice has resulted in an overestimation of the size of the Moldovan population, and, consequently, in a significant underestimation of mortality.

3.5. Population censuses and official population estimates

The 1970, 1979, and 1989 censuses differentiate between *de jure* and *de facto* residents of Moldova. The 1959 census refers to the *de facto* population only. For the 2004 census the NBS published official estimates of the *de jure* population only, although the official number of residents who were living abroad temporarily was published with a breakdown by sex, age, and duration of absence.

During the Soviet era, the difference between the *de jure* and the *de facto* population numbers at the time of each census was not large, because international migration flows in and out of Moldova were small. But since independence, the gap between these two numbers has widened considerably. At the time of the 2004 census, the number of Moldovans who had been away for at least one year reached 130,306, or 3.9% of the total *de jure* population.

For the 2014 census only preliminary results for the total population are available. They refer to the *de jure* population, and thus include Moldovan citizens who were absent at the time of the census (about 11% of the total population). The 2014 census data are also considered to be incomplete, as the Moldovan NBS has acknowledged that around 3% of the country’s housing units were not covered. The preliminary data are expected to be completed using administrative sources (National Bureau of Statistics of Moldova, 2014).

No annual population estimates prior to 1980 have been published or are otherwise available in Moldovan archives. For the years 1980 to 1988, the annual population estimates published by the NBS were produced by the Central Statistical Office of the USSR based on the results of the 1979 and 1989 censuses. The annual population estimates for the Soviet period refer to the *de jure* population.

Since Moldova became independent, the NBS has produced annual population estimates by sex, age, and region for the *de jure* population, which includes long-term emigrants (Moldovan citizens living abroad). These estimates have been used as the denominators for all of the official demographic indicators. Meanwhile, both the death and the birth records refer to the *de facto* population (i.e., to events that occurred within the country). This practice results in a systematic downward bias for all of the demographic indicators.

Demographic rates are further underestimated because the NBS did not replace post-1989 census annual population estimates with the new inter-censal estimates after the results of the 2004 census became available. Furthermore, the NBS continues to publish annual population estimates without taking into account the results of the 2004 census. On January 1, 2015, the NBS estimated on the basis of the 1989 census that the *de jure* population of Moldova was 3.550 million. This figure is much higher than the population estimates based on the 2004 census (3.383 million).

At the same time, the preliminary results of the 2014 census for Moldova seem to be consistent with the results of the 2004 census. Disregarding the 2004 census resulted in a huge discrepancy between the results of the 2014 census and the post-censal annual population estimates (640,000 people, or 18% of the total population). A re-estimation of the annual population counts on the basis of the 2004 census would reduce this gap considerably (Figure 2).

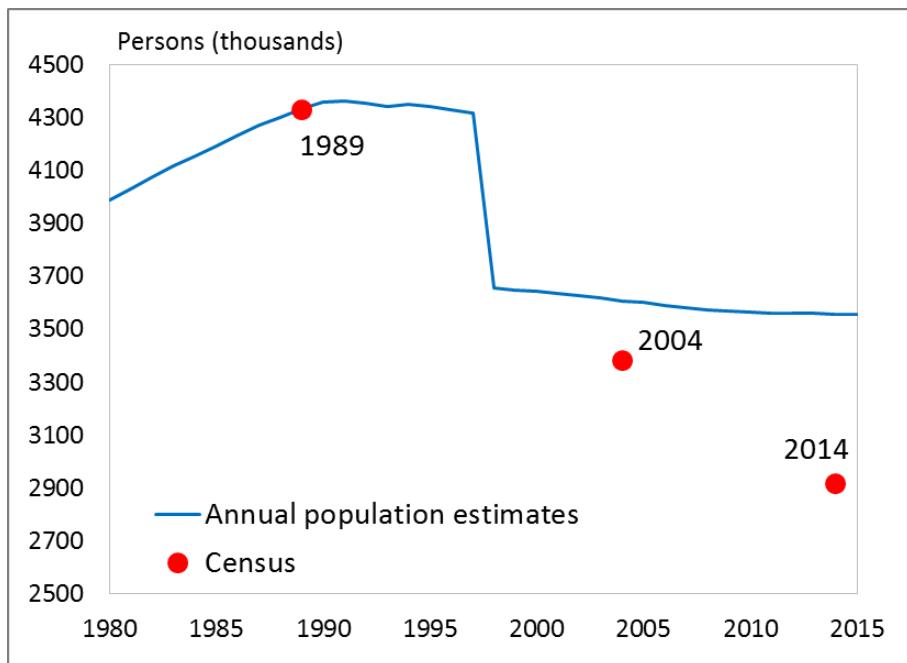


Figure 2. The official annual *de jure* population for 1980–2015 (as of January 1) and the *de jure* population according to the 2004 census and the preliminary results of the 2014 census; Moldova, both sexes

Source: National Bureau of Statistics of Moldova, www.statistica.md

Note: Neither the official annual population estimates (since 1998) nor the 2004 or 2014 population censuses cover the Transnistria region.

The current situation is likely attributable to the NBS's concerns about the completeness of the 2004 census. However, the population numbers in the census are 6% lower than the annual population estimates for the same year⁷. Furthermore, the deficit is mostly concentrated among people of young working ages (ages 20-39); i.e., among the age groups with the most intensive migration outflows. In the other age groups, the numbers are extremely close (Figure 3). These observations strongly suggest that the discrepancy can be attributed to the inappropriate definition of “international migrant.” We can assume that after the final results of the 2014 census are published, the age profile of the population deficit will cover not only people of young working ages, but also those adult citizens who were not present in the country at the time of the 2004 census. Further analyses will be conducted when the final results of the 2014 census become available.

⁷ A six percent difference between the annual population counts and the census estimates was, for example, registered in Bulgaria in 1992 and in Romania in 2011.

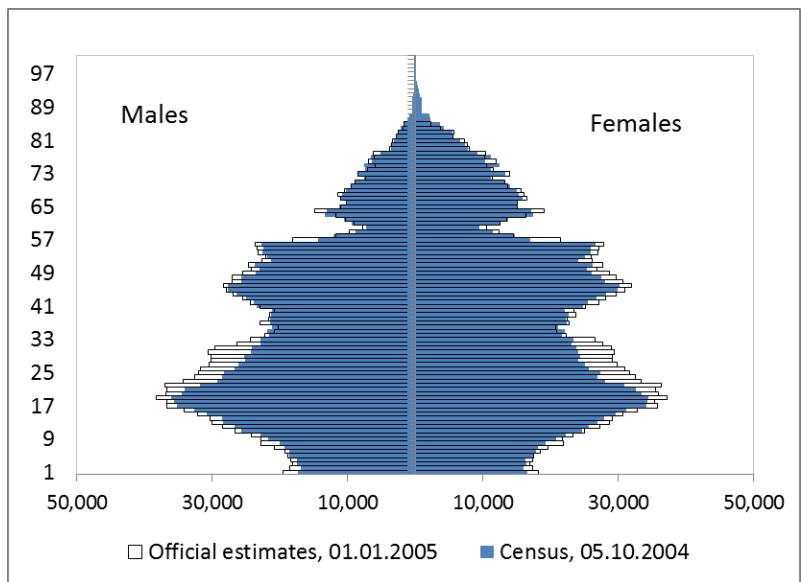


Figure 3. Age pyramid of the *de jure* population of Moldova; 2004 census versus 2005 official population estimates

Source: National Bureau of Statistics of Moldova, www.statistica.md

Although the NBS did not take the results of the 2004 census into account when computing its post-censal estimates, some adjustments to the age structure were carried out in 2007. This procedure resulted in significant discrepancies between these estimates and the population estimates from the previous year for some ages (Figure 4).



Figure 4. Official annual population estimates by single year of age in 2006 and 2007, Moldova

Source: NBS of the Republic of Moldova, www.statistica.md
Note: the last age group is 80-84

4. Data quality issues

4.1. Infant mortality

Like in the other former Soviet republics, the system of registration of infant mortality in Moldova has long had serious problems. These problems can be broadly divided into two major types: the first and most important type of problem (in terms of its impact on the level of infant mortality) is the under-registration of infant deaths up to the mid-1970s, while the second type of problem is how a live birth is defined.

At the beginning of the 1970s, an unexpected increase in infant mortality occurred in all of the Soviet republics. Of all of the European countries of the former USSR, the increase in Moldova was by far the largest: the infant mortality rate in the MSSR rose 50% from one year to the next (from 24.5 per 1,000 in 1972 to 36.8 in 1973). Penina, Meslé, and Vallin (2010) have attributed this increase to improved registration of infant deaths, especially in rural areas. More moderate increases in the number of infant deaths were reported for subsequent years (up to 1977). These increases very likely reflected not just improvements in infant death registration practices, but also a real deterioration of the health status of the population, especially in rural areas. However, since there are no obvious ways to disentangle the impact of artificial growth due to improved registration from real health deterioration, a minimal adjustment option was chosen. The correction dealt solely with the sudden improvement observed in 1973, while ignoring the more moderate death count increase in subsequent years. Following these assumptions, the infant mortality rate should be 27% higher in 1945, 34% higher in 1955, 47% in higher 1965, and 50% higher in 1972 (Penina, Meslé and Vallin, 2010).

Figure 5 shows the observed and the corrected infant mortality rates in Moldova from the late 1950s. We used corrected estimates of births and infant deaths to produce mortality series specific to Moldova.

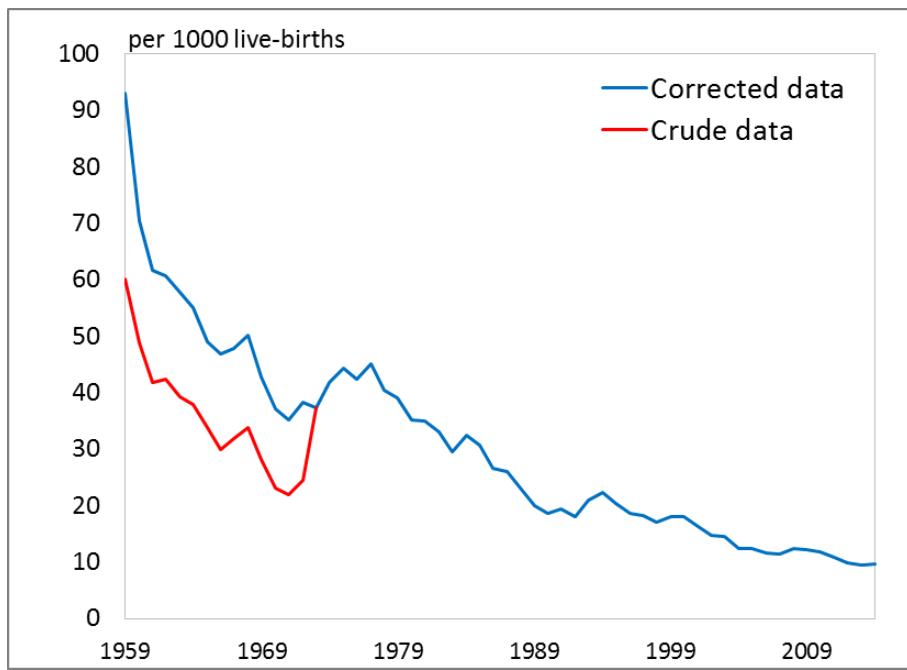


Figure 5. Infant mortality rate in Moldova before and after correction prior to 1973, both sexes, Moldova, 1959–2014

Source: Penina, Meslé, Vallin (2010), updated

The other problem is how a live birth was defined in Moldova, as the definition used did not conform to the standard definition recommended by the World Health Organization (WHO). During the Soviet era, a birth was considered live and was registered as such only if the following conditions were met: the period of gestation was 28 weeks or longer, the birth weight was 1,000 grams or higher, the body length was 35 centimeters or longer, and the newborn did not die within the first seven days of life. Research has shown that the use of such a restrictive set of criteria could cause an underestimation of neonatal mortality of up to 50%, and an underestimation of infant mortality of up to 25% (Anderson and Silver, 1986; Blum and Monnier, 1989; Andreev, 1995; Velkoff and Miller, 1995).

In 1995, the Ministry of Health and NBS issued a decree titled, “On Shifting to WHO Standards for Live Births and Still Births” (Ministry of Health of Moldova, 1995). Under this definition, any infant with a birth weight of at least 500 grams who breathed or showed any other sign of life was to be counted as a live birth. However, until 2008 this definition was used only by health facilities for their own statistics, and not by the vital registration offices, which continued to use the Soviet-era definition.

In 2008, a new definition of a live birth that was closer to the WHO definition was introduced in Moldova. According to this definition, infants who were born after 22

weeks of gestation or who weighed at least 500 grams should be registered as live births. The transition to the new definition resulted in a 20% increase in the early neonatal mortality rate. Given what we know about the experiences of the Baltic countries, where the transition from the Soviet-era definition to the WHO definition resulted in a 50% increase in early neonatal mortality in the early 1990s (Estonian Medical Statistics Bureau, Latvian Medical Statistics Bureau, Lithuanian Statistics Bureau, 1993 as cited in (Meslé et al., 1996), we can assume that a fraction of the early neonatal deaths in Moldova might still be under-registered.

4.2. Age heaping

The distribution of the population by age in the censuses conducted during the Soviet era was significantly affected by age heaping. This problem was most serious in the 1959 census, especially among females. In subsequent censuses, age heaping gradually became less common (Figure 6), and had almost disappeared in the 2004 census (Figure 3).

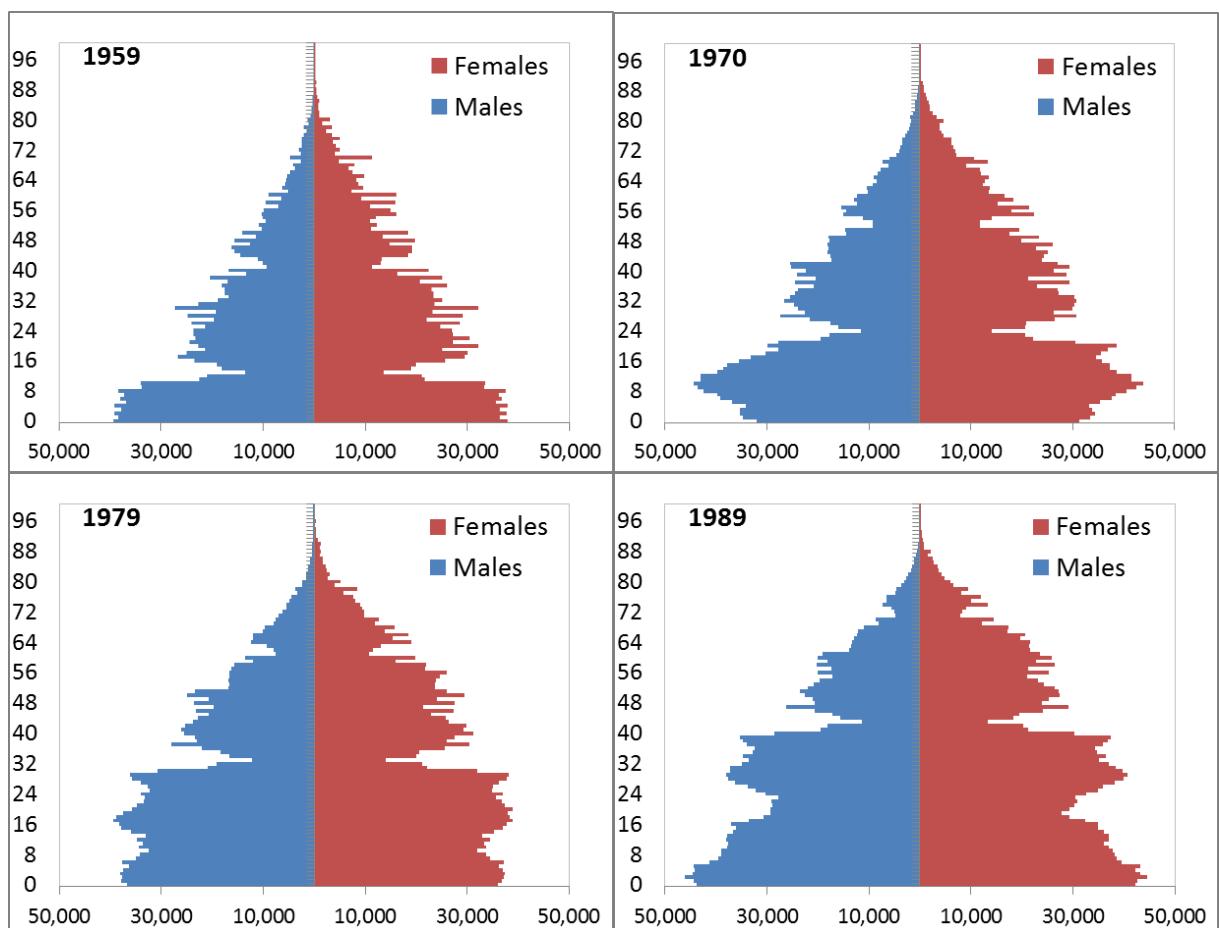


Figure 6. Population pyramid of Moldova; censuses of 1959, 1970, 1979, and 1989

Source: National Bureau of Statistics of Moldova, www.statistica.md

As is the case for the other former Soviet republics included in the HMD (Russia, Ukraine, the Baltic states, and Belarus), age heaping is also a problem for the distribution of deaths by age prior to 1970, especially at older ages. Figure 7 shows for males the ratio of the number of deaths at older ages ending in zero (60, 70, 80, and 90) to the adjacent age groups. The pattern for females is very similar (not presented here).

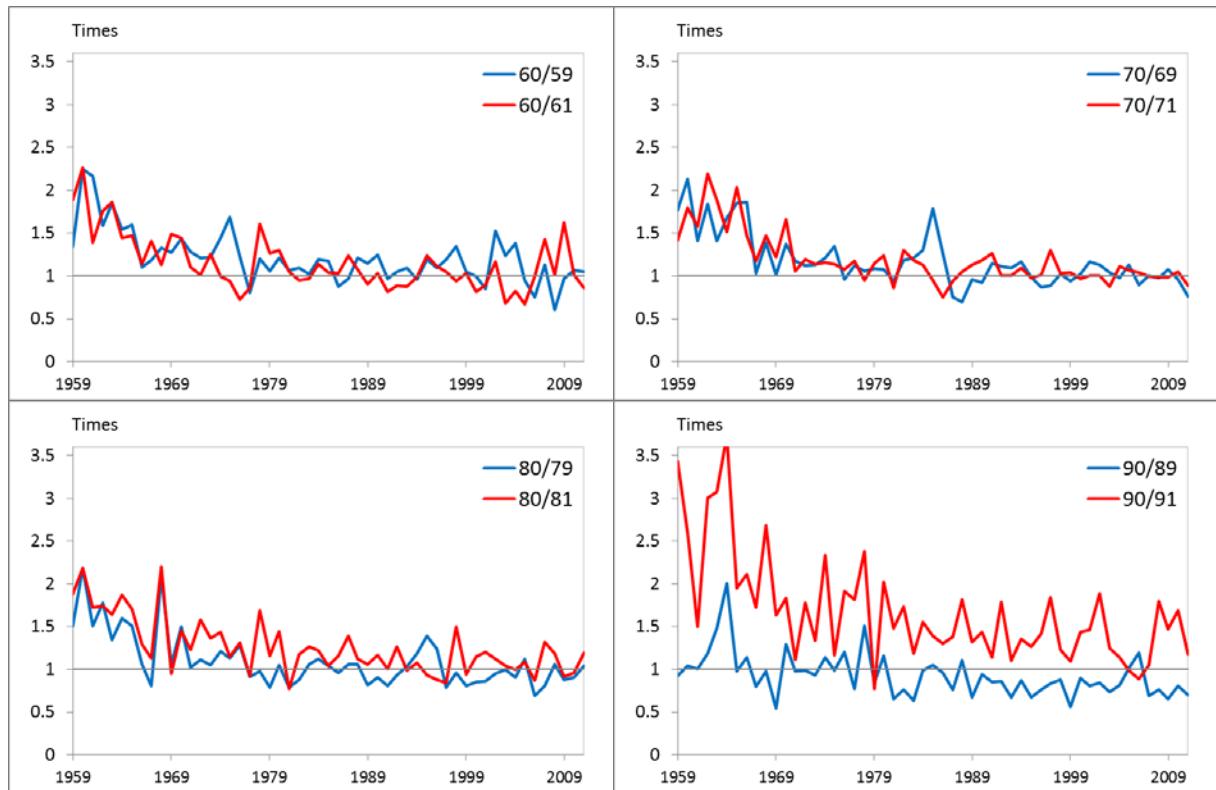


Figure 7. Ratios of the number of deaths at selected ages (60, 70, 80, and 90) to adjacent ages, Moldova, males

4.3. Old ages

The misreporting of age at ages 80 and above is a well-known issue in the European countries of the former USSR, including Russia and Ukraine (see the HMD Background and Documentation files for the corresponding countries). It is very likely that in Moldova the official population counts at older ages are similarly overestimated, and that the official deaths rates are therefore underestimated. This does not, however, affect the alternative population estimates, which are produced using the extinct cohort method (see the HMD Methods Protocol). This method depends entirely on the death statistics, and does not take into account potentially erroneous population estimates at advanced ages. Therefore, it is not the misreporting of age in the population but problems related

to the registration of the age at death (age heaping in death) that are responsible for the suspiciously low mortality rates at ages 80 and above in Moldova. Figure 8 shows the implausibly high life expectancy values at age 80 prior to 1970 in Moldova (compared to those of Sweden), with a decline over time reflecting an improvement in the age classification of the population at older ages.

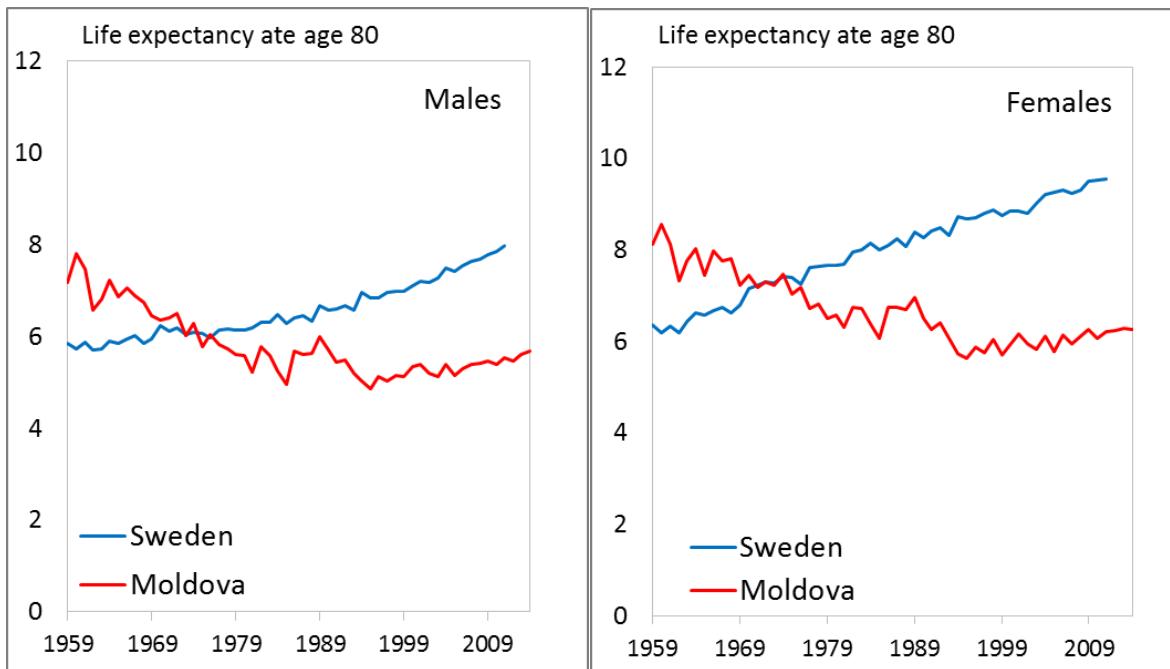


Figure 8. Life expectancy at age 80 in Moldova and Sweden, from 1959

4.4.Under-registration of out-migration

Large migration flows in the 1990s affected population estimates, and remained a problem in the 2000s. Reliable estimates of migration have been available only since 2009. Thus, as was mentioned above, standard HMD inter-censal methods (Wilmoth et al., 2007) were implemented to estimate the population counts for the years after 1989. According to these estimates, the total cumulated net migration count is 494,000 for the period from 1989 to 2004 (without taking into account the loss of Transnistria), or 11% of the total 1989 population; and is 357,000 for the period from 2004 to 2012, or 11% of the total 2004 population. Our estimates do not take into account year-to-year fluctuations in migration. These results indicate that migration is indeed concentrated in the working-age population, but also that assuming a uniform distribution of migration within each birth cohort does not significantly bias the mortality estimates.

5. Adjusting official data and producing mortality series using the HMD methodology

5.1. Input data

The census data, the annual population estimates, and the death and birth counts were taken from official statistics. Most of the official publications and the unpublished material were collected from the NBS archives and the National Archive of the Republic of Moldova. For the period since 2001, the data were provided in electronic format by the NBS. Data about state border crossings were provided by SE CSIR “*Registrul*”. Annual estimates of infant death and birth counts by sex for the period from 1945 to 1972 were received from Penina, Meslé, and Vallin (2010).

Table 1 describes the different population groups covered by the statistics used to produce the adjusted mortality series.

Table 1. Groups of population with corresponding dates

Dates	Population coverage
1959–1997	Population estimates cover the entire territory of Moldova
1998–2014	Population estimates cover the territory of Moldova without the Transnistria region
2004	Permanent residents who had been living abroad for at least one year at the time of the census
2009–2015	Moldovan citizens who had been living abroad for at least one year, but who are still registered in the country. These statistics only include emigrants who crossed the border after January 1, 2005.

The population estimates were corrected in the adjusted series using data on migrants who crossed state borders. The number of border crossing migrants included in the statistics represents the number of Moldovan citizens who left the country in 2005 or thereafter, and had been living abroad for at least one year at a given point in time during the observation period. These data are available as of January 1 by sex, five-year age group, and duration of absence from the country for all years from 2009 onward.

From 1997 onward, the vital statistics (birth and death counts) published by the NBS do not include the events that occurred in the Transnistria region. Similarly, from 1998

onward the population estimates published by the NBS do not include the residents of the Transnistria region. Thus, following the HMD methods protocol, the territorial adjustment factors for 1997 had to be computed using the demographic statistics available for the Transnistria region for that year⁸.

5.2. Adjusting population counts using alternative migration statistics

The NBS disseminates migration statistics provided by the SPR and the Bureau of Migration and Asylum, which is subordinate to the Ministry of Internal Affairs. As we have already mentioned, these official migration statistics are not reliable because they are based on non-standard definitions of international migration. However, appropriate adjustments of Moldovan population counts can be carried out using reliable international migration statistics. The Moldovan Integrated Automated System on "Migration and Asylum" (SIIAMA) combines several administrative databases or information systems managed by different institutions.⁹ Within this system, the Border Guard Service has been providing valuable information on state border crossing (entry into and exit from Moldova). The entry or the exit of an individual is recorded together with his/her passport identification number. The Border Guard database is also a system component of the State Register of Population. At the moment, it is the only national source of administrative information providing an estimate of the number of Moldovan emigrants that follows the international definition. For political reasons, the Moldovan authorities are unable to control the state border between Transnistria and Ukraine. This is a major source of underestimation of border crossing migration, and it is also a potential source of double counts of entries and exits (Poulain et al., 2011).

The border crossing data provide us with information about the Moldovan citizens (holders of Moldovan passports) who left the country on January 1, 2005, and who at a given point in time are not in the country. This type of data refers to a stock of emigrants at a point in time, while the difference between two points in time represents an estimate of the flow of emigrants during that period. The data are available for each day from January 1, 2009 onward by sex, age (five-year age groups), and duration of

⁸ See Appendix D of the HMD Methods Protocol (<http://www.mortality.org/Public/Docs/MethodsProtocol.pdf>) for information on territorial adjustments. Also note that the $R_{B(t)}$ factor was computed for both sexes combined as birth counts by sex were not available for Transnistria in 1997.

⁹ The Integrated Automated Information System on "Migration and Asylum" (SIIAMA) is operated by the Bureau of Migration and Asylum.

absence (less than three months, 3-12 months, 1-2 years, 2-3 years, and three years or more)¹⁰.

The completeness of border crossing data until the last year (2014) can be estimated by a comparison with the official immigration statistics from the recipient countries. Italy and Russia are the two most popular destination countries for Moldovan citizens (Vremiș et al., 2012). Figure 9 shows net migration calculated for Moldova from three different sources: official national statistics, official data on immigrants from Moldova provided by the statistical offices of Russia and Italy, and administrative state border crossing data. The net migration numbers used by the NBS to calculate the annual population counts for 2004-2014 were very small, and were even positive in 2010-2012¹¹. For example, for 2009 the official net number of migrants was only 2,000, whereas the official statistical migration data from Russia and Italy showed that the net number of migrants in that year was 33,000; thus, the difference between these figures is 31,000. The migration statistics from these two recipient countries are generally comparable with the state border crossing migration data for 2009-2013. In April 2014, the EU lifted the visa requirements for Moldovan citizens (up to three months)¹². Surprisingly, the introduction of the visa-free regime led to positive growth in net migration (+87,000 migrants) in 2014.

¹⁰ The State Population Register provides access to the border crossing migration data by means of "Access-Web." The statistical form on Moldovan emigrants by sex, age, and duration of absence is titled F3.2.

¹¹ The official net migration for 2004-2014 was calculated based on the annual official population counts and vital statistics (births and deaths). These data can differ from net migration estimates calculated as the difference between the official numbers of immigrants and emigrants.

¹² <http://www.osw.waw.pl/en/publikacje/analyses/2015-05-06/moldova-a-year-after-introduction-visa-free-regime>

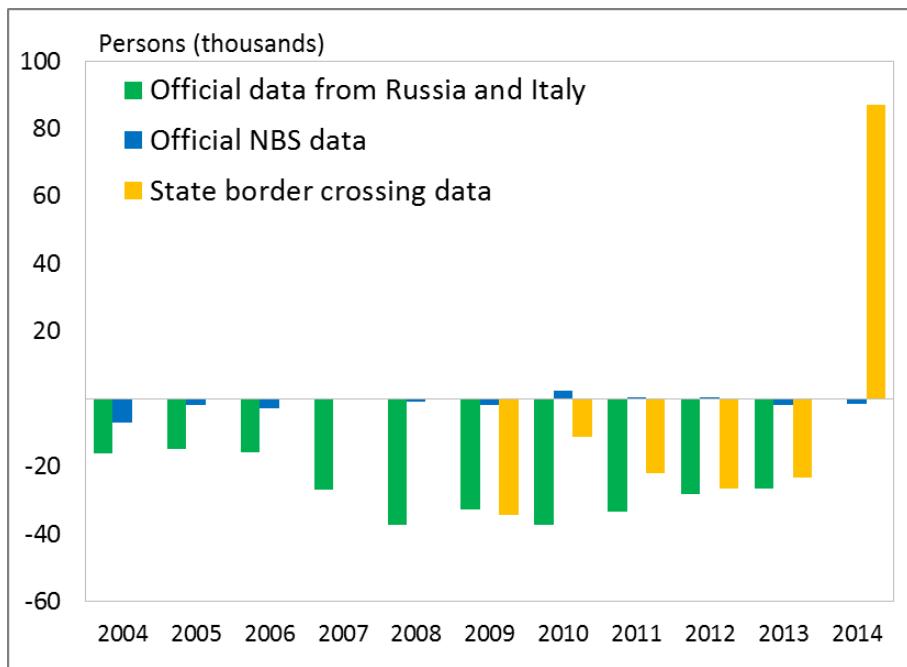


Figure 9. Net migration in Moldova: official National Bureau of Statistics data (2004-2014), state border crossing data (2009-2014), and data on Moldovan migrants registered in Italy and Russia (2004–2013), both sexes

Source: Calculated based on data from the NBS of the Republic of Moldova, Eurostat (for Italy), the Federal State Statistics Service of the Russian Federation, and the Centre for State Information Resources "Registru" (via Access-Web)

Figure 10 provides a more detailed picture of the migration flows by duration of absence from the country (1-3 months, 3-12 months, 1-2 years, 2-3 years, three or more years, and one or more years). We can see that a significant number of Moldovan citizens who had been living abroad for a long period (more than three years) had decided to return home by 2014. On the other hand, the numbers of emigrants who had been living abroad for shorter periods of time (1-2 or 2-3 years) was growing in 2014. However, this increase could not compensate for the decline in the number of long-term emigrants in 2014. The monthly trends in the number of short-term emigrants (less than three months and 3-12 months), which tend to be marked by seasonal fluctuations, did not change significantly following the removal of the visa requirements.

While the precise reason why there was a sudden decline in the number of long-term Moldovan emigrants in 2014 remains unclear, we can offer some speculation. As far as we know, there were no changes in registration practices beyond the introduction of the visa-free regime in April 2014. It is plausible that the effects of the economic crisis on European Union countries led some Moldovan emigrants to return home. Moreover, the decline in the numbers of long-term emigrants started at the beginning of 2014 (before

the introduction of the visa-free regime), and was more or less regular until October 2014, when the numbers began to stagnate. At this point in time, we cannot estimate for the year 2014 the migration flows of Moldovan citizens to European countries based on the migration statistics of the recipient countries (other than for Italy, the main European destination country for Moldovans; we lack information for the other leading destination countries, including for Greece, Portugal, and Spain). Finally, the introduction of the visa-free regime might have encouraged long-term emigrants (and especially those who had been living abroad illegally) to return to Moldova to obtain a biometric passport, which is needed for visa-free state border crossing. Regardless of the reason why, we can conclude that the lifting of the visa requirements for Moldovans in April 2014 did not result in a huge wave of Moldovan citizens emigrating to EU countries. On the contrary, a surprisingly large number long-term emigrants returned to Moldova, likely partly in response to the economic crisis in the EU. The official population statistics certainly do not reflect all of these important fluctuations in the number of migrants, and continue to operate with unreliable data.

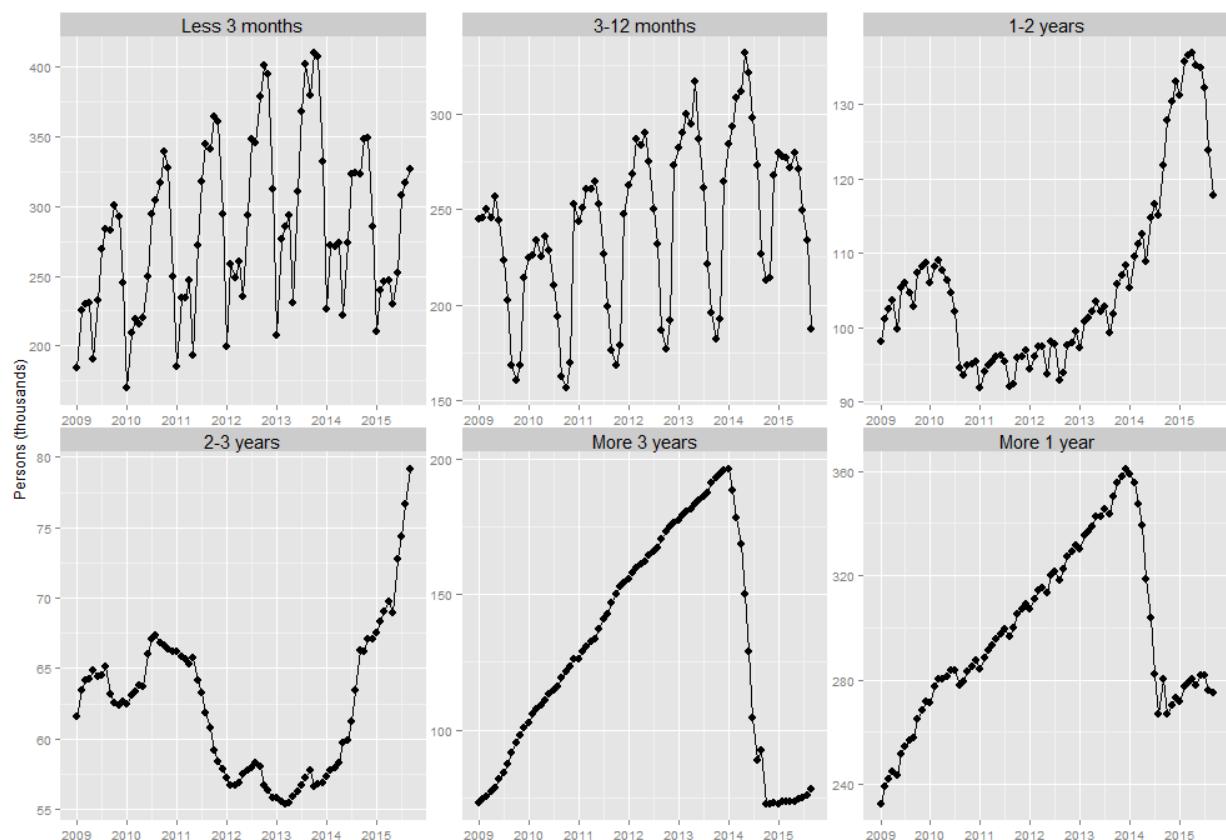


Figure 10. Monthly trends in the stock of Moldovan citizens abroad by duration of absence, from January 1, 2009 to October 1, 2015, both sexes

Source: Centre for State Information Resources "Registru" (data retrieved via Access-Web)

5.3. Adjusted inter-censal population estimates

As we have already shown (see sub-section 3.4), the official population estimates are not reliable, and therefore cannot be used in estimating demographic indicators.

The inter-censal annual population estimates for the 1970s were calculated using the standard HMD methodology (Wilmoth et al., 2007). The official population estimates are used for the years 1980-1988. An adaptation of the HMD inter-censal and post-censal methods were implemented to estimate the annual population counts for the years 2004-2015.

As we mentioned above, the official population estimates published by the NBS for the years after 1989 are problematic, mainly because they do not sufficiently take into account the large out-migration of this period. Thus, instead of using the official population numbers, we reconstructed our population estimates using standard HMD methods (Wilmoth et al., 2007).

First, data from the 2004 census were corrected to exclude Moldovans who had been out of the country for more than 12 months. Next, inter-censal population estimates were computed for the period 1989-2004. Then, population estimates for the year 2009 corrected for out-migration were used as the most recent reference in computing another series of inter-censal estimates for the period 2005-2008 that accounted for the actual net migration rate for these years. The same method was used to compute post-censal population estimates for the years 2010-2014.

Figure 11 shows the results of these calculations, comparing alternative population estimates with official annual population data for the period 1980-2014. The difference between the two series ranges from 1% at the beginning of the 1990s to more than 18% at the end of the period. The preliminary results of the 2014 census almost coincide with the alternative data for the same year.

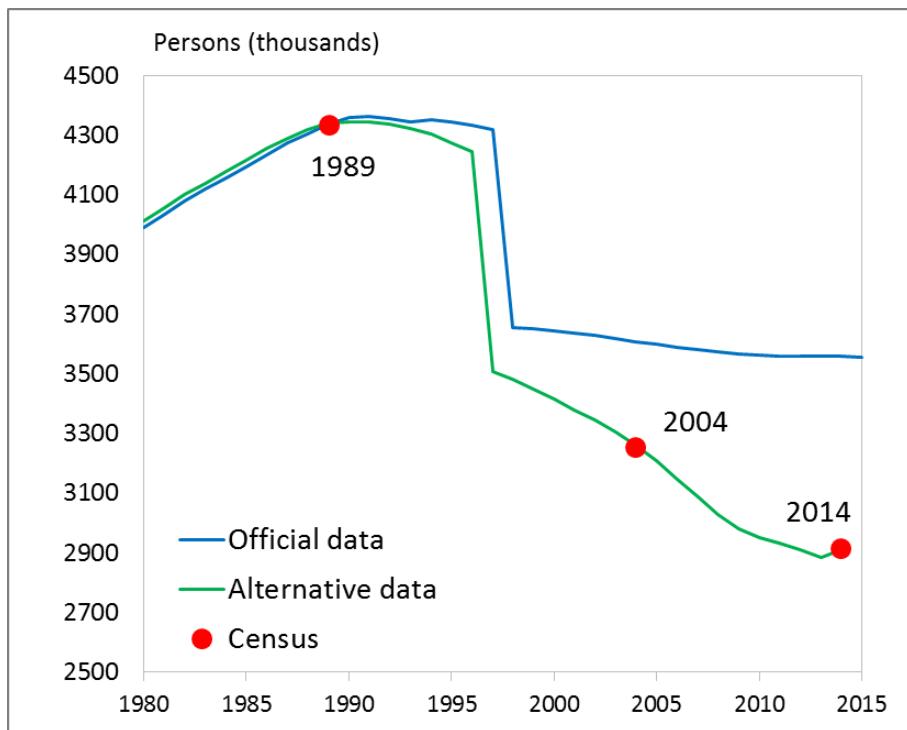


Figure 11. Population estimates for Moldova: official *de jure* (1980-2015) and alternative *de facto* (1980-2014), all ages, both sexes

Note: Since 1998 the official population counts do not include the Transnistria region. The 2004 census population estimates refer to the *de facto* population. The population estimates for the 2014 census are preliminary.

Figure 12 presents net migration counts according to official statistics and implied from adjusted series by sex since the 1980s. In 2010-2011 net migration was close to zero, and was even positive for males. In 2006 net migration was positive for males but strongly negative for females as a direct result of incorrect adjustments by the NBS to the population age structure in 2007 (see Figure 4).

According to the alternative population estimates, net migration was equally redistributed over the inter-censal years 1989-2004, as well as between 2004 and 2009. From 2009 onward, the annual net migration was estimated from border crossing migration statistics. According to the alternative estimates, about 490,000 people left the country between the 1989 census and the 2004 census, and 322,000 people left between the last two censuses, which were conducted in 2004 and 2014. Thus, independent Moldova lost close to 800,000 people to migration, or more than 20% of the total population, as counted by the 1989 census (excluding the Transnistria region, which had a population of about 700,000 in 1989). The official net migration numbers are far more modest: 206,000 and 17,000 for the two corresponding inter-censal periods. At the same time, the official statistics do not reflect an important positive jump

in net migration in 2014, which was probably caused by the economic crisis in the EU countries, and which coincided with visa liberalization for Moldovan citizens. The drop observed in 1997 in the official data and in 1996 in the alternative data is an artifact resulting from the change in territorial boundaries for statistical purposes.

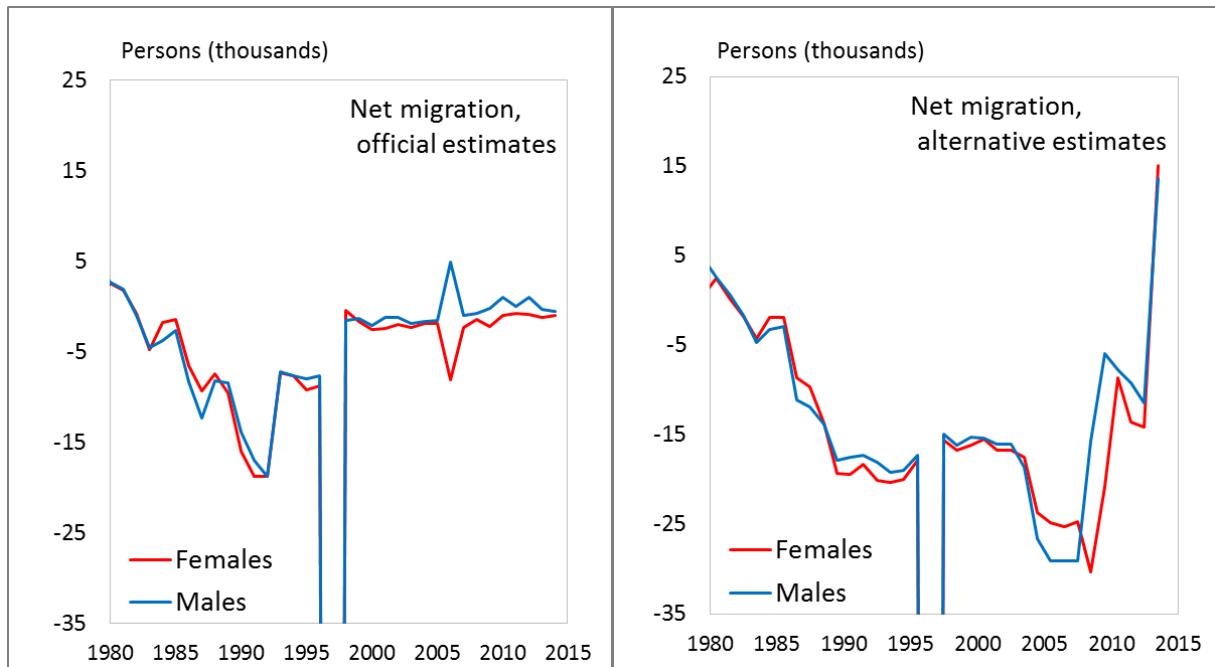


Figure 12. Net migration in Moldova: based on official population statistics (1980-2014) and alternative estimates (1980-2013), by sex

Note: The population counts do not cover the Transnistria region from 1998 onward for the official estimates and from 1997 onward for the alternative estimates.

The new population estimates lower life expectancy at birth to a significant and increasing extent. For example, the differences are 0.99 years for males and 0.68 years for females in 2005; and 2.58 years for males and 1.65 years for females in 2014 (Figure 13).

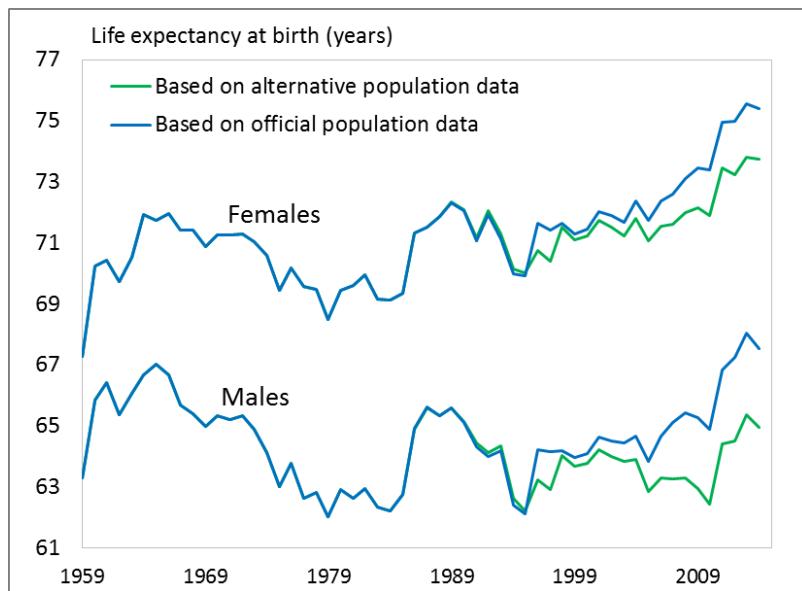


Figure 13. Life expectancy at birth in Moldova calculated on the basis of official and alternative population estimates, 1980-2014

Alternative estimates of male life expectancy at birth in Moldova based on adjusted population counts for the period since independence are much closer to the male life expectancy levels of the other former republics of the USSR in the HMD (especially of Ukraine and Belarus) than they are when computed from official population estimates (Figure 14). For females in Moldova, life expectancy at birth deteriorated especially rapidly in the 1970s, and remains much lower than it is in similar countries until today.

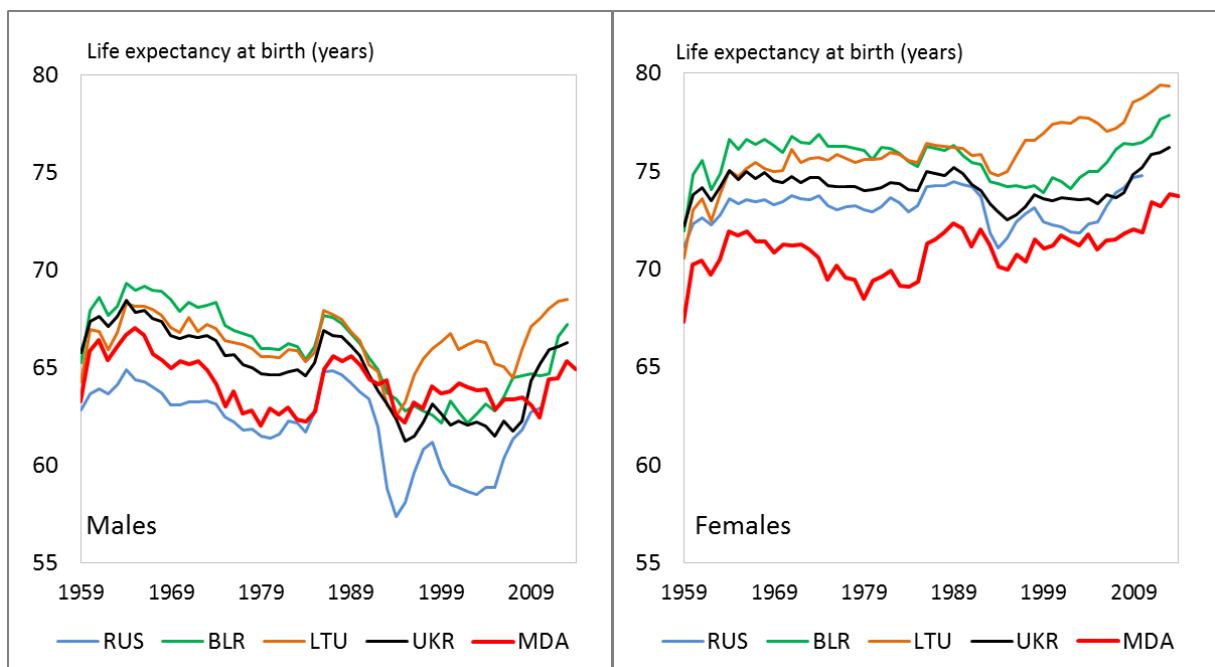


Figure 14. Life expectancy at birth in Moldova in comparison to Russia, Ukraine, Belarus, and Lithuania since 1959

6. Conclusion

Our motivation for conducting the analysis reported here was a desire to include Moldova in the HMD. Although we obtained results of reasonable quality (as suggested by the HMD data quality diagnostics tools), we concluded that Moldova should not be included in the database. The reason for this decision was that serious adjustments to the official data were used to produce the mortality series for Moldova. One of the main principles of the HMD is that such adjustments should be avoided, and that official data should be used; although there are some exceptions. Unfortunately, the extent of the adjustments needed was too great to meet the strict HMD requirements.

In the case of Moldova, using the official population estimates results in a considerable underestimation of mortality because of the discrepancies in the coverage of population estimates and vital events. The huge wave of out-migration complicates the problem. The population register in Moldova includes large numbers of people who actually left the country many years ago. It has been estimated that more than 18 percent of the official total population of the country in 2014 are actually emigrants who no longer live in Moldova. Unfortunately, the vital events affecting this part of population cannot be registered. This has two consequences: first, over the short term mortality and fertility are underestimated; and, second, over the long term the country develops an “immortal” sub-population, as the deaths that occur outside the country will never be included in the statistics, and the people who die will be not excluded from the population register.

Nevertheless, we demonstrated that the current statistical system has all of the necessary tools as well as the necessary data to make correct estimates of both the population size and the mortality rates. Because there is no way to get information about all of the deaths and births that occurred abroad, the statistical office of Moldova has to use the concept of present population for all of its calculations. The border crossing data provide us with a unique opportunity to make high-quality estimates of migration flows. We also demonstrated that the correction of population estimates is essential. Life expectancy based on adjusted population data is more than two (for both sexes) years lower than the published official estimates (please refer to the statistical annex of this report). However, our adjusted population estimates have certain limitations. The border crossing data do not include the people who are living or entering Moldova via the Transnistria region, and Moldovan citizens can have double

citizenship. But the “mirror” statistics on immigrants from Moldova in the recipient countries show the reliability of this type of data.

The Moldovan National Bureau of Statistics have stated that they will continue to compute the annual population estimates as before until the publication of the final results of the 2014 population census¹³, which may take a few years. This means that all of the official population statistics for Moldova will continue to be unreliable for at least the next few years.

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¹³ <http://www.statistica.md/newsview.php?l=ro&idc=168&id=4678> (in the state language of Moldova)

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ANNEX

Mortality series for Moldova, 1970–2014

This annex is supplementary material to the present working paper. It contains a concise description of mortality series produced for Moldova using HMD methodology, as well as the links to the individual data files. All of the data files appear in the standard output format of the HMD. For details, please refer to *explanatory notes* available at the HMD website (<http://www.mortality.org/Public/ExplanatoryNotes.php>). For the convenience of the users we provide the output in the .csv format (the fields are separated by commas).

ANNEX I. Life expectancy at birth

Life expectancy at birth (period) by sex, 1970–2014: [*E0per.csv*](#)

ANNEX II. Period life tables

Complete period life tables (up to 110+) for the period 1970–2014.

Males: [*mltper_1x1.csv*](#)

Females: [*fltpo_1x1.csv*](#)

Both sexes combined: [*bltper_1x1.csv*](#)

ANNEX III. Population size on January 1

Population by single year of age (up to 110+) and sex (as on January 1), 1970–2015:
[*Population.csv*](#)

ALL DATA IN ONE FILE ([ANNEX.zip](#))