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Beyond the Kannisto-Thatcher Database on Old Age Mortality: An Assessment of Data Quality at Advanced Ages

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The old age population in developed countries has been increasing remarkably, yet internationally comparable high quality data on oldest-old mortality remain relatively scarce. The Kannisto-Thatcher Old Age Mortality Database (KTD) is a unique source providing uniformly recalculated old-age mortality data for 35 countries. Our study addresses a number of data quality issues relevant to population and death statistics at the most advanced ages. Following previous studies by Väinö Kannisto, we apply the same set of measures. This allows us to identify dubious or irregular mortality patterns. Deviations such as this often suggest that the data quality has serious problems. We update previously published findings by extending the analyses made so far to thirty five countries and by adding data on longer historical periods. In addition, we propose a systematic classification of country- and period-specific data, thus simultaneously accounting for each indicator of data quality. We apply conventional procedures of hierarchical cluster analysis to distinguish four data quality clusters (best data quality, acceptable data quality, conditionally acceptable quality, and weak quality). We show that the reliability of old-age mortality estimates has been improving in time. However, the mortality indicators for the most advanced ages of a number of countries, such as Chile, Canada, and the USA should be treated with caution even for the most recent decade. Canada, Ireland, Finland, Lithuania, New Zealand (Non-Maori), Norway, Portugal, Spain, and the USA have particular problems in their historical data series. After having compared the KTD with official data, we conclude that the methods used for extinct and almost extinct generations produce more accurate population estimates than those published by national statistical offices. The most reliable official data come from the countries with fully functioning population registers.

Keywords: old age mortality, quality of statistics, population estimates

1. Introduction

The old age population in developed countries has increased very rapidly throughout the second half of the 20th century. Improvements in survival are pushing new limits: today more than half of all males and two thirds of all females born in Western countries may reach their 80th birthday. The proportion of centenarians increased about ten times over the last thirty years, and more and more people celebrate their 100th birthday (Robine & Vaupel, 2001). Despite these remarkable developments, internationally comparable high quality demographic data on old-age populations remain insufficient.

The most detailed and systematic assessment of international old-age mortality data was published by Väinö Kannisto (Kannisto, 1994; 1999). Introducing a set of data quality criteria, Kannisto (1994) divides thirty developed countries into four groups according to data quality: good, acceptable, conditionally acceptable, and weak quality data. Thatcher, Kannisto & Vaupel (1998) defined the good quality data as follows: no evidence of age heaping; no obvious age overstatement; plausible sex ratios; internal consistency in death rates, age pattern and sex ratio over time; comparability of country-specific data to international trends. In addition, the authors stress compulsory birth registration (at least with a history of more than 100 years) as an important factor in data reliability for highest ages.

Irregular old-age mortality patterns due to age reporting problems have been identified for the former USSR countries, the USA, Canada, Spain, Portugal, and some other countries (Anderson & Silver, 1997; Bourbeau & Lebel, 2000; Vaupel, Wang, Andreev & Yashin, 1997; Coale & Kisker, 1986; Elo & Preston, 1994; Preston, Elo & Stewart, 1999; Andreev & Wilmoth, 2004; Vaupel, Rau, Camarda & von Kistowski, 2006). Perhaps the most in-depth country-case studies were conducted in the USA, disclosing a complexity of problems that may influence old-age mortality statistics. Relying on individual-level data, Preston, Elo & Stewart (1999) have shown that age misreporting occurs in both directions – age overstatement and age understatement. The authors conclude that irrespective of the direction age misreporting takes, it leads to a substantial underestimation of mortality levels at ages over 80 (Preston, Elo & Stewart, 1999). To compensate for weak data quality, additional data sources such as Medicare Social Security Administration records have been widely applied to derive USA mortality estimates for oldest ages (Kestenbaum, 1992; Andreev & Wilmoth, 2004). A more favorable situation has been observed among countries with a long tradition of fully functioning population registries, such as Sweden, Denmark, and the Netherlands. But even here, age overstatement and age heaping in deaths and the population stopped only by the beginning of the 20th century (Skytthe & Jeune, 1995; Skytthe, Hauge & Jeune, 1999; Lundström, 1995; Jeune & Vaupel, 1999).

Studies on the validation of centenarian and super-centenarian (aged 110 and older) data require separate attention. Jeune & Vaupel (1999) suggest that the majority of countries have reported data on centenarians and super-centenarians that are questionable (particularly for cohorts born before reliable birth registrations began). The age validation of centenarians remains problematic for many countries since they do not have fully functioning population registers – so far, these are available only in a few countries. In other countries such as France and Italy, alternative data sources have been widely used (municipal election registers or birth registers) (Jeune & Vaupel, 1999). The most difficult situation is for countries with a relatively short history of official birth registration (for example, the USA and China). In these cases, Kannisto's (1994, 1999) criteria and other indirect indicators of the accuracy of age reporting have been used (Wang, Zeng, Jeune & Vaupel, 1999).

In our article, we study old-age mortality patterns in the thirty five countries that are currently included in the Kannisto-Thatcher Database[1]. Following previous studies by Kannisto, we apply a similar set of measures. This allows us to identify dubious or irregular mortality patterns, suggesting that there are potential problems of data quality. We update previously published findings by extending the analyses conducted so far to thirty five countries and by adding data for longer historical periods. Applying a cluster analysis, we propose a systematic classification of country- and period-specific data, thus simultaneously accounting for the whole set of data quality criteria. In addition, we examine the reliability of official population estimates by comparing the data series provided by statistical offices with those obtained from the Kannisto-Thatcher Database.

[1] Since 2002, the KTD methods for estimation of mortality at advanced ages over 80 have been applied for the recalculations of mortality surfaces for the Human Mortality Database (http://www.mortality.org).

2. Data and methods

Description of the database

The Kannisto-Thatcher Database on Old Age Mortality provides high quality data on death and population counts above age 80 for 35 countries. The available data are classified by sex, age, year of birth, and calendar year. The core set of data was collected, tested for quality, and converted into cohort mortality histories by Väinö Kannisto, former United Nations advisor on demographic and social statistics. Data on England and Wales with identical format were provided by A. Roger Thatcher, former Director of the Office of Population Censuses and Surveys and Registrar-General of England and Wales. With research funding from the U.S. National Institute on Aging and the Danish Research Council, the raw data were computerized at the Aging Research Unit of the Centre for Health and Social Policy at Odense University Medical School in 1993 under the supervision of James W. Vaupel. The Max Planck Institute for Demographic Research has been maintaining and updating the database since 1997 (http://www.demogr.mpg.de/databases/ktdb).

The main advantage of the KTD is that country-specific old-age mortality estimates were calculated by applying uniform methods. Consequently, artificial cross-country differences resulting from a variety of methods applied for the estimation of mortality surfaces have been avoided.

At least some of the potential old-age population data quality problems can be solved by using the method of extinct generations (Vincent, 1951). As the quality of population statistics has been continuously improving (in most cases), retrospective recalculations of population counts according to the most recent data allow us to adjust age-specific population counts for previous time periods. The recalculations are based on death counts only, but negligible international migration at these ages is not taken into account. This approach has been widely used to validate official population figures (Rosenwaike, 1979; Kannisto, 1988; Thatcher, 1992, 2001; Hill et al., 2000). Special adjustments to the method were introduced for "almost-extinct" cohorts (with a relatively small proportion of survivors), e.g., cohorts over age 90 or 95 (Thatcher, 1999).

The methodology applied to the Kannisto-Thatcher Database for the re-estimation of population counts above age 80 is a combination of methods built around Paul Vincent's basic method of the retrospective revision of population estimates, using data on deaths counts (extinct cohort method), with further modifications to it by Väinö Kannisto, Roger Thatcher, and John Wilmoth (Wilmoth et al., 2005). A brief summary of the KTD methodology is given in Appendix 1. A description of shapes of country-specific input data is given in Table 1.

Methods

We apply several indicators that identify irregular patterns in death and population counts above age 80. These indicators were successfully tested in prior studies on old-age data quality (Kannisto, 1994, 1999; Wang, Zeng, Jeune, & Vaupel 1999; Coale & Kisker, 1986).

We begin our analyses with describing *age overstatement* in death and population statistics among the KTD countries. The probability of age overstatement becomes more pronounced with increasing age. This leads to implausible age-specific distributions of deaths and population at old ages (Kannisto, 1999). Typically, such distortions are identified by comparing the observed age distributions to those obtained by using indirect methods, mathematical models or population register based estimates that are known as accurate (Kannisto, 1999; Perls et al., 1999; Coale & Kisker, 1986; Coale & Li, 1991; Kestenbaum, 1992; Preston, Elo, Stewart, 1999; Bennett & Garson, 1983). The validation studies reveal very significant distortions in centenarian statistics. For example, Perls et al. (1999) show that only 46 persons out of an initial list of 289 people qualify to be counted as centenarians in a local area of eight suburbs around Boston, USA.

Table 1. Review of KTD data for the 20th century

Country	Time series since*	Years with data on deaths ending with open age interval (90+-100+)	Shape of the elementary cell on the Lexis diagram**		Opened age interval in the population data of the last year
			Triangle	Rectangle	
Australia	1964	No	-	1964-…	Yes
Austria	1947	No	1947-…	-	Yes
Belgium	1944	1944-1973	1944-…	-	Yes
Canada	1921	1921-1949	1950-…	1921-1949	Yes
Chile	1977	No	1986-1996	1977-1985, 1997-…	Yes
Czech Republic	1945	1945-2000	1945-…	-	Yes
Denmark	1921	1921-1942	1921-…	-	No
England & Wales	1911	No	-	1911-…	Yes
Estonia	1959	1959-2000	1996-…	1959-1995	Yes[1]
Finland	1878	No	1917-….	1878-1916	No
France	1946	1998-2000	1946-…	-	Yes
Germany	1990	No	1990-…	-	Yes
Germany, East	1952	1952-1989	1952-…	-	Yes
Germany, West	1956	1956-1963	1956-…	-	Yes
Hungary	1950	1950-2000	1950-…	-	Yes
Iceland	1961	No	1961-1980	1981-2002	No
Ireland	1950	No	-	1950-…	Yes[1]
Italy	1955	No	1955-…	-	Yes
Japan	1950	No	1950-…	-	Yes
Latvia	1960	1960-2000	-	1960-…	Yes
Lithuania	1970	1970-2000	-	1970-…	Yes[1]
Luxemburg	1967	1967-1995	1996-…	1967-1995	Yes
Netherlands	1950	No	1950-86, 1990-99	1987-1989, 2000-…	Yes
New Zealand	1949	No	1979-…	1949-1979	Yes
New Zealand, NM	1917	No	1979-…	1917-1979	Yes
Norway	1846	No	1991-…	1846-1990[2]	No
Poland	1971	1971-2001	1971-…	-	Yes
Portugal	1940	No	1990-…	1940-1989	Yes[1]
Scotland	1950	1950-1962	1950-…	-	Yes
Slovakia	1953	1953-1995	1953-…	-	Yes
Slovenia	1983	1997-2001	1983-…	-	Yes
Spain	1908	1908-30, 1946-2002	1975-…	1908-1974	Yes
Sweden	1861	No	1895-…	1861-1894	No
Switzerland	1876	1876-1949	1950-…	1876-1949	Yes
USA	1959	No	1959-…	-	Yes

* Our analyses are restricted to data series since 1900 even if data for some countries are available for earlier periods. For some countries, the data series have been restricted to shorter periods, as shown in Table 1. Data quality indicators were calculated when the data are available at least for a five-year period out of a ten-year period. For example, the time series of the data quality indicators for Austria start from the 1951-1960 period, although the original data are available from 1947.

** "…" means "up to the most recent years".

[1] Official population estimates are available only up to the age group 85+.

[2] Between 1911and 1984, the death counts in the original statistics are given by sex and cohort (vertical trapezoids).

The first criterion of age overstatement examines whether the proportion of the population at the extreme old ages of the whole old age population is plausible. The proportion is calculated as the ratio of the total life table person-years lived at age 100 to the total life table person-years lived at age 80 (T100/T80). The final data quality index is obtained by dividing country and period-specific ratios (T100/T80) to the corresponding ratios for Sweden (the "golden standard"). Significantly higher scores (e.g., the ratios 1.5 or more times exceed those observed in Sweden) signal about potential age overstatement in the population data.

We are aware that in some cases higher ratios simply point to the fact that mortality above age 80 becomes lower than in Sweden (Cheung & Robine, 2007). This is applicable only to some successful countries (such as Japan and France) during the last two decades showing a greater progress in reducing mortality than in the reference country, Sweden. Therefore, we validate the T100/T80 criterion by performing an additional test for mortality crossovers. The mortality crossovers, occurring as the consequence of data inaccuracies at old age, refer to the cases when mortality rates at old ages are surprisingly low despite high mortality at young and adult ages (Coale & Kisker, 1986). Following Coale & Kisker (1986), we examine graphically the feasibility of relationships between survival probabilities between ages 10 and 55 and values of life expectancy at age 80. The calculations for this test have been based on the life table estimates from the Human Mortality Database (http://www.mortality.org, data retrieved on 14.02.2008). We consider that age overstatement is present only in the cases when: 1) the ratio T100/T80 is significantly (at least 1.5 times) higher than in Sweden; 2) the country shows implausibly high values of e(80) (e.g., close or even higher than in Sweden) despite high (if compared to the majority of other countries) mortality in adult ages.

The second criterion of age overstatement deals with deaths at the most advanced ages and refers to the ratio between deaths at ages 105+ to deaths at ages 100+ and the ratio between deaths at ages 110+ to deaths at ages 105+ (Kannisto, 1994, 1999). The ratios with considerably higher values than those for golden standard (Sweden) are considered as evidence of age overstatement.

Age heaping (digit preference) in death and population counts is assessed by applying Whipple's Index of age accuracy. Usually, the index is calculated as the ratio of the sum of population counts at ages ending with 5 and 0 to the total of sum population counts within a given age interval. Following Wang, Zeng, Jeune, & Vaupel (1999), we employ a modified version of this measure to the assessment of death data quality at oldest-old ages (Equation (1)). Again, we assume that significant deviations of this indicator from the "golden standard" (Sweden) suggest that there are possible age reporting problems.

$$WI = \frac{D_{95} + D_{100} + D_{105}}{\sum_{i=93}^{i=107} D_i} * 100 * 5, \qquad (1)$$

where D_i is number of deaths at age *i*.

We further investigate the quality of age reporting by applying several age heaping measures proposed by Kannisto (1994, 1999) and Vaupel, Wang, Andreev, & Yashin (1997). As the Kannisto-Thatcher Database does not include data below age 80, we employ the ratio between the probabilities of death at ages 80 and 81 as a criterion for age heaping at age 80. We assume that ratios considerably above the level of 1 suggest that there is a strong digit preference in reporting age at death.

Slightly more complex indicators are used for assessing the digit preference for age reporting (age heaping) for ages 90 and 100 (Kannisto, 1999):

$$AHI_i = \frac{D_i}{\exp\left(\frac{1}{5}\sum_{y=i-2}^{i+2}\ln(D_{и})\right)}, \quad (2)$$

where D_i is the number of deaths at age *i*.

In many cases, the literature has not clearly described precise criteria for distinguishing between “good” and “bad” data quality. Such criteria have been available for defining data quality groups according to age heaping and age-sex accuracy indicators. For the remaining criteria, we applied conventional procedures of cluster analysis. This procedure allows to avoid arbitrary definitions of quantitative borders between the data quality categories. Therefore, after dividing country-specific data series into 10-year periods, each country is assigned to one of the four data quality clusters[2] according to every data quality criterion described above. The first cluster refers to the best quality data and the fourth cluster describes the worst quality data. The maximum average values of indicator within the first three clusters across the whole period have been considered as limits B_i defining the groups of data quality:

$$B_i = \max_{1900 \le y \le 2000}\left(\frac{1}{N_i^y}\sum_{j=1}^{N_i^y} v_j\right), \quad i = 1,2,3 \quad (3)$$

where N_i^y refers to a number of countries assigned to cluster *i* in 10-years period *y*, v_j is a value of indicator for respective country and time period. To simplify the procedure we used rounded B_i. An example for maximum average cluster values of the age overstatement indicator (the ratio between deaths at ages 110+ to deaths at ages 105+) for each ten-year period is given in Figure 1.

Clusters 1-4 refer to average values of ratios between deaths at ages 110+ to deaths at ages 105+ calculated from the country specific data assigned to the respective cluster. Dashed lines correspond to maximal average values for the whole period 1900-2000. The latter values are used for defining limits of the data quality groups. Our further analyses assume that data quality indicators exceeding the maximum average values of the third cluster point to serious problems in data quality. In most cases we apply the same definitions of data quality groups for both males and females. However, we consider sex-specific differences in age composition of death and population counts for several indicators.

[2] We used a classical hierarchical clustering with single linkage (nearest neighbor) algorithm and restricted number (four) of clusters (see Everitt et all (2001)). All calculations have been performed using Matlab v.7.01, function *clusterdata* (see for detailed description http://www.mathworks.com/).

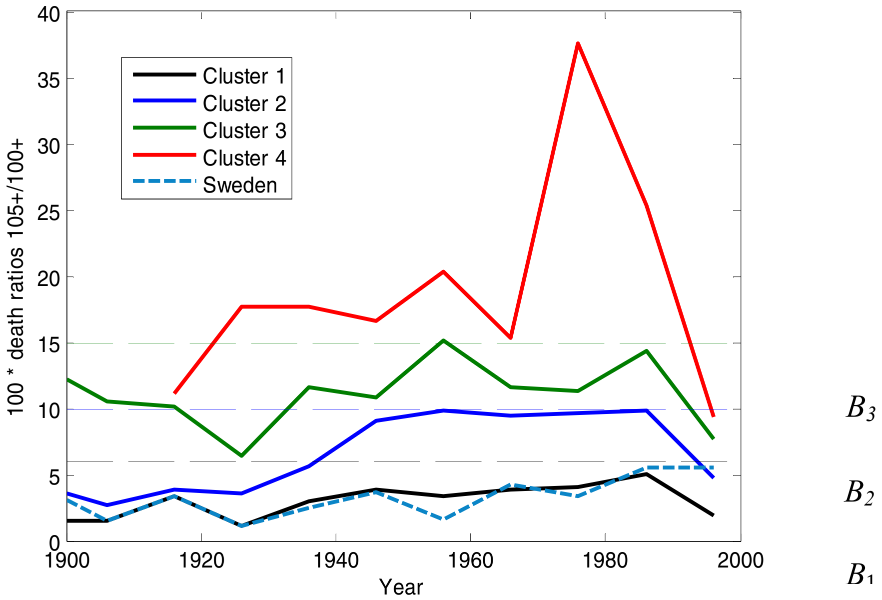

Figure1. Results of cluster analysis for death ratio 100+ to 105+ (females). Dashed lines show the maximum of average value (within the 1900-2000 period) in the respective cluster

3. Results

This section presents a set of age overstatement and age heaping indicators allowing for the identification of potential data quality problems for each KTD country. Each measure points to very specific aspects of data quality problems, thus a relatively complex approach is needed to draw final conclusions on the reliability of population and death figures for a particular country. Note that in some cases, the impact of certain data deficiencies may have a negligible effect on aggregate mortality measures (e.g., age heaping at age 100 has rather negligible impact life expectancy at age 80). Thus, several indicators simultaneously should be taken into account.

Below, we provide outcomes from our data quality validation study, with a special focus on countries that have problematic data on old age. The full results of our analyses are given in Appendix 2. The country-periods are divided into the following groups: good quality, acceptable quality, conditionally acceptable quality, and weak quality. We introduce a "golden standard" to some cases in order to reveal unusual patterns of age reporting indicators. Following numerous prior studies, we consider Sweden as having the best data quality in the world (Wang, Jeune & Vaupel, 1999). Accordingly, we calculate the relative ratios between country-specific and Swedish indicators. We assume that countries with higher data quality follows the pattern of data quality measures shown by the "golden standard" data.

Age overstatement. Our first measure of age overstatement is the ratio between T100 (life table person-years lived above age 100) to T80 (life table person-years lived above age 80) (T100/T80). Table A2-1[3] gives the ratios of T100 to T80 in the country under consideration to the corresponding ratios of T100 to T80 in

[3] All tables prefixed "A2" are placed in Appendix 2.

Sweden. According to the maximum average cluster values, the data quality groups are defined as follows: 0-1.49 (good quality), 1.50-1.99 (acceptable quality), 2.00-3.99 (conditionally acceptable quality), and 4.00 and over (weak quality).

For some countries with higher ratios of T100 to T80 than in Sweden, age overstatement cannot be confirmed according to the additional test for the presence of mortality crossovers (see methods section and graphs in the Annex for more details) (Appendix 2, Figure A2). The following countries-periods have been assigned to the good data quality group despite higher ratios of T100 to T80: Australia (1971-2000 for males and 1981-2000 for females), France (1991-2000 for males), Iceland (1981-2000 for males), Italy (1991-2000 for males), Japan (1981-2000 for males and 1991-2000 for females), Luxemburg (1971-1980 for males), and Spain (1971-2000 for males). It can be seen that many of these cases represent countries showing the most rapid mortality improvements during the last two-three decades (e.g., countries of southern Europe and Japan). Results for Luxemburg and Iceland are probably attributable to the large fluctuations due to small numbers.

Following this criterion, the weak quality group includes data for Canada (1921-1950 for males, 1921-1940 for females), Chile (1991-2000 for males), Spain (1921-1940 for females), Portugal (1941-1950 for females), and Lithuania (1971-1980 for males). The worst indicators are observed for Lithuanian males for 1971-1980 (6.5) and Spanish females for 1931-1940 (5.8).

Tables A2-1a and A2-1b suggest that the data for almost all countries included in the KTD have improved in quality over time. For example, a remarkable progress has been observed for Lithuanian males, who show a decrease in the age overstatement indicator from 6.5 in 1971-1980 to 1.8 in 1991-2000. For USA (both sexes), Canada (both sexes), and Spanish males, however, the relative difference from the Swedish standard have remained above the level of 2.0 (conditionally acceptable quality) throughout the whole period covered (1900-2000) (with the exception of lower rates for Spain in 1951-1970). The data for the 1990s shows that almost all countries are assigned to the good or acceptable data quality group, with the exception of Canada (conditionally acceptable quality for both sexes), Chile (weak quality for males, conditionally acceptable quality for females), Spanish males (conditionally acceptable quality for males), and the USA (conditionally acceptable quality for both sexes).

The consequence of age overstatement is underestimation of the overall level of mortality at old ages. Following Preston, Elo & Stewart (1999), we performed several simulations attempting to estimate how age overstatement may affect estimates of life expectancy at age 80. We have found that the decrease in the age overstatement index (T100/T80 ratio for Canada to the corresponding ratio for Sweden) from 2.0 to 1.5 times leads to the drop in life expectancy at age 80 (0.05-0.2 years or by 0.5-2%). A more notable effect (decrease of 0.5 years or by 25%) has been observed for life expectancy at age 90.

The next two indicators of age overstatement in deaths are the ratio of deaths at ages 105+ to deaths at ages 100+ and the ratio of deaths at ages 110+ to deaths at ages 105+ (Tables A2-2a, A2-2b, A2-3a, A2-3b). As to the death ratios between ages 105+ and age 100+, four data quality groups have been distinguished according to the maximal average values of each cluster: 0-5.9 (good quality), 6.0-9.9 (acceptable quality), 10.0-14.9 (conditionally acceptable quality), and 15.0 and over (weak quality). As for the death ratios at ages 110+ to deaths at ages 105+, the corresponding groups are organized as follows: 0-9.9 (good quality), 10.0-14.9

(acceptable quality), 15.0-24.9 (conditionally acceptable quality), and 25.0 and over (weak quality).

The ratios of deaths at ages 105+ to deaths at ages 100+ are very high for Chile (1981-1990 for both sexes), New Zealand (1951-1960 for both sexes), New Zealand Non-Maori (1951-1960 for males), and Portugal (1941-1950 for both sexes), suggesting that significant age overstatement in deaths has occurred. Exceptionally unfavorable indicators are identified for Chilean males and females for 1981-1990 (48.1 for males and 25.3 for females). At the same time, the corresponding ratios for Sweden have never reached the level of 6.0 throughout the whole period. In addition, the following country-period data are classified as only conditionally acceptable: Chile (1991-2000 for males), Lithuania (1981-1990 for males, 1971-1990 for females), New Zealand (1961-1970 for both sexes), New Zealand Non-Maori (1921-1930 for males), Portugal (1951-1960 for both sexes), Spain (1931-1940, 1951-1960, and 1981-1990 for males, 1911-1920, 1931-1950, and 1981-1990 for females), the USA (1961-1980 for both sexes) (Tables A2-2a, A2-2b). With the exception of Canada, the classification of countries generally agrees with the groups identified by the first indicator of age overstatement (T100/T80).

An interpretation of the indicator of age overstatement for super-centenarians (the death ratio at ages 110+ to ages 105+) is not so straightforward due to the small numbers (Tables A2-3a, A2-3b). In addition, it was not possible to calculate this indicator for several countries-periods due to the fact that denominators (deaths at ages 105+) were equal to zero. However, we found that a similar set of countries as in the previous analyses consistently show substantially higher death ratios than does Sweden. For example, weak quality or conditionally acceptable quality groups include Chile (1981-1990 for males), New Zealand (1951-1960 and 1971-1980 for males, 1951-1970 for females), New Zealand Non-Maori (1951-1960 and 1971-1980 for males), Portugal (1961-1970 for males, 1941-1960 for females), and the USA (1961-1980 for males, 1961-1970 for females). The most strikingly high ratios are found for New Zealand Non-Maori males for 1971-1980 (100.0), Finnish females for 1961-1970 (33.3), and New Zealand males for 1971-1980 (33.3). These results (especially for Finland) should be treated with caution, however, as they are probably due to random fluctuations in small death numbers.

Age heaping. Digit preference or age heaping in death and census records is another important source of errors in population and death statistics. Following formulae proposed by Kannisto (1999), we estimate the age heaping index for deaths at ages 90 and 100. Age heaping at these ages is verified by comparing death numbers at these ages to the expected number of deaths at adjacent ages. Due to the specifics of the Kannisto-Thatcher Database (data available only for ages above 80), it is not possible to calculate an age heaping indicator for age 80. We have used in place a simple ratio of the death probability at age 80 to the death probability at age 81. Kannisto (1999) assumed that an age heaping index greater than 1.2 signals very significant age reporting problems. As for ages 80, 90, and 100, the values of the age heaping indicators fall within the range of 1.1 (1.05 for age 80) and 1.2, and this suggests that evidence of data quality problems is small/ and this suggests that there is a small problem with data quality.

Data on age heaping at age 80 are given in Tables A2-4a and A2-4b. Our results indicate serious age heaping at age 80 in Ireland (1951-1980 for both sexes), Portugal (1941-1950 for males, 1941-1960 for females), and Spain (1911-1960 for both sexes). The most significant age heaping indicators are identified for Spanish males and females (2.4 and 3.1 for males and females respectively in 1911-1920). Canada (1931-1940 for males and 1931-1950 for females) and New Zealand Non Maori (1921-1930 and 1941-1950 for males and 1921-1950 for females) show moderate age heaping indicators (between 1.05 and 1.2).

As for age heaping at age 90, Portugal (1941-1950 for both sexes) and Spain (1911-1940 for males and 1911-1950 for females) again are assigned to the weak data quality group (Tables A2-5a and A2-5b). Canadian data (1921-1930 for females), Finnish data (1901-1910 for both sexes), Icelandic data (1961-1970 for females), Irish data (1951-1970 for both sexes), and Portuguese data (1951-1960 for females), Spanish data (1941-1960 for males, 1951-1960 for females) show moderate age heaping levels (with age heaping indicators between 1.1 and 1.2).

Concerning age heaping at age 100, the majority of countries show weak data quality at least for some decades preceding the 1980s (Tables A2-6a and A2-6b). Again, it was not possible to calculate this indicator for several countries-periods due to the absence of deaths at the most advanced ages. The data for the 1990s show serious age heaping at age 100 for Estonian males (1.6), Finish males (1.3), Iceland (1.2 for males and 1.4 for females), Latvian males (1.3), Scottish males (1.2), and Slovenian females (1.2). The following countries are assigned to the conditionally acceptable quality group, covering the same period: Chile (females), Germany (males), Italy (males), Latvia (females), Lithuania (females), Netherlands (males), New Zealand (females), Non Maori New Zealand (females), Norway (females), Poland (both sexes), Portugal (males), Slovakia (females), Slovenia (males), and Switzerland (males) These results (especially for smaller countries, such as Iceland or Estonia) should be treated with caution due to the very small numbers of deaths at these very advanced ages. However, our results on larger countries, such as France or Japan, confirm the importance of age heaping at age 100 in the past. Overall, our study shows that age reporting tends to improve with time in almost all countries included in the Kannisto-Thatcher Database. We do not find evidence of age heaping at ages 80 and 90 for the 1990s. However, the quality of age reporting at age 100 remains problematic for a relatively large number of countries.

Whipple's Index for centenarians is an additional measure of accuracy in age reporting in death counts at the most advanced ages (see methods section for more details). The relative differences between country-specific Whipple Indexes and the “golden standard” (Whipple Indexes for Sweden) are shown in Tables A2-7a and A2-7b. The data quality groups for females are constructed according to the following maximum average values of each cluster: 0-4.9 (good quality group), 5.0-8.9 (acceptable quality group), 9.0-11.9 (conditionally acceptable quality group), and 12 and over (weak data quality group). As for males, the corresponding intervals are organized using different values: 0-4.9 (good quality group), 5.0-9.9 (acceptable quality group), 10.0-14.9 (conditionally acceptable group), and 15 and over (weak data quality group).

Tables A2-7a and A2-7b point to countries and periods with age heaping problems in population statistics. According to Whipple’s Index, the weak and conditionally acceptable quality groups include Canada (1921-1930 for males), Finland (1921-1940 for males, 1911-1920 for females), East Germany (1961-1970 for males), Iceland (1971-1980 for females), Luxemburg (1971-1980 for males), Portugal (1941-1950 for both sexes), and Spain (1911-1930 for males, 1911-1930 and 1941-1950 for females). Again, the most significant deviations from the Swedish “golden standard” have been found for Spain (16.5 for males in 1911-1920) and Portugal (13.7 for males in 1941-1950).

Classification of country- and period-specific statistics

In this chapter, we introduce a more systematic classification of country- and period-specific data simultaneously accounting for the selected data quality criteria used in our study. The age overstatement criteria include T100/T80 criterion (validated by the test for mortality crossovers) and D105+/D100+ criterion. Age heaping criteria include the Whipple index and age heaping indexes (for ages 80 and 90 only). Several criteria (ratio of deaths at ages 110+ to deaths at ages 105+, age heaping indicator for age 100) discussed in the previous chapters have not been considered for the final classification due to a larger degree of uncertainty (a consequence of small numbers at the most advanced ages).

A number of points according to the selected data quality criteria have been assigned to each country-period data. The following rule has been applied: the good quality group refers to zero points, the acceptable quality group refers to one point, the conditionally acceptable quality group corresponds to two points, and the weak quality group refers to three points. Finally, the country-period data are appointed by a maximum of points collected according the whole set of criteria. Due to the fact that the data for both sexes are pooled together, the countries are classified by choosing either a male or female indicator showing maximum points.

The classification accounting for all data quality measures is presented in Table 2. It can be seen that for most of the KTD countries, the reliability of old age mortality statistics has improved. Ireland, Lithuania, New Zealand, New Zealand Non Maori, and Portugal, for example, have shown weak data quality in the past but now they are assigned to the acceptable quality group according to more recent indicators. The data for some other countries, however, have not improved over time: Canada and the USA, for example, remain in the conditionally acceptable group throughout the second half of the 20th century. The Chilean data is the most problematic, as are the historical series for some other countries, such as Canada, Ireland, Finland, Lithuania, New Zealand (Non-Maori), Norway, Portugal, Spain, and the USA. As expected, the data for the countries with a long history of fully functioning national population registers (Sweden and Denmark) or municipal population registers (the Netherlands, Belgium) show the best quality.

Overall, the country-period data can be summarized by applying the following schema:

- **Best data quality group**. It shows the highest quality throughout the whole period. The group includes Belgium, France, the Netherlands, and Sweden. The Danish, Finnish (since 1951-1960), Italian, Japan (since1971-1980), Swiss, Polish, and Western German data are also assigned to this category as they show best data quality throughout the whole period covered with exceptions of one or two periods (before 1991-2000) with acceptable data quality.
- **Acceptable data quality group**. It consist of Australia, Austria, the Czech Republic, England & Wales, Estonia, East Germany (except 1961-1970), Hungary, Iceland, Ireland (from 1981-1990) Japan (before 1970), Latvia (from 1971-1980), Luxemburg (from 1981-1990), New Zealand (from 1961-1970), New Zealand Non-Maori (from 1961-1970), Norway (from 1961-1970), Portugal (from 1961-1970), Scotland, Slovakia (from 1971-1980), Spain (from 1961-1970), and Slovenia.
- **Conditionally acceptable group**. It includes countries consistently showing moderate data quality problems (with a possible short-term improvement or

weakening in data quality): Canada (from 1951-1960), Finland (before 1951-1960), Latvia (before 1971), Lithuania (from 1981-1990), Luxembourg (before 1981-1990), New Zealand Non Maori (before 1961-1970), Norway (before 1961-1970), and the USA.

- **Weak data quality group.** It incorporates countries and periods showing very serious data quality problems: Canada (before 1951-1960), Chile, Ireland (before 1981-1990), Lithuania (1971-1980), New Zealand (1951-1960), Portugal (before 1961-1970), and Spain (before 1961-1970).

Table 2. Final classification of countries according to summary of data quality points. Both sexes combined

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	*1*	*1*	*1*
Austria	.	.	.	.	.	**0**	*1*	**0**	*1*	*1*
Belgium	.	.	.	.	.	**0**	**0**	**0**	**0**	**0**
Canada	.	.	**3**	**3**	**3**	2	2	2	2	2
Chile	.	.	.	.	.	.	.	.	**3**	**3**
Czech Rep.	.	.	.	.	.	**0**	**0**	**0**	*1*	*1*
Denmark	.	.	*1*	**0**	**0**	*1*	**0**	**0**	**0**	**0**
England &Wales	.	*1*	*1*	*1*	*1*	**0**	**0**	**0**	*1*	*1*
Estonia	.	.	.	.	.	.	*1*	*1*	*1*	*1*
Finland	*1*	2	2	2	*1*	**0**	*1*	**0**	**0**	**0**
France	.	.	.	.	.	**0**	**0**	**0**	**0**	**0**
Germany	.	.	.	.	.	.	.	.	.	**0**
Germany E.	.	.	.	.	.	.	2	*1*	*1*	*1*
Germany W.	.	.	.	.	.	.	*1*	**0**	**0**	**0**
Hungary	.	.	.	.	.	**0**	*1*	*1*	*1*	*1*
Iceland	.	.	.	.	.	.	*1*	2	*1*	*1*
Ireland	.	.	.	.	.	**3**	**3**	**3**	*1*	*1*
Italy	.	.	.	.	.	.	**0**	**0**	**0**	**0**
Japan	.	.	.	.	.	*1*	*1*	**0**	**0**	**0**
Latvia	.	.	.	.	.	.	2	*1*	*1*	*1*
Lithuania	.	.	.	.	.	.	.	**3**	2	*1*
Luxemburg	.	.	.	.	.	.	.	2	*1*	*1*
Netherlands	.	.	.	.	.	**0**	**0**	**0**	**0**	**0**
New Zealand	.	.	.	.	.	**3**	*1*	*1*	*1*	*1*
New Zealand (Non-Maori)	.	.	2	2	2	**3**	**0**	**0**	*1*	*1*
Norway	*1*	2	*1*	2	2	2	*1*	**0**	*1*	**0**
Poland	.	.	.	.	.	.	.	**0**	**0**	**0**
Portugal	.	.	.	.	**3**	**3**	*1*	*1*	**0**	*1*
Scotland	.	.	.	.	.	**0**	*1*	**0**	**0**	*1*
Slovakia	.	.	.	.	.	.	2	*1*	*1*	*1*
Slovenia	.	.	.	.	.	.	.	.	.	*1*
Spain	.	**3**	**3**	**3**	**3**	**3**	*1*	*1*	*1*	*1*
Sweden	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Switzerland	*1*	**0**	*1*	**0**	*1*	**0**	*1*	**0**	**0**	**0**
USA	.	.	.	.	.	.	2	2	2	2

Green color, bold: good quality; *Green color, regular, italic, underlined:* acceptable quality
Red color, regular, underlined: conditionally acceptable quality;
Red color, bold, underlined: weak quality

A comparison between the KTD and official statistics

Our results, presented in the previous sections, are based on the KTD data series. As described in the section on data and methods, a set of methods allowing improvements to be made to the quality of the mortality estimates has been applied within the framework of the KTD methods protocol. Therefore, country-specific population data from the KTD may differ from the official population figures provided by national statistical offices. It has been shown that the official population estimates often have various deficiencies, whereas the corresponding (adjusted) KTD data demonstrate more plausible patterns. Jdanov, Scholz & Shkolnikov (2005), for example, found evidence of population overestimation for West German males (1980s-1990s). The relative difference between the official and recalculated population estimates (using the extinct cohort method) manifested at ages 90+ in the beginning of the 1970s. This gap increased further between 1971 and 1987. The difference between the official and re-estimated population can be used as an indicator of potential data quality problems in official population statistics.

The relative weighted difference is calculated as

$$\delta(x,t) = \sum_{x=80,85,90,95+} w_x \frac{P_5^{KTD}(x,t) - P_5^{official}(x,t)}{P_5^{KTD}(x,t)},$$

where P_5^{KTD} and $P_5^{official}$ refer to a population in a 5-year age group in the KTD and official estimates, respectively, w_x denotes the population weights in the Swedish population averaged by 1950-2000. The official population estimates used for the following analysis have been drawn from the Human Mortality Database[4] (http://www.mortality.org). Due to data availability, we have excluded six countries (Chile, Ireland, Luxemburg, Poland, Scotland, and Slovenia) and limited the time series to shorter periods.

Relative differences between the KTD and the official population estimates by single age and calendar year for 27 countries[5] are shown by means of the Lexis diagrams[6] . In this case, the proportional difference is calculated as

$$\delta(x,t) = \frac{P^{KTD}(x,t) - P^{KTD}(x,t)}{P^{KTD}(x,t)}.$$

The magnitude of the difference $\delta(x,t)$ corresponds to the color of the Lexis trapezoid connecting points (x, t) with (x+1, t) and (x+1, t+1) with (x+2, t+1). The relative differences tend to form diagonal structures corresponding to birth cohorts. Continuous color patterns are periodically interrupted by vertical lines corresponding to the census points.

Figure A3-1 in Appendix 3 presents the relative differences between the KTD and the official populations above age 80. The results of the ordinary least squares regression connecting the absolute values of relative differences to decades and countries are presented in Table 4-1 in Appendix 4.

Figure A3-1 and results of regression analysis show that in all countries the difference between the official statistics and the KTD estimates tend to diminish to the level of zero. However, at least some small differences are observed for most of the

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[4] Note: here, we do not use the Human Mortality Database estimates. The official data are available at http://www.mortality.org in the Input Database section.

[5] Official population estimates downloaded from the Human Mortality Database (www.mortality.org). For the exact sources see references in the HMD.

[6] The freely available software for building Lexis maps has been developed by Kirill Andreev (Andreev, 1999).

countries at some points in the past. In addition, part of the decrease in the gap between the two series of the population estimates in the 1990s can be explained by the fact that the official population estimates (for the most recent years) have been used as input data for the backward re-estimation by extinct and almost extinct cohort methods (see Appendix 1 for details).

Deviations between the population estimates are significantly associated with sex, early calendar periods, and high ages. The differences are more notable among males than among females. This can be explained by the stronger impact of small numbers affecting the magnitude of the absolute difference between the official and KTDB data series among males. For the period around WW1, the quality of old age statistics for males is considerably lower than for other periods. The difference between official data and extinct cohort estimates dramatically increases with age, but this gradient becomes less pronounced in time. In general, all factors explaining the gap between the two series tend to loose their importance (Appendix 4). The only exception is the period 1941-1950.

The countries with fully functioning population registers (the Nordic countries, the Netherlands, and Belgium) show almost no difference between the official estimates and the KTD population estimates for the last few decades. The introduction of the population register systems seems to enhance the accuracy of population estimates and also to narrow differences between the official estimates and the estimates based on the KTD methodology. Finland is an illustrative example. Compared to the KTD data, this country shows a significant undercount of its old age population in the 1960s. However, the discrepancy continuously decreased over the 1970s and become very small afterwards.

Among the countries with good quality data, the most notable difference between the official and the KTD series has been found for Slovakia. The gap tends to diminish significantly for the population census years and this suggests that the quality of the post-censal population estimates tend to deteriorate with each subsequent year after the census (Appendix 3). As for the countries assigned to the acceptable quality group, the most pronounced disagreement between the two sources has been identified for East Germany[7]. Here, the gap is much more pronounced than in the Nordic countries but it is smaller than in Slovakia or New Zealand.

The most pronounced difference between the KTD and official population estimates are in the third group of countries, assigned to the conditionally acceptable quality group. There are very large discrepancies between the two sources for pre-war Spain (even for the census years).

Considerably less it is known about the discrepancies between the official and KTD data among countries in the weak quality group. Due to data unavailability, similar analyses have been made only for Lithuania. However, as the data series starts only from 1970, the findings are hardly comparable to other countries.

Results of visual inspection of the Lexis maps showing relative differences between the KTD and official population estimates by single age provides additional information about the quality of population estimates by sex and across different ages (Figure 3.2. in Appendix 3). In Figure 3-2 the magnitude of the difference $\delta(x,t)$ corresponds to color of the Lexis trapezoid connecting points (x, t) with (x+1, t) and (x+1, t+1) with (x+2, t+1). The white space in the upper part of the panels corresponds to open-ended age intervals, where official population numbers by single-

[7] Note that Germany is hardly comparable with Japan, where official estimates are available only for the census years.

year age group are unavailable. The relative differences tend to form diagonal structures corresponding to birth cohorts. Differences tend to increase with age and this pattern seems to be more pronounced for men than for women. Continuous color patterns are periodically interrupted by vertical lines corresponding to the census points. At these dates, official populations are re-estimated and new inter-census periods begin. Immediately after the census years, the relative differences tend to be lower but increase again shortly after. The blue colors correspond to negative relative differences (e.g., HMD estimates are lower than the official ones), while the red colors correspond to positive relative differences (e.g., HMD estimates are higher than the official ones).

In general, Figure 3-2 confirms outcomes from regression analyses. The population estimates for females systematically show higher quality than those for males (with exception for 1951-1960). The disagreement between the two sources increases with age. Immediately after the census years, the relative differences between the KTD and official population estimates become smaller. They increase again with each year after the censuses.

4. Conclusion

Our work was stimulated by prior substantial research done by Väinö Kannisto. Using his system of data quality indicators together with other internationally recognized criteria, we performed an analysis of data quality for all countries included in the most recent version of the Kannisto-Thatcher Database. We extended prior analyses by including 35 countries and by lengthening the time period back to include time since the beginning of the 20th century. Finally, applying cluster analysis, we introduced a more objective classification of countries and periods simultaneously accounting for a whole set of selected data quality indicators.

We assume that dubious or irregular mortality patterns identified in this study suggest (although indirectly) about data quality problems. The outcomes of the studies using indirect measures of age overstatement or age heaping have been proved by the findings based on individual or population register data (such as studies on age-validation of centenarians) (Perls et al., 1999; Kestenbaum, 1992).

Our results suggest that the data quality varies substantially across countries and time periods. The majority of the KTD countries show trends of improvement in each indicator. However, some countries, e.g. Canada, Chile, Spain, and the USA, systematically demonstrate worse results up to the most recent periods. Researchers should be aware of very serious inaccuracies in the historical series of old-age mortality statistics for Canada, Ireland, Lithuania, New Zealand Non-Maori, New Zealand, Portugal, and Spain. Very pronounced data quality problems in the aforementioned countries lead to misleading old-age mortality estimates. Age overstatement results in underestimation of the overall mortality level at old age, while age heaping only distorts mortality estimates at certain ages

We suggest that data quality problems come both from inaccuracies in the death count data and errors in estimating populations within the inter-censal periods. After having compared the KTD population estimates derived by applying a set of extinct- and almost-cohort methods, we conclude that the biggest discrepancies between the two sources are found for countries with conditionally acceptable or weak quality data. The smallest differences and the most reliable official data have been found for the countries with fully functioning population registers.

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Appendix 1. Brief Description of the Kannisto-Thatcher Database Methodology

Re-estimation of population counts[8].

For all countries included in the KTD, official population counts by one-year age group are available at least up to age 90. For the majority of the countries, the last open age interval is 90+. Designed for this case, Figure A1-1 (left) shows the zones of the Lexis diagram that correspond to different methods for the estimation of the number of survivors at ages above 80. For some countries, population data by one-year age group are available up to the highest age, shown on the right panel of Figure A1-1, as are the corresponding methods.

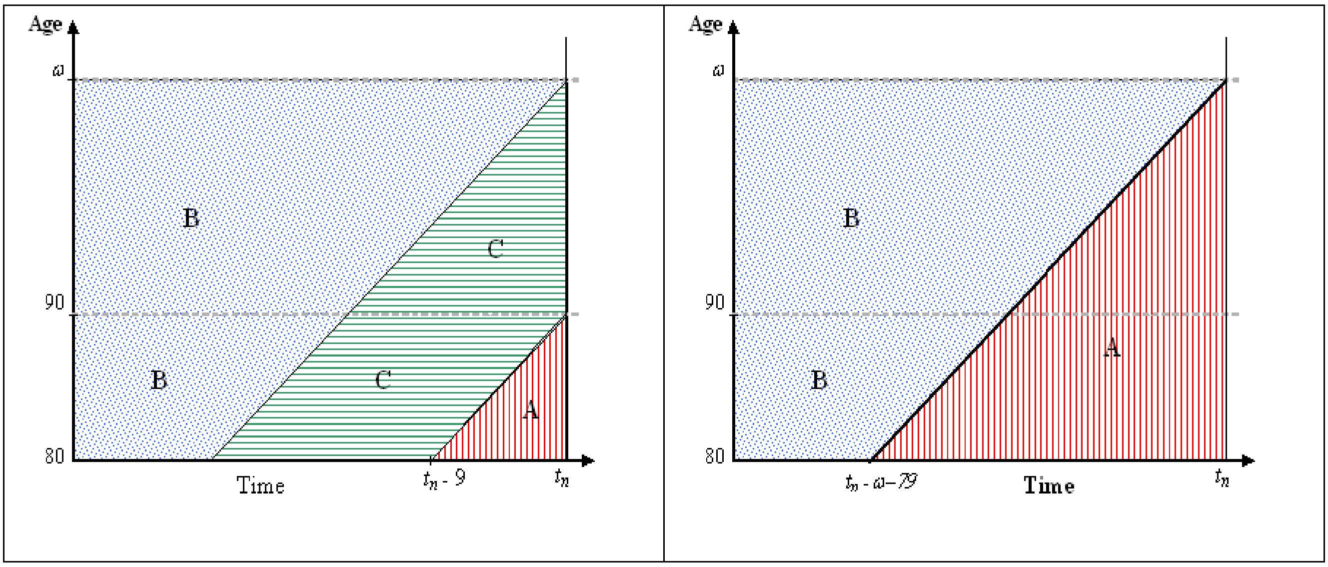


Figure A1-1. Zones of application of different methods for the re-estimation of populations aged 80+. The population data with open age interval are presented in the left panel, and the population data up to the highest age are given in the right panel.

Zone B in Figure A1-1 corresponds to the extinct cohort method. The method is applicable to cohorts that have reached a certain age of extinction ω (the highest age with non-zero survivor counts) by the beginning of last year t_n.. For countries with population estimates aggregated into the open age interval (90+), ω is defined as age, after which there are virtually no deaths. More precisely, for a candidate age x we count the average number of deaths over the cohorts aged x, x+1, …, x+4 on January 1st of the year y_n, from the years y_n-5 to y_n-1 (Figure 3):

$$\tilde{D}(x,t_n) = \frac{1}{5}\sum_{j=1}^{5}\sum_{i=0}^{j-1} D^c(x+i, t_n - x - j) \ , \qquad (1)$$

ω is defined as the lowest age x, such that $\tilde{D}(x,t_n) \le 0.5$.

[8] The material presented in Appendix 1 is entirely based on the KTD Methods protocol by Andreev et al. (2003), available at http://www.demogr.mpg.de/databases/ktdb/xservices/method.htm. The figures in this section and all formulas originate from this source.

According to the method of extinct generation, the population size at age x of a given cohort equals the total of all deaths in this cohort at age x to older ages:

$$P(x,t) = \sum_{i=0}^{\infty} D^c(x+i, t-x) . \qquad (2)$$

Here, $D^c(x,t)$ is the number of deaths in the cohort born in year t recorded among those aged $[x, x+1)$; $P(x,t)$ is the population size on January 1st of year t at age x.

Zone A in Figure A1-1 corresponds to non-extinct cohorts that attained age ω or below at the beginning of the year t_n. For estimating the population at risk in zone A we need not only to sum up the deaths in a particular cohort but also to add the number of survivors in this cohort at the beginning of year t_n :

$$P(x,t) = \sum_{i=0}^{t_n-t-1} D^c(x+i, t-x) + P(x+(t_n-t), t_n). \qquad (3)$$

In countries with reliable population registers, e.g. Sweden or Denmark, population (or survivor) estimates at the beginning of year t_n are readily available from official statistics and they can be directly added to the database. Unfortunately, this is usually not the case for other countries.

Zone C refers to countries with population estimates for very old ages, which are not available from the official statistics, i.e. they are given by age group 90+ only (or available data for higher ages are excluded due to poor quality). In this case, a number of survivors at the beginning of year t_n is estimated from the number of deaths in the previous years. We employ a most robust version of the survivor ratio method, allowing for adjustments to be made to the official population above age 90 (Thatcher et al., 2002).

As with the extinct cohort method, we assume that the whole change in population size is determined by deaths only. In addition, it is considered that a five-year survival in the oldest non-extinct cohort aged ω-1 on January 1st of the year y_n is equal to the average survival in five prior extinct cohorts. This allows us to estimate the population size of cohort ω-1 on January 1st of year y_n. The same procedure is applied to the next younger cohort and so forth down to the cohort aged 90 on January 1st of the year y_n (for further details, see "Survival ratio" in the KTD "Methods Protocol").

Adjustments of death counts

In the KTD, death counts are collected at the finest level of detail available – ideally, by sex, completed age, year of birth, and calendar year. However, for many countries and especially for earlier years, death counts are not available by Lexis triangles. Therefore, deaths in each Lexis triangle need to be estimated before they can be added to the database. Currently, we are using a simple 50/50 splitting for all possible death aggregates. As it has been shown by prior studies, in the Lexis square number of deaths in the older cohort is by 1-2% higher if compared to deaths at the younger cohort (see for example Vallin, 1973). This is due to: a) steep increase of the death rates at ages 80 and over, and, b) the fact that the average age at death in the Lexis triangle corresponding to the younger cohort is half of the year higher. Nevertheless, because it does not have a significant influence on mortality estimates, we are using the simplest "50/50" solution.

Another and even more serious difficulty is related to death counts in open-age intervals. The KTD methodology includes a method for the distribution of deaths within the open-age group. It relies on the assumption that deaths follow the pattern of a stationary population with an age-specific pattern of death rates given by the Kannisto model of the mortality age curve (Thatcher, 1999) (see “Splitting death counts in open age intervals into Lexis triangles” in the KTD “Methodology” for more details).

Appendix 2. Data Quality Indicators by Countries and Time Periods

Table A2-1a. Ratio T100/T80 to T100/T80 in Sweden, females.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	1.40	1.58*	1.67*
Austria	.	.	.	.	.	0.67	0.49	0.38	0.46	0.69
Belgium	.	.	.	.	.	0.63	0.45	0.42	0.82	1.01
Canada	.	.	**4.23**	**4.83**	3.10	2.80	2.28	2.34	2.49	2.07
Chile	.	.	.	.	.	.	.	.	1.36	2.15
Czech Rep.	.	.	.	.	.	0.41	0.38	0.31	0.19	0.31
Denmark	.	.	0.38	0.53	1.01	0.76	0.80	1.01	0.97	0.90
E&W	.	*1.51*	*1.56*	*1.63*	*1.53*	1.41	1.29	0.95	1.13	1.17
Estonia	.	.	.	.	.	.	1.06	0.73	0.53	0.43
Finland	0.64	0.23	0.36	0.41	0.50	0.60	0.37	0.75	0.88	0.72
France	.	.	.	.	.	1.08	1.02	0.89	1.13	1.47
Germany	.	.	.	.	.	.	.	.	.	0.87
Germany E.	.	.	.	.	.	.	0.21	0.24	0.25	0.83
Germany W.	.	.	.	.	.	.	0.48	0.43	0.71	0.87
Hungary	.	.	.	.	.	0.41	0.25	0.30	0.29	0.40
Iceland	.	.	.	.	.	.	1.20	2.18	*1.90*	1.10
Ireland	.	.	.	.	.	1.28	0.58	0.49	0.67	0.70
Italy	.	.	.	.	.	.	0.77	0.56	0.90	1.33
Japan	.	.	.	.	.	0.82	0.59	0.64	1.22	2.5*
Latvia	.	.	.	.	.	.	*1.71*	0.94	0.73	0.53
Lithuania	.	.	.	.	.	.	.	3.27	2.18	0.85
Luxemburg	.	.	.	.	.	.	.	1.46	1.29	0.84
Netherlands	.	.	.	.	.	1.33	0.99	1.07	1.15	0.98
New Zeal.	.	.	.	.	.	2.97	*1.99*	1.22	*1.51*	*1.69*
NZ (NMaori)	.	.	*2.94*	*3.43*	*1.88*	1.48	1.30	1.14	1.49	*1.69*
Norway	1.28	*1.73*	*1.70*	*2.39*	*1.83*	*1.69*	0.92	0.97	1.14	0.94
Poland	.	.	.	.	.	.	.	0.81	0.55	0.54
Portugal	.	.	.	.	**4.53**	1.34	0.90	0.54	0.73	0.84
Scotland	.	.	.	.	.	0.89	0.97	0.84	0.97	0.95
Slovakia	.	.	.	.	.	.	1.35	0.28	0.23	0.35
Slovenia	.	.	.	.	.	.	.	.	.	0.33
Spain	.	3.83	**5.18**	**5.76**	3.52	2.26	1.41	1.28	1.42	1.42
Sweden	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Switzerland	0.01	0.08	0.05	0.32	0.51	0.82	0.59	0.70	0.93	1.05
USA	.	.	.	.	.	.	3.06	2.72	2.42	2.03

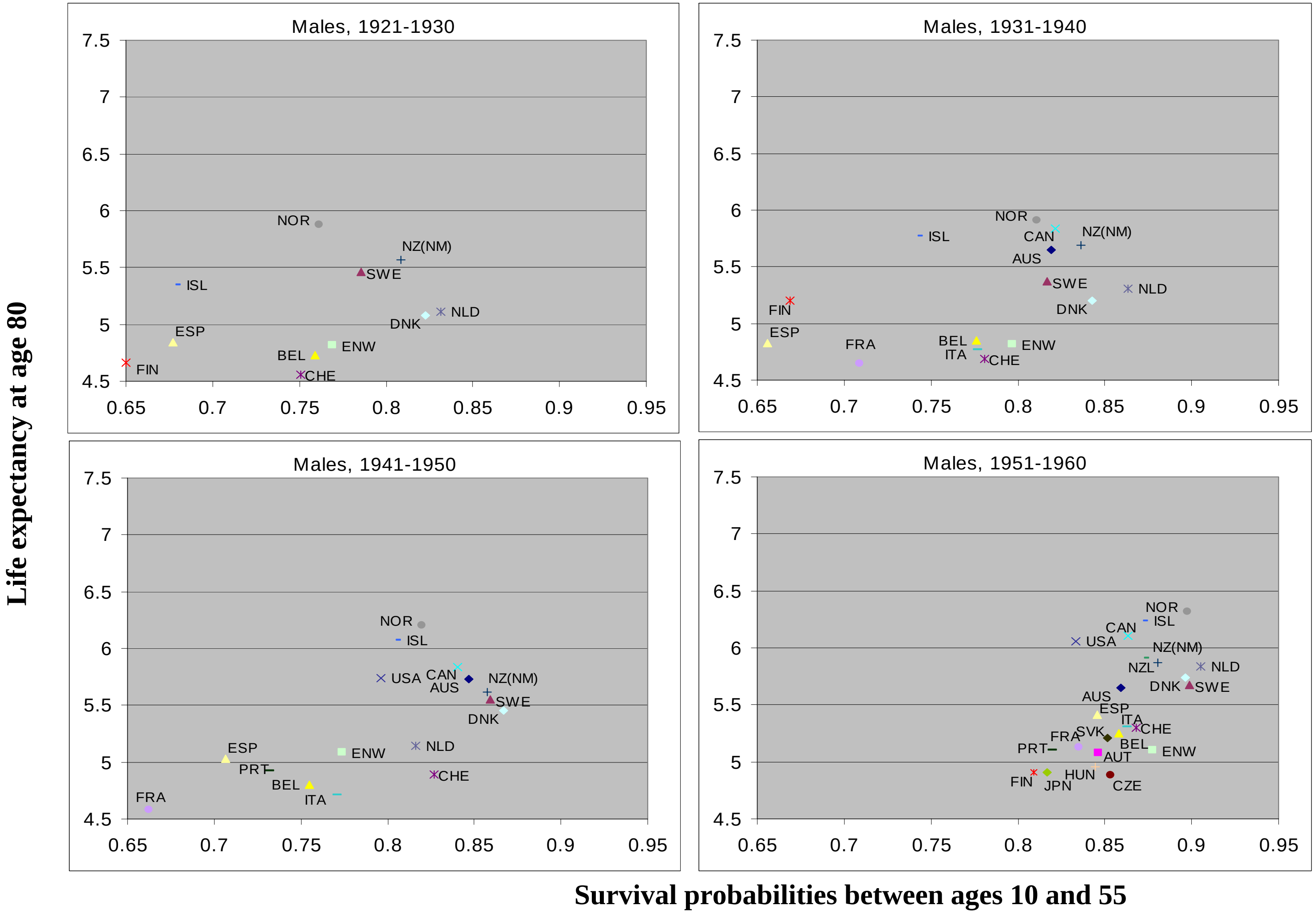
Black color, regular: good quality (0.0-1.4)
Blue color, regular, italic: acceptable quality (1.5-1.9)
Red color, regular, underlined: conditionally acceptable quality (2.0-3.9)
Red color, bold, underlined: weak quality (4.0 and over)
* Age overstatement has not been confirmed according to the test for mortality crossovers.

Table A2-1b. Ratio T100/T80 to T100/T80 in Sweden, males.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	1.51*	1.69*	1.80*
Austria	.	.	.	.	.	0.40	0.54	0.51	0.69	0.70
Belgium	.	.	.	.	.	0.52	0.55	0.58	0.94	0.89
Canada	.	.	**4.38**	**4.93**	**4.02**	2.77	2.36	2.61	2.66	2.15
Chile	.	.	.	.	.	.	.	.	*1.82*	**4.07**
Czech Rep.	.	.	.	.	.	0.22	0.30	0.44	0.26	0.40
Denmark	.	.	0.26	0.48	1.22	1.02	0.78	1.19	1.20	0.89
E&W	.	*1.90*	0.87	0.87	1.28	0.64	0.83	0.75	1.05	1.13
Estonia	.	.	.	.	.	.	*1.51*	*1.7*	0.41	0.61
Finland	0.70	0.39	0.51	0.14	0.43	0.53	0.44	0.46	0.96	0.77
France	.	.	.	.	.	0.76	0.91	0.94	1.13	1.54*
Germany	.	.	.	.	.	.	.	.	.	1.04
Germany E	.	.	.	.	.	.	0.20	0.38	0.32	0.90
Germany W	.	.	.	.	.	.	0.56	0.58	0.85	1.07
Hungary	.	.	.	.	.	0.31	0.16	0.23	0.31	0.62
Iceland	.	.	.	.	.	.	*1.51*	0.98	2.10*	1.87*
Ireland	.	.	.	.	.	0.76	0.61	0.39	0.47	0.82
Italy	.	.	.	.	.	.	0.82	0.72	1.18	1.52*
Japan	.	.	.	.	.	0.79	0.80	0.93	1.62*	2.34*
Latvia	.	.	.	.	.	.	2.12	*1.81*	*1.88*	0.62
Lithuania	.	.	.	.	.	.	.	**6.49**	3.75	*1.80*
Luxemburg	.	.	.	.	.	.	.	1.63*	1.43	0.48
Netherlands	.	.	.	.	.	1.07	1.35	1.35	1.36	1.02
New Zeal.	.	.	.	.	.	3.92	*1.59*	0.89	1.45	1.24
NZ (NMaori)	.	.	*2.80*	*3.52*	*2.40*	*2.78*	1.09	0.84	1.43	1.15
Norway	*1.92*	2.28	1.39	2.66	2.91	2.16	1.36	1.38	1.36	1.05
Poland	.	.	.	.	.	.	.	1.33	1.10	0.94
Portugal	.	.	.	.	3.28	0.88	0.68	0.50	0.95	1.07
Scotland	.	.	.	.	.	0.42	0.62	0.60	0.72	0.98
Slovakia	.	.	.	.	.	.	0.66	0.64	0.17	0.42
Slovenia	.	.	.	.	.	.	.	.	.	0.41
Spain	.	3.69	2.26	2.33	2.57	*1.87*	1.40	2.38*	2.38*	2.22*
Sweden	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Switzerland	0.06	0.00	0.13	0.05	0.54	1.34	0.70	0.97	1.12	1.17
USA	.	.	.	.	.	.	3.65	3.42	2.77	2.41

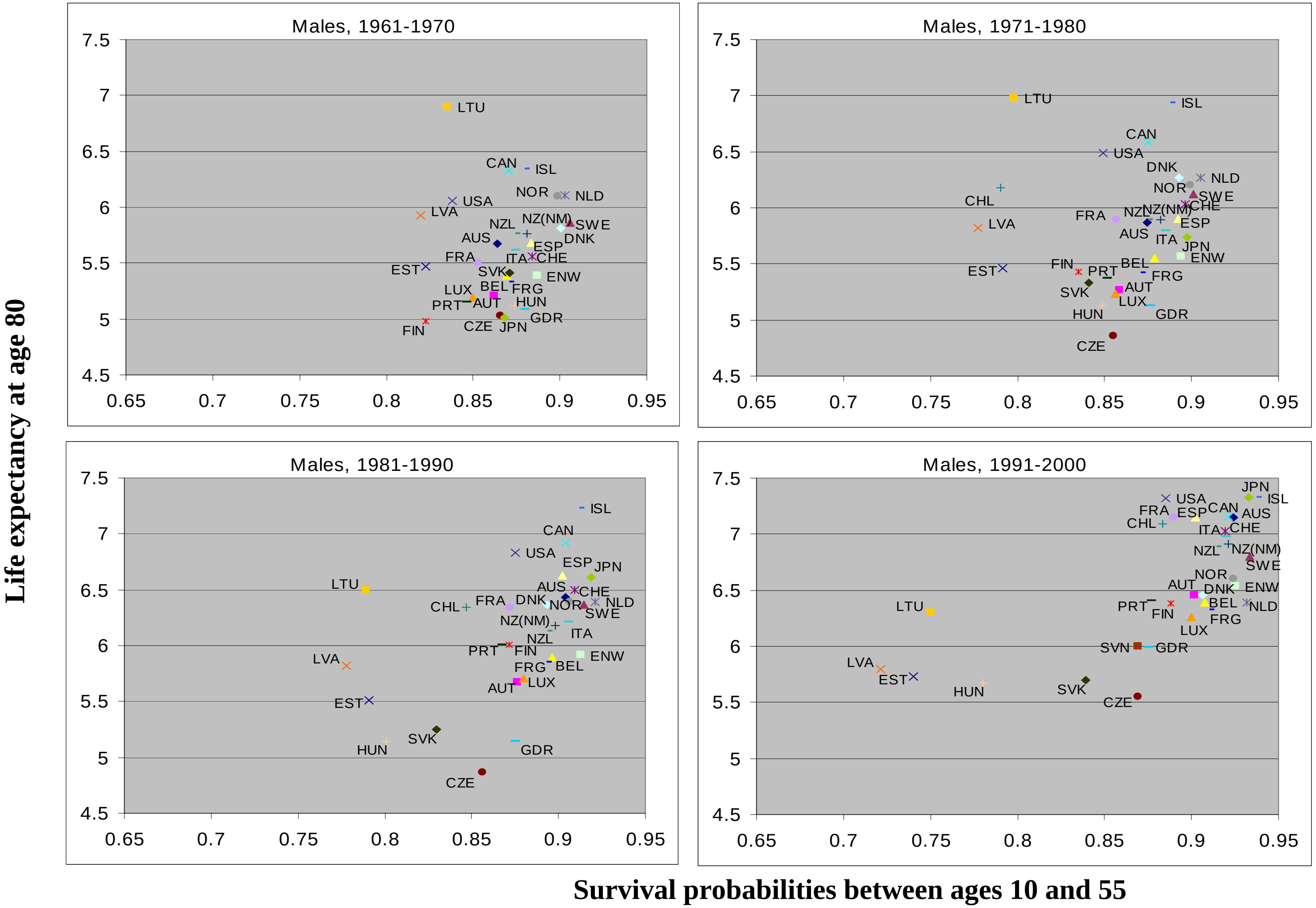
Black color, regular: good quality (0.0-1.4)
Blue color, regular, italic: acceptable quality (1.5-1.9)
Red color, regular, underlined: conditionally acceptable quality (2.0-3.9)
Red color, bold, underlined: weak quality (4.0 and over)
* Age overstatement has not been confirmed according to the test for mortality crossovers.

Figure A2. Survival probabilities between ages 10 and 55 and corresponding values of life expectancy at age 80



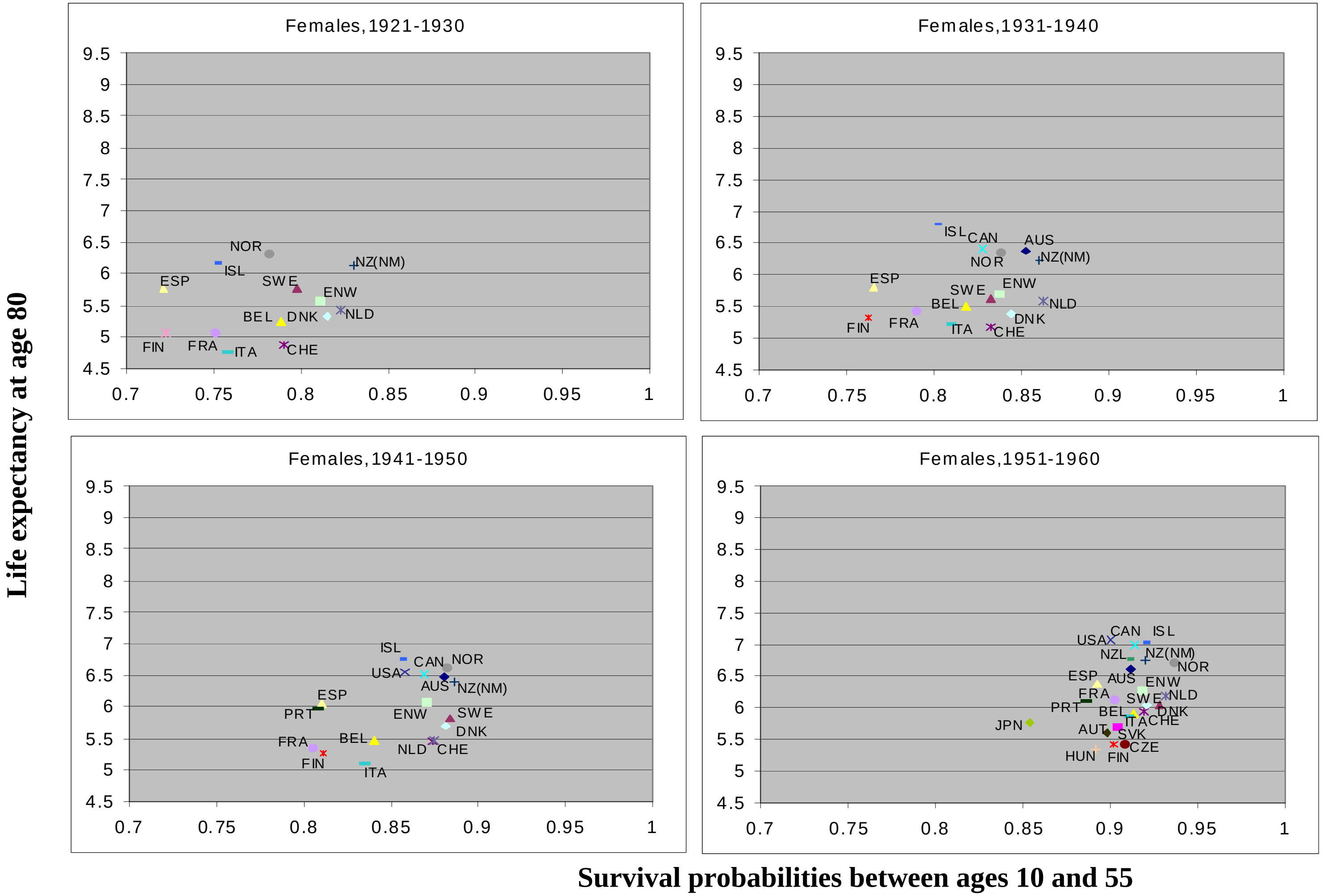
Note: Country-specific labels refer to the standard UN numeric code (ISO 3166-1 numeric-3) (http://www.nationsonline.org/oneworld/countrycodes.htm).

Figure A2 (continued). Survival probabilities between ages 10 and 55 and corresponding values of life expectancy at age 80



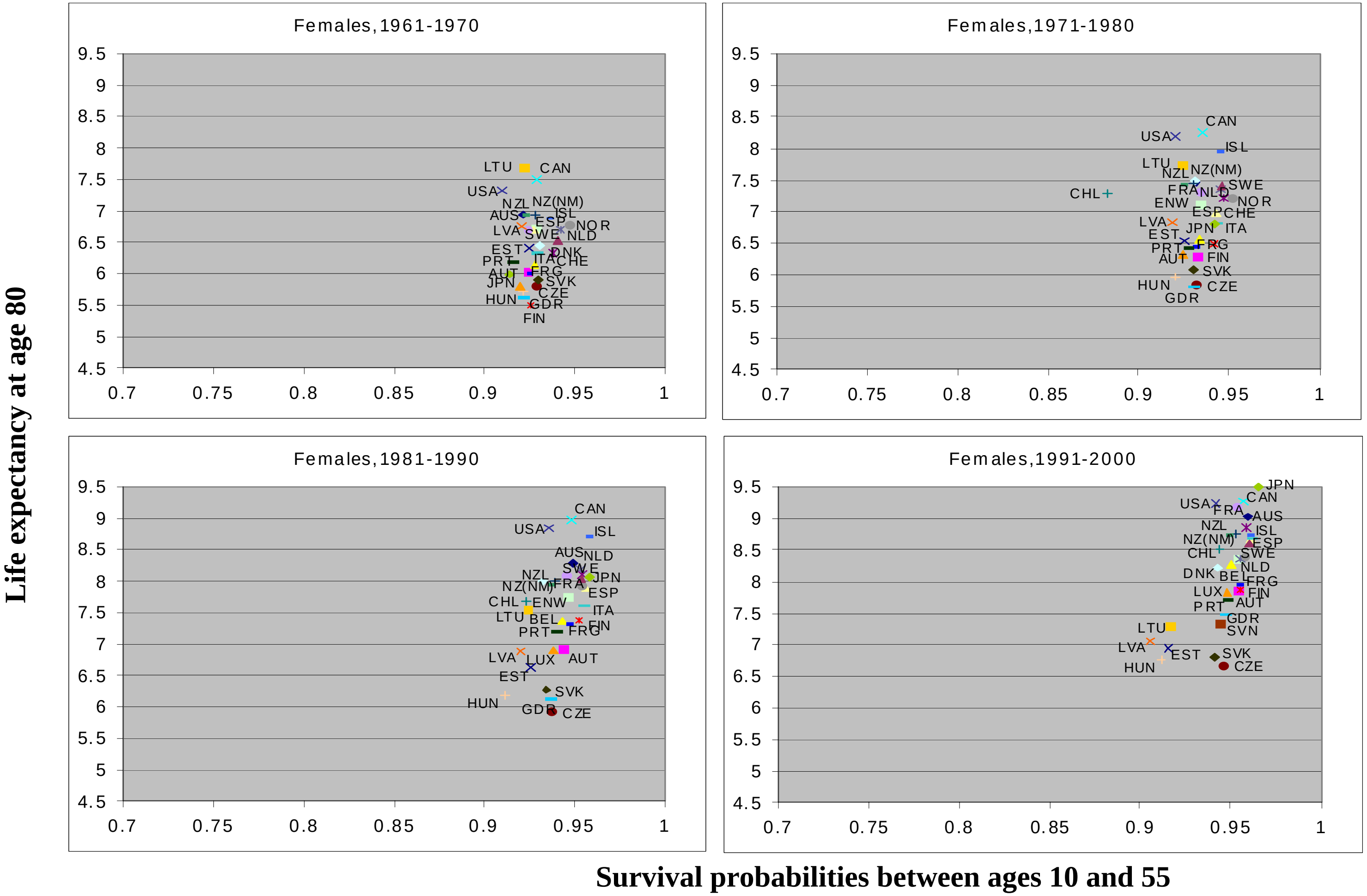
Note: Country-specific labels refer to the standard UN numeric code (ISO 3166-1 numeric-3) (http://www.nationsonline.org/oneworld/countrycodes.htm).

Figure A2 (continued). Survival probabilities between ages 10 and 55 and corresponding values of life expectancy at age 80



Note: Country-specific labels refer to the standard UN numeric code (ISO 3166-1 numeric-3) (http://www.nationsonline.org/oneworld/countrycodes.htm).

Figure A2 (continued). Survival probabilities between ages 10 and 55 and corresponding values of life expectancy at age 80



Note: Country-specific labels refer to the standard UN numeric code (ISO 3166-1 numeric-3) (http://www.nationsonline.org/oneworld/countrycodes.htm).

Table A2-2a. Ratio of deaths at ages 105+ to deaths at ages 100+, females.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	5.43	*7.47*	*7.59*
Austria	.	.	.	.	.	3.16	2.27	4.63	3.36	4.63
Belgium	.	.	.	.	.	0.00	0.55	1.04	3.98	4.4
Canada	.	.	*7.02*	5.59	4.81	4.99	*6.02*	*6.49*	*9.20*	*9.77*
Chile	.	.	.	.	.	.	.	.	**25.34**	10.27
Czech Rep.	.	.	.	.	.	0.00	0.00	1.66	1.95	2.79
Denmark	.	.	0.00	0.00	1.52	0.95	1.25	3.59	4.43	5.45
E&W	.	3.85	5.81	5.46	3.17	4.27	4.64	4.88	*6.12*	*6.78*
Estonia	.	.	.	.	.	.	4.55	5.00	3.78	*8.64*
Finland	0.00	0.00	0.00	5.00	*9.09*	0.00	4.17	3.79	5.81	4.83
France	.	.	.	.	.	2.04	3.40	4.52	5.09	5.77
Germany	.	.	.	.	.	.	.	.	.	4.59
Germany E	.	.	.	.	.	.	0.00	2.53	2.52	3.25
Germany W	.	.	.	.	.	.	1.46	3.17	3.92	4.79
Hungary	.	.	.	.	.	1.87	0.00	0.36	2.63	3.57
Iceland	.	.	.	.	.	.	4.00	0.00	5.88	3.13
Ireland	.	.	.	.	.	0.77	1.84	2.24	*6.38*	5.00
Italy	.	.	.	.	.	.	5.02	4.13	4.18	5.55
Japan	.	.	.	.	.	5.96	3.37	3.90	4.74	5.85
Latvia	.	.	.	.	.	.	*7.50*	*7.21*	*6.32*	4.26
Lithuania	.	.	.	.	.	.	.	11.65	14.33	*9.60*
Luxemburg	.	.	.	.	.	.	.	0.00	3.52	*7.89*
Netherlands	.	.	.	.	.	3.16	4.46	4.30	5.62	4.88
New Zeal.	.	.	.	.	.	**20.37**	11.27	*9.34*	*7.65*	*8.60*
NZ (NMaori)	.	.	4.76	*6.67*	4.17	4.76	4.50	5.90	*6.96*	*8.71*
Norway	2.74	0.00	3.55	3.38	4.00	5.04	5.12	4.38	*6.87*	5.81
Poland	.	.	.	.	.	.	.	5.51	5.20	3.94
Portugal	.	.	.	.	17.50	14.60	*9.45*	*7.86*	4.72	*6.13*
Scotland	.	.	.	.	.	3.10	2.54	3.48	5.51	*6.54*
Slovakia	.	.	.	.	.	.	14.69	3.05	0.00	2.77
Slovenia	.	.	.	.	.	.	.	.	.	1.92
Spain	.	10.15	*8.15*	11.58	10.81	*9.89*	*7.47*	*9.90*	10.67	*9.29*
Sweden	1.52	3.39	1.14	2.53	3.65	1.59	4.27	3.41	5.52	5.50
Switzerland	0.00	0.00	0.00	0.00	0.00	0.00	1.62	2.14	4.25	3.74
USA	.	.	.	.	.	.	11.91	11.07	*9.68*	*9.75*

Black color, regular: good quality (0.0-5.9)
Blue color, regular, italic: acceptable quality (6.0-9.9)
Red color, regular, underlined: conditionally acceptable quality (10.0-14.9)
Red color, bold, underlined: weak quality (15.0 and over)

Table A2-2b. Ratio of deaths at ages 105+ to deaths at ages 100+, males.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	*6.60*	*6.53*	5.98
Austria	.	.	.	.	.	4.44	4.29	3.79	4.19	3.17
Belgium	.	.	.	.	.	0.00	0.00	2.28	3.39	3.85
Canada	.	.	*7.54*	3.50	2.11	2.88	4.48	4.55	*8.68*	*7.46*
Chile	.	.	.	.	.	.	.	.	**48.14**	*9.84*
Czech Rep.	.	.	.	.	.	0.00	0.00	0.00	0.00	2.94
Denmark	.	.	0.00	0.00	0.00	2.53	1.23	1.56	2.29	3.93
E&W	.	3.87	*6.37*	3.39	*6.53*	2.31	2.18	2.49	4.91	4.68
Estonia	.	.	.	.	.	.	0.00	0.00	*8.51*	2.13
Finland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	3.43
France	.	.	.	.	.	3.96	1.62	3.30	3.95	3.97
Germany	.	.	.	.	.	.	.	.	.	4.10
Germany E	.	.	.	.	.	.	0.00	0.69	1.04	3.16
Germany W	.	.	.	.	.	.	1.53	2.64	3.72	4.26
Hungary	.	.	.	.	.	0.00	0.00	0.00	0.00	1.37
Iceland	.	.	.	.	.	.	0.00	0.00	5.26	0.00
Ireland	.	.	.	.	.	0.00	*9.26*	4.55	4.94	*7.25*
Italy	.	.	.	.	.	.	2.42	3.27	2.91	4.75
Japan	.	.	.	.	.	*9.84*	1.62	4.48	3.86	4.05
Latvia	.	.	.	.	.	.	5.66	5.56	0.61	*6.08*
Lithuania	.	.	.	.	.	.	.	*7.66*	10.56	*9.41*
Luxemburg	.	.	.	.	.	.	.	0.00	0.00	0.00
Netherlands	.	.	.	.	.	3.09	1.38	2.60	4.92	4.45
New Zeal.	.	.	.	.	.	**28.00**	*10.00*	3.19	2.90	5.99
NZ (NMaori)	.	.	11.11	3.85	0.00	**25.71**	1.85	1.20	3.03	5.49
Norway	3.45	0.00	1.52	0.00	0.00	5.56	*7.28*	4.21	4.67	5.24
Poland	.	.	.	.	.	.	.	4.40	5.06	3.95
Portugal	.	.	.	.	**15.81**	14.66	*8.54*	2.47	3.87	4.73
Scotland	.	.	.	.	.	0.00	0.00	0.96	2.68	*6.37*
Slovakia	.	.	.	.	.	.	.	1.59	0.00	0.00
Slovenia	.	.	.	.	.	.	.	.	.	0.00
Spain	.	5.32	2.65	11.32	*7.81*	10.61	*7.74*	*9.99*	11.10	*9.82*
Sweden	5.26	0.00	2.63	2.86	3.57	0.81	1.88	3.30	2.66	4.04
Switzerland	0.00	0.00	0.00	0.00	0.00	2.50	*8.47*	1.69	2.96	4.12
USA	.	.	.	.	.	.	14.23	12.86	*9.67*	*8.17*

Black color, regular: good quality (0.0-5.9)
Blue color, regular, italic: acceptable quality (6.0-9.9)
Red color, regular, underlined: conditionally acceptable quality (10.0-14.9)
Red color, bold, underlined: weak quality (15.0 and over)

Table A2-3a. Ratio of deaths at ages 110+ to deaths at ages 105+, females.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	0.00	3.66	3.23
Austria	.	.	.	.	.	0.00	0.00	0.00	0.00	4.17
Belgium	.	.	.	.	.	*	0.00	0.00	0.00	5.51
Canada	.	.	0.00	0.00	0.00	0.00	0.00	0.00	2.92	4.00
Chile	.	.	.	.	.	.	.	.	*14.94*	5.73
Czech Rep.	.	.	.	.	.	*	*	0.00	0.00	0.00
Denmark	.	.	*	*	0.00	0.00	0.00	0.00	0.00	2.06
E&W	.	0.00	0.00	0.00	0.00	0.00	0.58	1.12	1.13	2.33
Estonia	.	.	.	.	.	.	0.00	0.00	0.00	5.26
Finland	*	*	*	0.00	0.00	*	**33.33**	0.00	4.17	2.33
France	.	.	.	.	.	0.00	0.00	0.00	1.57	2.54
Germany	.	.	.	.	.	.	.	.	.	1.99
Germany E	.	.	.	.	.	.	*	0.00	0.00	2.56
Germany W	.	.	.	.	.	.	0.00	1.19	1.19	1.93
Hungary	.	.	.	.	.	0.00	*	0.00	0.00	0.00
Iceland	.	.	.	.	.	.	0.00	*	0.00	0.00
Ireland	.	.	.	.	.	0.00	0.00	0.00	4.17	3.45
Italy	.	.	.	.	.	.	1.27	0.83	1.54	2.11
Japan	.	.	.	.	.	17.65	9.09	2.91	2.42	3.12
Latvia	.	.	.	.	.	.	0.00	0.00	0.00	0.00
Lithuania	.	.	.	.	.	.	.	1.15	4.74	0.68
Luxemburg	.	.	.	.	.	.	.	*	0.00	0.00
Netherlands	.	.	.	.	.	0.00	0.00	0.00	4.20	2.36
New Zeal.	.	.	.	.	.	**27.27**	**25.00**	22.22	2.22	1.10
NZ (NMaori)	.	.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10
Norway	0.00	*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.15
Poland	.	.	.	.	.	.	.	0.00	0.00	0.00
Portugal	.	.	.	.	18.86	16.16	*13.33*	*11.63*	6.82	3.60
Scotland	.	.	.	.	.	0.00	0.00	0.00	1.75	3.54
Slovakia	.	.	.	.	.	.	19.23	0.00	*	0.00
Slovenia	.	.	.	.	.	.	.	.	.	0.00
Spain	.	0.74	0.00	*10.85*	0.00	0.00	0.00	3.43	4.93	4.24
Sweden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	3.43
Switzerland	*	*	*	*	*	*	0.00	0.00	0.00	4.88
USA	.	.	.	.	.	.	19.05	*14.79*	*10.01*	6.16

Black color, regular: good quality (0.0-9.9)
Blue color, regular, italic: acceptable quality (10.0-14.9)
Red color, regular, underlined: conditionally acceptable quality (15.0-24.9)
Red color, bold, underlined: weak quality (25.0 and over)
*It was not possible to calculate this indicator due to the absence of deaths at the most advanced ages.

Table A2-3b. Ratio of deaths at ages 110+ to deaths at ages 105+, males.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	0.00	5.71	7.69
Austria	.	.	.	.	.	0.00	0.00	0.00	0.00	0.00
Belgium	.	.	.	.	.	*	*	0.00	0.00	8.33
Canada	.	.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chile	.	.	.	.	.	.	.	.	**30.47**	6.82
Czech Rep.	.	.	.	.	.	*	*	*	*	0.00
Denmark	.	.	*	*	*	0.00	0.00	0.00	0.00	0.00
E&W	.	0.00	0.00	0.00	0.00	0.00	7.14	0.00	0.00	0.00
Estonia	.	.	.	.	.	.	*	*	**25.00**	0.00
Finland	*	*	*	*	*	*	*	*	0.00	0.00
France	.	.	.	.	.	0.00	0.00	0.00	4.35	5.92
Germany	.	.	.	.	.	.	.	.	.	2.07
Germany E	.	.	.	.	.	.	*	0.00	0.00	0.00
Germany W	.	.	.	.	.	.	*	0.00	1.32	2.33
Hungary	.	.	.	.	.	*	*	*	*	0.00
Iceland	.	.	.	.	.	.	*	*	0.00	*
Ireland	.	.	.	.	.	*	0.00	0.00	0.00	0.00
Italy	.	.	.	.	.	0.00	7.14	0.00	0.00	2.19
Japan	.	.	.	.	.	5.56	0.00	3.13	3.90	1.93
Latvia	.	.	.	.	.	.	0.00	0.00	0.00	0.00
Lithuania	.	.	.	.	.	.	.	0.00	0.00	0.00
Luxemburg	.	.	.	.	.	.	.	*	*	*
Netherlands	.	.	.	.	.	0.00	0.00	0.00	2.27	0.00
New Zeal.	.	.	.	.	.	21.43	*14.29*	**33.33**	0.00	*10.00*
NZ (NMaori)	.	.	0.00	0.00	*	22.22	0.00	**100**	0.00	*11.11*
Norway	0.00	*	0.00	*	*	0.00	0.00	0.00	7.14	0.00
Poland	.	.	.	.	.	.	.	0.00	0.00	0.00
Portugal	.	.	.	.	*	0.00	**28.57**	0.00	0.00	5.00
Scotland	.	.	.	.	.	*	*	0.00	0.00	0.00
Slovakia	.	.	.	.	.	0.00	0.00	0.00	*	*
Slovenia	.	.	.	.	.	.	.	.	.	*
Spain	.	0.00	0.00	9.30	0.00	0.00	0.00	0.00	0.50	1.45
Sweden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	*	*	*	*	*	0.00	0.00	0.00	0.00	0.00
USA	.	.	.	.	.	.	22.96	15.55	*14.27*	9.26

Black color, regular: good quality (0.0-9.9)
Blue color, regular, italic: acceptable quality (10.0-14.9)
Red color, regular, underlined: conditionally acceptable quality (15.0-24.9)
Red color, bold, underlined: weak quality (25.0 and over)
*It was not possible to calculate this indicator due to the absence of deaths at the most advanced ages.

Table A2-4a. Ratio of probability of death at age 80 to probability of death at age 81, females.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	0.97	0.91	0.93
Austria	.	.	.	.	.	0.92	0.90	0.91	0.88	0.89
Belgium	.	.	.	.	.	0.92	0.91	0.90	0.89	0.92
Canada	.	.	*1.12*	*1.08*	*1.05*	0.98	0.95	0.93	0.90	0.91
Chile	.	.	.	.	.	.	.	.	0.93	0.89
Czech Rep.	.	.	.	.	.	0.92	0.91	0.90	0.92	0.90
Denmark	.	.	0.95	0.88	0.91	0.89	0.92	0.89	0.90	0.89
E&W	.	1.02	0.99	0.97	0.96	0.93	0.93	0.92	0.91	0.90
Estonia	.	.	.	.	.	.	0.93	0.93	0.89	0.85
Finland	0.98	0.93	0.97	0.95	0.89	0.92	0.91	0.92	0.92	0.89
France	.	.	.	.	.	0.91	0.90	0.90	0.88	0.89
Germany	.	.	.	.	.	.	.	.	.	0.89
Germany E	.	.	.	.	.	.	0.89	0.91	0.90	0.89
Germany W	.	.	.	.	.	.	0.91	0.90	0.89	0.88
Hungary	.	.	.	.	.	0.94	0.91	0.92	0.91	0.90
Iceland	.	.	.	.	.	.	0.79	0.81	0.80	0.93
Ireland	.	.	.	.	.	**1.37**	**1.34**	**1.31**	*1.13*	0.96
Italy	.	.	.	.	.	.	0.91	0.90	0.89	0.88
Japan	.	.	.	.	.	0.91	0.91	0.90	0.89	0.87
Latvia	.	.	.	.	.	.	0.97	0.93	0.90	0.92
Lithuania	.	.	.	.	.	.	.	0.97	0.92	0.90
Luxemburg	.	.	.	.	.	.	.	0.87	0.82	0.96
Netherlands	.	.	.	.	.	0.88	0.89	0.89	0.90	0.87
New Zeal.	.	.	.	.	.	1.03	*1.05*	0.99	0.99	0.90
NZ (NMaori)	.	.	*1.10*	*1.13*	*1.10*	1.01	1.03	0.98	0.99	0.90
Norway	0.95	0.94	0.93	0.93	0.89	0.90	0.89	0.88	0.88	0.90
Poland	.	.	.	.	.	.	.	0.91	0.91	0.89
Portugal	.	.	.	.	**1.82**	**1.34**	1.02	0.94	0.91	0.90
Scotland	.	.	.	.	.	0.90	0.91	0.91	0.93	0.92
Slovakia	.	.	.	.	.	.	0.92	0.92	0.91	0.90
Slovenia	.	.	.	.	.	.	.	.	.	0.85
Spain	.	**3.13**	**2.93**	**2.38**	**2.05**	**1.47**	*1.12*	0.97	0.90	0.89
Sweden	0.91	0.91	0.88	0.92	0.90	0.89	0.91	0.88	0.87	0.9
Switzerland	0.93	0.94	0.95	0.91	0.90	0.94	0.90	0.90	0.86	0.88
USA	.	.	.	.	.	.	0.97	0.95	0.91	0.91

Black color, regular: good or acceptable quality (below 1.05)
Blue color, regular, italic: moderate age heaping (1.05-1.19)
Red color, bold, underlined: significant age heaping (1.20 and over)

Table A2-4b Ratio of probability of death at age 80 to probability of death at age 81, males.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	0.98	0.96	0.91
Austria	.	.	.	.	.	0.92	0.92	0.93	0.92	0.92
Belgium	.	.	.	.	.	0.93	0.92	0.95	0.94	0.90
Canada	.	.	*1.10*	*1.05*	1.00	0.96	0.95	0.95	0.93	0.93
Chile	.	.	.	.	.	.	.	.	0.94	0.93
Czech Rep.	.	.	.	.	.	0.91	0.92	0.94	0.92	0.94
Denmark	.	.	0.94	0.93	0.91	0.91	0.93	0.92	0.94	0.91
E&W	.	1.01	0.99	0.96	0.95	0.94	0.94	0.94	0.93	0.93
Estonia	.	.	.	.	.	.	1.03	0.94	0.93	0.92
Finland	0.98	0.91	0.96	0.96	0.93	0.89	0.94	0.95	0.90	0.92
France	.	.	.	.	.	0.92	0.92	0.92	0.91	0.9
Germany	.	.	.	.	.	.	.	.	.	0.92
Germany E	.	.	.	.	.	.	0.92	0.93	0.92	0.91
Germany W	.	.	.	.	.	.	0.92	0.92	0.91	0.91
Hungary	.	.	.	.	.	0.93	0.91	0.91	0.92	0.92
Iceland	.	.	.	.	.	.	0.93	0.81	0.83	0.92
Ireland	.	.	.	.	.	**1.27**	**1.26**	**1.22**	*1.06*	0.97
Italy	.	.	.	.	.	.	0.92	0.93	0.92	0.91
Japan	.	.	.	.	.	0.89	0.93	0.92	0.91	0.90
Latvia	.	.	.	.	.	.	1.00	0.97	0.93	0.94
Lithuania	.	.	.	.	.	.	.	0.97	0.94	0.90
Luxemburg	.	.	.	.	.	.	.	0.94	0.88	0.92
Netherlands	.	.	.	.	.	0.87	0.91	0.92	0.93	0.91
New Zeal.	.	.	.	.	.	0.96	1.00	0.99	0.97	0.92
NZ (NMaori)	.	.	*1.13*	0.97	*1.07*	1.00	0.99	0.98	0.96	0.92
Norway	0.91	0.94	0.91	0.92	0.90	0.90	0.91	0.91	0.91	0.92
Poland	.	.	.	.	.	.	.	0.94	0.94	0.92
Portugal	.	.	.	.	**1.43**	*1.15*	0.97	0.93	0.93	0.93
Scotland	.	.	.	.	.	0.92	0.92	0.92	0.96	0.92
Slovakia	.	.	.	.	.	.	0.92	0.90	0.92	0.94
Slovenia	.	.	.	.	.	.	.	.	.	0.88
Spain	.	**2.38**	**2.25**	**1.83**	**1.63**	**1.28**	*1.06*	0.96	0.92	0.91
Sweden	0.93	0.90	0.91	0.92	0.91	0.91	0.90	0.91	0.91	0.90
Switzerland	0.94	0.91	0.92	0.90	0.93	0.91	0.89	0.91	0.92	0.90
USA	.	.	.	.	.	.	0.96	0.95	0.93	0.92

Black color, regular: good or acceptable quality (below 1.05)
Blue color, regular, italic: moderate age heaping (1.05-1.19)
Red color, bold, underlined: significant age heaping (1.20 and over)

Table A2-5a. Age heaping index at age 90, females

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	1.02	1.01	1.02
Austria	.	.	.	.	.	1.01	1.03	1.01	1.04	1.04
Belgium	.	.	.	.	.	1.04	1.03	1.03	1.03	1.03
Canada	.	.	*1.13*	1.08	1.08	1.01	1.01	1.03	1.02	1.02
Chile	.	.	.	.	.	.	.	.	1.01	1.02
Czech Rep.	.	.	.	.	.	1.01	1.02	1.02	1.03	1.04
Denmark	.	.	1.01	1.04	1.05	1.00	1.03	1.05	1.02	1.03
E&W	.	1.01	1.03	1.03	1.04	1.02	1.03	1.03	1.03	1.03
Estonia	.	.	.	.	.	.	1.03	0.99	1.04	1.06
Finland	*1.16*	1.09	1.09	1.03	1.02	1.06	1.05	0.99	1.02	1.05
France	.	.	.	.	.	1.03	1.03	1.02	1.02	1.03
Germany	.	.	.	.	.	.	.	.	.	1.03
Germany E	.	.	.	.	.	.	1.03	1.02	1.02	1.03
Germany W	.	.	.	.	.	.	1.03	1.02	1.03	1.04
Hungary	.	.	.	.	.	1.04	1.02	1.02	1.04	1.01
Iceland	.	.	.	.	.	.	*1.14*	1.01	1.07	1.07
Ireland	.	.	.	.	.	*1.20*	*1.16*	1.05	1.06	1.00
Italy	.	.	.	.	.	.	1.02	1.04	1.03	1.03
Japan	.	.	.	.	.	1.01	1.02	1.03	1.02	1.03
Latvia	.	.	.	.	.	.	1.02	1.02	1.00	1.01
Lithuania	.	.	.	.	.	.	.	1.08	1.00	1.03
Luxemburg	.	.	.	.	.	.	.	0.98	*1.14*	1.02
Netherlands	.	.	.	.	.	1.02	1.03	1.00	1.01	1.02
New Zeal.	.	.	.	.	.	1.04	1.02	1.03	1.05	1.05
NZ (NMaori)	.	.	1.01	1.09	1.07	1.02	1.02	1.03	1.05	1.04
Norway	0.98	0.99	1.01	1.01	1.03	1.02	1.03	1.01	1.04	1.01
Poland	.	.	.	.	.	.	.	1.04	1.02	1.04
Portugal	.	.	·	·	**1.46**	*1.15*	1.00	1.03	1.04	1.03
Scotland	.	.	.	.	.	0.98	1.02	1.04	1.03	1.03
Slovakia	.	.	.	.	.	.	1.03	1.04	1.04	1.02
Slovenia	.	.	.	.	.	.	.	.	.	1.04
Spain	.	**1.99**	**1.8**	**1.66**	**1.37**	*1.19*	1.07	1.05	1.04	1.03
Sweden	1.03	1.03	1.05	1.02	1.04	1.00	1.03	1.03	1.01	1.03
Switzerland	1.07	1.02	0.98	0.99	1.03	1.02	1.03	1.06	1.03	1.04
USA	.	.	.	.	.	.	1.04	1.04	1.03	1.02

Black color, regular: good or acceptable quality (below 1.10)
Blue color, regular, italic: moderate age heaping (1.10-1.19)
Red color, bold, underlined: significant age heaping (1.20 and over)

Table A2-5b. Age heaping index at age 90, males.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	1.03	1.03	1.03
Austria	.	.	.	.	.	1.04	1.02	1.03	1.03	1.04
Belgium	.	.	.	.	.	1.04	1.03	1.04	1.04	1.03
Canada	.	.	1.09	1.06	1.04	1.02	1.01	1.04	1.02	1.01
Chile	.	.	.	.	.	.	.	.	1.00	1.02
Czech Rep.	.	.	.	.	.	1.01	1.02	1.02	1.03	1.03
Denmark	.	.	1.02	1.03	1.00	1.03	1.03	1.01	0.99	1.03
E&W	.	1.02	1.01	1.03	1.03	1.02	1.01	1.02	1.01	1.03
Estonia	.	.	.	.	.	.	0.96	1.04	1.03	1.00
Finland	*1.12*	1.05	0.98	1.03	1.01	1.06	1.03	1.03	1.03	1.01
France	.	.	.	.	.	1.01	1.02	1.03	1.02	1.03
Germany	.	.	.	.	.	.	.	.	.	1.04
Germany E	.	.	.	.	.	.	1.06	1.04	1.02	1.03
Germany W	.	.	.	.	.	.	1.02	1.03	1.02	1.04
Hungary	.	.	.	.	.	1.04	1.01	1.01	1.03	1.02
Iceland	.	.	.	.	.	.	1.09	1.00	1.06	1.04
Ireland	.	.	.	.	.	.	*1.13*	1.07	1.03	0.99
Italy	.	.	.	.	.	1.02	1.03	1.03	1.02	1.03
Japan	.	.	.	.	.	1.02	1.03	1.04	1.02	1.03
Latvia	.	.	.	.	.	.	1.06	1.03	1.03	1.06
Lithuania	.	.	.	.	.	.	.	1.01	0.97	1.03
Luxemburg	.	.	.	.	.	.	.	1.01	0.95	0.99
Netherlands	.	.	.	.	.	1.05	1.01	1.00	1.02	1.01
New Zeal.	.	.	.	.	.	0.98	1.04	1.03	1.02	1.03
NZ (NMaori)	.	.	1.06	1.06	0.97	0.97	1.04	1.03	1.02	1.02
Norway	1.01	1.02	1.06	1.07	1.03	1.02	1.02	1.00	1.02	1.03
Poland	.	.	.	.	.	.	.	1.03	1.01	1.03
Portugal	.	.	.		**1.23**	1.07	1.05	1.00	1.04	1.02
Scotland	.	.	.	.	.	1.02	1.04	1.00	1.02	1.03
Slovakia	.	.	.	.	.	.	1.03	1.04	1.01	0.96
Slovenia	.	.	.	.	.	.	.	.	.	1.03
Spain	.	**1.64**	**1.49**	**1.38**	*1.18*	*1.12*	1.04	1.02	1.03	1.02
Sweden	1.02	1.07	1.03	1.06	1.02	1.02	1.02	1.02	1.02	1.02
Switzerland	1.05	1.08	0.99	1.04	1.07	1.00	1.03	1.03	1.05	1.03
USA	.	.	.	.	.	.	1.03	1.02	1.02	1.02

Black color, regular: good or acceptable quality (below 1.10)
Blue color, regular, italic: moderate age heaping (1.10-1.19)
Red color, bold, underlined: significant age heaping (1.20 and over)

Table A2-6a. Age heaping index at age 100, females.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	1.03	1.02	1.02
Austria	.	.	.	.	.	1.09	**1.30**	1.09	1.05	1.06
Belgium	.	.	.	.	.	**1.33**	**1.43**	*1.19*	1.01	1.05
Canada	.	.	*1.11*	*1.14*	1.08	1.04	1.07	1.03	1.02	1.04
Chile	.	.	.	.	.	.	.	.	0.91	*1.12*
Czech Rep.	.	.	.	.	.	**1.22**	0.94	0.88	1.09	0.99
Denmark	.	.	**1.75**	*	*1.19*	*1.17*	1.02	*1.14*	*1.10*	1.08
E&W	.	0.98	0.94	1.05	1.05	1.01	1.07	1.05	1.06	1.05
Estonia	.	.	.	.	.	.	*1.11*	1.03	1.03	1.01
Finland	**1.33**	*1.14*	**1.7**	0.6	0.93	*1.12*	0.92	**1.21**	1.02	1.05
France	.	.	.	.	.	**1.32**	**1.24**	1.07	*1.11*	1.06
Germany	.	.	.	.	.	.	.	.	.	1.07
Germany E	.	.	.	.	.	.	0.97	1.05	1.06	*1.11*
Germany W	.	.	.	.	.	.	*1.15*	*1.16*	1.06	1.06
Hungary	.	.	.	.	.	1.07	0.98	1.09	1.08	1.02
Iceland	.	.	.	.	.	.	0.89	**1.45**	**1.39**	**1.39**
Ireland	.	.	.	.	.	1.04	0.95	0.78	1.02	0.99
Italy	.	.	.	.	.	.	0.99	0.97	1.03	1.06
Japan	.	.	.	.	.	1.07	0.99	1.03	1.02	1.04
Latvia	.	.	.	.	.	.	1.08	1.09	1.06	*1.16*
Lithuania	.	.	.	.	.	.	.	1.02	1.03	*1.10*
Luxemburg	.	.	.	.	.	.	.	**1.87**	**2.08**	1.07
Netherlands	.	.	.	.	.	*1.13*	1.08	1.01	1.00	1.03
New Zeal.	.	.	.	.	.	**1.27**	1.02	1.07	*1.12*	*1.12*
NZ (NMaori)	.	.	**1.42**	0.99	1.06	*1.20*	1.04	*1.10*	*1.11*	*1.12*
Norway	*1.16*	1.09	*1.16*	*1.19*	*1.12*	1.01	1.04	1.07	0.98	*1.11*
Poland	.	.	.	.	.	.	.	*1.16*	*1.17*	*1.11*
Portugal	.	.	·	·	**1.24**	*1.15*	*1.13*	1.02	0.97	1.08
Scotland	.	.	.	.	.	1.03	*1.10*	0.98	1.02	1.06
Slovakia	.	.	.	.	.	.	**1.28**	0.99	*1.15*	*1.18*
Slovenia	.	.	.	.	.	.	.	.	.	**1.21**
Spain	.	*1.13*	**1.29**	**1.32**	*1.12*	1.04	0.99	0.97	0.97	0.99
Sweden	1.09	0.99	*1.14*	0.96	0.94	*1.16*	*1.10*	1.07	1.06	1.06
Switzerland	*	*	*	*	**1.40**	0.99	**1.24**	**1.30**	*1.11*	1.09
USA	.	.	.	.	.	.	1.05	1.04	1.02	1.04

Black color, regular: good or acceptable quality (below 1.10)
Blue color, regular, italic: moderate age heaping (1.10-1.19)
Red color, bold, underlined: significant age heaping (1.20 and over)
*It was not possible to calculate this indicator due to the absence of deaths at the most advanced ages.

Table A2-6b. Age heaping index at age 100, males.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	1.04	1.01	1.05
Austria	.	.	.	.	.	**2.08**	*1.12*	*1.11*	1.08	1.03
Belgium	.	.	.	.	.	**1.85**	**1.42**	**1.25**	*1.18*	1.00
Canada	.	.	**1.23**	*1.17*	*1.12*	1.07	1.06	1.04	1.00	1.04
Chile	.	.	.	.	.	.	.	.	0.94	0.98
Czech Rep.	.	.	.	.	.	*	1.04	0.90	0.76	0.99
Denmark	.	.	*	*	**2.04**	**1.54**	**1.38**	0.92	1.07	1.09
E&W	.	1.09	*1.19*	0.95	0.78	0.98	1.07	1.07	1.07	1.01
Estonia	.	.	.	.	.	.	*	1.06	*1.14*	**1.56**
Finland	*	*	*	*	0.89	**1.21**	0.97	0.96	1.06	**1.3**
France	.	.	.	.	.	**1.56**	**1.33**	**1.27**	*1.18*	1.03
Germany	.	.	.	.	.	.	.	.	.	*1.17*
Germany E	.	.	.	.	.	.	1.02	*1.11*	*1.15*	*1.16*
Germany W	.	.	.	.	.	.	1.03	*1.16*	*1.17*	*1.17*
Hungary	.	.	.	.	.	**1.31**	*1.13*	*1.12*	*1.15*	1.08
Iceland	.	.	.	.	.	.	1.08	*	**2.38**	**1.24**
Ireland	.	.	.	.	.	0.94	0.76	0.77	0.84	1.05
Italy	.	.	.	.	.	.	1.01	1.08	1.04	*1.11*
Japan	.	.	.	.	.	1.08	1.08	1.09	1.04	1.02
Latvia	.	.	.	.	.	.	0.93	1.08	**1.27**	**1.31**
Lithuania	.	.	.	.	.	.	.	1.00	0.99	1.08
Luxemburg	.	.	.	.	.	.	.	**2.66**	**2.54**	*
Netherlands	.	.	.	.	.	1.08	*1.13*	0.99	1.04	*1.10*
New Zeal.	.	.	.	.	.	*1.19*	0.90	**1.38**	**1.22**	0.97
NZ (NMaori)	.	.	*	0.78	*1.13*	*1.16*	1.01	**1.37**	**1.23**	0.95
Norway	0.88	**1.68**	*1.16*	1.09	**1.27**	0.99	*1.15*	1.05	0.96	1.05
Poland	.	.	.	.	.	.	.	*1.2*	*1.16*	*1.16*
Portugal	.	.	.	.	*	1.09	**1.21**	0.93	1.08	*1.13*
Scotland	.	.	.	.	.	0.96	0.95	**1.24**	*1.13*	**1.23**
Slovakia	.	.	.	.	.	.	0.94	**1.3**	**1.35**	1.08
Slovenia	.	.	.	.	.	.	.	.	.	*1.11*
Spain	.	0.95	*1.16*	*1.16*	1.09	1.02	0.89	0.94	0.96	0.97
Sweden	**1.28**	**1.41**	*1.17*	1.05	**1.33**	0.88	0.93	1.06	1.04	1.06
Switzerland	*	*	*	*	0.83	*1.15*	**1.26**	1.04	*1.11*	*1.12*
USA	.	.	.	.	.	.	1.06	1.02	1.01	1.04

Black color, regular: good or acceptable quality (below 1.10)
Blue color, regular, italic: moderate age heaping (1.10-1.19)
Red color, bold, underlined: significant age heaping (1.20 and over)
*It was not possible to calculate this indicator due to the absence of deaths at the most advanced ages.

Table A2-7a. Whipple's Index for centenarians, relative difference to Sweden, females.

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	2.11	1.17	2.04
Austria	.	.	.	.	.	3.35	*6.06*	2.99	*5.25*	2.24
Belgium	.	.	.	.	.	4.38	3.57	1.68	2.39	0.72
Canada	.	.	4.99	3.41	4.69	*5.67*	2.65	3.49	2.75	3.37
Chile	.	.	.	.	.	.	.	.	0.21	0.29
Czech Rep.	.	.	.	.	.	1.39	4.55	3.73	*7.28*	*5.78*
Denmark	.	.	*5.84*	2.41	2.21	0.37	1.95	0.65	1.10	0.78
E&W	.	2.91	0.91	2.41	0.44	2.26	0.66	2.10	0.59	1.22
Estonia	.	.	.	.	.	.	1.27	0.30	1.87	1.99
Finland	3.53	10.43	1.65	1.62	3.56	1.85	*7.51*	2.38	3.52	2.57
France	.	.	.	.	.	1.42	2.06	0.72	0.39	1.27
Germany	.	.	.	.	.	.	.	.	3.78	2.08
Germany E	.	.	.	.	.	.	*8.21*	*5.09*	*8.08*	3.45
Germany W	.	.	.	.	.	.	*6.31*	2.71	4.33	1.82
Hungary	.	.	.	.	.	2.12	*7.61*	*5.58*	*7.15*	3.51
Iceland	.	.	.	.	.	.	4.72	9.11	3.94	0.23
Ireland	.	.	.	.	.	3.13	0.78	2.50	0.40	0.41
Italy	.	.	.	.	.	.	3.60	1.11	2.33	0.47
Japan	.	.	.	.	.	3.99	*5.38*	1.72	3.67	0.57
Latvia	.	.	.	.	.	.	2.22	2.75	0.07	1.70
Lithuania	.	.	.	.	.	.	.	*5.73*	4.20	1.08
Luxemburg	.	.	.	.	.	.	.	3.70	3.07	2.25
Netherlands	.	.	.	.	.	0.41	0.62	0.39	0.56	0.38
New Zeal.	.	.	.	.	.	3.90	0.02	2.67	1.21	2.59
NZ (NMaori)	.	.	1.28	1.11	3.46	1.65	0.69	2.39	1.12	2.67
Norway	4.91	1.78	2.46	0.78	2.81	3.28	0.93	2.05	0.47	0.73
Poland	.	.	.	.	.	.	.	.	2.52	3.71
Portugal	.	.	.	.	11.51	*8.63*	0.13	0.57	1.31	1.37
Scotland	.	.	.	.	.	0.06	2.02	2.05	0.67	0.56
Slovakia	.	.	.	.	.	.	0.56	2.92	*7.19*	*5.26*
Slovenia	.	.	.	.	.	.	.	.	.	*5.42*
Spain	.	**12.62**	9.61	*7.51*	9.51	*7.93*	2.26	2.28	0.40	0.62
Sweden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	*6.74*	3.03	*7.77*	3.24	1.93	2.58	*5.93*	0.74	2.50	0.67
USA	.	.	.	.	.	.	2.10	3.94	2.57	3.69

Black color, regular: good quality (0.0-4.9)
Blue color, regular, *italic*: acceptable quality (5.0-8.9)
Red color, regular, underlined: conditionally acceptable quality (9.0-11.9)
Red color, bold, underlined: weak quality (12.0 and over)

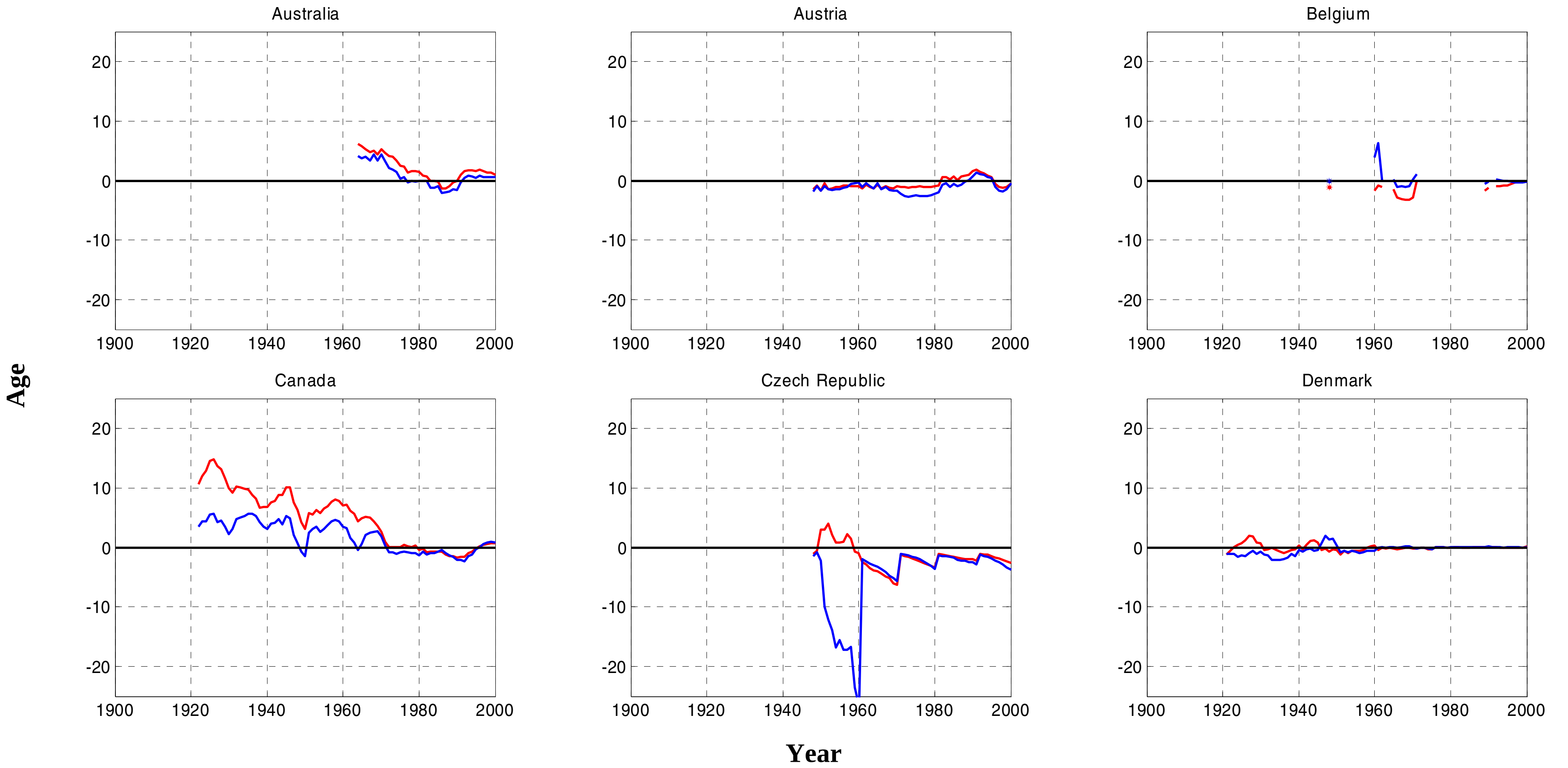
Table A2-7b Whipple's Index for centenarians, relative difference to Sweden, males

	1901-1910	1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000
Australia	.	.	.	.	.	.	.	0.97	2.49	0.92
Austria	.	.	.	.	.	4.85	*5.18*	2.82	2.21	*5.71*
Belgium	.	.	.	.	.	3.94	2.89	2.17	1.10	0.47
Canada	.	.	11.41	*5.57*	*5.63*	*8.66*	3.50	3.42	*5.52*	2.66
Chile	.	.	.	.	.	.	.	.	0.46	0.14
Czech Rep.	.	.	.	.	.	2.93	4.17	4.86	*5.53*	*9.03*
Denmark	.	.	3.94	4.37	4.84	*5.59*	2.11	0.51	1.77	2.16
E&W	.	*6.74*	2.56	4.56	1.74	0.90	1.57	0.49	0.37	2.16
Estonia	.	.	.	.	.	.	3.11	3.94	0.43	2.74
Finland	1.21	*7.52*	11.54	11.40	*8.51*	4.90	4.58	3.71	4.60	1.95
France	.	.	.	.	.	3.45	2.99	0.57	0.35	2.24
Germany	.	.	.	.	.	.	.	.	.	4.38
Germany E	.	.	.	.	.	.	10.40	2.05	4.13	*6.41*
Germany W	.	.	.	.	.	.	*6.55*	2.08	1.54	3.99
Hungary	.	.	.	.	.	2.46	*9.15*	4.79	*5.87*	*5.68*
Iceland	.	.	.	.	.	.	3.93	0.87	2.66	*5.14*
Ireland	.	.	.	.	.	*6.90*	1.55	0.72	1.26	1.37
Italy	.	.	.	.	.	.	3.25	0.08	0.29	1.91
Japan	.	.	.	.	.	*5.98*	4.75	3.03	3.14	0.01
Latvia	.	.	.	.	.	.	0.62	3.14	2.15	1.37
Lithuania	.	.	.	.	.	.	.	*8.38*	*7.15*	0.54
Luxemburg	.	.	.	.	.	.	.	10.94	0.81	*8.64*
Netherlands	.	.	.	.	.	0.17	1.14	1.48	1.71	1.42
New Zeal.	.	.	.	.	.	*7.68*	0.83	2.76	2.30	0.90
NZ (NMaori)	.	.	*6.68*	*5.69*	2.22	4.52	0.44	2.41	2.23	0.75
Norway	*9.65*	0.90	*8.05*	1.68	3.95	*5.10*	1.52	2.53	0.35	0.47
Poland	.	.	.	.	.	.	.	0.15	0.37	3.44
Portugal	.	.	.	.	13.64	*5.25*	3.82	1.87	1.42	2.74
Scotland	.	.	.	.	.	0.90	*5.97*	1.54	0.76	2.67
Slovakia	.	.	.	.	.	.	2.88	*5.21*	*5.19*	*5.22*
Slovenia	.	.	.	.	.	.	.	.	.	*7.13*
Spain	.	**16.46**	12.50	*7.23*	*9.37*	*8.74*	2.09	0.68	0.15	0.01
Sweden	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Switzerland	4.33	3.07	*7.77*	4.54	*5.16*	0.41	4.88	2.68	0.45	2.45
USA	.	.	.	.	.	.	4.86	3.86	4.29	2.79

Black color, regular: good quality (0.0-4.9)
Blue color, regular, italic: acceptable quality (5.0-9.9)
Red color, regular, underlined: conditionally acceptable quality (10.0-14.9)
Red color, bold, underlined: weak quality (15.0 and over)

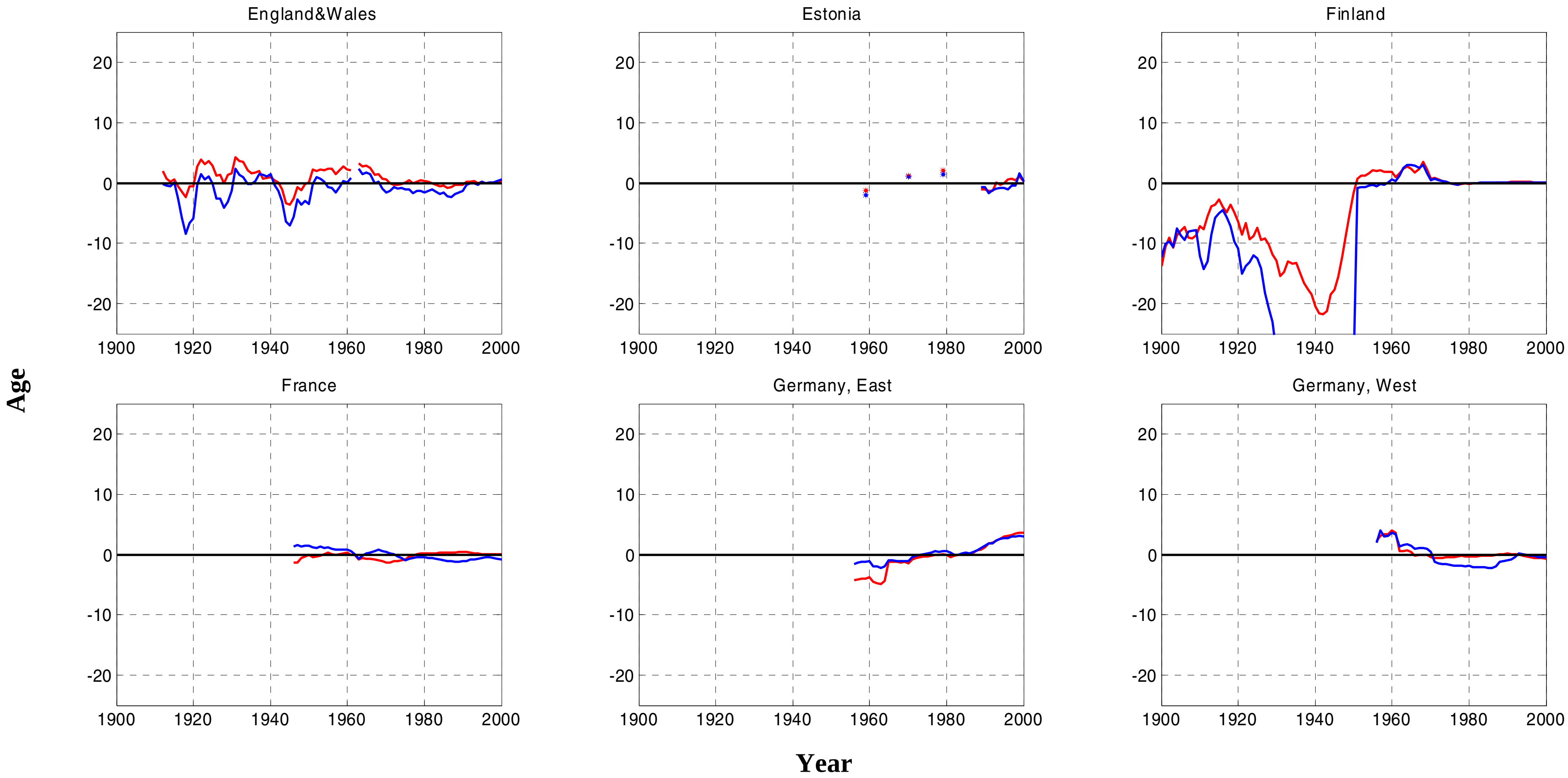
Appendix 3.

Figure 3-1. Relative weighted differences between the KTD and official population estimates (in percent)



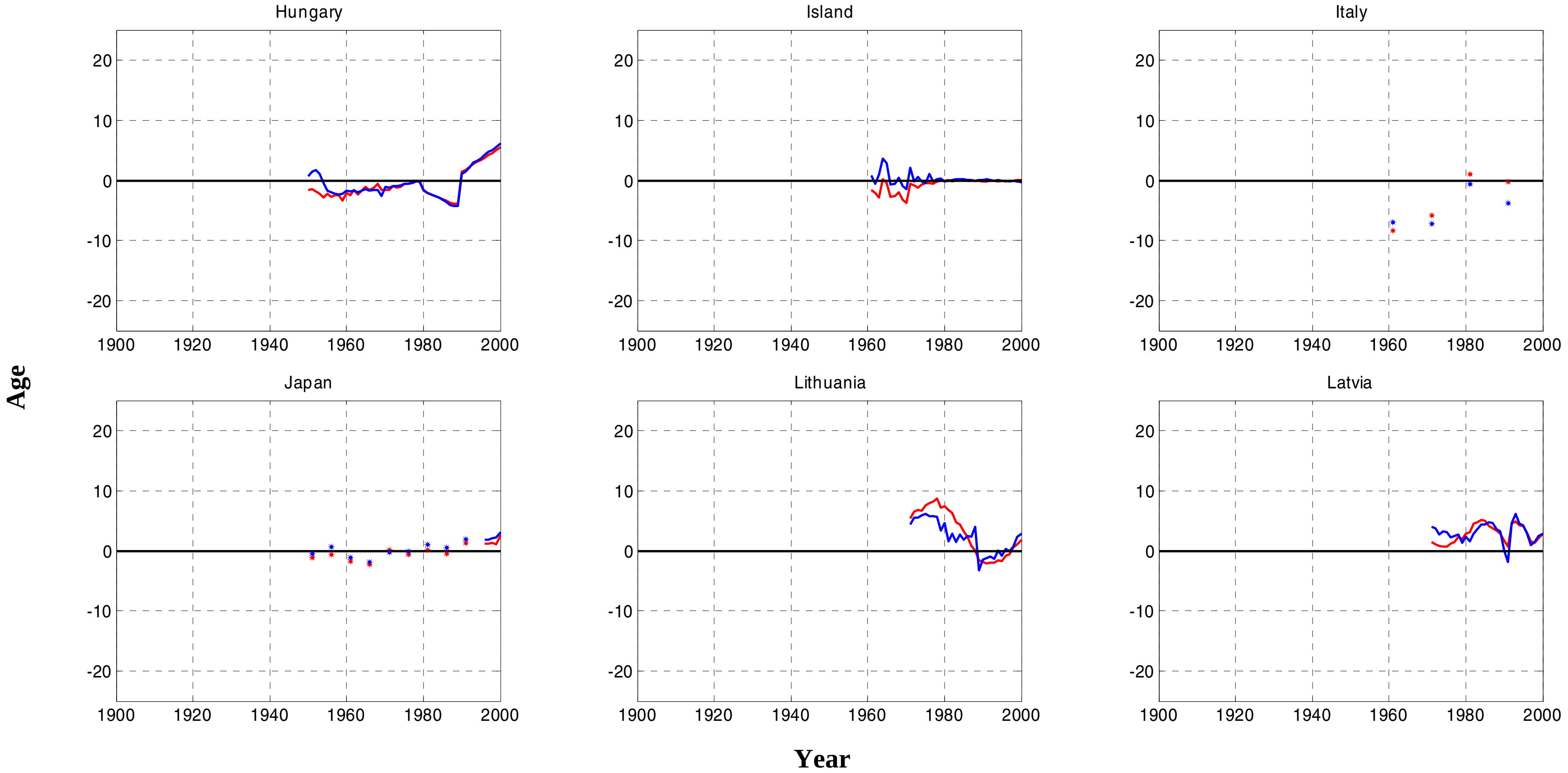
Note: red - females, blue - males. Stars are used to show point estimates (usually in census years) when data are not available as continuous series.

Figure 3-1 (continued). Relative weighted differences between the KTD and official population estimates (in percent)



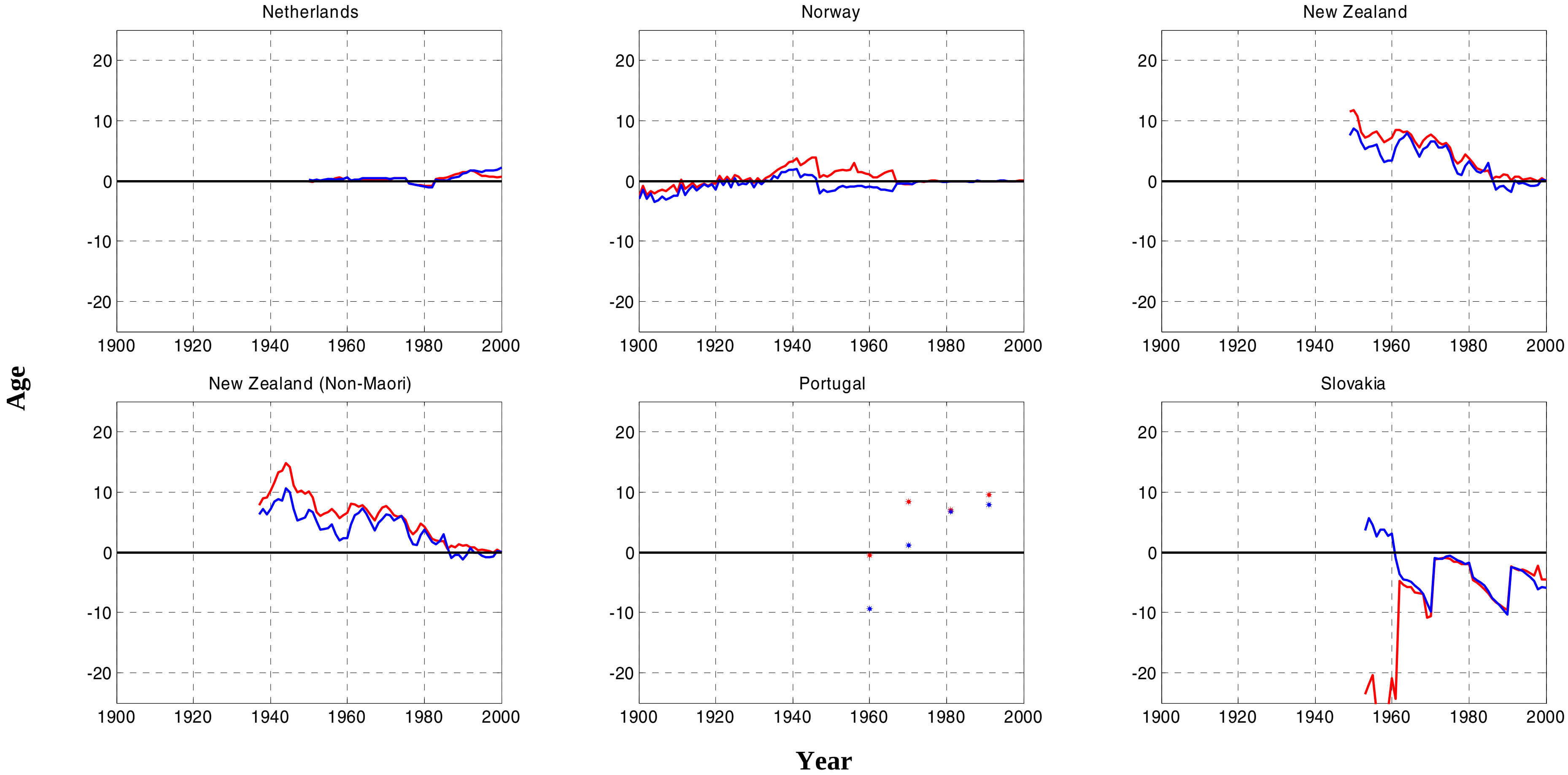
Note: red - females, blue - males. Stars are used to show point estimates (usually in census years) when data are not available as continuous series.

Figure 3-1 (continued). Relative weighted differences between the KTD and official population estimates (in percent)



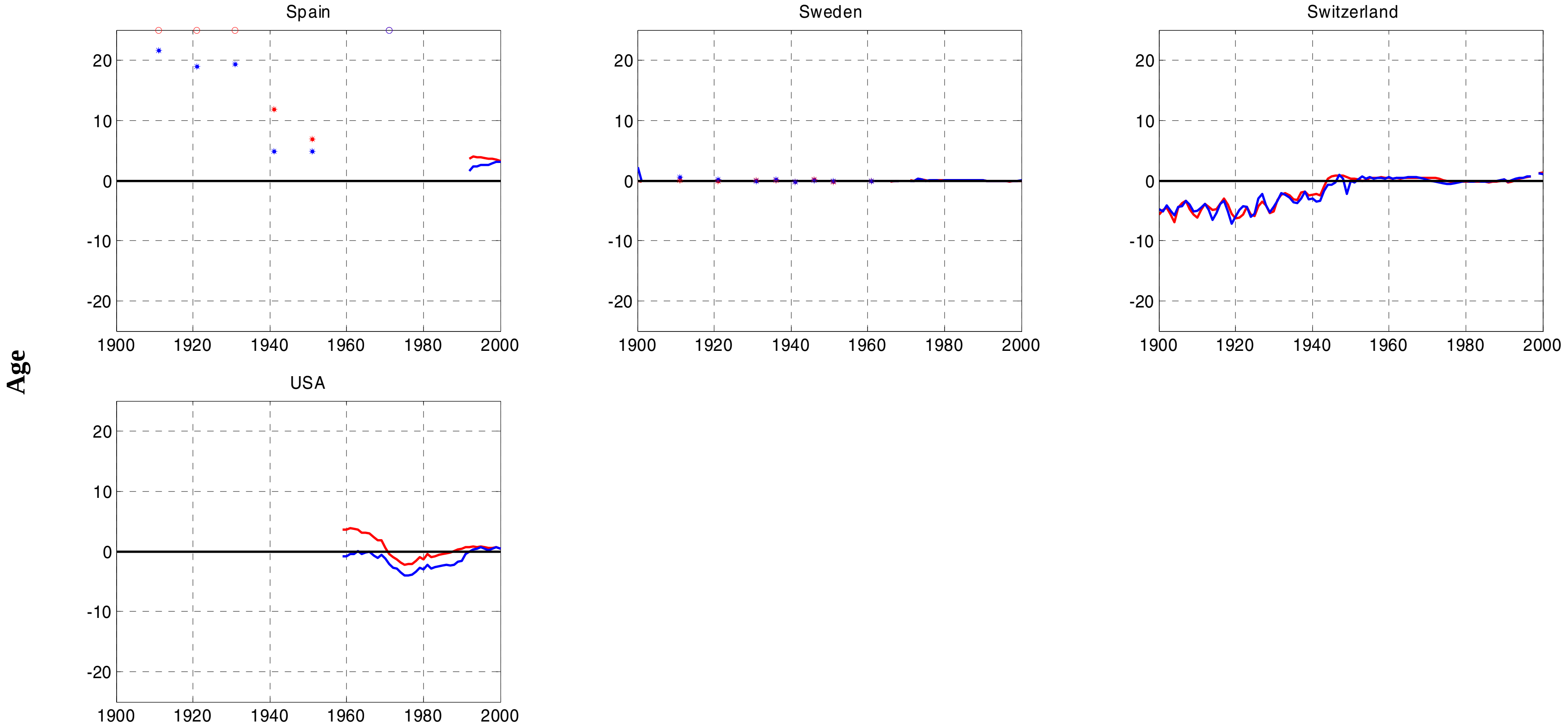
Note: red - females, blue - males. Stars are used to show point estimates (usually in census years) when data are not available as continuous series.

Figure 3-1 (continued). Relative weighted differences between the KTD and official population estimates (in percent)



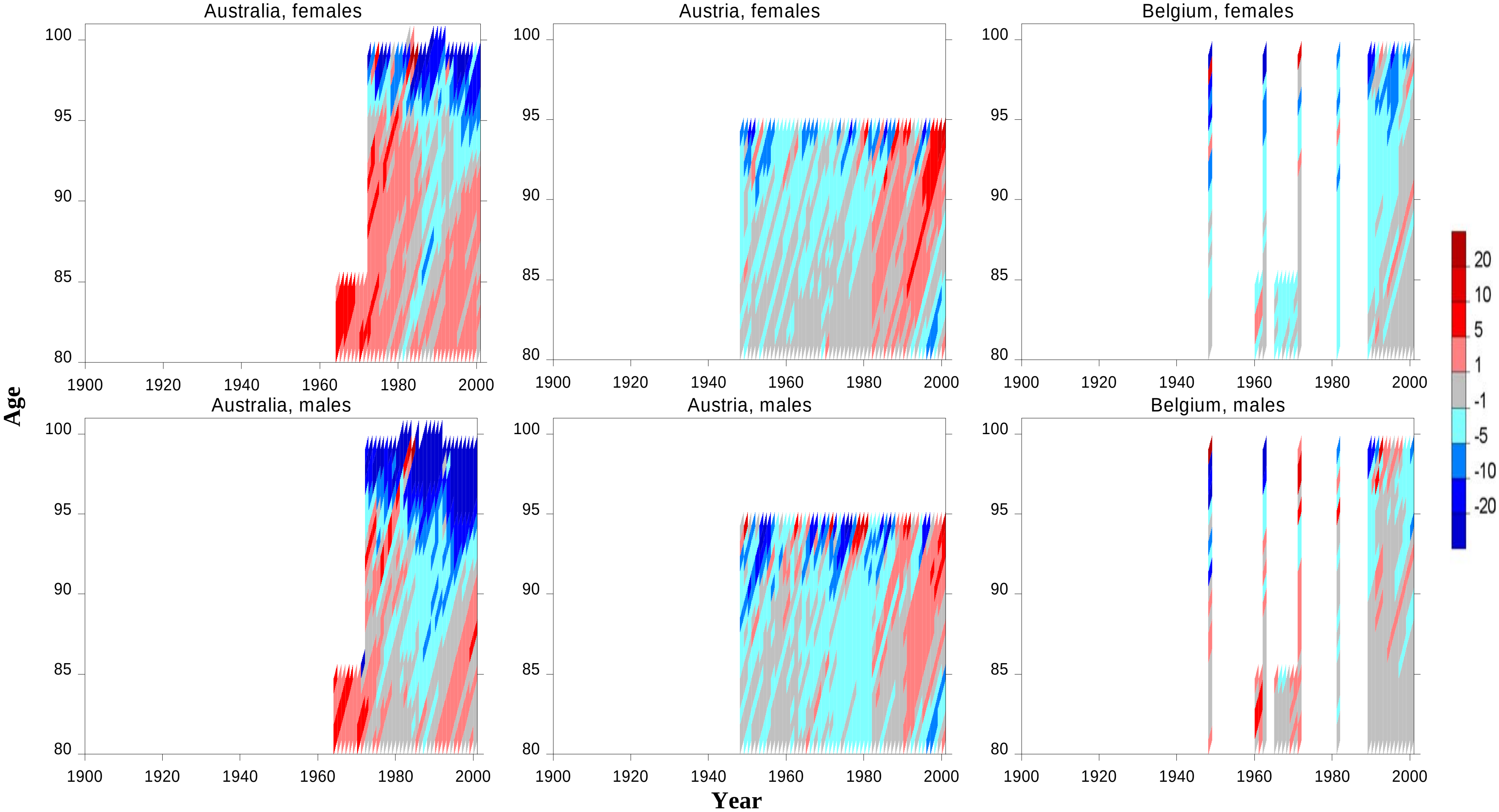
Note: relative weighted differences between the KTD and the official populations above age 80 (in percent). Red - females, blue - males. Stars are used to show point estimates (usually in census years) when data are not available as continuous series.

Figure 3-1 (continued). Relative weighted differences between the KTD and official population estimates (in percent)



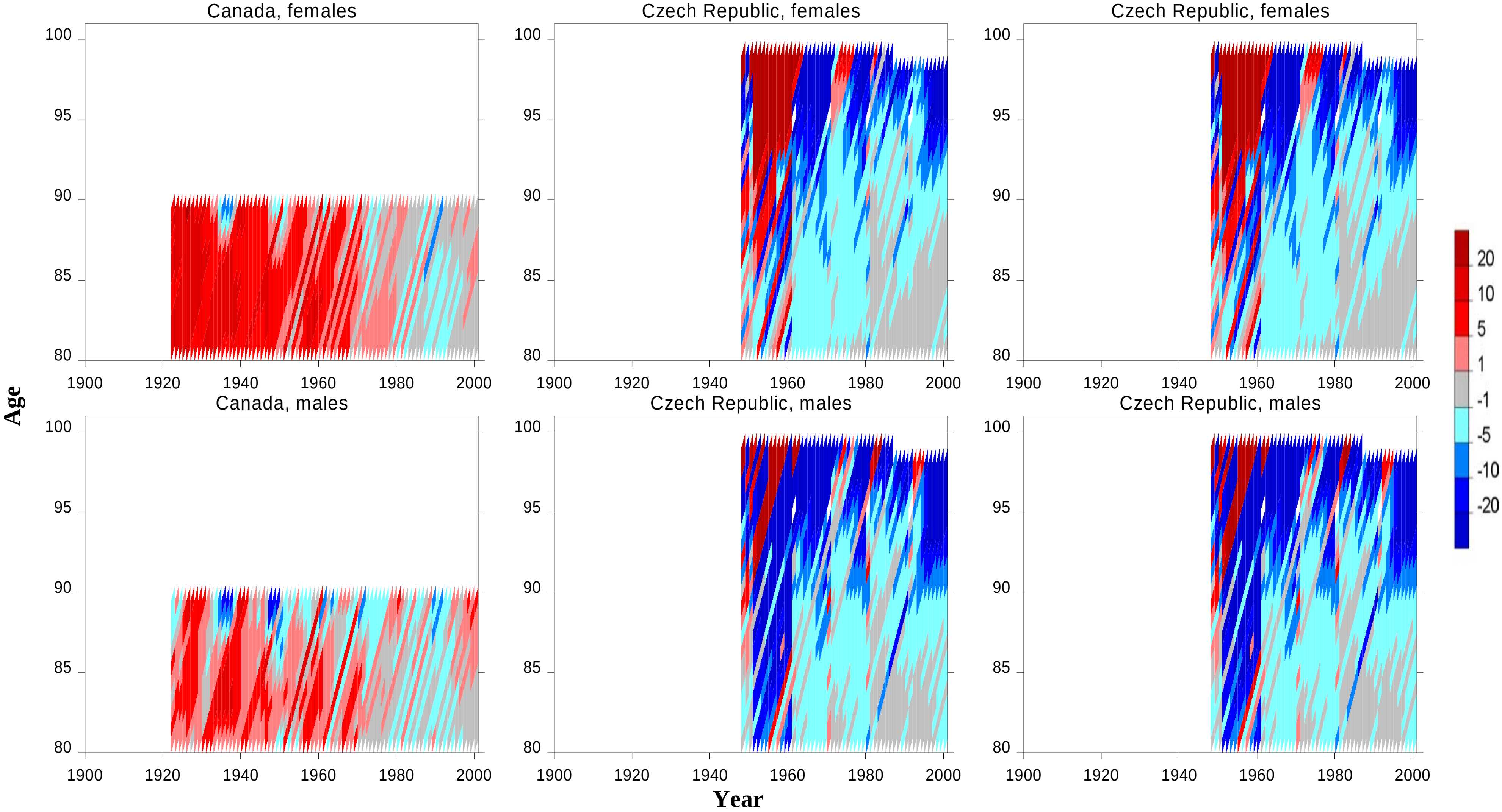
Note: red - females, blue - males. Stars are used to show point estimates (usually in census years) when data are not available as continuous series.

Figure 3-2. Age-specific relative differences between the KTD and the official population estimates (in percent)



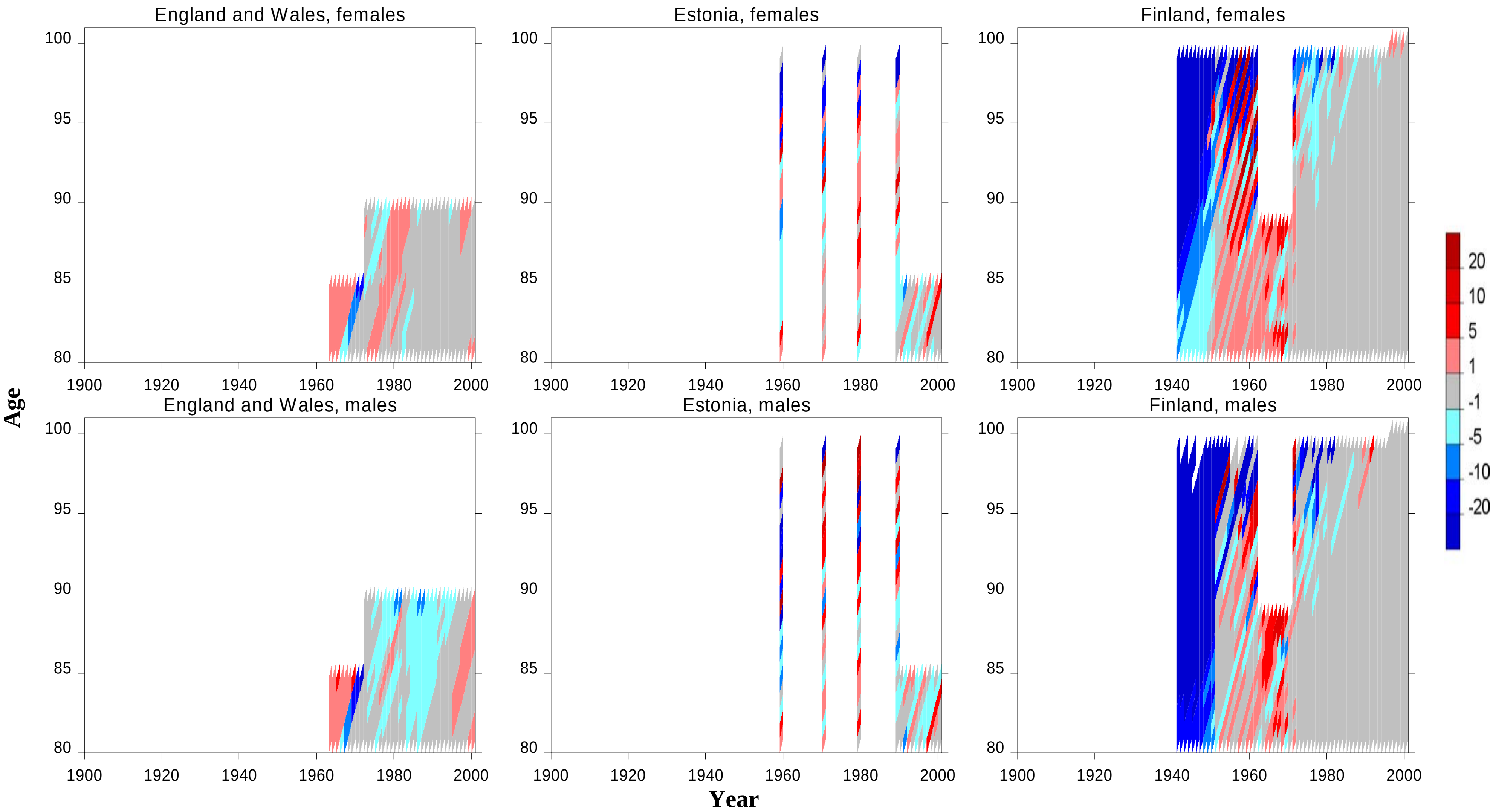
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



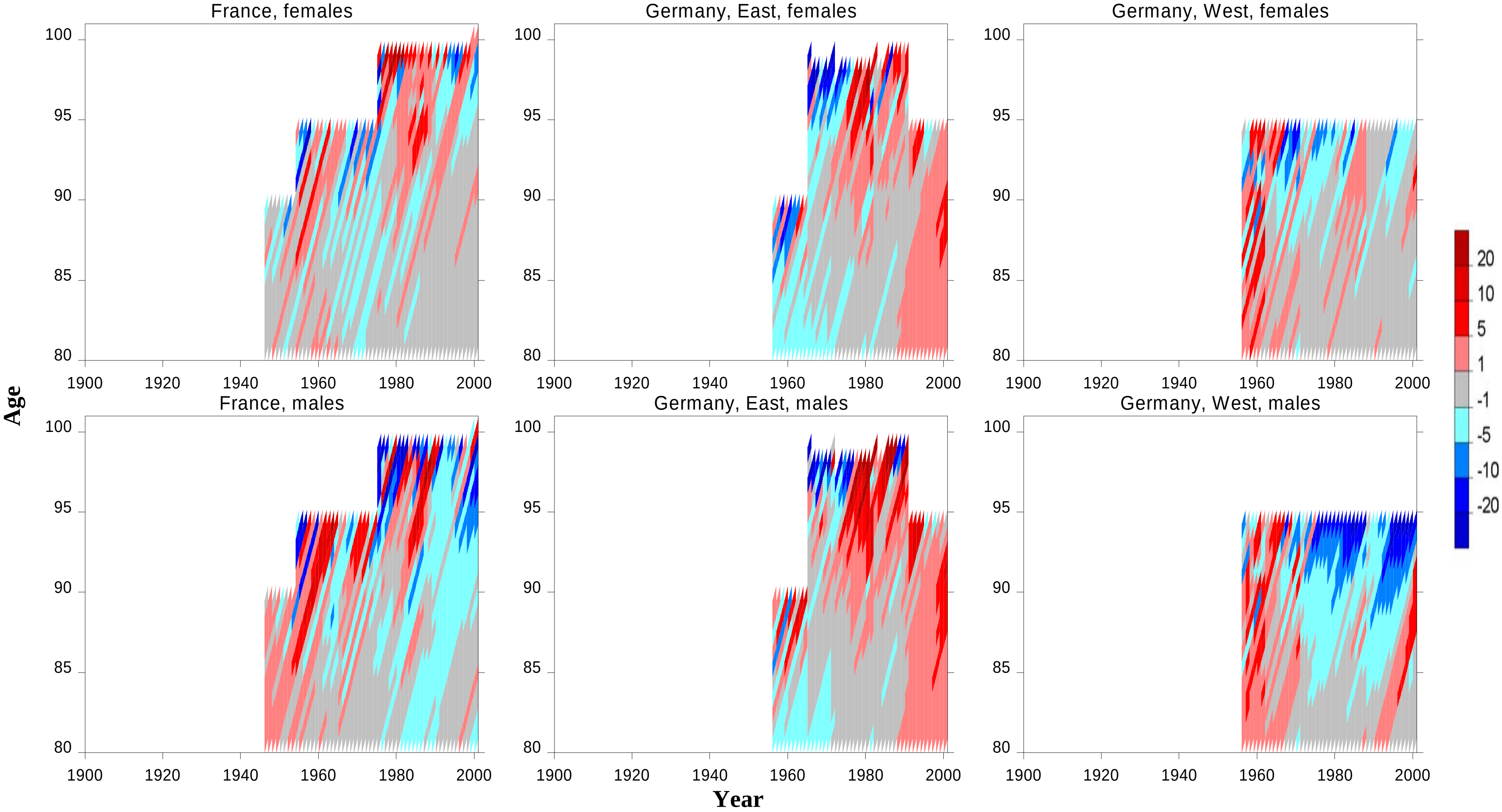
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



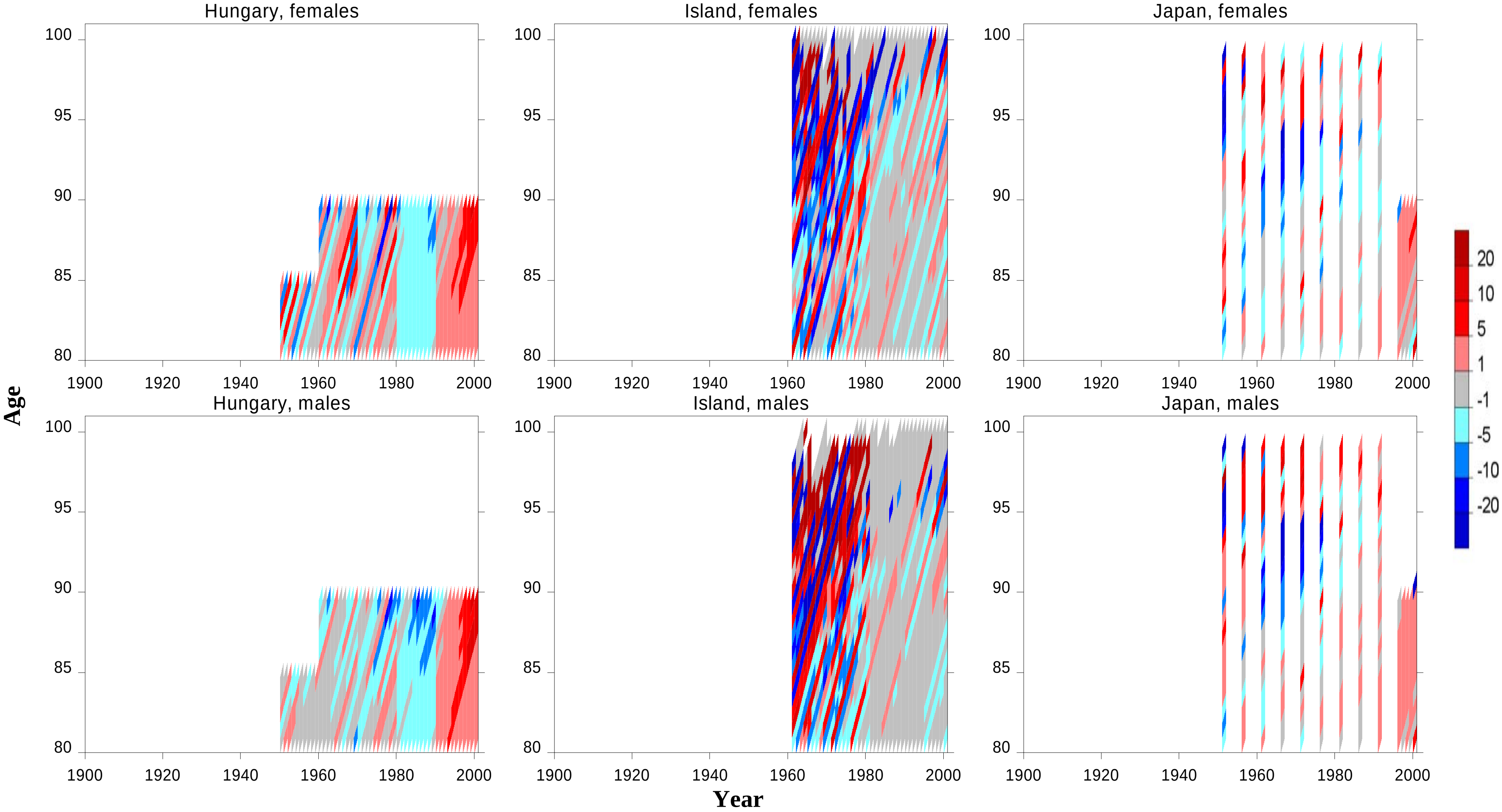
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



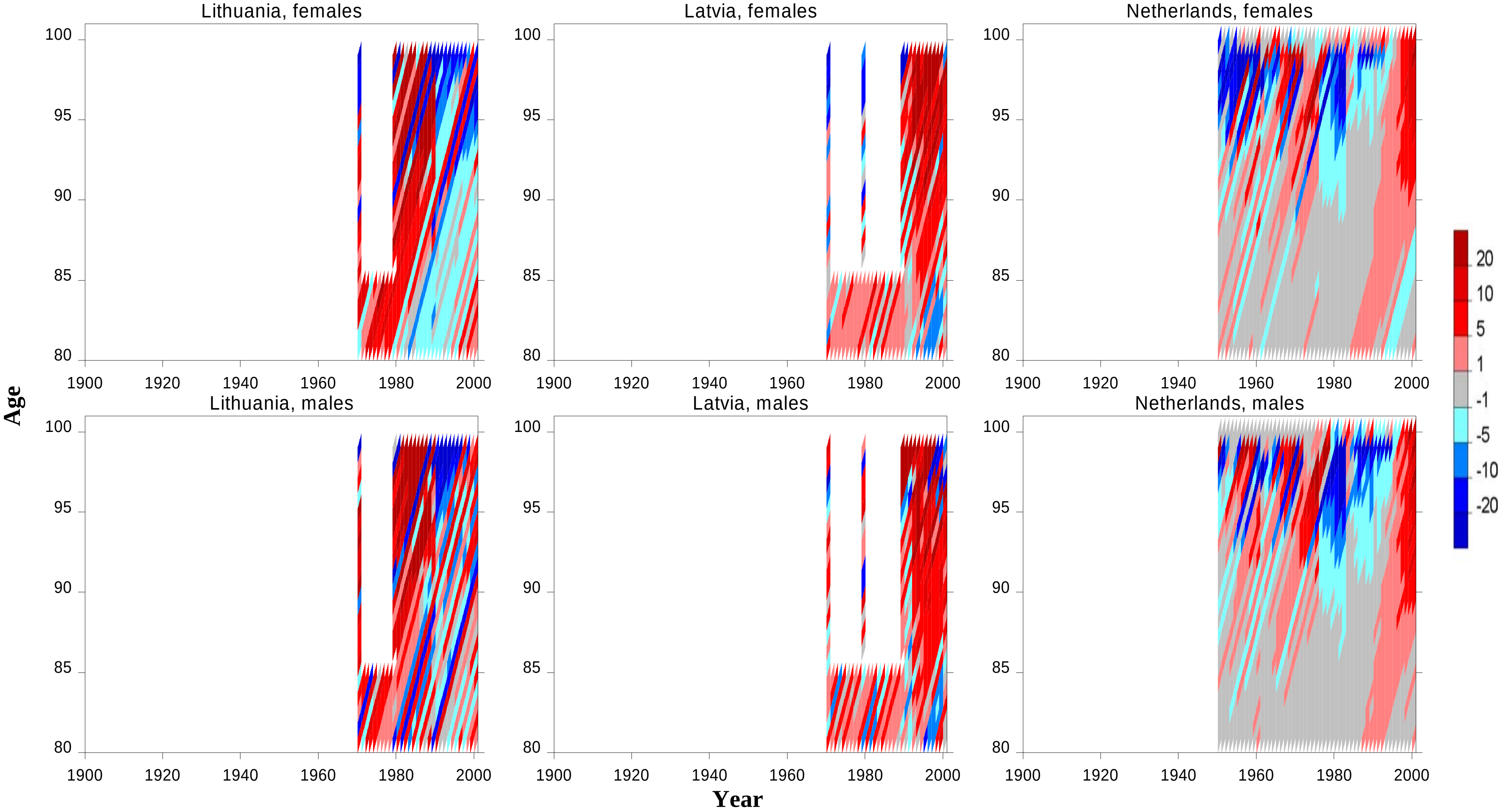
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



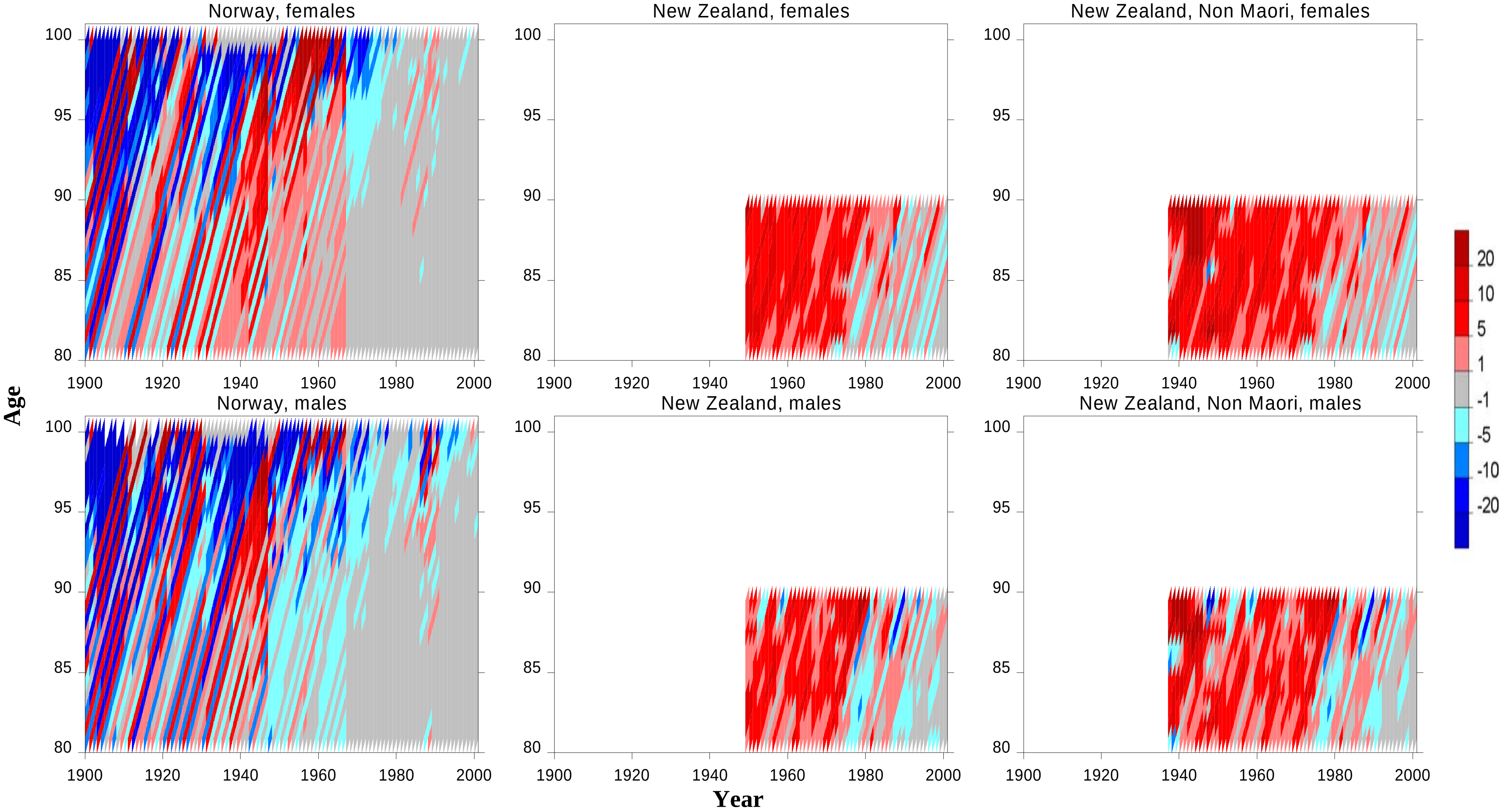
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



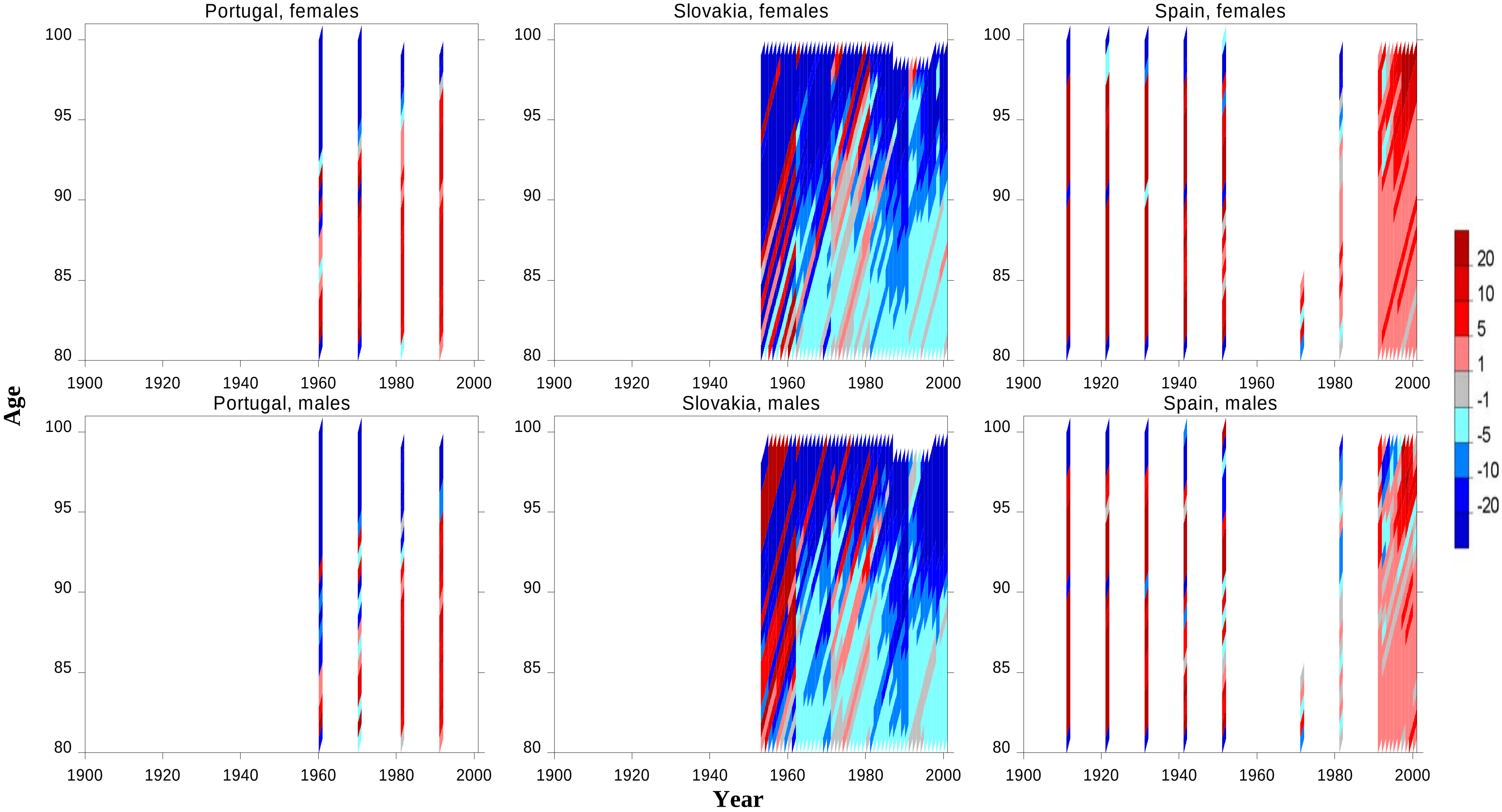
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



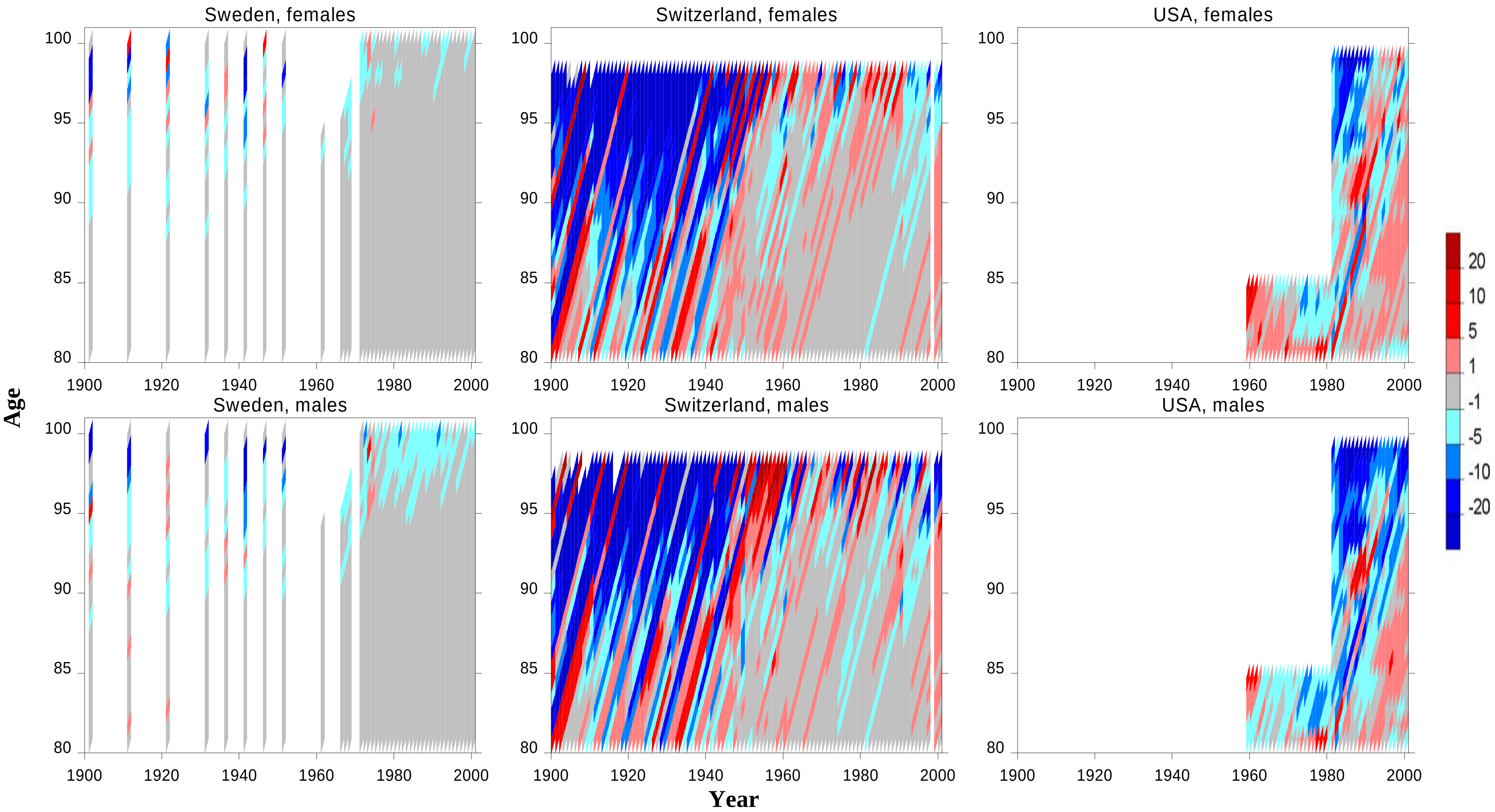
Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Figure 3-2 (continued). Age-specific relative differences between the KTD and the official population estimates (in percent)



Note: These Lexis maps show differences by single year of age. If official population estimates are available only in aggregated format, the difference for the corresponding year is missing. For example, population estimates for England and Wales prior 1962 are available only by 5 year age group. Therefore, the differences are shown only for the years 1962 onwards. Blue colors correspond to the negative relative difference (the KTD estimates are lower than the official estimates), while the red colors correspond to the positive relative difference (the KTD estimates are higher than the official estimates).

Appendix 4.

Table 4-1. Outcomes of the OLS regression connecting the relative differences between the KTD and official estimates to the sex, age group, and country of the data by 10 year periods since 1900 (coefficient and standard error; statistically insignificant values with p>0.1 are in italic; points mean that data are not available).

	1900-10	1911-20	1921-30	1931-40	1941-50
Males	0	0	0	0	0
Females	-3.93 (2.04)	-5.57 (2.11)	*-1.06 (1.41)*	-4.13 (1.74)	-33.54 (9.69)
age 80-84	0	0	0	0	0
age 85-89	5.17 (2.76)	*3.67 (2.72)*	3.28 (1.84)	4.73 (2.27)	*3.75 (12.75)*
age 90-94	12.79 (2.76)	10.69 (2.99)	4.33 (2.01)	9.73 (2.44)	*18.14 (13.36)*
age 95+	46.81 (3.2)	48.39 (3.43)	32.98 (2.54)	33.04 (3.21)	134.44 (15.64)
Australia	.	.	.	.	.
Austria	.	.	.	.	*-1.88 (27.68)*
Belgium	.	.	.	.	*-0.21 (44.1)*
Canada	.	.	14.29 (2.39)	8.95 (3.01)	*32.8 (20.6)*
Czech Republic	.	.	.	.	*3.62 (27.68)*
Denmark	.	.	7.51 (2.68)	6.14 (3.47)	*8.02 (18.8)*
Germany, East	.	.	.	.	.
Germany, West	.	.	.	.	.
England&Wales	.	8.57 (3.68)	9.68 (3.52)	8.29 (4.55)	*37.54 (23.61)*
Estonia	.	.	.	.	.
Finland	13.95 (2.75)	14.29 (3.06)	19.67 (2.32)	35.03 (3.01)	188.95 (18.8)
France	.	.	.	.	*29.08 (25.69)*
Hungary	.	.	.	.	.
Iceland	.	.	.	.	.
Italy	.	.	.	.	.
Japan	.	.	.	.	.
Latvia	.	.	.	.	.
Lithuania	.	.	.	.	.
Netherlands	.	.	.	.	.
New Zealand	.	.	.	.	*38.75 (36.97)*
New Zealand (Non-Maori)	.	.	.	9.33 (4.05)	39.4 (20.6)
Norway	0	0	0	0	0
Portugal	.	.	.	.	.
Slovakia	.	.	.	.	.
Spain	.	16.55 (6.45)	19.17 (4.89)	18.99 (6.35)	*7.14 (44.1)*
Sweden	*-4.32 (4.71)*	*-6.36 (6.45)*	*-1.78 (4.89)*	*-4.56 (4.69)*	*-1.82 (32.57)*
Switzerland	14.27 (2.46)	19.35 (2.75)	21.93 (2.08)	14.33 (2.71)	*2.77 (18.8)*
USA	.	.	.	.	.
Constant	-3.63 (2.66)	-4.95 (2.84)	-7.2 (2.05)	-4.64 (2.6)	*-17.79 (16.37)*

Table 4-1 (continued). Outcomes of the OLS regression connecting the relative differences between the KTD and official estimates to the sex, age group, and country of the data by 10 year periods since 1900 (coefficient (standard error, statistically insignificant values with p>0.1 are in italic).

	1951-60	1961-70	1971-80	1981-90	1991-2000
Males	0	0	0	0	0
Females	*2.44 (1.98)*	*-0.1 (1.06)*	-1.62 (0.31)	-1.42 (0.41)	-1.63 (0.42)
age 80-84	0	0	0	0	0
age 85-89	*1.57 (2.60)*	*0.55 (1.38)*	*0.54 (0.41)*	*0.68 (0.56)*	*0.54 (0.57)*
age 90-94	4.89 (2.76)	4.03 (1.50)	3.00 (0.44)	2.19 (0.57)	2.05 (0.58)
age 95+	35.17 (3.12)	22.94 (1.68)	11.63 (0.49)	12.51 (0.62)	10.1 (0.63)
Australia	.	9.26 (4.36)	1.9 (0.99)	3.99 (1.34)	6.25 (1.43)
Austria	*-0.78 (5.17)*	*1.61 (3.11)*	8.16 (0.98)	5.97 (1.34)	3.94 (1.43)
Belgium	*8.9 (16.79)*	*6.15 (3.97)*	*0.76 (2.29)*	*1.89 (2.32)*	*0.83 (1.47)*
Canada	*8.98 (5.63)*	7.04 (3.38)	5.15 (1.06)	3.9 (1.45)	3.89 (1.55)
Czech Republic	35.56 (5.17)	15.25 (3.11)	5.63 (0.98)	6.91 (1.34)	11.22 (1.43)
Denmark	*1.43 (5.17)*	*1.02 (3.11)*	*0.67 (1.01)*	*-0.25 (1.34)*	*-0.05 (1.43)*
Germany, East	*9.15 (7.03)*	5.53 (3.20)	1.63 (0.98)	*1.43 (1.34)*	4.7 (1.43)
Germany, West	*1.42 (6.33)*	*1.51 (3.11)*	9.89 (0.98)	12.59 (1.34)	7.22 (1.43)
England&Wales	*8.99 (6.42)*	7.58 (3.99)	4.47 (1.07)	4.64 (1.45)	3.17 (1.55)
Estonia	*0.83 (12.13)*	*0.53 (7.30)*	4.75 (2.29)	*3.03 (2.63)*	3.58 (1.77)
Finland	*4.17 (5.17)*	6.74 (3.72)	*0.67 (0.98)*	*-0.04 (1.34)*	*-0.14 (1.43)*
France	*3.45 (5.28)*	*0.83 (3.11)*	*1.39 (0.98)*	*1.28 (1.34)*	*1.16 (1.43)*
Hungary	*8.68 (6.13)*	9.1 (3.38)	4.66 (1.06)	6.9 (1.45)	6.13 (1.55)
Iceland	.	5.22 (3.11)	3.17 (0.98)	*0.11 (1.34)*	*0.11 (1.43)*
Italy	.	28.62 (7.30)	26.28 (2.29)	*2.21 (3.14)*	*3.26 (3.36)*
Japan	*1.6 (8.96)*	*3.91 (5.39)*	3.39 (1.69)	*0.61 (2.32)*	3.56 (1.79)
Latvia	.	.	5.25 (1.21)	6.62 (1.6)	9.69 (1.43)
Lithuania	.	.	8.81 (1.17)	9.14 (1.34)	3.21 (1.43)
Netherlands	*-1.16 (5.05)*	*-0.81 (3.11)*	3.07 (0.98)	2.47 (1.34)	3.01 (1.43)
New Zealand	10.8 (5.63)	11.39 (3.38)	9.47 (1.06)	5.15 (1.45)	3.10 (1.55)
New Zealand (Non-Maori)	9.91 (5.63)	10.76 (3.38)	9.3 (1.06)	5.06 (1.45)	3.14 (1.55)
Norway	0	0	0	0	0
Portugal	.	53.83 (5.39)	.	16.9 (3.14)	13.06 (3.36)
Slovakia	60.34 (5.48)	32.71 (3.11)	6.04 (0.98)	19.57 (1.34)	16.68 (1.43)
Spain	*5.49 (12.13)*	.	37.64 (4.44)	.	4.07 (1.47)
Sweden	*-2.56 (12.13)*	*-1 (4.12)*	*-0.41 (0.98)*	*-0.07 (1.34)*	*-0.02 (1.43)*
Switzerland	*-1.53 (5.17)*	*-1.21 (3.11)*	*-0.01 (0.98)*	*1.14 (1.34)*	*1.78 (1.47)*
USA	*8.79 (12.17)*	6.79 (3.85)	5.43 (1.21)	4.26 (1.34)	*2.26 (1.43)*
Constant	-7.9 (4.14)	-5.02 (2.43)	-2.31 (0.76)	-2.83 (1.03)	-2.13 (1.09)

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