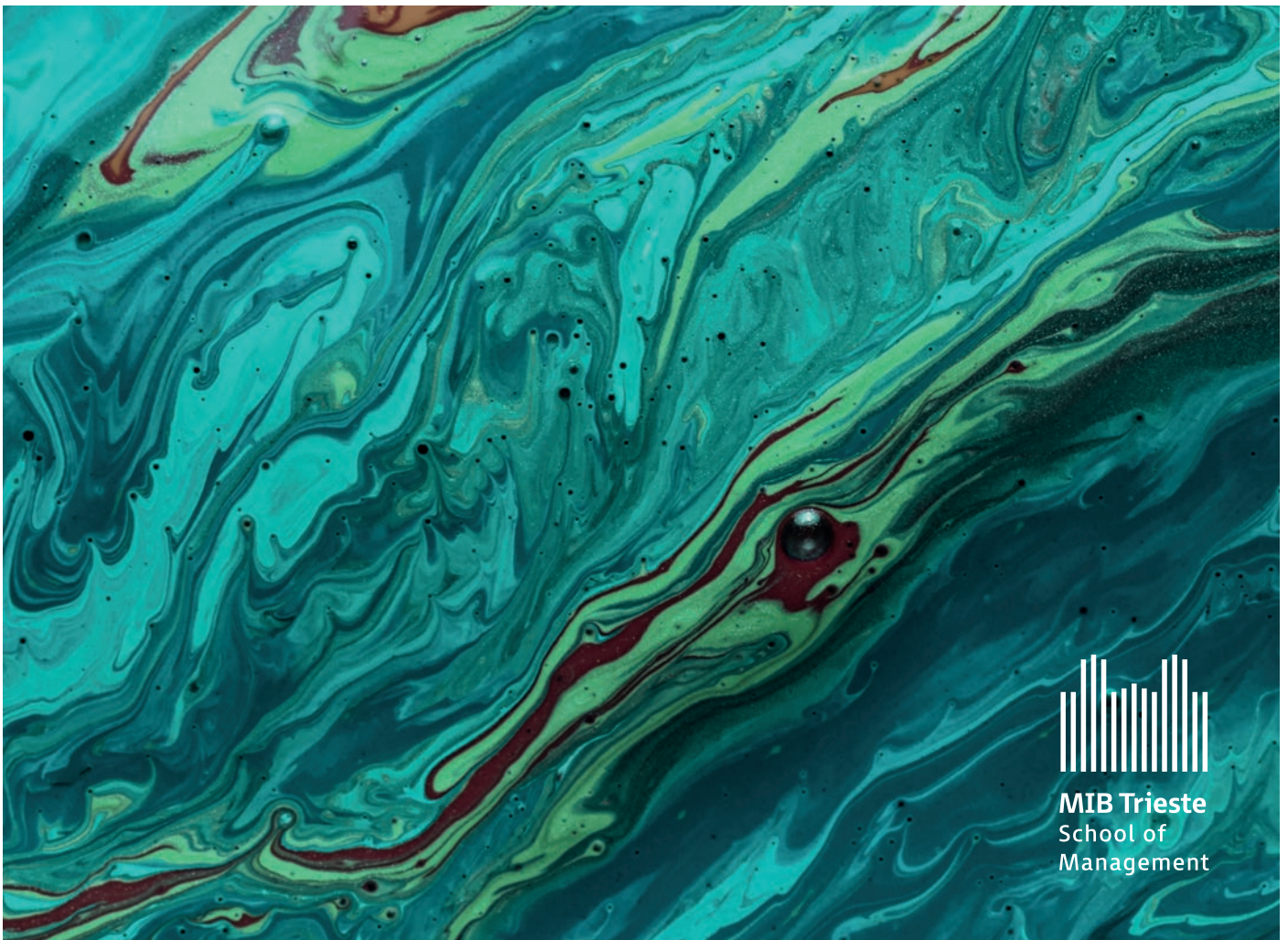


Ermanno Pitacco  
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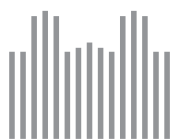
# Longevity Trends: historical aspects and recent issues





Ermanno Pitacco  
Gaetano Carmeci

# Longevity Trends: historical aspects and recent issues





## Preface

The present Report is the first output of the Demographic Laboratory – DemoLab of MIB Trieste School of Management.

MIB DemoLab is the most recent insurance-based initiative of the School, which is recognized by companies, authorities and associations as one of the most advanced International Centers for training, advanced studies and research in the field of insurance and risk management.

Training activities in the field include a wide portfolio of Master programs (Executive Master in Insurance & Finance and Master in Insurance & Risk Management - ranked 5th in the world in the Insurance sector by the international Rating Agency EdUniversal), Corporate Projects (for Allianz Group, Assicurazioni Generali, Marsh, Genertel, Cattolica Assicurazioni, ANIA, among others), short recurring Courses (Enterprise Risk Management and IFRS17), on demand training, conferences, seminars and workshops.

School's Insurance research programs are centered on the Demographic Laboratory: the new MIB Research Center investigating issues at the forefront of population research.

MIB DemoLab explores topics, which play a central role in social, economic and political development, such as demographic change, aging, fertility, population health, migration flows and redistribution of work. It is a think tank capable of collecting and analyzing data, processing comparisons, producing reports on the structure and the dynamics of populations and acting as a qualified partner for private and public organizations, with the aim of supporting sustainable development.

Vladimir Nanut

Dean

MIB Trieste School of Management

## Abstract

This first DemoLab Report on Longevity Trends consists of two parts: Longevity trends: The Italian scenario (with a look to foreign experiences), and Changing trends in mortality: an international comparison using the Human Mortality Database.

The first part aims at providing an insight into historical and recent longevity trends, with special focus on the Italian scenario. In the second part, recent trends in mortality in 19 countries are compared, for which relatively up-to-date data from the Human Mortality Database (HMD) are available.

Longevity trends have been focussed by demographers and actuaries since the last decades of the Nineteenth century. Actuaries have in particular been involved in analyzing and forecasting longevity trends since the beginning of the Twentieth century: pricing and reserving for life annuities and pensions appeared as a dramatic challenge because of uncertainty in future trends.

More generally, longevity trends impact on the evolution over time of the age structure of the population. Of course, other factors impact on this structure dynamics, viz fertility, immigration, emigration. In its turn, the evolution of the age structure of the population has a tremendous impact on a number of activities, the insurance activity and the public policy in particular.

A significant degree of heterogeneity affects all the populations, as regards the age pattern of mortality. An important contribution to the mortality heterogeneity is provided by health conditions, which are in turn determined by environmental features, individual income, eating habits, etc. With reference to adult and old ages, health conditions in particular impact on the so called healthy life expectancy, that is, the expected number of years spent by an individual in good or very good health conditions.

Of course, also health conditions have important effects on both the private sector (the insurance industry in particular) as well as the public sector (involving, in particular, care providers).

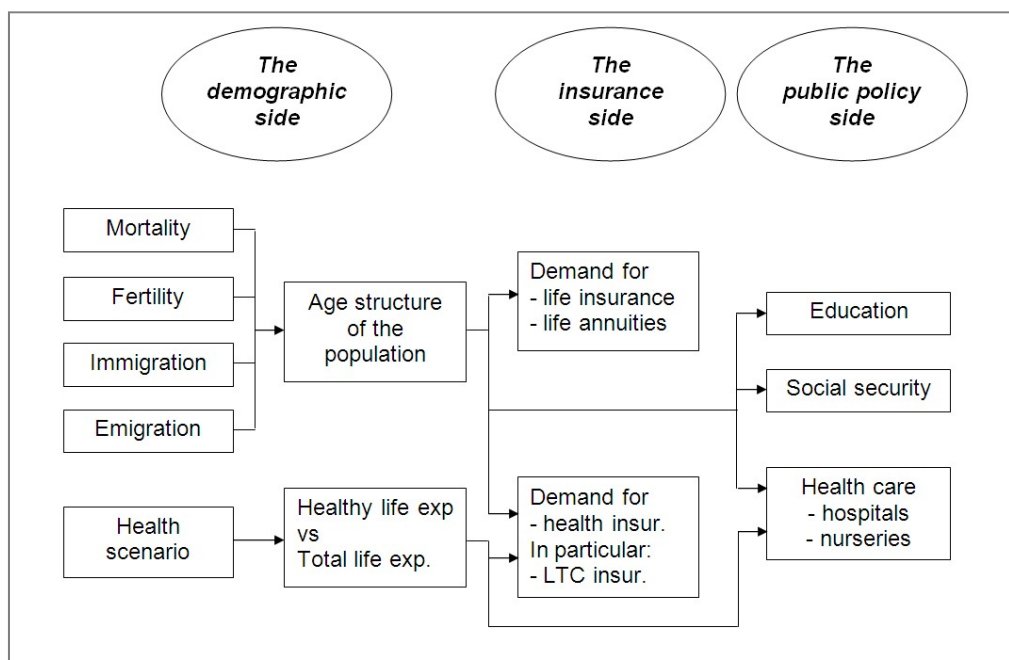
The following Figure shows (some of) the links between the demographic scenario and activities of specific interest to the Demographic Laboratory of the MIB Trieste School of Management. While the present Report only focusses on features of longevity trends, future planned research will in particular address healthy life expectancy and relevant impacts on insurance and care providers, as well as the dynamics of the age structure of the Italian population and the related effects on private and public activities.

Our research work will be based on data provided by several Institutions. The following list, although incomplete, includes the main data providers:

- ISTAT, as regards the Italian population (<https://www.istat.it/>);
- Human Mortality Database (HMD), which provides the life tables of more than 40 countries (<https://www.mortality.org/>);
- World Health Organization (WHO), which, besides being a source of information, “works worldwide to promote health, keep the world safe, and serve the vulnerable” (<https://www.who.int/>);
- Organization for Economic Cooperation and Development (OECD), an international organization which aims at building better policies to improve life conditions (<http://www.oecd.org/>).

Interesting material (papers, reports, presentations, bibliographic references) is provided by the International Actuarial Association (IAA, <https://www.actuaries.org/iaa>), and in particular by the two following working groups:

- Mortality Working Group (MWG, <https://www.actuaries.org/mortality>);
- Population Issues Working Group (PIWG, [https://www.actuaries.org/IAA/IAA/Committees/Scientific/Population\\_Issues\\_Working\\_Group.aspx](https://www.actuaries.org/IAA/IAA/Committees/Scientific/Population_Issues_Working_Group.aspx)).



*Some significant impacts of the demographic features*

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# Longevity trends: the Italian scenario (with a look at foreign experiences)

Ermanno Pitacco

## 1. Introduction

Mortality assumptions have played a central role throughout the whole history of life insurance and pension mathematics, whose origins can be traced back to the second half of the 17th century. The age pattern of mortality actually constitutes a critical issue in pricing and reserving for life insurance and life annuity products, as well as in the management of pension plans (see, for example, Haberman (1996), Pitacco (2004), and references therein). Despite this long history, it was not until the construction of a long series of mortality observations that trends in mortality clearly emerged, and hence the concept of “dynamic” mortality/longevity was achieved, namely between the end of the 19<sup>th</sup> century and the beginning of the 20th century (see Pitacco (2004)).

The earliest attempt to project mortality is probably due to the Swedish astronomer Gylden (see [Cramér and Wold \(1935\)](#)). In a work presented to the Swedish Assurance Association in 1875, he fitted a straight line to the sequence of general death rates of the Swedish population concerning the years 1750–1870. A similar graphical interpolation was proposed in 1901 by Richardt for sequences of the life annuity values  $a_{60}$  and  $a_{65}$ , calculated according to various Norwegian life tables, and then projected via extrapolation for application to pension plan calculations. Note that, as in the proposal by Gylden, also in this case the projection of a single-figure index was concerned.

Mortality trends and the relevant effects on life assurance and life annuities were clearly perceived at the beginning of the 20th century, as shown by various initiatives in the actuarial field. In particular, the subject “Mortality tables for annuitants” was one of the topics discussed at the Fifth International Congress of Actuaries, held in Berlin in 1906. [Nordenmark \(1906\)](#), for instance, pointed out that improvements in mortality must be carefully considered when pricing life annuities and, in particular, cohort mortality should be addressed to avoid underestimation of the related liabilities. The Seventh International Congress of Actuaries, held in Amsterdam in 1912, included the subject “The course, since 1800, of the mortality of assured persons”.

A life table for annuities was constructed in 1912 by Lindstedt (see [Cramér and Wold \(1935\)](#)), who used data from Swedish population experience and, for each age  $x$ , extrapolated the sequence of the annual probabilities of death, namely the so called mortality time-profile. Probably, this work constitutes the earliest projection of an age-specific function.

Mortality/longevity trends, besides their importance in constructing the technical bases for life insurance and life annuity products, play a central role in demography. Together with dynamic features of fertility, immigration and emigration, mortality/longevity trends constitute a key issue in forecasting the age structure of a population.

It is worth noting that, whatever the projection approach adopted for mortality forecasts, the future mortality/longevity trend is, of course, unknown and thus can be different from the expected one. Hence, an “aggregate” risk arises (besides the idiosyncratic risk caused by random fluctuations in mortality).

We stress that the research work presented in this Report does not aim at forecasting future trends. Conversely, we analyze past mortality/longevity trends, with special focus on recently experienced trends compared to trends observed up to the end of the 20<sup>th</sup> century.

## 2. Longevity trends up to the turn of the century

This Section focusses on “historical” mortality/longevity trends in the Italian population. The following figures are based on census ISTAT data.

A first insight into the longevity dynamics can be obtained looking at the behavior over time of some typical values (markers), in particular: expected lifetime at the birth ( $e_0$ ), total expected lifetime at age 65 ( $e_{65}+65$ ), Lexis point (that is, the adult-old age at which the maximum number of deaths occurs).

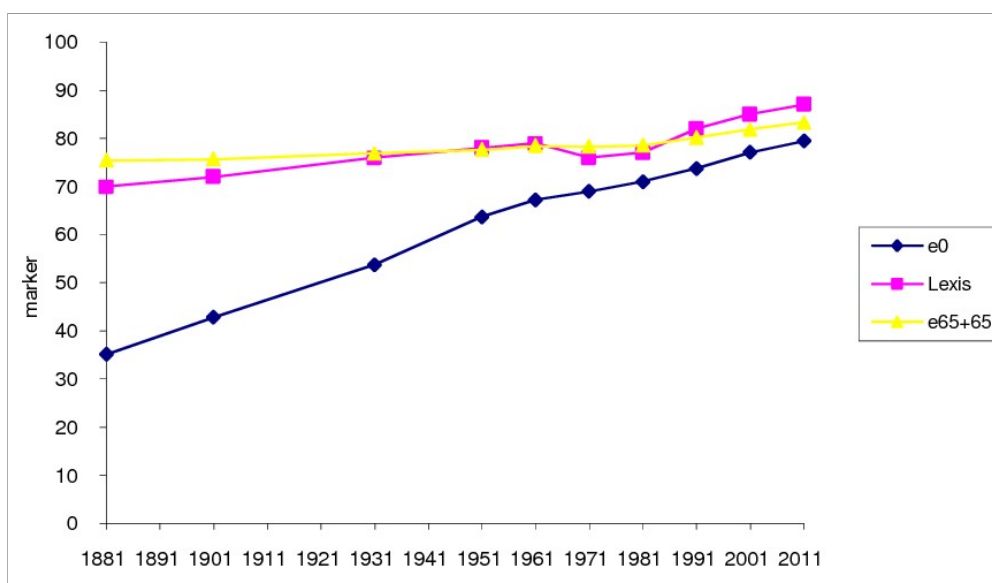


Figure 2.1: Life expectancy and Lexis point – Italian male population (source: ISTAT)

A significant increase in the life expectancy at the birth clearly appears from Fig. 2.1. This increase is mainly due to a strong decrease in infant mortality and in young-adult mortality, as can be argued looking at the weaker increase in the total life expectancy at age 65.

A deeper understanding of the mortality/longevity dynamics can be achieved looking at age-specific functions, plotted in a sequence of calendar years, in particular:

- the number of survivors at exact age  $x$  ( $l_x$ ) in a notional generation of 100000 individuals i.e. the survival curve;
- the number of deaths between age  $x$  and  $x+1$  ( $d_x = l_x - l_{x+1}$ ) i.e. the curve of deaths;
- the probability of dying between age  $x$  and  $x+1$  for an individual alive at age  $x$  ( $q_x = d_x / l_x$ ).

We recall that the normalized curve of deaths, that is the function  $d_x / l_0$ , represents the probability distribution of the individual random lifetime,  $T_0$ .

The dynamics of the survival curves is sketched in Fig. 2.2. Two features clearly appear:

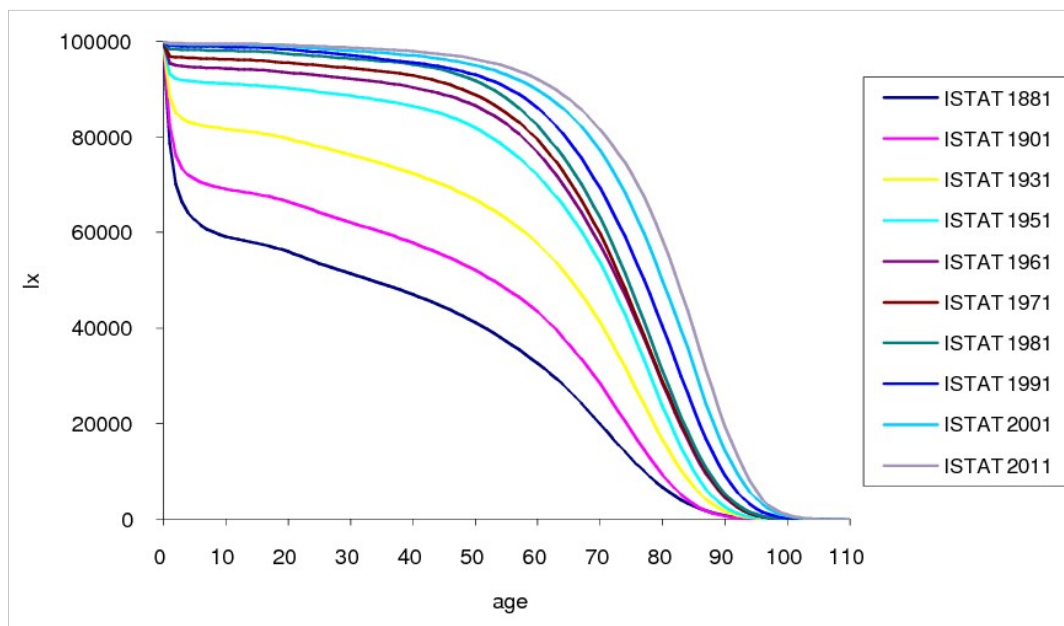
- survival curves progressively move towards a rectangular shape (rectangularization);
- a shift of the curves implies a higher number of survivors at older ages (expansion).

The same features can be clearly perceived looking at the dynamics of the curves of deaths shown in Fig. 2.3. The rectangularization implies a higher concentration of deaths around the Lexis point (apart the prevailing infant mortality in the older curves), whereas the expansion implies a progressive shift of the Lexis point towards older ages.

It is worth noting that:

- the rectangularization implies a decreasing idiosyncratic risk, thanks to the higher concentration of deaths around the Lexis point:
- the uncertainty in future expansion implies an increasing aggregate risk.

The combined impact of the two phenomena can be summarized as follows: “people tend to die at the same age, but this age is unknown”.



*Figure 2.2: Survival curves – Italian male population (Source: ISTAT)*

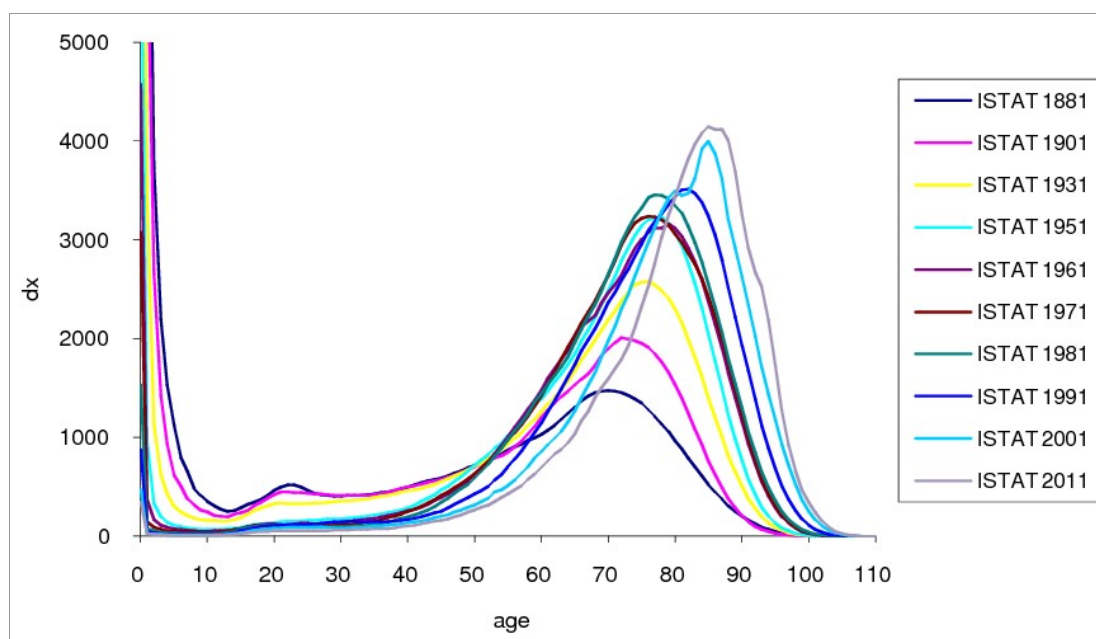


Figure 2.3: Curves of deaths – Italian male population (Source: ISTAT)

The decrease in annual probabilities of dying (mortality rates), in particular for ages in the range 60-90, is shown in Fig. 2.4. Mortality time-profiles in normalized terms, for some ages in the range 50-80, are plotted in Fig. 2.5. We note that the analysis of mortality profiles is the traditional starting point for projecting the age pattern of mortality (for example, see Pitacco et al (2009)).

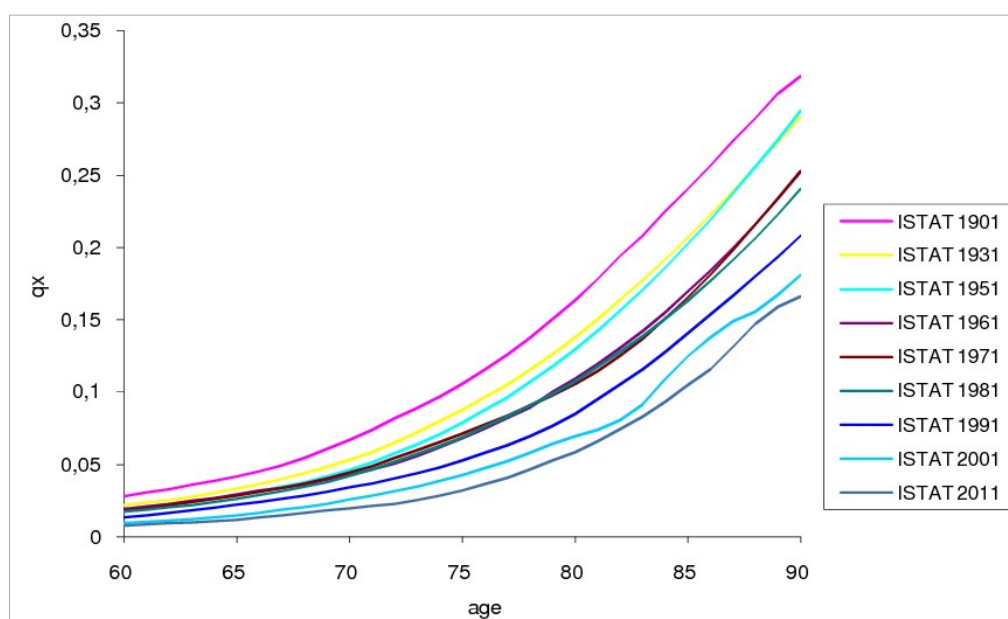


Figure 2.4: Mortality rates – Italian male population (Source: ISTAT)

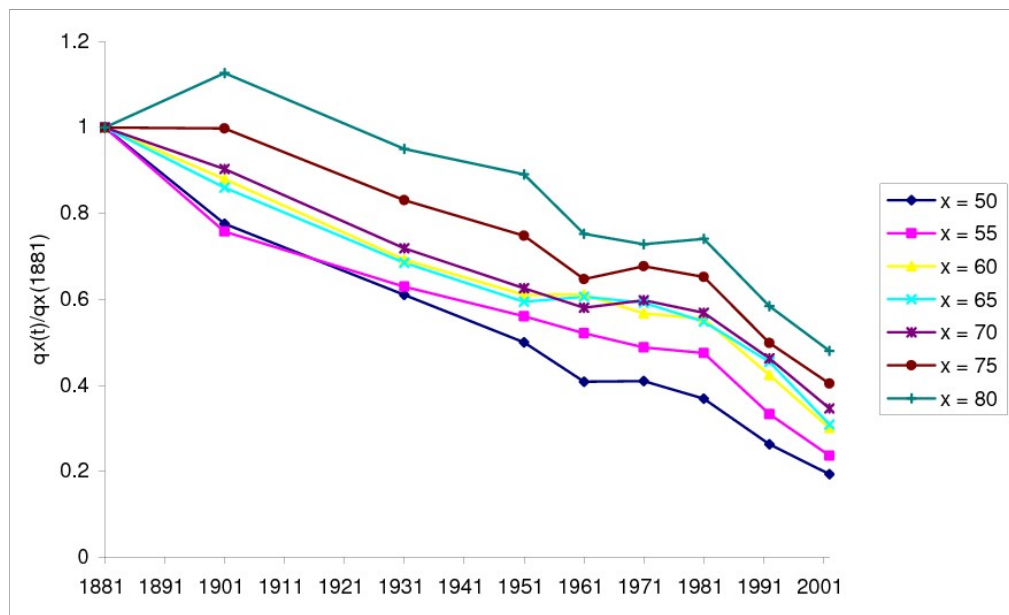


Figure 2.5: Mortality time-profiles – Italian male population (Source: ISTAT)

Back to the analysis of the curves of deaths, it is worth focusing on the behavior over time of the functions  $d_x / l_{65}$ , which represent the probability distribution of the remaining individual random lifetime,  $T_{65}$ , of people aged 65.

From Fig. 2.6, an increasing dispersion clearly appears. Hence, while the rectangularization phenomenon occurs over the whole life span, when focusing on a restriction to old ages the rectangularization no longer holds.

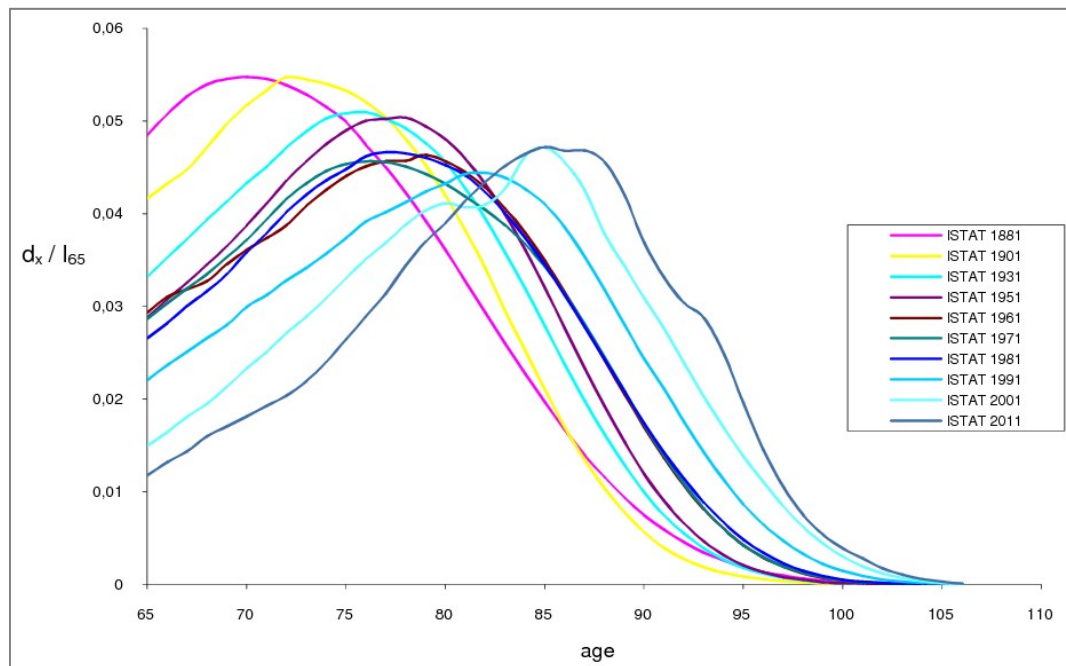


Figure 2.6: Curves of death conditional on attaining age 65 – Italian male population (Source: ISTAT)

The increasing dispersion can in particular be quantified by the behavior throughout time of the inter-quartile range IQR. In Table 2.1, the following markers of the probability distribution of  $T_{65}$  are displayed for a set of years in the range 1881-2001: the median, the first quartile, the third quartile, and the inter-quartile range.

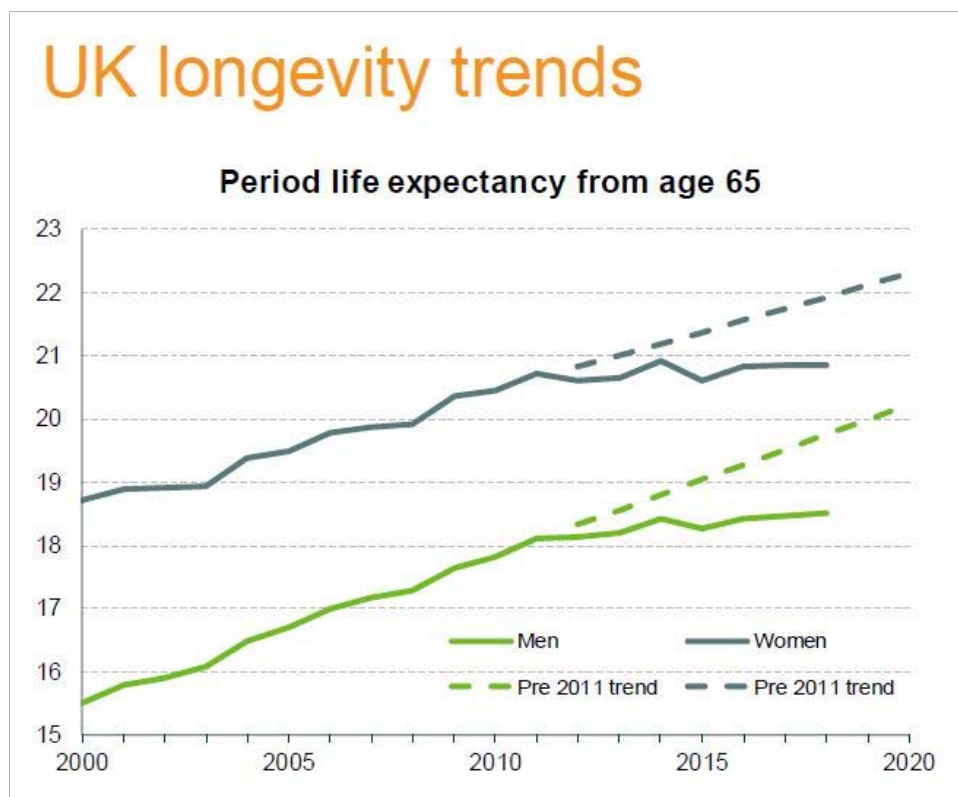
	1881	1901	1931	1951	1961	1971	1981	1991	2001
$Me[T_{65}]$	74.45827	75.09749	76.55215	77.42349	78.21735	77.94686	78.27527	80.23987	82.20066
$x_{25}[T_{65}]$	69.80944	70.45377	71.45070	72.16008	72.43802	72.32797	72.65518	73.89806	75.73235
$x_{75}[T_{65}]$	79.95515	80.14873	81.80892	82.63073	83.86049	83.84586	83.96275	86.02055	87.83705
$IQR[T_{65}]$	10.14570	9.694965	10.35822	10.47065	11.42247	11.51789	11.30757	12.12249	12.10470

Table 2.1: Markers of the probability distribution of the lifetime conditional on attaining age 65 – Italian male population (Source: ISTAT)



### 3. Recent longevity trends <sup>1</sup>

As is well known, in many countries mortality improvements have been slowing down in recent years. For example, in UK this trend has been experienced since 2011. Examples of this new aspect of mortality are provided, with reference to UK and US, by Figs. 3.1 and 3.2. In particular, Fig. 3.1 shows the slow-down in life expectancy improvements in UK, compared to previous projections, while Fig. 3.2 displays the behavior of the crude death rate in the US population and, in particular, its increase in very recent years.

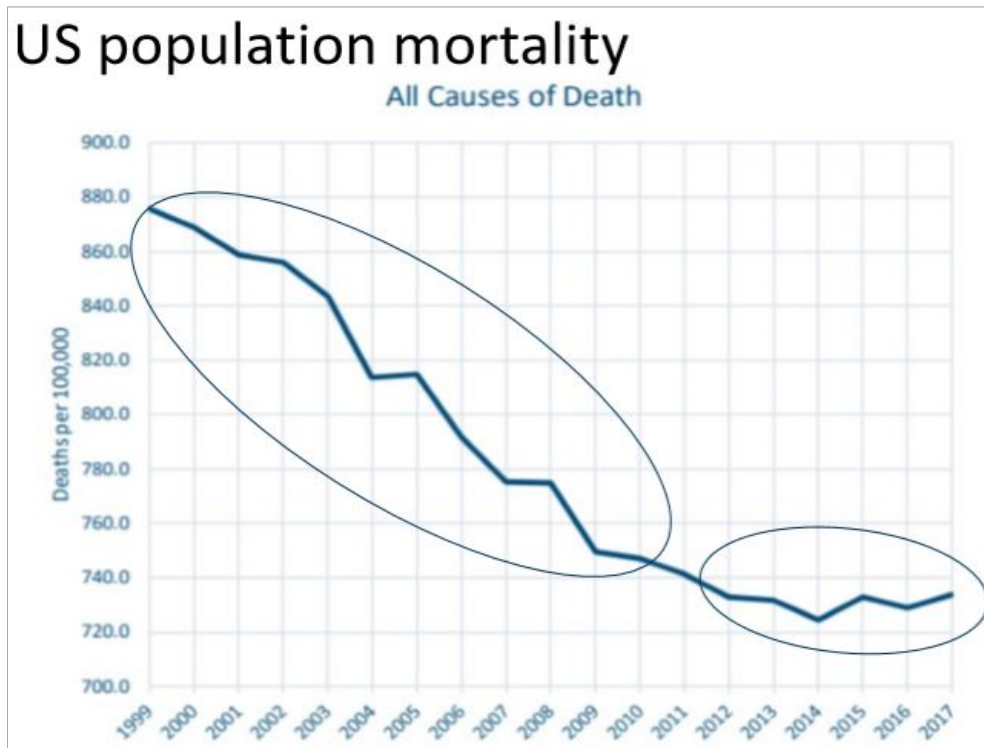


*Figure 3.1: Time-profile of life expectancy at age 65 in UK*  
 (Source: *Recent Developments in Longevity Trends*, IAA, 2019)

<sup>1</sup> The author thanks Chiara Furlan for her valuable contribution to numerical and graphical elaboration of ISTAT data.



In the second part of this report, recent trends in mortality in 19 countries are compared, for which relatively up-to-date data from the Human Mortality Database (HMD) are available. Conversely, in this Section we analyze recent mortality trends in Italy.



*Figure 3.1: Time-profile of crude death rate in US*  
(Source: Society of Actuaries - 2018 Mortality Research)

Starting from ISTAT population data, for all the years

$$y = 2000, \dots, 2017,$$

the following quantities have been calculated for various ages  $x$ :

- the normalized mortality time-profile, that is, the ratio  $q_x(y) / q_x(2000)$ ;
- the normalized time-profile of the life expectancy at age  $x$ , that is, the ratio  $e_x(y) / e_x(2000)$ , for  $x=0, 65$ .

Moreover, the following quantities have been determined:

- the Lexis point (that is, the adult-old age at which the maximum number of deaths occurs)  $x^*(y)$ ;
- the inter-quartile range IQR at ages 0 and 65.

All the above quantities have separately been calculated for males, females and for the whole population.

A more detailed analysis has been performed by separately focussing on four Italian macroregions, i.e. North Italy, Central Italy, Southern Italy, and Italian Islands.

Behavior of life expectancy is shown in Figs. 3.3 to 3.11. As regards the life expectancy at the birth, we note in particular (see Figs. 3.3 to 3.5) the following features.

- The slowdown in the increase or even the decrease in the time interval 2016-2017.
- The diversity of the behavior in the various Italian macroregions.

The life expectancy at age 65 (Figs. 3.6 to 3.8) is characterized by a general decrease. Interesting information can also be captured from the normalized time-profiles of the life expectancy at various ages (see Figs. 3.9 to 3.11).

Mortality time-profiles in terms of normalized annual probabilities of death are shown, for various ages, in Figs. 3.12 to 3.14. The slow-down of the mortality improvements in recent years clearly appears

The behavior over time of the Lexis point (that is, the modal age at death) is displayed in Fig. 3.15, from which the diversity between males and females can be captured.

Interesting information is provided by Figs. 3.16 and 3.17, which show the trends in the variability of the age at death in terms of the inter-quartile range (IQR). Lower values of IQR are the results of a lower variability of the age at death. We can see that this variability (referring to both the whole lifespan as well as conditional on attaining age 65) generally decreased over the time interval 2000 – 2017, with a significant decrease between 2016 and 2017. Hence, a higher concentration of deaths occurs around the Lexis point and a reduction in the risk of mortality random fluctuations follow.

Variability in the age at death of course depends on the whole probability distribution of the lifetime. Nonetheless, it can be interesting to separately analyze the trends in some “portions” of the lifetime distribution. As a measure of the longevity trend in a population, we can assume the change in the probability related to a conveniently defined tail of the lifetime distribution, for example the tail defined by ages greater than 90.

From Figs. 3.18 to 3.20, we see the trends in the tail probability. In spite of the decreasing variability in the age at death, we note an almost regular increase in the tail probability, however with some exceptions, as, for example, between year 2016 and 2017.

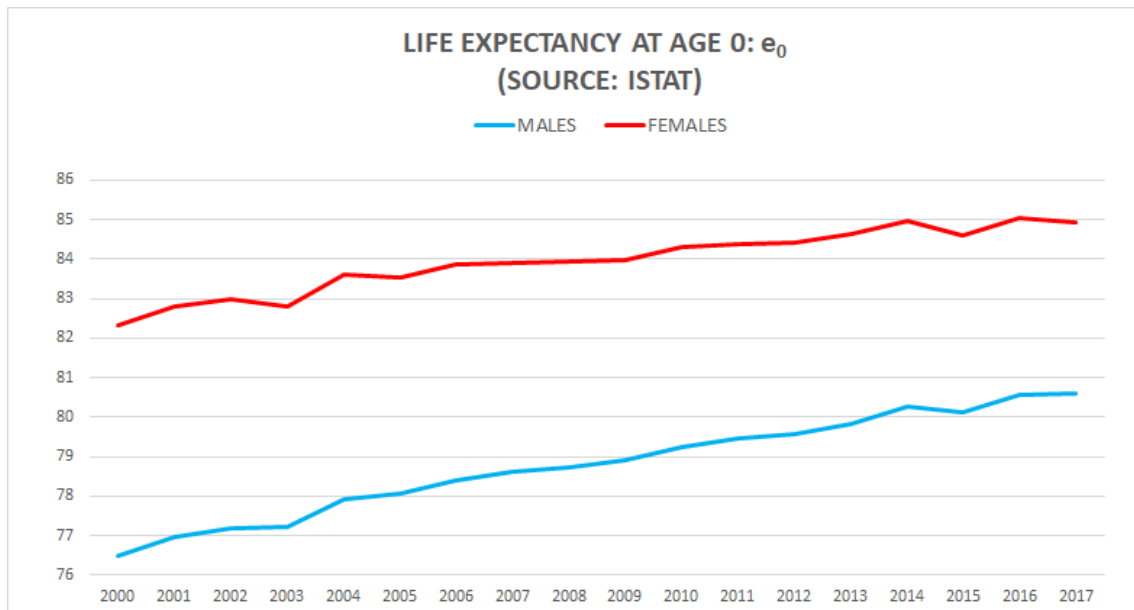


Figure 3.3: Life expectancy at age 0

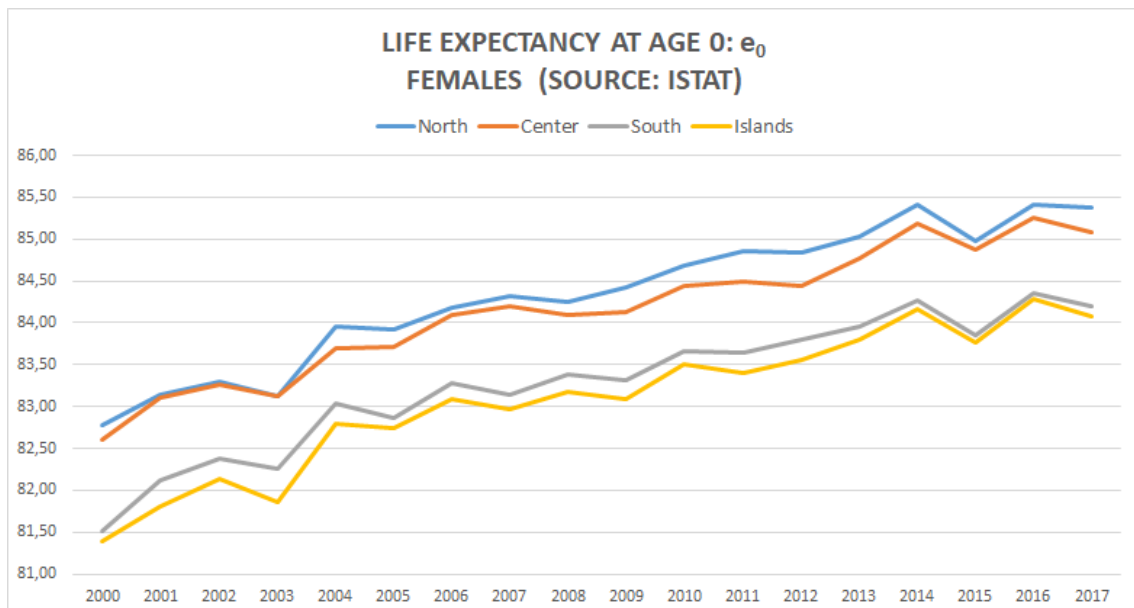


Figure 3.4: Life expectancy at age 0, in the Italian macroregions

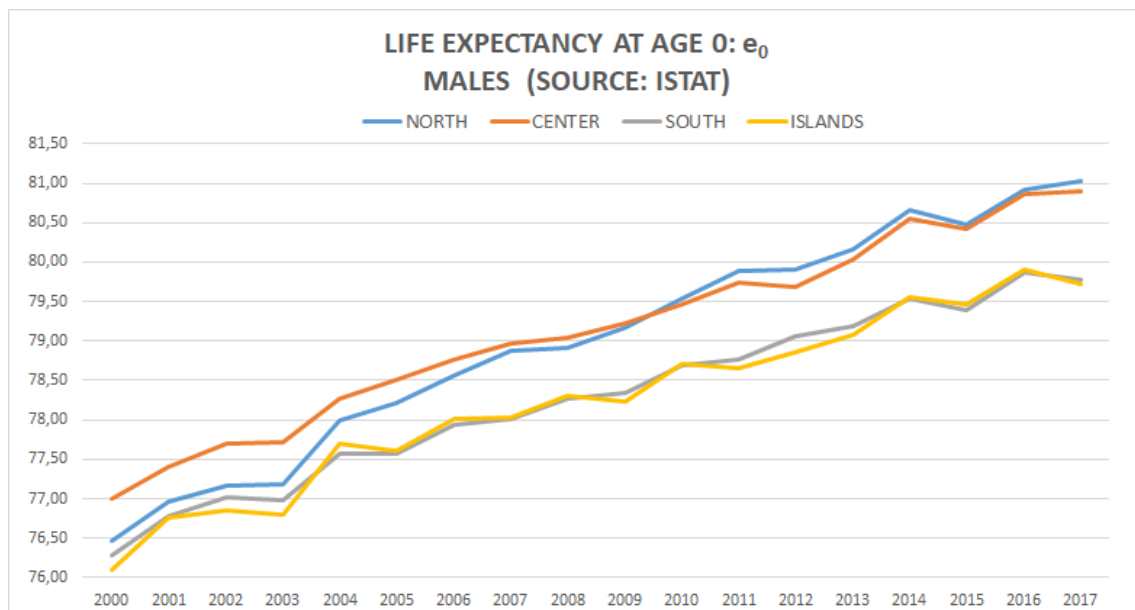


Figure 3.5: Life expectancy at age 0, in the Italian macroregions

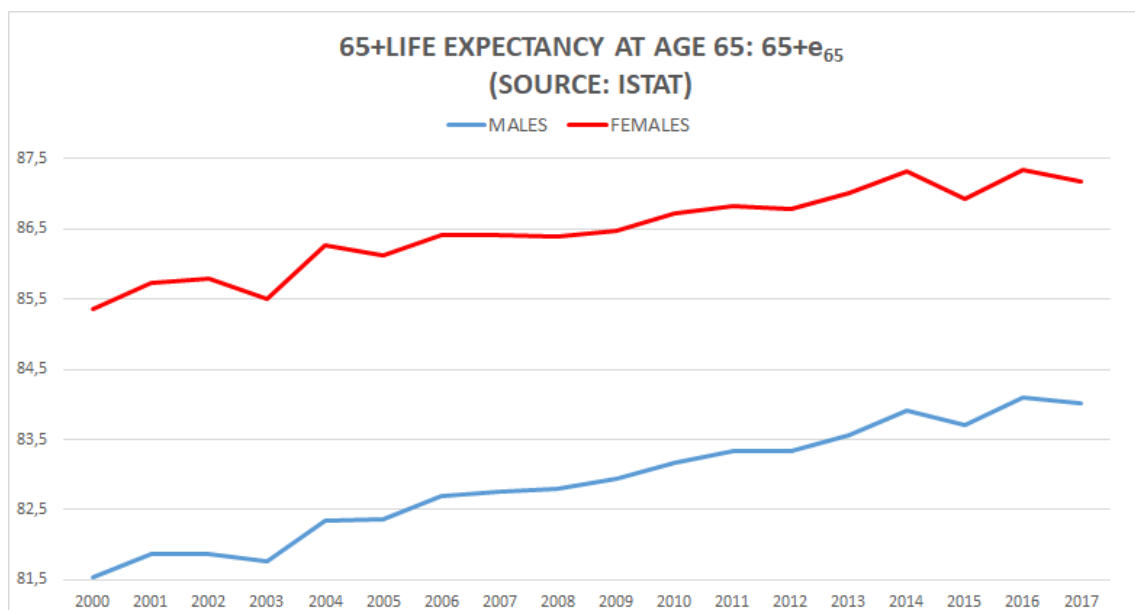


Figure 3.6: Total life expectancy at age 65

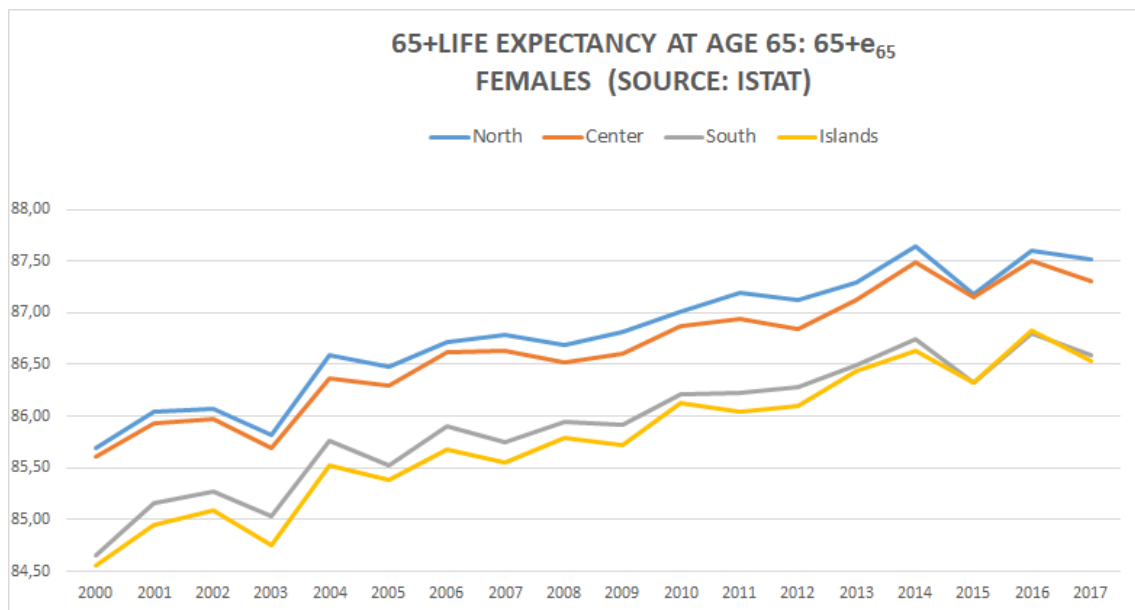


Figure 3.7: Total life expectancy at age 65, in the Italian macroregions

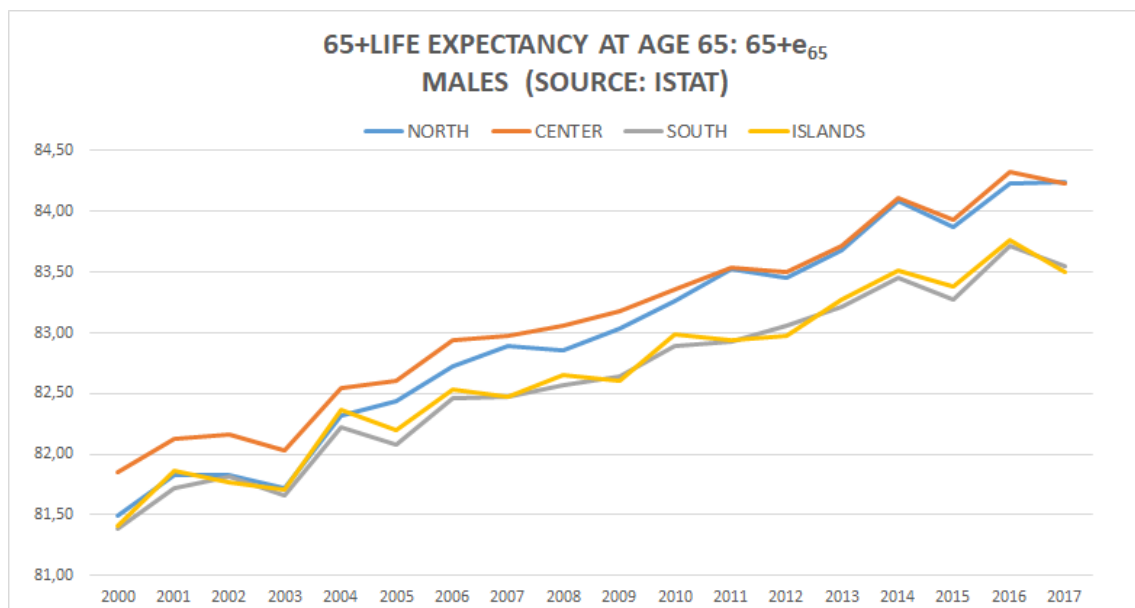


Figure 3.8: Total life expectancy at age 65, in the Italian macroregions

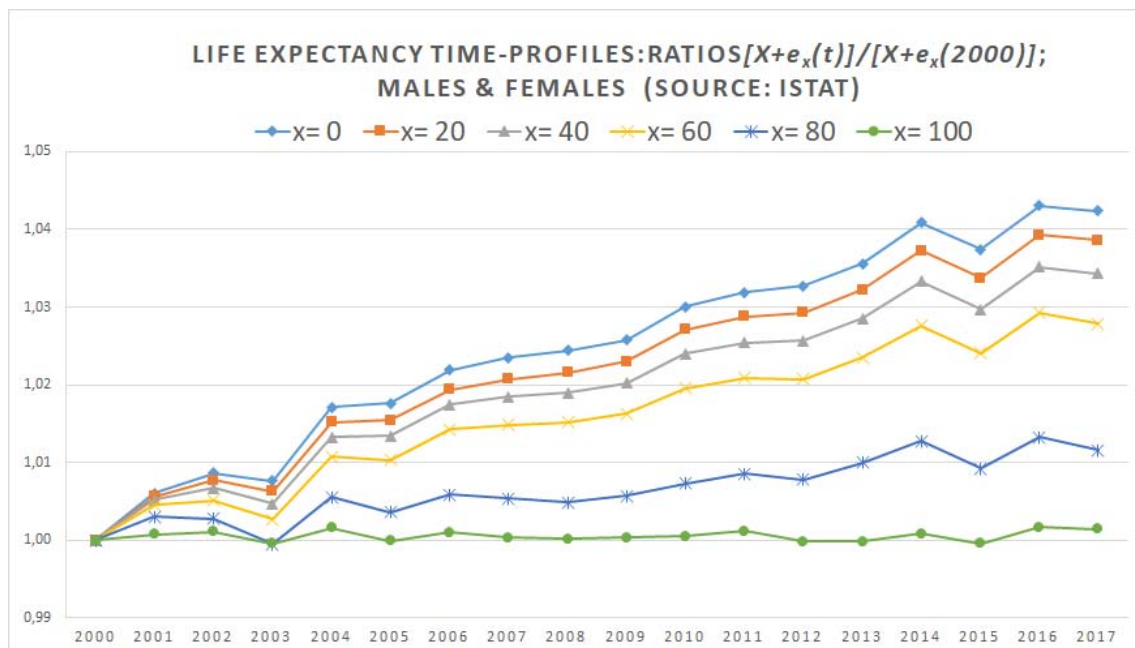


Figure 3.9: Normalized life expectancy time-profiles at various ages

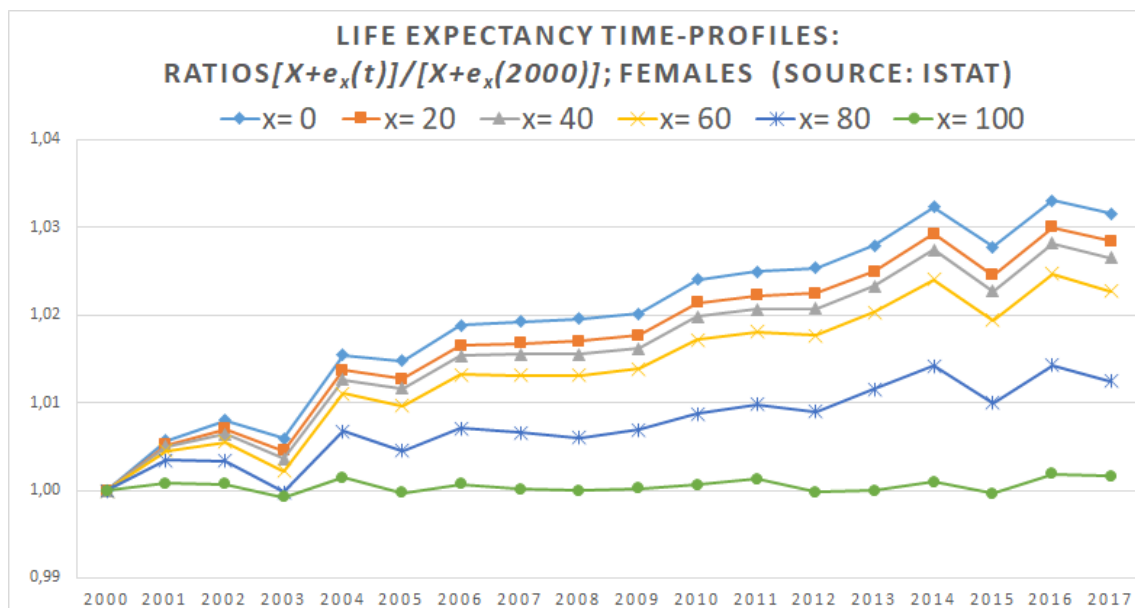


Figure 3.10: Normalized life expectancy time-profiles at various ages

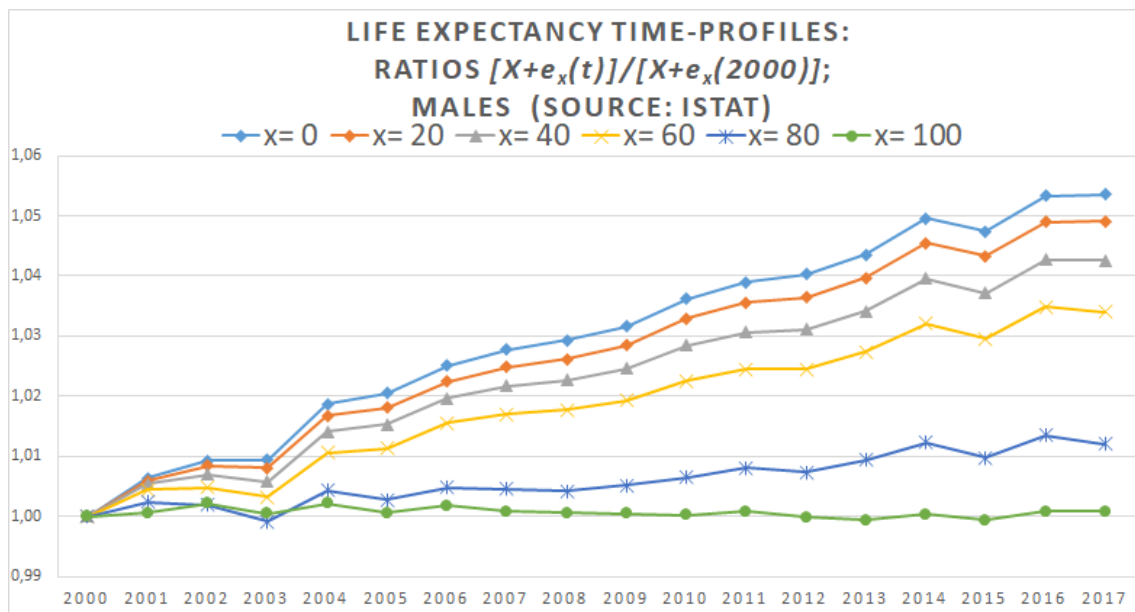


Figure 3.11: Normalized life expectancy time-profiles at various ages

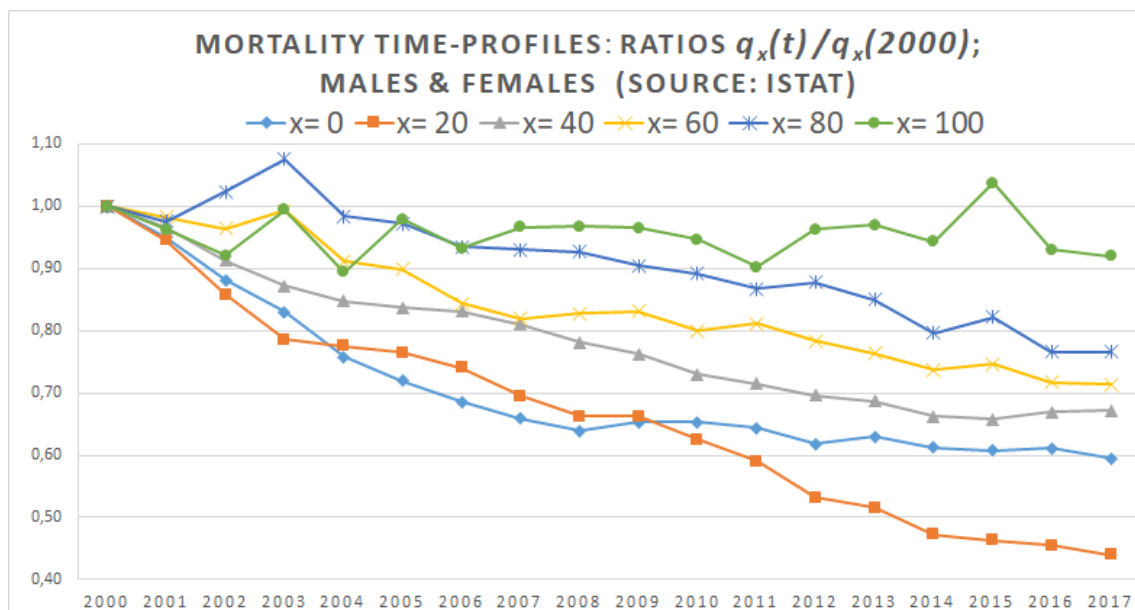


Figure 3.12: Normalized mortality time-profiles at various ages

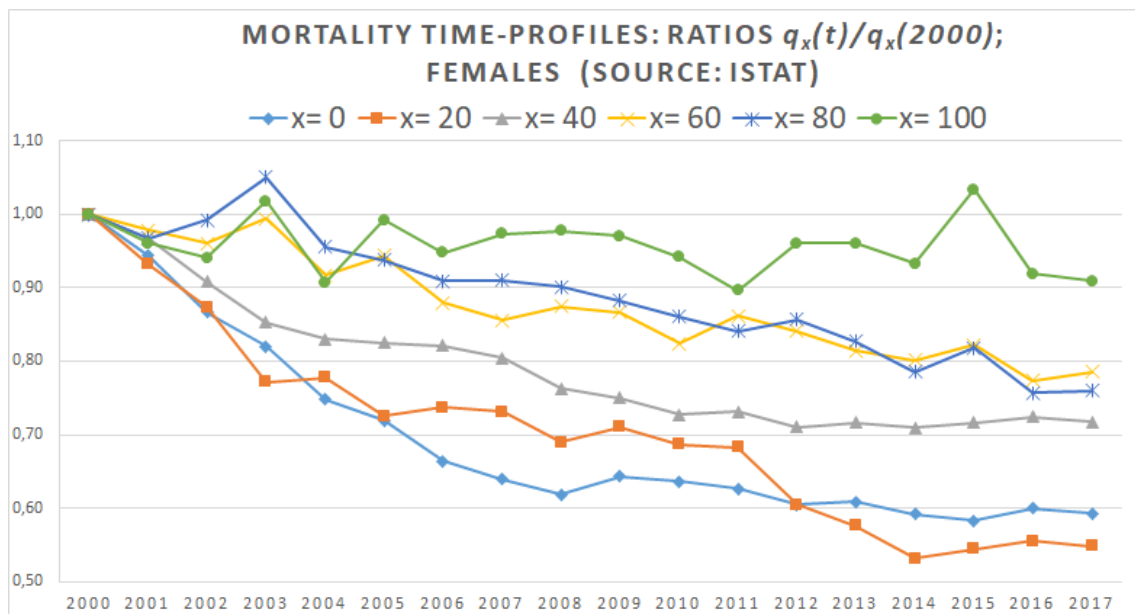


Figure 3.13: Normalized mortality time-profiles at various ages

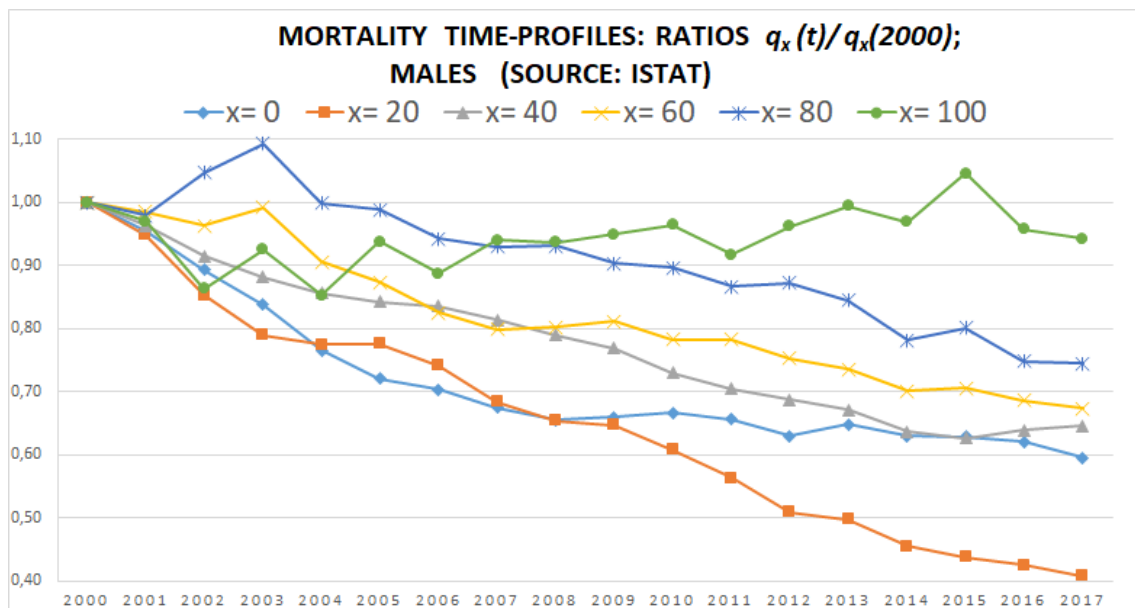


Figure 3.14: Normalized mortality time-profiles at various ages



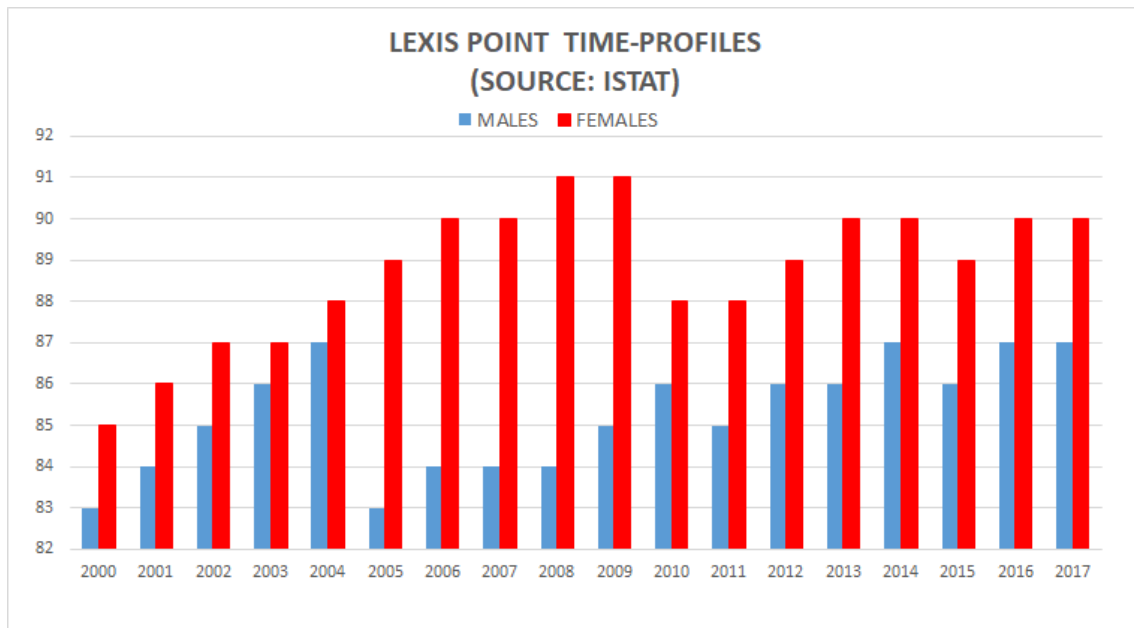


Figure 3.15: Time-profiles of the Lexis point (modal age at death)

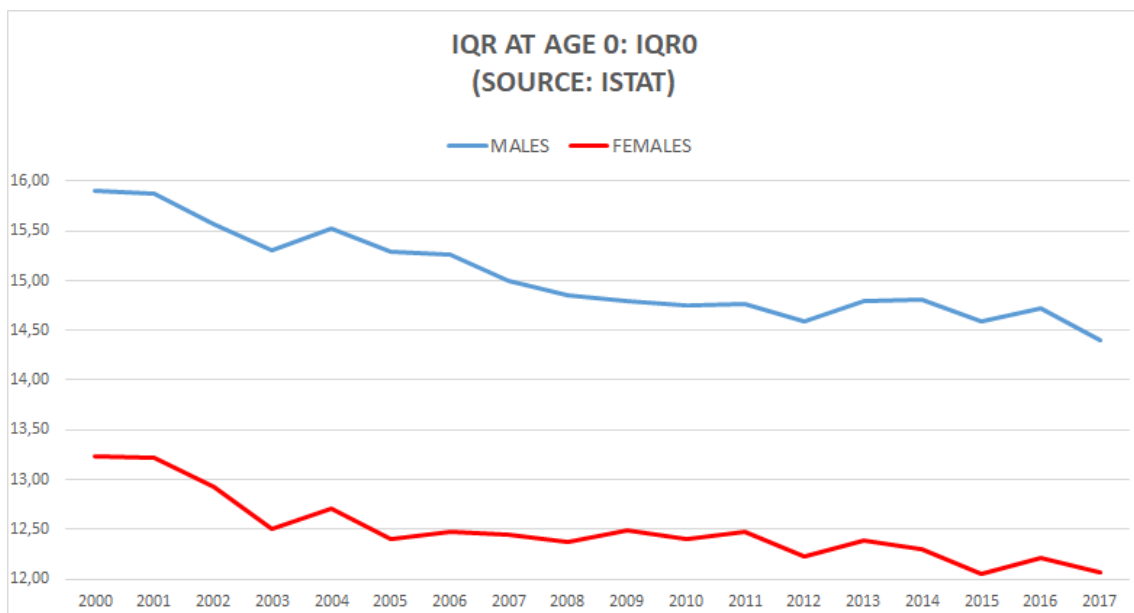
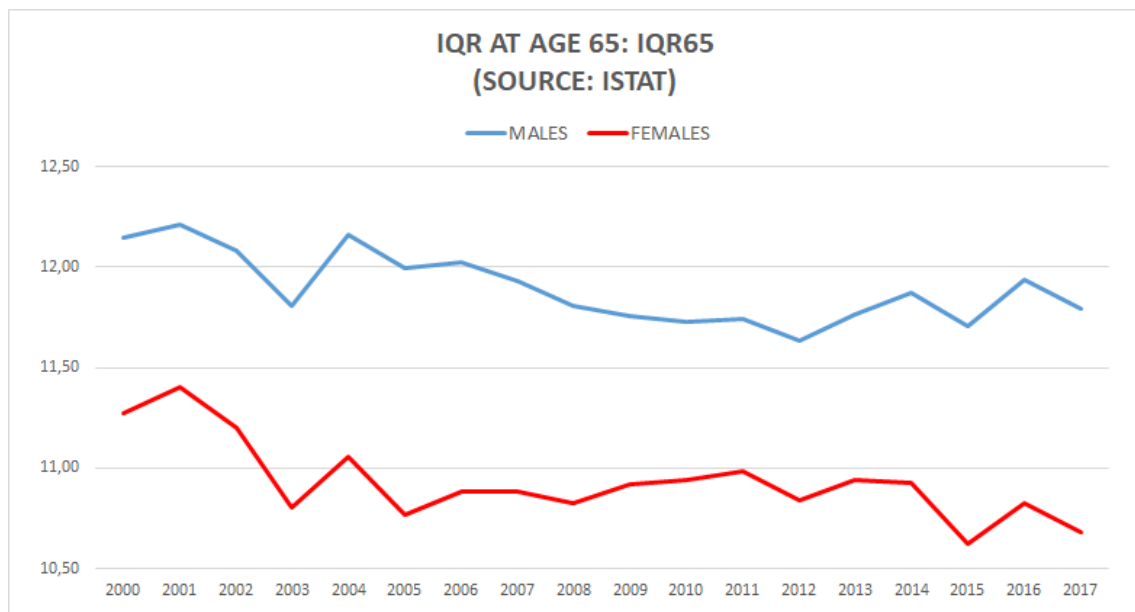
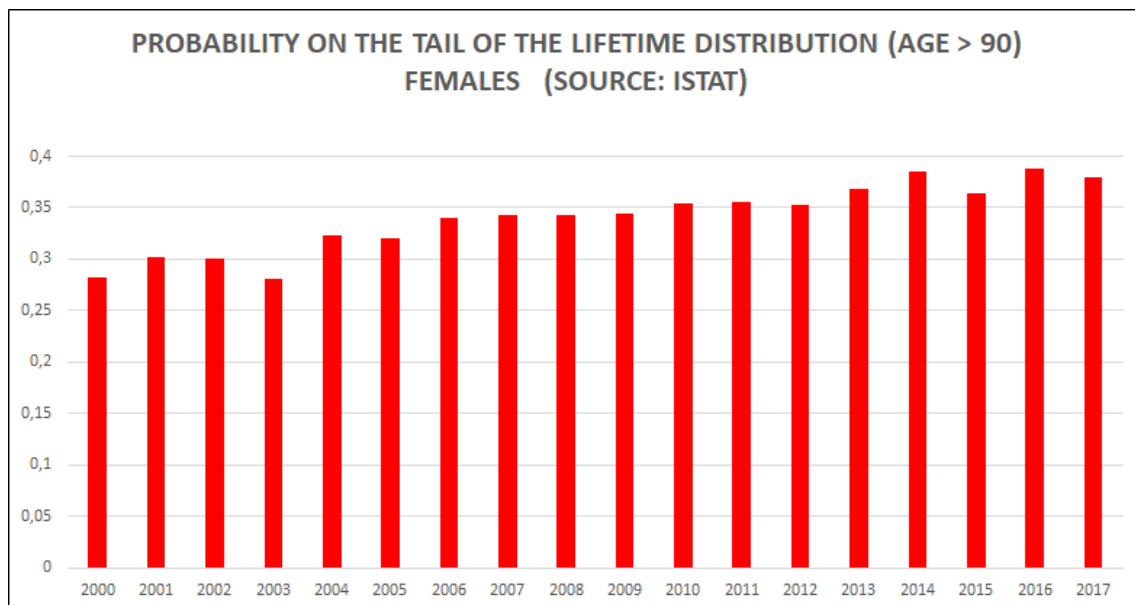


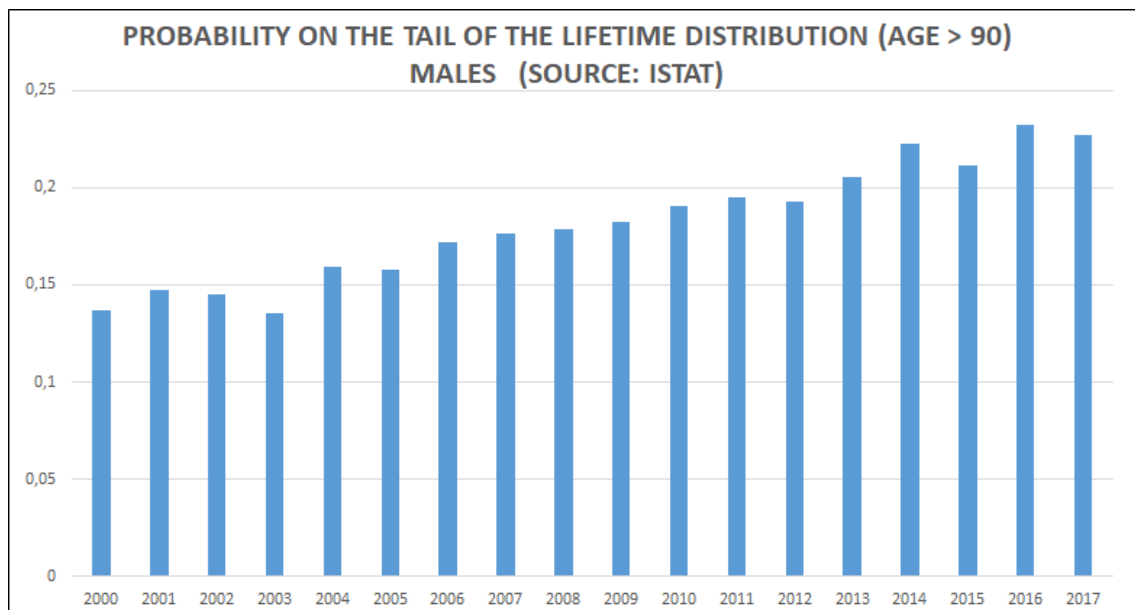
Figure 3.16: Time-profiles of the Inter Quartile Range at age 0



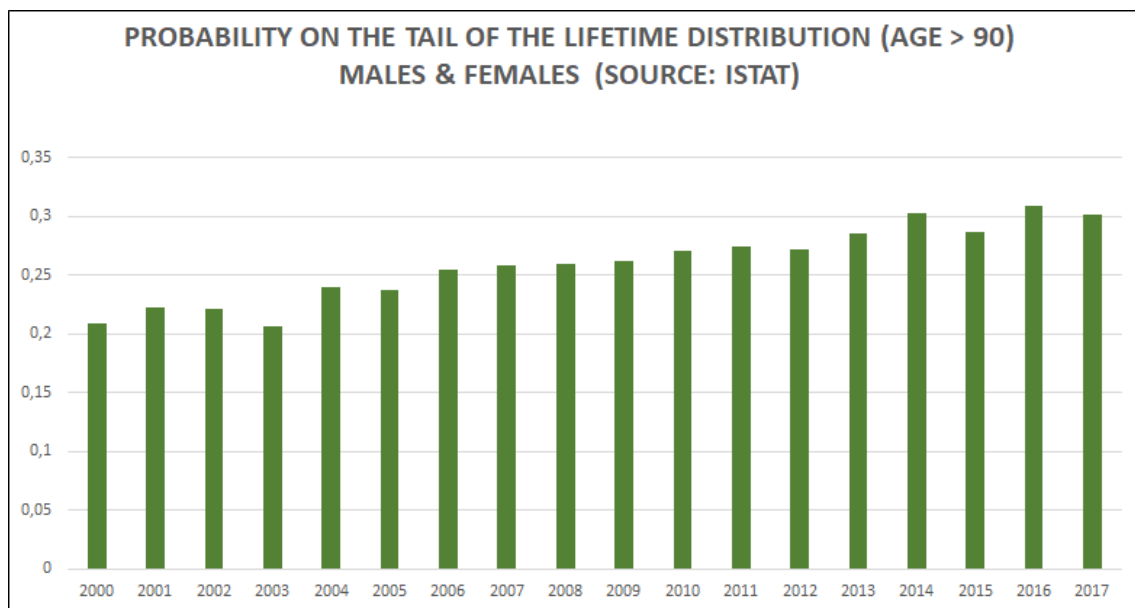
*Figure 3.17: Time-profiles of the Inter Quartile Range at age 65*



*Figure 3.18: Tail of the lifetime distribution*



*Figure 3.19: Tail of the lifetime distribution*



*Figure 3.20: Tail of the lifetime distribution*

## 4. Healthy life expectancy vs total life expectancy

In all lifelong living benefits (i.e. life annuities, lifelong sickness insurance covers, etc.) the insurer bears the longevity risk, and in particular its systematic component (that is, the aggregate longevity risk, see Sect. 1) caused by the possibility that all the insureds live, on average, longer than expected. This risk component is undiversifiable via pooling, i.e. inside the traditional insurance-reinsurance process.

In the case of health-related insurance products, such as LTC covers, risk emerges further from uncertainty concerning the time spent in the disability state. Actually, when living benefits are paid in the case of disability (senescent disability, or loss of autonomy, in particular) it is not only important how long one lives, but also how long he/she lives in a condition of poor health conditions, disability in particular.

Although it is reasonable to assume a relationship between mortality and morbidity or disability, the relevant definition is difficult due to the complexity of such a link and the impossibility of defining and measuring disability objectively.

Three main theories have been proposed about the evolution of senescent disability (see Pitacco (2014), and references therein). The most important features of the three theories can be expressed in terms of the evolution of the total life expectancy (TLE) and the healthy life expectancy (HLE) (both expectancies can be considered either at the birth or at some given adult age), as represented in Fig. 4.1.

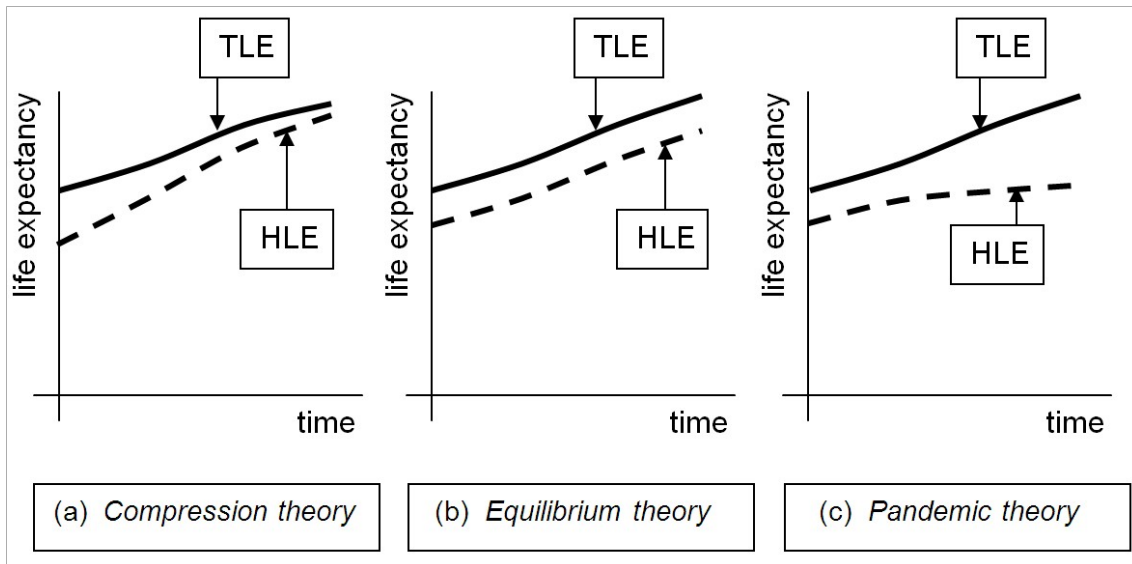


Figure 4.1: Trends in total life expectancy (TLE) and healthy life expectancy (HLE), according to different theories

Ideas underlying the three theories are as follows.

- *Compression theory*: chronic degenerative diseases will be postponed until the latest years of life thanks to medical advances. Assuming there is a maximum limit for the total life expectancy, these improvements will result in a compression of the period of disability.
- *Equilibrium theory*: most of the changes in mortality are related to specific pathologies. The onset of chronic degenerative diseases and disability will be postponed, and the time of death as well, resulting in a more or less constant spread between TLE and HLE.
- *Pandemic theory*: improvements in mortality are not accompanied by a decrease in disability rates, and this results in an increasing spread between TLE and HLE. Hence, the number of disabled people will increase steadily.

Moving from theories (and controversial issues) to experienced trends, we only quote results related to 25 countries of the European Union. As shown by Fig. 4.2, the observed average trends (up to 2011) reveal an increasing total life expectancy, and a healthy life expectancy fluctuating but roughly constant in the time frame addressed.

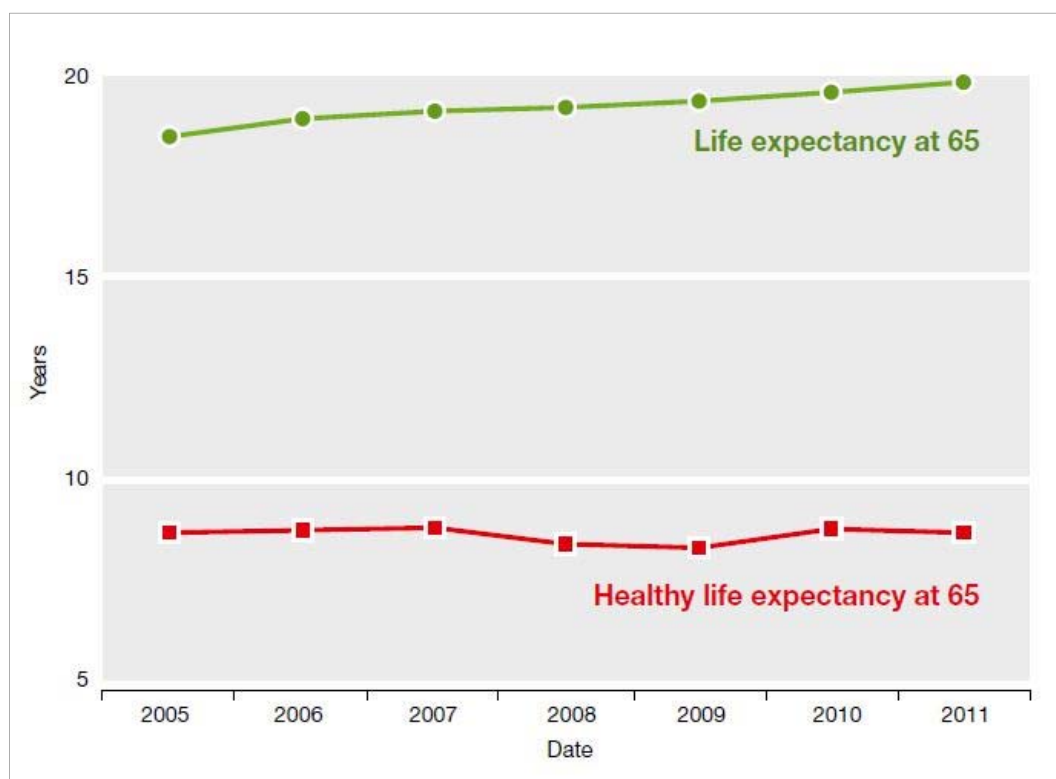


Figure 4.2: Life expectancy and Healthy life expectancy at age 65 – Average values in 25 EU countries (Source: Brown (2015))

## 5. Concluding remarks and outlook

Recent and, in particular, very recent longevity trends, clearly witness a slow-down in mortality improvements, and, in some cases, even a decrease in life expectancy. Of course, these features, captured while looking at the current longevity trends, must be carefully monitored in future years. Indeed, the aggregate longevity risk still affects the behavior of mortality and hence the risk profile of life annuity and pension business.

On the other side, term assurances providing benefits in case of death might be affected by mortality peaks, i.e. by catastrophic events. Climate change can significantly impact on the behavior of mortality, even though this impact is currently limited to old and very old ages.

While the progressive reduction in the inter-quartile range witnesses, as previously noted, a decrease in the importance of the risk of random fluctuations (that is, the one which can be offset via pooling and traditional reinsurance arrangements), the features mentioned above raise the importance of the risk of systematic deviations (due to uncertainty in future longevity trends) and the catastrophic risk (due to sudden mortality peaks). These risk components may heavily affect the risk profile of life insurance portfolios and hence call for appropriate risk management actions (Alternative Risk Transfers, in particular).

Besides quantitative aspects of mortality and survivorship, special attention should be placed on health conditions in a population. In particular, the evolution of healthy life expectancy (or disability-free life expectancy) should be analyzed and assessed in quantitative terms. Health conditions significantly impact on both public policy actions (in particular related to healthcare) as well as on private insurance (especially in the development of appropriate insurance products, as, for example, whole-life sickness insurance and long-term care covers). As mentioned in the Preface, this topic will be the object of our future research work.

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# Changing trends in mortality: an international comparison using the Human Mortality Database

Gaetano Carmeci

It has been widely reported that improvements (decreases) in UK mortality rates, i.e. the number of deaths divided by the population exposed to risk, have been slowing since around 2011. Moreover, in 2018 the United Kingdom's Office for National Statistics (ONS) presented evidence supporting the view that the slowdown seen in UK was not unique.

In this part of the report, using new data released by the Max Planck Institute for Demography, we analyze trends in standardized mortality rates along the lines of ONS (2018c). More specifically, we compare recent trends in mortality in 19 countries<sup>2</sup> for which relatively up-to-date data from the Human Mortality Database (HMD) are available.<sup>3</sup>

Since the populations of different countries vary in terms of size and age structure, we have standardized the mortality data to the European Standard Population (ESP) 2013; see Appendix. This corresponds to a normalized population with a given age structure that reflects the average population structure in Europe around the years we analyze. Therefore, ESP accounts for differences in the size and age structure of the populations over time and allows for comparisons between males and females.

In the following, we present the results of the analyses of standardized age-specific deaths to identify in which countries, and to what extent, the slowdown in mortality

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<sup>2</sup> The countries are: USA, Sweden, Germany, Austria, UK, Switzerland, Spain, the Netherlands, Poland, France, Denmark, Czech Republic, Japan, Portugal, Finland, Belgium, Norway, Italy and Australia.

<sup>3</sup> All deaths data used in this analysis relate to death registrations.



improvements has occurred. We consider four age classes: 15-39, 40-64, 65-79, and 80 years and over (80+).

We also compare mortality rates by gender, since females tend to have longer life expectancies than males.

The time-period covered in the analysis spans the years 2000-2017, but many countries do not have data for the most recent years. For example, only USA, Sweden, Germany and Austria have data available until 2017 included.

Following ONS (2018c), we compare trends in mortality rates before and after the year 2011. To this end, we computed the average percentage annual variation of standardized death rates in the two sub-periods (2011- $k$ ) - 2011 and 2011- (2011+ $k$ ), where  $k$  depends on data availability of the countries.

Specifically, we consider mortality trends for the following sub-periods: a) 2008-2011 and 2011-2014, b) 2007-2011 and 2011-2015, c) 2006-2011 and 2011-2016, and d) 2005-2011 and 2011-2017, corresponding to four different subgroups of countries.

Below we report the average annual variation of standardized death rates by age class and gender, for these different subgroups of countries.

Moreover, for a selection of countries the annual standardized death rates over the period 2000-2017 are reported.

Globally, the group of 19 countries here analyzed shows a slowdown in mortality improvements for males aged 80 years and over. Only Italy, Finland and much more markedly Japan have seen improvements accelerate in the period 2011-2014.

The pattern is similar for females, but, besides Japan, Denmark and Norway have seen improvements accelerate in 2011-2014 for them.

Looking at the group of 16 countries for which data are available until 2015, we can see that only Japan presents a remarkable acceleration of improvements in the second sub-period of time 2011-2015 for both males and females aged 65 to 79 years.

Like ONS (2018c), we find that USA results to be the only country to experience an increase in male and female standardized deaths for those aged 40 to 64 years. However, Sweden, Austria, Norway and more markedly Finland, Czech Republic and Japan show acceleration of improvements for males in 2011-2015. In the time-period 2011-2015, for females belonging to the same age class, we find a slowdown in mortality improvements besides USA in UK, Switzerland, Spain, Poland and Denmark.

For those aged 15 to 39 years, we find that USA and Sweden are the only countries to experience an increase both in male and female standardized deaths.

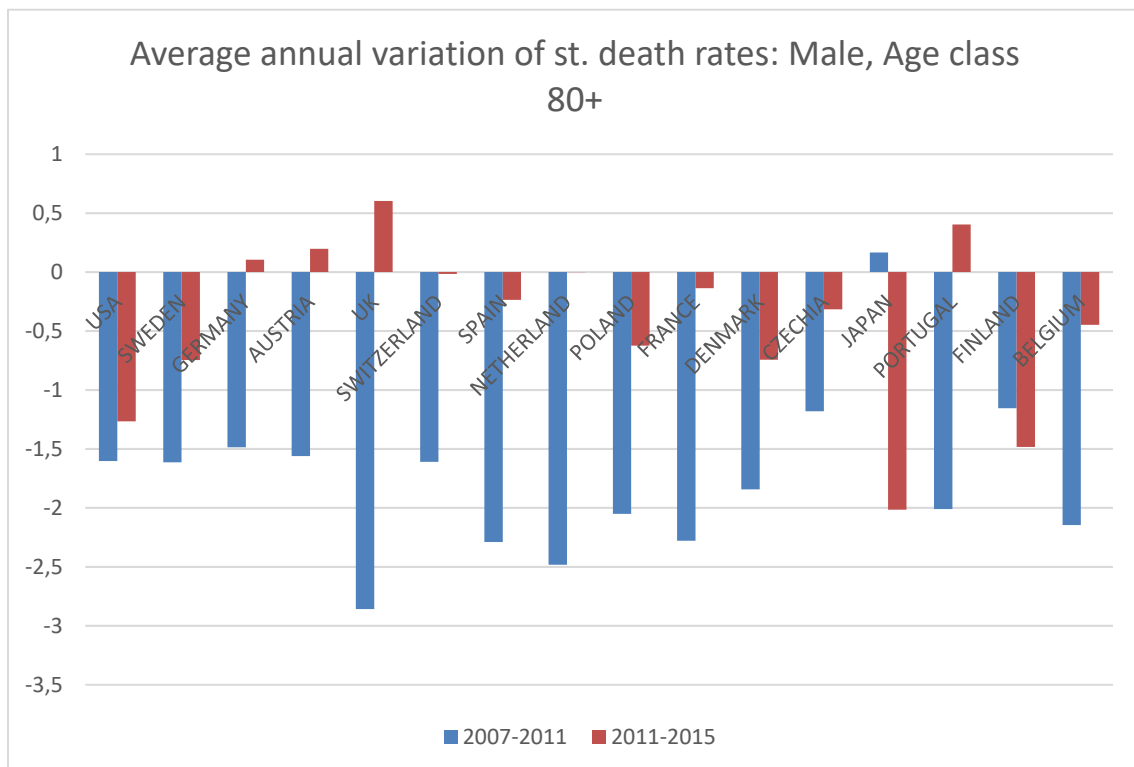
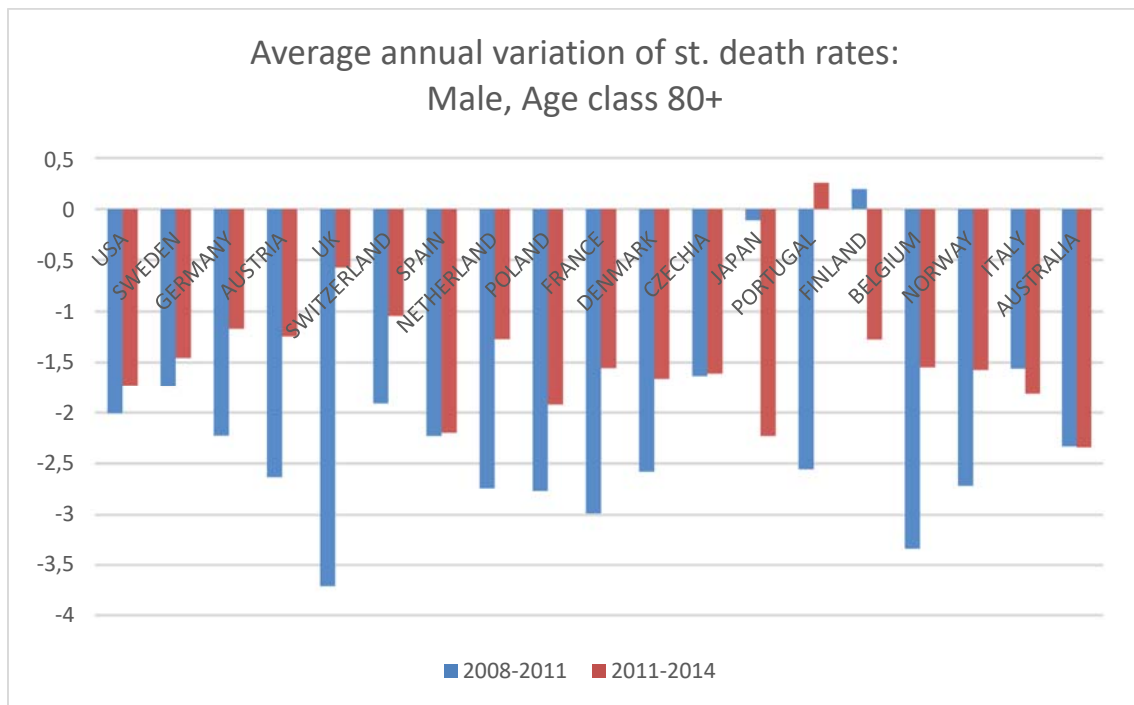
As for the age-class 40-64, Japan shows acceleration of improvements both for males and females aged 15 to 39 years in 2011-2016 (but also 2011-2014 and 2011-2015).

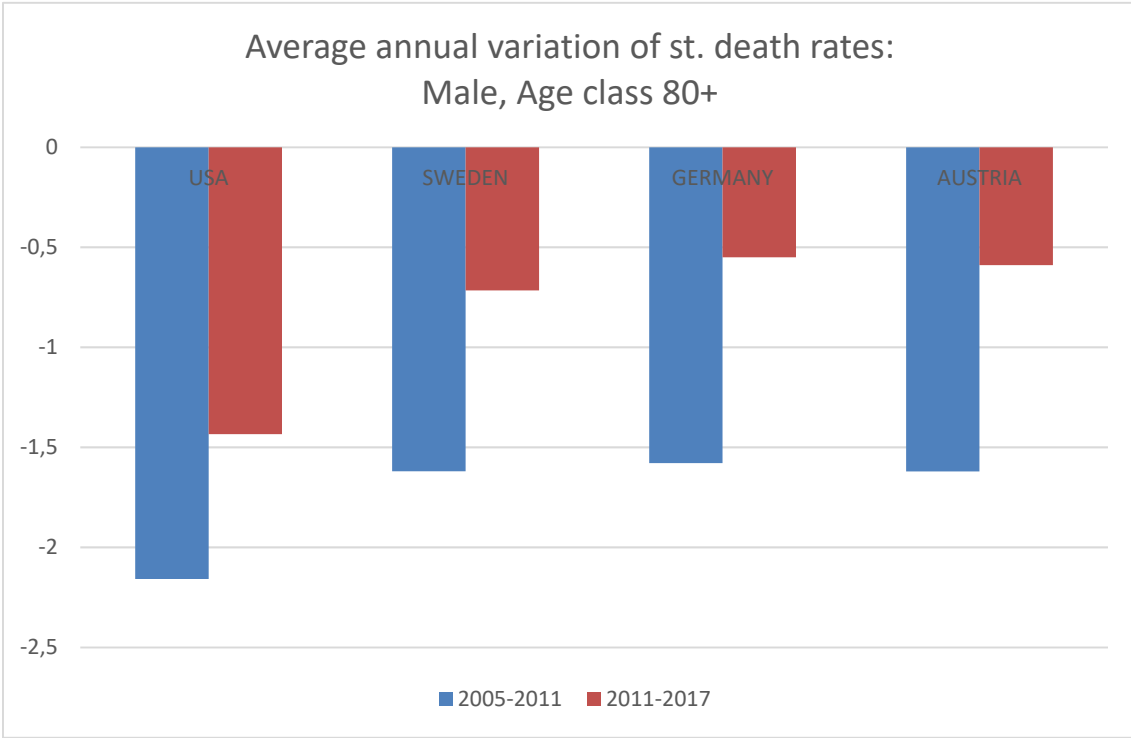
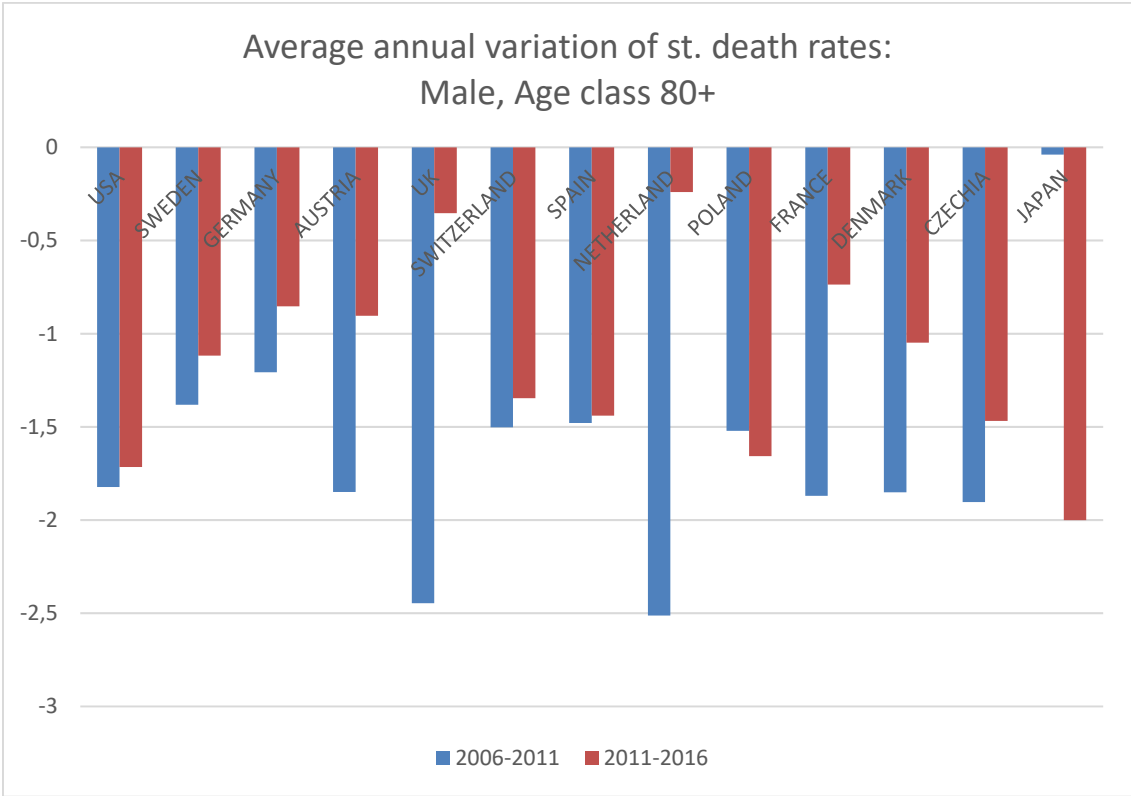
Among Eastern Europe countries, Poland shows a consistent acceleration of reduction in standardized deaths for both males and females in the age-class 15-39 years over the time-periods 2011-2014, 2011-2015 and 2011-2016. The same is true for Norway in 2011-14 and France in 2011-14, 2011-2015 and 2011-2016.

Among the analyzed countries, UK presents the smallest reduction in standardized deaths for both male and female youngsters in sub-periods 2011-2014, 2011-2015 and 2011-2016.

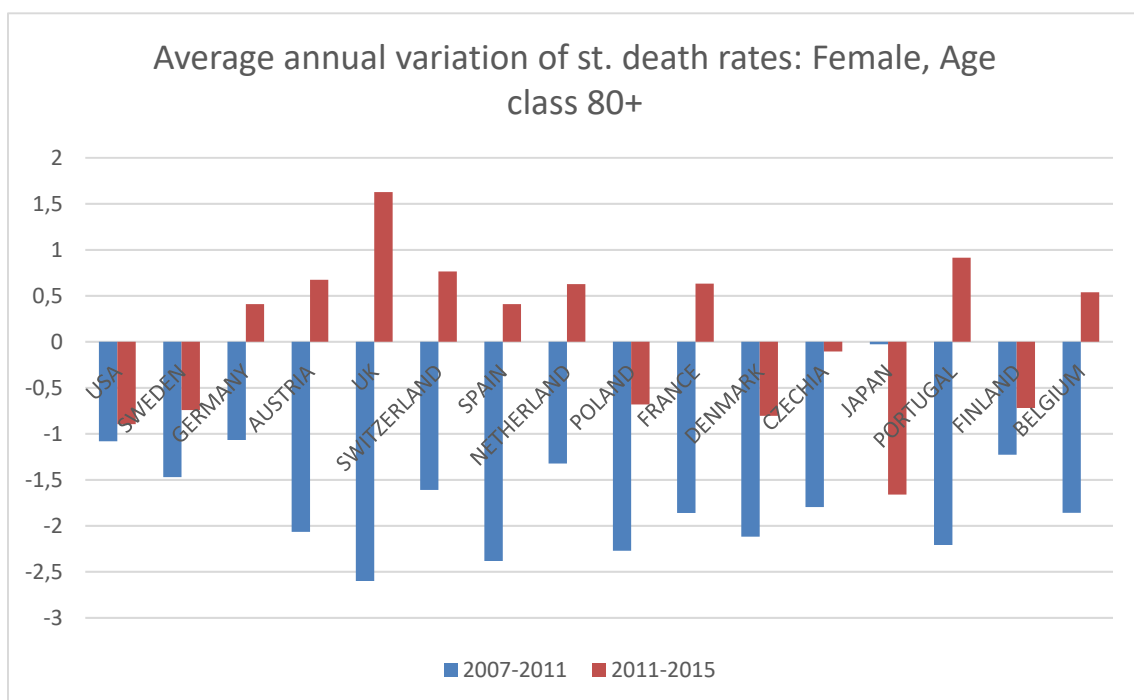
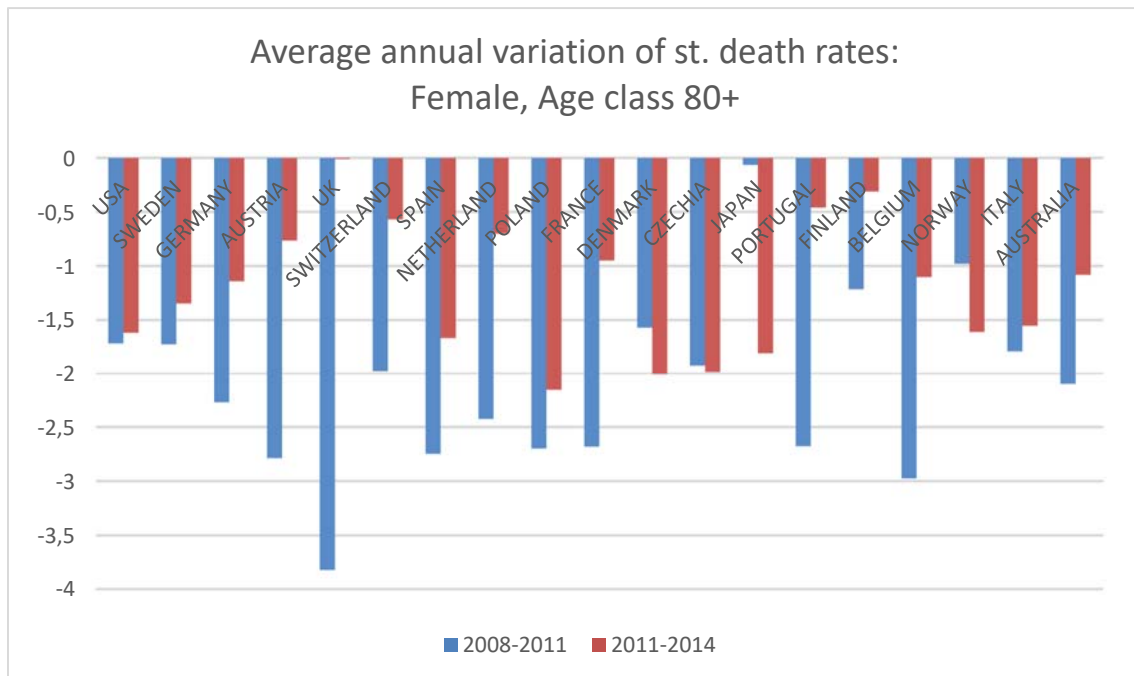
As usual, in the second set of figures ("Standardized death rates") all death rates are reported in terms of number of deaths in a notional population consisting of 100000 individuals.

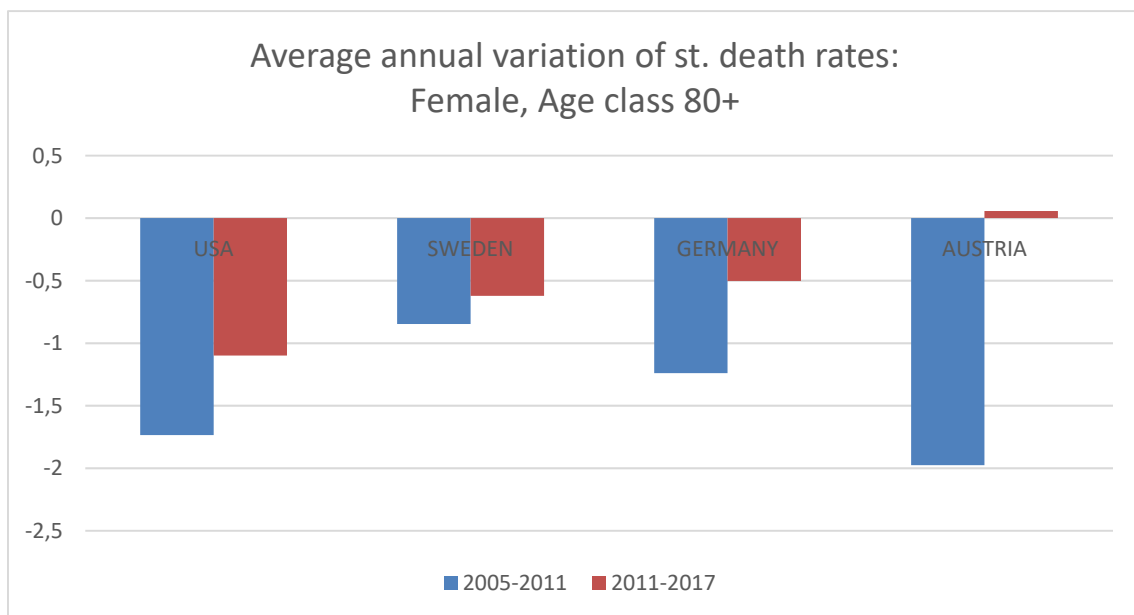
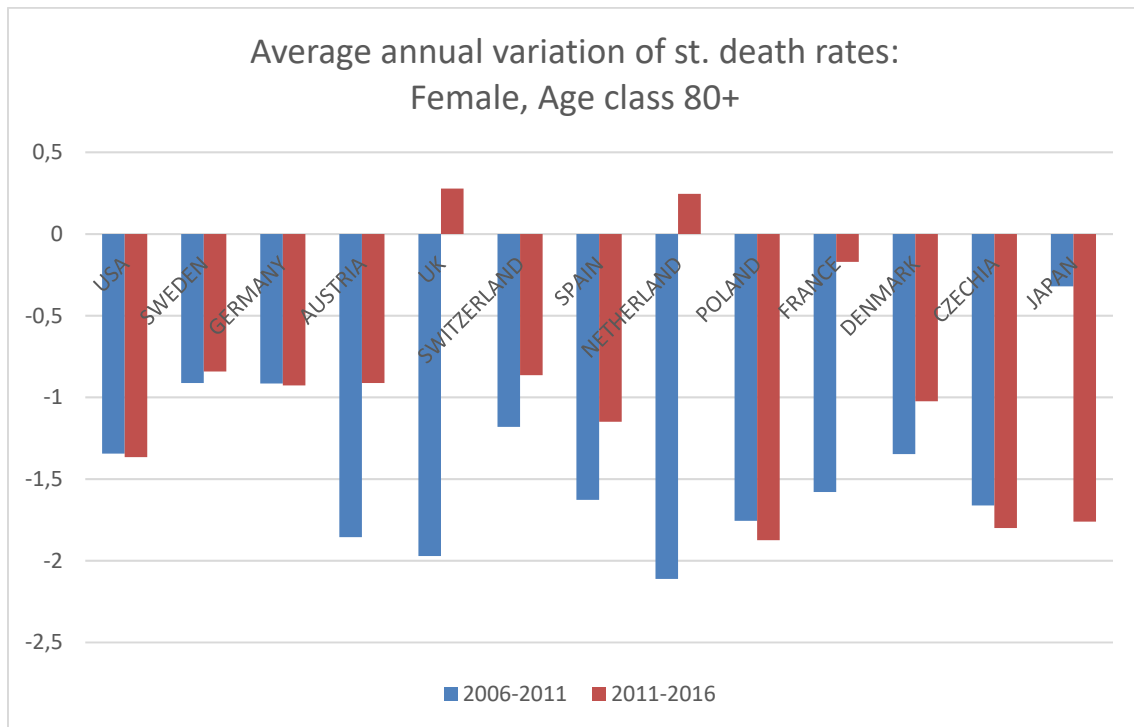
## Male, Age class 80+



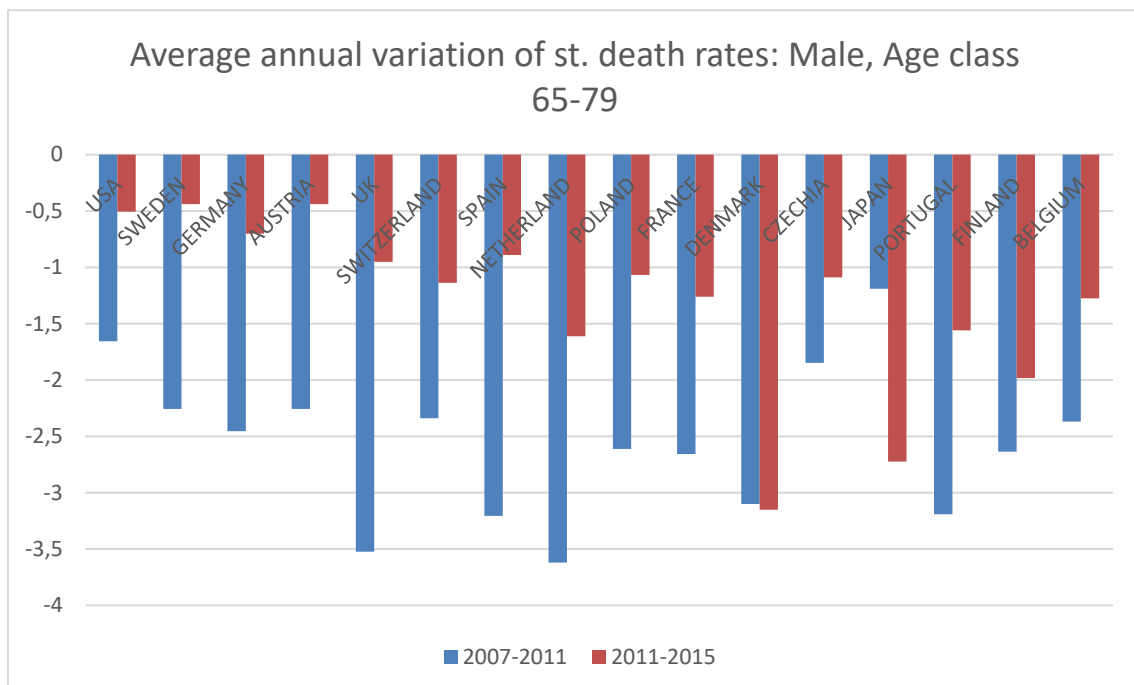
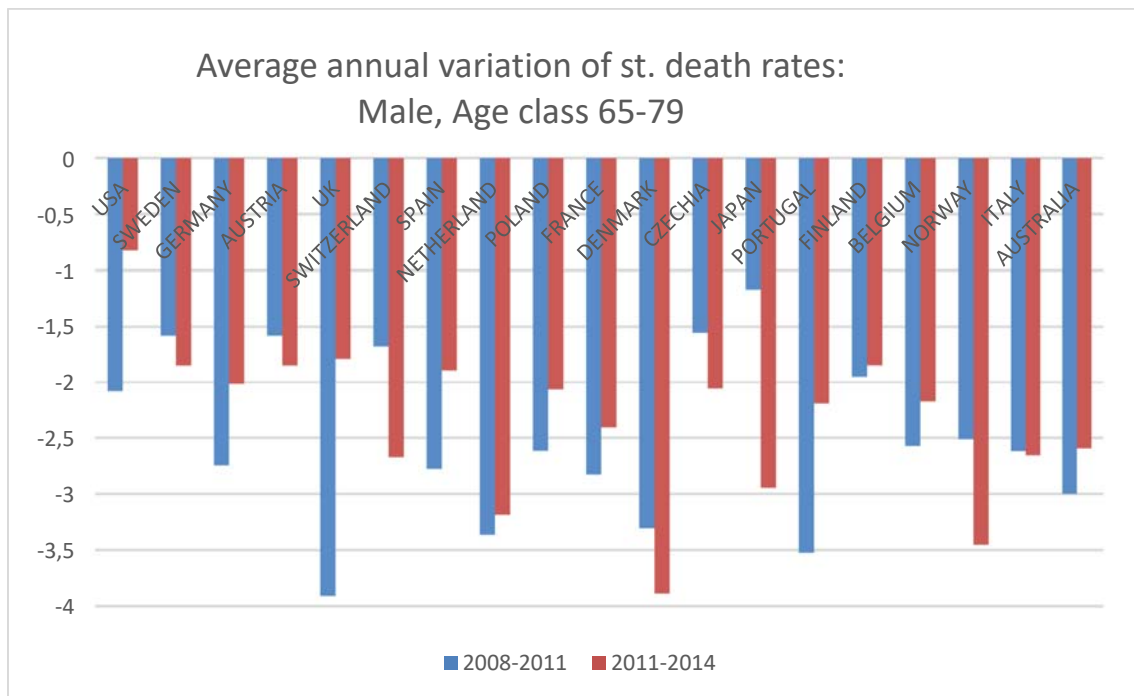


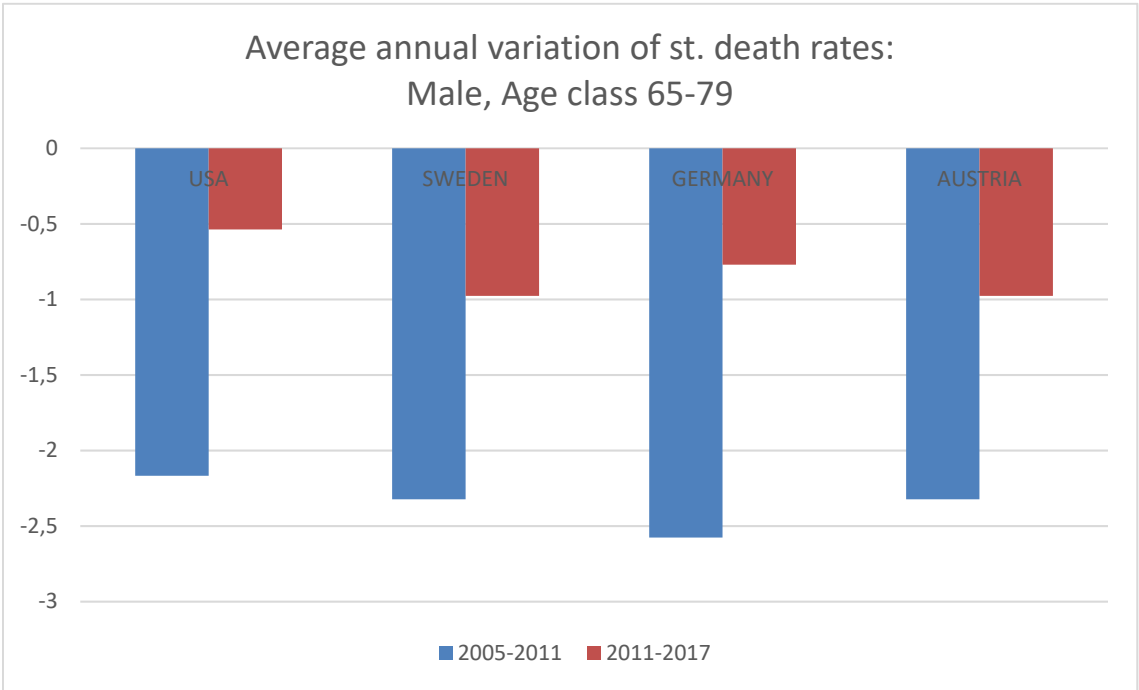
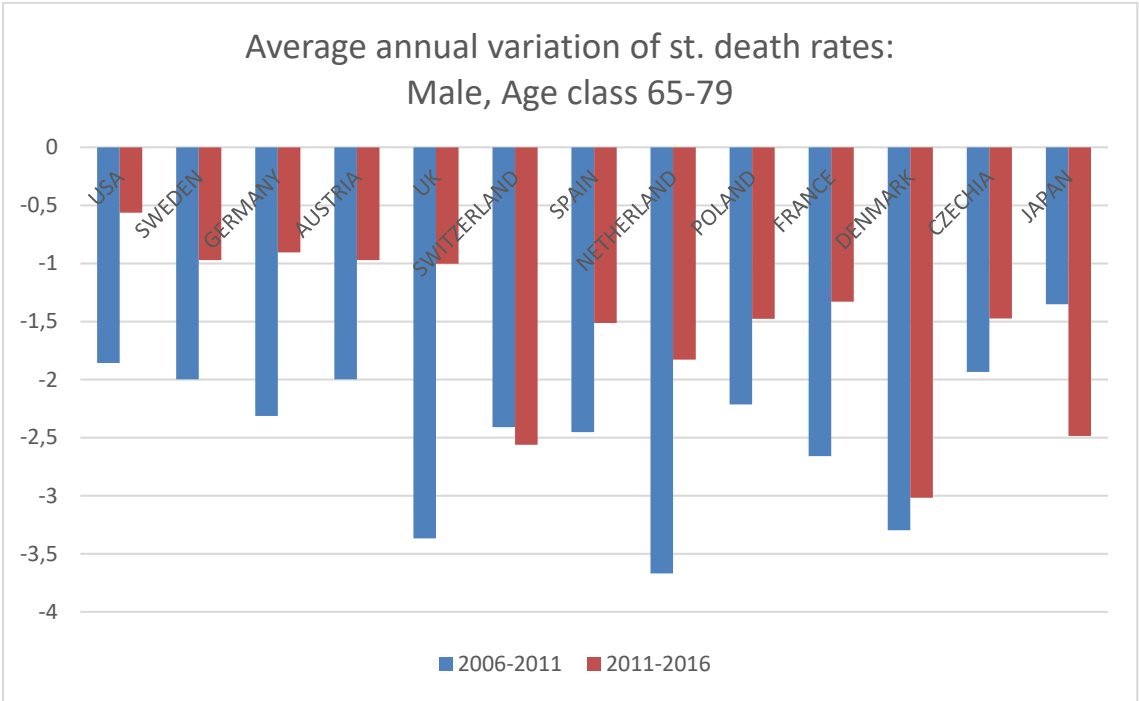
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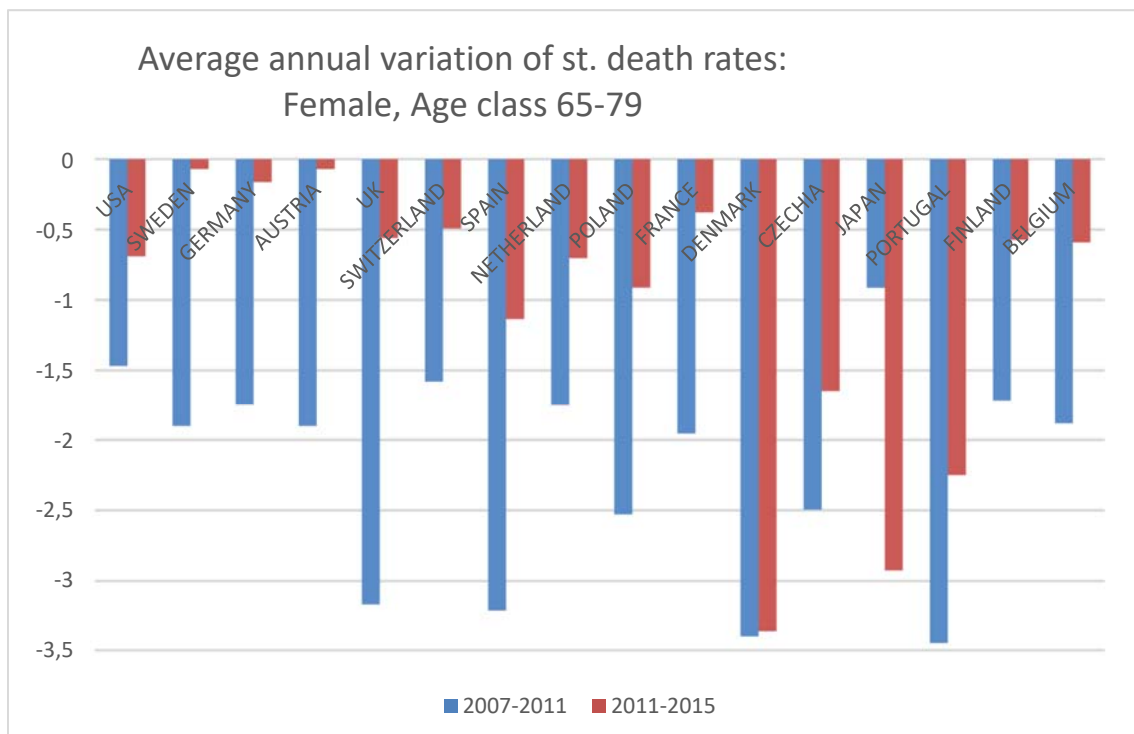
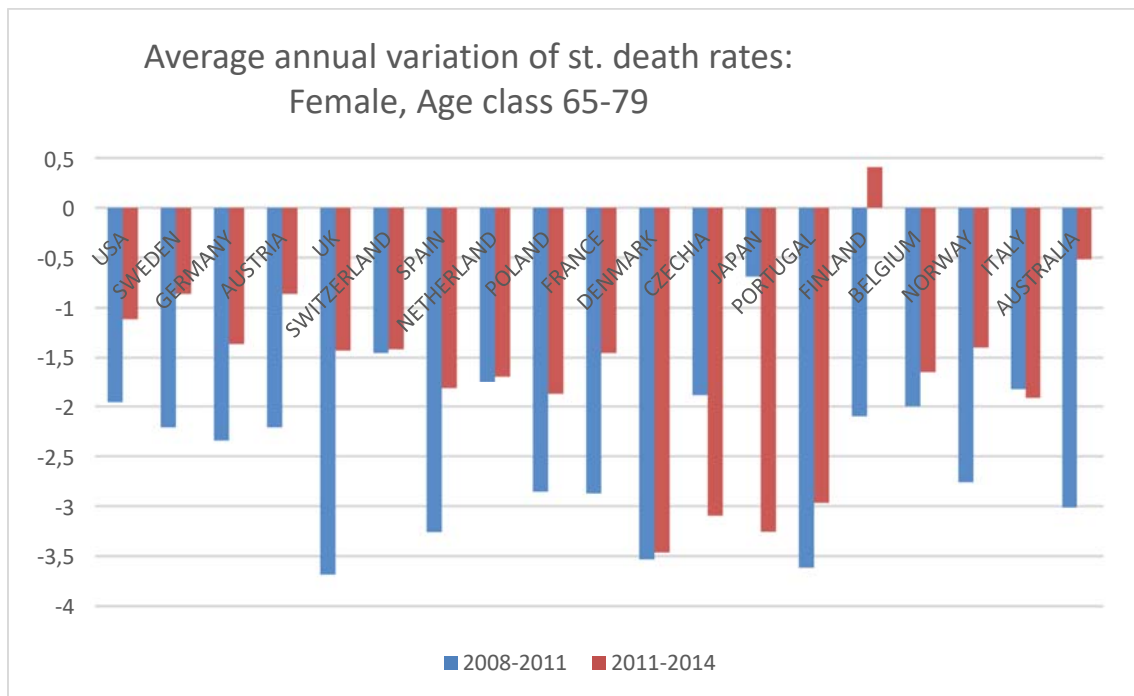
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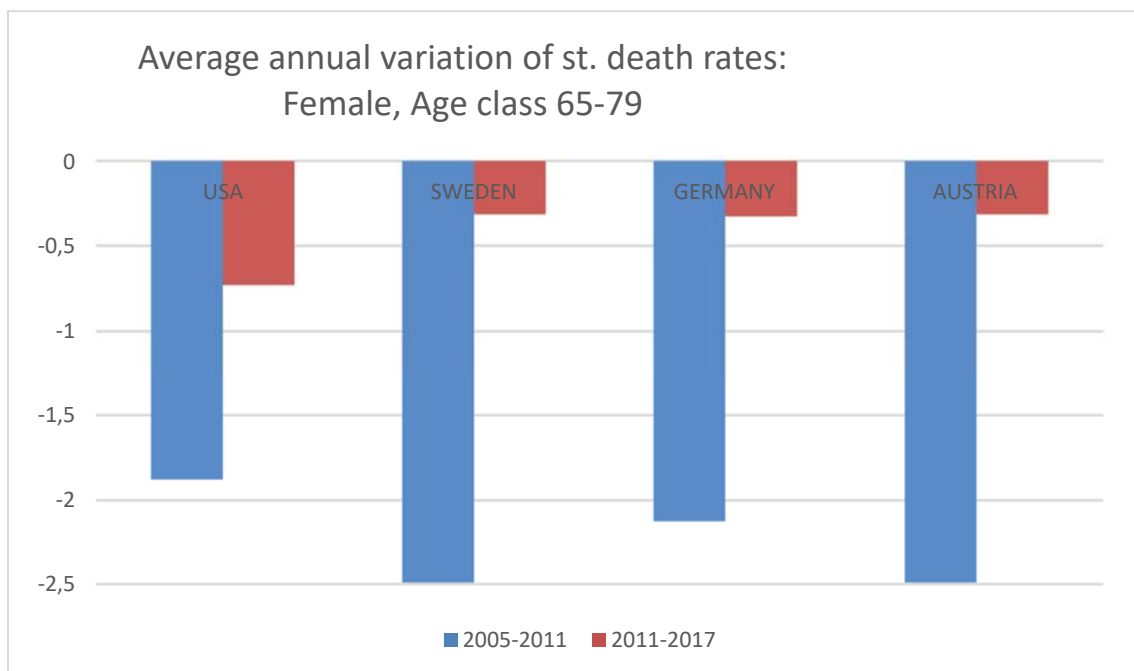
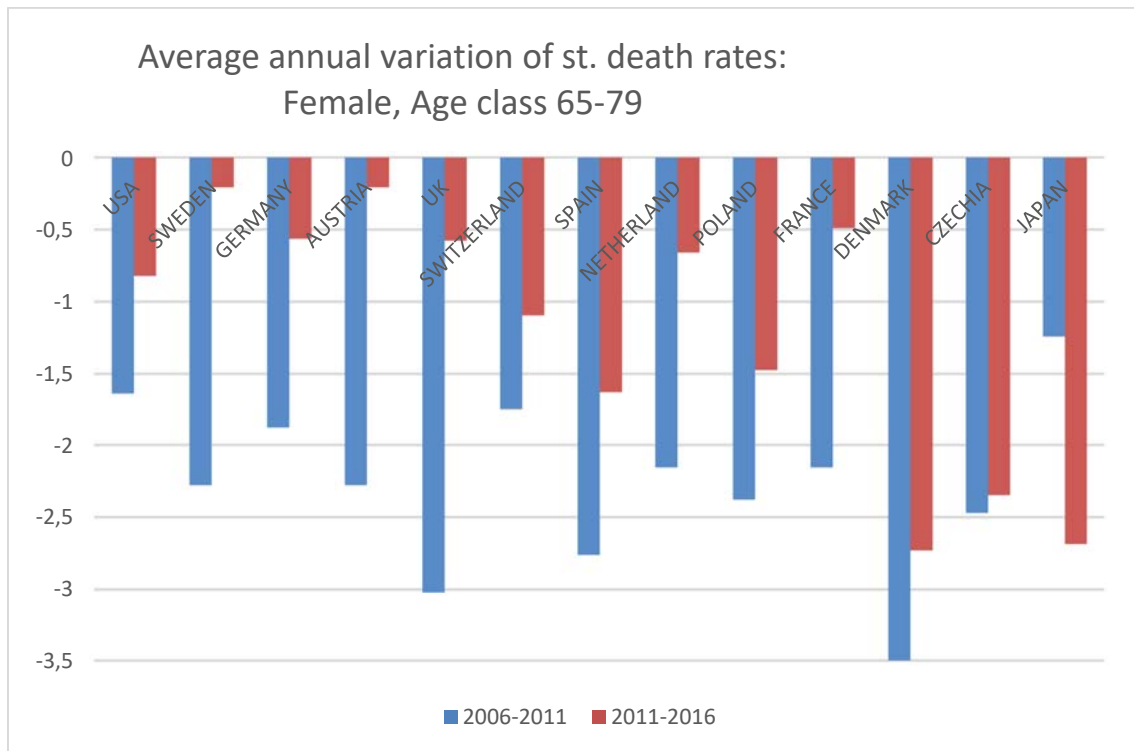




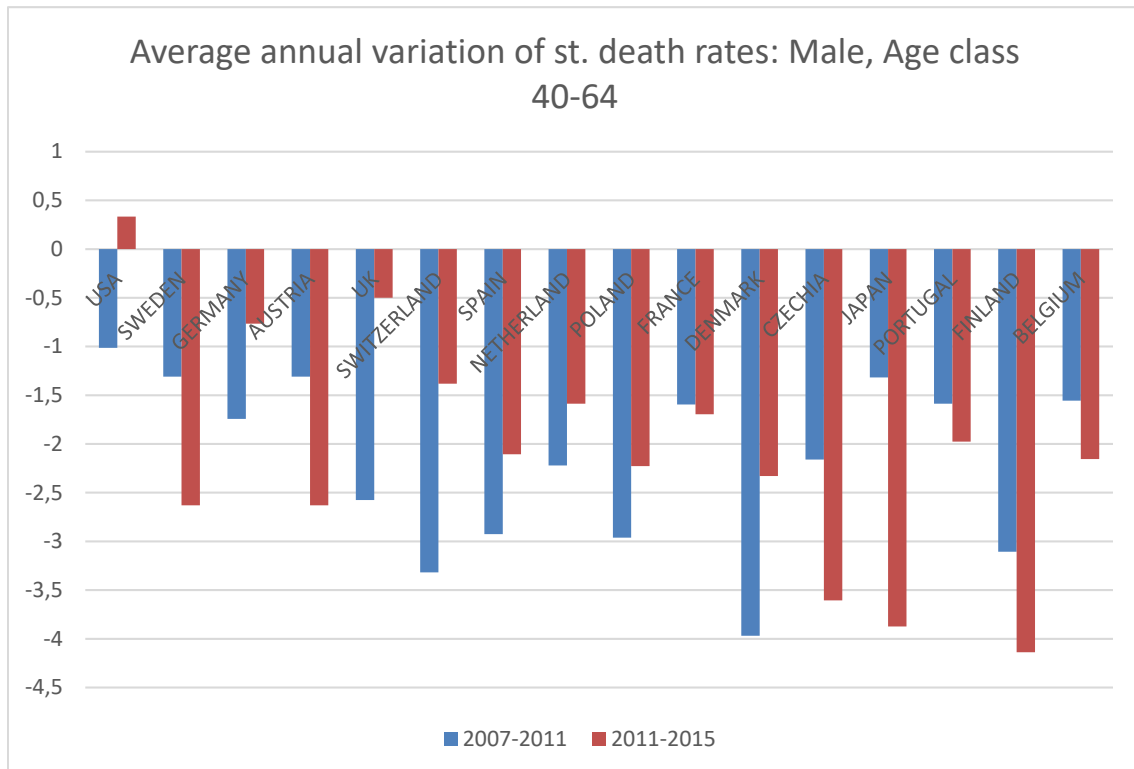
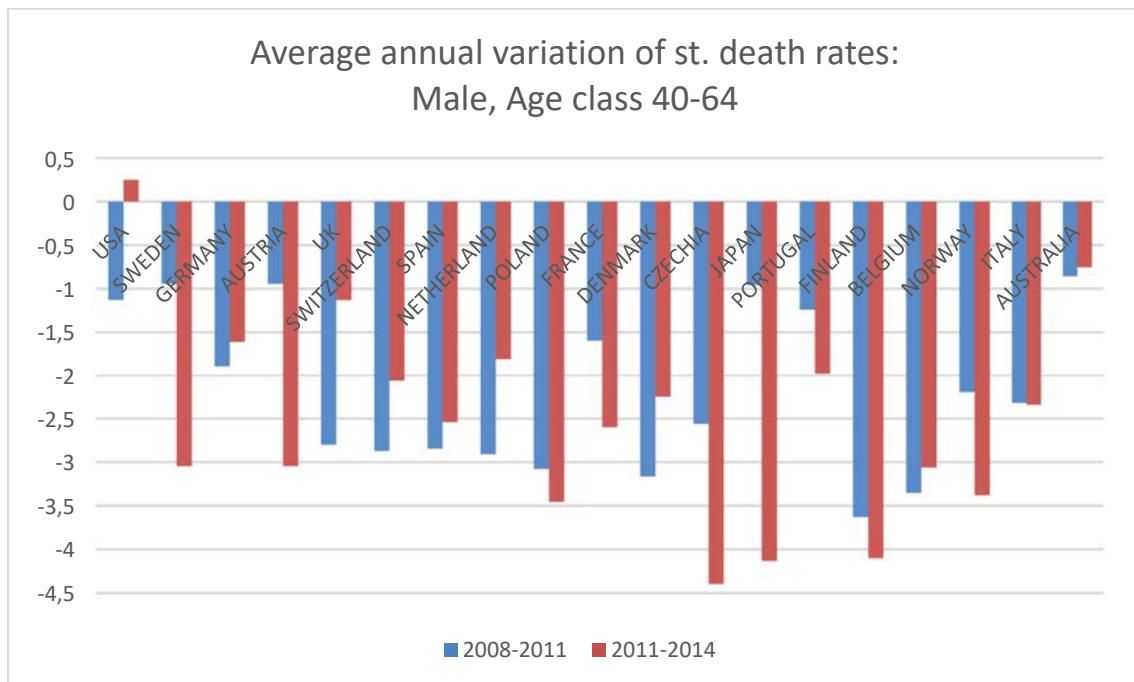


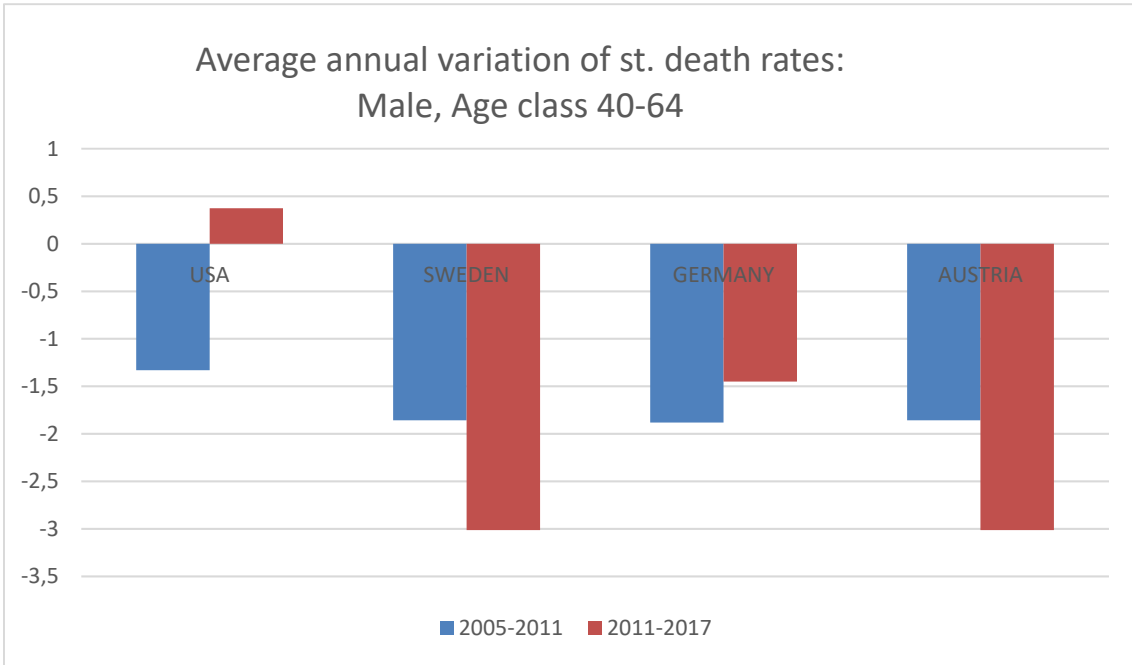
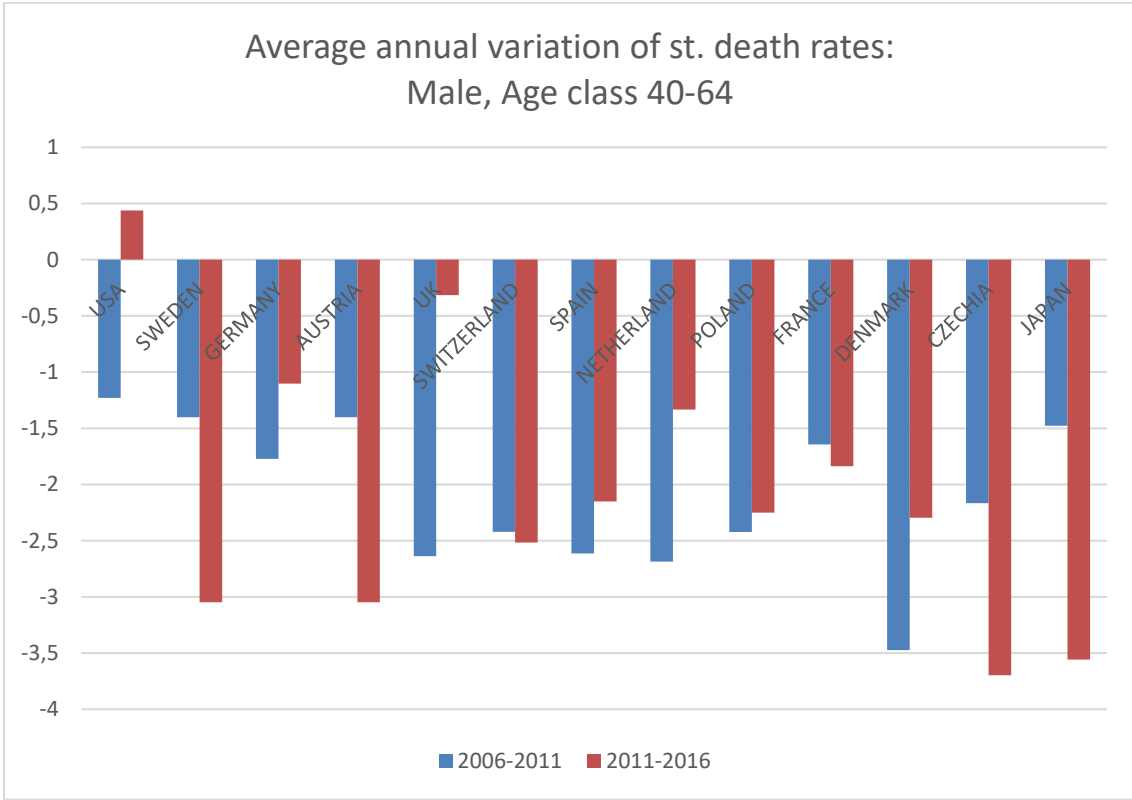
## Female, Age class 65-79



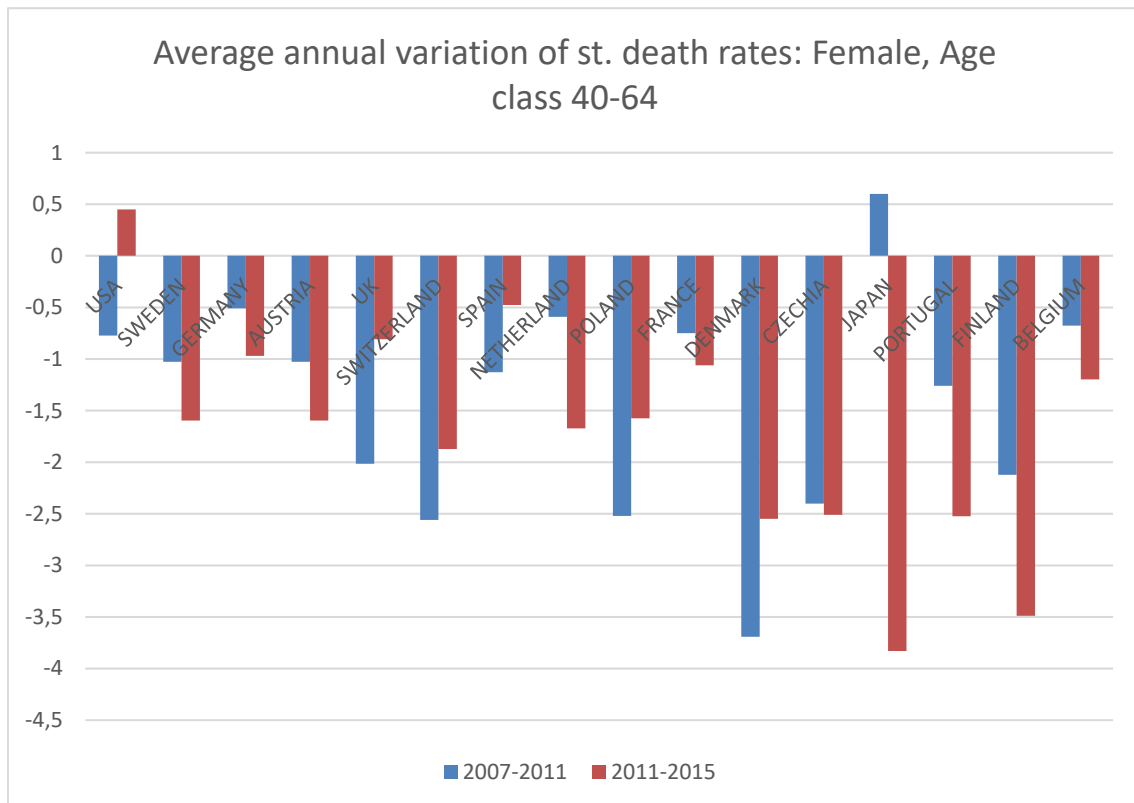
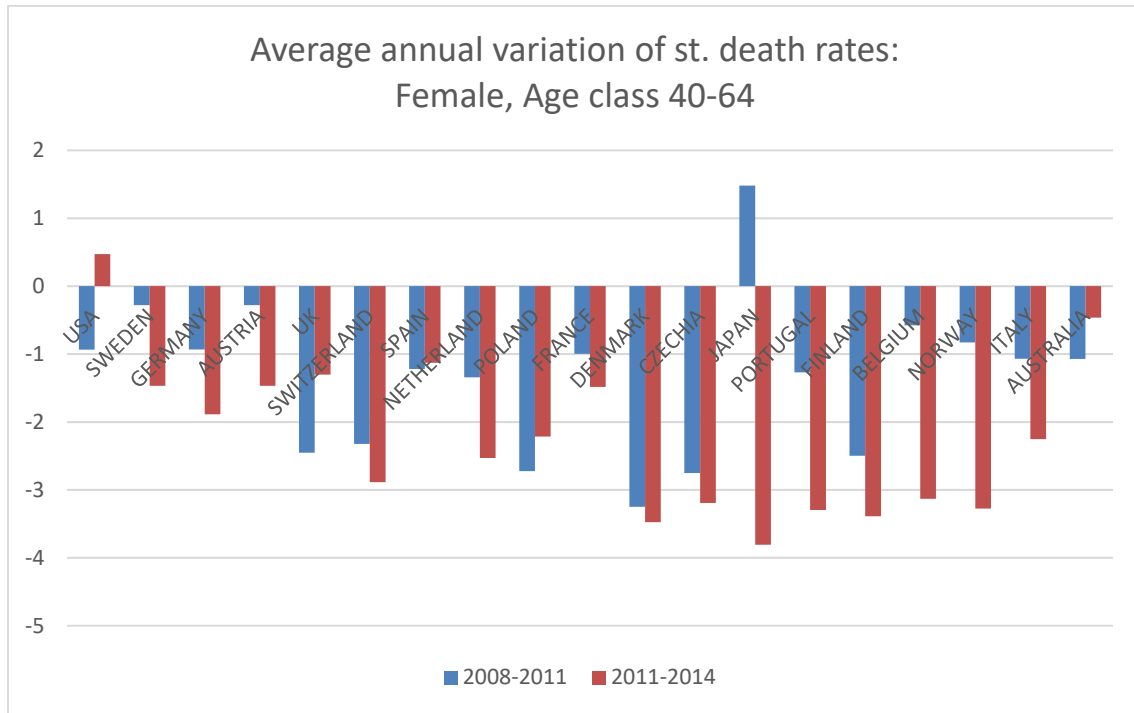


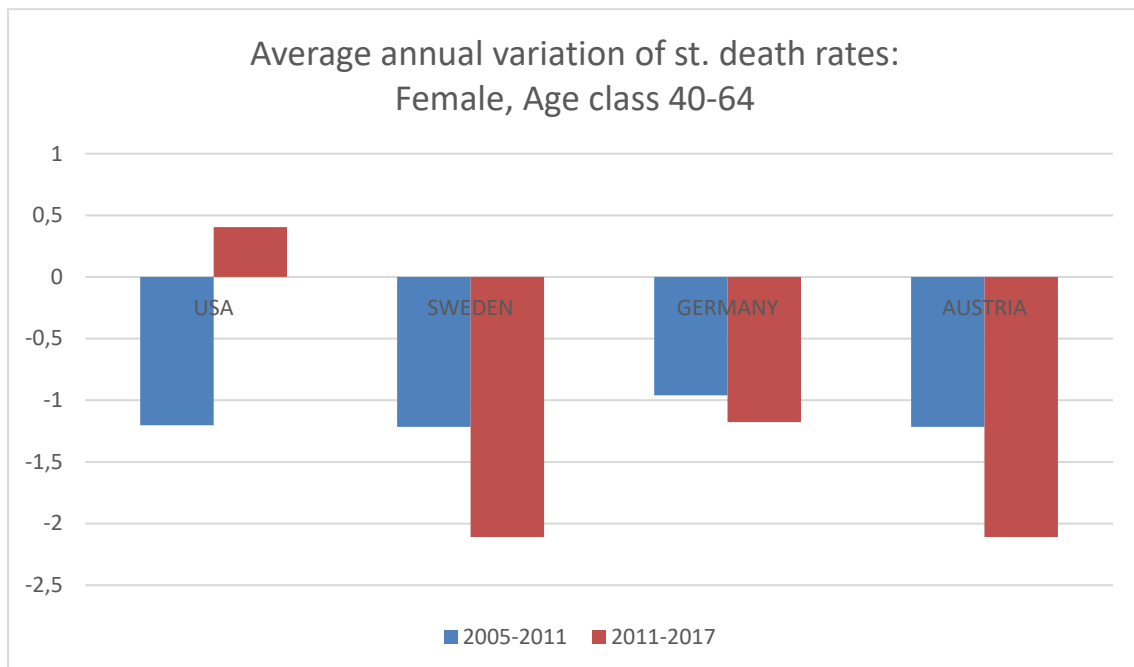
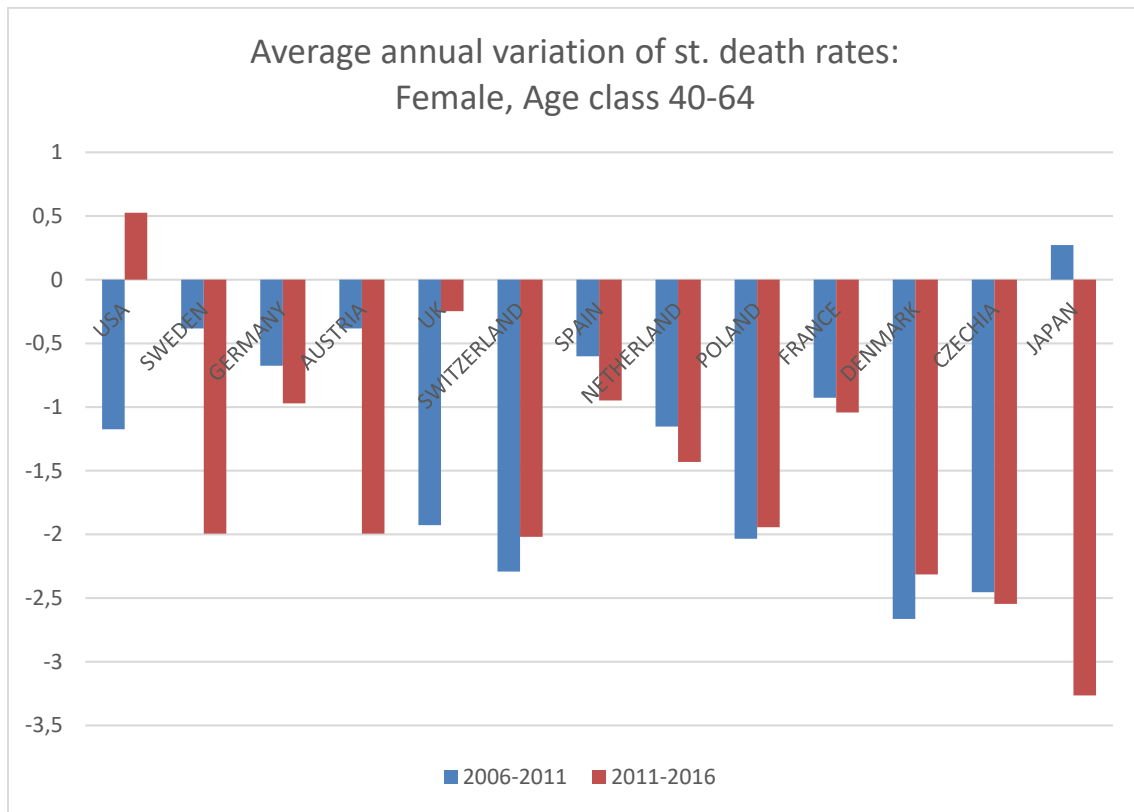
## Male, Age class 40-64



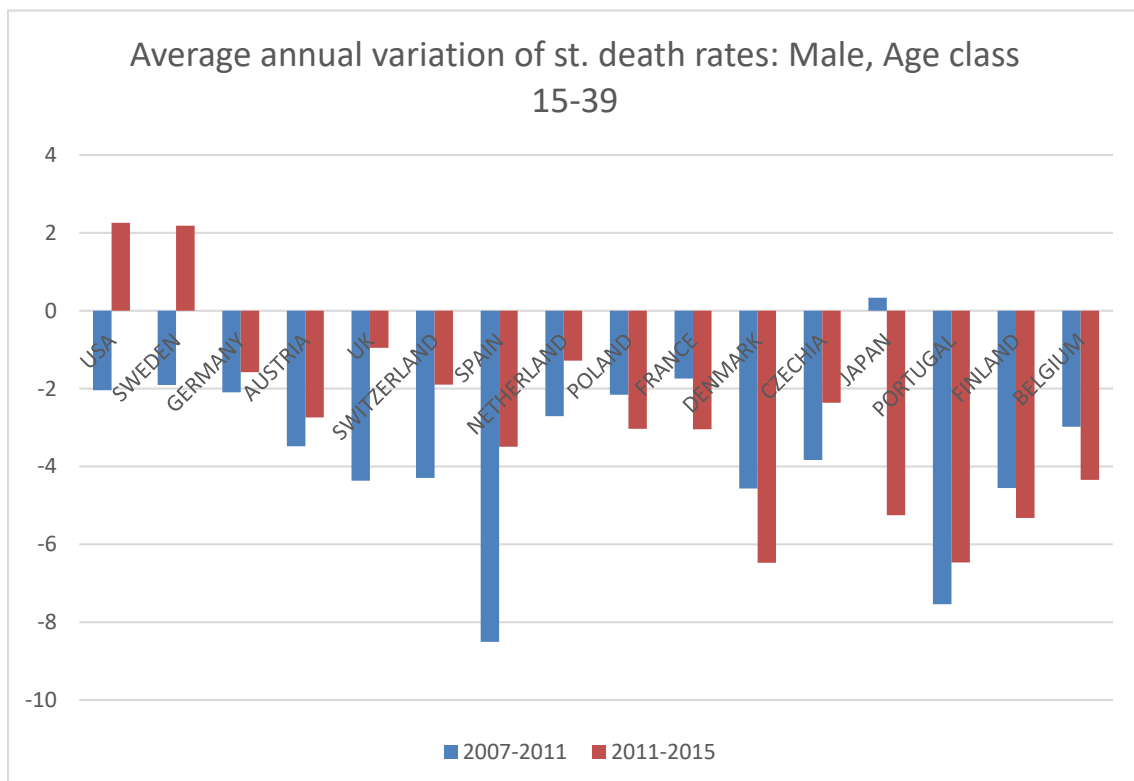
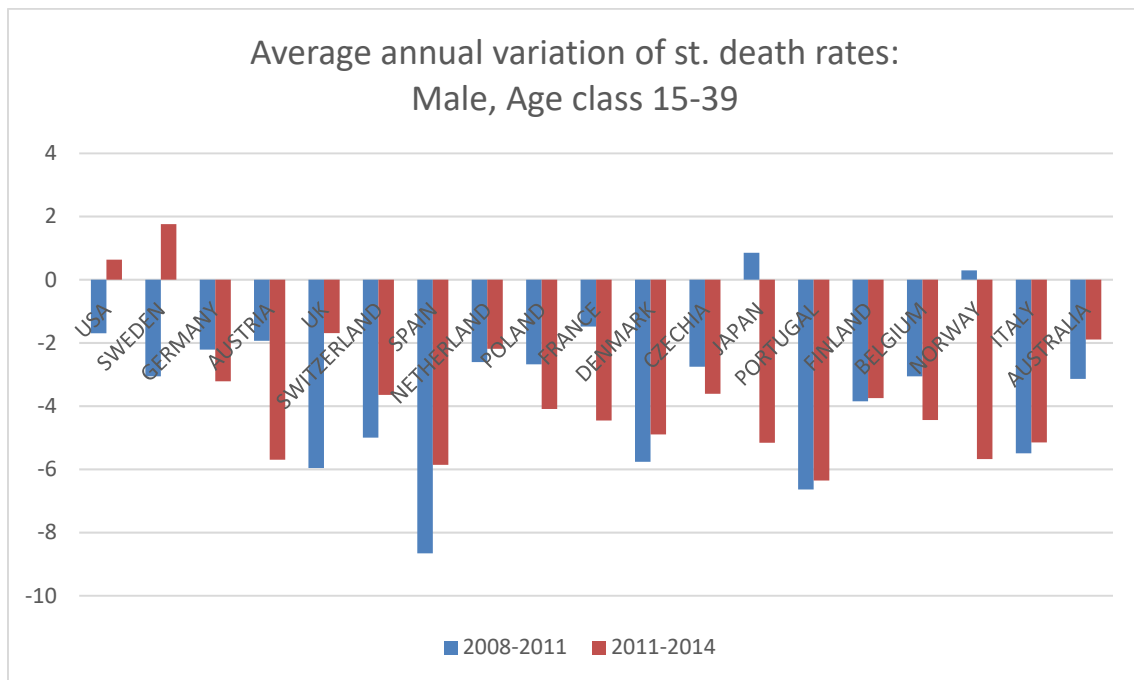


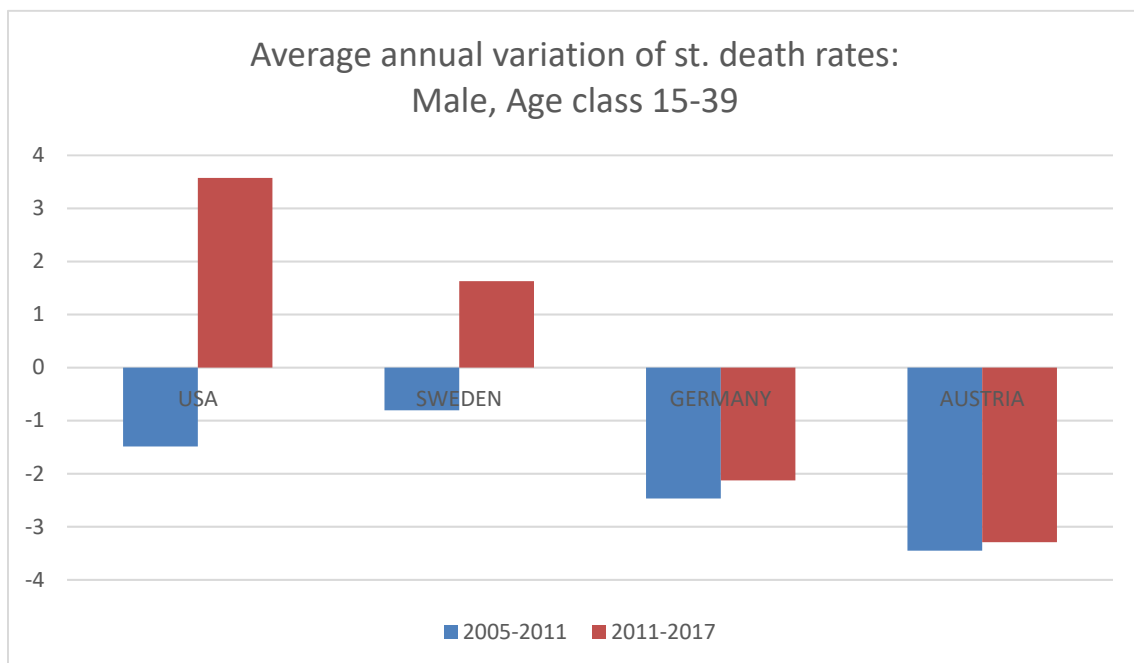
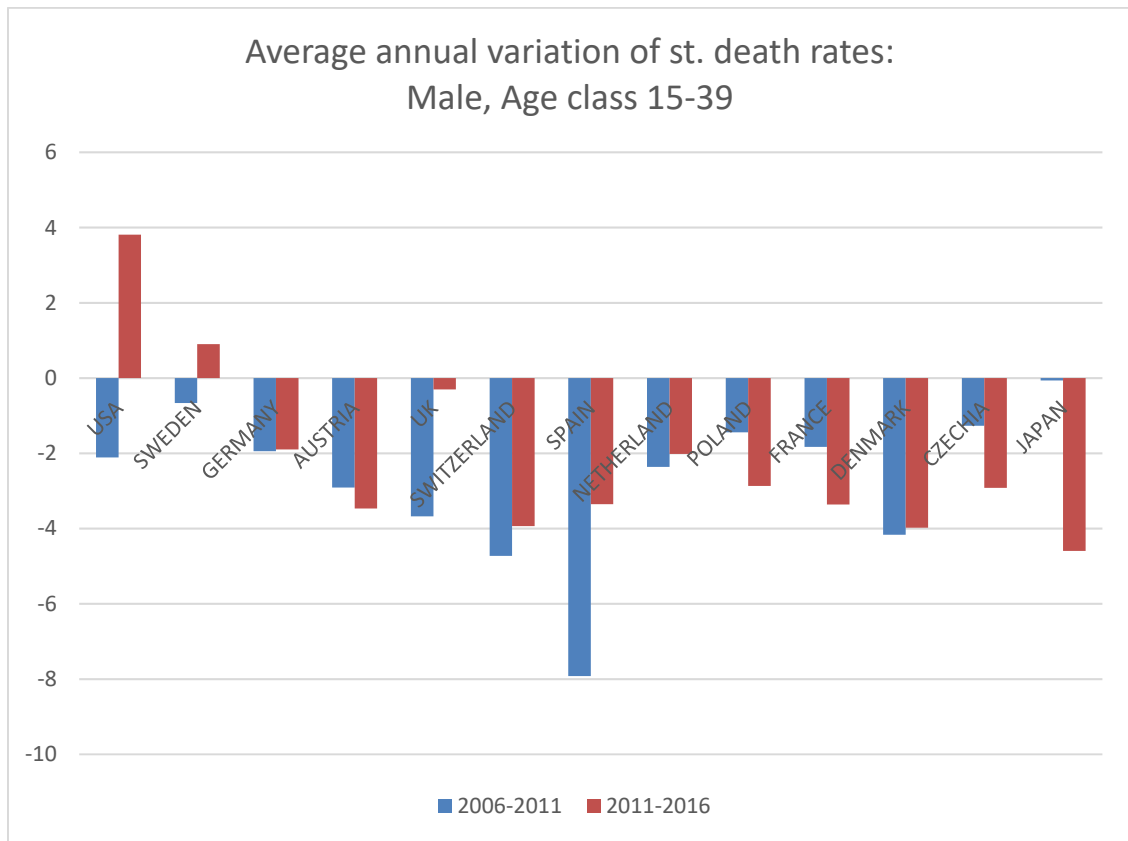
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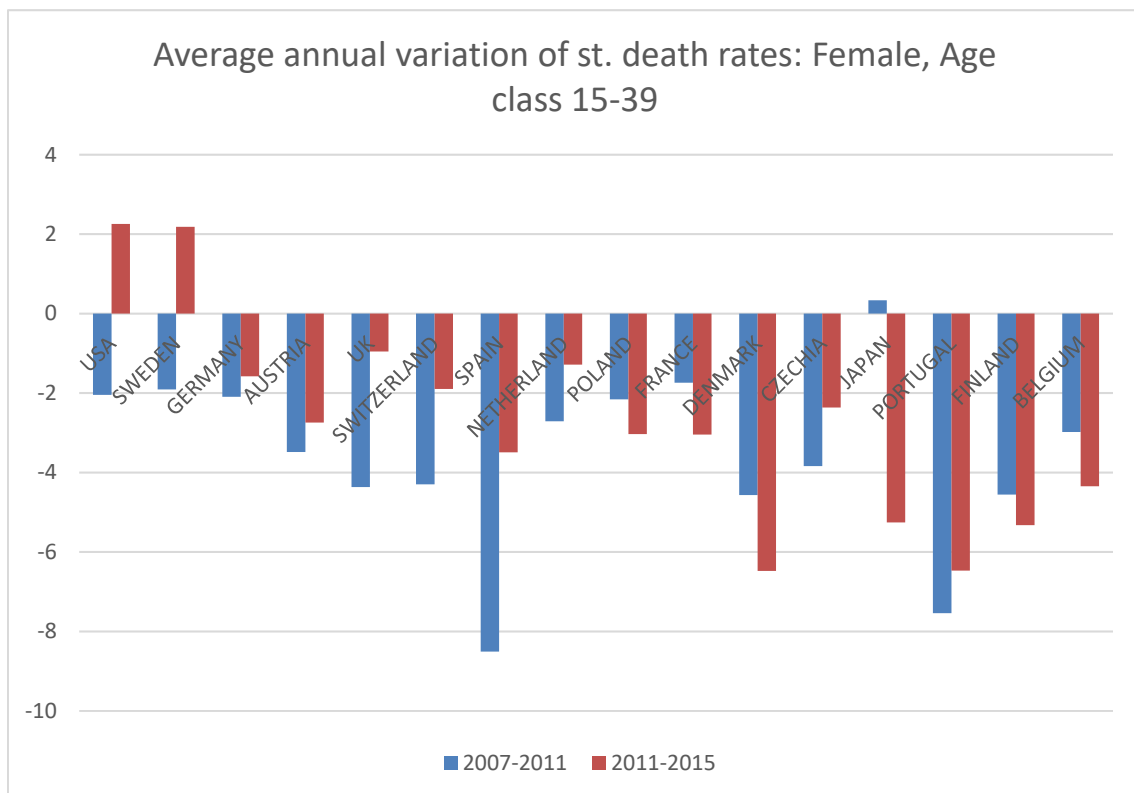
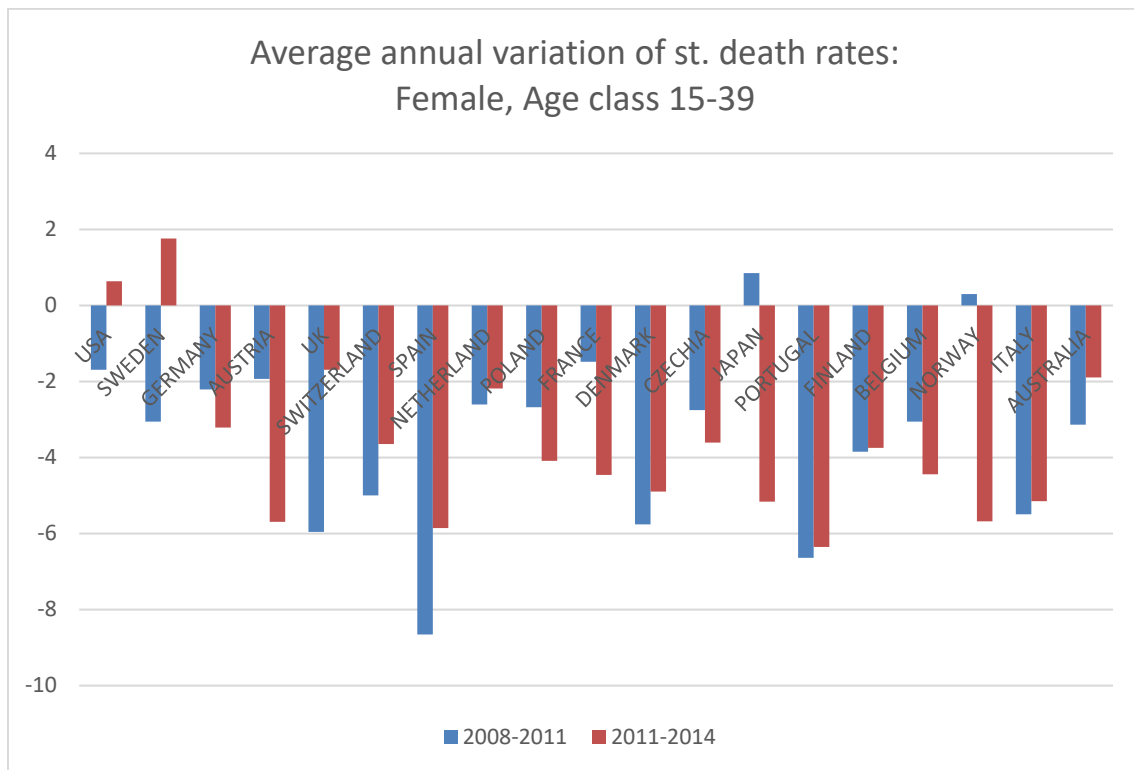
## Male, Age class 15-39

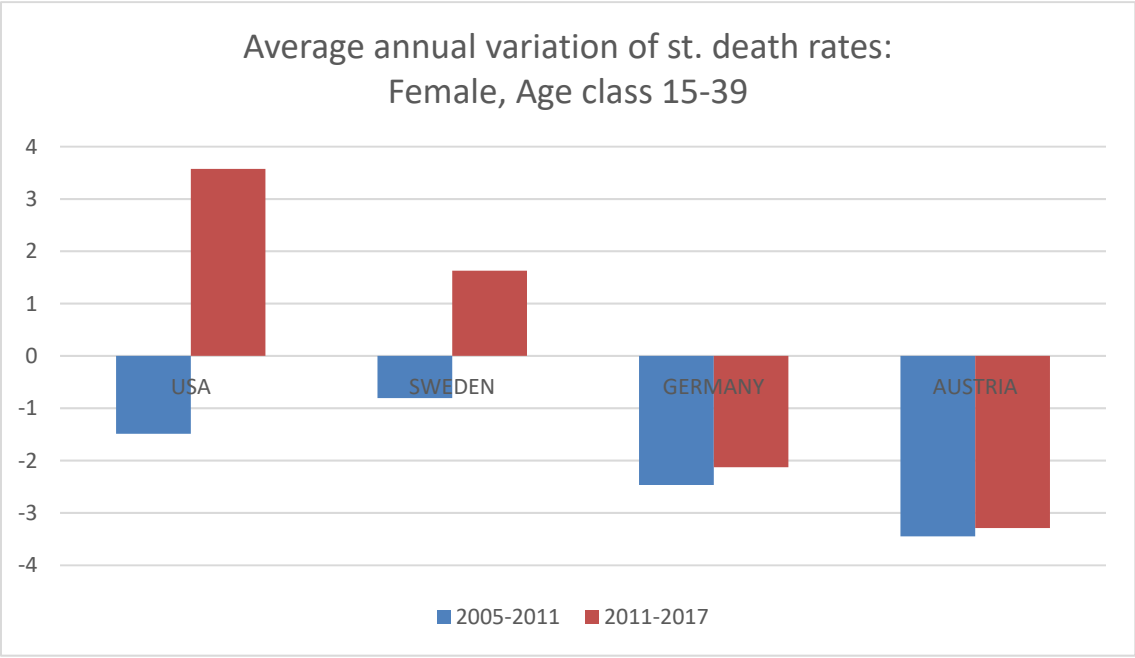
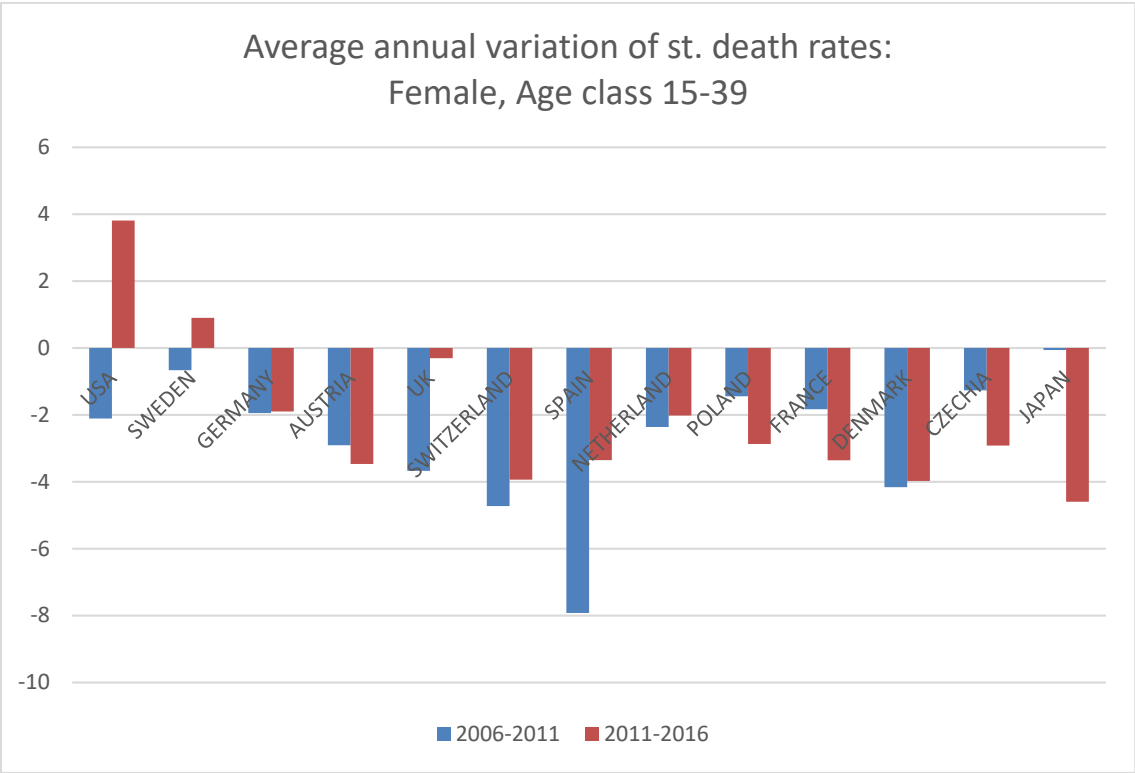




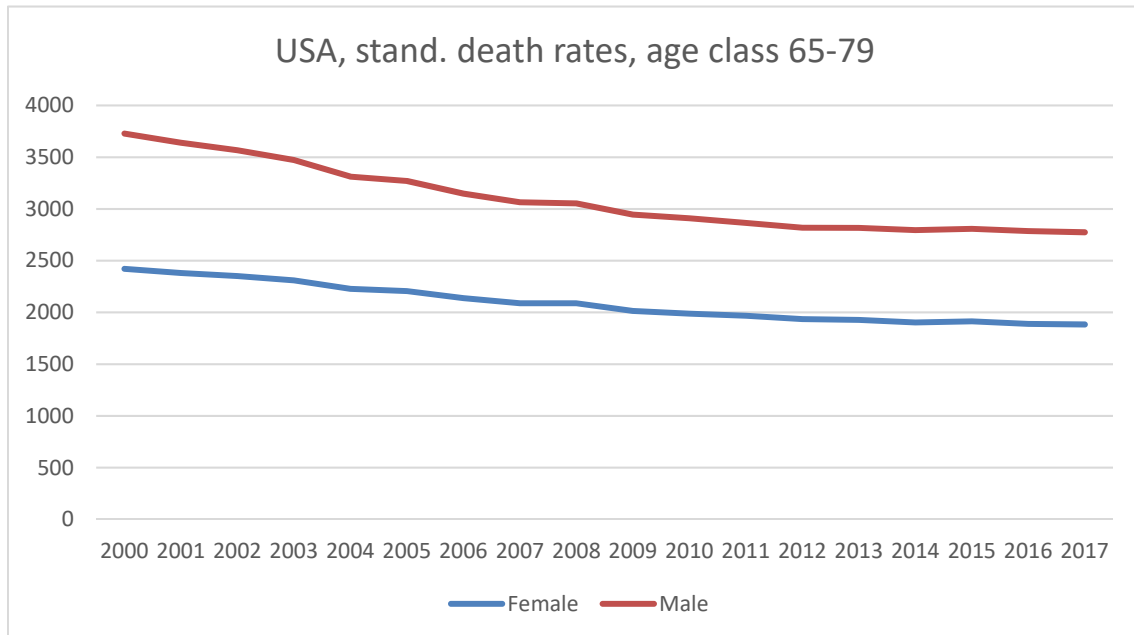
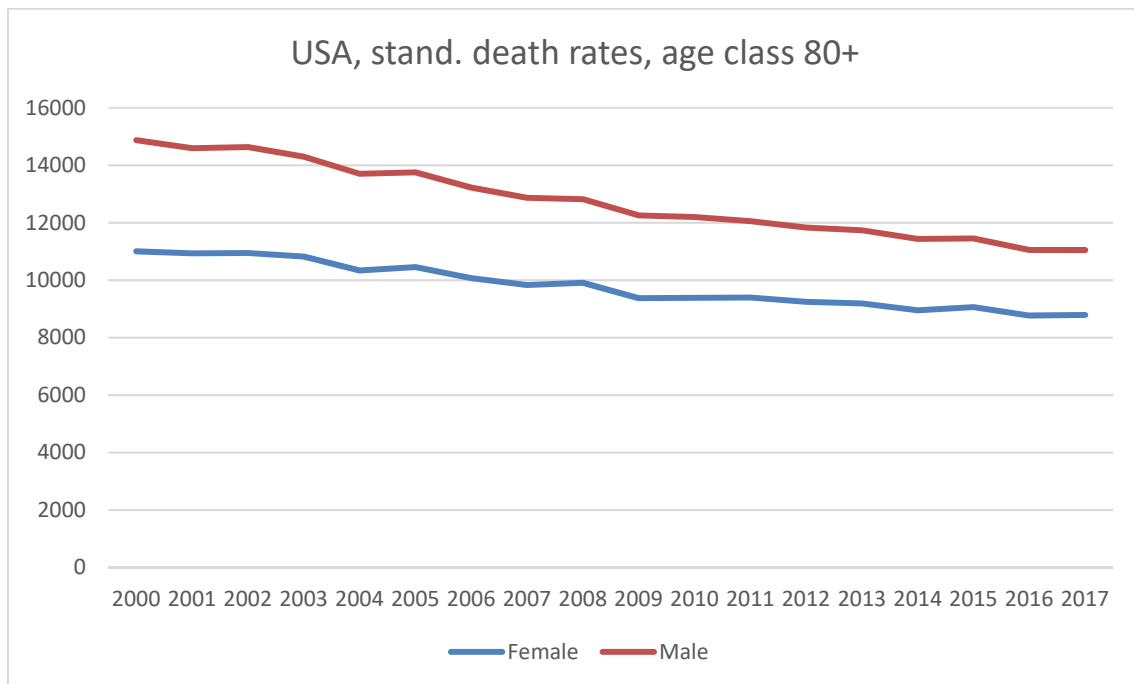


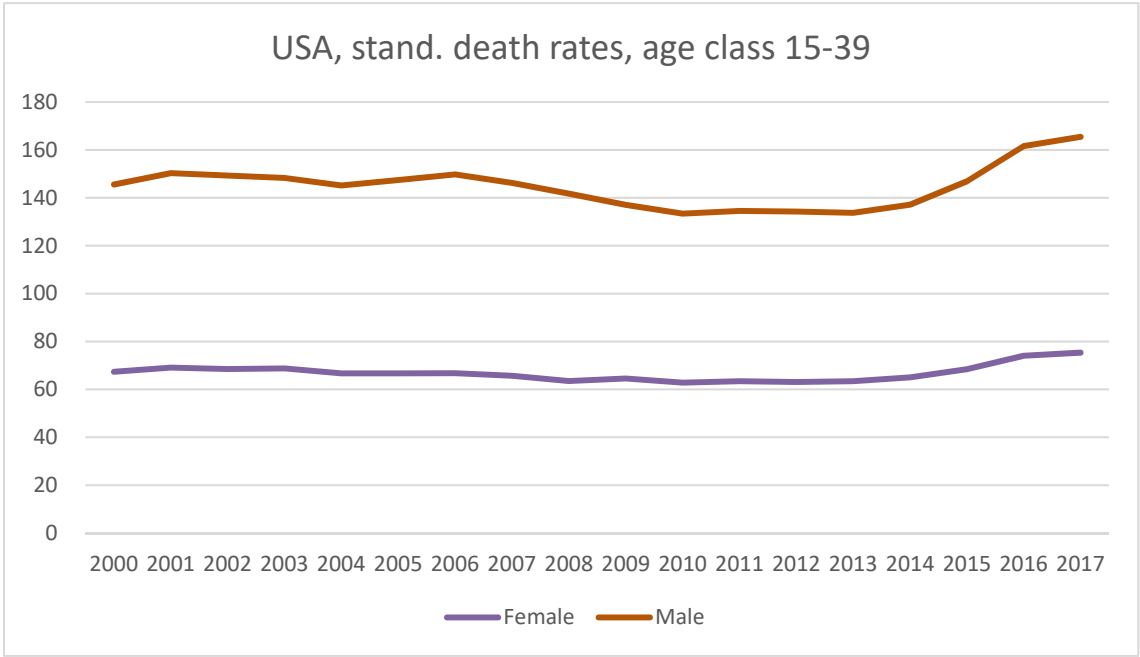
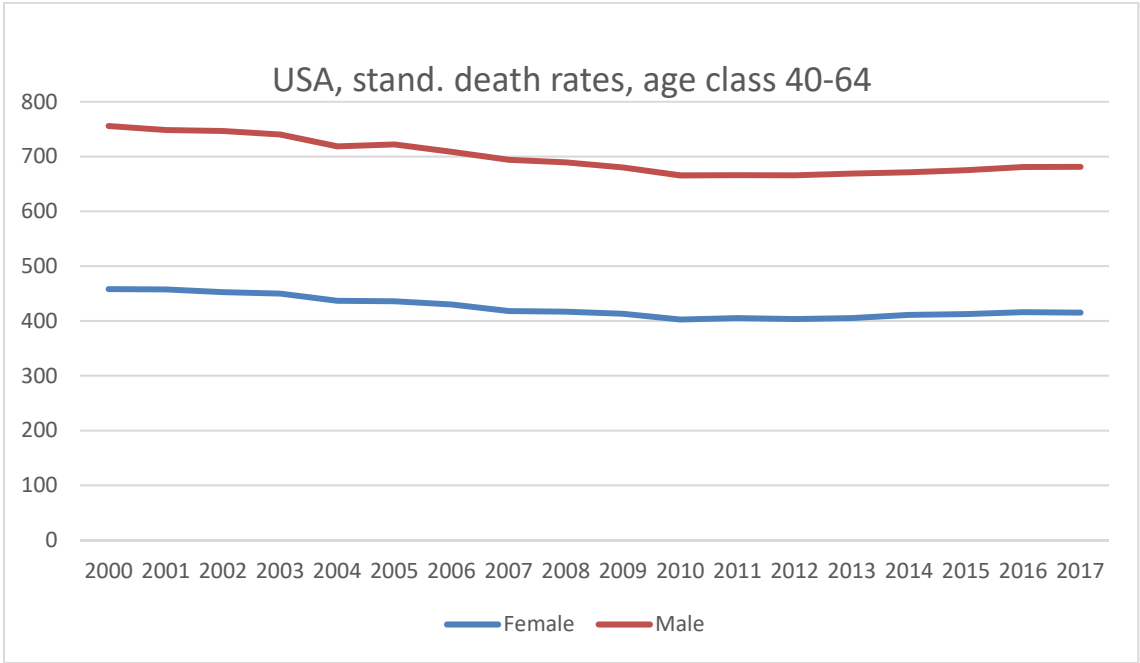
## Female, Age class 15-39



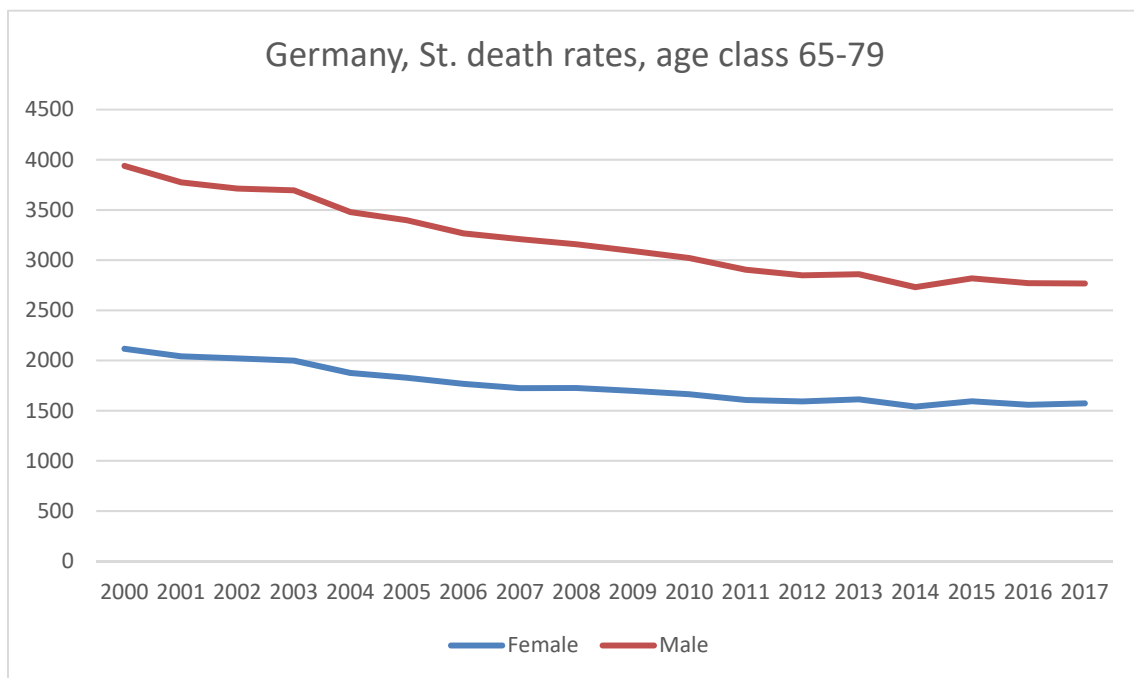
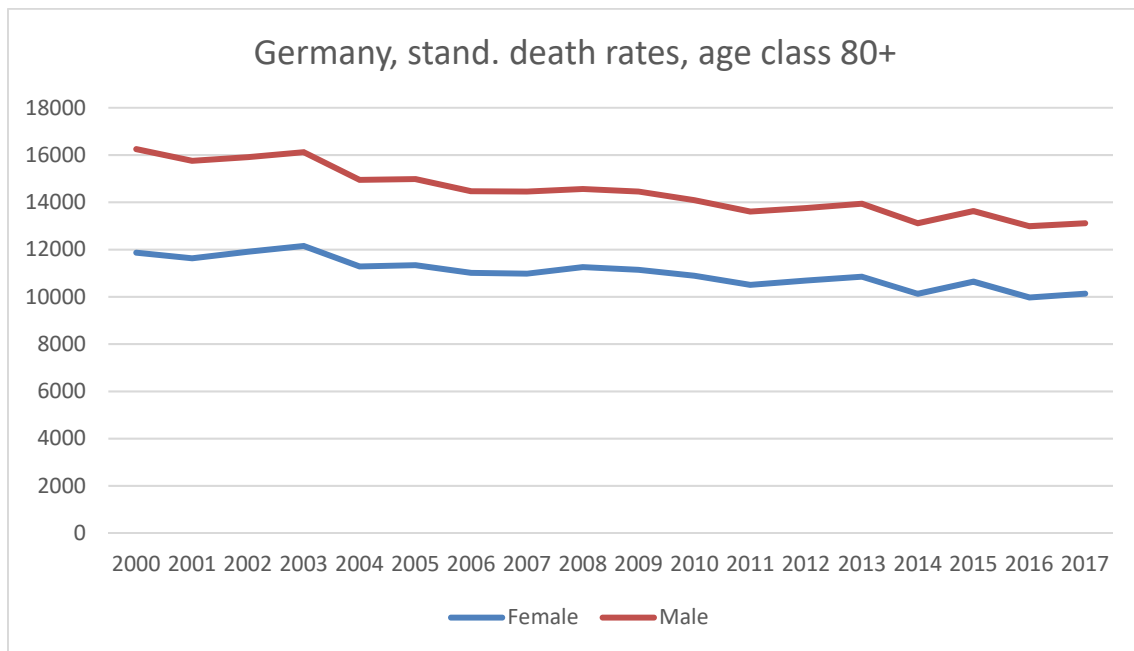


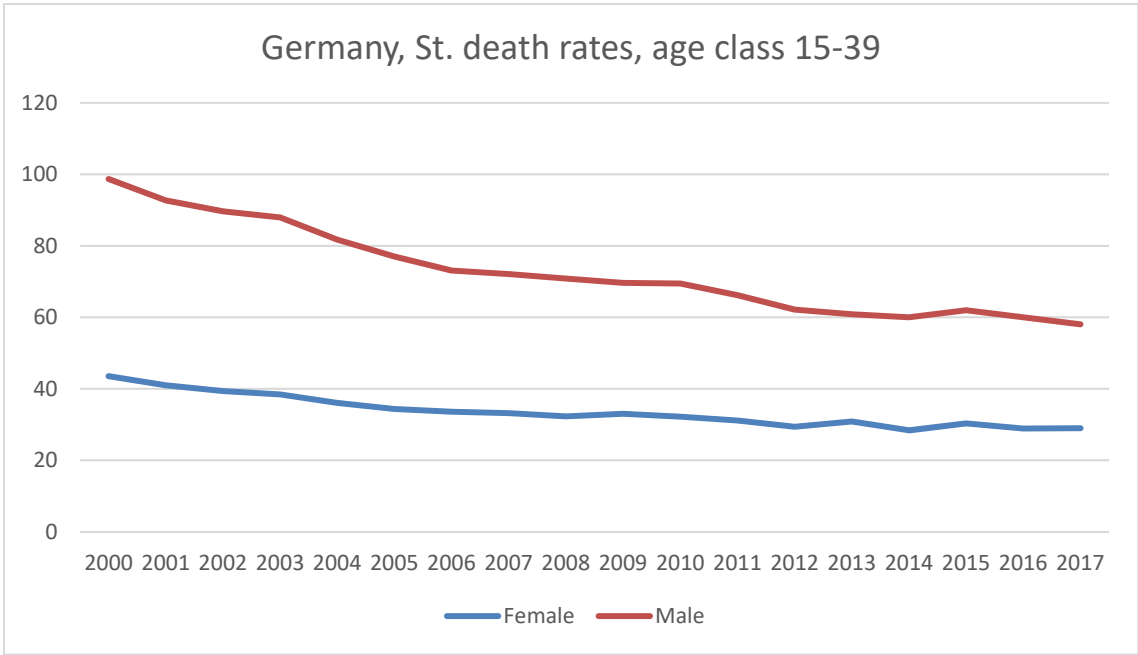
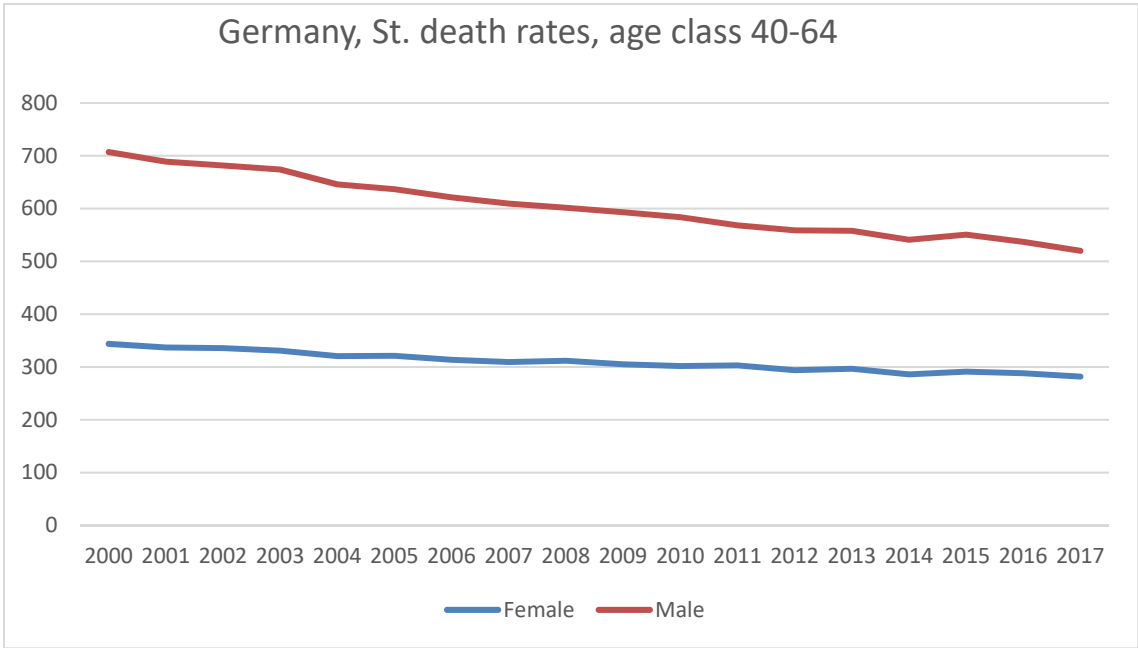
## USA, standardized death rates



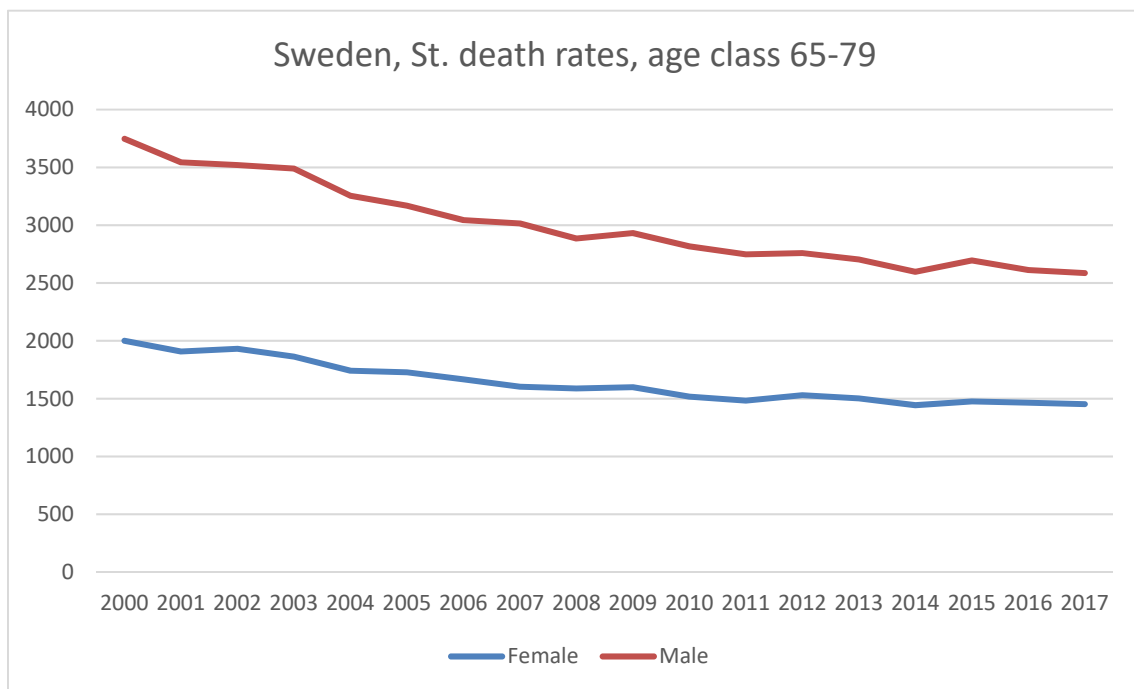
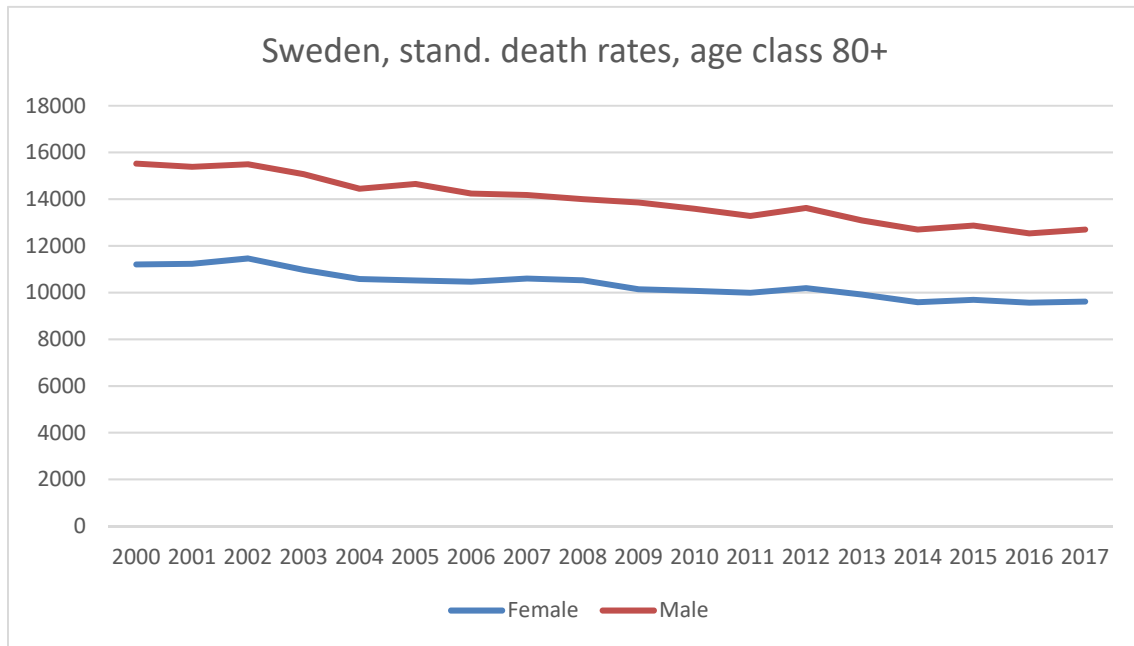


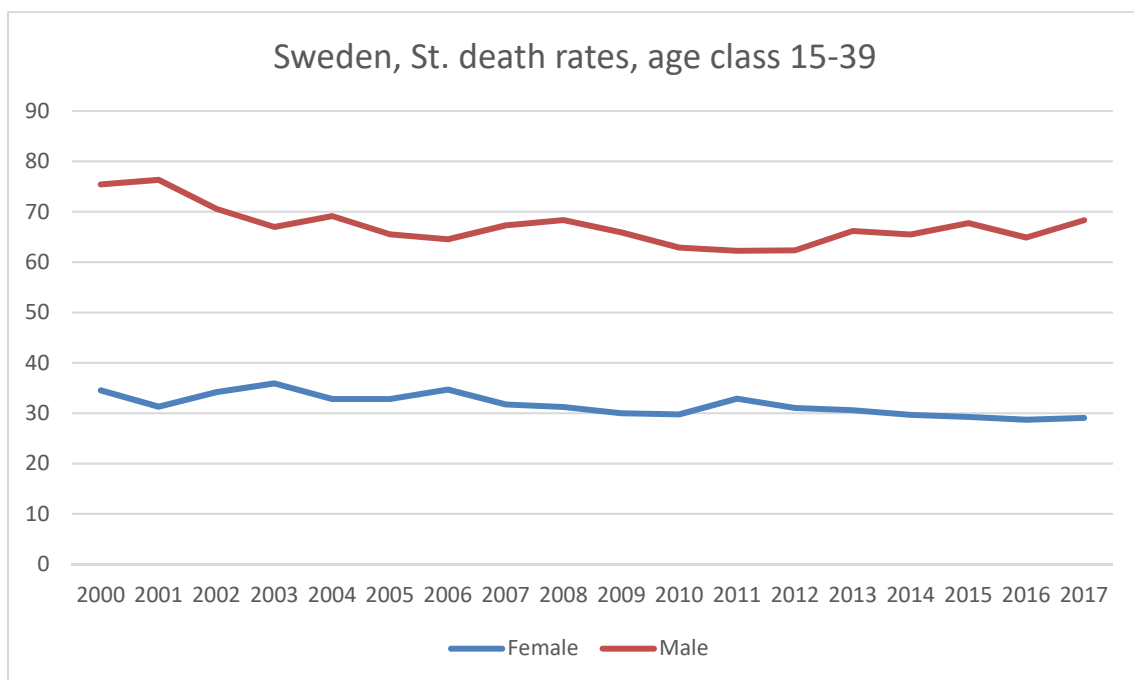
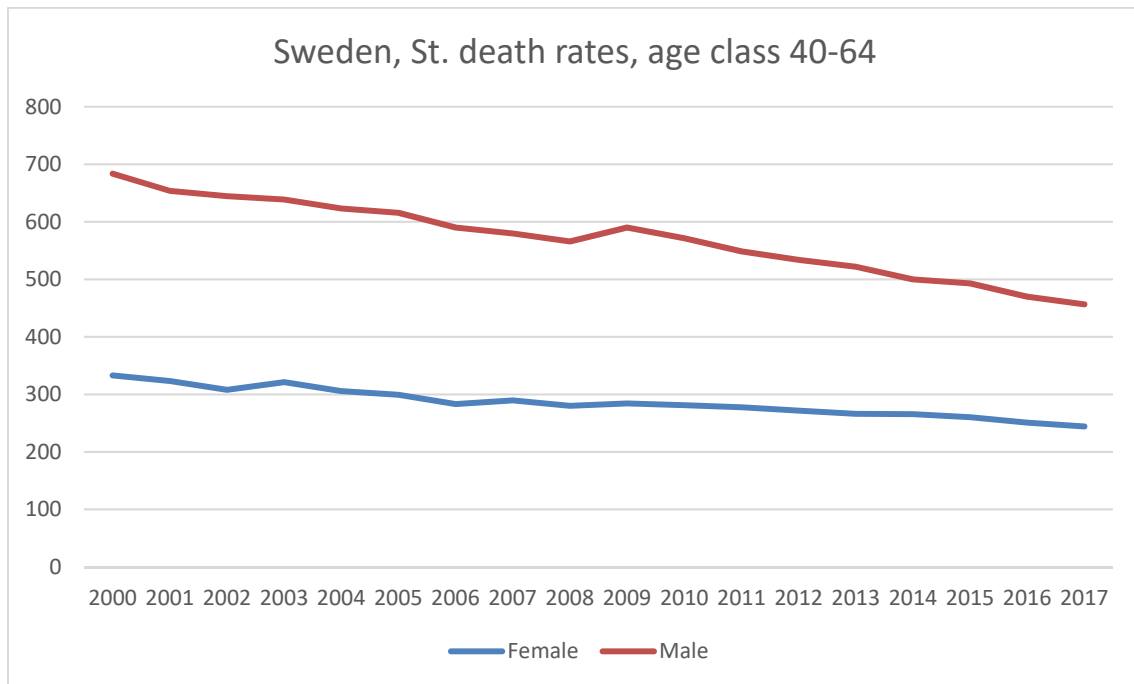
## Germany, standardized death rates





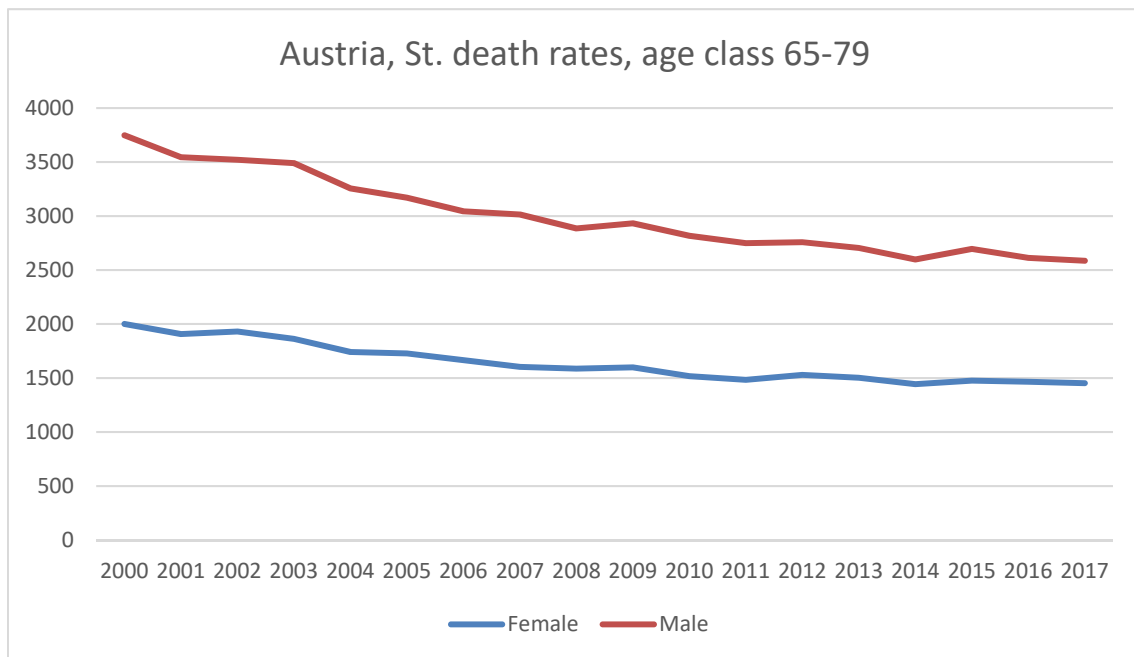
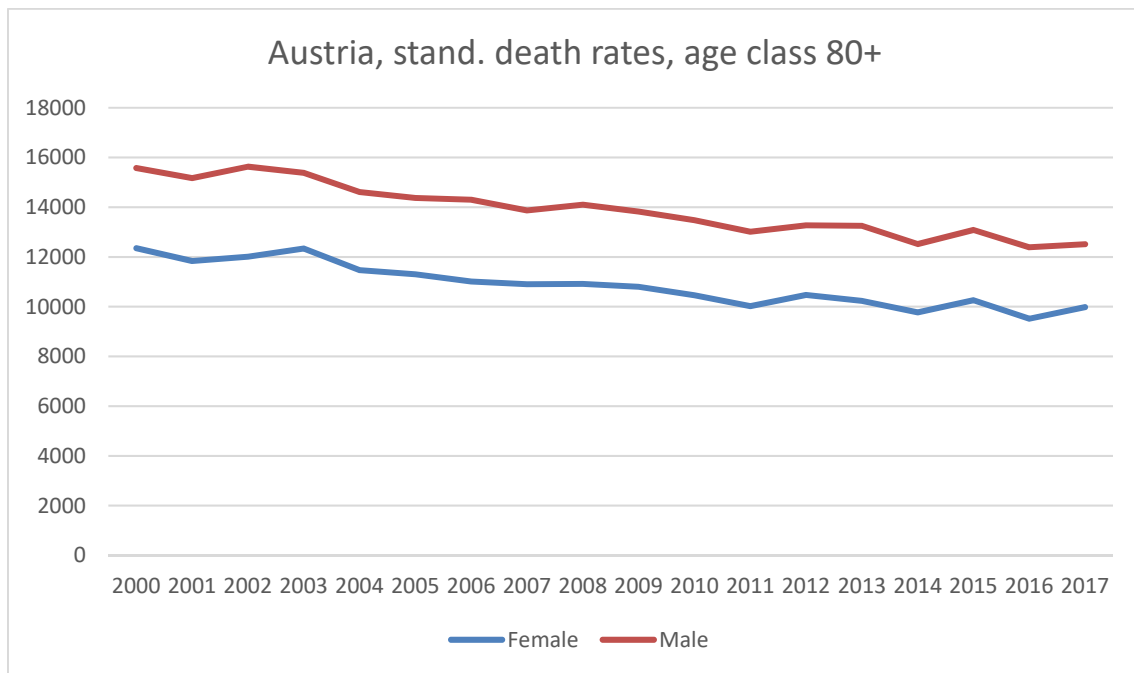
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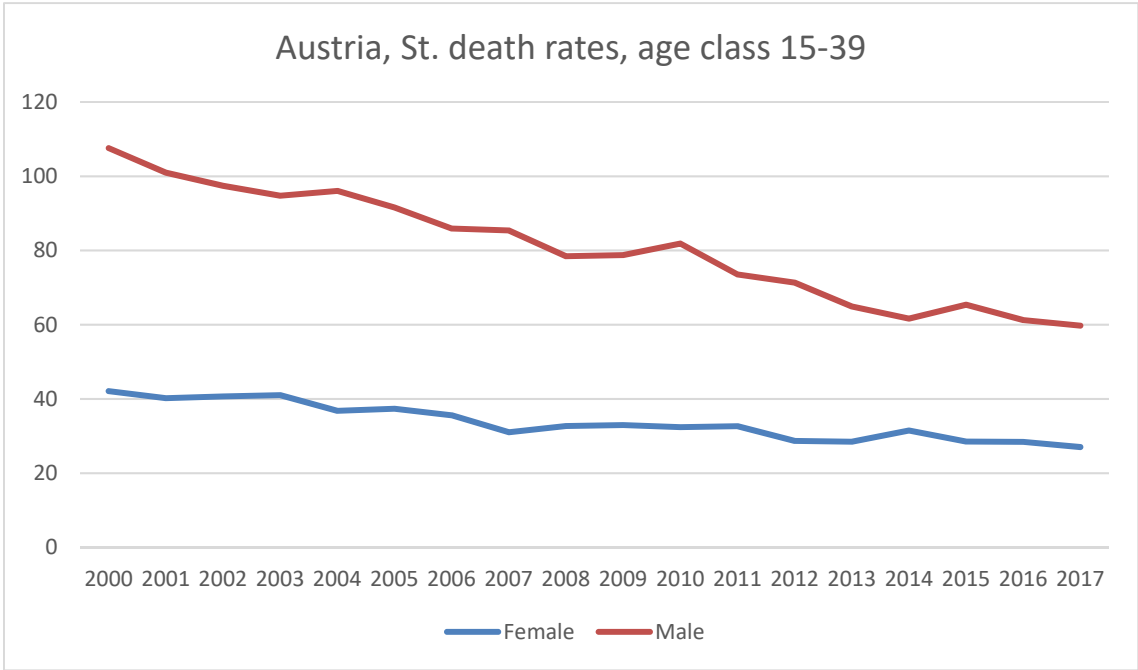
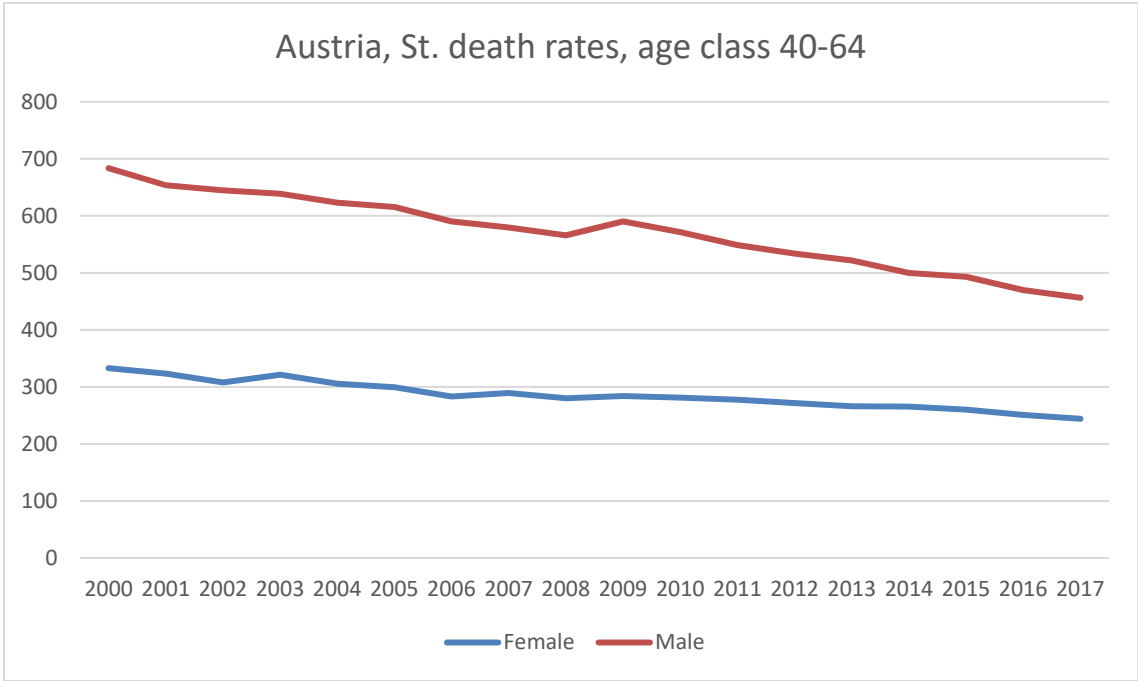




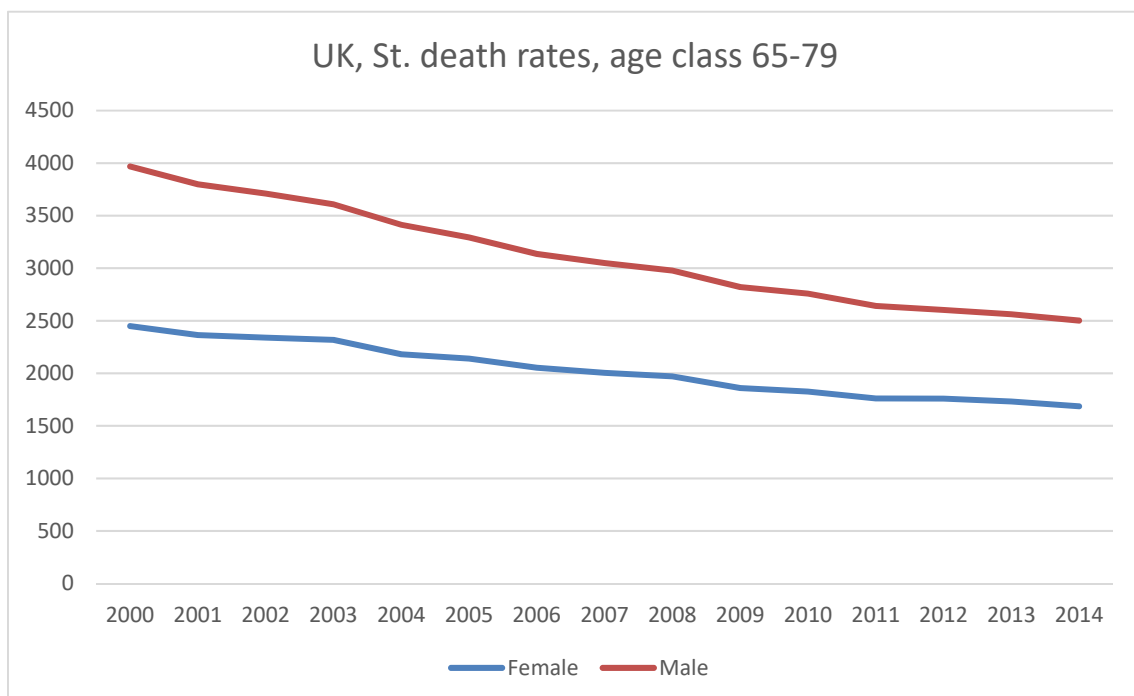
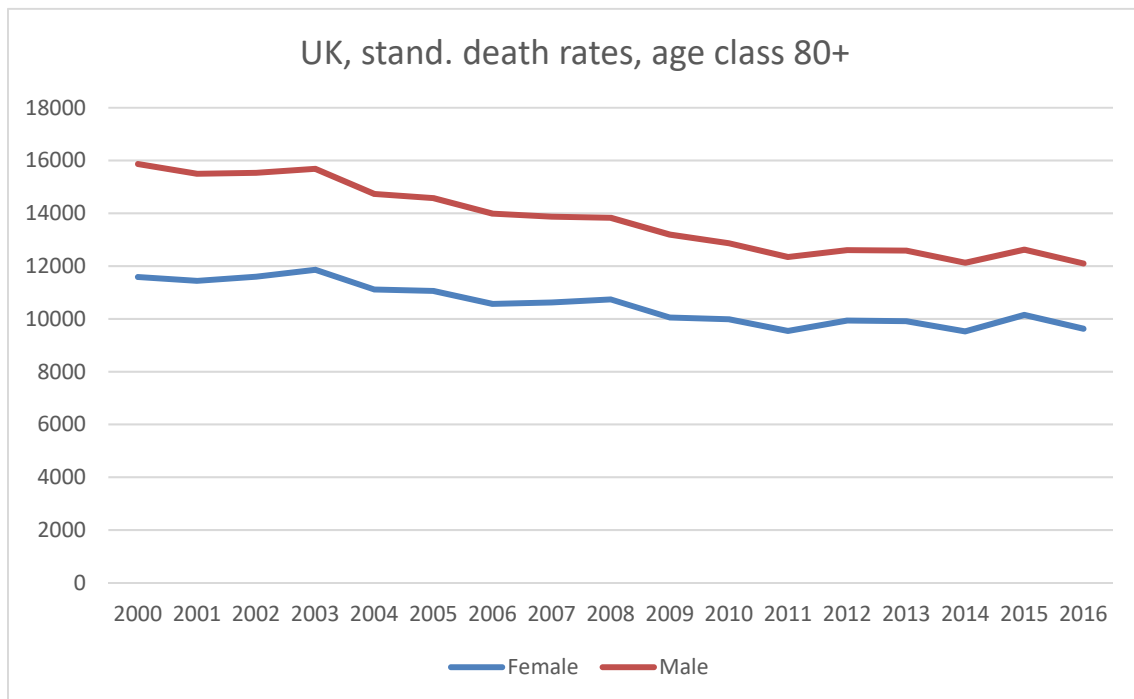


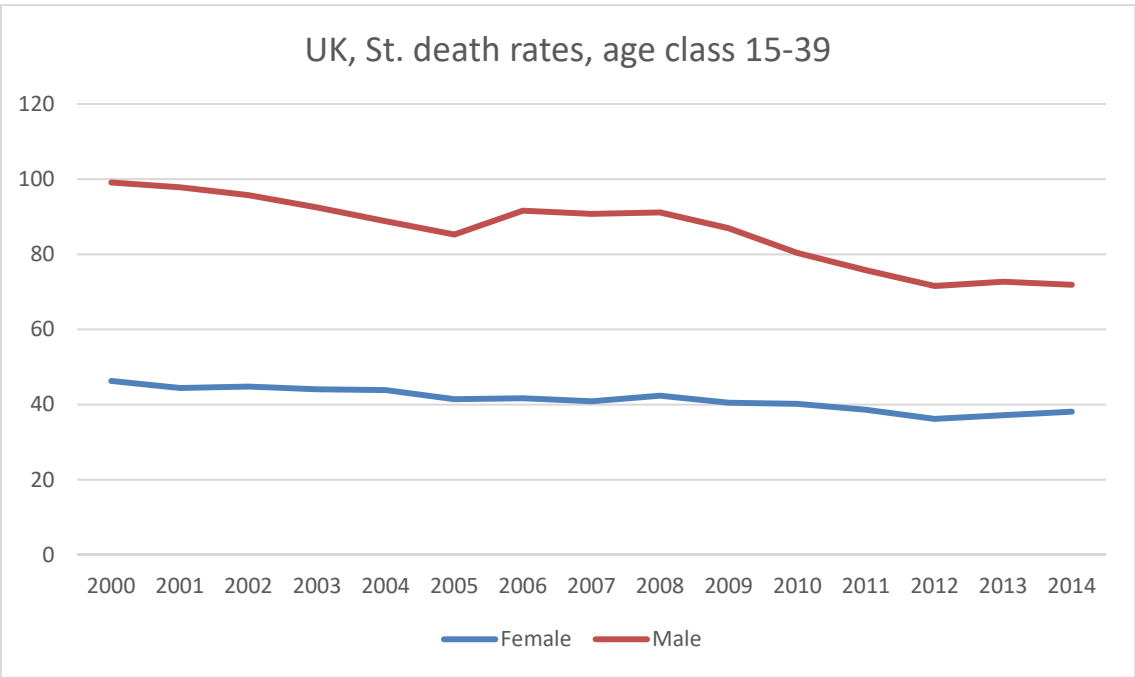
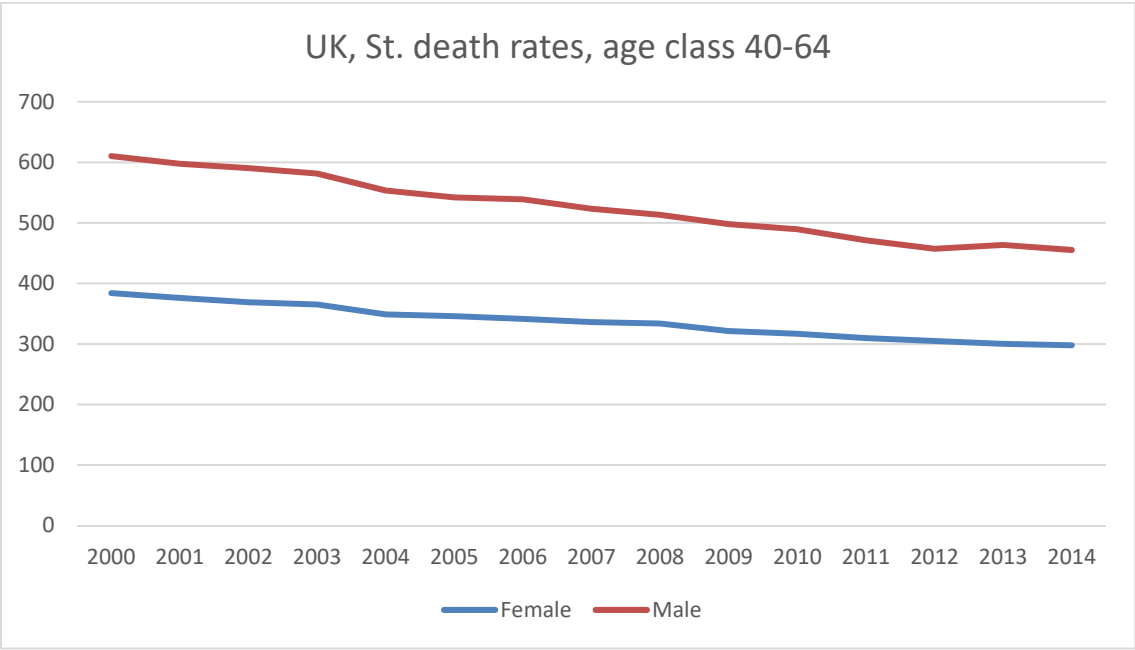
## Austria, standardized death rates



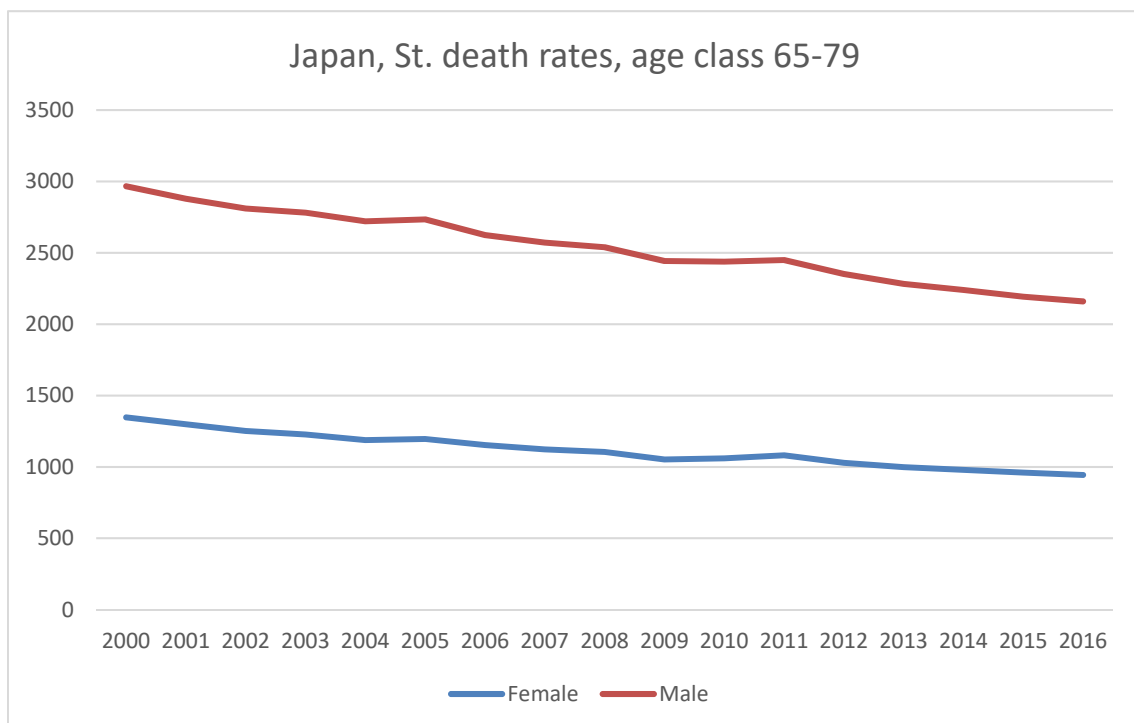
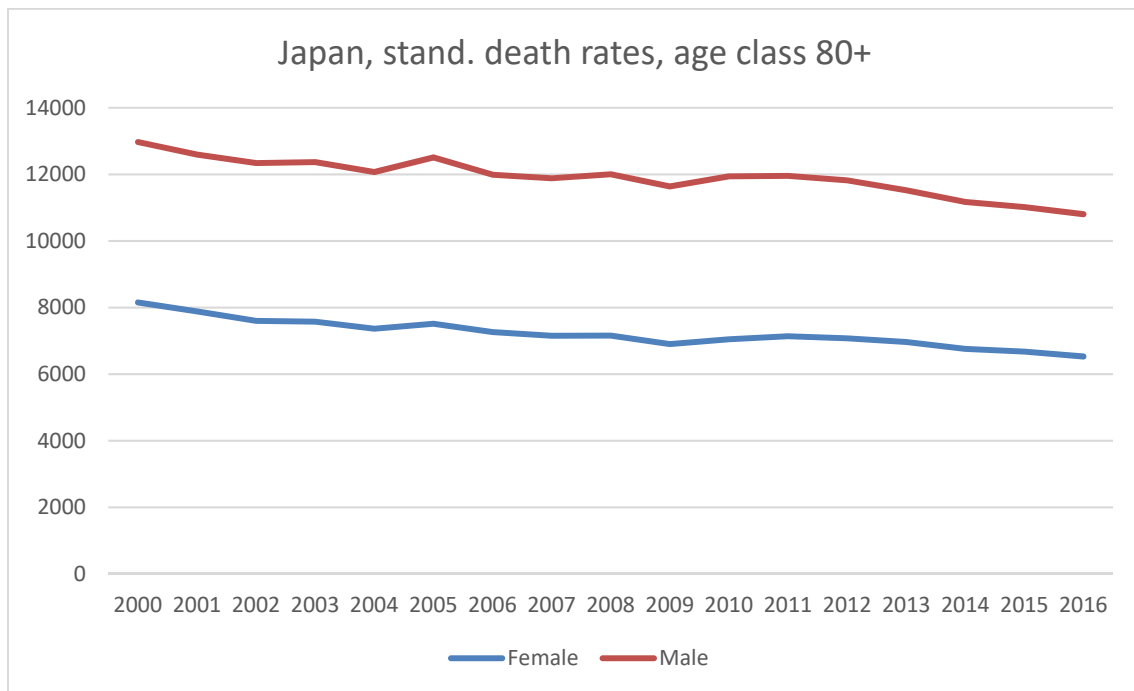


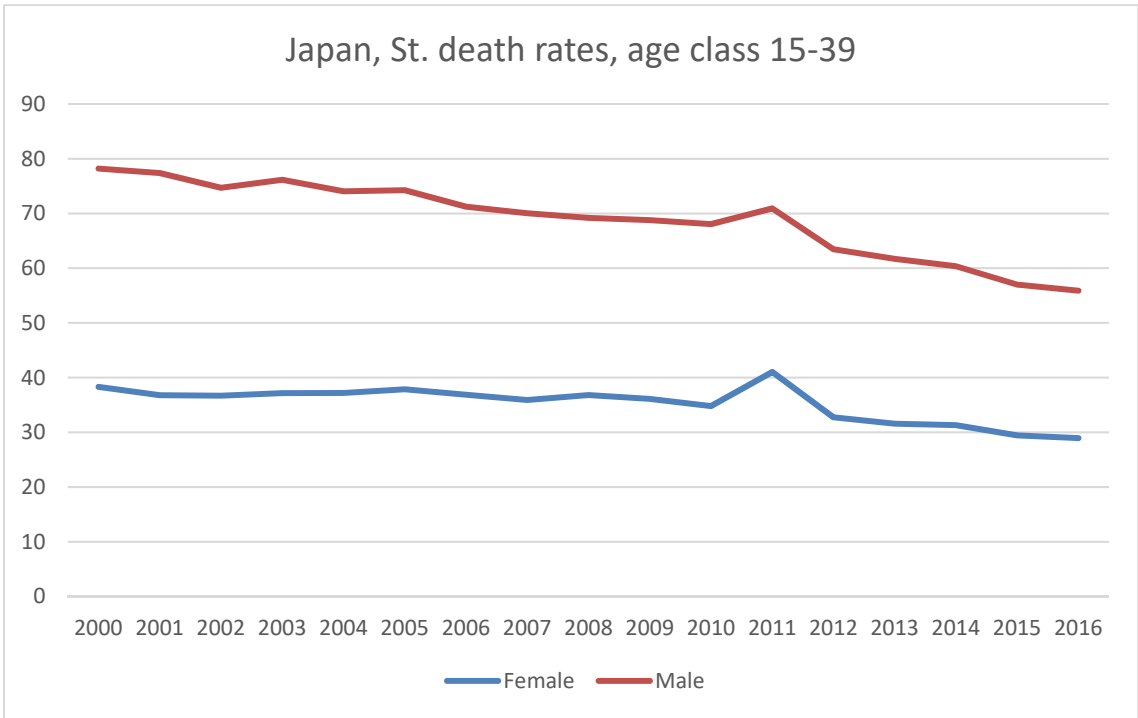
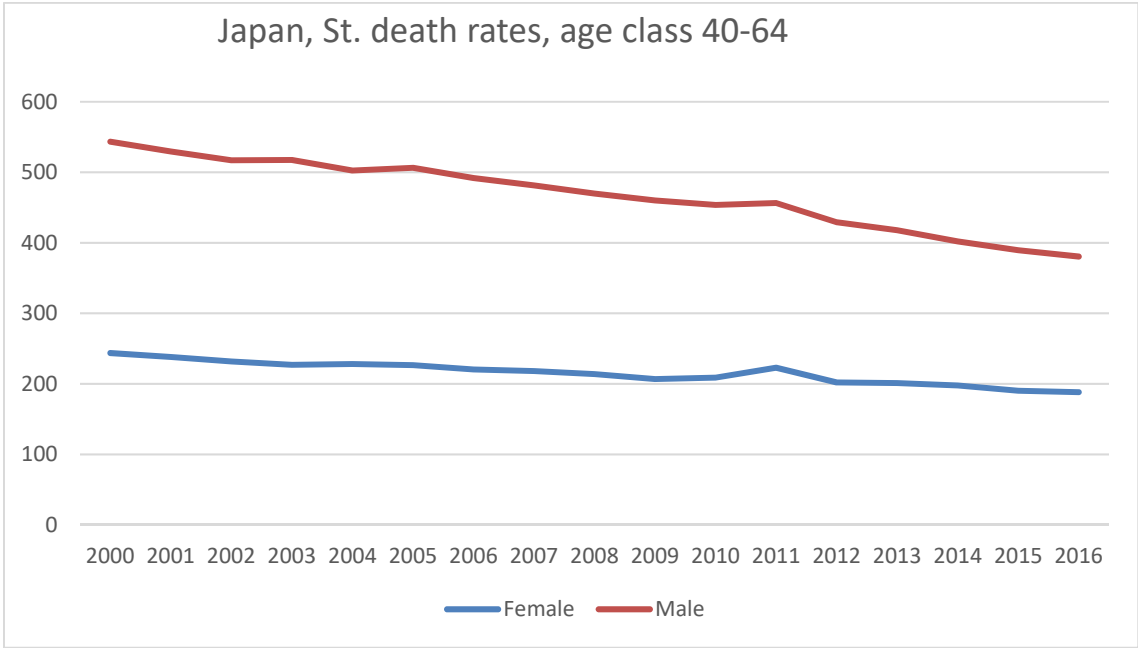
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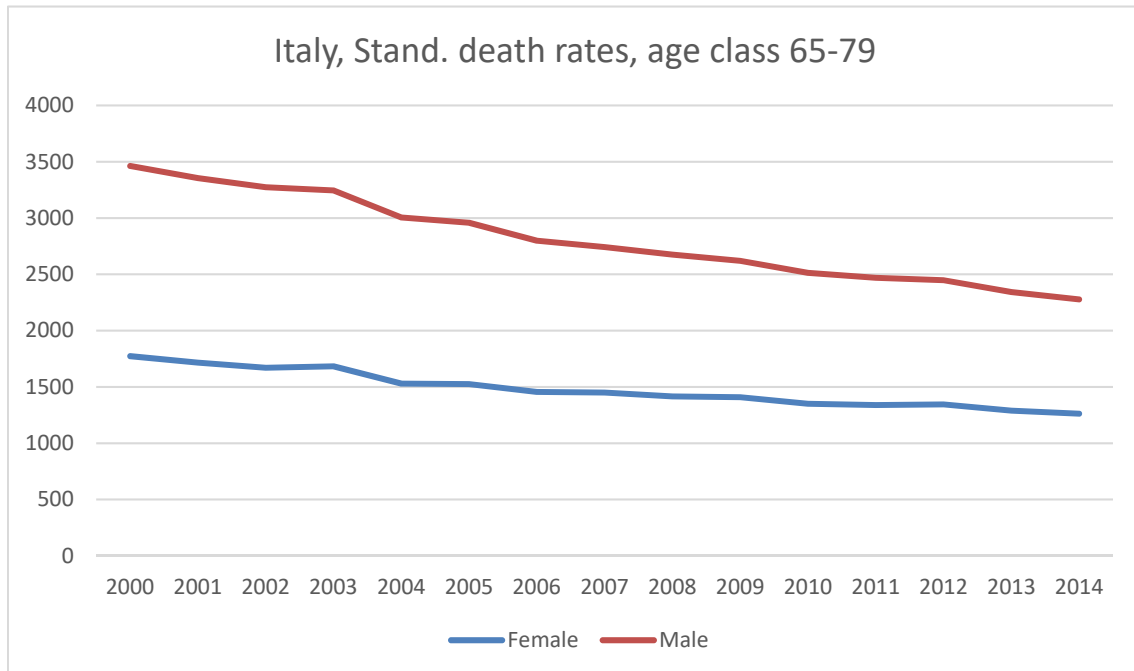
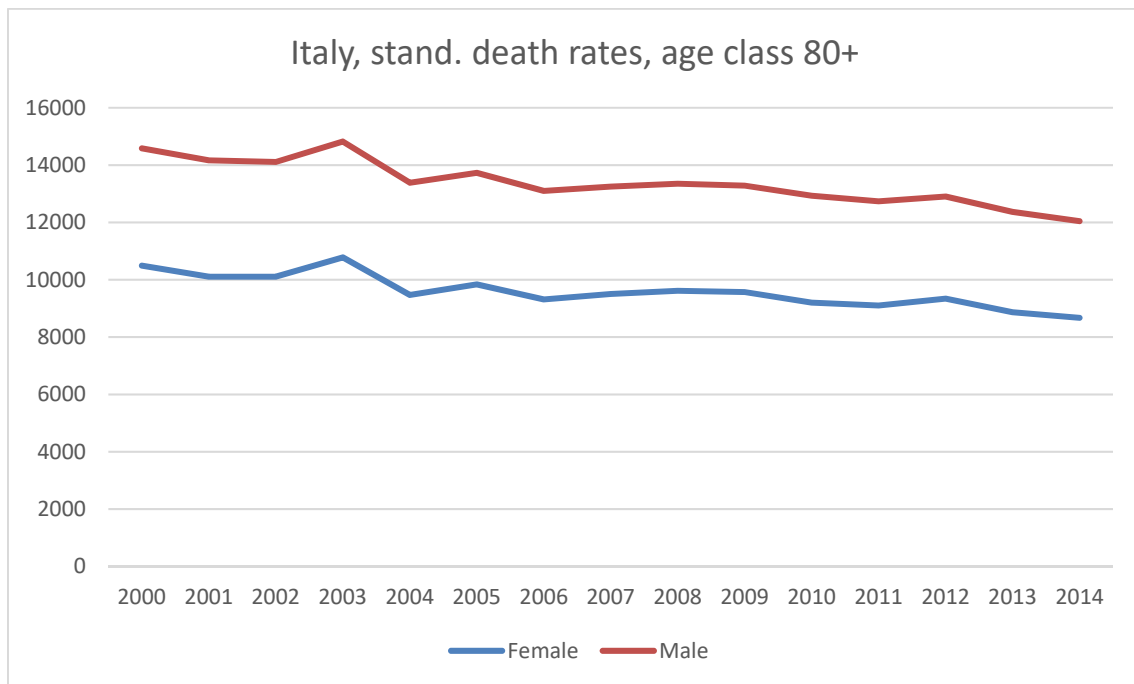


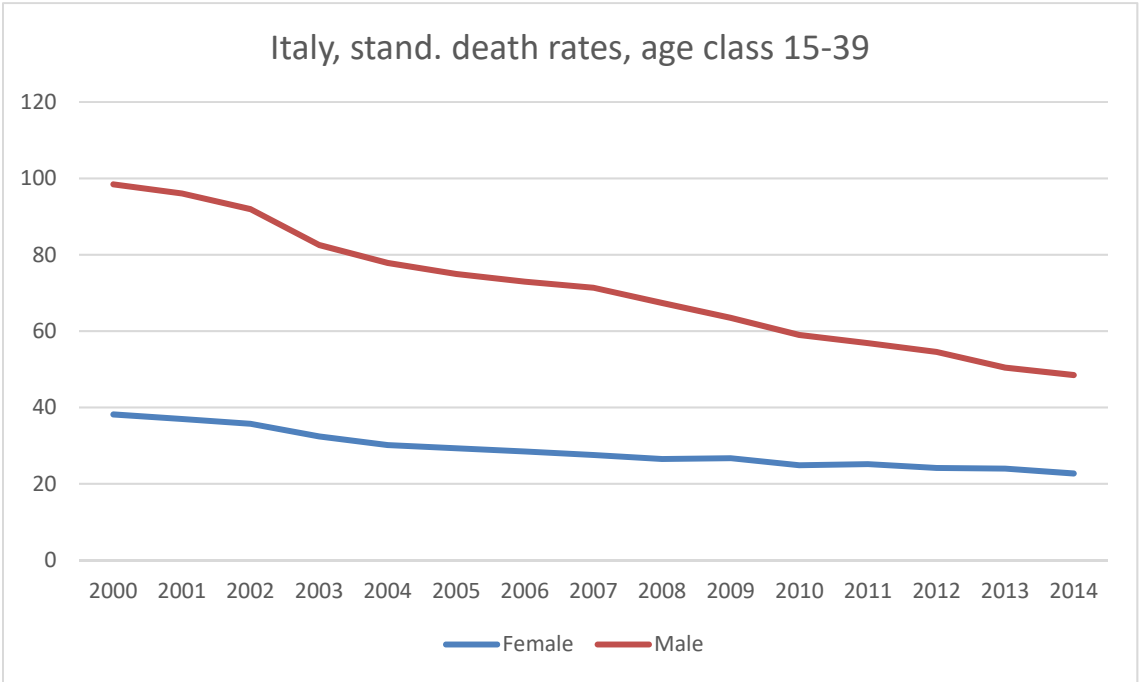
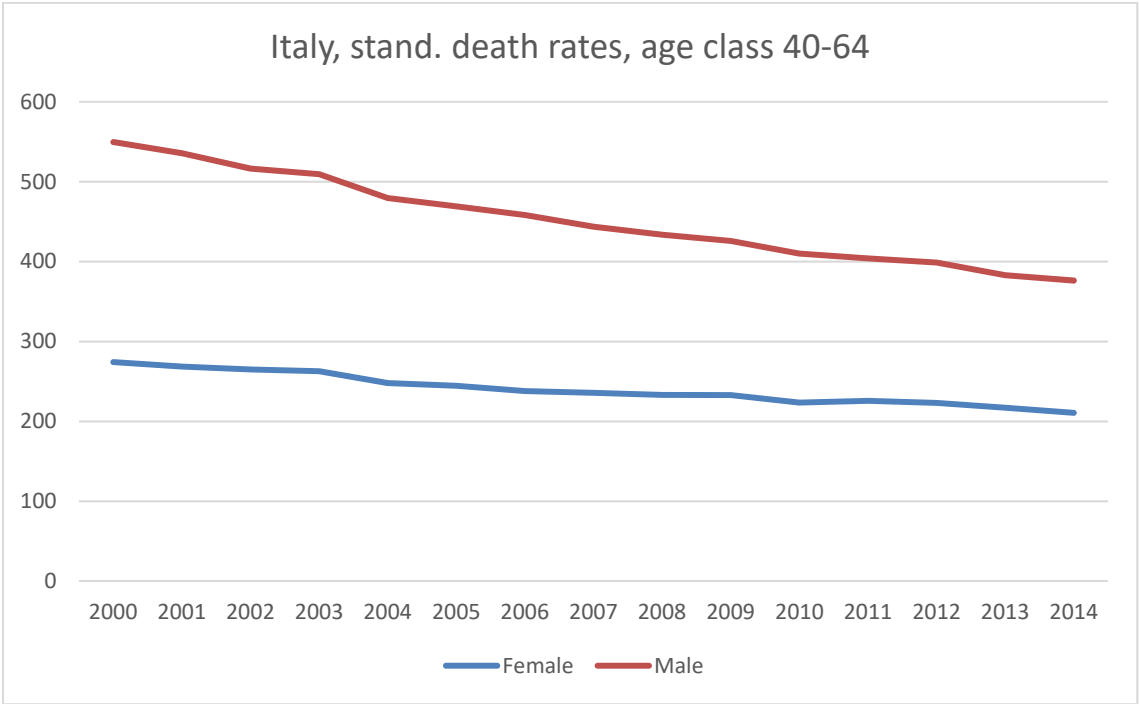
## Japan, standardized death rates





## Italy, standardized death rates







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Office for National Statistics (2018b), Changing trends in mortality: a cross-UK comparison, 1981 to 2016, UK, August, <https://www.ons.gov.uk/releases/changingtrends inmortality across uk comparison 1981 to 2016>

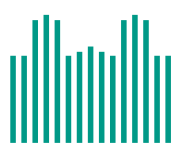
Office for National Statistics (2018c), Changing trends in mortality: an international comparison: 2000 to 2016, UK, August, <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/changingtrends inmortality an international comparison/2000 to 2016>

## Appendix: European Standard Population 2013

agegroup	sex	ESP2013
0-4	M	5 000
0-4	F	5 000
5-9	M	5 500
5-9	F	5 500
10-14	M	5 500
10-14	F	5 500
15-19	M	5 500
15-19	F	5 500
20-24	M	6 000
20-24	F	6 000
25-29	M	6 000
25-29	F	6 000
30-34	M	6 500
30-34	F	6 500
35-39	M	7 000
35-39	F	7 000
40-44	M	7 000
40-44	F	7 000
45-49	M	7 000
45-49	F	7 000
50-54	M	7 000
50-54	F	7 000
55-59	M	6 500
55-59	F	6 500
60-64	M	6 000
60-64	F	6 000
65-69	M	5 500
65-69	F	5 500

70-74	M	5 000
70-74	F	5 000
75-79	M	4 000
75-79	F	4 000
80-84	M	2 500
80-84	F	2 500
85-89	M	1 500
85-89	F	1 500
90-94	M	800
90-94	F	800
95+	M	200
95+	F	200
		200 000





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