

Description of the Danish FSA's longevity benchmark

Use of benchmark

The Danish Financial Supervisory Authority's (The Danish FSA) benchmark for the current observed mortality is found in the spreadsheet "Benchmark for den observerede nuværende dødelighed" ("Benchmark for the current observed mortality" (Danish only)). The benchmark constitutes fixed mortality intensities for all ages and is fixed separately for men and women. A reference year for the benchmark has been established for the observed current mortality. The reference year is the year for which the benchmark can be used for establishing mortality without including expected future mortality improvements. The reference year for this benchmark is 2012.

The Danish FSA's benchmark for the expected future mortality improvements is found in the spreadsheet "Benchmark for de forventede fremtidige levetidsforbedringer" ("Benchmark for the expected future mortality improvements" (Danish only)). The benchmark consists of a fixed annual percentage reduction of the mortality intensity for all ages and is fixed separately for men and women.

When using the Danish FSA's benchmark for calculating capital values or remaining life expectancy, the benchmarks for the current observed mortality and the expected future mortality improvements are to be combined as described below.

The reduction of the mortality intensities is calculated in relation to the reference year for the benchmark for the current observed mortality. The mortality intensity $\mu_W(x, t)$ and $\mu_M(x, t)$ for a woman and man, respectively, aged x in year t , is calculated as

$$\mu_W(x, t) = \mu_W(x, 2012) \times (1 - R_W(x))^{t-2012}$$

$$\mu_M(x, t) = \mu_M(x, 2012) \times (1 - R_M(x))^{t-2012},$$

where $\mu_W(x, 2012)$ and $\mu_M(x, 2012)$ for $x = 0, 1, \dots, 110$ are benchmark for the current observed mortality for men and women respectively, and $R_W(x)$ and $R_M(x)$ for $x = 0, 1, \dots, 110$ are benchmark for the expected future mortality improvements for men and women respectively.

If, for instance, you want to compute the mortality intensity for a 50-year-old woman in the year 2036, the computation has to include 24 years of mortality reductions compared to the current observed mortality. Thus, the mortality intensity for a 50-year-old woman in 2036 is computed as

$$\begin{aligned} \mu_W(50, 2036) &= \mu_W(50, 2012) \times (1 - R_W(50))^{2036-2012} \\ &= 0,00156 \times (1 - 0,01946)^{24} \\ &= 0,00097 \end{aligned}$$

Benchmarks for the current observed mortality for 2008-2012 are found in the spreadsheet "Benchmark for den observerede nuværende dødelighed for tidsperioden 2008-2012" ("Benchmark for the current observed mortality for the years 2008-2012" (Danish only)). These benchmarks are to be used for the statistical analysis and include mortality intensities for the years 2008 to 2012 for all ages and are fixed separately for men and women.

Benchmark for the current observed mortality

Data

The benchmark is based on data from 2008-2012 provided by a number of Danish life insurance companies and multi-employer pension funds and processed by the Danish Centre of Health & Insurance (hereinafter Health & Insurance) (DK: Videncenter for Helbred og Forsikring). Health and Insurance has provided the Danish FSA with a specification of exposure and number of deaths in the abovementioned period from the following Danish pension funds and pension providers: Alka, AP Pension, Arkitekternes Pensionskasse, Danica Pension, Danske civil- og akademiingeniørers Pensionskasse, Finanssektorens Pensionskasse, If Forsikring, JØP, Lærernes Pension, Lægernes Pensionskasse, MP Pension, Nordea Liv & Pension, Pensionskassen for Jordbrugsakademikere & Dyrlæger, Pædagogernes Pensionskasse, PFA Pension, PKA, Sampension, SEB Pension and Topdanmark. In total, the data is based on approx. 2 million people.

Since the data provided by Health & Insurance is largely only based on adults, the Danish FSA has used data for the entire Danish population to calculate mortality intensities for the ages 0-25. The data was provided by the Human Mortality Database.

Description of the model

The benchmark for the current observed mortality is calculated based on the data provided by Health & Insurance, cf. the four items outlined below.

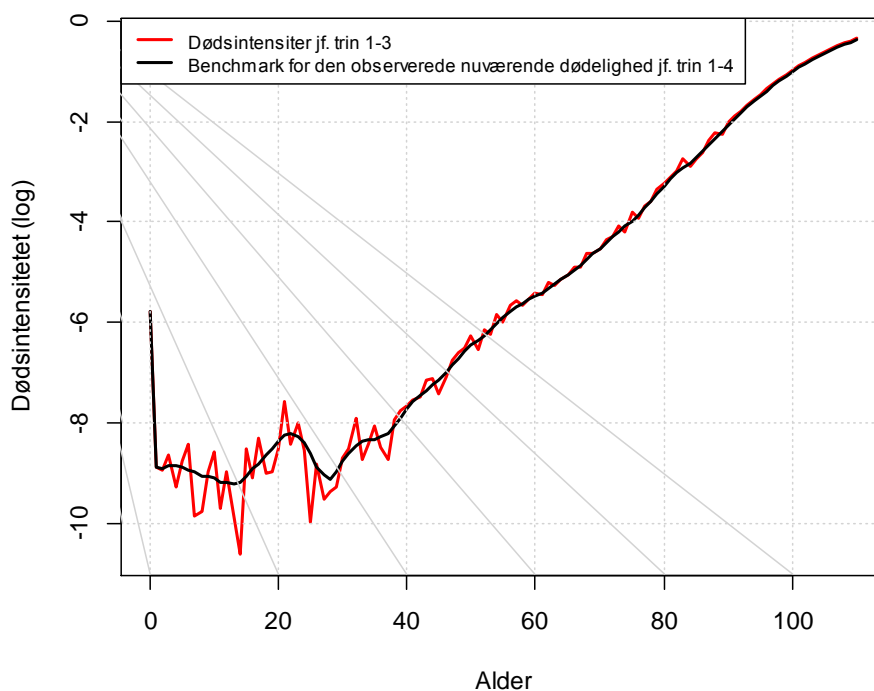
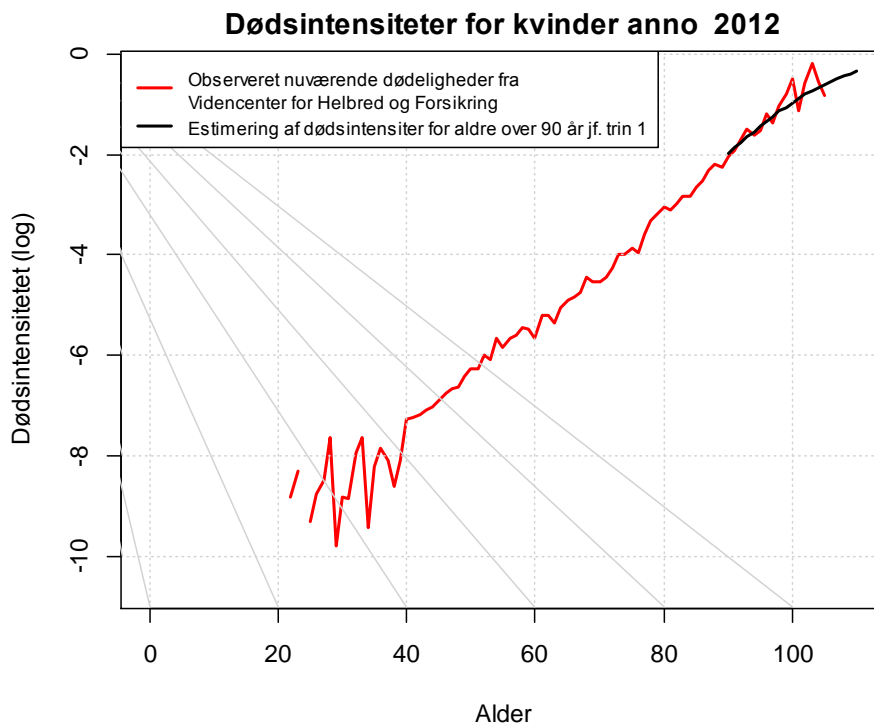
1. Due to the limited amount of data for high ages and the resulting substantial fluctuations in the observed mortality, a parametric model for mortality intensities for ages above 90 is estimated. The Danish FSA uses the parametric model described in the Methods Protocol for the Human Mortality Database.¹ The parameters of the model are estimated on the basis of data for the ages 80 to 110.
2. Data for the entire Danish population is used for the ages 0-25.
3. The applied data includes observations from 2008-2012. In order to use information from the entire data period to estimate mortality intensities in 2012, a linear regression of the logarithm for the mortality intensities from 2008 to 2012² is carried out for each age.

¹ <http://www.mortality.org/Public/Docs/MethodsProtocol.pdf>

² For the ages 0 to 25 years, the log-linear regression is carried out on the basis of mortality intensities from 2008-2011 due to the fact that mortality data for the entire Danish population does not yet include 2012.

4. Finally, the benchmark for the current observed mortality is calculated by smoothing the estimated mortality intensities of the age dimension.

The figure below shows the processing of the observed mortalities, cf. items 1-4. The black curve of the lower graph shows the Danish FSA's benchmark for the current observed mortality for women in 2012.



The benchmark for the current observed mortality for 2008-2011, which is to be used for the statistical analysis, is fixed based on the same data and a corresponding method of calculation as the benchmark for the current observed mortality for 2012, cf. the description above.

Benchmark for the expected future mortality improvements

Data

The data is provided by the Human Mortality Database (HMD) and consists of data for the entire Danish population. The forecast is based on data from 1982-2011. The data period is selected on the basis that the period should be long enough to provide a solid and stable forecast for the mortality intensities, but also short enough to describe the current development.

Description of the model

The benchmark for the expected future mortality improvements is computed on the basis of mortalities for the entire Danish population, cf. the three items below:

1. Due to the limited amount of data for high ages and the resulting substantial fluctuations in the observed mortality, a parametric model for mortality intensities for ages above 100 is estimated. The Danish FSA uses the parametric model described in the Methods Protocol for the Human Mortality Database. The parameters of the model are estimated on the basis of data for the ages 90 to 110. This item is analogous to item 1 of the description of the model for benchmark for the current observed mortality.
2. A linear regression of the development of the logarithm for the mortality intensities for the last 30 years is carried out for each age. Thus, an annual percentage reduction of the mortality intensities is fixed for each age.
3. Finally, the benchmark for the future mortality improvements is calculated by smoothing the estimated reductions of the age dimension. When smoothed, the reduction is maximised to 0, so that there will be no mortality deteriorations in the benchmark solely on the basis of very few observations for high ages. If a 0-reduction is calculated for an age above 100, the reduction is set to 0 for all higher ages in order to avoid that the benchmark is affected by the limited data material for very high ages.

The figure below shows the processing of the observed mortalities for the last 30 years, cf. item 1-3. The black curve shows the Danish FSA's benchmark for the expected future mortality improvements for women.

