FUTURE DEVELOPMENT OF COHORT LIFE EXPECTANCY IN SWEDEN

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Abstract

The aim of the paper is to analyze future development of cohort life expectancy in Sweden. Life expectancy from cohort perspective brings different information about mortality patterns than traditional period life expectancy. Analysis show that changes in life style and different mortality patterns could cause rapidly increase of life expectancy for current cohorts. Future development is based on simple alternative approach of mortality modeling (future estimates of mortality rates) which is based on cohort mortality patterns. The assumption of constant change of the force of mortality between two following ages across cohorts is the fundamental base of the proposed model. Estimation of cohort life expectancy based on presented model for already extinct cohorts is compared with empirical life expectancy which is already known and forecasting of cohort life expectancy for still living cohorts is done.

Keywords: Cohort life expectancy, mortality, mortality modelling

Introduction

Mortality as one of the basic demographic field plays important role for a long time. Study of “mortality laws” (or general mortality patterns) is one of the fundamental demographic issues already from the beginnings of demography itself. It could be followed up to 17th century and John Grount’s study of Bills of mortality in London.

The need for accurate mortality analyses and forecast in the contemporary world is supported among others also by its connection to life insurance products or social policy and pension systems. In many spheres of life information about mortality development and its expected future changes become more and more crucial.

Main analysis of the mortality patterns in the history were based on period life tables (see Lee, Carter, 1992) but in the last years more studies focus on cohort perspective. We can find studies as Renshaw, Haberman, 2006 where traditional models are developed and extended to cohort factor. Importance of cohort influence are described as APC (age-period-cohort) models (Allai, Sherris, 2012) and are now used more often than before.

It is clear that cohort effect can be monitored only when data time series is long enough (for analyzing some cohort we need about 100 years – till the cohort is extincted). This fact could be reason why cohort perspective is taken into account now, when data series for many countries are available.

In this paper data for Sweden are used (Sweden has the longest time-series of mortality data) and extrapolation of the cohort life expectancy for still living cohort is done. For extrapolation model developed by Mazouch and Hulíková, Tesárková is used (see Mazouch, 2010, Mazouch, Hulíková, Tesárková, 2010 or Mazouch, Hulíková, Tesárková 2012).

Data

Data from the Human Mortality Database (www.mortality.org) were used. The longest time series in the Database is available for Sweden (starting in 1751, cohort data are available starting for the cohort 1676 to cohort 1981). For the analysis data for ages 60 and more were used.

Methodology

The proposed method is based on the relationship:

$$ar_{x,z} = \frac{m_{x,z}}{m_{x-1,z}},$$

where $ar_{x,z}$is ratio of age-specific mortality rates defined for one particular cohort, x is completed age, z is the year of birth of the cohort (modeling of the ratio was used also in Haberman, Ranshaw, 2013). Because these ratios are highly time-variant (differs for particular cohorts, however, it was proved that its values do not follow any particular trend), it was necessary to estimate these ratios for individual ages in a particular modeled cohort by some average measure calculated for that age ($\overline{ar}_{x,z,n,s}$). This measure was calculated from n previous cohorts and these average measures are used for the estimation of future values of age-specific mortality rates. There are many possibilities how to estimate $\overline{ar}_{x,z,n,s}$. Among others it is possible to use the relation:

$$\overline{ar}_{x,z,n,s} = \frac{\sum_{k=1}^{n} \alpha^{k-1} * ar_{x,z-k-x+s}}{\sum_{k=0}^{n} \alpha^{k-1}}, \text{ for x = s,…, } \omega - 1$$

where $\overline{ar}_{x,z,n.s}$ is the average ratio of cohort-specific rates at age x, z is the year of birth of the modeled cohort, s is first age which is used for calculation (for example 60 years), α is weight used in the model having values from the interval (0;1). This weight could be selected subjectively according to needed “memory“ of the model.
After all the average ratios are calculated for all ages (x) where mortality will be estimated, it is possible to calculate the first unknown mortality rate (for age x + 1):

$$\dot{m}_{x+1,z} = m_{x,z} * \overline{ar}_{x+1,z,n,s}$$

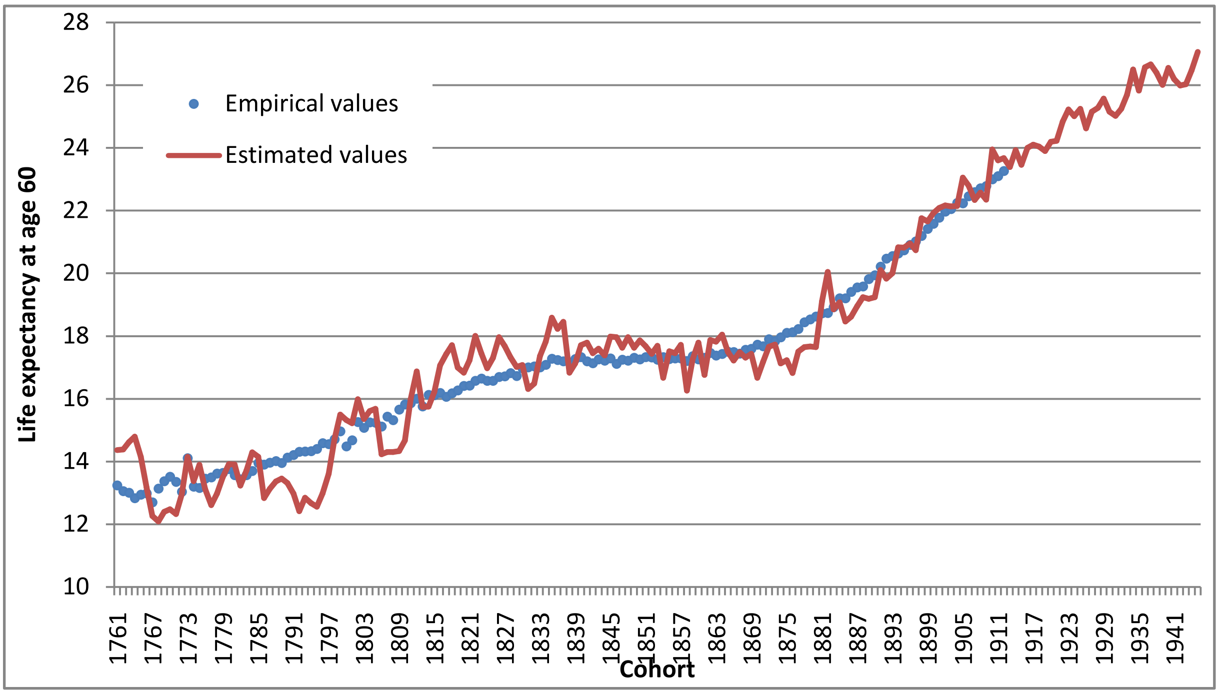
Results

To evaluate model quality it could be done comparison of empirical and modelled life expectancy at age 60 for already extinct cohorts in Sweden is shown in fig. 1 and 2. Cohort life expectancy at age 60 for Swedish females was equal to 13 years (one year higher than for males) at the beginning of the analyzed period, for cohort born in 1761. In next 150 cohorts the life expectancy for females grew to 23.3 for females and to 18.5 for males. The development of the life expectancy was not linear among analyzed cohorts, there were some periods of stagnation and periods of acceleration. It is evident that presented model described above respects all those changes in trend of life expectancy and estimated values are not dissimilar to the empirical ones. Differences between estimates and empirical values were decreasing in their values for younger cohorts. The biggest differences for males occurred for cohort born in 1818, modeled life expectancy at age 60 was overestimated for 1.5 years. For females the biggest difference was the overestimation for 1.9 years for cohort born in 1764. The variability of life expectancy of more historical cohorts, which also causes higher differences between empirical and estimated values, is dependent on many factors as war conflicts, epidemics and also poor data quality. If we focus just on later cohorts (younger) we can find that differences are much smaller than for older ones. If we compare just analyzed complete cohorts from 1850, differences are smaller. For males is the biggest difference equal to 1.0 year (for cohort 1882) and for females 1.3 years (for cohorts 1882 and 1876).

Those results show that model is good and respected all changes in life expectancy in the past and could be used for extrapolation of the future trend (for still living cohorts). For

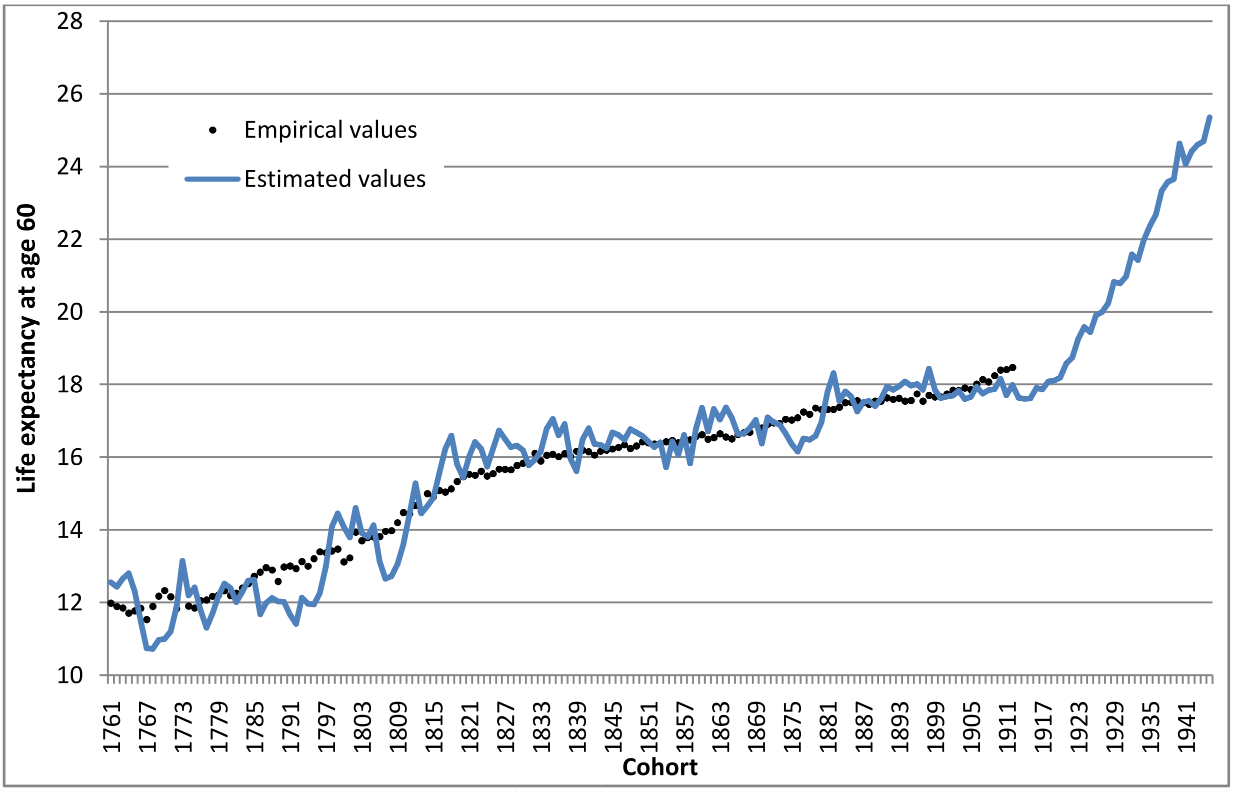
Sweden females the model respect past trend and for cohort born in 1945 is the life expectancy at age 60 around 27 years. Last complete (almost extinct cohort) cohort born in 1911 had life expectancy at age 60 only 23.5 years.

Fig. 1: Comparison of empirical and modeled life expectancy at age 60, cohorts born 1761–1945, Sweden, females



Source: Human Mortality Database (2012), author's calculation

Fig. 2: Comparison of empirical and modeled life expectancy at age 60, cohorts born 1761–1945, Sweden, males



Source: Human Mortality Database (2012), author's calculation

Estimates for males are different. As it is clear from fig. 2 there are many differences between males and females. Males' life expectancy in the past did not grow so fast as for females. Last complete (almost extinct cohort) cohort born in 1911 had life expectancy at age 60 only 18.5 years. Described model predicts that life expectancy for cohort born in 1945 would be around 25.5 years. That is a rapid increase about 7 years (for females 3.5 years only) of life expectancy at age 60.

Conclusion

Mortality patterns are very complex and depend on many other factors (cohort effect, period effect, age effect) and to find and describe all those relationships is almost impossible.

The model is very simple way how to estimate cohort mortality development in the future, it works with very simple presumptions and its application is not time-consuming in comparison to the other common models which are used.

Results show that in the next years there will be more changes in mortality patterns and problems with population aging, could become more important than before. Needs of the society when there is growing ratio of aging people are different than needs nowadays.

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