Cohort mortality pattern modeling – Model application to Swedish cohort data

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Abstrakt

Mortality modeling is one of the traditional and fundamental demographic issues. The purpose of the mortality modeling is to find relations and hidden regularities and patterns in the mortality development. Knowledge of these patterns could be used among others for the forecasting of the future development of mortality. There exist many various methods of mortality forecasting leading to more and less accurate outlooks. This paper introduces a simple alternative approach which is based on cohort mortality patterns modeling. The assumption of constant change of the force of mortality between two following ages across cohorts is the fundamental base of the proposed model. This assumption was verified on time series of Swedish data which are long enough for this purpose. It was proved that the mentioned changes of mortality between ages were really nearly constant for all the cohorts and ages used for this verification. Moreover, the created time series of mortality changes meet the requirements for further statistical modeling. Finding of the coefficients of mortality increase between two ages and its intrinsic patterns across generations could be used for its very simple application to not yet extinct generations and through that for the estimation of their future mortality development. The verification of this potential usage of the proposed model was realized on the shortened cohort data of the Swedish population. After the application of the methodology described in this paper, the comparison of the estimated and real development was carried out and assessed.

Data and methodology

As was stated above, the main idea of the proposed model is very simple. The fundamental assumption could be formulated as the statement that we propose constant changes of mortality (ratios of mortality rates) between two ages across cohorts. This could be expressed also more formally. For all the age groups older than 30 years (where the mortality development could be considered as more stable) we can assume:

$$m_{x,z} \geq m_{x-1,z} \ , \qquad (1)$$

where *x* represents age and *z* is the year of birth of the considered generation. Then the ratios of the mortality change between ages could be computed as

$$\frac{m_{x,z}}{m_{X-1,z}} = r_{x,z} \qquad (2)$$

Finally the above mentioned fundamental assumption of the proposed model (the constant change of mortality between two following ages across generations) could be defined as:

$r_{x,z} = r_{x,z+1}$ for all analyzed cohorts *z*. (3)

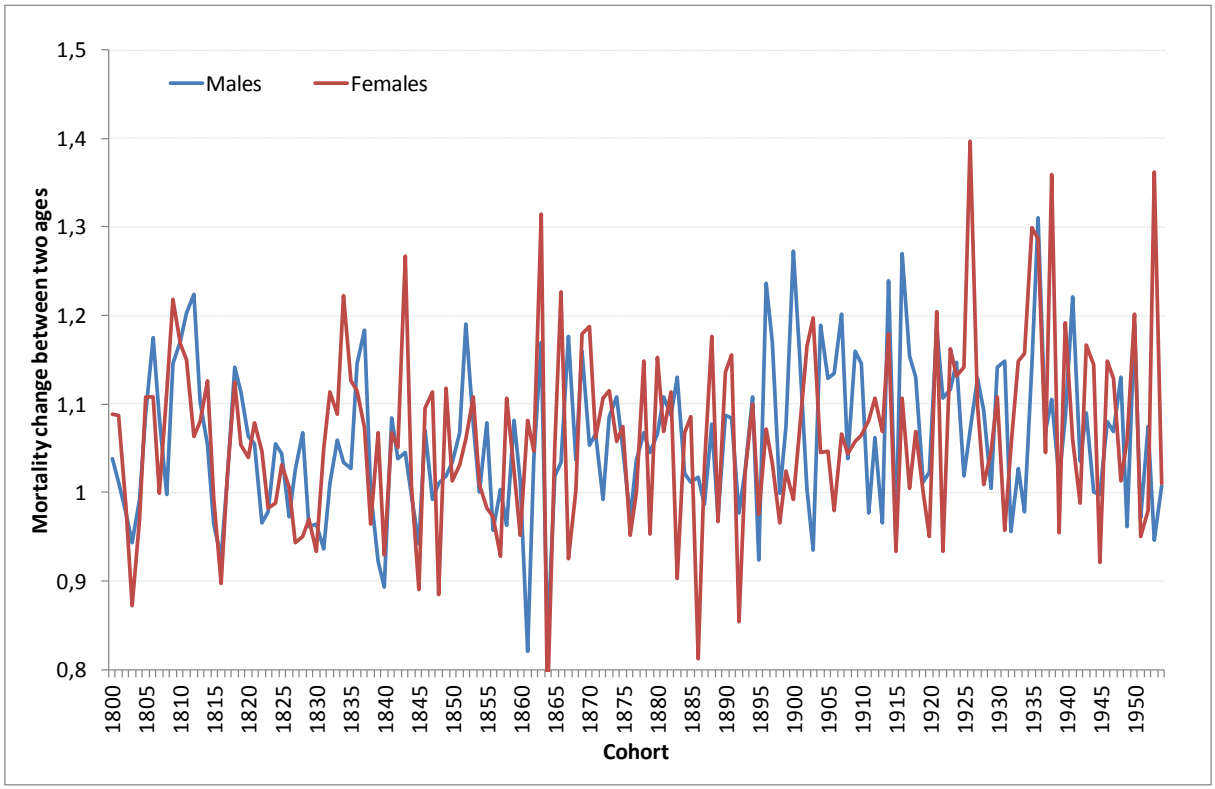
The time series of the ratios ($r_{x,z}$) were analyzed using the specialized statistical software (Statgraphics or SAS). First of all the basic time-series analysis was done with the purpose of finding the features of the series (analysis of autoregression). The main question in this phase was to verified whether the considered series meet the requirements for being classified as a "white noise process".

For the whole analysis the data from the Human Mortality Database (www.mortality.org) were used.

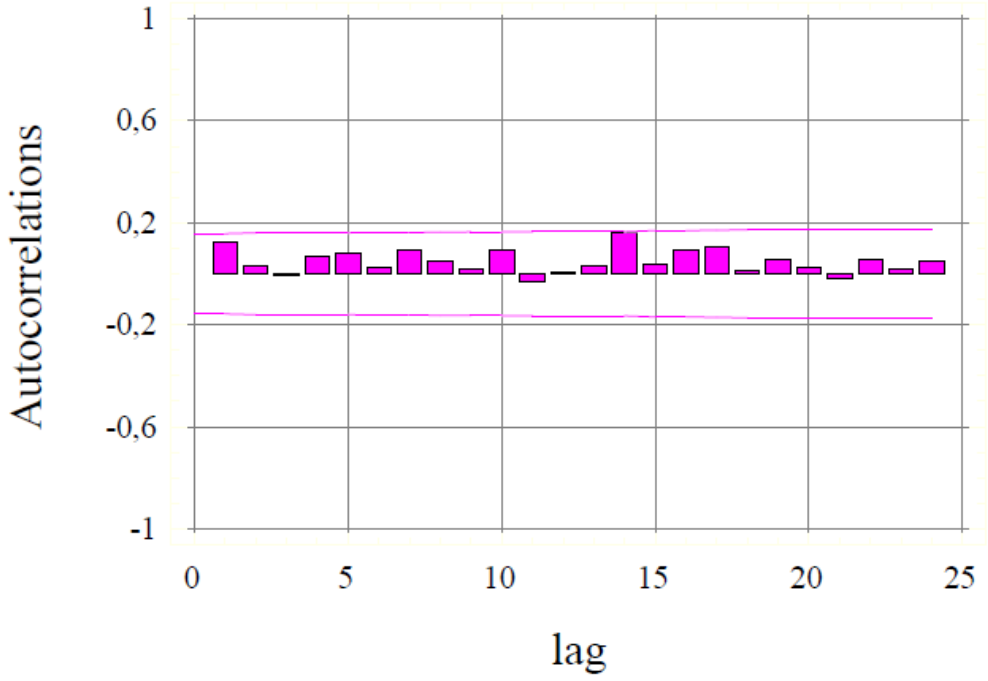
Results

For illustration of the results the mortality ratio between ages 55 and 54 is used here. The analysis was prepared for the data of Swedish males and females born between 1800 and 1954 (data were taken from the Human Mortality Database). The time-series of this ratio is relatively stable in time (across generations) and the variability has a random character, no trend could be followed in the data. So it could be summarized that the rate of mortality increase between the two ages almost hasn't change during the period of more than 150 years. The average value of the ratio for this two ages is around 5,9 %. Also the values of the autoregressive function don't show any particular trend what is one of the main assumption of the white noise process. The results could be shown in the pictures:

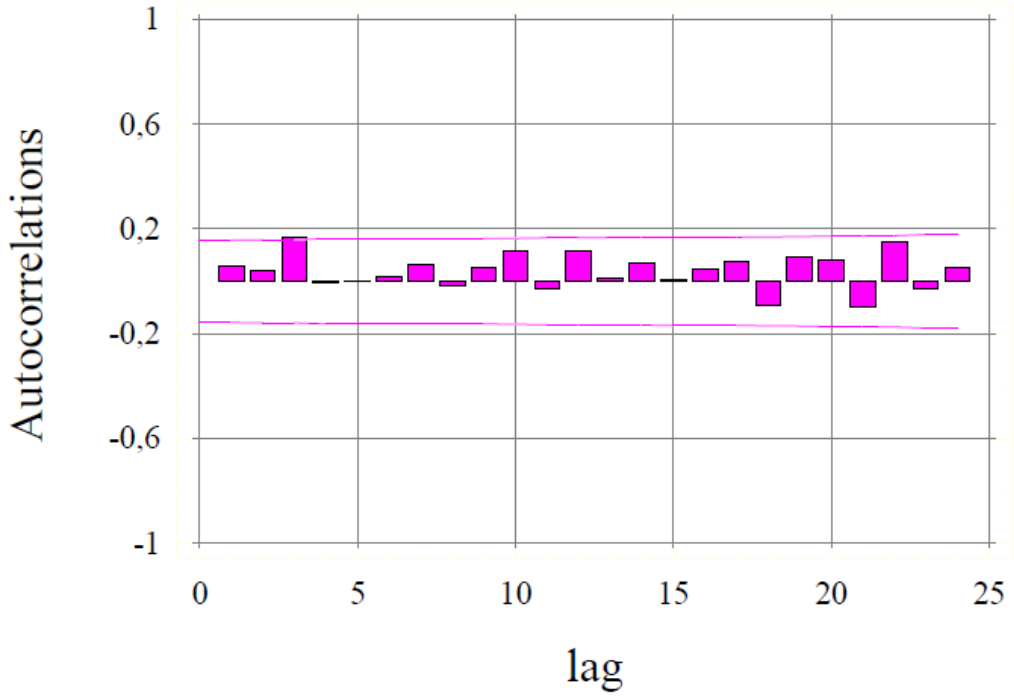
Picture 1: Mortality change between ages 54 and 55, Sweden, cohorts 1800-1954



Picture 2: Estimated autocorrelations of the mortality change between age 54 and 55, Sweden, males, cohorts 1800-1954



Picture 3: Estimated autocorrelations of the mortality change between age 54 and 55, Sweden, females, cohorts 1800-1954



After the analysis of all the age groups is done and the average coefficients of increase of mortality between the two ages (age groups) are found, it is possible to apply them to not yet extinct generations. Then their future development could be estimated by this model. For the evaluation of the proposed methodology the verification was carried out on real data and the differences of the real and estimated values were analyzed.

By the application of this methodology to data from more countries some special and unusual cases (ages, years, cohorts) could be identified easily.

References:

MAZOUCH P., TESÁRKOVÁ K. (2010): *Different ways of mortality modeling*. European Population Conference 2010, hosted by the Office of Population Research at Princeton University. European Association for Population Studies (EAPS). Poster presentation, 1 – 4. 9. 2010, Vienna, Ausatria.