Cohort mortality pattern modeling – – model application to Swedish cohort data

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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. This is an introduction of 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.

Data and methodology

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

For all the age groups older than 45 years (where the mortality development could be considered as more stable) we can assume:

$$m_{x,z} \geq m_{x-1,z}$$

where x represents age and z is the year of birth of the considered generation

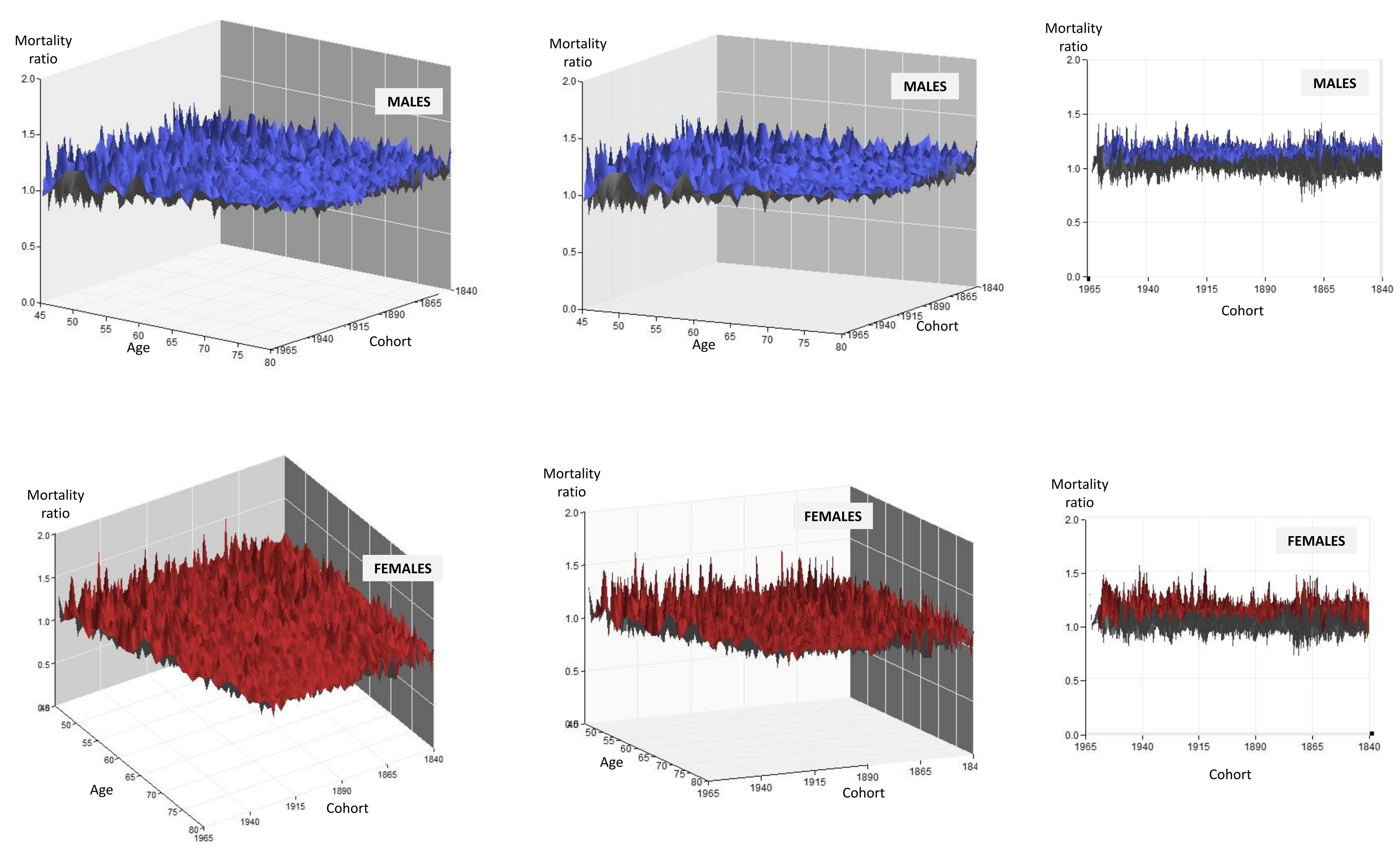
Then the ratios of the mortality change between ages could be computed as $\frac{m_{x,z}}{m_{x-1,z}} = r_{x,z}$

Finally the 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*.

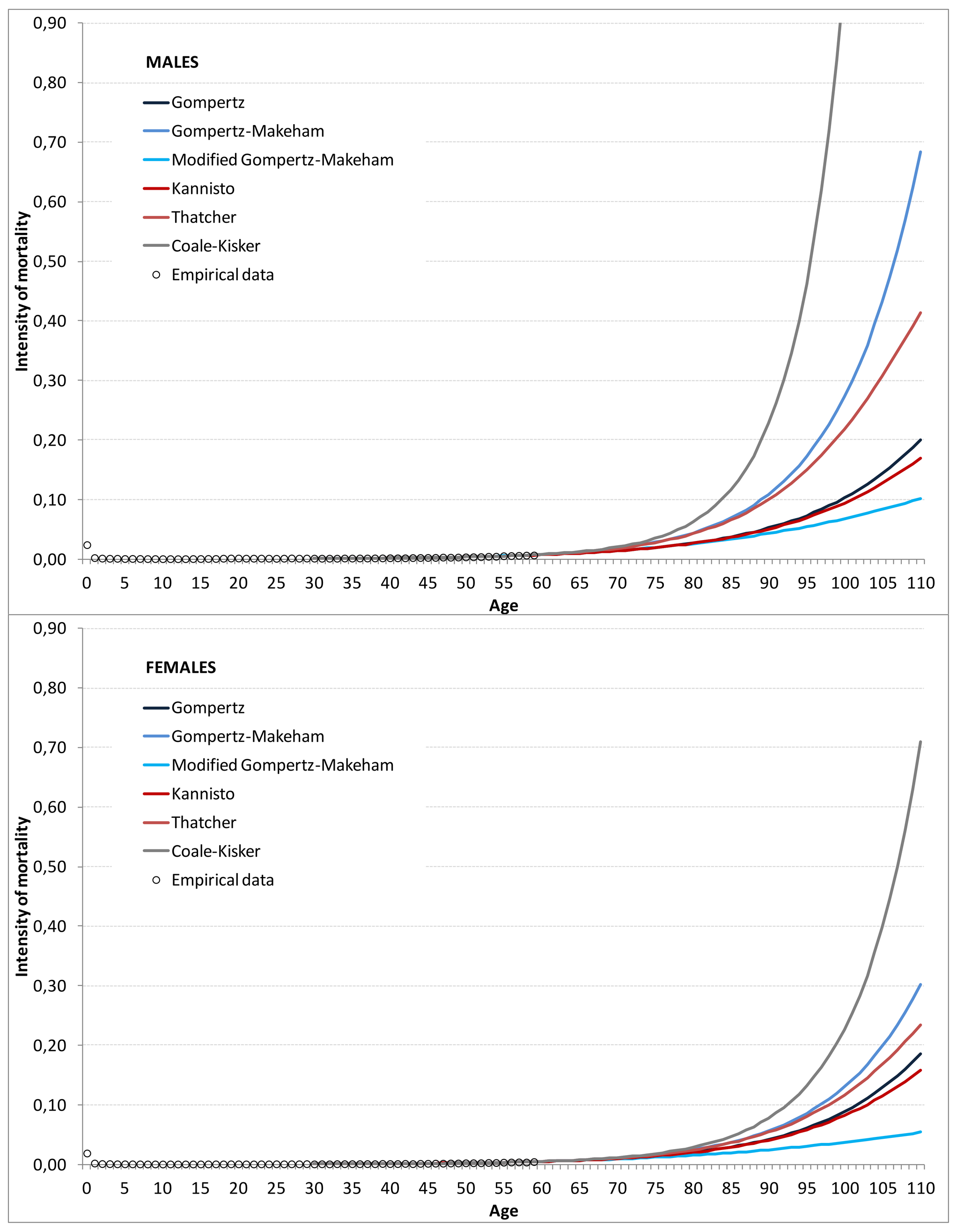
Also we can compute average ratio and standard deviation for each age *x* where *a* is the first and *b* is the last cohort for which we have data.

$$\bar{r}_x = \sum_a^b r_{x,z} \qquad s_{r_x} = \sqrt{\frac{\sum_a^b (r_{x,z} - \bar{r}_x)^2}{b-a}}$$

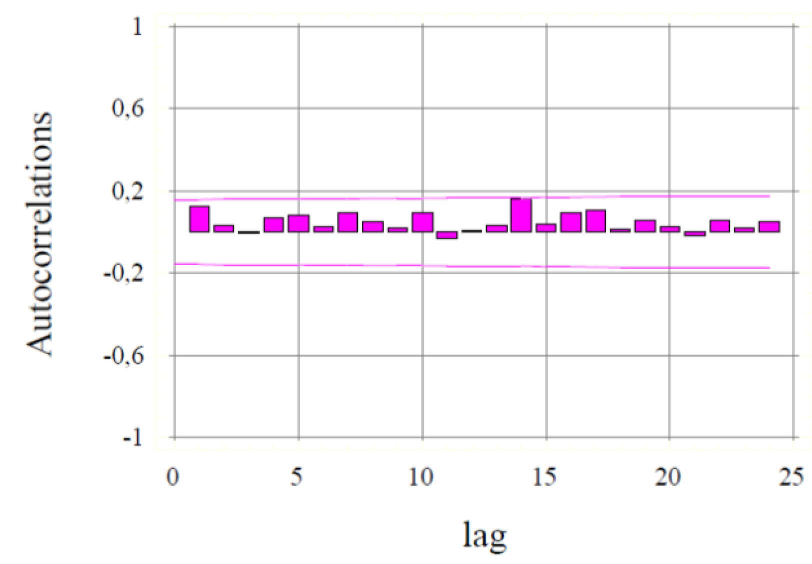
Mortality ratios accros ages and cohorts in 3D-view



What do we need? To model mortality for not yet extinct cohort



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



This result shows that mortality change is random in time.

Average and standard deviation of ratios of mortality change ($r_{x,z}$), age groups 45-85 and cohorts from 1840

x	Male		Female	
	$\bar{r}_x$	s_{rx}	$\bar{r}_x$	s_{rx}
45	1,08	0,14	1,05	0,15
46	1,05	0,12	1,06	0,15
47	1,09	0,13	1,06	0,13
48	1,06	0,12	1,08	0,13
49	1,08	0,12	1,06	0,12
50	1,08	0,11	1,07	0,12
51	1,07	0,10	1,05	0,12
52	1,08	0,10	1,07	0,11
53	1,08	0,11	1,06	0,11
54	1,09	0,09	1,07	0,11
55	1,06	0,09	1,07	0,11
56	1,09	0,10	1,08	0,11
57	1,08	0,08	1,08	0,10
58	1,07	0,09	1,08	0,09
59	1,10	0,09	1,07	0,10
60	1,09	0,07	1,09	0,09
61	1,09	0,07	1,08	0,08
62	1,07	0,08	1,08	0,08
63	1,10	0,07	1,10	0,08
64	1,10	0,07	1,09	0,07
65	1,09	0,06	1,10	0,07
66	1,09	0,07	1,09	0,07
67	1,09	0,07	1,10	0,08
68	1,10	0,06	1,10	0,07
69	1,08	0,05	1,10	0,08
70	1,10	0,06	1,11	0,08
71	1,10	0,06	1,11	0,08
72	1,09	0,06	1,10	0,07
73	1,10	0,06	1,11	0,07
74	1,10	0,06	1,12	0,07
75	1,10	0,06	1,10	0,07
76	1,10	0,06	1,12	0,06
77	1,10	0,06	1,11	0,06
78	1,10	0,06	1,11	0,07
79	1,09	0,05	1,11	0,07
80	1,10	0,06	1,11	0,08
81	1,11	0,06	1,12	0,07
82	1,10	0,06	1,11	0,07
83	1,09	0,06	1,10	0,06
84	1,10	0,07	1,11	0,08
85	1,10	0,07	1,11	0,08

Results, conclusion and future plans

- Mortality change between two ages is nearly constant across all cohorts (is constant in time – we cannot reject hypothesis that this time series are white noise). This is very good assumption for next modeling.
- The average ratio $\bar{r}_x$ is not constant across age – G-M assumption about parameter *b* is incorrect – the ratio grows with age. Also its variability s_x is not constant. It decreases with age due to higher numbers of deaths.
- High variability in young ages and oldest cohorts could make the estimate of the ratio inaccurate. We are going to test what is the optimal number of cohorts used for the calculation of the average ratio or we plan to apply some weights declining to the past, so older cohorts will be used with smaller weights.
- Than we can prove our theory on real cohorts which are extinct and we can compare model numbers with the empirical ones. The aim is to apply this method to cohorts which are not yet extinct so that it would be possible to forecast next development of their mortality.

References:

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