Projecting future mortality in the Netherlands taking into account mortality delay and smoking

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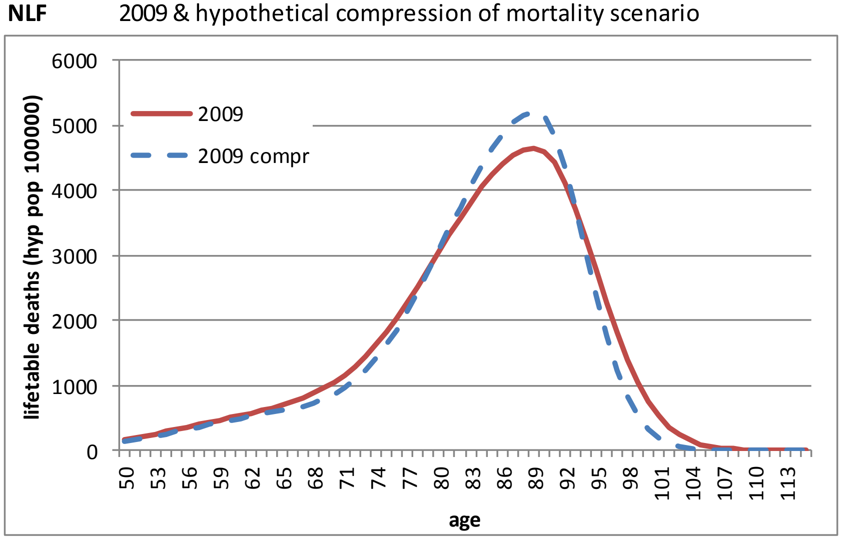
Background

› Conventional extrapolative mortality projection methods do not capture:
  - Impact of life-style epidemics (non-gradual trends + large differences)
  - Mortality delay: the shift in the age-at death distribution towards older ages

Changes in age at death distribution

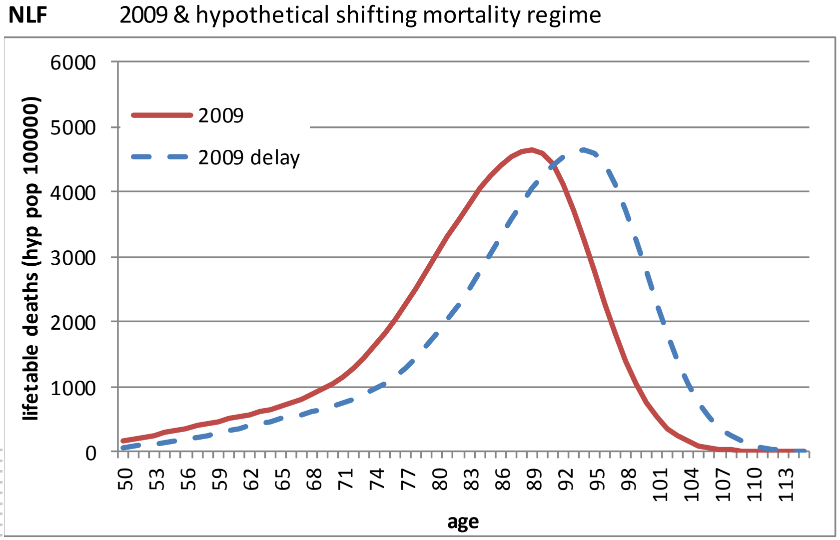
Compression of mortality scenario (Fries 1980)

- Rectangularization
- declining variability in the age of dying



› Shifting mortality regime / **delay of ageing** (Vaupel 2010)

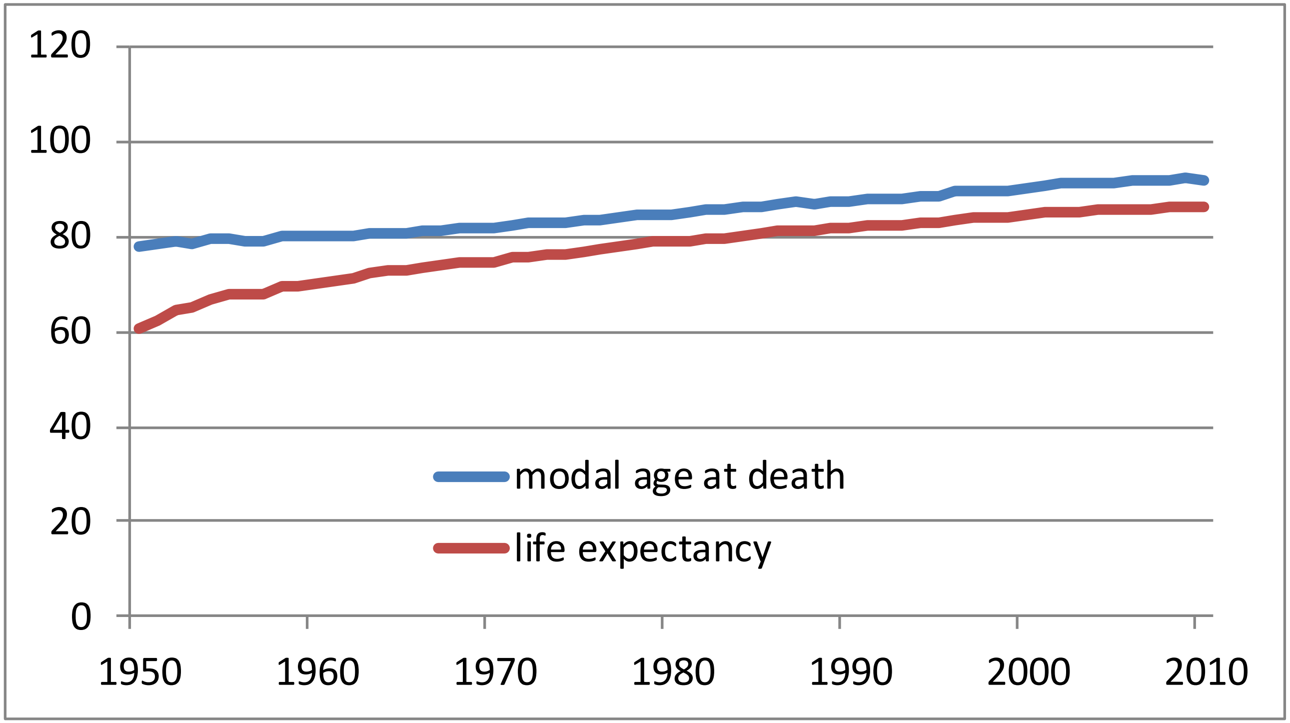
- Increase in modal age at dying
- No changes in shape



Importance of delay vs compression

- Delay: a limit to life exp is unlikely for the near future
- Past trends:
  - Over time: delay increases in importance
  - Delay more important than compression
  - In some countries trends in modal age at dying run parallel to trends in e_0
- Mortality projections including age-at-death distribution are still scarce (only M, only single populations, do not take into account smoking)

Japanese women – M increases parallel with eo



Source data: Human Mortality Database www.mortality.org

Important role of smoking

- Added value of incorporating smoking in mortality projections has been demonstrated recently
- Within Europe, smoking most important determinant of mortality levels, trends and differences
- Cohort effect, non-linear trends
- Smoking greatly affects (trends in) the age-at-death distribution (Janssen et al. 2015)
- For NL, strong impact of smoking on mortality trends => smoking is taken into account in the official mortality forecast (Stoeldraijer et al. 2013, Janssen et al. 2013)

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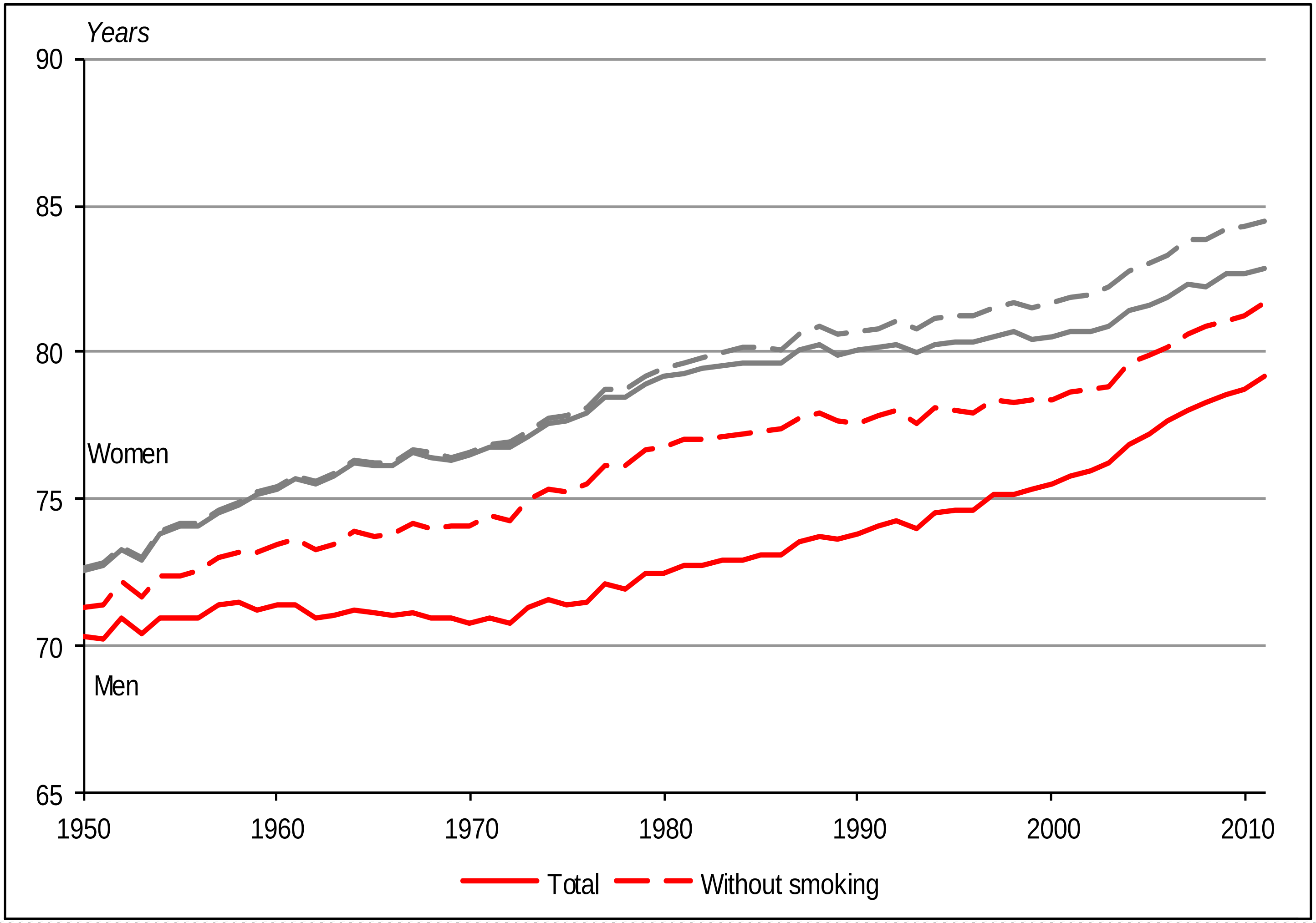
Total life expectancy and life expectancy without smoking, the Netherlands



Stoeldraijer, van Duin and Janssen (2013)

Objective

› To estimate future life expectancy for the Netherlands by simultaneously taking into account the effect of smoking and developments in delay and compression of mortality

Data & methods

- NL; 1950-2012
- All-cause mortality and population numbers by sex and single year of age (CBS)
- Lung-cancer deaths by sex and five-year age groups (WHOSIS)
- Adjusted Peto et al method => smoking-attributable mortality fractions (SAMF)
- Applying a simplified version of the CoDe mortality model (de Beer & Janssen, submitted) to the total population, non-smokers, and smokers. Aged 40+.
- Projections using the parameters of the CoDe mortality model for non-smokers up to 2050, plus projection of SAMF. Comparison with Lee-Carter. 1950-2012; 1980-2012.

Simplified CoDe mortality model, 40+

Modelling *q(x)* with minimum number of interpretable parameters

$$q(x) = a + I(x \le x_1)\left[\frac{b_1 e^{b_1(x-M)}}{1+\frac{b_1}{g}e^{b_1(x-M)}}\right] + I(x_1 < x \le x_2)\left[\frac{b_2 e^{b_2(x-M)}}{1+\frac{b_2}{g}e^{b_2(x-M)}} + c_1\right]$$
$$+I(x > x_2)\left[\frac{b_3 e^{b_3(x-M)}}{1+\frac{b_3}{g}e^{b_3(x-M)}} + c_2\right]$$

background + adult age + middle age + old age

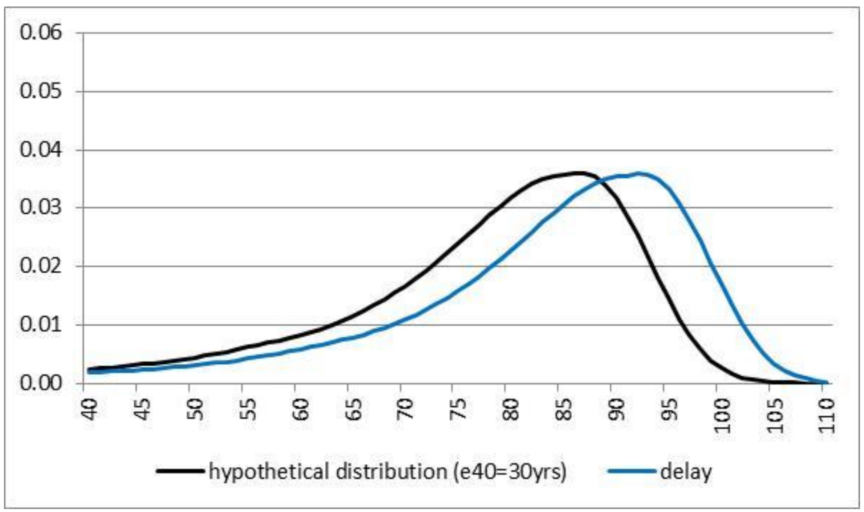
$x_2 = M; x_1 = M - h$

g (0.7) and h (30) time invariant

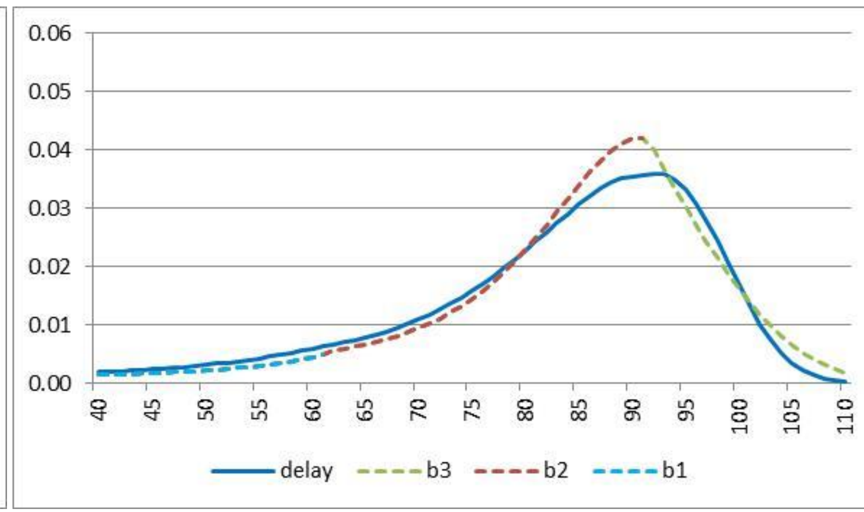
five interpretable time-varying parameters: a, b_1, b_2, b_3, M

Effects of the parameters of the model

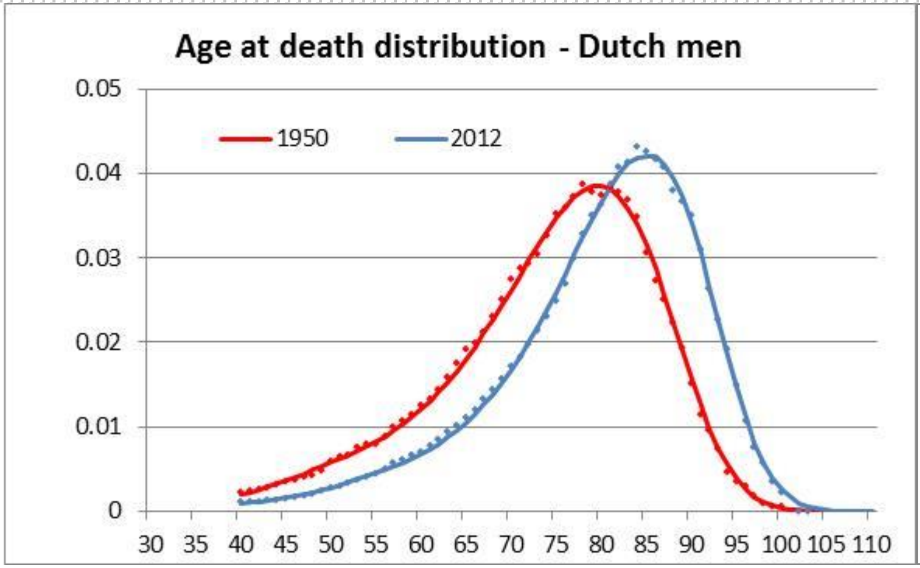
Increase in M that corresponds with 5 yrs increase in e40

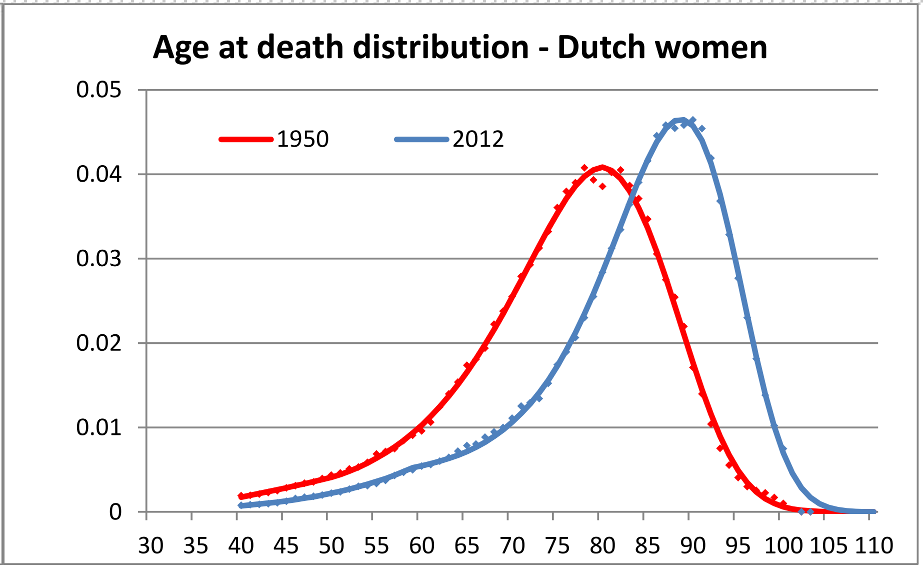


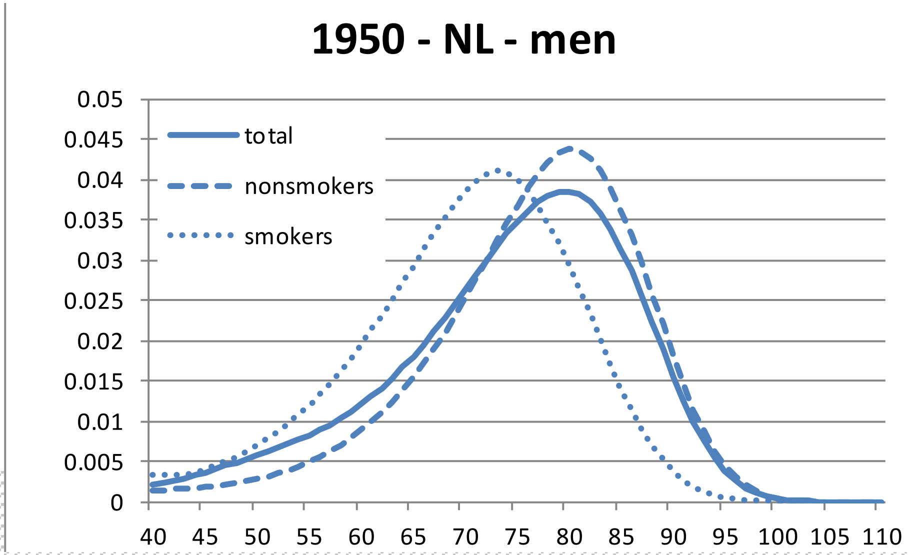
Increase in b1 and b2, and decrease in b3 that all three correspond with a 0.5 yrs increase in e40

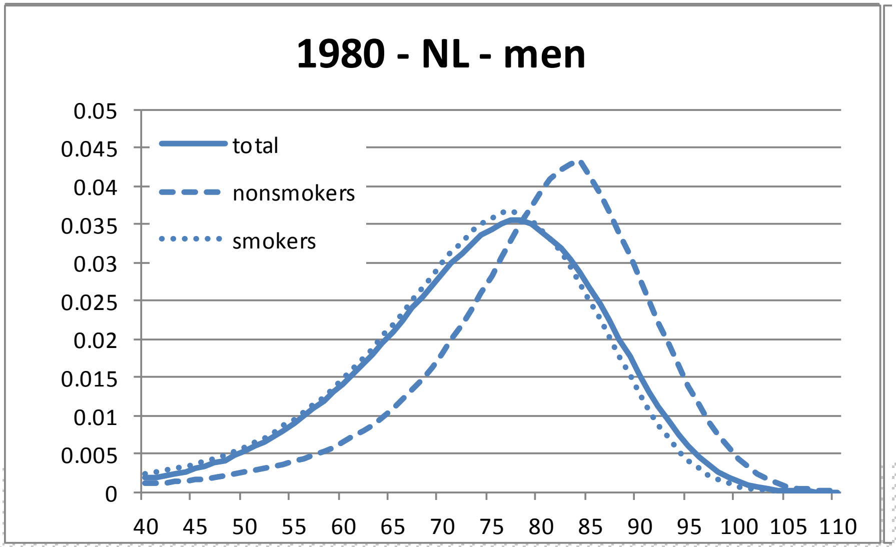


Age at death distributions

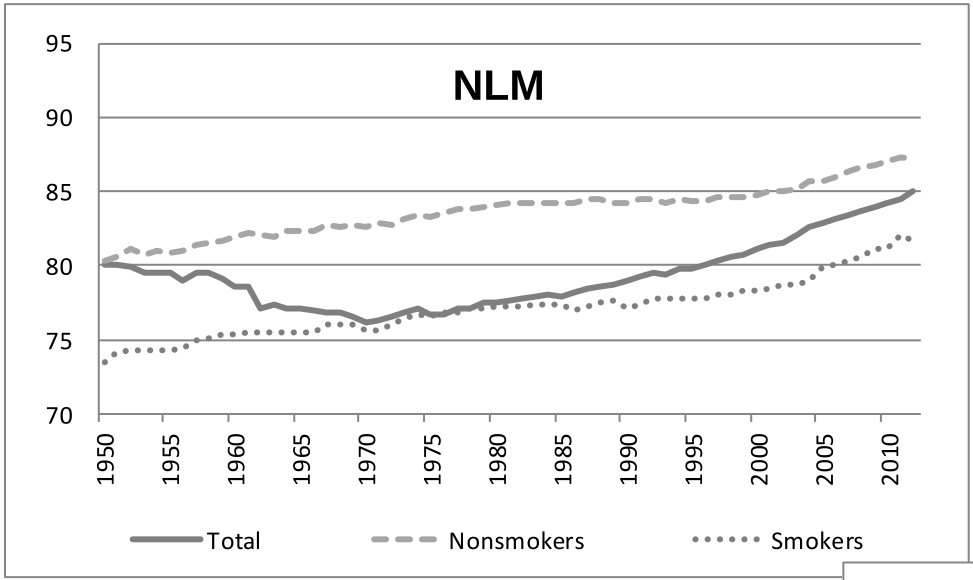


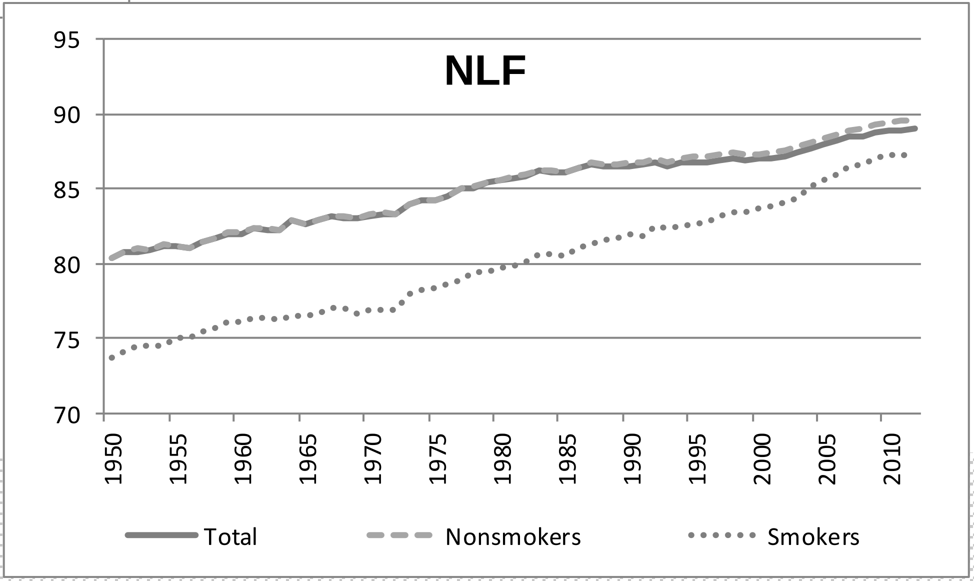




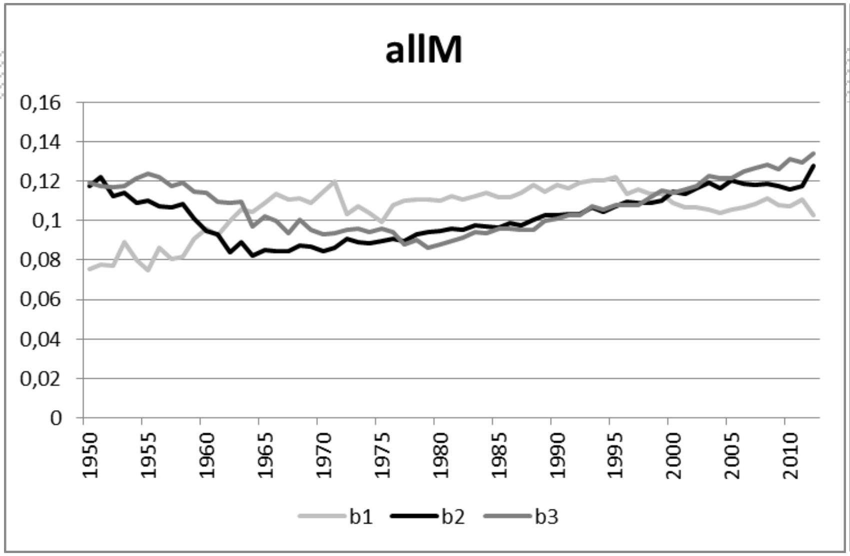


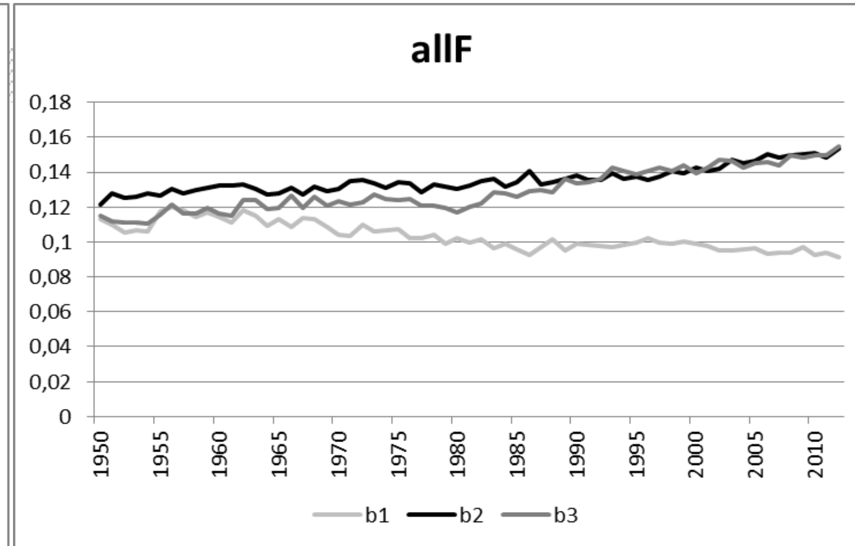
Model age of death

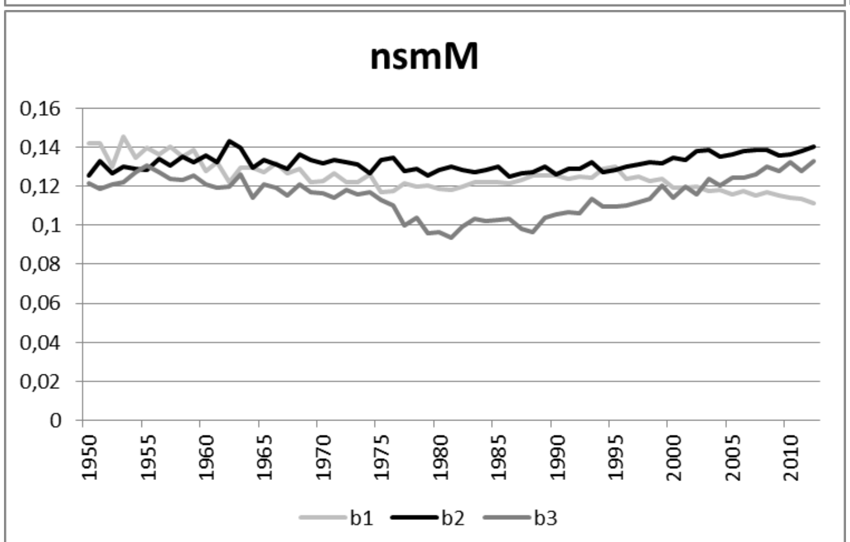


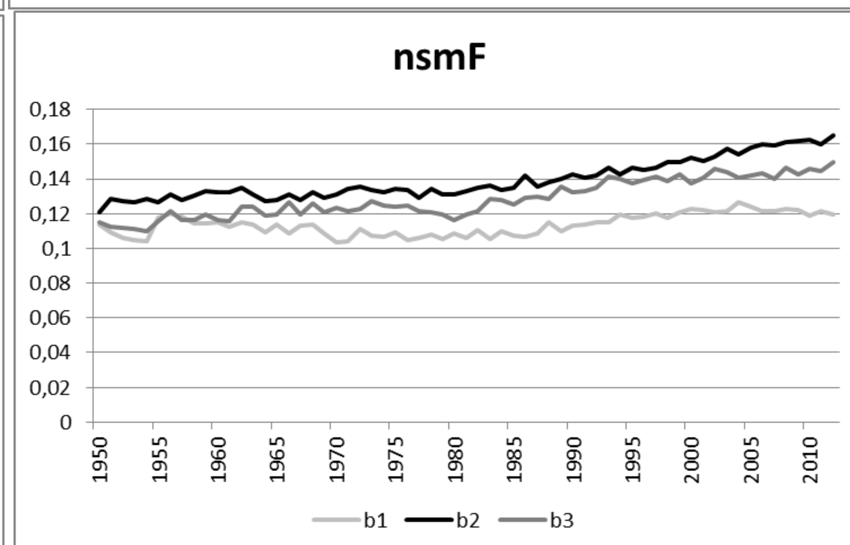


Additional parameters





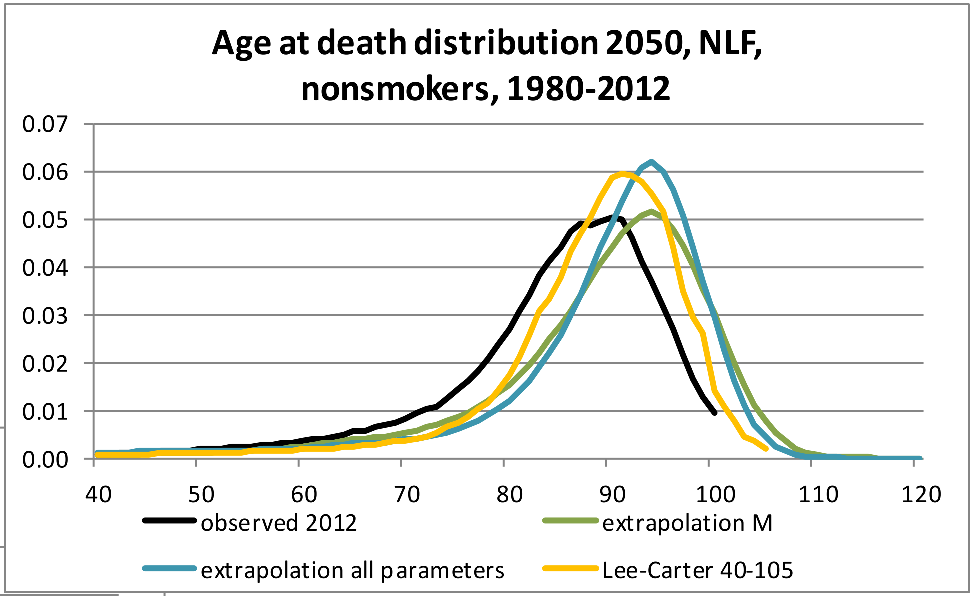


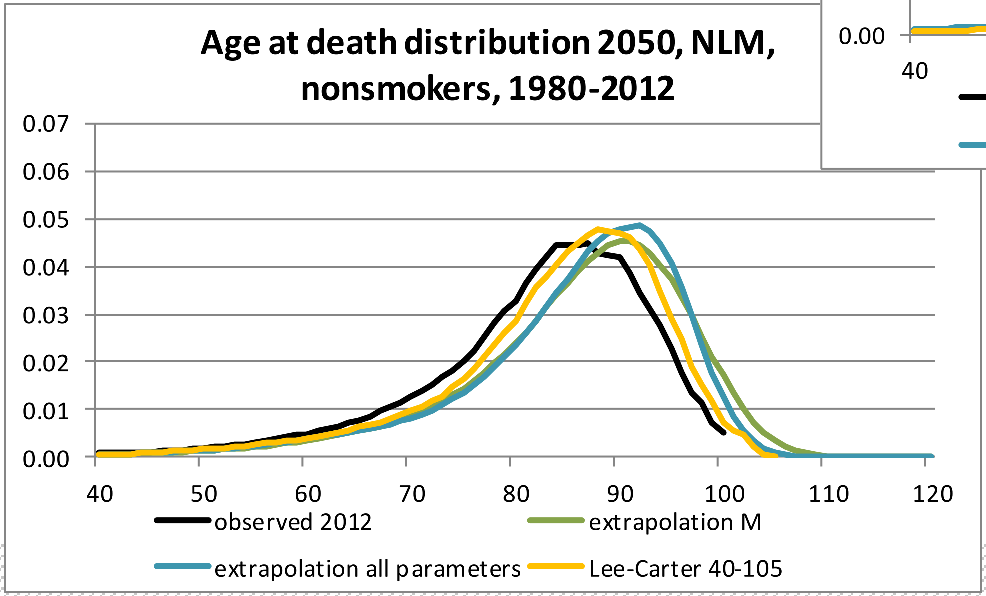


e40 2050, the Netherlands

	1950-2012		1980-2012	
	men	women	men	women
nonsmokers (e40 2012 = 42.76 (M), 45.15 (F))				
extrapolation M; rest similar to 2012 ns	46.80	50.51	46.37	49.62
extrapolation a, b1, b2, b3, M	46.47	50.58	46.00	50.02
LC 40-100	45.94	49.23	45.07	48.68
total (e40 2012 = 40.22 (M), 43.57 (F))				
extrapolation nonsmokers (M) + SAM (APC)	45.63	48.79	45.20	47.92
extrapolation nonsmokers (all parameters) + SAM (APC)	45.21	48.94	44.87	48.51
LC 40-100	42.69	47.54	44.89	46.39
SAM = smoking-attributable mortality				
APC = age-period-cohort analyses				

Difference with Lee-Carter





Conclusion

- Changes in delay and compression for total population result from changes in the age at death distribution of smokers and non-smokers, and the prevalence of smoking
- For both non-smokers and smokers, the delay is more linear than for the total population, and more similar for M and F
- Projection by means of the modal age at death should – for NL – take into account smoking and should not ignore compression & expansion
- Such projections result in higher life exp values , more delay, and more deaths at advanced ages compared to Lee Carter

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Future plans

1) From individual to coherent mortality projection

2) Novel mortality projection technique for Europe:
   trends in lifestyle-related mortality trends (smoking + obesity + alcohol) + trends in the age-at-death distribution + trends in other countries

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Thanks for your attention

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Parameters of the CoDe model (for ages 40+)

	total population			nonsmokers			smokers		
	1950	1980	2012	1950	1980	2012	1950	1980	2012
Men									
a	-0.0017	0.0000	0.0000	0.0009	0.0005	0.0002	0.0031	0.0009	0.0000
b1	0.0755	0.1103	0.1029	0.1419	0.1188	0.1115	0.2137	0.1152	0.0948
b2	0.1177	0.0948	0.1277	0.1258	0.1285	0.1402	0.1157	0.1017	0.1044
b3	0.1193	0.0880	0.1341	0.1215	0.0963	0.1329	0.1057	0.0933	0.1215
M	79.9984	77.5729	85.0469	80.4220	84.0962	87.2444	73.5540	77.2369	81.4735
Women									
a	0.0007	0.0002	-0.0003	0.0007	0.0004	0.0005	0.0002	-0.0010	-0.0011
b1	0.1133	0.1020	0.0916	0.1136	0.1084	0.1193	0.1303	0.0983	0.0809
b2	0.1211	0.1305	0.1535	0.1211	0.1313	0.1649	0.1087	0.0939	0.1301
b3	0.1150	0.1168	0.1548	0.1150	0.1166	0.1496	0.0873	0.0938	0.1531
M	80.3754	85.5382	89.0655	80.3748	85.6003	89.5696	73.7691	79.7570	87.5596

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Past smoking intensities (40+)