Modelling Causal Mortality and the Impact of Cause-Elimination

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AFIR/ERM - PBSS - LIFE Colloquium
Lyon, June 24, 2013

Table of contents

Introduction

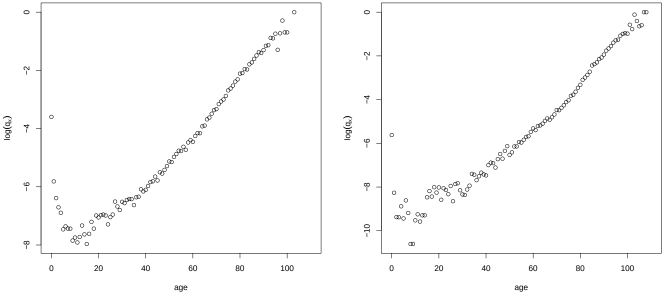
Data

Theoretical Background

Application
- Results
- Forecasts

Conclusion

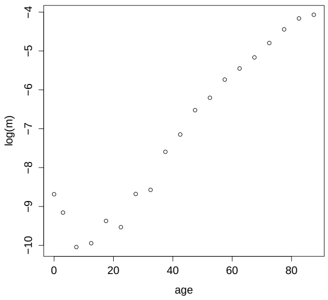
Why should we look at mortality by cause of death?



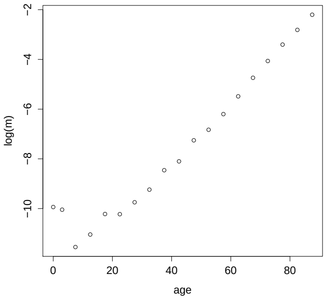
(a) 1950 (b) 2005

Figure: Log-mortality over ages, Switzerland, females

Why should we look at mortality by cause of death?



(a) Cancer



(b) Circulatory system

Figure: Log-mortality over ages, Switzerland, females, 1955

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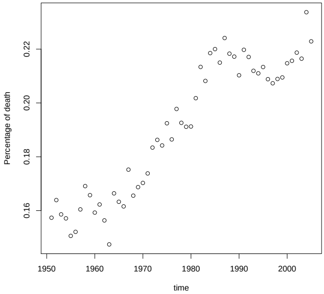
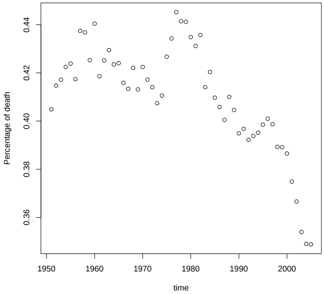


(a) Cancer



(b) Circulatory system

Figure: Percentage of deaths by cause, ages 65 and over, Switzerland, females

Why are causes of death not so often analyzed?

Many problems arise:

- Differences in interpretation of international rules, in coding practices and in training of physicians;
- Cause of death reporting less reliable at older ages where most of the deaths occurs (inaccuracy of reported age at death, sampling error);
- Different causes may impact different age-groups;
- Multiple causes;
- Misclassifications of deaths by cause;
- ...
- Causes of death = competing risks $\rightarrow$ a dependance exist.

[Booth and Tickle(2008)] and [Richards(2009)]

Aim

What? Get a better understanding of mortality by causes of death
$\rightarrow$ especially the dependance
$\rightarrow$ improve the forecasting performance

Data

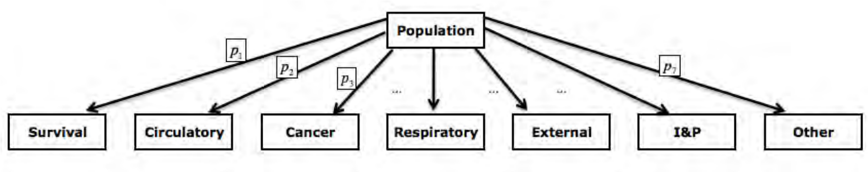
Countries:

- USA (1950 - 2007)
- Japan (1950 - 2009)
- France (1952-2008)
- E & W (1950 - 2009)
- Italy (1951 - 2003)
- Australia (1950 - 2004)
- Sweden (1951 - 2010)
- Switzerland (1951 - 2007)
- Singapore (1955 - 2009)
- Norway (1951 - 2009)

Causes of death:

- Diseases of the circulatory system
- Cancer
- Diseases of the respiratory system
- External causes (mainly: accidents)
- Infectious & parasitic diseases

Multinomial logit models



- Typically used for a response with several unordered categories

Multinomial logit models

$$
\begin{aligned}
\log\left(\frac{q_1(x,t)}{p(x,t)}\right) &= a_x^{(1)} + b_x^{(1)} \cdot t + c_x^{(1)} \cdot t^2 \\
\log\left(\frac{q_2(x,t)}{p(x,t)}\right) &= a_x^{(2)} + b_x^{(2)} \cdot t + c_x^{(2)} \cdot t^2 \\
&\cdots \\
\log\left(\frac{q_6(x,t)}{p(x,t)}\right) &= a_x^{(6)} + b_x^{(6)} \cdot t + c_x^{(6)} \cdot t^2
\end{aligned}
$$

The *logit* probabilities depend on a set of factors: the age and a period effect that interacts with age.
$\rightarrow$ each age has its own period effect.

Do we have a good fit?

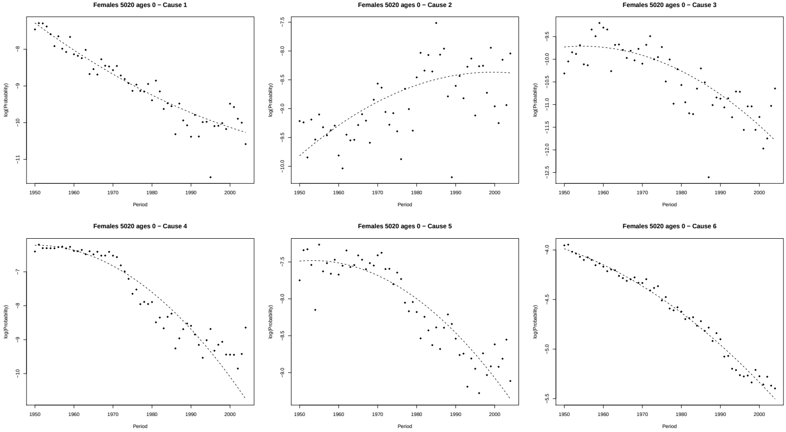


Figure: Data versus model at age 0, females, Australia

Do we have a good fit?

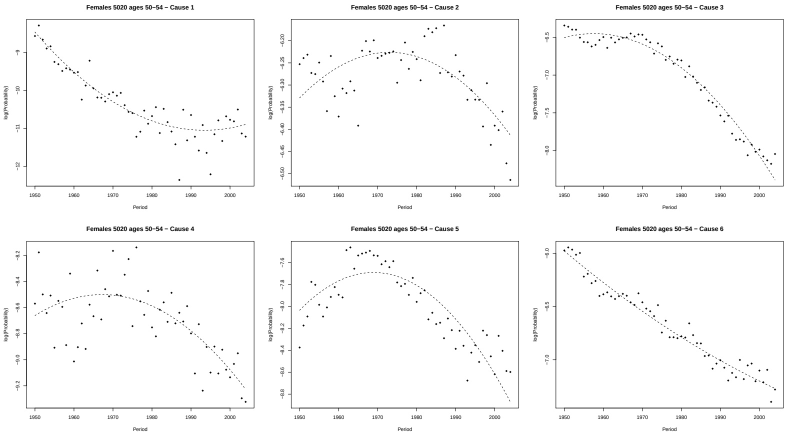


Figure: Data versus model at age-group 50-54, females, Australia

Do we have a good fit?

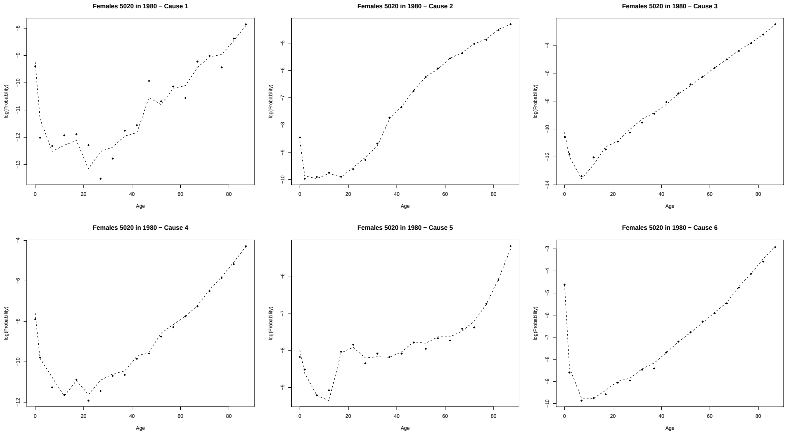


Figure: Data versus model in 1980, females, Australia

Do we have a good fit?

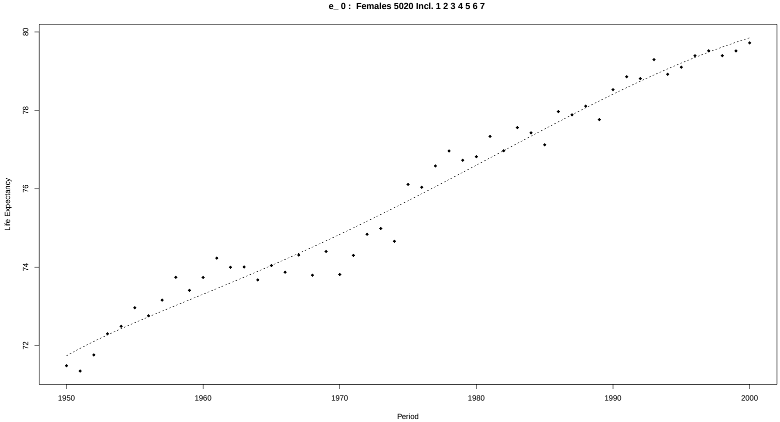
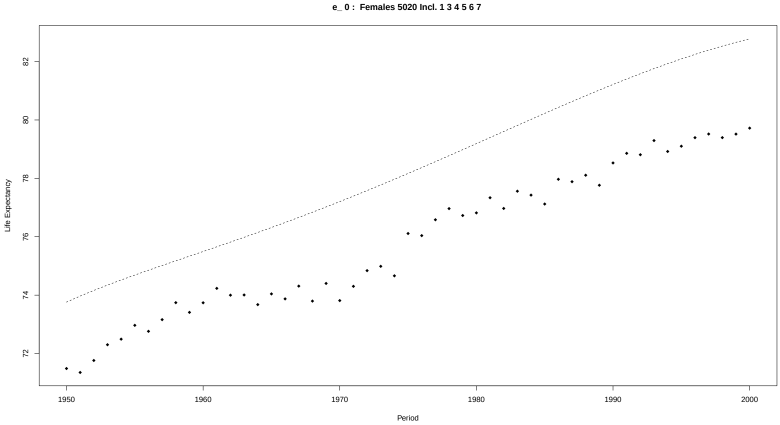


Figure: Life expectancy at age 0, females, Australia

What happens if a cure for cancer is found?



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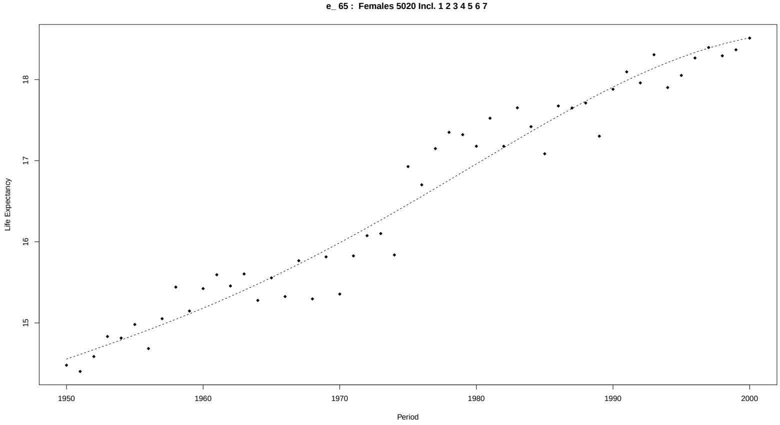

Figure: Life expectancy at age 65, females, Australia

What happens if a cure for cancer is found?

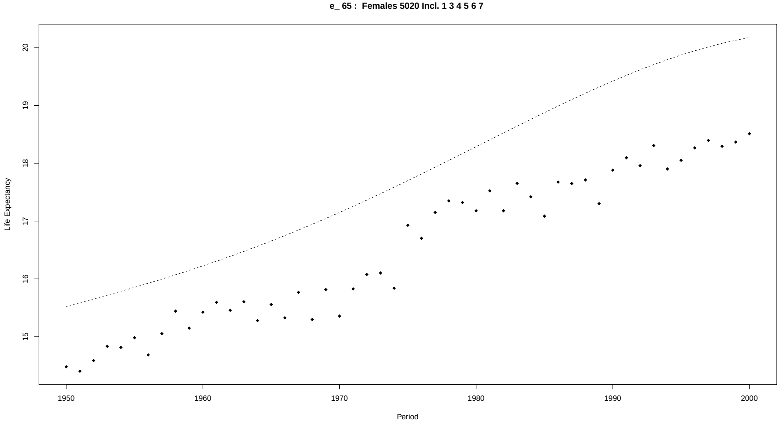

Figure: Life expectancy at age 65, females, Australia

Next step

Can we use these models for forecasting?

Cause-of-death mortality forecasts

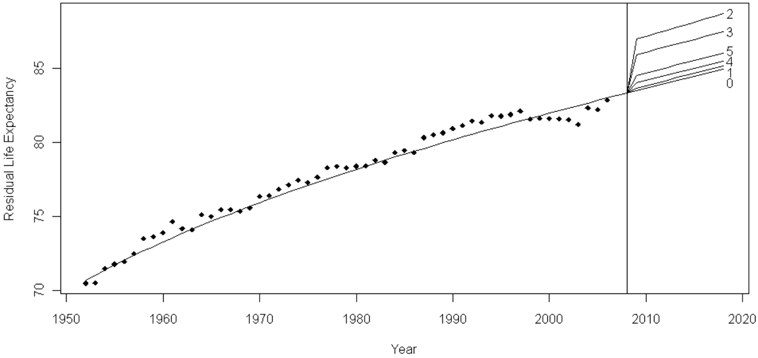

Figure: Life expectancy at age 0, females, France

Cause-of-death mortality forecasts - continue

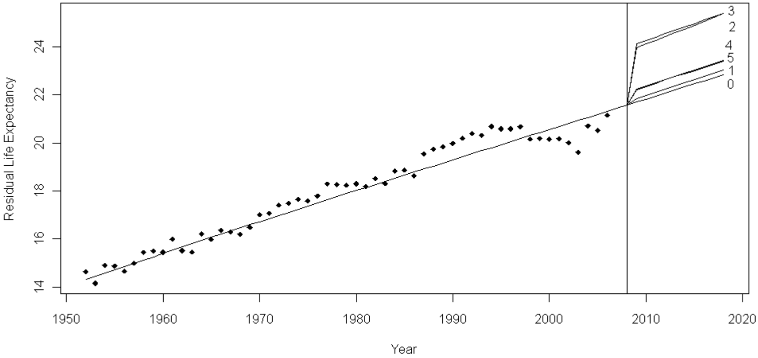

Figure: Life expectancy at age 65, females, France

Concluding remarks

- Multinomial logit model is an interesting and easy to understand framework

  $\rightarrow$ very useful for cause-elimination analysis

  $\rightarrow$ allows for a straightforward implementation of information with respect to known links between the various causes

  $\rightarrow$ need to be careful for forecasting purposes

$\rightarrow$ Models incorporating this information need to be further developed

Bibliography

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Thank you for your attention!