

Transferring recent advances in statistical models for relative survival to applied research.

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Models for Relative Survival

- Relative survival can be estimated separately for subgroups of interest using life tables.
- Why do we fit statistical models?
 - Assess the effect of many covariates simultaneously.
 - Quantify differences.
 - Statistical testing.
 - Confounding variables.
 - Quantify differences between groups.
 - Investigate effect modifiers (statistical interaction).
 - Predictions.
- Standard model is Poisson regression [1].

New Methods for Relative Survival

- Increasing number of publications regarding new methods.
- Which methods are the most useful?

We believe that flexible parametric survival models have a number of advantages and should be used more in applied research.

Flexible Parametric Models

- First introduced by Royston and Parmar [5].
- Extended to relative survival [4].
- Improved user-friendly software [3].
- Much more flexible than standard parametric models through the use of splines.
- Treat time as continuous (no need to split the time scale).
- Cause-specific analysis: flexible parametric models effectively give the same estimates as a Cox model.

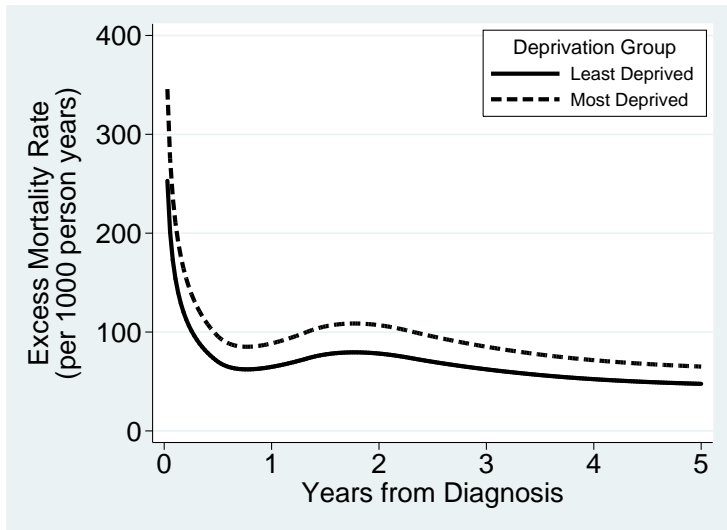
Breast Cancer Data

- 115, 331 women diagnosed with breast cancer
- England and Wales 1986-1990.
- Compare deprivation groups using relative survival models.

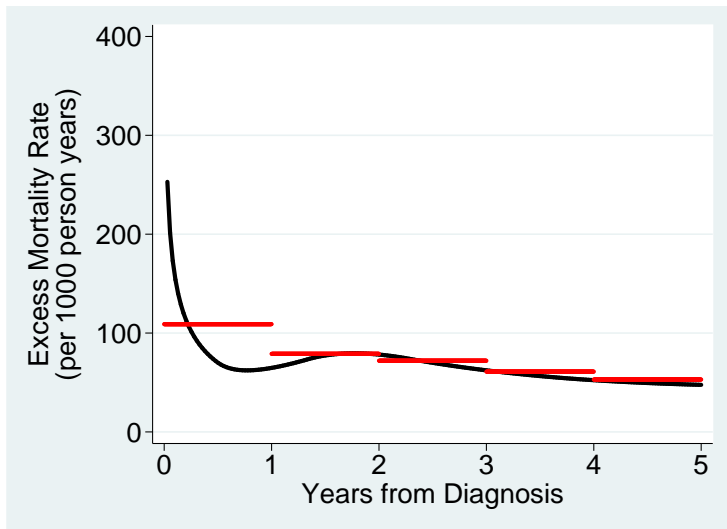
Proportional Excess Hazards Model

		Poisson	Flexible Parametric
Deprivation group	Affluent	1.00 (-)	1.00 (-)
	2	1.07 (1.03 to 1.10)	1.06 (1.03 to 1.10)
	3	1.12 (1.08 to 1.16)	1.12 (1.08 to 1.16)
	4	1.22 (1.18 to 1.84)	1.23 (1.18 to 1.27)
	Deprived	1.36 (1.31 to 1.41)	1.37 (1.32 to 1.42)

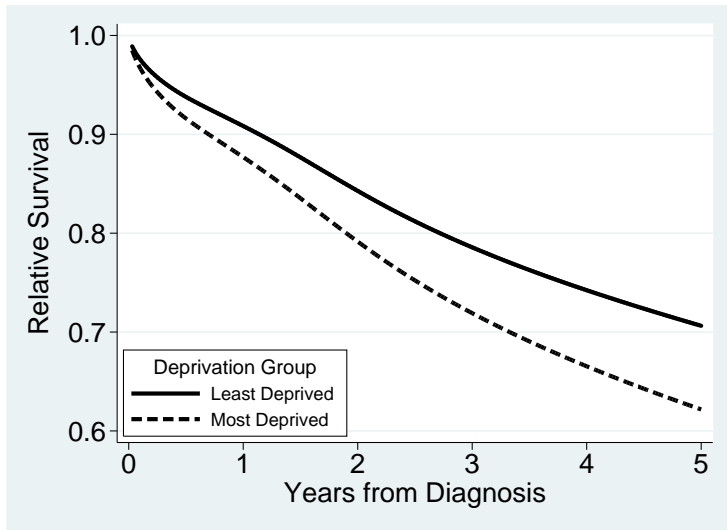
Excess Mortality Rates



Splines vs Poisson Model



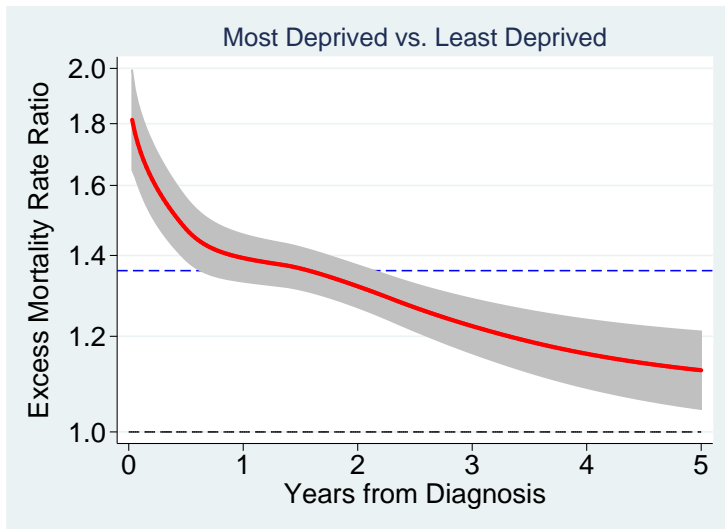
Predicted Relative Survival



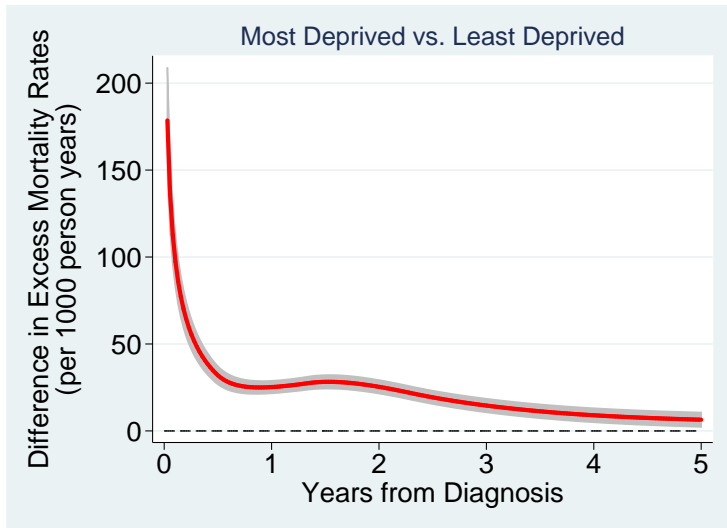
Time-Dependent Effects

- It is common for the effect of a covariate to be time-dependent, i.e. there are non-proportional excess hazards.
- A key advantage of the flexible parametric survival approach is that complex time-dependent effects are simple to fit.

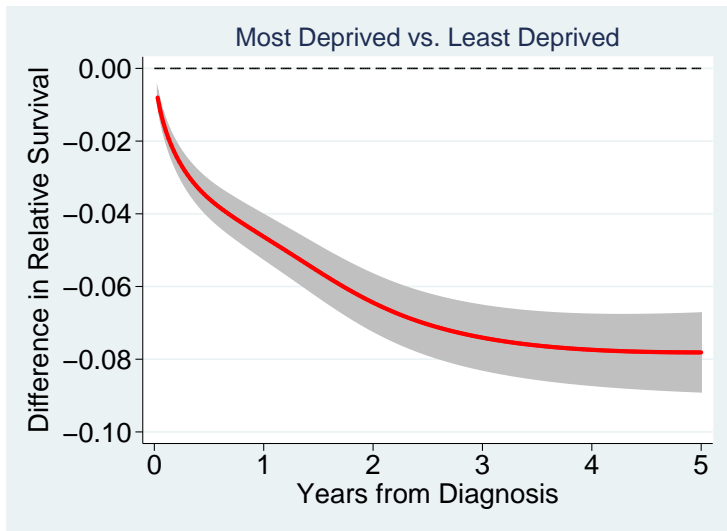
Time-Dependent Effects



Differences in Excess Mortality



Differences in Relative Survival



- Freely available software for Stata: `stpm2`.

Proportional Excess Hazards

```
. stpm2 dep2-dep5, scale(hazard) df(5) bhazard(rate)
```

Non Proportional Excess Hazards

```
. stpm2 dep2-dep5, scale(hazard) df(5) bhazard(rate)  
   tvc(dep2-dep5) dftvc(3)
```

- Flexible parametric models have a number of advantages over current methods including.
 - Smooth estimates of survival and hazard functions
 - Simple extension to time-dependent effects.
 - Alternative presentation of results.
- Further extensions include
 - Using age as the time-scale.
 - Multiple time-scales
 - Period Analysis
 - Crude and net mortality [2].
 - Adjusted (standardised) survival curves.

References I

- [1] Paul W Dickman, Andy Sloggett, Michael Hills, and Timo Hakulinen. Regression models for relative survival. *Statistics in Medicine*, 23(1):51–64, Jan 2004.
- [2] P. C. Lambert, P. W. Dickman, C. P. Nelson, and P. Royston. Estimating the crude probability of death due to cancer and other causes using relative survival models. *Statistics in Medicine*, (in press), 2009.
- [3] P. C. Lambert and P. Royston. Further development of flexible parametric models for survival analysis. *The Stata Journal*, 9:265–290, 2009.
- [4] Christopher P Nelson, Paul C Lambert, Iain B Squire, and David R Jones. Flexible parametric models for relative survival, with application in coronary heart disease. *Statistics in Medicine*, 26(30):5486–5498, Dec 2007.
- [5] Patrick Royston and Mahesh K B Parmar. Flexible parametric proportional-hazards and proportional-odds models for censored survival data, with application to prognostic modelling and estimation of treatment effects. *Statistics in Medicine*, 21(15):2175–2197, Aug 2002.