Constrained extrapolation of multistate transitions

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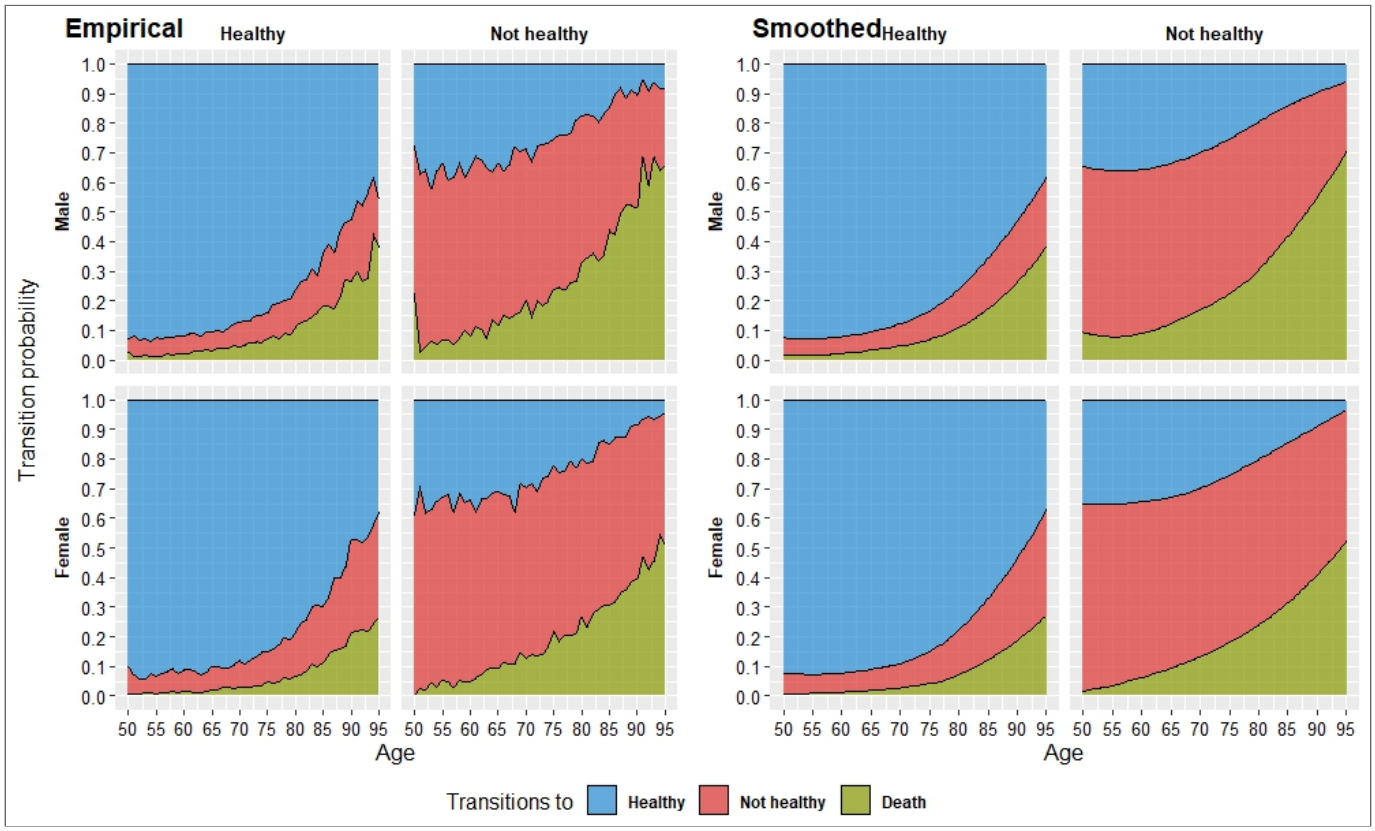
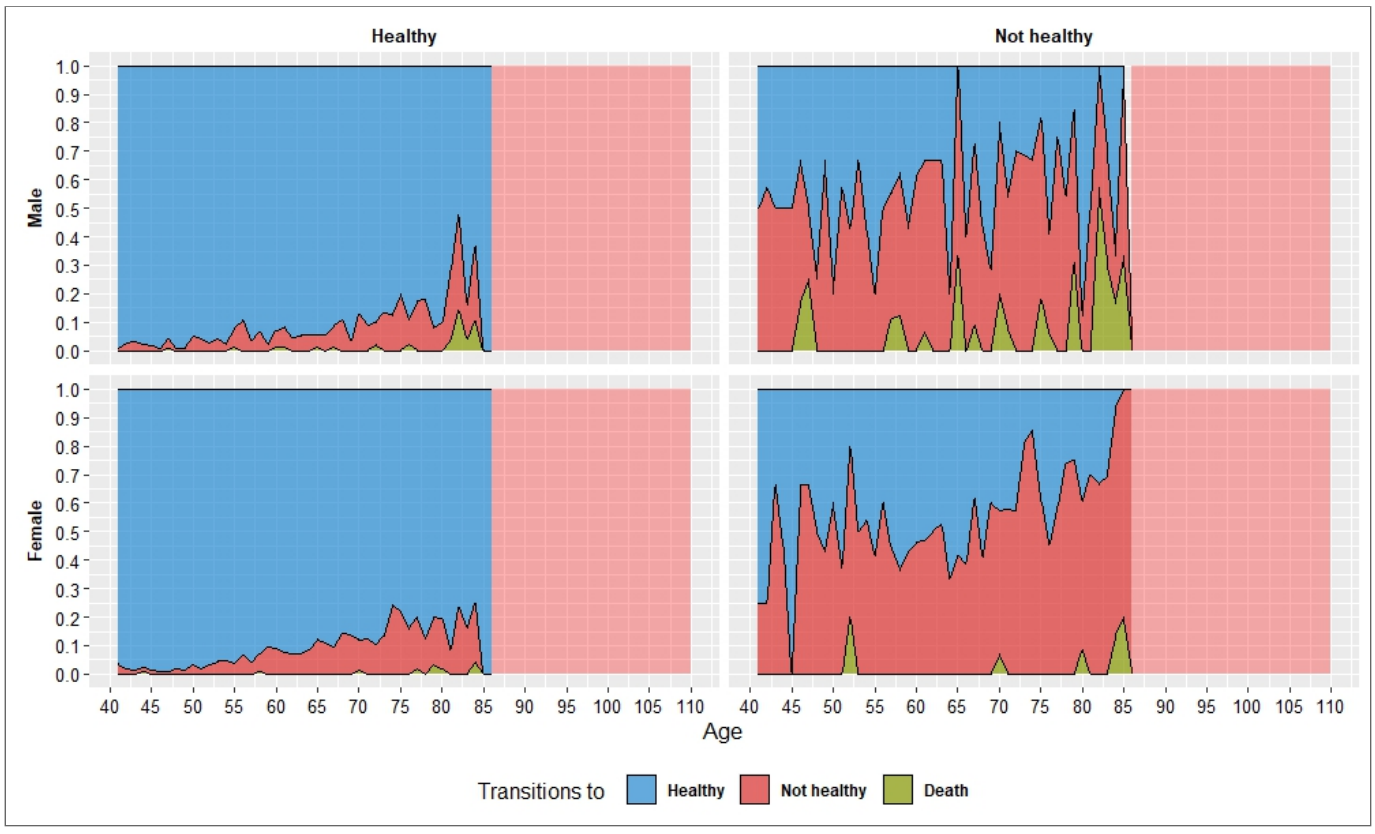
Motivation:

- Surveys used for calculation of multistate transition probabilities or HLE often have truncated age ranges.
- SHARE covers ages 50 to 110, but EU-SILC only has data for ages 17 to 85.
- Compositional nature of transition probabilities makes it difficult to extrapolate them with naive methods due to their constrained structure.

Empirical data example:



(a) Empirical SHARE



(b) Empirical EU-SILC

Standard approaches:

- Imach software (Maximum Likelihood Computer Program using Interpolation of Markov Chains) - great tool, but notoriously difficult to use.
- Multistate transition probabilities approach - fast and efficient method, easily modified for changes in workflow making it a great tool for EDA, does not require external software, but may be less accurate.

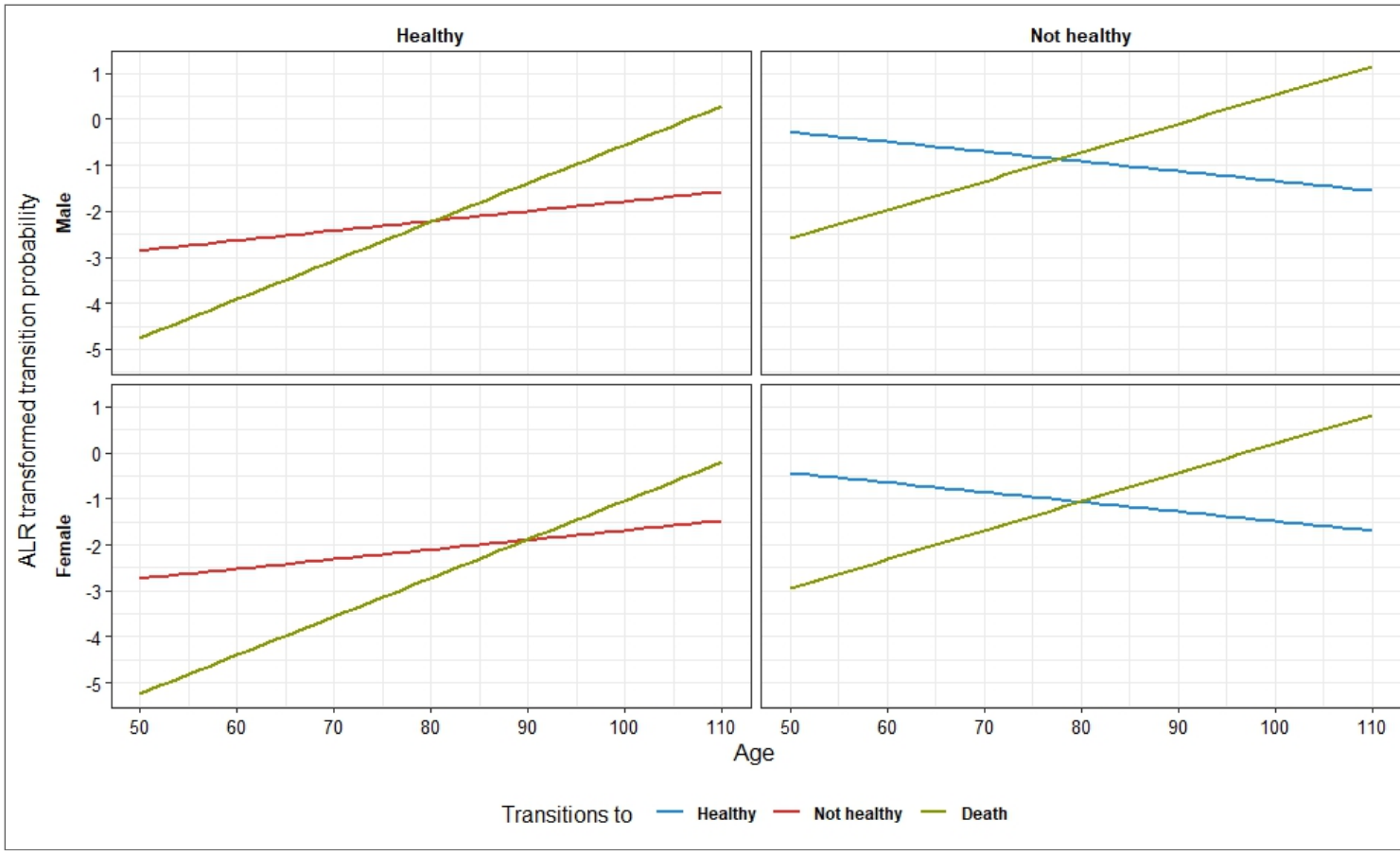
Methods:

- We fit the multistate model (multinomial logistic) to the SHARE data to calculate the parameters.
- We compare the obtained results with those from the Imach, to check for systematic errors. To do so we plot the models vs. the empirical (interpolated for Imach) transition probabilities.
- We truncate age range (by age 80) and extrapolate transitions up to the age 110.

A thoughtful fact:

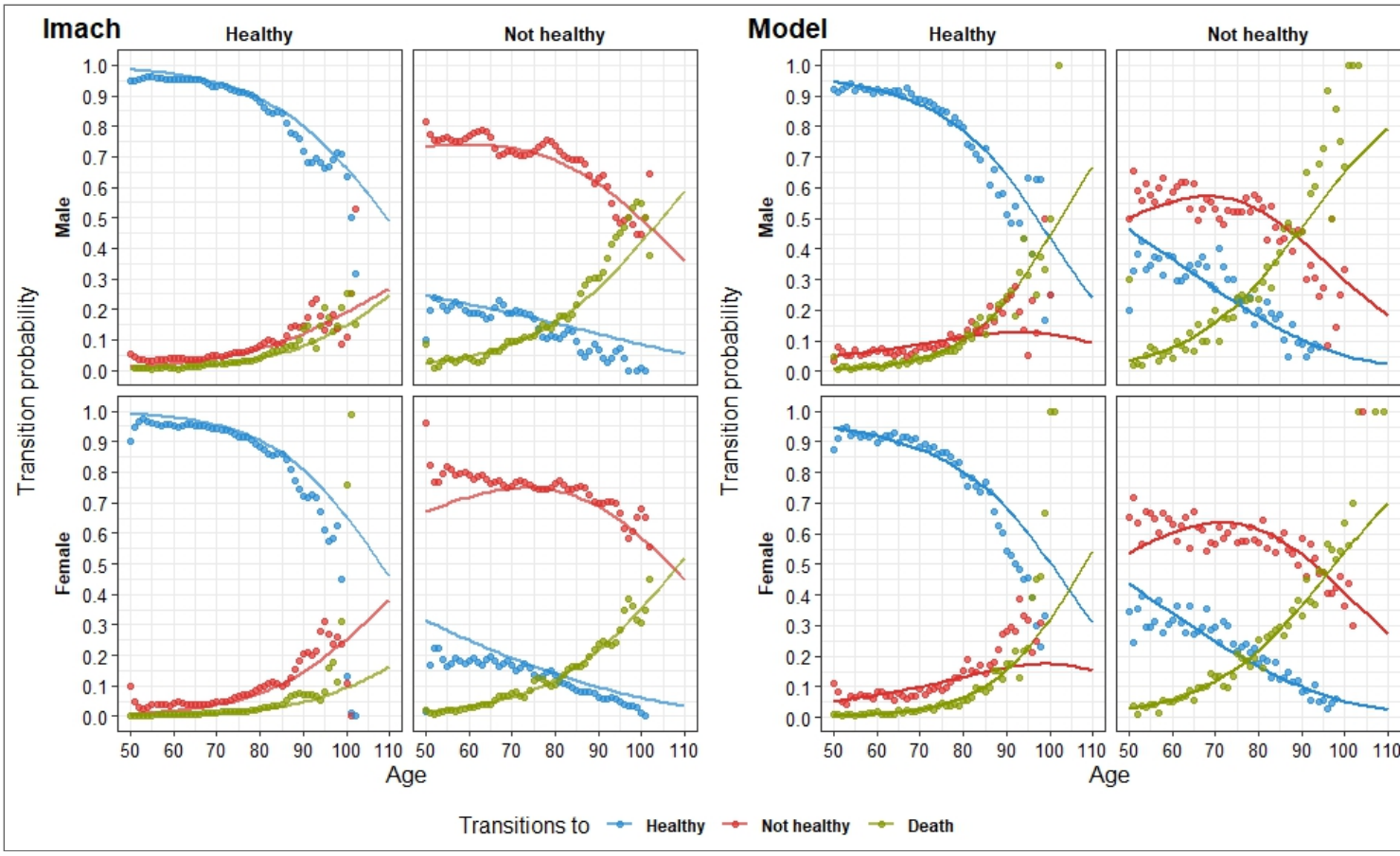
- Transformed transition probabilities from multinomial logistic turn out linear. This transformation is largely identical to the compositional ALR $alr(x)_i = ln\frac{x_i}{x_D}$
- This transforms compositional simplex $alr : S^D$ to R^{D-1} and allows for a neat reparametrization of the model from multinomial to compositional linear regression.
- The results then can be sent back by inverse ALR.

ALR transformation:



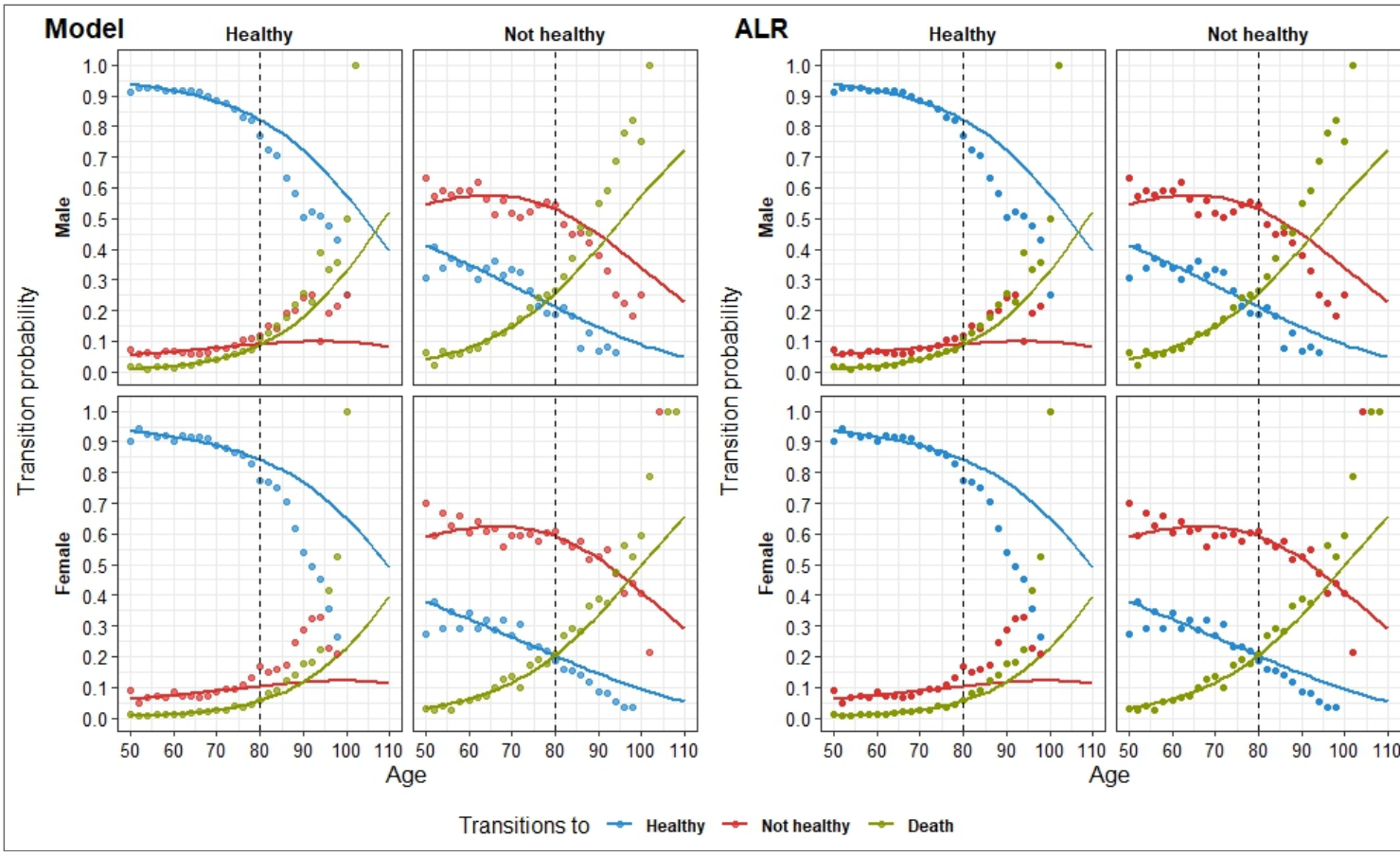
ALR transformed transitions from multistate model with SHARE data

Imach and multistate model:



Comparison of Imach and Multistate model fit

Multistate vs ALR:



Extrapolation of truncated (age 80) data from model. Traditional approach vs. ALR

Discussion:

- Modal age at death is often higher than 85 and not all people at high ages are unhealthy.
- We can derive more information from the survey using the multistate health expectancies rather than prevalence.
- Eurostat closes the HLE with QALY indicator obtained with from EU-SILC that follows a Sullivan approach with constant prevalence for closing of a lifetable.
- There are better ways of doing so, for example the UN method that needs more age range.

Discussion pt. 2:

- Imagine we only have a figure of transition probabilities for a subset of ages generated by Imach or by multistate model.
- We can parse it and extrapolate to generate the full age range with the ALR transformation.
- We can disregard the estimation of parameters in this case.

Conclusion:

- ALR transformation is a neat re-parametrization of multinomial model.
- Our multinational model currently fits worse compared to Imach, but can be used to extrapolate the constrained data, especially for the initial research purposes, like covariate selection and EDA.
- The further improvement of the model could be made, for example the incorporation of missing data handling.