Bayesian Multivariate Modelling of Patient Level Healthcare Resource Use Data in RCTs

S. Conti, A. Manca, P. C. Lambert, K. R. Abrams

The University of York

Backdrop

- CEA informs allocation decisions in UK health policy
- RCTs typically offer (a wealth of) IPD on health-care resource use
- analyses often proceed from converting data into monetary figures
- by direct modelling of health-care resources
  1. a more efficient and transparent analytic perspective is enabled
  2. features of the underlying distributions are explicitly addressed
  3. relationships between the different cost drivers are accounted for
- The Bayesian approach provides sound and powerful model building, criticism and selection tools

Modelling Approach

- Patients \( r = 1, \ldots, n \) in arm \( t \in \{ C, T \} \) of a RCT consume health-care resource items \( i = 1, \ldots, I \)
  - individual resource uses \( R_{it} \) are recorded
  - their distributions are characterised by unknown parameters \( \phi_t \)
- Experience and tractability drive model choices for \( R_{it} \mid \phi_t \)
  - joint modelling of heterogeneous variables is not viable
  - conditioning facilitates the model structuring process
  - reliance on (arguable) Normal approximations is not required

ATLAS: a Test-Bed

- The ATLAS trial compared low versus high-dose ACE-inhibitor losartan in the study of chronic heart failure
- Focus is upon “Day Cases”, “Days in Hospital” and “Drug Use”, with \( n_C = 1571 \) and \( n_T = 1544 \)
  - discrete variables \( R_{i} \) are over-dispersed and strongly concentrated at zero
    \[ \rightarrow (N, PoI, HPoI, NLBi, NHlBi, ZINtBi) \]
  - continuous variable \( R_i \) is strongly asymmetric – and negatively (!) log-skewed
    \[ \rightarrow (N, LN, G, LSN, LST) \]

Model Formulation

- Conventional Bayesian diagnostics are based around residuals
  - RMSFs measure the fit of marginal predictive distributions
  - SMDs account for how well the observed relationships are modelled
- Various statistical tools for model selection are available off-the-shelf
  - AIC, BIC and DEC offer model adequacy and complexity
  - consistent scores to be expected in non-hierarchical contexts
  - models should not just be ranked at their score’s face value

Model Validation and Selection

- Review distributions were fitted with ‘vague’ priors
- Locations are linear in their conditioning variables (as in Normal case)
- reviewed distributions were fitted with ‘vague’ priors
- parametrisation meets constraints on variables (e.g. non-negativity)
- non-Normal distributions are fitted by means of MCMC simulation

Model Diagnostics

- Conventional Bayesian diagnostics are based around residuals
  - RMSFs measure the fit of marginal predictive distributions
  - SMDs account for how well the observed relationships are modelled

References