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Statistical Analysis of Questionnaires: A Unified Approach Based on **R** and **Stata**

This book follows a well established approach to the psychometric analysis of questionnaire data as found in educational, survey and medical research. The authors provide an in-depth discussion of the analysis of score reliability and item properties grounded in classical test theory (CTT), and of the probabilistic modeling of individual responses based on latent variable models. The R and Stata statistical packages are used to illustrate these different steps.

After a brief overview of psychometric theory and the development of a questionnaire (Chapter 1), CTT and item-level psychometric analysis are discussed at length in Chapter 2. The authors describe various approaches to estimate score reliability before going into more substantive considerations about the many facets of test validity. Factor analysis is, however, little discussed except through a small Stata application.

Item response theory (IRT) for dichotomously and polytomously scored items is presented in the next two chapters. In the case of binary responses, the authors highlight the fact that the person parameter can be regarded either as a fixed effect, as originally proposed by Rasch for the one-parameter model, or as a random-effect that can be accounted for using nonlinear mixed effects models and marginal likelihood estimation. This has implications in terms of statistical inference but also when deciding about which software to use. Models for ordinal and nominal responses using a logit link function and a parameterization suitable for such data are discussed next. A particular emphasis is put on models that are members of the Rasch family such as the Partial Credit and Rating Scale models, although more flexible models like the Graded Response Model are also discussed. Stata (**gllamm** package and `xtlogit` built-in command) and R (**ltm** and **mirt** packages) code are provided to illustrate parameter estimation in the case of the one- and two-parameter models for binary response variables, as well as polytomous items using the different flavors of ordinal models.

Chapter 5 is a bit different and focus on the estimation of item and person parameters and the diagnostic of IRT models. The first part is rather technical but it does a good job at describing

the pros and cons of each technique–joint, conditional and marginal maximum likelihood–and how they could be implemented using custom software. The latter part focuses on graphical tools (item and test information curve, person item map) and parametric and nonparametric tests to assess goodness-of-fit of the model as a whole. Finally, measurement invariance is discussed by highlighting various approaches relying on CTT sum scores or on IRT latent trait. In this particular domain, it should be noted that R seems to offer more graphical options for diagnosing IRT models compared to Stata.

The last chapter highlights more recent development in IRT modeling, including models with person covariates that allow to extend the measurement model with an explanatory framework for continuous or discrete latent variables. Clustered and longitudinal data that arise naturally as a result of community-based studies or survey designs are also discussed with a detail account of continuous and discrete latent outcome. The authors conclude this chapter by highlighting multidimensional IRT models which allow to relax the strong hypothesis of unidimensionality that is attached to all previous models, as well as the main strengths of structural equation models which can be viewed as providing the glue between factor analytic methods and IRT.

Overall, the authors succeed at presenting a solid and reliable framework for psychometric analysis of questionnaire data. A better account of Factor analysis as an exploratory tool to unravel the latent dimensions of a questionnaire and as a statistical model with strong connection to IRT models could have been made, though. The joint use of Stata and R to perform similar statistical analyses leaves the choice to the user to rely on one or the other of these two softwares, although the user must keep in mind that oftentimes Stata **gllamm** package is not as fast as most of its R counterparts.

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