Introduction to the second edition

We are delighted that this second edition of *Meta-Analysis in Stata* reflects the continuing innovations in meta-analysis software made by the Stata community since the publication of the first edition in 2009. This new collection of articles about meta-analysis from the *Stata Technical Bulletin* and the *Stata Journal* includes 27 articles, of which 11 are new additions.

The main Stata meta-analysis command `metan` has been widely used by researchers and, according to Google Scholar, has to date been cited by over 300 articles (adding the citations for Bradburn, Deeks, and Altman [1998], Harris et al. [2008], and its listing on the Statistical Software Components archive). We hope that this collection will facilitate the widespread use of both the existing and new commands.

The new articles reflect recent methodological developments in meta-analysis and provide new commands implementing these methods. The second edition extends the structure of the first edition by including parts on multivariate meta-analysis, individual participant data (IPD) meta-analysis, and network meta-analysis.

Part 1 is concerned with fitting meta-analysis models. It additionally includes the article by Kontopantelis and Reeves (2010) describing the `metaan` command, which provides additional estimators for random-effects meta-analysis and can report alternative measures of heterogeneity.

Part 2 remains unchanged from the first edition.

Part 3 is concerned with investigation of bias. It additionally includes the article by Crowther, Abrams, and Lambert (2012) describing the `extfunnel` command, which can be used to examine the impact of a hypothetical additional study on a meta-analysis by augmenting the funnel plot with statistical significance or heterogeneity contours.

Part 4, which addresses multivariate (multiple outcomes) meta-analysis, discusses a substantial update to the `mvmeta` command for multivariate outcome meta-analysis as described by White (2011). The update includes multivariate meta-regression and additional postestimation reporting features, such as I^2 statistics for each outcome.

Part 5 is a new collection of commands for IPD meta-analysis. The article by Kontopantelis and Reeves (2013) describes the `ipdforest` command, which performs IPD meta-analysis using either hierarchical linear or logistic regression and can provide a forest plot. A two-stage approach to IPD meta-analysis is described by Fisher (2015) and implemented in the `ipdmetan` command. The command can incorporate studies reporting both IPD and study-level (aggegrate) data and has options to fine tune the forest plots in such settings.

Part 6 includes three new articles on network meta-analysis, which is a major recent development in meta-analysis methodology (Bucher et al. 1997, Caldwell, Ades, and Higgins 2005; Salanti et al. 2008; Salanti 2012). The first article, by Miladinovic et al. (2014), concerns comparisons of treatments in the absence of direct evidence between them (so-called indirect comparisons). The second article, by White (Forthcoming), presents the `network` suite of commands for network meta-analysis, which is centered around fitting network meta-analysis models with the multivariate normal approach using `mvmeta`. Third the article, by Chaimani and Salanti (Forthcoming), describes the `network_graphs` package of graphical commands for network meta-analysis. These commands have been designed to work with the same data structures as those provided by the `network` suite.

Part 7 includes articles on various advanced meta-analysis methods. New articles include that by Crowther et al. (2013), which provides the `metasim`, `metapow`, and `metapowplot` commands. These estimate the probability that the conclusions of a meta-analysis will change given the inclusion of a hypothetical new study and are based on the methodology of Sutton et al. (2007). Stata 12 and 13 introduced the `sem` and `gsem` commands for structural equation modeling. These commands are very flexible and allow a wide range of constraints to be placed on the parameters in the model. Palmer and Sterne (Forthcoming) describe how these features enable these commands to fit fixed- and random-effects meta-analysis models, including meta-regression and multivariate meta-analysis models. Cumulative meta-analysis was discussed in the first edition by Sterne (1998). Through their `metacumbounds` command, Miladinovic, Hozo, and Djulbegovic (2013) automate the use of the "ldbounds" package for R (Casper and Perez 2014). This command implements trial sequential boundaries for cumulative meta-analyses for controlling the type I error of the meta-analysis.

Information about user-written commands for meta-analysis can be obtained by typing `help meta` in Stata. In addition to this, Stata maintains a frequently asked questions on meta-analysis at

http://www.stata.com/support/faqs/statistics/meta-analysis/

We hope that this second edition of articles about meta-analysis repeats the success of the first edition and continues to encourage users to implement the latest methods for meta-analysis in new Stata commands.

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1 References

Bradburn, M. J., J. J. Deeks, and D. G. Altman. 1998. sbe24: metan—an alternative meta-analysis command. *Stata Technical Bulletin* 44: 4–15. Reprinted in *Stata Technical Bulletin Reprints*, vol. 8, pp. 86–100. College Station, TX: Stata Press. (Reprinted in this collection on pp. 3–28.)

Bucher, H. C., G. H. Guyatt, L. E. Griffith, and S. D. Walter. 1997. The results of direct and indirect treatment comparisons in meta-analysis of randomized controlled trials. *Journal of Clinical Epidemiology* 50: 638–691.

Caldwell, D. M., A. E. Ades, and J. P. T. Higgins. 2005. Simultaneous comparison of multiple treatments: Combining direct and indirect evidence. *British Medical Journal* 331: 897–900.

Casper, C., and O. A. Perez. 2014. ldbounds: Lan–DeMets method for group sequential boundaries. R package version 1.1-1. http://CRAN.R-project.org/package=ldbounds.

Chaimani, A., and G. Salanti. Forthcoming. Visualizing assumptions and results in network meta-analysis: The network graphs package. *Stata Journal* (Reprinted in this collection on pp. 355–400.)

Crowther, M. J., K. R. Abrams, and P. C. Lambert. 2012. Flexible parametric joint modelling of longitudinal and survival data. *Statistics in Medicine* 31: 4456–4471.

Crowther, M. J., S. R. Hinchliffe, A. Donald, and A. J. Sutton. 2013. Simulation-based sample-size calculation for designing new clinical trials and diagnostic test accuracy studies to update an existing meta-analysis. *Stata Journal* 13: 451–473. (Reprinted in this collection on pp. 476–498.)

Fisher, D. J. 2015. Two-stage individual participant data meta-analysis and generalized forest plots. *Stata Journal* 15: 369–396. (Reprinted in this collection on pp. 280–307.)

Harris, R. J., M. J. Bradburn, J. J. Deeks, R. M. Harbord, D. G. Altman, and J. A. C. Sterne. 2008. metan: Fixed- and random-effects meta-analysis. *Stata Journal* 8: 3–28. (Reprinted in this collection on pp. 29–54.)

Kontopantelis, E., and D. Reeves. 2010. metaan: Random-effects meta-analysis. *Stata Journal* 10: 395–407. (Reprinted in this collection on pp. 55–67.)

———. 2013. A short guide and a forest plot command (ipdforest) for one-stage meta-analysis. *Stata Journal* 13: 574–587. (Reprinted in this collection on pp. 321–354.)

Miladinovic, B., A. Chaimani, I. Hozo, and B. Djulbegovic. 2014. Indirect treatment comparison. *Stata Journal* 14: 76–86. (Reprinted in this collection on pp. 311–320.)

Miladinovic, B., I. Hozo, and B. Djulbegovic. 2013. Trial sequential boundaries for cumulative meta-analyses. *Stata Journal* 13: 77–91. (Reprinted in this collection on pp. 462–475.)

Palmer, T. M., and J. A. C. Sterne. Forthcoming. Fitting fixed- and random-effects meta-analysis models using structural equation modeling with the sem and gsem commands. *Stata Journal* (Reprinted in this collection on pp. 435–461.)

Salanti, G. 2012. Indirect and mixed-treatment comparison, network, or multiple-treatments meta-analysis: Many names, many benefits, many concerns for the next generation evidence synthesis tool. *Research Synthesis Methods* 3: 80–97.

Salanti, G., J. P. T. Higgins, A. E. Ades, and J. P. A. Ioannidis. 2008. Evaluation of networks of randomized trials. *Statistical Methods in Medical Research* 17: 279–301.

Sterne, J. A. C. 1998. sbe22: Cumulative meta analysis. *Stata Technical Bulletin* 42: 13–16. Reprinted in *Stata Technical Bulletin Reprints*, vol. 7, pp. 143–147. College Station, TX: Stata Press. (Reprinted in this collection on pp. 68–77.)

Sutton, A. J., N. J. Cooper, D. R. Jones, P. C. Lambert, J. R. Thompson, and K. R. Abrams. 2007. Evidence-based sample size calculations based upon updated meta-analysis. *Statistics in Medicine* 26: 2479–2500.

White, I. R. 2011. Multivariate random-effects meta-regression: Updates to mvmeta. *Stata Journal* 11: 255–270. (Reprinted in this collection on pp. 249–264.)

———. Forthcoming. Network meta-analysis. *Stata Journal* (Reprinted in this collection on pp. 321–354.)