Introduction

This first collection of articles from the *Stata Technical Bulletin* and the *Stata Journal* brings together updated user-written commands for meta-analysis, which has been defined as a statistical analysis that combines or integrates the results of several independent studies considered by the analyst to be combinable (Huque 1988). The statistician Karl Pearson is commonly credited with performing the first meta-analysis more than a century ago (Pearson 1904)—the term "meta-analysis" was first used by Glass (1976). The rapid increase over the last three decades in the number of meta-analyses reported in the social and medical literature has been accompanied by extensive research on the underlying statistical methods. It is therefore surprising that the major statistical software packages have been slow to provide meta-analytic routines (Sterne, Egger, and Sutton 2001).

During the mid-1990s, Stata users recognized that the ease with which new commands could be written and distributed, and the availability of improved graphics programming facilities, provided an opportunity to make meta-analysis software widely available. The first command, `meta`, was published in 1997 (Sharp and Sterne 1997), while the `metan` command—now the main Stata meta-analysis command—was published shortly afterward (Bradburn, Deeks, and Altman 1998). A major motivation for writing `metan` was to provide independent validation of the routines programmed into the specialist software written for the Cochrane Collaboration, an international organization dedicated to improving health care decision-making globally, through systematic reviews of the effects of health care interventions, published in The Cochrane Library (see www.cochrane.org). The groups responsible for the `meta` and `metan` commands combined to produce a major update to `metan` that was published in 2008 (Harris et al. 2008). This update uses the most recent Stata graphics routines to provide flexible displays combining text and figures. Further articles describe commands for cumulative meta-analysis (Sterne 1998) and for meta-analysis of p-values (Tobias 1999), which can be traced back to Fisher (1932). Between-study heterogeneity in results, which can cause major difficulties in interpretation, can be investigated using meta-regression (Berkey et al. 1995). The `metareg` command (Sharp 1998) remains one of the few implementations of meta-regression and has been updated to take account of improvements in Stata estimation facilities and recent methodological developments (Harbord and Higgins 2008).

Enthusiasm for meta-analysis has been tempered by a realization that flaws in the conduct of studies (Schulz et al. 1995), and the tendency for the publication process to favor studies with statistically significant results (Begg and Berlin 1988; Dickersin, Min, and Meinert 1992), can lead to the results of meta-analyses mirroring overoptimistic results from the original studies (Egger et al. 1997). A set of Stata commands— `metafunnel`, `confunnel`, `metabias`, and `metatrim`—address these issues both graphically (via routines to draw standard funnel plots and "contour-enhanced" funnel plots) and statistically, by providing tests for funnel plot asymmetry, which can be used to diagnose publication bias and other small-study effects (Sterne, Gavaghan, and Egger 2000; Sterne, Egger, and Moher 2008).

This collection also contains advanced routines that exploit Stata's range of estimation procedures. Meta-analysis of studies that estimate the accuracy of diagnostic tests, implemented in the `metandi` command, is inherently bivariate, because of the trade-off between sensitivity and specificity (Rutter and Gatsonis 2001; Reitsma et al. 2005). Meta-analyses of observational studies will often need to combine dose–response relationships, but reports of such studies often report comparisons between three or more categories. The method of Greenland and Longnecker (1992), implemented in the `glst` command, converts categorical to dose–response comparisons and can thus be used to derive the data needed for dose–response meta-analyses. White and colleagues (White and Higgins 2009; White 2009) have recently provided general routines to deal with missing data in meta-analysis, and for multivariate random-effects meta-analysis.

Finally, the appendix lists user-written meta-analysis commands that have not, so far, been accepted for publication in the *Stata Journal*. For the most up-to-date information on meta-analysis commands in Stata, readers are encouraged to check the Stata frequently asked question on meta-analysis:

http://www.stata.com/support/faqs/stat/meta.html

Those involved in developing Stata meta-analysis commands have been delighted by their widespread worldwide use. However, a by-product of the large number of commands and updates to these commands now available has been that users find it increasingly difficult to identify the most recent version of commands, the commands most relevant to a particular purpose, and the related documentation. This collection aims to provide a comprehensive description of the facilities for meta-analysis now available in Stata and has also stimulated the production and documentation of a number of updates to existing commands, some of which were long overdue. I hope that this collection will be useful to the large number of Stata users already conducting meta-analyses, as well as facilitate interest in and use of the commands by new users.

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1   References

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1. The original command to perform meta-analysis was `meta`, documented in the sbe16 articles; `meta` is now `metan`. `metan` is described in an updated article, sbe24, on pages 3–28 of this collection.—Ed.