Preface to the fourth edition

Maximum Likelihood Estimation with Stata, Fourth Edition is written for researchers in all disciplines who need to compute maximum likelihood estimators that are not available as prepackaged routines. To get the most from this book, you should be familiar with Stata, but you will not need any special programming skills, except in chapters 13 and 14, which detail how to take an estimation technique you have written and add it as a new *command* to Stata. No special theoretical knowledge is needed either, other than an understanding of the likelihood function that will be maximized.

Stata's `ml` command was greatly enhanced in Stata 11, prescribing the need for a new edition of this book. The optimization engine underlying `ml` was reimplemented in Mata, Stata's matrix programming language. That allowed us to provide a suite of commands (not discussed in this book) that Mata programmers can use to implement maximum likelihood estimators in a matrix programming language environment; see [M-5] **moptimize()**. More important to users of `ml`, the transition to Mata provided us the opportunity to simplify and refine the syntax of various `ml` commands and likelihood evaluators; and it allowed us to provide a framework whereby users could write their likelihood-evaluator functions using Mata while still capitalizing on the features of `ml`.

Previous versions of `ml` had just two types of likelihood evaluators. Method-`lf` evaluators were used for simple models that satisfied the linear-form restrictions and for which you did not want to supply analytic derivatives. `d`-family evaluators were for everything else. Now `ml` has more evaluator types with both long and short names:

Short name	Long name
`lf`	`linearform`
`lf0`	`linearform0`
`lf1`	`linearform1`
`lf1debug`	`linearform1debug`
`lf2`	`linearform2`
`lf2debug`	`linearform2debug`
`d0`	`derivative0`
`d1`	`derivative1`
`d1debug`	`derivative1debug`
`d2`	`derivative2`
`d2debug`	`derivative2debug`
`gf0`	`generalform0`

You can specify either name when setting up your model using `ml model`; however, out of habit, we use the short name in this book and in our own software development work. Method `lf`, as in previous versions, does not require derivatives and is particularly easier to use.

Chapter 1 provides a general overview of maximum likelihood estimation theory and numerical optimization methods, with an emphasis on the practical implications of each for applied work. Chapter 2 provides an introduction to getting Stata to fit your model by maximum likelihood. Chapter 3 is an overview of the `ml` command and the notation used throughout the rest of the book. Chapters 4–10 detail, step by step, how to use Stata to maximize user-written likelihood functions. Chapter 11 shows how to write your likelihood evaluators in Mata. Chapter 12 describes how to package all the user-written code in a do-file so that it can be conveniently reapplied to different datasets and model specifications. Chapter 13 details how to structure the code in an ado-file to create a new Stata estimation command. Chapter 14 shows how to add survey estimation features to existing `ml`-based estimation commands.

Chapter 15, the final chapter, provides examples. For a set of estimation problems, we derive the log-likelihood function, show the derivatives that make up the gradient and Hessian, write one or more likelihood-evaluation programs, and so provide a fully functional estimation command. We use the estimation command to fit the model to a dataset. An estimation command is developed for each of the following:

- Logit and probit models
- Linear regression
- Weibull regression
- Cox proportional hazards model
- Random-effects linear regression for panel data
- Seemingly unrelated regression

Appendices contain full syntax diagrams for all the `ml` subroutines, useful checklists for implementing each maximization method, and program listings of each estimation command covered in chapter 15.

We acknowledge William Sribney as one of the original developers of `ml` and the principal author of the first edition of this book.

College Station, TX
September 2010

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