# Contents

Preface
List of illustrations
Notation

1 The technology of estimation
   1.1 Least squares
   1.2 Modern computing
   1.3 An example: money demand
   1.4 Maximum Likelihood methodology
   1.5 Computing and clerical errors

2 Likelihood
   2.1 Simple linear regression
   2.2 Generalities
   2.3 Regularity
   2.4 Score vector and information matrix
       Questions and exercises
   2.5 The inequality of Cramér–Rao
   2.6 Maximum Likelihood estimation
   2.7 Independent observations
   2.8 Consistency of the MLE
   2.9 Asymptotic distribution of the MLE
   2.10 Estimation of the covariance matrix
       Questions and exercises

3 Tests of simplifying assumptions
   3.1 Invariance of MLE and transformation of parameters
       Questions and exercises
   3.2 Nested hypotheses
   3.3 Constrained estimation
       Questions and exercises
   3.4 Likelihood Ratio test
   3.5 Wald’s test
   3.6 Lagrange multiplier test
Contents

3.7 Discussion
Questions and exercises 43

4 The use of likelihood in econometrics 45
4.1 A Bayesian interpretation 46
4.2 Asymptotic behavior 47
4.3 Statistical models 49
4.4 Economic aggregates 50
4.5 Genuine samples 53

5 Techniques of maximization 56
5.1 Stepwise maximization 57
5.2 Concentrating the likelihood function 59
Questions and exercises 62
5.3 Grid search: optimization in one dimension 63
5.4 Directions in \( \hat{\Theta} \) 65
5.5 Choice of a direction 66
5.6 Quadratic approximation 69
Questions and exercises 70
5.7 Two-stage estimation procedures 71
5.8 Starting values and convergence criteria 72
5.9 Choice of a method 73
5.10 Local and global maxima 75
5.11 Some common failures 76

6 Generalized classical regression 79
6.1 Generalized classical regression 80
6.2 Score vector and information matrix 84
6.3 Concentrating the likelihood function 86
Questions and exercises 89
6.4 Estimation 90
6.5 Scalar nonlinear regression: choice of a function 92
6.6 Scalar nonlinear regression: estimation 94
Questions and exercises 96

7 Systems of linear regression equations 100
7.1 Seemingly unrelated regression equations and the single regression equation 102
7.2 The Generalized Least Squares model 104
Questions and exercises 108
7.3 Sum-constrained dependent variables 108
7.4 Restrictions on the linear coefficients 112
Questions and exercises 118
7.5 Simultaneous linear equations 119