Contents

Acknowledgements xv

1 Introduction and Overview 1
1.1 What is Experimetrics? 1
1.2 Experimental Design 2
1.3 The Experimetrics of Theory Testing 3
1.4 Dependence in Experimental Data 5
1.5 Parametric versus Non-parametric Approaches 6
1.6 Structural Experimetrics 7
1.7 Modelling Subject Heterogeneity 9
1.8 Experimetrics of Other-regarding Preferences 10
1.9 Experimetrics of Bounded Rationality 11
1.10 Experimetrics of Learning 12
1.11 What is in this Book? 13

2 Statistical Aspects of Experimental Design in Experimental Economics 17
2.1 Introduction 17
2.2 The Average Treatment Effect 17
2.3 Randomisation Techniques 18
2.3.1 Completely randomised designs 19
2.3.2 Factorial designs 19
2.3.3 Block designs 20
2.3.4 Within-subject designs 20
2.3.5 Crossover designs 21
2.3.6 ABA designs 21
2.4 How Many Subjects? A Primer in Power Analysis 21
2.4.1 The case of one sample 21
2.4.2 Choosing the sample size in a treatment test 24
2.4.3 Treatments with unequal costs 26
2.4.4 Sample size in cluster designs 27
2.5 Four Very Popular Experiments 28

2.5.1 The ultimatum game 28
2.5.2 The dictator game 29
2.5.3 The trust game 29
2.5.4 The public goods game 29
2.6 Other Aspects of Design 30
2.6.1 The random lottery incentive (RLI) mechanism 30
2.6.2 The strategy method 31
2.6.3 "One-shot", "partners", and "strangers" designs 31
2.7 Summary and Further Reading 32

3 Treatment Testing 35
3.1 Introduction 35
3.2 The Mechanics of Treatment Testing 36
3.3 Testing with Discrete Outcomes 37
3.3.1 The binomial test 37
3.3.2 Fisher's exact test 38
3.3.3 The chi-squared test 41
3.3.4 The chi-squared test on a real data set 43
3.4 Testing for Normality 46
3.5 Treatment Testing 48
3.5.1 Parametric tests of treatment effects 48
3.5.2 Non-parametric tests of treatment effects: the Mann-Whitney test 51
3.5.3 The bootstrap 52
3.5.4 Tests comparing entire distributions 55
3.6 Testing for Gender Effects 57
3.7 Within-subject Tests 60
3.7.1 The Allais paradox 61
3.7.2 Preference reversals 64
3.7.3 Continuous outcome 65
3.8 Summary and Further Reading 68

4 Theory Testing, Regression, and Dependence 71
4.1 Introduction 71
4.2 Experimental Auctions 73
4.2.1 Overview of auction theory 73
4.2.2 Carrying out an experimental auction 75
4.2.3 The simulated auction data 75
4.3 Tests of Auction Theory 78
4.3.1 A test of RNNE in a second-price common value auction 78
4.4 Tests of Comparative Static Predictions 80
4.4.1 Standard treatment tests 80
4.4.2 Treatment testing using a regression 82
4.4.3 Accounting for dependence: the ultra-conservative test 82
4.4.4 Accounting for dependence in a regression 84
4.4.5 Accounting for dependence: the block bootstrap 85

4.5 Multiple Regression with Auction Data 86
4.5.1 Introducing the effect of uncertainty 86
4.5.2 Introducing the effect of experience 88
4.5.3 Introducing the effect of cash balance 89
4.6 Panel Data Estimators 90
4.7 Multi-level Modelling 92
4.8 Modelling Data from Contest Experiments 97
4.8.1 The Tullock contest 97
4.8.2 A contest experiment 98
4.8.3 Analysis of data from contest experiment 99
4.9 Meta-analysis 102
4.10 Summary and Further Reading 105

5 Modelling of Decision Times Using Regression Analysis 107
5.1 Introduction 107
5.2 The Decision-time Data 108
5.3 A Theoretical Model of Effort Allocation 109
5.4 An Econometric Model of Effort Allocation 111
5.5 Panel Data Models of Effort Allocation 116
5.6 Discussion of Results 120
5.7 Post-estimation 121
5.8 Summary and Further Reading 123

6 Dealing with Discreteness in Experimental Data 125
6.1 Introduction 125
6.2 Binary Data 126
6.2.1 Likelihood and log-likelihood explained 126
6.2.2 Modelling choices between lotteries (the "house money effect") 129
6.2.3 Marginal effects 133
6.2.4 Wald tests and LR tests 134
6.2.5 Analysis of ultimatum game data 135
6.2.6 The strategy method 138
6.3 The `ml` Routine in STATA 140
6.4 Structural Modelling 141
6.5 Further Structural Modelling 144
6.5.1 The heterogeneous agent model 144
6.5.2 The delta method 147
6.5.3 Another example using the delta method 148
6.6 Other Data Types 149
6.6.1 Interval data: the interval regression model 149
6.6.2 Continuous (exact) data 152
6.6.3 Censored data: the Tobit model 155
6.7 The Ultimatum Game: Further Analysis 160
6.7.1 Further tests of gender effects 160

6.7.2 The proposer's decision as a risky choice problem 161
6.8 Summary and Further Reading 164

7 Ordinal Data in Experimetrics 167
7.1 Introduction 167
7.2 Ordered Outcomes: The Case for Special Treatment 168
7.3 The Ordered Probit Model: Theory 169
7.4 Interpreting the Cut-point Parameters 171
7.5 Application to Data on Emotions 172
7.6 Application to Data on Strength of Preference 177
7.7 Summary and Further Reading 181

8 Dealing with Heterogeneity: Finite Mixture Models 183
8.1 Introduction 183
8.2 Mixture of Two Normal Distributions 184
8.2.1 Data and model 184
8.2.2 Posterior type probabilities 186
8.2.3 The estimation program 186
8.2.4 Results 187
8.3 The `fmm` Command in STATA 188
8.4 A Mixture Model for the "Acquiring a Company" Task 190
8.5 A Mixture Model for Giving in a Public Goods Experiment 193
8.5.1 Background 193
8.5.2 Experiment 194
8.5.3 The data 195
8.5.4 The finite mixture two-limit Tobit model with tremble 197
8.5.5 Program 201
8.5.6 Results 206
8.5.7 Posterior type probabilities 208
8.6 Summary and Further Reading 210

9 Simulating Experimental Data, and the Monte Carlo Method 211
9.1 Introduction 211
9.2 Random Number Generation in STATA 212
9.3 Simulating Data Sets 214
9.3.1 Simulating data from a linear model 214
9.3.2 Simulating panel data 216
9.3.3 Simulating dynamic panel data 217
9.3.4 Simulating binary panel data 219
9.4 Monte Carlo Investigation of the Hausman Test 220
9.5 Summary and Further Reading 224

10 Introduction to the Method of Maximum Simulated Likelihood (MSL) 227
10.1 Introduction 227
10.2 The Principle of Maximum Simulated Likelihood (MSL) 228
10.3 Halton Draws 229
10.3.1 The case for using Halton draws 229
10.3.2 Generating Halton draws in STATA 230
10.3.3 Halton draws for panel data estimation 233
10.4 The Random Effects Probit Model 234
10.4.1 Model 234
10.4.2 Simulation 236
10.4.3 Estimation by MSL 238
10.4.4 Preparation of data for estimation 239
10.4.5 The likelihood evaluator 240
10.4.6 Complete annotated code 244
10.4.7 Results 246
10.5 The Random Effects Two-limit Tobit Model 248
10.5.1 Construction of log-likelihood function 249
10.5.2 Estimation by MSL 250
10.5.3 STATA code 251
10.5.4 Results from random effects two-limit Tobit model 253
10.6 Summary and Further Reading 255

11 Dealing with Zeros: Hurdle Models 257
11.1 Introduction 257
11.2 Review of Tobit and Random Effects Tobit 258
11.3 The Need for Hurdle Models 260
11.4 The Double Hurdle Model and Variants 261
11.4.1 p-Tobit 261
11.4.2 Double hurdle 261
11.4.3 The single hurdle model 263
11.5 The Panel Hurdle Model 264
11.5.1 The basic model 264
11.5.2 The panel single hurdle model 265
11.5.3 Construction of likelihood function 265
11.5.4 Panel hurdle with upper censoring 266
11.5.5 Panel hurdle model with tremble 266
11.5.6 Panel hurdle model with dependence 267
11.5.7 Obtaining posterior probabilities 268
11.5.8 Estimation 269
11.5.9 STATA code and simulation 269
11.6 A Panel Hurdle Model of Dictator Game Giving 275
11.6.1 The experiment 275
11.6.2 Estimation 278
11.6.3 Results 279

11.7 A Panel Hurdle Model of Contribution in a Public Goods Game 282
11.8 Summary and Further Reading 288

12 Choice under Risk: Theoretical Issues 291
12.1 Introduction 291
12.2 Utility Functions and Risk Aversion 291
12.3 Lottery Choice 295
12.4 Stochastic Dominance 298
12.5 Non-expected Utility Models 299
12.5.1 Weighting functions 299
12.6 Stochastic Models of Choice under Risk 302
12.7 Summary and Further Reading 304

13 Choice under Risk: Econometric Modelling 307
13.1 Introduction 307
13.2 The Choice Models 310
13.2.1 The framework 310
13.2.2 Incorporating violations of EU 311
13.2.3 The Fechner model 312
13.2.4 The Random Preference (RP) model 312
13.2.5 Dominance problems in the RP model 313
13.2.6 The tremble parameter 313
13.2.7 The role of experience 314
13.2.8 Between-subject variation and the sample log-likelihood 315
13.2.9 Posterior estimation of risk attitude 316
13.3 Simulation and Estimation 316
13.3.1 Data generating process 316
13.3.2 The STATA code 317
13.3.3 The simulated data 325
13.3.4 Output from estimation routines 326
13.4 Results and Post-estimation 327
13.4.1 The model estimates 327
13.4.2 Vuong's non-nested likelihood ratio test 328
13.4.3 Clarke's non-parametric non-nested test 329
13.4.4 Obtaining individual risk attitudes 331
13.4.5 Obtaining closeness to indifference 331
13.4.6 Simulation of decision times 332
13.5 Summary and Further Reading 333

14 Optimal Design in Binary Choice Experiments 335
14.1 Introduction 335
14.2 Rudiments of Experimental Design Theory 337
14.2.1 The principle of D-optimal design 337
14.2.2 Simple linear regression 338
14.2.3 Simple probit and simple logit 339

14.3 The Random Preference (RP) Model Revisited 341
14.4 Application of D-optimal Design Theory to a Risky Choice Experiment 344
14.5 Optimal Design in the Presence of a Tremble Parameter 345
14.6 Optimal Design for a Sample of Subjects 347
14.6.1 Choice of design used in Chapter 13 348
14.7 Summary and Further Reading 349

15 Social Preference Models 351
15.1 Introduction 351
15.2 Estimation of Preference Parameters from Dictator Game Data 352
15.2.1 The framework 352
15.2.2 The Andreoni-Miller data 352
15.2.3 Estimating the parameters of a CES utility function 357
15.3 A Model of Altruism with Binding Non-negativity Constraints 360
15.3.1 Background 360
15.3.2 The model 360
15.3.3 Estimation 363
15.3.4 Results 366
15.4 Finite Mixture Models of Altruism 367
15.4.1 The experiment 368
15.4.2 The data 368
15.4.3 A mixture model of fairness 368
15.4.4 The "fairness ideals" 370
15.4.5 The econometric model 370
15.4.6 The program and results 371
15.5 Estimation of Social Preference Parameters Using Discrete Choice Models 374
15.5.1 The setting 374
15.5.2 Formalising the criteria for choosing between allocations 375
15.5.3 Data 376
15.5.4 The conditional logit model (CLM) 376
15.5.5 Results 378
15.5.6 The effect of subject characteristics 378
15.6 Summary and Further Reading 379

16 Repeated Games and Quantal Response Models 383
16.1 Introduction 383
16.2 Analysis of Repeated Game Data 384
16.2.1 Computing a mixed strategy Nash equilibrium 384
16.2.2 Non-parametric tests on repeated game data 385
16.3 Quantal Response Equilibrium (QRE) 389
16.3.1 Theory of QRE 389
16.3.2 Computing the probabilities in the QRE model 391
16.4 Estimation of the QRE Model 392
16.5 The Risk-averse QRE Model 397

16.6 QRE Applied to Contest Data 400
16.7 Summary and Further Reading 406

17 Depth of Reasoning Models 407
17.1 Introduction 407
17.2 A Level-k Model for the Beauty Contest Game 408
17.3 The Cognitive Hierarchy Model 413
17.4 Summary and Further Reading 418

18 Learning Models 419
18.1 Introduction 419
18.2 Directional Learning (DL) 420
18.3 Data Used for Estimation of RL, BL and EWA 423
18.4 Notation Used in RL, BL and EWA 423
18.5 Reinforcement Learning (RL) 424
18.5.1 Program and results for RL 425
18.6 Belief learning (BL) 427
18.6.1 Program and results for BL 429
18.7 The Experience Weighted Attraction (EWA) Model 431
18.7.1 Introduction to EWA 431
18.7.2 Simulation of data set using EWA 432
18.7.3 Estimation of EWA Model 434
18.7.4 Results from EWA Model 436
18.8 Summary and Further Reading 439

19 Summary and Conclusion 441
19.1 Experimental Design Issues 441
19.2 Experimetrics and Theory Testing 443
19.3 Data Features 443
19.4 Experimetrics of Social Preferences 444
19.5 Risk Experimetrics 445
19.6 The Experimetrics of Games 447
19.7 Heterogeneity 448

A List of Data Files and Other Files 451

B List of STATA Commands 453

C Choice Problems Used in Chapters 5 and 13 461

References 463

Index 473