

Contents

1	Introduction	<i>page</i> 1
1.1	Motivation	1
1.2	Choice Probabilities and Integration	3
1.3	Outline of Book	7
1.4	A Couple of Notes	8
Part I Behavioral Models		
2	Properties of Discrete Choice Models	11
2.1	Overview	11
2.2	The Choice Set	11
2.3	Derivation of Choice Probabilities	14
2.4	Specific Models	17
2.5	Identification of Choice Models	19
2.6	Aggregation	29
2.7	Forecasting	32
2.8	Recalibration of Constants	33
3	Logit	34
3.1	Choice Probabilities	34
3.2	The Scale Parameter	40
3.3	Power and Limitations of Logit	42
3.4	Nonlinear Representative Utility	52
3.5	Consumer Surplus	55
3.6	Derivatives and Elasticities	57
3.7	Estimation	60
3.8	Goodness of Fit and Hypothesis Testing	67
3.9	Case Study: Forecasting for a New Transit System	71
3.10	Derivation of Logit Probabilities	74
4	GEV	76
4.1	Introduction	76
4.2	Nested Logit	77
		vii

Cambridge University Press

978-0-521-74738-7 - Discrete Choice Methods with Simulation, Second Edition

Kenneth E. Train

Table of Contents

[More information](#)

viii	Contents	
	4.3	Three-Level Nested Logit 86
	4.4	Overlapping Nests 89
	4.5	Heteroskedastic Logit 92
	4.6	The GEV Family 93
5	Probit	97
	5.1	Choice Probabilities 97
	5.2	Identification 100
	5.3	Taste Variation 106
	5.4	Substitution Patterns and Failure of IIA 108
	5.5	Panel Data 110
	5.6	Simulation of the Choice Probabilities 114
6	Mixed Logit	134
	6.1	Choice Probabilities 134
	6.2	Random Coefficients 137
	6.3	Error Components 139
	6.4	Substitution Patterns 141
	6.5	Approximation to Any Random Utility Model 141
	6.6	Simulation 144
	6.7	Panel Data 145
	6.8	Case Study 147
7	Variations on a Theme	151
	7.1	Introduction 151
	7.2	Stated-Preference and Revealed-Preference Data 152
	7.3	Ranked Data 156
	7.4	Ordered Responses 159
	7.5	Contingent Valuation 164
	7.6	Mixed Models 166
	7.7	Dynamic Optimization 169
Part II Estimation		
8	Numerical Maximization	185
	8.1	Motivation 185
	8.2	Notation 185
	8.3	Algorithms 187
	8.4	Convergence Criterion 198
	8.5	Local versus Global Maximum 199
	8.6	Variance of the Estimates 200
	8.7	Information Identity 202

Contents	ix
9 Drawing from Densities	205
9.1 Introduction	205
9.2 Random Draws	205
9.3 Variance Reduction	214
10 Simulation-Assisted Estimation	237
10.1 Motivation	237
10.2 Definition of Estimators	238
10.3 The Central Limit Theorem	245
10.4 Properties of Traditional Estimators	247
10.5 Properties of Simulation-Based Estimators	250
10.6 Numerical Solution	257
11 Individual-Level Parameters	259
11.1 Introduction	259
11.2 Derivation of Conditional Distribution	262
11.3 Implications of Estimation of θ	264
11.4 Monte Carlo Illustration	267
11.5 Average Conditional Distribution	269
11.6 Case Study: Choice of Energy Supplier	270
11.7 Discussion	280
12 Bayesian Procedures	282
12.1 Introduction	282
12.2 Overview of Bayesian Concepts	284
12.3 Simulation of the Posterior Mean	291
12.4 Drawing from the Posterior	293
12.5 Posteriors for the Mean and Variance of a Normal Distribution	294
12.6 Hierarchical Bayes for Mixed Logit	299
12.7 Case Study: Choice of Energy Supplier	305
12.8 Bayesian Procedures for Probit Models	313
13 Endogeneity	315
13.1 Overview	315
13.2 The BLP Approach	318
13.3 Supply Side	328
13.4 Control Functions	334
13.5 Maximum Likelihood Approach	340
13.6 Case Study: Consumers' Choice among New Vehicles	342

Cambridge University Press

978-0-521-74738-7 - Discrete Choice Methods with Simulation, Second Edition

Kenneth E. Train

Table of Contents

[More information](#)

x	Contents	
14	EM Algorithms	347
14.1	Introduction	347
14.2	General Procedure	348
14.3	Examples of EM Algorithms	355
14.4	Case Study: Demand for Hydrogen Cars	365
	<i>Bibliography</i>	371
	<i>Index</i>	385