

Table of Contents

Preface	xv
1 Focus of the Book	xvi
2 Who Should Read This Book?	xvii
3 Material We Intend to Presume	xviii
4 What a Learner Will Know	xix
5 Notation	xix
6 Comments and Suggestions	xxii
7 Acknowledgments	xxiii
1 Introduction	1
1.1 An Example	2
1.2 Some Intriguing Problems	6
1.3 Plan of Book	10
1.4 Practice Problems	14
2 Overview of Auction Theory	21
2.1 Auction Formats and Rules	22
2.1.1 Oral, Ascending-Price (English) Format	22
2.1.2 First-Price, Sealed-Bid Format	22
2.1.3 Oral, Descending-Price (Dutch) Format	22
2.1.4 Second-Price, Sealed-Bid (Vickrey) Format	23
2.1.5 Additional Rules	24
2.2 Information Structure	25
2.2.1 Independent Private-Values Paradigm	25
2.2.2 Common-Value Paradigm	26
2.2.3 Affiliated-Values Paradigm	27
2.2.4 Asymmetries	27
2.3 Bidder Preferences	29
2.4 Purposeful Bidding and Game Equilibrium	30
2.4.1 Vickrey Auctions	30
2.4.2 English Auctions	31
2.4.3 Dutch and First-Price, Sealed-Bid Auctions	32
2.5 A Binding Reserve Price	35

2.6	Expected Revenues and Optimal Auctions	37
2.6.1	Revenue Equivalence Proposition	37
2.6.2	Optimal Reserve Price	41
2.6.3	Expected Revenues under Risk Aversion	42
2.6.4	Optimal Auctions	43
2.7	Winner's Curse	47
2.8	Practice Problems	48
3	Vickrey and English Auctions	53
3.1	Nonparametric Identification and Estimation	54
3.2	Covariates	55
3.3	Single-Index Models: Semiparametric Estimation	56
3.3.1	Density-Weighted Derivative Estimator	57
3.3.2	Maximum Rank-Correlation Estimator	59
3.4	Reserve Prices and Parametric Estimation	61
3.5	Policy Application	65
3.5.1	Some Institutional Background	67
3.5.2	Bidding of Timber in British Columbia	68
3.5.3	Defense of IPVP Assumption	69
3.5.4	Mapping Observables into Bids	70
3.5.5	Deriving the Empirical Specification	72
3.5.6	Implementing the Empirical Specification	75
3.5.7	Estimates of the Optimal Reserve Price	76
3.6	Incomplete Data	77
3.7	Incomplete Inference	81
3.8	Asymmetric Bidders	84
3.8.1	Nonparametric Identification	85
3.8.2	Semi-Nonparametric Estimation	88
3.9	Practice Problems	91
4	First-Price, Sealed-Bid and Dutch Auctions	97
4.1	Deriving the Data-Generating Process	98
4.2	Identification and Estimation: Simplest Case	99
4.2.1	Nonparametric Identification	100
4.2.2	Nonparametric Estimation	101
4.2.3	Maximum Likelihood Estimation	105
4.2.4	Simulated Nonlinear Least-Squares	116
4.2.5	Extreme-Order, Generalized Method-of-Moments	120
4.3	Binding Reserve Price	130
4.4	Risk-Averse Bidders	133
4.4.1	Parametric Identification and Estimation	134
4.4.2	Semiparametric Identification and Estimation	137

4.5	Stochastic Private Values	143
4.6	Asymmetric Bidders	148
4.6.1	First-Price, Sealed-Bid Auctions	150
4.6.2	Dutch Auctions	153
4.6.3	Unobserved Heterogeneity	156
4.7	Policy Experiment	163
4.7.1	Some Institutional Background	163
4.7.2	Empirical Results	165
4.7.3	Comparing Institutions	166
4.7.4	Another Way to Solve Asymmetric Auctions	169
4.8	Endogenous Bidding Participation	171
4.9	Practice Problems	176
5	Multi-Unit Auctions	183
5.1	Weber's Classification System	184
5.1.1	Simultaneous-Dependent Auctions	184
5.1.2	Simultaneous-Independent Auctions	185
5.1.3	Sequential Auctions	185
5.2	Pricing Rules	185
5.2.1	Shading and Demand Reduction	187
5.2.2	Generalized Vickrey Auction	198
5.2.3	Ausubel Auction	199
5.3	Singleton Demand	201
5.4	Multi-Unit Demand	201
5.4.1	Nonrandom Demand	202
5.4.2	Random Demand	202
5.5	Sequential, Clock Auctions: Random Demand	203
5.5.1	Two-Bidder, Two-Unit Example	205
5.5.2	Two-Bidder, Three-Unit Example	207
5.5.3	Demand-Generation Scheme	207
5.5.4	Solving the Auction Game	209
5.5.5	Properties of the Equilibrium	211
5.5.6	Estimating the Model	213
5.6	Sequential, Clock Auctions: Nonrandom Demand	217
5.6.1	Nonparametric Identification	220
5.6.2	Semi-Nonparametric Estimator	222
5.7	Practice Problems	222
6	Directions for Further Research	225
6.1	Simultaneous, Dependent, Sealed-Bid Auctions	225
6.2	Infinitely Lived Auction Games	226
6.3	Multi-Object Auctions	227
6.4	Summary	228

Appendixes	229
A.1 Transformations of Random Variables	229
A.1.1 Linear Transformations	229
A.1.2 Monotonic Nonlinear Transformations	231
A.2 Order Statistics	234
A.2.1 Independent and Identically Distributed Case	234
A.2.2 General Independent Case	237
A.3 Simulation	239
A.3.1 Distribution of Cumulative Distribution Functions	239
A.3.2 Generating Random Numbers	240
A.3.3 Pseudo-Random Numbers	241
A.4 Asymptotic Methods: Some Elementary Tools	244
A.4.1 Parameter Consistency: Laws of Large Numbers	244
A.4.2 Asymptotic Normality: Central Limit Theorems	246
A.4.3 Continuous Mapping Theorem	248
A.4.4 Delta Method	249
A.4.5 Extreme Value Theorems	250
A.5 Evaluating Estimators	259
A.5.1 Finite-Sample Properties	260
A.5.1.1 Unbiasedness	260
A.5.1.2 Variance	262
A.5.1.3 Mean Squared-Error	263
A.5.2 Large-Sample Properties	264
A.5.2.1 Parameter Consistency	264
A.5.2.2 Asymptotic Distribution	265
A.5.3 The Bootstrap	266
A.6 Estimation Strategies	271
A.6.1 Generalized Method of Moments	271
A.6.1.1 Definition	272
A.6.1.2 Parameter Consistency/Asymptotic Normality	273
A.6.1.3 Testing Over-Identifying Restrictions	275
A.6.2 Method of Maximum Likelihood	277
A.6.2.1 Definition	277
A.6.2.2 Parameter Consistency/Asymptotic Normality	278
A.6.3 Nonparametric Estimation	280
A.6.3.1 Histogram	281
A.6.3.2 Kernel-Smoothed Density Functions	282
A.6.3.3 Empirical Distribution Function	284
A.6.4 Bandwidth Choice	285
A.6.5 Asymptotic Distribution of Order Statistics	286
A.6.6 Characteristic Functions: Deconvolution Methods	288

A.7 Numerical Methods	290
A.7.1 Finding the Zero of a Function	291
A.7.1.1 Bisection Method	291
A.7.1.2 Newton's Method	291
A.7.2 Unconstrained Optimization	293
A.7.3 Constrained Optimization	294
A.7.4 Numerical Integration	295
A.7.4.1 Newton-Cotes Formulae	295
A.7.5 Approximation Methods	297
A.8 A High-Level Programming Environment	301
A.8.1 Getting Started	301
A.8.1.1 The Interface	302
A.8.1.2 Loading and Cataloging Data	302
A.8.1.3 Manipulating Data	303
A.8.1.4 Basic Matrix Functions	306
A.8.1.5 Linear Systems	307
A.8.1.6 Two-Dimensional Plotting	309
A.8.1.7 Three-Dimensional Plotting	310
A.8.2 Statistics Toolbox	311
A.8.2.1 Descriptive Statistics	311
A.8.2.2 Pseudo-Random Number Generators	313
A.8.2.3 Probability Density Functions	313
A.8.2.4 Cumulative Distribution Functions	314
A.8.2.5 Bootstrapping	315
A.8.3 User-Defined Functions	315
A.8.3.1 A Generic Function	316
A.8.3.2 Writing a User-Defined Function	316
A.8.3.3 Another User-Defined Function	317
A.8.4 Optimization Toolbox	320
A.8.4.1 Driver Files and Objective Functions	320
A.8.4.2 Gradient Vectors and Hessian Matrices	321
A.8.4.3 Unconstrained Optimization	321
A.8.4.4 Constrained Optimization	323
A.8.4.5 Algorithm Options: <code>optimset</code>	324
References	327
Solutions	337
1.1 Logarithmic Series	337
1.2 Log-Normal Estimation	344
1.3 Logarithmic Series with Covariates	347
1.4 Practice with the Bootstrap	349
1.5 Approximating Functions	350

1.6	Approximating Integrals	350
2.1	Uniform Case: Risk Neutrality, No Reserve	354
2.2	Uniform Case: Risk Neutrality, Positive Reserve	358
2.3	Uniform Case: Risk Aversion, No Reserve	359
2.4	Procurement with Independent, Private Costs	362
2.5	All-Pay Auction	371
3.1	Test Scores within the Location-Scale Family	373
3.2	Vickrey Auctions and the Location-Scale Family	375
3.3	ML Estimation of Vickrey Auctions	377
3.4	Nonparametric Estimation of English Auctions	381
3.5	English Auctions: Incomplete Data and Inference	383
4.1	Uniform Case: First-Price, Sealed-Bid Auctions	384
4.2	Pareto Case: Low-Price, Sealed-Bid Auctions	389
4.3	Government Procurement	394
4.4	Solving Asymmetric Auctions	399
5.1	Generalized Vickrey Auctions	402
5.2	Multi-Unit, Sequential, Clock Auctions	403
	Name Index	407
	Subject Index	411