Contents

Preface xiii

PART I Rational Decision Making

Chapter 1 The Single-Person Decision Problem 3
1.1 Actions, Outcomes, and Preferences 4
1.1.1 Preference Relations 5
1.1.2 Payoff Functions 7
1.2 The Rational Choice Paradigm 9
1.3 Summary 11
1.4 Exercises 11

Chapter 2 Introducing Uncertainty and Time 14
2.1 Risk, Nature, and Random Outcomes 14
2.1.1 Finite Outcomes and Simple Lotteries 15
2.1.2 Simple versus Compound Lotteries 16
2.1.3 Lotteries over Continuous Outcomes 17
2.2 Evaluating Random Outcomes 18
2.2.1 Expected Payoff: The Finite Case 19
2.2.2 Expected Payoff: The Continuous Case 20
2.2.3 Caveat: It's Not Just the Order Anymore 21
2.2.4 Risk Attitudes 22
2.2.5 The St. Petersburg Paradox 23
2.3 Rational Decision Making with Uncertainty 24
2.3.1 Rationality Revisited 24
2.3.2 Maximizing Expected Payoffs 24
2.4 Decisions over Time 26
2.4.1 Backward Induction 26
2.4.2 Discounting Future Payoffs 28
2.5 Applications 29
2.5.1 The Value of Information 29
2.5.2 Discounted Future Consumption 31
2.6 Theory versus Practice 32
2.7 Summary 33
2.8 Exercises 33

PART II Static Games of Complete Information

Chapter 3 Preliminaries 43
3.1 Normal-Form Games with Pure Strategies 46
3.1.1 Example: The Prisoner's Dilemma 48
3.1.2 Example: Cournot Duopoly 49
3.1.3 Example: Voting on a New Agenda 49
3.2 Matrix Representation: Two-Player Finite Game 50
3.2.1 Example: The Prisoner's Dilemma 51
3.2.2 Example: Rock-Paper-Scissors 52
3.3 Solution Concepts 52
3.3.1 Assumptions and Setup 54
3.3.2 Evaluating Solution Concepts 55
3.3.3 Evaluating Outcomes 56
3.4 Summary 57
3.5 Exercises 58

Chapter 4 Rationality and Common Knowledge 59
4.1 Dominance in Pure Strategies 59
4.1.1 Dominated Strategies 59
4.1.2 Dominant Strategy Equilibrium 61
4.1.3 Evaluating Dominant Strategy Equilibrium 62
4.2 Iterated Elimination of Strictly Dominated Pure Strategies 63
4.2.1 Iterated Elimination and Common Knowledge of Rationality 63
4.2.2 Example: Cournot Duopoly 65
4.2.3 Evaluating IESDS 67
4.3 Beliefs, Best Response, and Rationalizability 69
4.3.1 The Best Response 69
4.3.2 Beliefs and Best-Response Correspondences 71
4.3.3 Rationalizability 73
4.3.4 The Cournot Duopoly Revisited 73
4.3.5 The "p-Beauty Contest" 74
4.3.6 Evaluating Rationalizability 76
4.4 Summary 76
4.5 Exercises 76

Chapter 5 Pinning Down Beliefs: Nash Equilibrium 79
5.1 Nash Equilibrium in Pure Strategies 80
5.1.1 Pure-Strategy Nash Equilibrium in a Matrix 81
5.1.2 Evaluating the Nash Equilibria Solution 83
5.2 Nash Equilibrium: Some Classic Applications 83
5.2.1 Two Kinds of Societies 83
5.2.2 The Tragedy of the Commons 84
5.2.3 Cournot Duopoly 87
5.2.4 Bertrand Duopoly 88
5.2.5 Political Ideology and Electoral Competition 93
5.3 Summary 95
5.4 Exercises 95

Chapter 6 Mixed Strategies 101
6.1 Strategies, Beliefs, and Expected Payoffs 102
6.1.1 Finite Strategy Sets 102
6.1.2 Continuous Strategy Sets 104
6.1.3 Beliefs and Mixed Strategies 105
6.1.4 Expected Payoffs 105
6.2 Mixed-Strategy Nash Equilibrium 107
6.2.1 Example: Matching Pennies 108
6.2.2 Example: Rock-Paper-Scissors 111
6.2.3 Multiple Equilibria: Pure and Mixed 113
6.3 IESDS and Rationalizability Revisited 114
6.4 Nash's Existence Theorem 117
6.5 Summary 123
6.6 Exercises 123

PART III Dynamic Games of Complete Information

Chapter 7 Preliminaries 129
7.1 The Extensive-Form Game 130
7.1.1 Game Trees 132
7.1.2 Imperfect versus Perfect Information 136
7.2 Strategies and Nash Equilibrium 137
7.2.1 Pure Strategies 137
7.2.2 Mixed versus Behavioral Strategies 139
7.2.3 Normal-Form Representation of Extensive-Form Games 143
7.3 Nash Equilibrium and Paths of Play 145
7.4 Summary 147
7.5 Exercises 147

Chapter 8 Credibility and Sequential Rationality 151
8.1 Sequential Rationality and Backward Induction 152
8.2 Subgame-Perfect Nash Equilibrium: Concept 153
8.3 Subgame-Perfect Nash Equilibrium: Examples 159
8.3.1 The Centipede Game 159
8.3.2 Stackelberg Competition 160
8.3.3 Mutually Assured Destruction 163
8.3.4 Time-Inconsistent Preferences 166
8.4 Summary 169
8.5 Exercises 170

Chapter 9 Multistage Games 175
9.1 Preliminaries 176
9.2 Payoffs 177
9.3 Strategies and Conditional Play 178
9.4 Subgame-Perfect Equilibria 180
9.5 The One-Stage Deviation Principle 184
9.6 Summary 186
9.7 Exercises 186

Chapter 10 Repeated Games 190
10.1 Finitely Repeated Games 190
10.2 Infinitely Repeated Games 192
10.2.1 Payoffs 193
10.2.2 Strategies 195
10.3 Subgame-Perfect Equilibria 196
10.4 Application: Tacit Collusion 201
10.5 Sequential Interaction and Reputation 204
10.5.1 Cooperation as Reputation 204
10.5.2 Third-Party Institutions as Reputation Mechanisms 205
10.5.3 Reputation Transfers without Third Parties 207
10.6 The Folk Theorem: Almost Anything Goes 209
10.7 Summary 214
10.8 Exercises 215

Chapter 11 Strategic Bargaining 220
11.1 One Round of Bargaining: The Ultimatum Game 222
11.2 Finitely Many Rounds of Bargaining 224
11.3 The Infinite-Horizon Game 228
11.4 Application: Legislative Bargaining 229
11.4.1 Closed-Rule Bargaining 230
11.4.2 Open-Rule Bargaining 232
11.5 Summary 235
11.6 Exercises 236

PART IV Static Games of Incomplete Information

Chapter 12 Bayesian Games 241
12.1 Strategic Representation of Bayesian Games 246
12.1.1 Players, Actions, Information, and Preferences 246
12.1.2 Deriving Posteriors from a Common Prior: A Player's Beliefs 247
12.1.3 Strategies and Bayesian Nash Equilibrium 249
12.2 Examples 252
12.2.1 Teenagers and the Game of Chicken 252
12.2.2 Study Groups 255
12.3 Inefficient Trade and Adverse Selection 258
12.4 Committee Voting 261
12.5 Mixed Strategies Revisited: Harsanyi's Interpretation 264
12.6 Summary 266
12.7 Exercises 266

Chapter 13 Auctions and Competitive Bidding 270
13.1 Independent Private Values 272
13.1.1 Second-Price Sealed-Bid Auctions 272
13.1.2 English Auctions 275
13.1.3 First-Price Sealed-Bid and Dutch Auctions 276
13.1.4 Revenue Equivalence 279
13.2 Common Values and the Winner's Curse 282

13.3 Summary 285
13.4 Exercises 285

Chapter 14 Mechanism Design 288
14.1 Setup: Mechanisms as Bayesian Games 288
14.1.1 The Players 288
14.1.2 The Mechanism Designer 289
14.1.3 The Mechanism Game 290
14.2 The Revelation Principle 292
14.3 Dominant Strategies and Vickrey-Clarke-Groves Mechanisms 295
14.3.1 Dominant Strategy Implementation 295
14.3.2 Vickrey-Clarke-Groves Mechanisms 295
14.4 Summary 299
14.5 Exercises 299

PART V Dynamic Games of Incomplete Information

Chapter 15 Sequential Rationality with Incomplete Information 303
15.1 The Problem with Subgame Perfection 303
15.2 Perfect Bayesian Equilibrium 307
15.3 Sequential Equilibrium 312
15.4 Summary 314
15.5 Exercises 314

Chapter 16 Signaling Games 318
16.1 Education Signaling: The MBA Game 319
16.2 Limit Pricing and Entry Deterrence 323
16.2.1 Separating Equilibria 324
16.2.2 Pooling Equilibria 330
16.3 Refinements of Perfect Bayesian Equilibrium in Signaling Games 332
16.4 Summary 335
16.5 Exercises 335

Chapter 17 Building a Reputation 339
17.1 Cooperation in a Finitely Repeated Prisoner's Dilemma 339
17.2 Driving a Tough Bargain 342
17.3 A Reputation for Being "Nice" 349
17.4 Summary 354
17.5 Exercises 354

Chapter 18 Information Transmission and Cheap Talk 357
18.1 Information Transmission: A Finite Example 358
18.2 Information Transmission: The Continuous Case 361
18.3 Application: Information and Legislative Organization 365
18.4 Summary 367
18.5 Exercises 367

Chapter 19 Mathematical Appendix 369
19.1 Sets and Sequences 369
19.1.1 Basic Definitions 369
19.1.2 Basic Set Operations 370
19.2 Functions 371
19.2.1 Basic Definitions 371
19.2.2 Continuity 372
19.3 Calculus and Optimization 373
19.3.1 Basic Definitions 373
19.3.2 Differentiation and Optimization 374
19.3.3 Integration 377
19.4 Probability and Random Variables 378
19.4.1 Basic Definitions 378
19.4.2 Cumulative Distribution and Density Functions 379
19.4.3 Independence, Conditional Probability, and Bayes' Rule 380
19.4.4 Expected Values 382

References 385

Index 389