Game Theory with Economic Applications

SECON D EDITION

H. SCOTT BIERMAN
Carleton College

LUIS FERNANDEZ
Oberlin College

ADDISON-WESLEY

An imprint of Addison Wesley Longman

Reading, Massachusetts • Menlo Park, California • New York • Harlow, England
Don Mills, Ontario • Sydney• Mexico City • Madrid • Amsterdam

Brief Contents

Preface / xv

PARTI
Static Games with Complete Information 1

CHAPTER 1 Nash Equilibrium 3
CHAPTER 2 Oligopoly 32
CHAPTER 3 Strategic Trade Policy 60
CHAPTER 4 Property Rights and Efficiency 76
CHAPTER 5 Voting Games-, ... 98

PART II
Dynamic Games with Complete Information 119

CHAPTER 6 Subgame Perfect Equilibrium 121
CHAPTER 7 Bargaining 149
CHAPTER 8 Time-Consistent Macroeconomic Policy 167
CHAPTER 9 Repeated Games and Dynamic Competition 185

PART III
Games with Uncertain Outcomes 205

CHAPTER 10 Uncertainty and Expected Utility 207
CHAPTER 11 Moral Hazard and Incomplete Insurance 239
CHAPTER 12 Moral Hazard and Involuntary Unemployment 256

PART IV
Static Games with Incomplete Information 272
CHAPTER 13 Bayesian Nash Equilibrium 273
CHAPTER 14 Auctions 289

PARTV
Dynamic Games with Incomplete Information 315
CHAPTER 15 Perfect Bayesian Equilibrium 317
CHAPTER 16 Bargaining with Private Information 342
CHAPTER 17 Corporate Takeovers and Greenmail 371
CHAPTER 18 Adverse Selection and Credit Rationing 384
CHAPTER 19 Limit Pricing and Entry Deterrence 402
CHAPTER 20 Cartel Enforcement 424

Index 441

Contents

Preface xv

PART I
Static Games with Complete Information 1

CHAPTER 1
Nash Equilibrium 3

1.1 INTRODUCTION, 3
1.2 AN EXAMPLE: THE OIL DRILLING GAME, 5
1.3 CHRONOLOGICAL TIME AND GAME TIME, 8
1.4 DOMINANT STRATEGY EQUILIBRIUM, 9
1.5 ITERATED DOMINANT STRATEGY EQUILIBRIUM, 13
1.6 NASH EQUILIBRIUM,-14-'
1.7 FOCAL POINT EQUILIBRIUM, 17
1.8 EVOLUTIONARY EQUILIBRIUM, 19
1.9 GAMES WITH CONTINUOUS STRATEGIES, 21
1.10 SUMMARY, 24
1.11 FURTHER READING,* 25
1.12 DISCUSSION QUESTIONS,* 26
1.13 NEW TERMS,* 26
1.14 EXERCISES,* 27
GAME THEORY IN ACTION: Game Theory in the News, 5

CHAPTER 2
Oligopoly 32

2.1 INTRODUCTION, 32
2.2 THE COURNOT GAME, 33
2.2.1- Isoprofit Curves and Best Response Functions, 35
2.2.2 Cournot-Nash Equilibrium, 38
2.2.3 Stronger Properties of the Cournot-Nash Equilibrium, 38

* These sections appear at the end of each chapter.

2.2.4 Experimental Evidence, 41
2.2.5 Perfect Competition as the Limiting Case of the Cournot Game, 43
2.3 THE BERTRAND GAME, 45
2.3.1 The Bertrand Game with Capacity Constraints, 46
2.4 CONTEST ABLE MONOPOLY, 52
2.5 SUMMARY, 55
GAME THEORY IN ACTION: Avoiding the Prisoner's Dilemma, 42

CHAPTER 3
Strategic Trade Policy..;.....60
3.1 INTRODUCTION, 60
3.2 IMPERFECT COMPETITION AND INTRAINDUSTRY TRADE, 61
3.3 EXPORT SUBSIDIES, 66
3.4 OPTIMAL EXPORT SUBSIDIES, 67
3.5 SUBSIDY WARS, 68
3.6 INCREASING RETURNS TO SCALE, 70
3.7 SUMMARY, 72
GAME THEORY IN ACTION: Strategic Trade Policy in Action: Voluntary Export Restraints on Automobiles, 71

CHAPTER 4
Property Rights and Efficiency.....:.....76
4.1 INTRODUCTION, 76 - "
4.2 UNDEFINED PROPERTY RIGHTS AND FISHING, *77*
4.3 WELL-DEFINED PROPERTY RIGHTS AND THE COASE THEOREM, 83
4.3.1 Resource Allocation by a Benevolent Dictator, 86
4.3.2 Resource Allocation When Property Rights Are Well Defined and Bargaining Costs Are Zero, 87
4.3.3 Resource Allocation When Property Rights Are Well Defined and Bargaining Costs Exist, 90
4.3.4 Bureaucracy versus the Market, 93
4.4 SUMMARY, 94
GAME THEORY IN ACTION: The Coase Theorem and Baseball, 93

CHAPTER 5
Voting Games.....98
5.1 INTRODUCTION, 98
5.2 CHOOSING AMONG VOTING MECHANISMS, 99
5.3 MAJORITY RULE WITH TWO CHOICES, 101
5.4 PLURALITY RULE AND THE CONDORCET CANDIDATE, 104
5.5 A MODIFIED PLURALITY RULE: THE SINGLE TRANSFERABLE VOTE, 105
5.6 STRATEGIC VOTING WITH PLURALITY RULE, 109
5.6.1 The Naive Voting Model, 111
5.6.2 The Strategic Voting Model, 111
5.6.3 Other Equilibria, 113
5.6.4 A Concern: The Limits of Rationality, 114

5.7 SUMMARY, 115
GAME THEORY IN ACTION: Verdict Voting, 106

PART II
Dynamic Games with Complete Information.....119

CHAPTER 6 /
Subgame Perfect Equilibrium.....121

6.1 INTRODUCTION, \1\
6.2 AN EXAMPLE: SOFTWARE GAME I, 122
6.2.1 Game Trees, 124
6.2.2 Strategies, 127
6.2.3 Information, 127
6.2.4 Outcomes and Payoffs, 127
6.3 NASH EQUILIBRIUM AND BACKWARD INDUCTION, 128
6.4 THREATS AND CREDIBLE THREATS, 131
6.5 SUBGAMES AND SUBGAME PERFECT EQUILIBRIUM, 133
6.6 A SECOND EXAMPLE: SOFTWARE GAME II, 135
6.7 DYNAMIC GAMES WITH CONTINUOUS STRATEGIES: THE STACKELBERG DUOPOLY GAME, 139
6.8 SUMMARY, 143

CHAPTER 7 . --
Bargaining.....149

7.1 INTRODUCTION, 149
7.2 BARGAINING WITHOUT IMPATIENCE, 150
7.3 BARGAINING WITH SYMMETRIC IMPATIENCE, 151
7.4 BARGAINING WITH ASYMMETRIC IMPATIENCE, 153
7.4.1 A General Model of Bargaining with[1] Impatience, 154
7.5 EXPERIMENTAL EVIDENCE ON SEQUENTIAL BILATERAL BARGAINING, 158
7.6 A BARGAINING EXAMPLE: SHARING SUNK COSTS, 161
7.6.1 A More Specific Example, 162
7.7 SUMMARY, 164

r

CHAPTER 8
Time-Consistent Macroeconomic Policy.....167

8.1 INTRODUCTION, 167
8.2 INFLATION, 168
8.3 A SIMPLE MACROECONOMIC MODEL, 169
8.3.1 Identities, 171
8.3.2 Actions and Order of Play, 172
8.3.3 Strategies, 173
8.3.4 Payoffs, 173

8.3.5 Equilibrium, 175
8.3.6 A Numerical Example, 177
8.4 ONE SOLUTION TO THE CENTRAL BANK'S PROBLEM: PRECOMMITMENT, 180
8.5 SUMMARY, 181
GAME THEORY IN ACTION: How Chairman Volker Changed Inflationary Expectations, 170
GAME THEORY IN ACTION: Optimal Central Bank Performance, 180

CHAPTER 9
Repeated Games and Dynamic Competition 185
9.1 INTRODUCTION, 185
9.2 EXAMPLE: DUOPOLY REVISITED, 187
9.3 FINITELY REPEATED GAMES, 191
9.4 A FIRST MODIFICATION: PRECOMMITMENT, 194
9.5 A SECOND MODIFICATION: DISCOUNTING THE FUTURE, 196
9.5.1 A "Noncooperative" Equilibrium, 198
9.5.2 A "Cooperative" Equilibrium, 198
9.5.3 And Now the Bad News: The Folk Theorem, 200
9.6 THE BERTRAND GAME REVISITED, 201
9.7 SUMMARY, 202
GAME THEORY IN ACTION: Cooperation in the Trenches of World War I, 193

PART III
Games with Uncertain Outcomes 205

CHAPTER 10
Uncertainty and Expected Utility 207
10.1 INTRODUCTION, 207
10.2 EXOGENOUS UNCERTAINTY IN STATIC GAMES, 208
10.3 EXOGENOUS UNCERTAINTY IN DYNAMIC GAMES, 209
10.4 ENDOGENOUS UNCERTAINTY IN STATIC GAMES, 215
10.5 THE EXPECTED UTILITY HYPOTHESIS, 220
10.6 THE EXPECTED UTILITY THEOREM, 224
10.7 ATTITUDES TOWARD RISK, 227
10.8 SUMMARY, 232

CHAPTER 11
Moral Hazard and Incomplete Insurance 239
11.1 INTRODUCTION, 239
11.2 INSURANCE IN THE ABSENCE OF MORAL HAZARD, 241
11.3 INSURANCE IN THE PRESENCE OF MORAL HAZARD, 244
11.4 WELFARE EFFECTS OF MORAL HAZARD, 252
11.5 GOVERNMENT RESPONSES TO MARKET FAILURE IN THE UNEMPLOYMENT INSURANCE MARKET, 253

11.6 SUMMARY, 253

GAME THEORY IN ACTION: The S&L Mess: Double Moral Hazard, 250

CHAPTER 12
Moral Hazard and Involuntary Unemployment 256

12.1 INTRODUCTION, 256
12.2 A SIMPLE MODEL OF MORAL HAZARD IN THE LABOR MARKET, 257
12.2.1 Moral Hazard and Incredible Promises, 263
12.3 COMPLETION OF THE MODEL: THE NECESSITY OF INVOLUNTARY UNEMPLOYMENT, 265
12.4 SUMMARY, 267

GAME THEORY IN ACTION: Did Henry Ford Pay Efficiency Wages?, 262

PART IV
Static Games with Incomplete Information 271

CHAPTER 13
Bayesian Nash Equilibrium 273

13.1 INTRODUCTION, 273
13.2 THE HARSANYI TRANSFORMATION, 275
13.3 MIXED STRATEGIES REINTERPRETED, 279
13.4 THE REVELATION PRINCIPLE AND GAME DESIGN, 282
13.5 SUMMARY, 284

CHAPTER 14
Auctions 288

14.1 INTRODUCTION, 288
14.2 A PRIMER FOR AUCTIONEERS, 292
14.3 AUCTIONS WITH PERFECT INFORMATION, 293
14.4 SEALED-BID AUCTIONS WITH INDEPENDENT PRIVATE VALUES, 297
14.4.1 An Example, 298
14.5 ORAL AUCTIONS WITH INDEPENDENT PRIVATE VALUES, 301
14.6 COMMON VALUE AUCTIONS AND THE "WINNER'S CURSE," 303
14.6.1 Our Example Revisited, 303
14.7 THE EFFICIENCY OF AUCTIONS, 305
14.8 SUMMARY, 306
14.13 APPENDIX: A GUIDE TO WORKING WITH UNIFORMLY DISTRIBUTED RANDOM VARIABLES, 312

GAME THEORY IN ACTION: Game Theorists Design a Historic Auction for the FCC, 290

PARTV
Dynamic Games with Incomplete Information 315

CHAPTER 15
Perfect Bayesian Equilibrium 317

15.1 INTRODUCTION, 317
15.2 INFORMATION SETS, 318
15.3 BAYES' THEOREM, 321
15.4 PERFECT BAYESIAN EQUILIBRIUM, 325
15.5 SIGNALING GAMES, 329
15.5.1 Education as a Signal, 330
15.6 A SCREENING GAME, 336
15.7 SUMMARY, 337
15.12 APPENDIX: BAYES' THOREM, 341

CHAPTER 16
Bargaining with Private Information 342

16.1 INTRODUCTION, 342
16.2 BARGAINING WHEN THE UNINFORMED PLAYER MOVES FIRST, 343
16.3 BARGAINING WHEN THE INFORMED PLAYER MOVES FIRST, 346
16.4 BARGAINING WHEN DELAY IS AN OPTION, 355
16.5 SUMMARY, 364
GAME THEORY IN ACTION: How Well Do Strategic Bargaining Models Explain Strike Data?, 363

CHAPTER 17
Corporate Takeovers and Greenmail 371

17.1 INTRODUCTION, 371
17.2 THE CURRENT LEXICON AND CONVENTIONAL WISDOM, 372
17.3 GREENMAIL WITHOUT WHITE KNIGHTS, 373
17.4 GREENMAIL WITH WHITE KNIGHTS, 378
17.5 SUMMARY, 381
GAME THEORY IN ACTION: Greenmail and Stockholder Weil-Being: Some Evidence, 378

CHAPTER 18
Adverse Selection and Credit Rationing 384

18.1 INTRODUCTION, 384
18.2 LENDING IN THE ABSENCE OF ADVERSE SELECTION, 386
18.3 ADVERSE SELECTION AND MONOPOLISTIC BANKING, 389
18.4 ADVERSE SELECTION AND BERTRAND BANKING COMPETITION, 393
18.5 OTHER EXAMPLES OF ADVERSE SELECTION, 398

18.6 SUMMARY, 399

GAME THEORY IN ACTION: "Credit Crunches" and Lending Risk, 397

CHAPTER 19
Limit Pricing and Entry Deterrence 402

19.1 INTRODUCTION, 402

19.2 BAIN'S MODEL OF ENTRY LIMIT PRICING, 403

19.3 A GAME-THEORETIC LOOK AT LIMIT PRICING, 405

19.3.1 The Spence-Dixit Model of Entry Deterrence, 407
19.3.2 The Milgrom-Roberts Model of Entry Deterrence, 410
19.3.3 Finding a Separating Equilibrium, 415
19.3.4 Finding a Pooling Equilibrium, 417

19.4 SOME WELFARE IMPLICATIONS, 420

19.5 SUMMARY, 420

GAME THEORY IN ACTION: The Search for Predatory Pricing, 406

CHAPTER 20
Cartel Enforcement 424

20.1 INTRODUCTION, 424

20.2 CARTEL ENFORCEMENT WITH PERFECT MONITORING, 425

20.3 CARTEL ENFORCEMENT WITH IMPERFECT MONITORING, 426

20.3.1 The Game Tree, 427
20.3.2 Strategies, 428"
20.3.3 Payoffs, 429
20.3.4 Some Equilibria, 430
20.3.5 Calculating the Trigger Price Best Response Function, 432
20.3.6 The OpUmal Cartel Agreement, 436

20.4 SUMMARY, 438

GAME THEORY IN ACTION: Cartel Enforcement in Real Life, 436

Index 441