Behavioral Game Theory

Experiments in Strategic Interaction

Colin F. Camerer

Russell Sage Foundation, New York, New York
Princeton University Press, Princeton, New Jersey

Contents

Preface xiii

1 **Introduction** 1
1.1 What Is Game Theory Good For? 5
1.2 Three Examples 7
1.2.1 Example 1: Ultimatum Bargaining 8
1.2.2 Example 2: Path-Dependent Coordination in "Continental Divide" Games 12
1.2.3 Example 3: "Beauty Contests" and Iterated Dominance 16
1.3 Experimental Regularity and Behavioral Game Theory 20
1.4 Conclusion 24
Appendix 25
A1.1 Basic Game Theory 25
A1.2 Experimental Design 34

2 **Dictator,** Ultimatum, **and** Trust Games 43
2.1 Ultimatum and Dictator Games: Basic Results 48
2.2 Methodological Variables 59
2.2.1 Repetition 59
2.2.2 Methodology: Stakes 60
2.2.3 Anonymity and Experimenter "Blindness" 62
2.3 Demographic Variables 63
2.3.1 Gender 64
2.3.2 Race 65
2.3.3 Academic Major 65
2.3.4 Age 65
2.3.5 Brains, Biology, and Beauty 67
2.4 Culture 68

2.5 Descriptive Variables: Labeling and Context 74
2.6 Structural Variables 75
2.6.1 Identity, Communication, and Entitlement 76
2.6.2 Competitive Pressure and Outside Options 77
2.6.3 Information about the Amount Being Divided 78
2.6.4 Multiperson Games 80
2.6.5 Intentions: Influence of Unchosen Alternatives 81
2.7 Trust Games 83
2.7.1 Is Trustworthiness Just Altruism? 89
2.7.2 Indirect Reciprocity, Karma, Culture 90
2.7.3 A Complex Omnibus Game 93
2.7.4 Multistage Trust Games 94
2.7.5 Gift Exchange in Experimental Labor Markets 95
2.8 Theory 101
2.8.1 Pure and Impure Altruism 102
2.8.2 Inequality-Aversion Theories 102
2.8.3 Fairness Equilibrium (Rabin) 105
2.8.4 Extensive-Form Fairness Equilibrium 107
2.8.5 Comparing Approaches 110
2.9 Conclusion 113

3 **Mixed-Strategy Equilibrium** **118**
3.1 Early Studies 121
3.2 Modern Studies 125
3.3 Subjective Randomization and Mixed Strategies 134
3.4 Explicit Randomization 138
3.5 Patent Race and Location Games with Mixed Equilibria 142
3.6 Two Field Studies 145
3.7 Conclusion 147

4 Bargaining **151**
4.1 Unstructured Bargaining 153
4.1.1 Unstructured Bargaining over Ticket Allocations 153
4.1.2 Self-Serving Interpretations of Evidence in Unstructured Bargaining 158
4.2 Structured Bargaining 161
4.2.1 Finite Alternating-Offer Games 161
4.2.2 Limited Computation 167
4.2.3 Random Termination 174
4.2.4 Games with Fixed Delay Costs and Outside Options 175
4.3 Bargaining under Incomplete Information 182
4.3.1 One-Sided Buyer Information with Seller-Only Offers 183

4.3.2 One-Sided Private Information and Strikes 184
4.3.3 Sealed-Bid Mechanisms for Bilateral Bargaining 187
4.4 Conclusion 196

5 Dominance-Solvable Games 199
5.1 Simple Dominance-Solvable Games 203
5.1.1 Games Solvable by Two Steps of Iterated Dominance 203
5.1.2 Iterated Dominance and Tree-Matrix Differences 205
5.1.3 A Partially Dominance-Solvable Patent Race Game 208
5.2 Beauty Contest Games 209
5.3 Games in Which Iterated Reasoning Decreases Payoffs 218
5.3.1 Centipede Games 218
5.3.2 Prisoners' Dilemma and Quasi-Centipede Games 221
5.3.3 Price Competition 223
5.3.4 The Travelers' Dilemma 224
5.3.5 The "Email Game" 226
5.3.6 An Implementation Mechanism That Uses Iterated Dominance 232
5.4 When More Iteration Is Better: The "Dirty Faces" Game 236
5.5 The "Groucho Marx" Theorem in Zero-Sum Betting 239
5.6 Structural Models of Decision Rules and Levels of Reasoning 242
5.7 Theories 254
5.7.1 Multiple Types 254
5.7.2 Payoff-Sensitive Noisy Iteration 255
5.7.3 QRE Refinements: Differences and Asymmetry in X 255
5.7.4 A Poisson Cognitive Hierarchy 257
5.8 Conclusion 258
Appendix: Raw Choices in Email Game and Additional Data 259

6 Learning 265
6.1 Theories of Learning 266
6.2 Reinforcement Learning 273
6.2.1 Reinforcement in Weak-Link Games 274
6.2.2 Reinforcement with Payoff Variability 275
6.2.3 Reinforcement with "Mood Shocks" 279
6.2.4 Information Conditions 279
6.3 Belief Learning 283
6.3.1 Weighted Fictitious Play 283

6.3.2 General Belief Learning 285
6.3.3 Learning Direction Theory 288
6.3.4 Bayesian Learning 290
6.3.5 Measuring Beliefs Directly 292
6.3.6 Population-Level Replicator Dynamics 293
6.4 Imitation Learning 295
6.5 Comparative Studies 298
6.5.1 Comparing Belief Models 299
6.5.2 Comparing Belief and Reinforcement Models 299
6.6 Experience-Weighted Attraction (EWA) Learning 304
6.6.1 Example: Continental Divide 308
6.6.2 Example: /?-Beauty Contest, and Sophistication 318
6.6.3 Functional EWA (fEWA) 322
6.7 Rule Learning 324
6.8 Econometric Studies of Estimation Properties 330
6.9 Conclusions 332

7 Coordination 336
7.1 Matching Games 341
7.1.1 Assignment Games and Visual Selection 345
7.1.2 Unpacking Focality 349
7.2 Asymmetric Players: Battle of the Sexes 353
7.2.1 Outside Options 355
7.2.2 Communication 356
7.2.3 Evolution of Meaning 357
7.2.4 External Assignment 362
7.2.5 Timing 365
7.3 Market Entry Games 367
7.3.1 Multiple Markets 371
7.3.2 Skill 372
7.4 Payoff-Asymmetric Order-Statistic Games 375
7.4.1 Experimental Evidence 378
7.4.2 Weak-Link Games 381
7.4.3 Mergers, Bonus Announcements, and "Leadership" 386
7.4.4 Median-Action Games 388
7.4.5 Preplay Auctions and Entry Fees 390
7.4.6 General Order-Statistic Games 393
7.5 Selecting Selection Principles 396
7.5.1 Simplicity 396
7.5.2 Empirical Comparison of Selection Principles 398

7.6 Applications: Path-Dependence, Market Adoption, and Corporate Culture 399
7.6.1 Path-Dependence: Creating a Laboratory "Continental Divide" 399
7.6.2 Market Adoption 400
7.6.3 Culture 402
7.7 Conclusion 403
Appendix: Psycholinguistics 405

8 Signaling and Reputation 408
8.1 Simple Signaling Games and Adaptive Dynamics 411
8.2 Specialized Signaling Games 427
8.2.1 Lobbying 427
8.2.2 Corporate Finance 430
8.2.3 Games with Ratchet Effects 436
8.2.4 Belief Learning in Limit Pricing Signaling Games 439
8.3 Reputation Formation 445
8.3.1 Trust 446
8.3.2 Entry Deterrence 453
8.3.3 Learning in Repeated Games 458
8.4 Conclusion 462

9 Conclusion: What Do We Know, and Where Do We Go? 465
9.1 Summary of Results 466
9.1.1 Simple Bargaining Games 466
9.1.2 Mixed-Strategy Equilibria 468
9.1.3 Bargaining 469
9.1.4 Iterated Dominance 469
9.1.5 Learning 469
9.1.6 Coordination 470
9.1.7 Signaling 471
9.2 Top Ten Open Research Questions 473

Appendix: Design Details 477

References 497

Index 535