Contents

	Acknowledgments	xv
	Introduction	xvii
I	Static Games of Complete Information	1
1	Games in Strategic Form and Nash Equilibrium	3
1.1	Introduction to Games in Strategic Form and Iterated	
	Strict Dominance	4
	1.1.1 Strategic-Form Games	4
	1.1.2 Dominated Strategies	6
	1.1.3 Applications of the Elimination of Dominated	0
1.0	Strategies	9
1.2	Nash Equilionum	11
	1.2.1 Examples of Pure-Strategy Equilibria	11
	1.2.2 Examples of 1 die-Strategy Equilibrium	16
	1.2.4 Multiple Nash Equilibria, Focal Points, and Pareto	10
	Optimality	18
	1.2.5 Nash Equilibrium as the Result of Learning or	
	Evolution	23
1.3	Existence and Properties of Nash Equilibria	29
	1.3.1 Existence of a Mixed-Strategy Equilibrium	29
	1.3.2 The Nash-Equilibrium Correspondence Has a	
	Closed Graph	30
	1.3.3 Existence of Nash Equilibrium in Infinite Games	
	with Continuous Payoffs	34
	Exercises	36
	References	42
2	Iterated Strict Dominance, Rationalizability, and	
	Correlated Equilibrium	45
2.1	Iterated Strict Dominance and Rationalizability	45
	2.1.1 Iterated Strict Dominance: Definition and	
	Properties	45
	2.1.2 An Application of Iterated Strict Dominance	47
	2.1.3 Rationalizability	48
	2.1.4 Rationalizability and Iterated Strict Dominance	50
	2.1.5 Discussion	53
2.2	Correlated Equilibrium	53
2.3	Rationalizability and Subjective Correlated Equilibria	59
	Exercises	60
	References	63

II	Dynamic Games of Complete Information	65
3	Extensive-Form Games	67
3.1	Introduction	67
3.2	Commitment and Perfection in Multi-Stage Games with Observed Actions	70
	3.2.1 What Is a Multi-Stage Game?	70
	3.2.2 Backward Induction and Subgame Perfection	72
	3.2.3 The Value of Commitment and "Time Consistency"	74
3.3	The Extensive Form	77
	3.3.1 Definition	77
	3.3.2 Multi-Stage Games with Observed Actions	82
3.4	Strategies and Equilibria in Extensive-Form Games	83
	3.4.1 Behavior Strategies	83
	3.4.2 The Strategic-Form Representation of Extensive-	
	Form Games	85
	3.4.3 The Equivalence between Mixed and Behavior	07
	Strategies in Games of Perfect Recall	8/
	3.4.4 Iterated Strict Dominance and Nash Equilibrium	90
3.5	Backward Induction and Subgame Perfection	92
3.6	Critiques of Backward Induction and Subgame Perfection	96
	3.6.1 Critiques of Backward Induction	97
	3.6.2 Critiques of Subgame Perfection	99
	Exercises	100
	References	105
4	Applications of Multi-Stage Games with Observed	
	Actions	107
4.1	Introduction	107
4.2	The Principle of Optimality and Subgame Perfection	108
4.3	A First Look at Repeated Games	110
	4.3.1 The Repeated Prisoner's Dilemma	110
	4.3.2 A Finitely Repeated Game with Several Static	
	Equilibria	112
4.4	The Rubinstein-Ståhl Bargaining Model	113
	4.4.1 A Subgame-Perfect Equilibrium	113
	4.4.2 Uniqueness of the Infinite-Horizon Equilibrium	115
	4.4.3 Comparative Statics	116
4.5	Simple Timing Games	117
	4.5.1 Definition of Simple Timing Games	117
	4.5.2 The War of Attrition	120
	4.5.3 Preemption Games	126

4.6	Iterated Conditional Dominance and the Rubinstein	(0)
47		128
4.7	Open-Loop and Closed-Loop Equilibria	130
	4.7.2 A Two-Period Example	130
	4.7.3 Open-Loop and Closed-Loop Equilibria in Games	152
	with Many Players	133
4.8	Finite-Horizon and Infinite-Horizon Equilibria	134
	Exercises	138
	References	141
5	Repeated Games	145
5.1	Repeated Games with Observable Actions	146
	5.1.1 The Model	146
	5.1.2 The Folk Theorem for Infinitely Repeated Games	150
<i></i>	5.1.3 Characterization of the Equilibrium Set	160
5.2	Finitely Repeated Games	165
.5.3	Repeated Games with Varying Opponents	168
	5.3.1 Repeated Games with Long-Kun and Short-Kun Players	168
	5.3.3 Randomly Matched Opponents	171
5.4	Pareto Perfection and Renegotiation-Proofness in	
5.1	Repeated Games	174
	5.4.1 Introduction	174
	5.4.2 Pareto Perfection in Finitely Repeated Games	176
	5.4.3 Renegotiation-Proofness in Infinitely Repeated Games	179
5.5	Repeated Games with Imperfect Public Information	182
	5.5.1 The Model	183
	5.5.2 Trigger-Price Strategies	185
	5.5.3 Public Strategies and Public Equilibria	187
5.6	5.5.4 Dynamic Programming and Sen-Ocheration	100
5.0	Changing the Information Structure with the Time Design	192
5.7	Changing the information Structure with the Time Period	197
	Exercises References	200 203
III	Static Games of Incomplete Information	207
6	Bayesian Games and Bayesian Equilibrium	209
6.1	Incomplete Information	209
6.2	Example 6.1: Providing a Public Good under Incomplete	
<i>(</i>)		211
0.3	i ne Notions of Type and Strategy	213

6.4	Bayesian Equilibrium	215
6.5	Further Examples of Bayesian Equilibria	215
6.6	Deletion of Strictly Dominated Strategies	226
	6.6.1 Interim vs. Ex Ante Dominance	226
	6.6.2 Examples of Iterated Strict Dominance	228
6.7	Using Bayesian Equilibria to Justify Mixed Equilibria	230
	6.7.1 Examples	230
	6.7.2 Purification Theorem	233
6.8	The Distributional Approach	234
	Exercises	237
	References	241
7	Bayesian Games and Mechanism Design	243
7.1	Examples of Mechanism Design	246
	7.1.1 Nonlinear Pricing	246
	7.1.2 Auctions	250
7.2	Mechanism Design and the Revelation Principle	253
7.3	Mechanism Design with a Single Agent	258
	7.3.1 Implementable Decisions and Allocations	258
	7.3.2 Optimal Mechanisms	262
7.4	Mechanisms with Several Agents: Feasible Allocations,	
	Budget Balance, and Efficiency	268
	7.4.1 Feasibility under Budget Balance	269
	7.4.2 Dominant Strategy vs. Bayesian Mechanisms	270
	7.4.5 Efficiency Theorems	271
	7.4.5 Efficiency Limit Theorems	275
	7.4.6 Strong Inefficiency Limit Theorems	281
7.5	Mechanism Design with Several Agents: Optimization	284
	7.5.1 Auctions	284
	7.5.2 Efficient Bargaining Processes	288
7.6	Further Topics in Mechanism Design	292
	7.6.1 Correlated Types	292
	7.6.2 Risk Aversion	295
	7.6.3 Informed Principal	297
	7.6.4 Dynamic Mechanism Design	299
	7.6.5 Common Agency	301
	Appendix	303
	Exercises	308
	References	314

Contents

IV	Dynamic Games of Incomplete Information	319
8	Equilibrium Refinements: Perfect Bayesian Equilibrium, Sequential Equilibrium, and	
	I rembling-Hand Perfection	321
8.1	Introduction	321
8.2	Perfect Bayesian Equilibrium in Multi-Stage Games of	
	Incomplete Information	324
	8.2.1 The Basic Signaling Game	324
	8.2.2 Examples of Signaling Games	326
	8.2.3 Multi-Stage Games with Observed Actions and	224
0.0		331
8.3	Extensive-Form Relinements	336
	8.3.1 Review of Game Trees	330
	8.3.2 Depresenties of Sequential Equilibrium	2/1
	8.3.4 Sequential Equilibrium Compared with Perfect	541
	Bayesian Equilibrium	345
8.4	Strategic-Form Refinements	350
	8.4.1 Trembling-Hand Perfect Equilibrium	351
	8.4.2 Proper Equilibrium	356
	Appendix	359
	Exercises	360
	References	364
9	Reputation Effects	367
9.1	Introduction	367
9.2	Games with a Single Long-Run Player	369
	9.2.1 The Chain-Store Game	369
	9.2.2 Reputation Effects with a Single Long-Run Player:	
	The General Case	374
	9.2.3 Extensive-Form Stage Games	381
9.3	Games with Many Long-Run Players	384
	9.3.1 General Stage Games and General Reputations	384
	9.3.2 Common-Interest Games and Bounded-Recall Reputations	386
9.4	A Single "Big" Player against Many Simultaneous Long-	
	Lived Opponents	389
	Exercises	391
	References	394

10	Sequential Bargaining under Incomplete Information	397
10.1	Introduction	397
10.2	Intertemporal Price Discrimination: The Single-Sale Model	400
	10.2.1 The Framework	400
	10.2.2 A Two-Period Introduction to Coasian Dynamics	402
	10.2.3 An Infinite-Horizon Example of the Coase Conjecture	405
	10.2.4 The Skimming Property	406
	10.2.5 The Gap Case	408
	10.2.6 The No-Gap Case	411
	10.2.7 Gap vs. No Gap and Extensions of the Single-Sale Model	414
10.3	Intertemporal Price Discrimination: The Rental or	
10.5	Repeated-Sale Model	416
	10.3.1 Short-Term Contracts	417
	10.3.2 Long-Term Contracts and Renegotiation	419
10.4	Price Offers by an Informed Buyer	421
	10.4.1 One-Sided Offers and Bilateral Asymmetric Information	422
	10.4.2 Alternating Offers and One-Sided Asymmetric Information	424
	10.4.3 Mechanism Design and Bargaining	427
	Exercises	428
	References	432
v	Advanced Topics	435
11	More Equilibrium Refinements: Stability, Forward	
	Induction, and Iterated Weak Dominance	437
11.1	Strategic Stability	437
11.2	Signaling Games	446
11.3	Forward Induction, Iterated Weak Dominance, and	
	"Burning Money"	460
11.4	Robust Predictions under Payoff Uncertainty	467
	Exercises	473
	References	475
12	Advanced Topics in Strategic-Form Games	479
12.1	Generic Properties of Nash Equilibria	479
	12.1.1 Number of Nash Equilibria	479
	12.1.2 Robustness of Equilibria to Payoff Perturbations	480
12.2	Existence of Nash Equilibrium in Games with	
	Continuous Action Spaces and Discontinuous Payoffs	484
	12.2.1 Existence of a Pure-Strategy Equilibrium	485
	1222 Existence of a Mixed Strategy Equilibrium	107

12.3	Supermodular Games Exercises	489 497
	References	498
13	Payoff-Relevant Strategies and Markov Equilibrium	501
13.1	Markov Equilibria in Specific Classes of Games	503
	13.1.1 Stochastic Games: Definition and Existence of MPE	503
	13.1.2 Separable Sequential Games	505
12.2	13.1.3 Examples from Economics	507
13.2	Markov Perfect Equilibrium in General Games: Definition	512
	13.2.1 Definition	513
	13.2.2 Existence	515
	13.2.3 Robustness to Payoff Perturbations	518
13.3	Differential Games	520
	13.3.1 Definition	520
	13.3.2 Equilibrium Conditions	521
	13.3.3 Linear-Quadratic Differential Games	523
	13.3.4 Technical Issues	525
	13.3.5 Zero-Sum Differential Games	527
13.4	Capital-Accumulation Games	528
	13.4.1 Open-Loop, Closed-Loop, and Markov Strategies13.4.2 Differential-Game Strategies	529 534
	Exercises	536
	References	537
14	Common Knowledge and Games	541
14.1	Introduction	541
14.2	Knowledge and Common Knowledge	542
14.3	Common Knowledge and Equilibrium	546
	14.3.1 The Dirty Faces and the Sage	547
	14.3.2 Agreeing to Disagree	548
	14.3.3 No-Speculation Theorems	550
	14.3.4 Interim Efficiency and Incomplete Contracts	554
14.4	Common Knowledge, Almost Common Knowledge, and	
	the Sensitivity of Equilibria to the information Structure	554 556
	14.4.2 Lower Hemi-Continuity and Almost Common Knowledge	550
	Evaning	570
	References	571
	Index	573