## **Contents**

Preface xi

| 1 | Preferences and Utility 1 |   |  |  |
|---|---------------------------|---|--|--|
|   | 1.1                       | Preference and Choice: The Preference-Based Approach 2                  |  |  |
|   | 1.2                       | Utility Function 10   |  |  |
|   | 1.3                       | Desirability 11   |  |  |
|   | 1.4                       | Indifference Sets, Upper Contour Sets, and Lower Contour Sets 16        |  |  |
|   | 1.5                       | Convexity of Preferences 17   |  |  |
|   | 1.6                       | Interpretation of Convexity 20  |  |  |
|   | 1.7                       | Quasi-Concavity 23  |  |  |
|   | 1.8                       | Common Utility Functions in Economics 33                                |  |  |
|   | 1.9                       | Properties of Preference Relations 39                                   |  |  |
|   | 1.10                      | Continuous Preferences 48   |  |  |
|   | 1.11                      | Existence of a Utility Function 50                                      |  |  |
|   | 1.12                      | Behavioral Economics—Two Utility Functions 51                           |  |  |
|   | 1.13                      | Choice-Based Approach 59  |  |  |
|   | 1.14                      | Consistency on Choices: The Weak Axiom of Revealed Preference (WARP) 60 |  |  |
|   | 1.15                      | Consumption Sets 63   |  |  |
|   | Apper                     | ndix: Rational Preference Relations Satisfy the WARP 68                 |  |  |
|   | Exerc                     | ises 69   |  |  |
|   | Refere                    | ences 74  |  |  |
| 2 | Demand Theory 77          |   |  |  |
|   | 2.1                       | The Utility Maximization Problem 78                                     |  |  |
|   | 2.2                       | Walrasian Demand—Comparative Statics 89                                 |  |  |

3

4

4.5

**Cost Minimization** 

264

| 2.3 Indirect Utility Function 94  |  |  |  |  |
|---|--|--|--|--|
| 2.4 WARP and Demand 99  |  |  |  |  |
| 2.5 Slutsky Matrix 109  |  |  |  |  |
| 2.6 Expenditure Minimization Problem 117  |  |  |  |  |
| Relationships between the Expenditure Function and Hicksian Demand 128  |  |  |  |  |
| Relationship between the Walrasian and Hicksian Demand 129  |  |  |  |  |
| 2.9 Relationship between the Walrasian Demand and the Indirect Utility Function 133                               |  |  |  |  |
| Summary of Relationships 134  |  |  |  |  |
| Appendix A: Duality in Consumption 139  |  |  |  |  |
| Appendix B: Relationship between the Expenditure Function and Hicksian Demand 146                                 |  |  |  |  |
| Appendix C: Generalized Axiom of Revealed Preference 148  |  |  |  |  |
| Exercises 153   |  |  |  |  |
| References 161  |  |  |  |  |
| Demand Theory—Applications 163  |  |  |  |  |
| 3.1 Measuring the Welfare Effects of a Price Change 164   |  |  |  |  |
| 3.2 Measuring the Welfare Change Associated with the Introduction of a Tax 172                                    |  |  |  |  |
| 3.3 What If We Use the Walrasian Demand to Measure Welfare Changes? 173   |  |  |  |  |
| 3.4 When Can We Use the Walrasian Demand as a Measure of Welfare Change? 179                                      |  |  |  |  |
| 3.5 Application of Income and Substitution Effects—I 182  |  |  |  |  |
| 3.6 Application of Income and Substitution Effects—II: The Consumer as a Labor Supplier 184                       |  |  |  |  |
| 3.7 Application of Income and Substitution Effects—III: Income and Substitution Effects among Different Goods 194 |  |  |  |  |
| 3.8 Aggregate Demand 202  |  |  |  |  |
| Appendix: Applying Euler's Theorem to the Hicksian Demand 208   |  |  |  |  |
| Exercises 210   |  |  |  |  |
| References 220  |  |  |  |  |
| Production Theory 221   |  |  |  |  |
| Production Sets 222   |  |  |  |  |
| 4.2 Properties of Production Sets 229   |  |  |  |  |
| 4.3 Elasticity of Substitution 244  |  |  |  |  |
| 4.4 Profit Maximization 249   |  |  |  |  |

5

6

| 4.6 Cost Function 274   |  |  |  |  |  |
|---|--|--|--|--|--|
| Conditional Factor Demand Correspondence, $z(w, q)$ 275   |  |  |  |  |  |
| 4.8 Production Function, $f(z)$ 282   |  |  |  |  |  |
| 4.9 Alternative Representation of the PMP 283   |  |  |  |  |  |
| 4.10 Average and Marginal Costs with a Single Output 289  |  |  |  |  |  |
| 4.11 Aggregation in Production 294  |  |  |  |  |  |
| Efficient Production 297  |  |  |  |  |  |
| Appendix A: Graphical Representation of Cost Functions 304  |  |  |  |  |  |
| Appendix B: Output and Cost Elasticity 311  |  |  |  |  |  |
| Exercises 316   |  |  |  |  |  |
| References 321  |  |  |  |  |  |
| Choice under Uncertainty 323  |  |  |  |  |  |
| 5.1 Simple and Compound Lotteries 324   |  |  |  |  |  |
| 5.2 Preferences over Lotteries 329  |  |  |  |  |  |
| 5.3 Violations of the IA 341  |  |  |  |  |  |
| 5.4 Behavioral Theories That Modify Expected Utility Theory 345   |  |  |  |  |  |
| 5.5 Money Lotteries 348   |  |  |  |  |  |
| 5.6 Measuring Risk Preferences 353  |  |  |  |  |  |
| 5.7 Arrow–Pratt Coefficients of Absolute and Relative Risk Aversion 360                                       |  |  |  |  |  |
| 5.8 Prudence 366  |  |  |  |  |  |
| 5.9 Prospect Theory and Reference-Dependent Utility 368   |  |  |  |  |  |
| 5.10 Comparison of Payoff Distributions 372   |  |  |  |  |  |
| 5.11 Subjective Probability Theory 381  |  |  |  |  |  |
| 5.12 Alternatives to SEU: Ambiguity Aversion (MEU), Capacities (CEU), and Smooth Ambiguity Aversion (SAA) 384 |  |  |  |  |  |
| Appendix A: State-Dependent Utility 391   |  |  |  |  |  |
| Appendix B: "Extended" Expected Utility Representation 393  |  |  |  |  |  |
| Exercises 398   |  |  |  |  |  |
| References 408  |  |  |  |  |  |
| Partial and General Equilibrium 411   |  |  |  |  |  |
| 6.1 Partial Equilibrium Analysis 412  |  |  |  |  |  |
| Comparative Statics 419   |  |  |  |  |  |
| 6.3 Welfare Analysis 424  |  |  |  |  |  |

7

8

| 6.4 General Equilibrium 428  |
|--|
| 6.5 Comparative Statics 460  |
| 6.6 Introducing Taxes 466  |
| Appendix A: Large Economies and the Core 468                               |
| Appendix B: Marshall-Hicks Four Laws of Derived Demand 477                 |
| Exercises 479  |
| References 487   |
| Monopoly 489   |
| 7.1 Barriers to Entry 490  |
| 7.2 Profit-Maximizing Output under Monopoly 491                            |
| 7.3 Welfare Loss of Monopoly 499   |
| 7.4 Comparative Statics 504  |
| 7.5 Multiplant Monopolist 506  |
| 7.6 Price Discrimination 509   |
| 7.7 Advertising in Monopoly 529  |
| 7.8 Regulation of Natural Monopolies 531                                   |
| 7.9 Monopsony 536  |
| Exercises 539  |
| References 546   |
| Game Theory and Imperfect Competition 547                                  |
| 8.1 Game Theory Tools 548  |
| 8.2 Bertrand Model of Price Competition with Homogeneous Products 580      |
| 8.3 Cournot Model of Quantity Competition 584                              |
| 8.4 Product Differentiation 594  |
| 8.5 Dynamic Competition 598  |
| 8.6 Reconciling Cournot and Bertrand: Introducing Capacity Constraints 606 |
| 8.7 Endogenous Entry 610   |
| 8.8 Repeated Interaction 614   |
| Appendix A: Cournot Model with Asymmetric Costs 625                        |
| Appendix B: Cournot Competition with $J \ge 2$ Firms 627                   |
| Exercises 629  |
| References 638   |

Contents

| 9  | Exter | nalities and Public Goods 641   |
|----|-------|---|
|    | 9.1   | Externalities 643   |
|    | 9.2   | Common Pool Resources 649   |
|    | 9.3   | Solutions to the Externality Problem 657                                    |
|    | 9.4   | Regulating a Polluting Monopolist 669                                       |
|    | 9.5   | Regulating a Polluting Oligopoly 671  |
|    | 9.6   | Fee Comparison 676  |
|    | 9.7   | Setting Quotas under Incomplete Information 680                             |
|    | 9.8   | Setting Emission Fees under Incomplete Information 682                      |
|    | 9.9   | Comparing Policy Instruments under Incomplete Information 684               |
|    | 9.10  | Pollution Abatement 685   |
|    | 9.11  | Public Goods 690  |
|    | 9.12  | Inefficiency of the Private Provision of Public Goods 693                   |
|    | 9.13  | Neutrality and the Crowding-out Effect 699                                  |
|    | 9.14  | Remedies to the Underprovision of Public Goods 702                          |
|    | 9.15  | Lindahl Equilibria 704  |
|    | 9.16  | Public Goods That Experience Congestion 707                                 |
|    | 9.17  | Behavioral Motives in Public Good Games 708                                 |
|    | Appe  | ndix: More General Policy Mechanisms 718                                    |
|    | Exerc | cises 722   |
|    | Refer | rences 731  |
| 10 | Cont  | ract Theory 735   |
|    | 10.1  | Moral Hazard 736  |
|    | 10.2  | Moral Hazard with a Continuum of Effort Levels—The First-Order Approach 751 |
|    | 10.3  | Moral Hazard with Multiple Signals 759                                      |
|    | 10.4  | Adverse Selection—The "Lemons" Problem 761                                  |
|    | 10.5  | Adverse Selection—The Principal—Agent Problem 766                           |
|    | 10.6  | Application of Adverse Selection—Regulation 777                             |
|    | Exerc | cises 785   |
|    | Refer | rences 800  |

x Contents

## Mathematical Appendix 803

- A.1 Sets 803
- A.2 Intervals of Real Numbers 805
- A.3 Inequalities 806
- A.4 Sequences 808
- A.5 Functions 812
- A.6 Limits 816
- A.7 Continuity 818
- A.8 Differentiation 825
- A.9 Integration 832
- A.10 Introduction to Topology 835
- A.11 Compactness 842
- A.12 Fixed Point Theorems 845
- A.13 Optimization 848
- A.14 Comparative Statics 853
- A.15 Monotone Comparative Statics: An Introduction 856
- A.16 Introduction to Mathematical Proofs 857

References 858

Index 861