CONTENTS

PREFACE

1 Technology

Measurement of inputs and outputs 1 Specification of technology 2

Example: Input requirement set Example: Isoquant Example: Shortrun production possibilities set Example: Production function Example: Transformation function Example: Cobb-Douglas technology Example: Leontief technology Activity analysis 5 Monotonic technologies
6 Convex technologies 7 Regular technologies 9 Parametric representations of technology 10 The technical rate of substitution 11

Example: TRS for a Cobb-Douglas technology The elasticity of substitution 13 Example: The elasticity of substitution for the Cobb-Douglas
production function Returns to scale 14 Example: Returns to scale
and the Cobb-Douglas technology Homogeneous and homothetic technologies 17 Example: The CES production function Exercises 21

2 Profit Maximization

Profit maximization 25 Difficulties 28 Example: The profit function for Cobb-Douglas technology Properties of demand and supply functions 31 Comparative statics using the first-order conditions 32 Comparative statics using algebra 35 Recoverability 36 Exercises 39

3 Profit Function

Properties of the profit function 40 Example: The effects of price stabilization Supply and demand functions from the profit function 43 The envelope theorem 45 Comparative statics using the profit function 46 Example: The LeChatelier principle Exercises 48

4 Cost Minimization

Calculus analysis of cost minimization 49 More on second-order conditions 52 Difficulties 53 Example: Cost function for the Cobb-Douglas technology Example: The cost function for the CES technology Example: The cost function for the Leontief technology Example: The cost function for the linear technology Conditional factor demand functions 58 Algebraic approach to cost minimization 61 Exercises 63

5 Cost Function

Average and marginal costs 64 Example: The short-run Cobb-Douglas cost functions Example: Constant returns to scale and the cost function The geometry of costs 67 Example: The Cobb-Douglas cost curves Long-run and short-run cost curves 70 Factor prices and cost functions 71 The envelope theorem for constrained optimization 75 Example: Marginal cost revisited Comparative statics using the cost function 76 Exercises 77

6 Duality

Duality 82 Sufficient conditions for cost functions 84 Demand functions 86 Example: Applying the duality mapping Example: Constant returns to scale and the cost function Example: Elasticity of scale and the cost function Geometry of duality 89 Example: Production functions, cost functions, and conditional factor demands The uses of duality 91 Exercises 93

7 Utility Maximization

Consumer preferences 94 Example: The existence of a utility function Example: The marginal rate of substitution Consumer behavior 98 Indirect utility 102 Some important identities 105 The money metric utility functions 108 Example: The Cobb-Douglas utility function Example: The CES utility function Appendix 113 Exercises 114

8 Choice

Comparative statics 116 Example: Excise and income taxes The Slutsky equation 119 Example: The Cobb-Douglas Slutsky equation Properties of demand functions 122 Comparative statics using the first-order conditions 123 The integrability problem 125 Example: Integrability with two goods Example: Integrability with several goods Duality in consumption 129 Example: Solving for the direct utility function Revealed preference 131 Sufficient conditions for maximization 133 Comparative statics using revealed preference 135 The discrete version of the Slutsky equation 137 Recoverability 138 Exercises 140

9 Demand

Endowments in the budget constraint 144 Labor supply • Homothetic utility functions 146 Aggregating across goods 147 Hicksian separability • The two-good model • Functional separability • Aggregating across consumers 152 Inverse demand functions 155 Continuity of demand functions 156 Exercises 157

10 Consumers' Surplus

Compensating and equivalent variations 160 Consumer's surplus 163

Quasilinear utility 164 Quasilinear utility and money metric utility

166 Consumer's surplus as an approximation 167 Aggregation 168

Nonparametric bounds 170 Exercises 171

11 Uncertainty

Lotteries 172 Expected utility 173 Uniqueness of the expected utility function 175 Other notations for expected utility 176 Risk aversion 177 Example: The demand for insurance Global risk aversion 181 Example: Comparative statics of a simple portfolio problem Example: Asset pricing Relative risk aversion 188 Example: Mean-variance utility State dependent utility 190 Subjective probability theory 190 Example: The Allais paradox and the Ellsberg paradox The Allais paradox • Exercises 194

12 Econometrics

The optimization hypothesis 198 Nonparametric testing for maximizing behavior 199 Parametric tests of maximizing behavior 200 Imposing optimization restrictions 201 Goodness-of-fit for optimizing models 201 Structural models and reduced form models 202 Estimating technological relationships 204 Estimating factor demands 207 More complex technologies 207 Choice of functional form 209 Example: The Diewert cost function Example: The translog cost function Estimating consumer demands 210 Demand functions for a single good Multiple equations • Example: Linear expenditure system Example: Almost Ideal Demand System Summary 213

13 Competitive Markets

The competitive firm 215 The profit maximization problem 216 The industry supply function 218 Example: Different cost functions ample: Identical cost functions Market equilibrium 219 Example: Identical firms Entry 220 Example: Entry and long-run equilibrium Welfare economics 221 Welfare analysis 222 Several consumers 224 Pareto efficiency 225 Efficiency and welfare 226 The discrete good Taxes and subsidies 228 Exercises 230 model 227

14 Monopoly

Special cases 236 Comparative statics 236 Welfare and output 238 Quality choice 239 Price discrimination 241 First-degree price discrimination 243 Second-degree price discrimination 244 Example: A graphical treatment Third-degree price discrimination 248 Welfare effects • Exercises 253

15 Game Theory

Description of a game 260 Example: Matching pennies Example: The Prisoner's Dilemma Example: Cournot duopoly Example: Bertrand duopoly Economic modeling of strategic choices 263 Solution concepts 264 Nash equilibrium 265 Example: Calculating a Nash equilibrium Interpretation of mixed strategies 268 Repeated games 269 Example: Maintaining a cartel Refinements of Nash equilibrium 271 Dominant strategies 272 Elimination of dominated strategies 272 Sequential games 273 Example: A simple bargaining model Repeated games and subgame perfection 278 Games with incomplete information 279 Example: A sealed-bid auction Discussion of Bayes-Nash equilibrium 281 Exercises 282

16 Oligopoly

Cournot equilibrium 285 Stability of the system • Comparative statics 288 Several firms 289 Welfare • Bertrand equilibrium 291 Example: A model of sales Complements and substitutes 294 Quantity leadership 295 Price leadership 298 Classification and choice of models 301 Conjectural variations 302 Collusion 303 Repeated oligopoly games 305 Sequential games 307 Limit pricing 308 Exercises 310

17 Exchange

Agents and goods **314** Walrasian equilibrium **315** Graphical analysis **316** Existence of Walrasian equilibria **317** Existence of an equilibrium **319** Example: The Cobb-Douglas Economy The first theorem of welfare economics **323** The second welfare theorem **326** A revealed preference argument • Pareto efficiency and calculus **329** Welfare maximization **333** Exercises **336**

18 Production

Firm behavior 338 Difficulties 340 Consumer behavior 341 Labor supply • Distribution of profits • Aggregate demand 342 Existence of an equilibrium 344 Welfare properties of equilibrium 345 A revealed preference argument • Welfare analysis in a productive economy 348 Graphical treatment 349 Example: The Cobb-Douglas constant returns economy Example: A decreasing-returns-to-scale economy The Nonsubstitution Theorem 354 Industry structure in general equilibrium 356 Exercises 357

19 Time

Intertemporal preferences **358** Intertemporal optimization with two periods **359** Intertemporal optimization with several periods **361** Example: Logarithmic utility General equilibrium over time **363** Infinity

• General equilibrium over states of nature **365** Exercises **366**

20 Asset Markets

Equilibrium with certainty 368 Equilibrium with uncertainty 369
Notation 370 The Capital Asset Pricing Model 371 The Arbitrage
Pricing Theory 376 Two factors • Asset-specific risk • Expected
utility 379 Example: Expected utility and the APT Complete markets
382 Pure arbitrage 383 Appendix 385 Exercises 386

21 Equilibrium Analysis

The core of an exchange economy **387** Convexity and size **393** Uniqueness of equilibrium **394** Gross substitutes • Index analysis • General equilibrium dynamics **398** Tatonnement processes **398** Nontatonnement processes **401** Exercises **402**

22 Welfare

The compensation criterion 404 Welfare functions 409 Optimal taxation 410 Exercises 413

23 Public goods

Efficient provision of a discrete public good 415 Private provision of a discrete public good 417 Voting for a discrete public good 417 Efficient provision of a continuous public good 418 Example: Solving for the efficient provision of a public good Private provision of a continuous public good 420 Example: Solving for Nash equilibrium provision Voting 424 Example: Quasilinear utility and voting Lindahl allocations 425 Demand revealing mechanisms 426 Demand revealing mechanisms with a continuous good 429 Exercises 430

24 Externalities

An example of a production externality 433 Solutions to the externalities problem 433 Pigovian taxes • Missing markets • Property rights • The compensation mechanism 436 Efficiency conditions in the presence of externalities 438 Exercises 439

25 Information

The principal-agent problem 441 Full information: monopoly solution 442 Full information: competitive solution 444 Hidden action: monopoly solution 445 Agent's action can be observed • Analysis of the optimal incentive scheme • Example: Comparative statics Example: Principal-agent model with mean-variance utility Hidden actions: competitive market 455 Example: Moral hazard in insurance markets Hidden information: monopoly 457 Market equilibrium: hidden information 464 Example: An algebraic example Adverse selection 466 The lemons market and adverse selection 468 Signaling 469 Educational signaling 470 Exercises 471

26 Mathematics

Linear algebra 473 Definite and semidefinite matrices 475 Tests for definite matrices • Cramer's rule 477 Analysis 477 Calculus 478 Higher-order derivatives • Gradients and tangent planes 480 Limits 481 Homogeneous functions 481 Affine functions 482 Convex sets 482 Separating hyperplanes 483 Partial differential equations 483 Dynamical systems 484 Random variables 485

27 Optimization

Single variable optimization 487 First-order and second-order conditions • Example: First- and second-order conditions. Concavity • The envelope theorem • Example: The value function Example: The envelope theorem Comparative statics • Example: Comparative statics for a particular problem Multivariate maximization 493 second-order conditions • Comparative statics • Example: Comparative statics Convexity and concavity • Quasiconcave and quasiconvex functions • Constrained maximization 497 An alternative second-order condition 498 How to remember the second-order conditions • The envelope theorem • Constrained maximization with inequality constraints Setting up Kuhn-Tucker problems 504 Existence and continuity of a maximum 506

References / A1 Answers to Odd-Numbered Exercises / A9 Index / A37