

# **Intermediate Microeconomics**

A Modern Approach
Ninth Edition

# **Intermediate Microeconomics**

A Modern Approach
Ninth Edition

Hal R. Varian

University of California at Berkeley



W. W. Norton & Company • New York • London

W. W. Norton & Company has been independent since its founding in 1923, when William Warder Norton and Mary D. Herter Norton first published lectures delivered at the People's Institute, the adult education division of New York City's Cooper Union. The firm soon expanded its program beyond the Institute, publishing books by celebrated academics from America and abroad. By mid-century, the two major pillars of Norton's publishing program—trade books and college texts—were firmly established. In the 1950s, the Norton family transferred control of the company to its employees, and today—with a staff of four hundred and a comparable number of trade, college, and professional titles published each year—W. W. Norton & Company stands as the largest and oldest publishing house owned wholly by its employees.

Copyright © 2014, 2010, 2006, 2003, 1999, 1996, 1993, 1990, 1987 by Hal R. Varian

All rights reserved Printed in the United States of America

#### NINTH EDITION

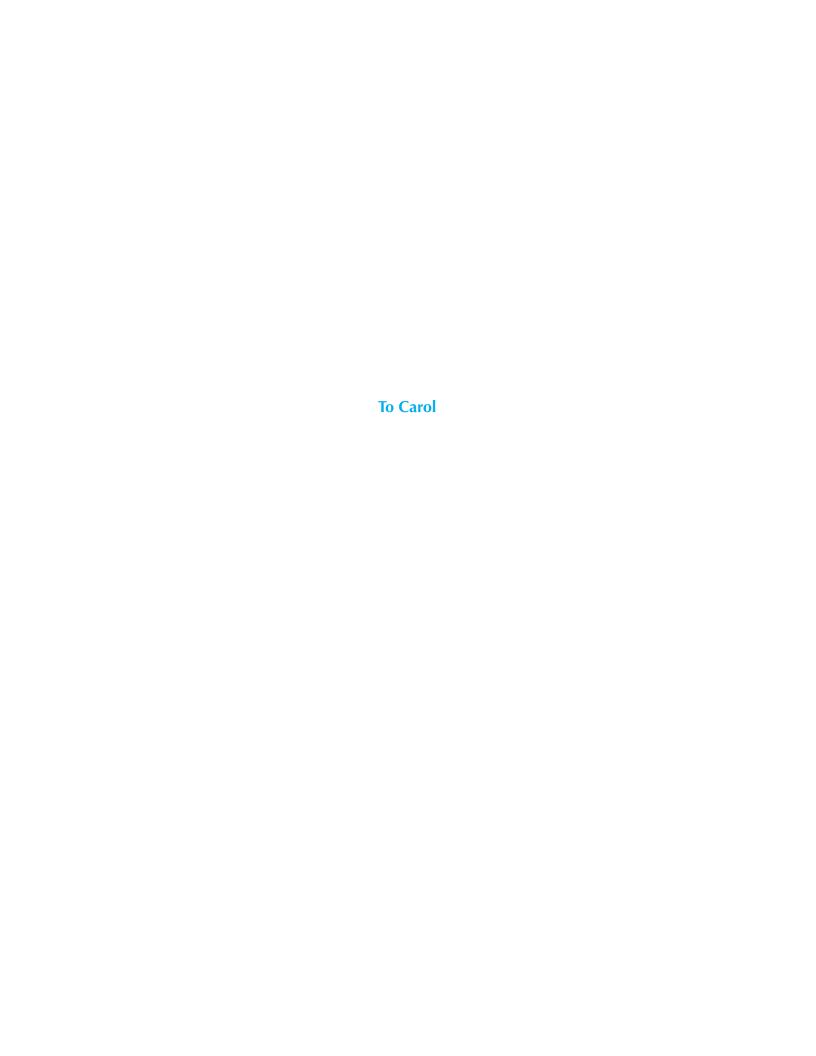
Editor: Jack Repcheck

Senior project editor: Thom Foley Production manager: Andy Ensor Editorial assistant: Theresia Kowara

 $T_E$ Xnician: Hal Varian

ISBN 978-0-393-12396-8

W. W. Norton & Company, Inc., 500 Fifth Avenue, New York, N.Y. 10110 W. W. Norton & Company, Ltd., Castle House, 75/76 Wells Street, London W1T 3QT www.wwnorton.com



# **CONTENTS**

Preface xix

#### 1 The Market

Constructing a Model 1 Optimization and Equilibrium 3 The Demand Curve 3 The Supply Curve 5 Market Equilibrium 7 Comparative Statics 9 Other Ways to Allocate Apartments 11 The Discriminating Monopolist • The Ordinary Monopolist • Rent Control • Which Way Is Best? 14 Pareto Efficiency 15 Comparing Ways to Allocate Apartments 16 Equilibrium in the Long Run 17 Summary 18 Review Questions 19

# 2 Budget Constraint

The Budget Constraint 20 Two Goods Are Often Enough 21 Properties of the Budget Set 22 How the Budget Line Changes 24 The Numeraire 26 Taxes, Subsidies, and Rationing 26 Example: The Food Stamp Program Budget Line Changes 31 Summary 31 Review Questions 32

#### 3 Preferences

Consumer Preferences 34 Assumptions about Preferences 35 Indifference Curves 36 Examples of Preferences 37 Perfect Substitutes

• Perfect Complements • Bads • Neutrals • Satiation • Discrete Goods • Well-Behaved Preferences 44 The Marginal Rate of Substitution 48 Other Interpretations of the MRS 50 Behavior of the MRS 51 Summary 52 Review Questions 52

## 4 Utility

Cardinal Utility 57 Constructing a Utility Function 58 Some Examples of Utility Functions 59 Example: Indifference Curves from Utility Perfect Substitutes • Perfect Complements • Quasilinear Preferences • Cobb-Douglas Preferences • Marginal Utility 65 Marginal Utility and MRS 66 Utility for Commuting 67 Summary 69 Review Questions 70 Appendix 70 Example: Cobb-Douglas Preferences

#### 5 Choice

Optimal Choice 73 Consumer Demand 78 Some Examples 78

Perfect Substitutes • Perfect Complements • Neutrals and Bads •

Discrete Goods • Concave Preferences • Cobb-Douglas Preferences •

Estimating Utility Functions 83 Implications of the MRS Condition 85

Choosing Taxes 87 Summary 89 Review Questions 89 Appendix 90 Example: Cobb-Douglas Demand Functions

#### 6 Demand

Normal and Inferior Goods **96** Income Offer Curves and Engel Curves **97** Some Examples **99** Perfect Substitutes • Perfect Complements • Cobb-Douglas Preferences • Homothetic Preferences • Quasilinear Preferences • Ordinary Goods and Giffen Goods **104** The Price Offer Curve and the Demand Curve **106** Some Examples **107** Perfect Substitutes • Perfect Complements • A Discrete Good • Substitutes and Complements **111** The Inverse Demand Function **112** Summary **114** Review Questions **115** Appendix **115** 

## 7 Revealed Preference

The Idea of Revealed Preference 119 From Revealed Preference to Preference 120 Recovering Preferences 122 The Weak Axiom of Revealed Preference 124 Checking WARP 125 The Strong Axiom of Revealed Preference 128 How to Check SARP 129 Index Numbers 130 Price Indices 132 Example: Indexing Social Security Payments Summary 135 Review Questions 135

# 8 Slutsky Equation

The Substitution Effect 137 Example: Calculating the Substitution Effect The Income Effect 141 Example: Calculating the Income Effect Sign of the Substitution Effect 142 The Total Change in Demand 143 Rates of Change 144 The Law of Demand 147 Examples of Income and Substitution Effects 147 Example: Rebating a Tax Example: Voluntary Real Time Pricing Another Substitution Effect 153 Compensated Demand Curves 155 Summary 156 Review Questions 157 Appendix 157 Example: Rebating a Small Tax

# 9 Buying and Selling

Net and Gross Demands 160 The Budget Constraint 161 the Endowment 163 Price Changes 164 Offer Curves and Demand Curves **167** The Slutsky Equation Revisited 168 Use of the Slutsky Equation 172 Example: Calculating the Endowment Income Effect Labor Supply 173 The Budget Constraint • Comparative Statics of Example: Overtime and the Supply of Labor Sum-Labor Supply 174 Review Questions 179 mary **178** Appendix 179

### 10 Intertemporal Choice

Preferences for Consumption 185 The Budget Constraint 182 parative Statics 186 The Slutsky Equation and Intertemporal Choice Inflation 189 Present Value: A Closer Look 191 ing Present Value for Several Periods 193 Use of Present Value 194 Example: Valuing a Stream of Payments Example: The True Cost of a Credit Card Example: Extending Copyright Bonds 198 ple: Installment Loans Taxes 200 Example: Scholarships and Savings Choice of the Interest Rate 201 Summary 202 Review Questions **202** 

#### 11 Asset Markets

Rates of Return 203 Arbitrage and Present Value 205 Adjustments for Differences among Assets 205 Assets with Consumption Returns 206 Taxation of Asset Returns 207 Market Bubbles 208 Applications 209 Depletable Resources • When to Cut a Forest • Example: Gasoline Prices during the Gulf War Financial Institutions 213 Summary 214 Review Questions 215 Appendix 215

# 12 Uncertainty

Contingent Consumption 217 Example: Catastrophe Bonds Utility Functions and Probabilities 222 Example: Some Examples of Utility Functions Expected Utility 223 Why Expected Utility Is Reasonable Risk Aversion 226 Example: The Demand for Insurance Diversification 230 Risk Spreading 230 Role of the Stock Market 231 Summary 232 Review Questions 232 Appendix 233 Example: The Effect of Taxation on Investment in Risky Assets

# 13 Risky Assets

Mean-Variance Utility 236 Measuring Risk 241 Counterparty Risk 243 Equilibrium in a Market for Risky Assets 243 How Returns Adjust 245 Example: Value at Risk Example: Ranking Mutual Funds Summary 249 Review Questions 250

# 14 Consumer's Surplus

Constructing Utility from Demand Demand for a Discrete Good 252 Other Interpretations of Consumer's Surplus 254 sumer's Surplus to Consumers' Surplus 255 Approximating a Continuous Demand 255 Quasilinear Utility 255 Interpreting the Change in Consumer's Surplus 256 Example: The Change in Consumer's Surplus Compensating and Equivalent Variation 258 Example: Compensating and Equivalent Variations Example: Compensating and Equivalent Variation for Quasilinear Preferences Producer's Surplus 262 Rationing • Calculating Gains and Losses 266 Analysis 264 mary **267** Review Questions 267 Appendix 268 Example: A Example: CV, EV, and Consumer's Surplus Few Demand Functions

#### 15 Market Demand

From Individual to Market Demand 270 The Inverse Demand Function 272 Example: Adding Up "Linear" Demand Curves Discrete Goods 273 The Extensive and the Intensive Margin 273 Elasticity 274 Example: The Elasticity of a Linear Demand Curve Elasticity and Demand 276 Elasticity and Revenue 277 Example: Strikes and Profits Constant Elasticity Demands 280 Elasticity and Marginal Revenue 281 Example: Setting a Price Marginal Revenue Curves 283 Income Elas-Summary 285 Review Questions 286 Appendix 287 Example: The Laffer Curve Example: Another Expression for Elasticity

# 16 Equilibrium

Market Equilibrium 293 Two Special Cases 294 Supply 293 verse Demand and Supply Curves 295 Example: Equilibrium with Linear Curves Comparative Statics 297 Example: Shifting Both Curves Taxes 298 Example: Taxation with Linear Demand and Supply Passing Along a Tax 302 The Deadweight Loss of a Tax 304 Example: The Market for Loans Example: Food Subsidies Example: Subsidies in Iraq Pareto Efficiency 310 Example: Waiting in Line Summary 313 Review Questions 313

#### 17 Measurement

Summarize data 316 Example: Simpson's paradox Test 320 Estimating demand using experimental data 320 Effect of treatment 321 Estimating demand using observational data 322 Functional form • Statistical model • Estimation • Identification 324 What can go wrong? 326 Policy evaluation 327 Example: Crime and police Summary 328 Review Questions 329

#### 18 Auctions

Classification of Auctions 331 Bidding Rules • Auction Design 332 Example: Goethe's auction Other Auction Forms 336 Bidding on eBay Position Auctions 338 Two Bidders • More Than Two Bidders • Quality Scores • Should you advertise on your brand? 341 Auction revenue and number of bidders 342 Problems with Auctions Example: Taking Bids Off the Wall The Winner's Curse 344 Stable Marriage Problem 345 Mechanism Design 346 Review Questions 349 mary 348

# 19 Technology

Inputs and Outputs 350 Describing Technological Constraints 351 Examples of Technology 352 Fixed Proportions • Perfect Substitutes • Cobb-Douglas • Properties of Technology 354 The Marginal Product 356 The Technical Rate of Substitution 356 Diminishing Marginal Product 357 Diminishing Technical Rate of Substitution 357 The Long Run and the Short Run 358 Returns to Scale 358 Example: Datacenters Example: Copy Exactly! Summary 361 Review Questions 362

#### 20 Profit Maximization

Profits 363 The Organization of Firms 365 Profits and Stock Market Value **365** The Boundaries of the Firm 367 Fixed and Variable Factors 368 Short-Run Profit Maximization 368 Comparative Statics Profit Maximization in the Long Run 371 Inverse Factor Demand Curves **372** Profit Maximization and Returns to Scale 373 Profitability 374 Example: How Do Farmers React to Price Supports? Cost Minimization 378 Summary 378 Review Questions 379 Appendix 380

#### 21 Cost Minimization

Cost Minimization 382 Example: Minimizing Costs for Specific Technologies Revealed Cost Minimization 386 Returns to Scale and the Cost Function 387 Long-Run and Short-Run Costs 389 Fixed and Quasi-Fixed Costs 391 Sunk Costs 391 Summary 392 Review Questions 392 Appendix 393

#### **22 Cost Curves**

Average Costs **396** Marginal Costs **398** Marginal Costs and Variable Costs **400** Example: Specific Cost Curves Example: Marginal Cost Curves for Two Plants Cost Curves for Online Auctions **404** Long-Run Costs **405** Discrete Levels of Plant Size **407** Long-Run Marginal Costs **408** Summary **409** Review Questions **410** Appendix **411** 

# 23 Firm Supply

Market Environments 413 Pure Competition 414 The Supply Decision of a Competitive Firm 416 An Exception 418 Another Exception 419 Example: Pricing Operating Systems The Inverse Supply Function 421 Profits and Producer's Surplus 421 Example: The Supply Curve for a Specific Cost Function The Long-Run Supply Curve of a Firm 425 Long-Run Constant Average Costs 427 Summary 428 Review Questions 429 Appendix 429

# **24 Industry Supply**

Short-Run Industry Supply 431 Industry Equilibrium in the Short Run Industry Equilibrium in the Long Run 433 The Long-Run Supply Curve **435** Example: Taxation in the Long Run and in the Short Run The Meaning of Zero Profits 439 Fixed Factors and Economic Rent 440 Example: Taxi Licenses in New York City Economic Rent 442 Rental Rates and Prices 444 Example: Liquor Licenses The Politics of Rent 445 Example: Farming the Government Energy Policy 447 Two-Tiered Oil Pricing • Price Controls • The Entitlement Program • Carbon Tax Versus Cap and Trade 451 Optimal Production of Emissions • A Carbon Tax • Cap and Trade • Summary 455 Questions 455

# 25 Monopoly

Maximizing Profits 458 Linear Demand Curve and Monopoly 459
Markup Pricing 461 Example: The Impact of Taxes on a Monopolist Inefficiency of Monopoly 463 Deadweight Loss of Monopoly 465
Example: The Optimal Life of a Patent Example: Patent Thickets Example: Managing the Supply of Potatoes Natural Monopoly 469 What Causes Monopolies? 472 Example: Diamonds Are Forever Example: Pooling in Auction Markets Example: Price Fixing in Computer Memory Markets Summary 476 Review Questions 476 Appendix 477

# 26 Monopoly Behavior

Price Discrimination 480 First-Degree Price Discrimination 480 Example: First-degree Price Discrimination in Practice Second-Degree Price Discrimination 483 Example: Price Discrimination in Airfares ample: Prescription Drug Prices Third-Degree Price Discrimination 487 Example: Linear Demand Curves Example: Calculating Optimal Price DiscriminationExample: Price Discrimination in Academic Journals Bundling 492 Example: Software Suites Two-Part Tariffs 493 nopolistic Competition 494 A Location Model of Product Differentiation Product Differentiation 500 More Vendors **501** Summary **502** Review Questions 502

#### 27 Factor Markets

Monopoly in the Output Market **503** Monopoly **506** Example: The Minimum Wage Upstream and Downstream Monopolies **510** Summary **512** Review Questions **513** Appendix **513** 

# 28 Oligopoly

Example: Pricing Matching Quantity Lead-Choosing a Strategy 516 The Follower's Problem • The Leader's Problem • Price Comparing Price Leadership and Quantity Leadership Leadership 522 Simultaneous Quantity Setting 525 An Example of Cournot Equilibrium **527** Adjustment to Equilibrium 528 Cournot Equilibrium **529** Simultaneous Price Setting 530 sion **531** Punishment Strategies 533 Example: Price Matching and CompetitionExample: Voluntary Export Restraints Comparison of the Solutions 537 Summary 537 Review Questions 538

# 29 Game Theory

The Payoff Matrix of a Game 540 Nash Equilibrium 542 Mixed Strategies 543 Example: Rock Paper Scissors The Prisoner's Dilemma 545 Repeated Games 547 Enforcing a Cartel 548 Example: Tit for Tat in Airline Pricing Sequential Games 550 A Game of Entry Deterrence 552 Summary 554 Review Questions 555

# **30 Game Applications**

Best Response Curves **556** Mixed Strategies **558** Games of Coordination **560** Battle of the Sexes • Prisoner's Dilemma • Assurance Games • Chicken • How to Coordinate • Games of Competition **564** Games of Coexistence **569** Games of Commitment **571** The Frog and the Scorpion • The Kindly Kidnapper • When Strength Is Weakness • Savings and Social Security • Example: Dynamic inefficiency of price discrimination Hold Up • Bargaining **580** The Ultimatum Game • Summary **583** Review Questions **583** 

#### 31 Behavioral Economics

Framing Effects in Consumer Choice **586** The Disease Dilemma • Anchoring Effects • Bracketing • Too Much Choice • Constructed Preferences • Uncertainty **590** Law of Small Numbers • Asset Integration and Loss Aversion • Time **593** Discounting • Self-control • Example: Overconfidence Strategic Interaction and Social Norms **595** Ultimatum Game • Fairness • Assessment of Behavioral Economics **597** Summary **599** Review Questions **599** 

# 32 Exchange

The Edgeworth Box 602 Trade **604** Pareto Efficient Allocations 605 Market Trade 607 The Algebra of Equilibrium 609 Walras' Law **611** Relative Prices 612 Example: An Algebraic Example of Equilibrium The Existence of Equilibrium 614 Equilibrium and Effi-The Algebra of Efficiency 616 ciency 615 Example: Monopoly in the Edgeworth Box Efficiency and Equilibrium 619 Implications of the First Welfare Theorem 621 Implications of the Second Welfare Theorem Summary 625 Review Questions 626 Appendix 626

#### 33 Production

The Robinson Crusoe Economy 628 Crusoe, Inc. 630 The Firm 631 Robinson's Problem **632** Putting Them Together **632** Different Technologies **634** Production and the First Welfare Theorem **636** tion and the Second Welfare Theorem 637 Production Possibilities 637 Comparative Advantage 639 Pareto Efficiency **641** Castaways, Inc. Robinson and Friday as Consumers 645 Decentralized Resource Summary 647 Allocation 646 Review Questions 647 dix **648** 

#### 34 Welfare

Aggregation of Preferences **651** Social Welfare Functions **653** Welfare Maximization **655** Individualistic Social Welfare Functions **657** Fair Allocations **658** Envy and Equity **659** Summary **661** Review Questions **661** Appendix **662** 

#### 35 Externalities

Smokers and Nonsmokers **664** Quasilinear Preferences and the Coase Theorem **667** Production Externalities **669** Example: Pollution Vouchers Interpretation of the Conditions **674** Market Signals **677** Example: Bees and Almonds The Tragedy of the Commons **678** Example: Overfishing Example: New England Lobsters Automobile Pollution **682** Summary **684** Review Questions **684** 

# **36 Information Technology**

Systems Competition 687 The Problem of Complements 687 lationships among Complementors • Example: Apple's iPod and iTunes Example: Who Makes an iPod? Example: AdWords and AdSense Lock-A Model of Competition with Switching Costs • Example: Online Bill Payment Example: Number Portability on Cell Phones Network Externalities 697 Markets with Network Externalities 697 ket Dynamics 699 Example: Network Externalities in Computer Software Implications of Network Externalities 703 Example: The Yellow Example: Radio Ads Two-sided Markets 705 A Model of Two-sided Markets • Rights Management 706 Example: Video Rental Sharing Intellectual Property 708 Example: Online Two-sided Markets Summary 711 Review Questions 712

#### 37 Public Goods

When to Provide a Public Good? 714 Private Provision of the Public Free Riding 718 Different Levels of the Public Good 720 Quasilinear Preferences and Public Goods 722 Example: Pollution Revisited The Free Rider Problem 724 Comparison to Private Goods 726 Voting 727Example: Agenda Manipulation The Vickrey-Groves Mechanism • The VCG Mech-Clarke-Groves Mechanism 730 anism • Examples of VCG 732 Vickrey Auction • Clarke-Groves Mechanism • Problems with the VCG 733 Summary 734 Questions 735 Appendix 735

# 38 Asymmetric Information

The Market for Lemons 738 Quality Choice 739 Choosing the Quality • Adverse Selection 741 Moral Hazard 743 Moral Hazard and Adverse Selection 744 Signaling 745 Example: The Sheepskin Effect Incentives 749 Example: Voting Rights in the Corporation Example: Chinese Economic Reforms Asymmetric Information 754 Example: Monitoring Costs Example: The Grameen Bank Summary 757 view Questions 758

# **Mathematical Appendix**

Functions A1 Graphs A2 Properties of Functions A2 Inverse Functions A3 Equations and Identities A3 Linear Functions A4 Changes and Rates of Change A4 Slopes and Intercepts A5 Absolute Values and Logarithms A6 Derivatives A6 Second Derivatives A7 The Product Rule and the Chain Rule A8 Partial Derivatives A8 Optimization A9 Constrained Optimization A10

Answers A11

Index A31

# **PREFACE**

The success of the first eight editions of *Intermediate Microeconomics* has pleased me very much. It has confirmed my belief that the market would welcome an analytic approach to microeconomics at the undergraduate level.

My aim in writing the original text was to present a treatment of the methods of microeconomics that would allow students to apply these tools on their own and not just passively absorb the predigested cases described in the text. I have found that the best way to do this is to emphasize the fundamental conceptual foundations of microeconomics and to provide concrete examples of their application rather than to attempt to provide an encyclopedia of terminology and anecdote.

A challenge in pursuing this approach arises from the lack of mathematical prerequisites for economics courses at many colleges and universities. The lack of calculus and problem-solving experience in general makes it difficult to present some of the analytical methods of economics. However, it is not impossible. One can go a long way with a few simple facts about linear demand and supply functions, and some elementary algebra. It is perfectly possible to be analytical without being excessively mathematical.

The distinction is worth emphasizing. An analytical approach to economics is one that uses rigorous, logical reasoning. This does not necessarily require the use of advanced mathematical methods. The language of mathematics certainly helps to ensure a rigorous analysis and using it is undoubtedly the best way to proceed when possible, but it may not be appropriate for all students.