ESSENTIAL MICROECONOMICS

Essential Microeconomics is designed to help students deepen their understanding of the core theory of microeconomics. Unlike other texts, this book focuses on the most important ideas and does not attempt to be encyclopedic. Two-thirds of the textbook focuses on price theory. As well as taking a new look at standard equilibrium theory, there is extensive examination of equilibrium under uncertainty, the capital asset pricing model, and arbitrage pricing theory. Choice over time is given extensive coverage and includes a basic introduction to control theory. The final third of the book, on game theory, provides a comprehensive introduction to models with asymmetric information. Topics such as auctions, signaling, and mechanism design are made accessible to students who have a basic rather than a deep understanding of mathematics. There is ample use of examples and diagrams to illustrate issues, as well as formal derivations.

John G. Riley is Distinguished Professor of Economics at the University of California, Los Angeles. A Fellow of the Econometric Society, his research has appeared in eminent journals such as the *American Economic Review, Econometrica, Journal of Political Economy, Quarterly Journal of Economics*, *Review of Economic Studies, Journal of Economic Theory*, and the *RAND Journal of Economics*. With the late Jack Hirshleifer, Professor Riley coauthored *The Analytics of Uncertainty and Information* (Cambridge University Press, 1992), a new edition of which is forthcoming with Sushil Bikhchandani of UCLA.

ESSENTIAL MICROECONOMICS

JOHN G. RILEY

University of California, Los Angeles

CAMBRIDGE
UNIVERSITY PRESS

Brief Contents

Contents

viii   *Contents*

Contents   ix

Preface

Although proving a theorem is always a special joy, finding a convincing way to understand why theorems are true has always been a major fascination. I often learn much more from an informal graphical argument or from a well-thought-out example than from the formal analysis. Perhaps that is why I have always enjoyed teaching so much. It is very satisfying to take a major idea in economic theory and explain it in a way that gives students a new and deeper understanding.

I have written this text with the core goal of answering the question "Why?" in a clear and convincing manner. Some texts try to be encyclopedic. This one does not. Instead it explores the most important contributions of both price theory and game theory with the objective of developing strong insights as to why the results are true.

People learn in different ways. I remember once excitedly showing Roy Radner a diagrammatic explanation of a paper he had written with Joe Stiglitz. Roy listened patiently, then smiled and said, "Very good, John, but I never did understand a graphical argument!" Despite this disappointment, most people do find a clear diagram very helpful. There are a lot of them in this text. Yet looking at a graph only takes learning so far. There is no substitute for learning by doing. For this reason there is a strong focus on exercises. Many of the exercises are illustrative examples, but many others provide opportunities for a student to prove something related to the theorems presented in the text. Answers to all of the questions are provided. Half are in the text, and the rest can be found on the Web site, http://www.essentialmicroeconomics.com.

I have learned from many remarkable economists. My earliest inspiration and mentor was Bert Brownlie at the University of Canterbury. In addition, two very early and profoundly different teachers were Joe Stiglitz, who presented a freshly written paper in every class, and Gerard Debreu, whose teaching discipline and clarity were stunning. At MIT my approach to both teaching and research was deeply influenced by Bob Solow. Then, as a junior

colleague at UCLA, I taught my first classes on the economics of uncertainty with my most important mentor, Jack Hirshleifer. Our teaching styles were very different but complementary. Among my recent colleagues at UCLA, Christian Hellwig and William Zame have been especially influential. Of course I have learned much from coauthors, in particular from Eric Maskin.

Synopsis of the Text

Essential Microeconomics is designed to help students deepen their understanding of the core theory of microeconomics. Unlike other texts, this book focuses on the most important ideas and does not attempt to be encyclopedic.

Two-thirds of the book focuses on price theory. As well as taking a new look at standard equilibrium theory, there is an extensive examination of equilibrium under uncertainty, the capital asset pricing model, and arbitrage pricing theory. Choice over time is also given extensive coverage and includes a basic introduction to continuous time models (control theory).

The final third of the book, on game theory, has an extensive introduction to models with asymmetric information. Topics such as auctions, signaling, and mechanism design are made very accessible to students who have a basic rather than a deep understanding of mathematics.

There is extensive use of examples and diagrams to illustrate the essence of an issue, as well as formal derivations. Readers have a choice of whether to go beyond the core ideas to the underlying mathematics of the model.

Problem solving is crucial to developing a deep understanding of a topic. Therefore the book contains a large number of exercises (all with answers available). Most provide the reader with opportunities to apply economic principles. Other questions ask the reader to extend the formal theory.

There is also a Web-based self-learning course to help students review the mathematics that is used in the text.

Approach of the Text and Summary of Chapters and Appendixes

In contrast to most economics textbooks, which typically hide all the "required mathematics" in an appendix, this book opens with a discussion of the theory of maximization. To be an effective economic theorist it is essential to develop the ability to look at a problem from both a mathematical and an economics perspective. To use a language metaphor, a student needs to be able to think not only in the language of mathematics but also like an economist. Developing that bilingual skill is the goal of the first chapter.

It is very important to read Chapter 1 carefully and thoroughly. Then, in working through the next four chapters, the reader will develop both a high comfort level with the principles of maximization and an appreciation of the role that prices play in allocating resources.

Although a large part of modern research is game theoretic, the core of economic theory is price theoretic. Therefore anyone who wants to be an effective economics practitioner needs to understand both the power of price theory and its limitations. Chapter 2 examines price-taking behavior by a consumer. In contrast with traditional texts, it focuses on extracting insights about the elasticity of demand with respect to prices and income. The timeless model is then generalized to incorporate choice over time. In a formal sense this is a direct reinterpretation of the timeless model. However, this mathematical viewpoint glosses over the role of futures markets, future spot markets, and market intermediaries like banks.

In Chapter 3 the two great welfare theorems are examined in a simple economy in which consumers exchange their endowments of commodities. In such an economy the theorems are quite easily proved. However, to develop a real appreciation of the theorems it is extremely helpful to consider them in the context of examples with two commodities and two consumers. These "Edgeworth box" economies are examined in detail.

Chapter 4 on firms begins by examining cost minimization by a single firm that is a price taker in input markets and then studies the relationship between local returns to scale and minimized average cost. The chapter then

xv

focuses on how costs influence the equilibrium price of output if there are many competing firms. Introductory textbooks study market equilibrium if firms are price takers in the output market as well as input markets. Given the deeper analysis of the relationship between input prices and cost, the focus here is on how changes in input prices affect each firm's cost and hence the equilibrium output price.

Under the assumption of increasing returns to scale it is efficient for industry output to be produced by a single firm. The final topic of the chapter is monopoly pricing. A monopoly firm profits from raising output price above marginal cost. If resale is costly, a monopoly also has an incentive to price a commodity differently for different groups of buyers. In addition, it has an incentive to vary the price per unit with the number of units purchased. One simple way to do so is to introduce two-part pricing. Each buyer is charged a monthly fee for access to the product or service and also pays a price for each unit purchased. Legal restrictions typically prohibit firms from excluding classes of consumers. However a monopoly still has an incentive to offer a menu of different two-part pricing schemes. The chapter concludes with a discussion of how to choose the profit-maximizing two-part pricing scheme.[1]

Chapter 5 adds firms to the simple exchange economy of Chapter 3, and also examines the conditions under which there exist prices at which all markets clear. The market equilibrium model is then generalized to incorporate public goods and choice over time. Finally the chapter considers equilibrium in an economy that exhibits constant returns to scale at the market level. In such an environment the price of outputs is determined by costs and hence by technology. This makes it possible to draw strong conclusions about the way technology affects equilibrium prices.

Most texts give short shrift to choice over time. Chapter 6 redresses the balance. With a finite number of periods a model with time is mathematically indistinguishable from a timeless model. However, to derive useful economic insights it is necessary to make strong assumptions about the linkages between periods, for both preferences and technology. As a modeling simplification it is often easier to assume that there is no last period. Instead the number of periods is infinite. The goal of this chapter is to provide an understanding both of why simplifying assumptions are made and of the tight connection between models with a large but finite number of periods and infinite horizon models. Another modeling choice is between models in which there are discrete time periods and those where time is a continuous variable. A further goal is to introduce the reader to the continuous model.

---

[1] The goal is to give the reader insights into "mechanism design" without having to worry about the subtleties.

First it is examined as the limit of the discrete time model. Then Pontryagin's Maximum Principle for continuous time models is derived.

Chapter 7 introduces uncertainty. A commodity is no longer defined only by its characteristics and time of delivery but also by the state of the world (or more simply "state"). For example, an insurance company contracts to supply funds for surgery if the state of the world is "malfunctioning heart." Aversion to risk is central to decision making under uncertainty. This chapter examines how to model differences in risk aversion. It also studies the conditions under which different risky prospects can be ranked regardless of a consumer's aversion to risk.

Chapter 8 extends the basic equilibrium model to financial markets. Typically texts focus on the Arrow-Debreu "complete market" equilibrium in which every commodity can be traded in every contingency. Such equilibrium is a direct extension of the standard timeless model. This chapter takes the complete market equilibrium as a starting point and then examines equilibrium when there are more limited trading opportunities. The chapter first provides conditions under which trading only in securities markets achieves complete market equilibrium outcomes. It then examines models when trading in financial markets offers more limited risk-spreading opportunities. Both the capital asset pricing model and arbitrage pricing model are examined.

Chapter 9 introduces the reader to the basic concepts in game theory. The strategies of the players in a game are Nash equilibrium strategies if they are mutual best responses. To play such a strategy requires that players share a deep understanding of the game being played. The chapter discusses in detail this critical but controversial assumption (the "common knowledge" assumption).

Chapter 10 takes up the subtleties of game theory when players have private information. Typically such games have multiple Nash equilibria or even a continuum of equilibria. The assumption that all players know which equilibrium is being played stretches the common knowledge assumption even further. As an alternative, game theorists have sought ways to refine the definition of equilibrium to yield a unique refined equilibrium. Commonly used refinements are examined. The final section examines an infinitely repeated game in which strategies are private but all players observe a public signal that is correlated with the actions taken.

Chapter 11 further develops the theory of games with private information. Different types of player typically take different actions. If each player is taking his or her equilibrium action there can be no advantage in switching to the strategy of some other type. Strategies for which this is true are said to be incentive compatible. At the core of successful modeling of private information is an assumption about preferences (the "single crossing

property") that greatly simplifies the constraints imposed by incentive compatibility. The implications of single crossing are examined and then applied to the theory of signaling. The chapter next introduces mechanism design under the single crossing property. To develop insights into solution methods, the chapter then examines the design of selling schemes by a monopolist facing buyers with different demand functions.

Chapter 12 applies the principles of mechanism design to the theory of auctions and public good provision. It explores major results in ranking different types of auctions. The method of analysis is then used to examine efficient public good provision. In contrast with the auction environment in which the efficient mechanism generates revenue to the mechanism designer, the efficient provision of public goods generates a loss to the designer. The reasons for the different results are examined, and it is shown that an auction is only efficient and profitable if the reservation price of the seller is public information.

The three appendixes cover the mathematics that is essential to any graduate course in microeconomics. Appendix A examines the foundations of calculus with a single variable and also introduces concave and quasi-concave functions. Appendix B focuses on mappings of vectors and includes an introduction to difference equations. Appendix C provides the foundations of multivariable constrained optimization.

Thoughts on Teaching Microeconomic Theory

Economics is built on two fundamental ideas: each agent in a population makes choices based on the agent's underlying preferences, and the outcome for the population is an equilibrium outcome. So a student who really understands individual optimizing behavior and notions of price and game theoretic equilibria is ready to do research in any field of economics. Therefore the key to successful teaching is to give each student a deep understanding of these two ideas.

Doing so means presenting the big theorems and proving a version of the theorems that is appropriate to the mathematical preparation of the class. Yet this is only the beginning. It is even more important to breathe life into the theorems by showing how they can be applied to generate useful insights. Thus I believe that a significant fraction of class time should be spent on applications and examples.

Consider, for example, the Walrasian equilibrium. Understanding the two great welfare theorems and how to prove existence using a fixed point theorem is important. Yet it is only through the study of the special cases of Edgeworth box and representative agent models that a student gets a sense of how general equilibrium influences economic outcomes. One great

example is the constant returns to scale model of international trade theory with two inputs and two outputs. There is so much to learn from this model. A second example is equilibrium risk sharing through trading in contingent and security markets. At a formal level it is simply a matter of showing that the new model is mathematically equivalent. Therefore all the theorems without uncertainty generalize. The important step is helping students develop an understanding of how risk is shared in a Walrasian equilibrium using simpler models such as the capital asset pricing model.

To further develop the ability to draw insights from and apply theory, homework should be devoted almost entirely to examples and applications. Of course, the teaching assistant must first offer help where the instructor has left students mystified, but after this is done, the focus should be on examples and applications.

The text offers many practice exercises, and there are more on the Web site. If you are willing to share exercises that you have found helpful, send them to me, and I will add a selection to the site and acknowledge your help. The Web site also contains a set of slides for each chapter and the appendixes. I am never satisfied with my presentations so I cannot say that the slides represent the way I would next teach the material. However, to a first approximation, they represent the way I recently thought the topics should be presented.

Web Site

The Web site www.essentialmicroeconomics.com complements the text. One critical challenge for a teacher of a first-year graduate class is the wide variation in students' mathematical backgrounds. To ameliorate these problems the Web site offers a two-part approach. First, there is a Web page containing a set of calculus and linear algebra review modules that students can work through to check their level of preparedness. Each module provides problem sets (primarily on optimization) and lots of hints to help a student work through each problem. Second, there is a Web page containing a set of slides on "Mathematical Foundations." These cover most of the topics in the three appendices. At UCLA these lectures are offered to entering graduate students in a two-week intensive "Summer Math Camp." Any student who has successfully worked through both the modules and the topics covered in the slides will be fully prepared.

The Web site also provides a set of slides for each chapter. These are designed to help an instructor or teaching assistant prepare lectures and also to provide students with a summary of material covered. Although half of the answers to the problems sets are in the textbook, the other half are accessible only from the Web site. Especially for the later chapters there are also notes on topics not covered in the text, additional exercises, and links to other Web-based material. Suggestions as to additional helpful links are welcome.

Finally the student has access to the UCLA Auction House. This Web site is designed to introduce the reader to competitive bidding. For a series of different auction environments, students have the opportunity to bid against one or more "robot" bidders who follow theoretical equilibrium strategies. Instructors are welcome to suggest additional auctions.