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ECONOMICS

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Third Edition

Global Edition

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Third Edition

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ECONOMICS

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Dedication

With love for Annika, Aras, Arda, Eli,
Greta, Mason, Max, and Noah,
who inspire us every day.

About the Authors

Daron Acemoglu is an Institute Professor in the Department of Economics at the Massachusetts Institute of Technology. He has received a B.A. in economics from the University of York, 1989; an M.Sc. in mathematical economics and econometrics from the London School of Economics, 1990; and a Ph.D. in economics from the London School of Economics in 1992.

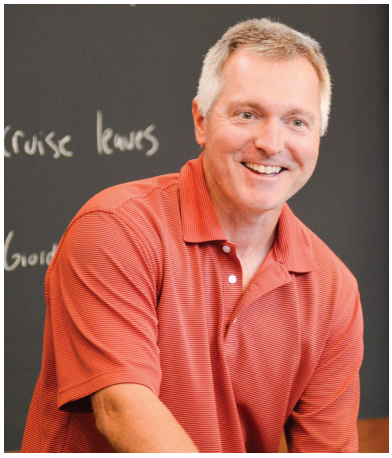
He is an elected fellow of the National Academy of Sciences, the American Academy of Arts and Sciences, the Econometric Society, the European Economic Association, and the Society of Labor Economists. He has received numerous awards and fellowships, including the inaugural T. W. Schultz Prize from the University of Chicago in 2004, the inaugural Sherwin Rosen Award for outstanding contribution to labor economics in 2004, the Distinguished Science Award from the Turkish Sciences Association in 2006, the John von Neumann Award, Rajk College, Budapest, in 2007, the Carnegie Fellowship in 2017, the Jean-Jacques Laffont Prize in 2018, and the Global Economy Prize in 2019.

He was also the recipient of the John Bates Clark Medal in 2005, awarded every two years to the best economist in the United States under the age of 40 by the American Economic Association, the Erwin Plein Nemmers Prize, awarded every two years for work of lasting significance in economics, and the BBVA Frontiers of Knowledge Award in Economics, Finance and Management. He holds honorary doctorates from the University of Utrecht, Bosporus University, University of Athens, Bilkent University, University of Bath, Ecole Normale Superieure, Saclay Paris, and the London Business School.

His research interests include political economy, economic development and growth, human capital theory, growth theory, innovation, inequality, search theory, network economics, and learning.

His books include *Economic Origins of Dictatorship and Democracy* (jointly with James A. Robinson), which was awarded the Woodrow Wilson and the William Riker prizes, *Introduction to Modern Economic Growth,* and *Why Nations Fail: The Origins of Power, Prosperity, and Poverty* (jointly with James A. Robinson), which has become a *New York Times* bestseller, and *The Narrow Corridor: States, Societies, and the Fate of Liberty* (jointly written with James A. Robinson).

David Laibson is the Robert I. Goldman Professor of Economics at Harvard University and the Faculty Dean of Lowell House. He is also a member of the National Bureau of Economic Research, where he is Research Associate in the Asset Pricing, Economic Fluctuations, and Aging Working Groups and where he co-directs the National Institute of Aging Roybal Center for Behavior Change in Health. His research focuses on the topics of behavioral economics, intertemporal choice, macroeconomics, and household finance, and he leads Harvard University's Foundations of Human Behavior Initiative. He serves on the Pension Research Council (Wharton), Harvard's Pension Investment Committee, and the Board of the Russell Sage Foundation. He has previously served on the boards of the Health and Retirement Study (National Institutes of Health) and the Academic Research Council of the Consumer Financial Protection Bureau. He is a recipient of a Marshall Scholarship, a Fellow of the Econometric Society, and an elected member of the American Academy of Arts and Sciences and the National Academy of Sciences. He is also a recipient of the T. W. Schultz Prize from the University of Chicago and the TIAA-CREF Paul A. Samuelson Award for Outstanding Scholarly Writing on Lifelong Financial Security. Laibson holds degrees from Harvard University (A.B. in economics), the London School of Economics (M.Sc. in econometrics and mathematical economics), and the Massachusetts Institute of Technology (Ph.D. in economics). He received his Ph.D. in 1994 and has taught at Harvard since then. In recognition of his teaching excellence, he has been awarded Harvard's Phi Beta Kappa Prize and a Harvard College Professorship.



John A. List is the Kenneth C. Griffin Distinguished Service Professor in Economics at the University of Chicago. He received his B.S. in economics at the University of Wisconsin-Stevens Point, and Ph.D. in economics at the University of Wyoming. List joined the UChicago faculty in 2005, and served as Chairman of the Department of Economics from 2012–2018. Prior to joining the University of Chicago, he was a professor at the University of Central Florida, University of Arizona, and University of Maryland.

List was elected a Member of the American Academy of Arts and Sciences in 2011, and a Fellow of the Econometric Society in 2015. He also received the Arrow Prize for Senior Economists in 2008, the Kenneth Galbraith Award in 2010, the Yrjo Jahnsson Lecture Prize in 2012, and the Klein Lecture Prize in 2016. He received an honorary doctorate from Tilburg University in 2014, and from the University of Ottawa in 2017. John was also named a Top 50 Innovator in the Non-Profit Times for 2015 and 2016 for his work on charitable giving. He also served in the White House on the Council of Economic Advisers from 2002–2003, and is a Research Associate at the NBER.

His research focuses on questions in microeconomics, with a particular emphasis on using field experiments to address both positive and normative issues. For decades his field experimental research has focused on issues related to the inner-workings of markets, the effects of various incentives schemes on market equilibria and allocations, how behavioral economics can augment the standard economic model, on early childhood education and interventions, and most recently on the gender earnings gap in the gig economy (using evidence from rideshare drivers).

His research includes over 200 peer-reviewed journal articles and several published books, including the 2013 international best-seller, *The Why Axis: Hidden Motives and the Undiscovered Economics of Everyday Life* (with Uri Gneezy).

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Brief Contents

Contents

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Preface

What's New in the Third Edition?

This revision is driven by the extraordinary period of economic history in which we are living in and its rich supply of applications that help bring the content into context for today's learners.

In our new edition of *Economics*, in addition to updating the existing data and empirical features, we have added Evidence-Based Economics Problems at the end of each chapter. These exercises provide students meaningful practice in analyzing and interpreting real-world economic questions. Here are some examples of other changes in the edition. Throughout this revision, we updated the data and charts to the most recent releases and made the text current for the recent global recession, the COVID-19 pandemic, and the 2020 election. We also undertook a number of more specific changes and added various new materials as we detail next.

- In Chapter 1, we've added new coverage on how to examine the economic impacts of COVID-19 through positive and normative lenses. We also discuss the trade-offs between health and economic output during the COVID-19 crisis. New Evidence-Based Economics Problems focus on the opportunity cost of social media, higher education, and going to a movie.
- In Chapter 4, we tell the story of how stay-at-home orders in 2020 impacted the demand for gasoline. A new Letting the Data Speak section profiles how the price of crude oil temporarily fell below $0 per barrel.
- Chapter 5, a new Letting the Data Speak feature focuses on the impact of tax salience on price elasticity. New Evidence-Based Economics Problems explore the effectiveness of financial incentives to get people to quit smoking.
- In Chapter 6, a new Letting the Data Speak segment provides an example of long-run competitive equilibrium by examining the effect of base fare increases on Uber driver earnings.
- In Chapter 7, a new Letting the Data Speak feature "Adam Smith Visits the White House" examines the costs and benefits of government regulation and safety.
- In Chapter 9, a new Choices & Consequences example "Coronavirus Vaccination: Positive Externalities in Spots You Never Imagined," explores the society-wide impacts vaccination. New Evidence-Based Economics Problems analyze the linkage between hydraulic fracking and increased rates of earthquakes in Oklahoma.
- In Chapter 11, we emphasize the role of microeconomics in examining prominent social issues, from "Paying for Worker Training" to "Broadband and Inequality." New Evidence-Based Economics opener on employment discrimination and the Democratic presidential nomination. Using empirical research from economists Claudia Goldin, Cecilia Rouse, Marianne Bertrand, Sendhil Mullainathan, Kerwin Charles, and Jon Guryan, a new Evidence-Based Economics exercise examines the role of discrimination in explaining differences in wages across gender and ethnicity.
- In Chapter 14, we explore the connection between market power and the two-party system in a new Letting the Podcast Speak feature.
- In Chapter 16, we discuss how corporate social responsibility programs can address information asymmetries in the workplace in a new Letting the Podcast Speak section.

- Chapter 18 includes a new Letting the Podcast Speak feature focused on how companies can optimize apologies to their customers. The feature uses field experiment data of millions of Uber trips to answer the question "What is the most effective and efficient way to say 'I'm sorry'?"
- In Chapter 19, we explore the macroeconomic indicators related to the COVID-19 recession. A new Evidence-Based Economics Problem highlights the national income accounting identity.
- Chapter 20 includes new Evidence-Based Economics Problems on efficiency and determinants of cross-country differences in GDP per capita.
- Chapter 21 features new Evidence-Based Economics Problems on GDP growth and investment into human capital, physical capital, and technology.
- In Chapter 22, a new Evidence-Based Economics Problem examines whether economic development is tied to climate.
- In Chapter 23, we added a new Evidence-Based Economics section about wages and employment during the COVID-19 pandemic. A new Letting the Data Speak feature profiles racial discrimination in the labor market. An updated "Luddites and Robots" Choice and Consequence feature explores future implications of AI on employment. New Evidence-Based Economics Problems assess downward rage rigidity and labor market contractions.
- In Chapter 24, we examine savings rate and bank failures during the COVID-19 recession and include a new Evidence-Based Economics Problem on bank failures.
- In Chapter 25, we explore the Fed's reaction to the COVID-19 recession. Our new treatment of monetary policy emphasizes interest on reserves (IOR), which is now the key mechanism that the Fed uses to pin down the federal funds rate. A new Letting the Data Speak section includes research on inflation expectations. The Evidence- Based Economics Problem examines the quantity theory of money.
- In Chapter 26, we offer an updated and expanded discussion on the causes of recessions and a new Evidence-Based Economics section tracking the recession of 2020 and the global economic impact of the COVID-19 pandemic. New Evidence- Based-Economic Problems cover the 2007–2009 and 2020 recessions, as well as an application of Okun's Law.
- In Chapter 27, we've added a new discussion of the government expenditure multiplier during the 2007–2009 and 2020 recessions. We examine shifting the federal funds rate by shifting the demand for reserves and analyze recent changes in the Fed's balance sheet and the federal funds rate. Chapter 27 also includes this new material:
- We discuss quantitative easing, the Fed's role as lender of last resort, and monetary policy at the zero lower bound.
- A new Evidence-Based Economic Problem examines the spending multipliers of the CARES act, which builds from in-chapter explorations of the CARES act and the impact of fiscal policy on government deficits.
- Chapter 28 contains an updated Choice and Consequence feature on trade policy and politics, including recent changes in U.S. trade policy and Brexit. New Evidence- Based Economics Problems examine economic growth, different sectors of the economy, and child labor.
- Using updated data from 2020, Chapter 29 investigates the foreign exchange market and how it relates to the real economy. Updated Evidence-Based Economics Problems on managed exchange rates explore how George Soros's hedge funds made considerable profits by betting on the devaluation of the British pound, Thai baht, and U.S. dollar.

Solving Learning and Teaching Challenges

Many students who take introductory economics courses have difficulty seeing the relevance of the key concepts of opportunity cost, trade-offs, scarcity, and demand and supply to their lives and their careers. This reduces the willingness of many students to prepare for class and to be engaged during class. With this textbook, we show them how to apply economic thinking creatively to improve their work, their choices, and their daily lives. One of our main objectives in writing this textbook was to show that the fundamentals of economics are not just exciting but also alive with myriad personal applications.

We love economics. We marvel at the way economic systems work. When we buy a smartphone, we think about the complex supply chain and the hundreds of thousands of people who played a role in producing an awe-inspiring piece of technology that was assembled from components manufactured across the globe.

The market's ability to do the world's work without anyone being in charge strikes us as a phenomenon no less profound than the existence of consciousness or life itself. We believe that the creation of the market system is one of the greatest achievements of humankind.

We wrote this book to highlight the simplicity of economic ideas and their extraordinary power to explain, predict, and improve what happens in the world. We want students to master the *essential* principles of economic analysis. With that goal in mind, we identify the three key ideas that lie at the heart of the economic approach to understanding human behavior: optimization, equilibrium, and empiricism. These abstract words represent three ideas that are actually highly intuitive.

The breakneck speed of modern technological change has, more than ever, injected economics into the lives—and hands—of our students. The technologies that they use daily illustrate powerful economic forces in action: Uber users observe real-time congestion in the transportation market when they confront surge pricing, and Airbnb travelers explore the relationships among location, convenience, and price by comparing listings near different subway stops in the same city.

As educators, it's our job to transform economic concepts into language, visual representations, and empirical examples that our students understand. Today, markets are much more interactive than they were only a decade ago, and they exemplify that it is not just competitive markets with perfect information that are relevant to our economic lives. Our students routinely take part in auctions, purchase goods and services via organized platforms such as Uber, have to struggle with pervasive informational asymmetries as they participate in online exchanges, and have to guard themselves against a bewildering array of mistakes and traps that are inherent to these new transactions.

In this ever-changing world, students must understand not just well-known economic concepts such as opportunity cost, supply, and demand but also modern ones such as game theory, auctions, and behavioral mistakes. It is these modern concepts, which are bit parts in most Principles textbooks, that occupy center stage in ours. Today economic analysis has expanded its conceptual and empirical boundaries and, in doing so, has become even more relevant and useful.

This new world provides opportunities for the teaching of economics as well, provided that we adjust our Principles canon to include modern and empirically based notions of economics. This has been our aim from day one and continues to be our aim in this third edition.

At a time when competing empirical claims abound and news sources across the political spectrum are denounced as "fake," our students need the skills to systematically question and evaluate what they read. That is why, in our Evidence-Based Economics segments and end-of-chapter assignments, we examine both the implications and the limitations of academic studies. We hope that our textbook will help form a new generation of careful thinkers, smart decision makers, engaged citizens, and even a few future economists!

Our Vision: Three Unifying Themes

Optimization

The first key principle is that people try to choose the best available option: optimization. We don't assume that people always successfully optimize, but we do believe that people try to choose the best option and often do a relatively good job of it. Because most decision makers try to choose the alternative that offers the greatest net benefit, optimization is a useful tool for predicting human behavior. Optimization is also a useful prescriptive tool. By teaching people how to do cost-benefit analysis we improve their decisions and the quality of their lives. By the end of this course, every student should be a skilled optimizer—without using complicated mathematics, simply by using economic intuition.

Equilibrium

The second key principle extends the first: economic systems operate in equilibrium, a state in which everybody is simultaneously trying to choose the best option. We want students to see that they're not the only ones maximizing their well-being. An economic system is in equilibrium when each person feels that he or she cannot do any better by picking another course of action. The principle of equilibrium highlights the connections among economic actors. For example, Apple stores stock millions of iPhones because millions of consumers are going to turn up to buy them. In turn, millions of consumers go to Apple stores because those stores are ready to sell those iPhones. In equilibrium, consumers and producers are simultaneously optimizing, and their behaviors are intertwined.

Empiricism

Our first two principles—optimization and equilibrium—are conceptual. The third is methodological: empiricism. Economists use data to test economic theories, learn about the world, and speak to policymakers. Accordingly, data play a starring role in our book, though we keep the empirical analysis extremely simple. It is this emphasis on matching theories with real data that we think most distinguishes our book from others. We show students how economists use data to answer specific questions, which makes our chapters concrete, interesting, and fun. Modern students demand the evidence behind the theory, and our book supplies it.

For example, we begin every chapter with an empirical question and then answer that question using data. One chapter begins by asking: Would a smoker quit the habit for $100 per month? Later in that chapter, we describe how smoking rates fell when researchers paid smokers to quit.

In our experience, students taking their first economics class often have the impression that economics is a series of theoretical assertions with little empirical basis. By using data, we explain how economists evaluate and improve our scientific insights. Data also make concepts more memorable. Using evidence helps students build intuition because data move the conversation from abstract principles to concrete facts. Every chapter sheds light on how economists use data to answer questions that directly interest students. Every chapter demonstrates the key role that evidence plays in advancing the science of economics.

Features

All of our features showcase intuitive empirical questions.

- In **Evidence-Based Economics (EBE)**, we show how economists use data to answer the question we pose in the opening paragraph of the chapter. The EBE uses actual data from field experiments and lab experiments or naturally occurring data while

highlighting some of the major concepts discussed within the chapter. This tie-in with the data gives students a substantive look at economics as it plays out in the world around them.

The questions explored aren't just dry intellectual ideas; they spring to life the minute the student sets foot outside the classroom—*Is Facebook free? Is college worth it? Will free trade cause you to lose your job? Is there value in putting yourself into someone else's shoes? What is the optimal size of government? Is there discrimination in the labor market?*

EVIDENCE-BASED ECONOMICS

Q: Would a smoker quit the habit for $100 per month?

At the beginning of this chapter, we posed a question concerning whether *a smoker would quit the habit for $100 a month.* The tools of this chapter can help us begin to think about whether such an incentive can work and why it might work.

In thinking about such a reward, we have learned that the impact of an increase in income leads to changes in the consumer budget constraint and subsequently the demand for goods and services. To see these tools in action, we return to the shopping-spree example. Exhibit 5.5 shows the mechanics behind the effects of an increase in what we have available to spend.

With that foundation laid, we can return to the question of quitting smoking for a month. Given our economic framework, the very same principle that was at work in the shopping-spree problem applies when considering the smoker's problem. By providing $100 for not smoking, we create a trade-off between the current benefits of smoking and the benefits obtained by $100 of increased income. There is also another saving: by not smoking, you save the money otherwise spent on cigarettes or cigars. For simplicity, let's assume that is another $100 per month. Thus the comparison that we need to make is whether, at the margin, $200 of additional monthly income provides more benefits than the current benefits you gain from smoking. If they do, then you quit smoking. If they do not, then you continue smoking and miss out on the $200 incentive.

- **Letting the Data Speak** is another feature that analyzes an economic question by using real data as the foundation of the discussion. Among the many issues we explore are such questions as *Should McDonald's be interested in elasticities? Do wages really go down if labor supply increases? Why do some firms advertise while others don't?*

LETTING THE DATA SPEAK

Fair Trade Products

What's Behind the Boom?

In response to the feeling that the growth of free trade has led to the exploitation of developing countries, a new market has opened up for the consumer concerned with a broad variety of production-related issues, including the environment, fair labor practices, and child labor in the developing world. Goods imported from the developing world that meet certain criteria are certified by third-party organizations as "fair trade" products.

To receive a fair trade label, the production of a good has to meet certain standards. For example, if the producer doesn't allow unionization, uses child or slave labor, or doesn't adhere to the UN Charter on Human Rights, then the product can't be classified as fair trade.

Consumers can't seem to get enough fair trade products. Sales growth for fair trade goods has reached double-digit proportions over the past decade. Surprisingly, sales continued to expand even after the 2008 recession, growing 15 percent in 2009.[1]

Despite the recent surge in demand for fair trade products, not everyone is a fan. Overseeing billions of dollars of production isn't easy, and the capacity for certifying organizations to enforce labor standards sometimes can't keep up with the increasing demand for fair trade products.[2]

- In keeping with the optimization theme, in a feature titled **Choice & Consequence** we ask students to make a real economic decision or evaluate the consequences of past real decisions. We then explain how an economist might analyze the same decision. Among the questions investigated are *Do people really optimize? Should LeBron James paint his own house? Does revenge have an evolutionary logic?*

CHOICE & CONSEQUENCE

Coronavirus Vaccination: Positive Externalities in Spots You Never Imagined

Externalities are the result of agents trying to do the best they can and ignoring how their actions affect others. In this sense, it would be wrong to think of externalities as "mistakes." Externalities may result from just *not knowing* the harm we cause others. In this case, we might make choices that we later regret.

Consider the case of coronavirus (COVID-19) vaccination. When you make the decision of whether to be vaccinated against COVID-19, you likely consider only the private benefits and costs from the vaccination—namely, the benefits and costs to yourself. But you are not the only person to incur benefits or costs.

If you decide to take the COVID-19 shot, others gain: once you are vaccinated, they are now protected against catching the coronavirus from you. But people can also lose if you choose not to get the shot because you could catch the coronavirus and spread it. Many of us do not naturally consider such externalities—whether positive or negative—when making a decision about whether to get a vaccination, but governments around the globe are beginning to bring such factors into the public eye. Indeed, in shutting down schools, business, airports, and any event that holds more than 50 people, policymakers have brought the externality discussion to every household in the world.

When considering the typical flu, how important is the externality? Researchers who have studied the

externalities of vaccinations report quite large effects.[2] For instance, in certain situations, the external effect of you getting a flu shot can be as high as 1.5 infections. Given that approximately 10 percent to 20 percent of the U.S. population contracts the flu each year, this estimate reveals the potential value in flu vaccination programs.

If you find it important to take account of your own externalities, the next time you are weighing your private benefits and costs of getting a flu or coronavirus vaccination, remember that not getting a shot could result in as many as 1.5 more infections for everyone else. In this sense, by avoiding the needle you have imposed a great externality on the rest of the population.

Acknowledgments

As the three of us worked on this project, we taught each other a lot about economics, teaching, and writing. But we learned even more from the hundreds of other people who helped us along the way. For their guidance, we are thankful and deeply humbled. Their contributions turned out to be critical in ways that we never imagined when we started, and our own ideas were greatly improved by their insights and advice.

Our reviewers, focus group participants, and class testers showed us how to better formulate our ideas and helped us sharpen our writing. Through their frequently brilliant feedback, they corrected our economic misconceptions, improved our conceptual vision, and showed us how to write more clearly. Their contributions appear in almost every paragraph of this book. All of their names are listed below.

Our brilliant, creative, and resourceful research assistant for this edition—Alicia Zhang—played a critical role at every phase of the project, from identifying and critiquing our implicit analytic assumptions to analyzing data to editing prose to reviewing Evidence-Based Economics problems that are woven throughout the book. Alicia continuously inspired us and educated us as we jointly probed and improved the pedagogical principles developed in this text. Her masterful contributions appear on almost every page of this new edition. We are also deeply grateful to the many research assistants who made key contributions to the previous editions: Alec Brandon, Justin Holz, Xavier Jaravel, Angelina Liang, Daniel Norris, Yana Peysakhovich, and Jan Zilinsky. We are especially grateful to Josh Hurwitz and Maggie Yellen who made monumental contributions to previous editions.

We are also deeply grateful to the many inspiring economists who contributed major components of the project. Scott Ogawa of Northwestern University contributed extensively to the updates of the end-of-chapter questions and problems, which stand out as examples of inspiring pedagogy. Todd Sorensen of the University of Nevada, Reno updated the innovative and intuitive Instructor's Manual to provide useful teaching tips to facilitate synchronous and asynchronous online learning. Nathan Kemper updated the outstanding PowerPoint slides that illuminate and distill the key lessons of the book. Kalina Staub from the University of North Carolina at Chapel Hill made critical contributions to the TestBank.

Most importantly, we acknowledge the myriad contributions of our editors and all of our amazing colleagues at Pearson. They have marched with us every step of the way. We wouldn't dare count the number of hours that they dedicated to this project, including evenings and weekends. Their commitment, vision, and editorial suggestions touched every sentence of this book. Most of the key decisions about the project were made with the help of our editors, and this collaborative spirit proved to be absolutely essential to our writing. Dozens of people at Pearson played key roles, but the most important contributions were made by Christopher DeJohn, Manager of Content Strategy; Thomas Hayward, Senior Content Analyst; Samantha Lewis, Product Manager Elaine Page, Content Producer; Heidi Allgair, Project Manager; Kristin Jobe, Content Project Management; Noel Lotz, Digital Content Team Lead; and Melissa Honig, Digital Studio Producer.

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Finally, we wish to thank our many other support networks. Our own professors, who first inspired us as economists and showed, through their example, the power of teaching and the joy that one can take from studying economics. Our parents, who nurtured us in so many ways and gave us the initial human capital that made our entire careers possible. Our kids, who implicitly sacrificed when our long hours on this book ate into family life. And, most profoundly, we thank our spouses, who have been supportive, understanding, and inspirational throughout the project.

Reviewers

This book is the product of many streams that have flowed together and so many people who have contributed their insights and their passion to this project. We are deeply grateful for these myriad collaborations.

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1 The Principles and Practice of Economics

Is Facebook free?

Facebook doesn't charge you a monthly fee, so it's tempting to say "it's free."

Here's another way to think about it: what do you give up when you use Facebook? Stop reading for a moment and answer that question: *What do you give up when you use Facebook?*

Facebook may not take your money, but it does take your data and your time. For the moment, let's focus on your time (although your data are very valuable too!). When you spend time on Facebook, you are giving up an alternative use of your time. You could spend that time playing soccer, watching YouTube, napping, studying, listening to Spotify, or pursuing any other activity that generates something that you value. For example, you could spend the time earning money. If a typical college student went cold turkey on social media and reallocated just that time to paid work, they would earn enough money to pay the annual lease on a sports car.

A part-time job is just *one* alternative way to use the time you spend on Facebook, Instagram, TikTok, and hundreds of other social media apps. In *your* view, what is the best alternative use of your social media time? That's the economic way of thinking about the time *cost* of Facebook, which we'll explore further in the Evidence-Based Economics feature in this chapter.

In this chapter, we introduce you to the economic way of thinking about the world. Economists study all of the choices that people make, from the big decisions like choosing a job to the small decisions like logging onto Facebook or any other social media platform. To understand those choices, economists focus on the costs and benefits involved, including subtle costs like the activities that get *crowded out*.

How do people make all of these choices? How should people make these choices? Economists have answers that will occasionally surprise you and, most importantly, help you make choices that improve your well-being.

CHAPTER OUTLINE

KEY IDEAS

- Economics is the study of people's choices.
- The first principle of economics is that people try to *optimize*: they try to choose the best available option.
- The second principle of economics is that economic systems tend to be in *equilibrium*, a situation in which nobody believes they will benefit by changing his or her own behavior.
- The third principle of economics is *empiricism*—analysis that uses data. Economists use data to test theories and to determine what is causing things to happen in the world.

1.1 The Scope of Economics

Economics involves far more than money. Economists study *all* human behavior, from a person's decision to lease a car, to her decision not to wear a seat belt, to the speed the new driver chooses as she rounds a hairpin corner. These are all choices, and they are all fair game to economists. Choice—not money—is the unifying feature of all the things that economists study.

Choice—not money—is the unifying feature of all the things that economists study.

In fact, economists think of almost all human behavior as the outcome of choices. For instance, imagine that Dad tells his teenage daughter that she *must* wash the family car. The daughter has several options: she can wash it, she can negotiate for an easier chore, she can refuse to wash it and suffer the consequences, or she can move out (a drastic response, sure, but still an option). The way economists think about it, everything you do is the outcome of a choice that you are making.

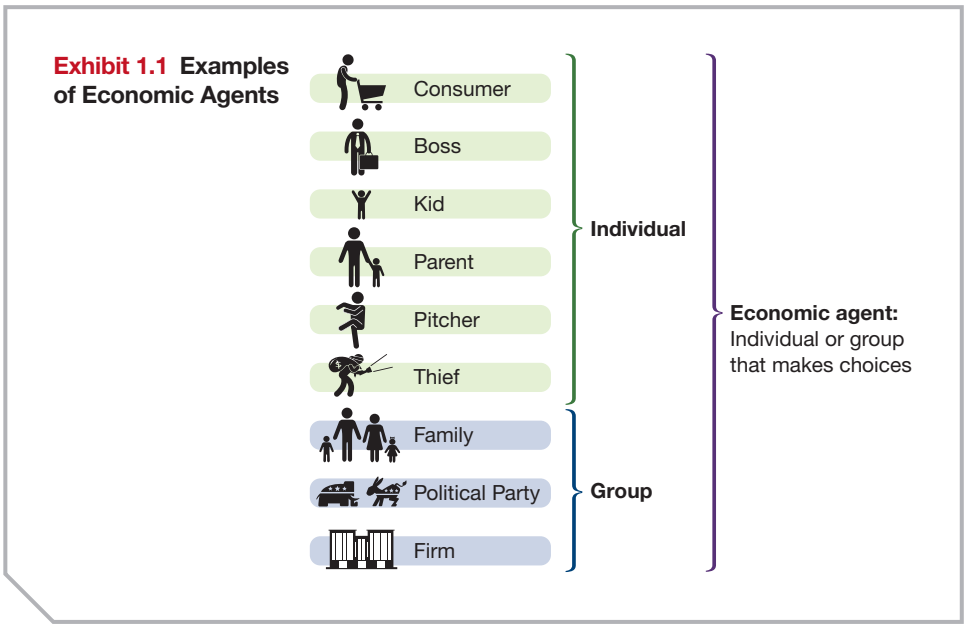
Economic Agents and Economic Resources

Saying that economics is all about choices is an easy way to summarize the topic of study. To give you a more precise definition, we first need to introduce two important concepts: *economic agents* and *resource allocation*.

An **economic agent** is an individual or a group that makes choices.

An **economic agent** is an individual or a group that makes choices. To demonstrate the enormous range of this concept, let's start with a few illustrative types of *individual* economic agents and one choice that they make. For example, a *consumer* chooses which cell phone to purchase. A *parent* chooses whether and how to reward their teenager for good behavior. A *student* chooses to attend classes or skip them. A *citizen* chooses whether or not to vote, and if so, which candidate to support. A *worker* chooses to do her job or slack off. A *criminal* chooses to sell meth or opioids (or neither or both). A *business leader* chooses where in the world to open a new production facility. A *senator* chooses to vote for or against a Supreme Court nominee. Of course, you are also an economic agent because you make an enormous number of choices every day.

Not all economic agents, however, are individuals. An economic agent can also be a group—a government, an army, a firm, a university, a political party, a labor union, a sports team, a family, or a street gang (Exhibit 1.1). Sometimes economists simplify their analysis by treating these groups as a single decision maker, without worrying about the details of how the different individuals in the group contributed to the decision. For example, an economist might say that "Apple prices the iPhone to maximize its profits," glossing over the fact that many employees participated in the internal debates that led to the choice of the price.



Scarce resources are things that people want, where the quantity that people want exceeds the quantity that is available.

Scarcity is the situation of having unlimited wants in a world of limited resources.

The second important concept to understand is that economics studies the allocation of *scarce resources*. **Scarce resources** are things that people want, where the quantity that people want (if the resources were being given away for free) exceeds the quantity that is available. Gold wedding bands, Shiatsu massages, Italian handbags, Broadway shows, iPhones, triple-chocolate-fudge ice cream, and rooms with a view are all scarce resources. But a resource doesn't need to be luxurious to be scarce—everyday goods are also scarce, like toilet paper, subway seats, and clean drinking water. **Scarcity** exists because people have unlimited wants in a world of limited resources. The world does not have enough resources to give everyone *everything* they want (for free).

Consider cars: if cars were given away at a zero price, there would not be enough of them to go around. So how does society determine who gets the limited supply of cars? In general, how does society allocate all of the scarce resources in the economy?

In a modern economy, consumers like you play a key role in this resource allocation process. You have 24 hours to allocate each day—this is your daily time budget. You choose how many of those 24 hours you will allocate to Facebook. You choose how many of those 24 hours you will allocate to other activities, including schoolwork and/or a job. If you have a job, you choose how to spend your hard-earned wages. These types of decisions determine how scarce resources are allocated in a modern economy: to the consumers who are able and willing to pay for them.

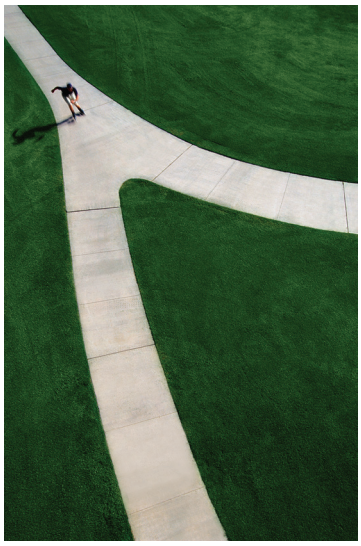
Economists don't want to impose our personal tastes on you. Imagine that you needed to decide whether to commute by car, bicycle, foot, Uber/Lyft, taxi, or public transportation. We are interested in showing you how to use economic reasoning so that *you* can compare the costs and benefits of the alternative options and make the choices that are best for you.

Definition of Economics

Economics is the study of how agents choose to allocate scarce resources and how those choices affect society.

We are now ready to define economics precisely. **Economics** is the study of how agents choose to allocate scarce resources and how those choices affect society.

Our earlier examples all emphasized people's *choices,* and choices play a key role in the formal definition of economics. However, the definition of economics also adds a new element to our discussion: the effects of any individual agent's choices on society. For example, the sale of a new car doesn't just affect the person driving off the dealer's lot. The sale generates sales tax, which the government uses to fund projects like highways and hospitals. The purchase of the new car also generates some congestion—that's one more car in rush-hour gridlock. It's another car that might grab the last parking spot on your street. If the new owner drives recklessly, the car may generate risks to other drivers. Economists study the original choice and its multiple consequences for other people in the world.



Economics is the study of choice.

Positive economics is analysis that generates objective descriptions or predictions, which can be verified with data.

Normative economics is analysis that recommends what an individual or society ought to do.

Positive Economics and Normative Economics

We now have an idea of what economics is about: people's choices. But why study these choices? Part of the answer is that economists are just curious, but that's only a small piece of the picture. Understanding people's choices is practically useful for two key reasons. Economic analysis:

1. Describes what people *actually* do (positive economics)
2. Recommends what people, including society, *ought* to do (normative economics)

The first application is descriptive, and the second is advisory.

Positive Economics Describes What People Actually Do Descriptions of what economic agents actually do are *objective* statements about the world—in other words, statements that can be confirmed or tested with data. For instance, from March to April 2020, the percentage of the U.S. labor force that was unemployed increased from 4.4 percent to 14.7 percent, the largest jump ever recorded.[1] During this month COVID-19 lockdowns caused firms to close for business and, in many cases, to lay off their workers. Describing what has happened or predicting what will happen is referred to as **positive economics** or positive economic analysis.

For instance, consider the prediction that renewable power capacity will expand by 50 percent between 2019 and 2024 (especially solar, wind, hydropower, and bioenergy).[2] This forecast can be compared to future data and either confirmed or disproven. Because a prediction is eventually testable—after the passage of time—it is also part of positive economics.

Normative Economics Recommends What People Ought to Do **Normative economics**, the second of the two types of economic analysis, advises individuals and society on their choices. Normative economics is about what people ought to do. Normative economics is almost always dependent on *subjective* judgments, which means that normative analysis depends at least in part on personal feelings, tastes, or opinions. So whose subjective judgments do we try to use? Economists believe that the people being advised should determine the preferences to be used.

For example, consider an economist who is helping a worker to decide how much risk to take in her investments. The economist might ask the worker about her own preferences regarding investment risk. Suppose the worker said that she wouldn't sleep well at night if her retirement savings were invested in the stock market, which does fall sharply (and unpredictably) from time to time—for example, the Dow Jones Industrial Average (a U.S. stock index) fell 38 percent at the start of the COVID-19 crisis in February and March 2020. The economist would explain that eliminating risk comes at a cost—riskless investments have a lower *average* rate of return in the long run than investments in the stock market. Stocks have had an annual average return that is about 6 percentage points higher per year than the return on riskless investments. If the worker acknowledged this difference and still wanted the riskless investments, the economist would help the worker find such riskless investments. Here the economist plays the role of engineer, finding the investment portfolio that will deliver the level of risk that the worker wants.

And that's the key—*what the worker wants*. In the mind of most economists, it is legitimate for the worker to choose any level of risk, as long as she understands the implications of that risk for her average rate of return—less risk implies a lower average rate of return. When economic analysis is used to help *individual* economic agents choose what is in their personal best interest, this type of normative economics is referred to as *prescriptive economics*.

Sometimes the normative analysis gets more complicated because there are many economic agents in the picture. We turn to these harder normative analyses next.

Normative Analysis and Public Policy Normative analysis also generates advice to society in general. For example, economists are often asked to evaluate public policies, like taxes or regulations. When public policies create winners and losers, citizens tend to have opposing views about the desirability of the government program. One person's migratory bird sanctuary is another person's mosquito-infested swamp. Protecting a wetland with environmental regulations benefits bird-watchers but may harm a landowner who would like to develop that land.

Economic agents have divergent views on the future of this swamp. The owner of the property wants to build housing units. An environmentalist wants to preserve the wetland to protect the whooping crane, an endangered species. What should happen?

When a government policy creates winners and losers, economists need to make some ethical judgments to conduct normative analysis. Economists must make ethical judgments when evaluating policies that make one group worse off so another group can be made better off.

Ethical judgments are usually unavoidable when economists think about government policies because there are few policies that make everyone better off. Deciding whether the costs experienced by the losers are justified by the benefits experienced by the winners is partly an ethical judgment. Is it ethical to create environmental regulations that prevent a real estate developer from draining a swamp so she can build new homes? What if those environmental regulations protect migratory birds that other people value? Are there possible compromises—should the government, for example, try to buy the land from the real estate developer? These public policy questions—which all ask what society *should* do—are normative economic questions.

Microeconomics and Macroeconomics

There is one other distinction that you need to know to understand the scope of economics. Economics can be divided into two broad fields of study, though many economists do a bit of both.

Microeconomics is the study of how individuals, households, firms, and governments make choices, and how those choices affect prices, the allocation of resources, and the well-being of other agents. In general, microeconomists are called on when we want to understand a particular piece of the overall economy, like the market for coal-fired electricity generation.

Microeconomics is the study of how individuals, households, firms, and governments make choices, and how those choices affect prices, the allocation of resources, and the well-being of other agents.

For example, some microeconomists study pollution generated by coal-fired power plants. A microeconomist might predict the level of coal-based pollution over the next decade, basing her forecast on the overall demand for electricity and likely technological developments in the energy industry—including solar- and wind-energy substitutes for coal-fired power plants. Predicting future levels of pollution from coal-fired plants is part of positive economic analysis.

Some microeconomists undertake normative analysis of coal-based pollution. For example, because global warming is largely caused by carbon emissions from coal, oil, and other fossil fuels, microeconomists design new government policies that attempt to reduce the use of these fuels. For example, a "carbon tax" targets carbon emissions. Under a carbon tax, relatively carbon-intensive energy sources—like coal-fired power plants—pay more tax per unit of energy produced than do energy sources with lower carbon emissions—like wind farms. Some microeconomists have the job of designing interventions like carbon taxes and determining how such interventions will affect the energy choices of households and firms.

Macroeconomics is the study of the economy as a whole. Macroeconomists study economy-wide phenomena, like the growth rate of a country's *total* economic output, the percentage increase in *overall* prices (the inflation rate), or the fraction of the *nation's* labor force that is looking for work but cannot find a job (the unemployment rate). Macroeconomists design government policies that improve overall, or "aggregate," economic performance.

Macroeconomics is the study of the economy as a whole. Macroeconomists study economy-wide phenomena, like the growth rate of a country's total economic output, the inflation rate, or the unemployment rate.

For example, macroeconomists try to identify the best policies for stimulating an economy that is experiencing a sustained period of negative growth—in other words, an economy in recession. Macroeconomists played an active role in the policy responses to the 2020 economic contraction caused by the COVID-19 crisis. Macroeconomists *also* worry about how to manage an economy that is growing well. For example, in 2018, with a historically low unemployment rate below 4 percent and strong (inflation-adjusted) annual economic growth above 3 percent, macroeconomists debated whether it was prudent for the Federal Reserve System to raise interest rates to head off the potential threat of rising inflation.

1.2 Three Principles of Economics

You now have a sense of what economics is about. But you might be wondering what distinguishes it from the other social sciences, including anthropology, history, political science, psychology, and sociology. All social sciences study human behavior, so what sets economics apart?

Economists emphasize three key concepts.

Optimization means trying to pick the best feasible option, given whatever limited information, knowledge, experience, and training the economic agent has.

1. **Optimization:** We have explained economics as the study of people's choices. The study of all human choices may initially seem like an impossibly huge and diverse topic. At first glance, your decision to log on to Facebook tonight does not appear to have much in common with a corporate executive's decision to build a $500 million laptop factory in China. However, economists have identified some powerful concepts that unify the enormous range of choices that economic agents make. One such insight is that choices are tied together by the concept of *optimization*: trying to pick the best feasible option. Economists do *not* believe that people always succeed in picking the best feasible option. Rather, economists believe that people *try* to pick the best feasible option. People don't always succeed because we are not perfect, all-knowing decision makers. There is a great deal of discussion among economists about how well people succeed in actually picking the best feasible option, a discussion that we will return to in Chapter 3.

Decisions aren't made with a crystal ball. People try to do as well as they can.

Optimization is the first principle of economics. Economists believe that optimization—trying to pick the best feasible option—explains the choices that people make, including minor decisions like accepting an invitation to see a movie and major decisions like deciding whom to marry. Decisions aren't made with a crystal ball. People try to do as well as they can, given the limited information, knowledge, experience, and training that they have.

Equilibrium is the special situation in which *everyone* is simultaneously optimizing, so nobody believes they would benefit personally by changing their own behavior, given the choices of others.

2. **Equilibrium:** The second principle of economics holds that economic systems tend to be in *equilibrium*, a situation in which no agent believes they would benefit personally by changing their own behavior, given the choices of others. The economic system is in equilibrium when *all* agents believe they cannot do any better by picking another course of action. In other words, equilibrium is a situation in which everyone is simultaneously optimizing.

Empiricism is analysis that uses data—evidence-based analysis. Economists use data to develop theories, to test theories, to evaluate the success of different government policies, and to determine what is causing things to happen in the world.

3. **Empiricism:** The third principle of economics is an emphasis on *empiricism*—evidence-based analysis. In other words, analysis that uses data. Economists use data to develop theories, to test theories, to evaluate the success of different government policies, and to determine what is causing things to happen in the world.

1.3 The First Principle of Economics: Optimization

Let's now consider our first principle in more detail. Economics is the study of choices, and economists have a leading theory about how choices are made. Economists believe that people optimize, meaning that economic agents try to choose the best feasible option, given whatever (limited) information, knowledge, experience, and training the economic agents have. Feasible options are those that are available and affordable to an economic agent. If you have $10 in your wallet and no credit/debit/ATM cards, then a $5 veggie burger is a feasible dinner option, while a $50 lobster dinner is not.

The concept of feasibility goes beyond the financial budget of the agent. Many different constraints can determine what is feasible. For instance, it is not feasible to work more than 24 hours in a day. It is not feasible to attend meetings *in person* in London and Beijing at the same time.

In cases where agents make predictable mistakes, normative (prescriptive) economic analysis can help them realize their mistakes and make better choices in the future.

Any decision can depend only on the information available at the time of the choice. For example, if you choose to drive from San Diego to Los Angeles and your car is hit by a drunk driver, you are unlucky, but you haven't necessarily failed to optimize. Optimization means that you weigh the information that you have, not that you perfectly foresee the future. When someone chooses the best feasible option *given the information that is available*, economists say that the decision maker is being rational or, equivalently, that he or she is exhibiting rationality. Rational action does not require a crystal ball, just a logical appraisal of the costs, benefits, and risks that are known to the economic agent.

However, if you decide to let a friend drive you from San Diego to Los Angeles and you know that your friend is drunk, this is likely a case in which you are not choosing the best feasible option. Again, evaluating the rationality of a decision means examining the quality of your initial decision, not the outcome. Even if you and your drunk driver arrive at your destination without a crash, your choice to let your friend drive is still a bad choice. Fortunately, you got lucky despite making a bad decision.

We devote much of this book to the analysis of optimization. We explain how to choose the best feasible option, and we discuss some evidence that supports the theory that economic agents often do choose the best feasible option (or something close to it). We also discuss important cases where people consistently fail to choose the best feasible option. In cases where agents make predictable mistakes, normative (prescriptive) economic analysis can help them realize their mistakes and make better choices in the future.

Finally, it is important to note that *what* we optimize varies from person to person and group to group. Many firms try to maximize profits, but most individual people are not trying to maximize their personal income. If that were our goal, we'd work far more than 40 hours per week, and we'd keep working long past retirement age. Most households are trying to maximize their overall well-being, which involves a mix of income, leisure, health, and a host of other factors, like social networks, personal relationships, and a sense of purpose in life. Most governments, meanwhile, are optimizing a complex mix of policy goals. For most economic agents, then, optimization (and economics) is about much more than money.

The COVID-19 crisis is a good example of the complexity of optimization. If governments were simply trying to maximize total economic output, firms and employees would have kept working through the pandemic despite the health consequences. Instead, almost all countries adopted aggressive public health measures during the crisis, including lockdowns and shelter-in-place rules, causing their overall economies to sharply contract. Accordingly, the policy response to the COVID-19 crisis involved a trade-off between health and economic output. Almost all countries accepted a sharp drop in economic output as the price for partially reducing illness and deaths—morbidity and mortality—resulting from the pandemic. You can think of this as the first recession that was equivalent to intentionally putting the economy into a coma.

Trade-offs and Budget Constraints

An economic agent faces a **trade-off** when the agent needs to give up one thing to get something else.

All optimization problems involve trade-offs. **Trade-offs** arise when some benefits must be given up to gain others. Think again about the simple case of Facebook. If you spend an hour on Facebook, then you cannot spend that hour doing other things. For example, you cannot work at most part-time jobs at the same time you are editing your Facebook profile. (However, some students believe that they can read their friends' posts while listening to a lecture. When the authors of this textbook try to do this ourselves, we find that we don't learn very much from that lecture.)

A **budget constraint** shows the bundles of goods or services that a consumer can choose given her limited budget.

Economists use budget constraints to describe trade-offs. A **budget constraint** is the set of things that a person can choose to do (or buy) without breaking her budget.

Here's an illustration. To keep the analysis simple, suppose that you can do only one of two activities with each hour of your free time: use social media sites or work at a part-time job. Suppose that you have 5 free hours in a day (once we take away necessities like sleeping, eating, bathing, attending classes, doing problem sets, and studying for exams). Think of these 5 free hours as your budget of free time. Then your budget constraint would be:

$$5 \text{ hours} = \text{Hours on social media} + \text{Hours working at part-time job}.$$

This equation, which is also called a budget constraint, implies that you face a trade-off. If you spend an extra hour on social media, you need to spend one less hour working at a part-time job (unless you secretly use Facebook while you are being paid for a job—in this case, don't put your boss on your friend list). Likewise, if you spend an extra hour working at the part-time job, you need to spend one less hour surfing the Web. More of one activity implies less of the other. We can see this in Exhibit 1.2, where we list all the ways that you could allocate your 5 free hours.

Budget constraints are useful economic tools because they quantify trade-offs. When economists talk about the choices that people make, the economist always takes into account the budget constraint. It's important to identify the feasible options and the trade-offs—the budget constraint gives us that information.

Exhibit 1.2 Possible Allocations of 5 Free Hours (Round Numbers Only)

Each row reports a different way that a person could allocate 5 free hours, assuming that the time must be divided between social media and working at a part-time job. To keep things simple, the table only reports allocations in round numbers.

Budget	Hours on Social Media	Hours at Part-Time Job
5 hours	0 hours	5 hours
5 hours	1 hours	4 hours
5 hours	2 hours	3 hours
5 hours	3 hours	2 hours
5 hours	4 hours	1 hours
5 hours	5 hours	0 hours

Opportunity Cost

We are now ready to introduce another critical tool in the optimization toolbox: opportunity cost. Social media provides an illustration of the concept. The time that we spend on social media is time that we could have spent in some other way. In the illustrative example just discussed, the only two alternative activities were social media and working at a part-time job. But in real life, there are an enormous number of activities that might get squeezed out when you use social media—for instance, playing soccer, jogging, daydreaming, taking a yoga class, meditating, sleeping, eating with friends, or working on a problem set. You implicitly sacrifice time on some alternative activities when you spend time on social media.

Generate your own list of alternative activities that are squeezed out when you use social media. Think about the best alternative to an extra hour of social media, and put that at the top. Pause here and write that alternative activity down. Having a cup of coffee with a friend? Studying for an exam? Going for a jog? What is your best alternative to an extra hour of social media?

We face trade-offs whenever we allocate our time. When we do one thing, something else gets squeezed out. Joining the basketball team might mean dropping lacrosse. During exam week, an extra hour of sleep means one less hour spent studying or decompressing with friends. You can't write a term paper and update your Facebook page at the same moment. And postponement is not an escape hatch from this ironclad logic. For example, even if you only postpone writing that term paper, something has got to give when the paper deadline rolls around. (Perhaps studying for your economics final?)

Evaluating trade-offs can be difficult because so many options are under consideration. Economists tend to focus on the *best* alternative activity. We refer to this best alternative activity as the **opportunity cost**. This is what an optimizer is effectively giving up when she allocates an hour of her time. Recall your own best alternative to an extra hour of social media. That's your opportunity cost of an hour of social media time.

Opportunity cost is the best alternative use of a resource.

Here's another example to drive home the concept. Assume that your family is taking a vacation over spring break. Your choices are a Caribbean cruise, a trip to Miami, or a trip to Los Angeles. (Assume that they all have the same monetary cost and use the same amount of time.) If your first choice is the cruise and your *second* choice is Miami, then your opportunity cost of taking the cruise is the Miami trip. The cruise is crowding out the Miami trip, so the Miami trip is what you are giving up to take the cruise.

The concept of opportunity cost applies to all trade-offs, not just your daily time budget of 24 hours. Suppose that a woodworker has a beautiful piece of maple that can be used to make a sculpture, a bowl, or a picture frame. (Assume that they all use the same amount of wood and take the same amount of time.) If the woodworker's first choice is the sculpture and the second choice is the bowl, then the bowl is the opportunity cost of making the sculpture.

Assigning a Monetary Value to an Opportunity Cost Economists sometimes try to put a monetary value on opportunity cost. One way to estimate the monetary value of an hour of your time is to analyze the consequences of taking a part-time job or working additional hours at the part-time job you already have.

The opportunity cost of an hour of your time spent on social media is at least the value that you would receive from an hour of work at a job, assuming that you can find one that fits your schedule. Here's why. A part-time job is one item in the long list of alternative

ways to spend your time. If the part-time job is at the top of your list, then it's the best alternative, and the part-time job is your opportunity cost of spending time on social media. What if the part-time job is not at the top of your list, so it's not the best alternative? Then the best alternative is even better than the part-time job, so the best alternative is worth more than the part-time job. To sum up, your opportunity cost is either the value of a part-time job or a value that is even greater than that.

To turn these insights into something quantitative, it helps to note that the median wage for U.S. workers between 16 and 24 years of age was $14.70 in 2020—this statistic is from the U.S. Bureau of Labor Statistics.[3] A job has many attributes other than the wage you are paid: unpleasant tasks (like being nice to obnoxious customers), on-the-job training, friendly or unfriendly coworkers, and resume building, to name a few.

If we ignore these non-wage attributes, the value of an hour of work is just the wage (minus taxes paid). However, if the positive and negative non-wage attributes don't cancel each other, the calculation is much harder. To keep things simple, we'll focus only on the after-tax wage in the analysis that follows—about $13 per hour for young workers—but we urge you to keep in mind all of the non-wage consequences that flow from a job.

Cost-Benefit Analysis

Let's use opportunity cost to solve an optimization problem. Specifically, we want to compare a set of feasible alternatives and pick the best one. We call this process *cost-benefit analysis*. **Cost-benefit analysis** is a calculation that identifies the best option by summing benefits and subtracting costs, with both benefits and costs denominated in a common unit of measurement, like dollars. Cost-benefit analysis is used to identify the alternative that has the greatest **net benefit**, which is the sum of the benefits of choosing an alternative minus the sum of the costs of choosing that alternative.

Cost-benefit analysis is a calculation that identifies the best alternative, by summing benefits and subtracting costs, with both benefits and costs denominated in a common unit of measurement, like dollars.

Net benefit is the sum of the benefits of choosing an alternative minus the sum of the costs of choosing that alternative.

To see these ideas in action, suppose that you and a friend are going to Miami Beach from Boston for spring break. Imagine that the only question is whether you should drive or fly. Your friend argues that you should drive because splitting the cost of a rental car and gas "will only cost $200 each." He tries to seal the deal by pointing out "that's much better than a $300 plane ticket."

To analyze this problem using cost-benefit analysis, you need to list all benefits and costs of driving compared to the alternative of flying. Here we'll express these benefits and costs comparatively, which means the benefits of driving compared to flying and the costs of driving compared to flying. We'll need to translate those benefits and costs into a common unit of measurement.

From a benefit perspective, driving saves you $100—the difference between driving direct costs of $200 and a plane ticket of $300. We sometimes refer to these direct costs as "out-of-pocket" costs. But out-of-pocket costs aren't the only thing to consider. Driving also costs you an extra 40 hours of time—the difference between 50 hours of round-trip driving time and about 10 hours of round-trip airport/flying time. Spending 40 extra hours traveling is a *cost* of driving, even if it isn't a direct out-of-pocket cost.

We're now ready to decide whether it is optimal to drive or fly to Florida. We need to express all benefits and costs in common units, which will be dollars for our example. Recall that driving will take an additional 40 hours of travel time. To complete the analysis, we must translate this time cost into dollars. To make this translation, we will use a $13 per hour opportunity cost of time. The net benefit of driving compared to flying is the *benefit* of driving (saving $100 in out-of-pocket costs) minus the *cost* of driving (40 additional hours of your time):

$$(\$100 \text{ reduction in out-of-pocket costs}) - (40 \text{ hours of additional travel time}) \times (\$13/\text{hour})$$
$$= \$100 - \$520 = -\$420.$$

Hence, the net benefit of driving is overwhelmingly negative. Using the numbers in this example, an optimizer would choose to fly.

This analysis about travel to Miami is a simple example of cost-benefit analysis, which is a great tool for collapsing all sorts of things down to a single number: a dollar-denominated net benefit. This course will guide you in making such calculations. When you are making almost any choice, cost-benefit analysis can help.

To an economist, cost-benefit analysis is an example of optimization. When you pick the option with the greatest net benefits, you are optimizing. Cost-benefit analysis is useful for

normative economic analysis. It enables an economist to determine what an individual or a society should do. Cost-benefit analysis also yields many useful positive economic insights. In many cases, cost-benefit analysis correctly predicts the choices made by actual consumers.

We'll see hundreds of examples of optimization throughout this course. Moreover, we dedicate a whole chapter to optimization (Chapter 3) to give you a more complete grounding in this foundational principle of economics.

EVIDENCE-BASED ECONOMICS

Q: Is Facebook free?

We can now turn to the question posed at the beginning of the chapter. By now you know that Facebook has an opportunity cost—the best alternative use of your time. We now estimate this cost. To do this, we're going to need some data. Whenever you see a section in this textbook titled "Evidence-Based Economics," you'll know that we are using data to analyze an economic question.

U.S. adults are estimated to spend 56 minutes per day on social media platforms in 2019, which includes sites like Facebook, TikTok, Instagram, Snapchat, Twitter, Pinterest, Tumblr, and LinkedIn.[4] To simplify our calculation, let's round this up to 1 hour per day. Even if we pick a relatively conservative opportunity cost of time of \$13/hour, this amounts to \$4,745 per year per U.S. adult:

$$(1 \text{ hour/day}) \times (365 \text{ days/year}) \times (\$13/\text{hour}) = \$4{,}745 \text{ per year.}$$

In 2019, there were 254 million adults (ages 18 and older) in the United States, so the opportunity cost of social media use among U.S. adults was at least

$$(\$4{,}745/\text{adult}) \times (254 \text{ million adults}) = \$1.2 \text{ trillion per year.}$$

We can also think about this calculation another way. If U.S. adults had substituted their time on social media for work with average pay of \$13 per hour, the U.S. economy would have produced about \$1.2 trillion more measured output in 2019. This is more than the annual combined economic output of Austria and Sweden.

So far, we have gone through a purely positive economic analysis, describing the frequency of social media usage and the trade-offs that this usage implies. None of this analysis, however, answers the related question: Are Facebook and other social media users optimizing? We've seen that the time spent on sites like Facebook has valuable alternative uses (see Exhibit 1.3). But Facebook users are deriving substantial benefits that may justify this allocation of time. For example, social networking sites keep us up-to-date on the activities of our friends and family. They facilitate the formation of new friendships and new connections. And Facebook and similar sites are entertaining. Indeed, it is possible that we should spend more time on Facebook!

Because we cannot easily quantify these benefits, we're going to leave that judgment to you. Economists won't tell you what to do, but we will help you identify the trade-offs that you are making in your decisions. Here is how an economist would summarize the prescriptive issues that are on the table:

> Assuming a \$13/hour opportunity cost, the opportunity cost of using social media for an hour per day is \$4,745 per year. Do you receive benefits from Facebook that exceed this opportunity cost? If the annual benefits that you receive are less than \$4,745, you should scale down your Facebook usage.

Economists don't want to impose their tastes on other people. In the view of an economist, people who get big benefits from frequent use of Facebook should stay the course. However, we do want economic agents to recognize the implied trade-offs that are being made. Economists are interested in helping people make the best use of scarce resources

EVIDENCE-BASED ECONOMICS *(continued)*

like budgets of money and leisure time. In many circumstances, people are already putting their resources to best use. Occasionally, however, economic reasoning can help people make better choices. In other words, economic reasoning can help you be a better optimizer.

	Cost per unit	Number of units	Total cost
Starbucks cappuccino	$4	52 cups	$208
iPhone	$740	1	$740
Round trip: NYC to Paris	$1,200	1	$1,200
Hotel in Paris	$275	5 nights	$1,375
Round trip: NYC to U.S. Virgin Islands	$300	1	$300
Hotel in Virgin Islands	$180	5 nights	$900
Eleven iPhone apps	$2	11	$22
Total			**$4,745**

Exhibit 1.3 What Could You Buy with $4,745?

Everyone would choose to spend $4,745 in their own particular way. This list illustrates one feasible basket of goods and services. Note that this list includes just the monetary costs of these items. A complete economic analysis would also include the opportunity cost of the time that you would need to consume them.

Question

Is Facebook free?

Answer

No. The opportunity cost of time spent on Facebook and other social media was over $1.2 trillion in the United States in 2019.

Data

Facebook usage statistics estimated by www.eMarketer.com. Wage data from U.S. Department of Labor.

Caveat

We have only presented a calculation for U.S. social media users. It would be useful to extend these calculations to cover the billions of social media users worldwide. For example, Facebook alone has more than 1.7 billion worldwide users.

Use the concepts presented in this feature by working through the Evidence-Based Economics Problems at the end of this chapter.

1.4 The Second Principle of Economics: Equilibrium

In most economic situations, you aren't the only one trying to optimize. Other people's behavior will influence what you decide to do. Economists think of the world as a large number of economic agents who are interacting and influencing one another's efforts at optimization. Recall that *equilibrium* is the special situation in which everyone is trying to optimize, so nobody believes that they would benefit personally by changing his or her own behavior.

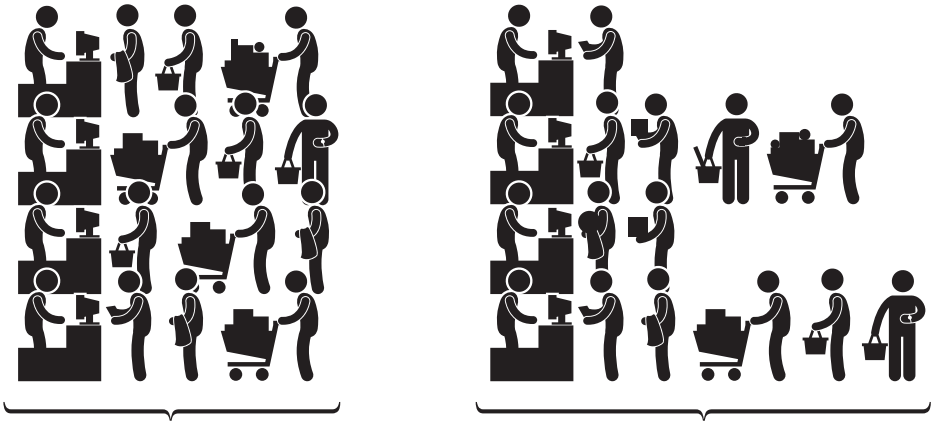
An important but subtle point is embedded in this definition. We say that in equilibrium, nobody *believes* he or she would benefit from changing their own behavior. In equilibrium, all economic agents are trying to make their best feasible choices, taking into account the information they have, including their beliefs about the behavior of others.

To build intuition for the concept of equilibrium, consider the length of the standard checkout lines at your local supermarket (ignore the express lines). If any line has a shorter wait than the others, optimizers will choose that line. If any line has a longer wait than the others, optimizers will avoid that line. So the short lines will attract shoppers, and the long lines will drive them away. And it's not just the length of the lines that matters. You may pick your line by estimating which line will move the fastest, an estimate that incorporates what you can see, including the number of items in each person's shopping cart. Sometimes, you might end up waiting longer because of twists you didn't anticipate: a customer who takes 5 minutes to find the right change, or someone with a sea of tiny items at the bottom of their cart. Still, economists say that "in equilibrium," all checkout lines will have roughly the same wait time. When the wait times are expected to be the same, no shopper has an incentive to switch lines. In other words, nobody believes that they will benefit by switching lines.

Here's another example. Suppose the market price of gasoline is $2 per gallon and the gasoline market is in equilibrium. Three conditions will need to be satisfied:

1. The amount of gasoline produced by gasoline sellers—energy companies—will equal the amount of gasoline purchased by buyers.
2. Energy companies will only operate wells where they can extract crude oil and produce gasoline at a cost that is less than the market price of gasoline: $2 per gallon.
3. The buyers of gasoline will only use it for activities that are worth at least $2 per gallon—like driving to their best friend's wedding—and they won't use it for activities that are worth less than $2 per gallon.

In equilibrium, both the sellers and the buyers of gasoline are optimizing, given the market price of gasoline. Nobody would benefit by changing their own behavior. (We'll



In equilibrium, everyone is simultaneously optimizing, so nobody would benefit by changing his or her own behavior.

A free rider in the New York subway system. Are you paying for this person to ride the subway?

have much more to say about this example of equilibrium analysis in Chapter 4.)

Notice that we've started to think about what happens when many economic agents interact. This could be two chess players, thirty participants in an eBay auction, hundreds of millions of investors buying and selling shares on the New York Stock Exchange, or billions of households buying gasoline to fuel their tractors, trucks, mopeds, motorcycles, and cars. In all these cases, we assume that everyone is constantly simultaneously optimizing—for instance, at every move in a chess game and during every trade on the New York Stock Exchange. Combined, these choices produce an equilibrium—and economists believe that this kind of equilibrium analysis provides a good description of what actually happens when many people interact.

The Free-Rider Problem

Let's use the concept of equilibrium to analyze an economic problem that may interest you: roommates. Assume that five roommates live in a rented house. Each roommate can spend some of their time contributing to the general well-being of all the roommates by throwing away empty pizza boxes and soda cans. Or each roommate can spend all their time on activities that only benefit themselves—for instance, watching TikTok videos or listening to Spotify.

Imagine that one roommate hates the mess and starts spending time cleaning up the kitchen. Although the other roommates appreciate it, they may have no incentive to chip in. If the public-spirited roommate spends 30 minutes doing the dishes, all the other roommates benefit without having to lift a finger. It would be beneficial to each of the roommates if everyone chipped in and did a little cleaning. But each of the five roommates has an incentive to leave that to others. Consequently, rentals with lots of roommates are often a mess. The *equilibrium* prediction is that when people live in large rooming groups, they will have messier apartments than if the same people each had their own apartment.

Roommates who leave the cleaning to others are an example of something that economists call the *free-rider problem*. Most people want to let someone else do the dirty work. We would like to be the free riders who don't contribute but still benefit from the work done by others.

Sometimes free riders get away with it. When there are few free riders and lots of contributors, the free riders might be overlooked. For example, a small number of people sneak onto public transportation without paying. These turnstile jumpers are so rare that they don't jeopardize the subway system. But if everyone started jumping turnstiles, the subway would soon run out of cash. Indeed, that is happening more and more often in New York City. The government agency that oversees New York City's mass transit system released a report in December 2018 estimating that *each day,* 208,000 people take the subway without paying and 350,000 people take the bus without paying.[5] You can see videos capturing New Yorkers in the act.[6]

In the subway system, free riding is discouraged by security patrols. In rooming groups, free riding is discouraged by social pressure. Free riding is a problem because it's not easy to catch the free rider in the act. It's possible to slip over a turnstile in a subway station. It's easy to leave crumbs on the couch when nobody is watching.

People's private benefits are sometimes out of sync with the public interest. Equilibrium analysis helps us predict the behavior of interacting economic agents and understand why free riding occurs. People sometimes pursue their own private interests and don't contribute voluntarily to the public interest. Unfortunately, selfless acts—like those of a war hero—are exceptional, and selfish acts are more common. When people interact, each individual might do what's best for themselves instead of acting in a way that optimizes the well-being of society.

Equilibrium analysis helps us design special institutions—like financial contracts—that reduce or even eliminate free riding. For example, what would happen in the rooming

group if everyone agreed to pay $5 per week so the roommates could hire a cleaning service? It would be easier to enforce $5 weekly payments than to monitor compliance with the rule "clean up after yourself, even when nobody is here to watch you." Pizza crumbs don't have identity tags. So equilibrium analysis explains both why individuals sometimes fail to serve the interest of society and how the incentive structure can be redesigned to fix these problems.

1.5 The Third Principle of Economics: Empiricism

Economists test their ideas with data. We refer to such evidence-based analysis as empirical analysis or *empiricism*. Economists use data to determine whether our theories about human behavior—like optimization and equilibrium—match up with actual human behavior. Of course, we want to know if our theories fail to explain what is happening in the world. In that case, we need to go back to the drawing board and come up with better theories. That is how economic science, and science in general, progresses.

Economists are also interested in understanding what is *causing* things to happen in the world. We can illustrate what causation is—and is not—with a simple example. Hot days and crowded beaches tend to occur at the same time of the year. What is the cause and what is the effect here? It is, of course, that high temperatures cause people to go swimming. It is not that swimming causes the outside air temperature to rise.

But there are some cases when cause and effect are hard to untangle. Does being relatively smart cause people to go to college, or does going to college cause people to be relatively smart? Perhaps both directions of causation apply. Or perhaps some other factor plays the causal role—for instance, a love for reading might cause people to become smarter *and* cause them to go to college.

We'll come back to the topic of empiricism in general, and causality in particular, in great detail in Chapter 2. Sometimes causes are easy to determine, but sometimes identifying cause and effect requires great ingenuity.

1.6 Is Economics Good for You?

Should you take this course? Cost-benefit analysis can help you think about this question.

Let's begin by assuming that you've already chosen to go to college. So we can assume that tuition costs and room and board are *sunk costs* (they won't be affected by your decision to take economics). With those costs accounted for, are there any other costs associated with this course? The key opportunity cost of this course is another course that you won't be able to take during your time spent as a student. What other course did economics crowd out? Japanese history? Biochemistry? Russian poetry? If you are taking the two-semester version of this course, then you need to consider the *two* other courses that economics is crowding out.

Learning how to make good choices is the biggest benefit you'll realize from learning economics.

Now consider the benefits of an economics education. The benefits come in a few different forms, but the biggest benefit is the ability to apply economic reasoning in your daily life. Whether you are deciding how to keep an apartment clean with four other roommates or deciding how to use your free time, economic reasoning will improve the quality of your decisions. These benefits will continue throughout your life as you make important decisions, such as where to invest your retirement savings and how to choose a house to buy.

Most decisions are guided by the logic of costs and benefits. Accordingly, you can use positive economic analysis to predict *other* people's behavior. Economics illuminates and clarifies human behavior.

We also want you to use economic principles when you give other people advice and when you make your own choices. This is normative economics. Learning how to make

good choices is the biggest benefit you'll realize from learning economics. That's why we have built our book around the concept of decision making. Looking at the world through the economic lens puts you at an enormous advantage throughout your life.

We also think that economics is a lot of fun. Understanding people's motivations is fascinating, particularly because there are many surprising insights along the way.

To realize these payoffs, you'll need to connect the ideas in this textbook to the economic activities around you. To make those connections, keep a few tips in mind:

- You can apply economic tools, such as trade-offs and cost-benefit analysis, to any economic decision, so learn to use them in your own daily decisions. This will help you master the tools and also appreciate their limitations.
- Even if you are not in the midst of making a decision, you will learn a lot of economics by keeping your eyes open when you walk through any environment in which people are using or exchanging resources. Think like an economist the next time you find yourself in a supermarket or at a used-car dealership, a poker game, or a soccer match. For example, why is it an equilibrium for a soccer player to randomize the side of the goal into which they launch a penalty kick? Why is it an equilibrium for the goal keeper to randomize the side of the goal that they jump to when the penalty kick occurs? (*Hint:* What would happen if the penalty kicker predictably kicked in one direction?)
- The easiest way to encounter economic ideas is to keep up with what's happening in the world. Go online and read a newspaper with excellent economics coverage like the *New York Times, The Wall Street Journal,* or the *Financial Times*. News magazines will also do the job. There's even a news magazine called *The Economist*, which is required reading for prime ministers and presidents. However, you don't need to read *The Economist* to learn about economics. Almost every page of any magazine—including *People, Sports Illustrated*, and *Vogue*—describes events driven by economic factors. Identifying and understanding these forces will be a challenge. Over time, though, you'll find that it gets easy to recognize and interpret the economic story behind every headline.

Once you realize that you are constantly making economic choices, you'll understand that this course is only a first step. You'll discover the most important applications outside class and after the final exam. The tools of economics will improve your performance in all kinds of situations—making you a better businessperson, a better consumer, and a better citizen. Keep your eyes open and remember that every choice is economics in action.

Summary

- Economics is the study of how agents choose to allocate scarce resources and how those choices affect society. Economics can be divided into two kinds of analysis: positive economic analysis (what people actually do) and normative economic analysis (what people ought to do). There are two key topics in economics: microeconomics (individual decisions and individual markets) and macroeconomics (the total economy).
- Economics is based on three key principles: optimization, equilibrium, and empiricism.
- Trying to choose the best feasible option, given the available information, is called optimization. To optimize, an economic agent needs to consider many issues, including trade-offs, budget constraints, opportunity costs, and cost-benefit analysis.
- Equilibrium is a situation in which nobody believes they would benefit personally by changing their own behavior, given their beliefs about the choices of others. In equilibrium, everyone is simultaneously optimizing.
- Economists test their ideas with data. We call such evidence-based analysis empirical analysis or empiricism. Economists use data to determine whether our theories about human behavior—like optimization and equilibrium—match actual human behavior. Economists also use data to determine what is causing things to happen in the world.

Key Terms

economic agent *p. 37*
scarce resources *p. 38*
scarcity *p. 38*
economics *p. 38*
positive economics *p. 39*
normative economics *p. 39*
microeconomics *p. 40*
macroeconomics *p. 40*
optimization *p. 41*
equilibrium *p. 41*
empiricism *p. 41*
trade-off *p. 42*
budget constraint *p. 42*
opportunity cost *p. 43*
cost-benefit analysis *p. 44*
net benefit *p. 44*

Questions

1. Give examples to explain how economic analysis can be positive and normative.
2. Economists think of almost all human behavior as the outcome of choices. Do you agree with this statement? Based on your reading of the chapter, how would you define economics?
3. Examine the following statements and determine if they are examples of normative economics or positive economics. Explain your answer.
   a. According to the World Economic Outlook Update released by the International Monetary Fund in January 2021, the global economy is projected to grow 5.5 percent in 2021 and 4.2 percent in 2022.
   b. According to an article published in the European Central Bank (ECB) *Economic Bulletin* in January 2021, government spending on investment should be a priority during the interim phase in the run-up to the economic recovery in the euro area.
4. How does microeconomics differ from macroeconomics? Would the sales of iPhones in China be studied under microeconomics or macroeconomics? What about the growth rate of *total* economic output in China?
5. Why do economic agents have to make trade-offs on any given day of their lives? What kind of non-monetary budget constraints do agents face?
6. This chapter introduced the idea of opportunity cost.
   a. What is meant by opportunity cost?
   b. What is the opportunity cost of taking a year after graduating from high school and backpacking across Europe? Are people who do this being irrational?
7. Suppose you wish to take out a mortgage to buy a new house for your family. However, the houses you like exceed your budget. You are considering three options: choose a neighborhood that is less fashionable and, therefore, the prices are lower; take out a mortgage with a longer maturity period; or instead of buying a house, buy a larger apartment in your current neighborhood. How would you evaluate these options and choose the optimal one?
8. Suppose the market price of the latest model of iPhone is €759 in Germany. What are the three conditions that will need to be satisfied for the iPhone market to be in equilibrium at this price?
9. Suppose you are living in a housing project that has 100 apartments. The housing project has its own garden, swimming pool, library, and community center. To be able to utilize the available amenities, residents must contribute €50 a month towards the upkeep while also taking turns keep it clean. In this context, answer the following questions.
   a. What is meant by free riding?
   b. How would you define a free-riding resident? Why would it be a problem for the housing project?
10. "Scarcity exists because people have unlimited wants in a world of limited resources." Explain this statement using a real-life example.
11. Identify the cause and the effect in the following phenomena in a hypothetical country:
    a. A surge in the price of goods and an increase in the workers' income.
    b. A rise in GDP and an increase in the number of university graduates.

Evidence-Based Economics Problems

1. Estimate the opportunity cost of going to see a movie in a movie theater. Express this opportunity cost in dollars. *Hint:* Think about both the out-of-pocket cost (i.e., the price of the ticket) and the indirect cost (the value of your time).
2. Estimate the opportunity cost for a hypothetical student to spend one year in college. Express this opportunity cost in dollars. Assume that the student spends $\$T$ in tuition and $\$R$ in room and board. Estimate the value of the student's time spent studying during a typical academic year, which is the indirect cost of going to college.
3. Estimate how many hours you spend on social media each year. Now estimate the opportunity cost of this time in dollars.

Problems

1. You have purchased a non-refundable ticket to the Maldives with an early morning departure scheduled for Saturday. You receive a call notifying you about an interview for a job that may be scheduled around the same time. While you really wanted this job, you think that going on the trip is more important for your mental well-being as you have been planning this trip for a year now.
   a. The human resources department from the company you applied to informs you that there is only one slot available for the interview, which clashes with your flight. Should this affect your decision to go on the trip? Explain by using the term "opportunity cost."
   b. Suppose instead that you realize that the non-refundable travel ticket, which you already purchased, cost you €100; previously you had mistakenly believed the price was €250. Should learning this information affect your decision to go to the Maldives trip?
2. You are thinking about buying a house in London. You find one you like that costs £1,000,000. You learn that, based on the value of the house and your wages, your bank will give you a mortgage for 20 years in the region of £600,000. This means that you must make a down payment of £400,000. What are some of the monetary and non-monetary opportunity costs of this purchase?
3. Your local coffee shop used to be the best in the neighborhood; however, due to a recent change in ownership the quality of the service and products offered has been steadily decreasing. Nevertheless, you have some fond memories of the place and it is also quite conveniently located—on the way to the train station that you use to get to work.
   a. What is the opportunity cost of searching for a new coffee shop?
   b. You have found a new coffee shop, but to get there you have to take a longer route to the train station. How would you determine, every morning, which coffee shop to visit? The old one or the new one?
4. You are watching your weight, and you have decided that you are going to consume 800 calories of pizza and cheeseburgers at a party Saturday night. A slice of pizza has 200 calories, and a cheeseburger has 400 calories.
   a. Create a table that shows the various combinations of pizza slices and cheeseburgers you can consume while staying within your 800-calorie "budget." To keep things simple, use only round numbers for pizza slices and cheeseburgers (e.g., don't worry about half portions).
   b. Under these assumptions, what is the opportunity cost of a cheeseburger?
5. Consider the following three statements:
   a. You are planning a conference in St. Petersburg, Russia, and your closing gala will be on a cruise boat in November. Do you think hosting the event on a boat is a rational choice?
   b. You have to reach the airport during rush hour to catch your flight to St. Petersburg. You have two options: take the underground or take a taxi. Although you have an hour to get there, traffic most of the time is heavy during rush hour. Which option would be the rational choice?
   c. Suppose you decided to take a taxi to the airport and made it to the airport in time. Once you landed in St. Petersburg, you noticed that the temperature was surprisingly mild, making the cruise boat experience comfortable. Do these outcomes mean that the decisions to host an event on a cruise boat in November and take a taxi to the airport were rational?
6. Consider the following three statements:
   a. Your friends are coming over for lunch and you realize you have forgotten to get groceries. You go to the local market, where there are about 50 stalls. You are in a hurry, so you decide to do all of your shopping at the first two stalls.
   b. You find a stall that sells good quality vegetables and fruit. However, you do not have enough money on you. You start to haggle and agree on a 15 percent discount for the products you are buying.
   c. Despite being in a hurry, you now decide to go around the market to check the prices and quality at all stalls.

   Which of these statements deals with optimization, which deals with equilibrium, and which deals with empiricism? Explain.
7. In 2014, California was in its third year of a major drought. With water supplies dwindling, Governor Brown issued a plea for a voluntary 20 percent reduction in water use. This target was not reached. In early 2015, Governor Brown issued an executive order requiring local water agencies to reduce water use by 25 percent, but no enforcement mechanism was specified. No taxes or fines were in the executive order. State officials hoped that they could achieve compliance without resorting to fines.[7]
   a. From an individual homeowner's perspective, what are the costs and benefits of using water during a drought? Why do you think that the voluntary reduction order in 2014 didn't work?
   b. Using concepts from this chapter, explain how you might get individual homeowners to reduce water use during a drought.
   c. Eventually, many communities began levying fines on water use. However, while many middle-income families dramatically cut water use, wealthy households cut back their water use relatively little.[8] How can you explain this phenomenon from an economic perspective?

8. Use the concepts discussed in this chapter to answer the following problems:

a. Oskar is about to join a new factory where he has the option of joining a trade union. Being a part of the trade union means that he will have to pay 5 percent of his wages to the union. Why do you think some workers decide not to join a trade union?

b. You are living in a semi-detached house with a common garden. This means that both families living in the house can use it while being jointly responsible for its maintenance and upkeep. However, you decide that you cannot spare any time to maintain the garden. How can the other family get you to do your share of the maintenance?

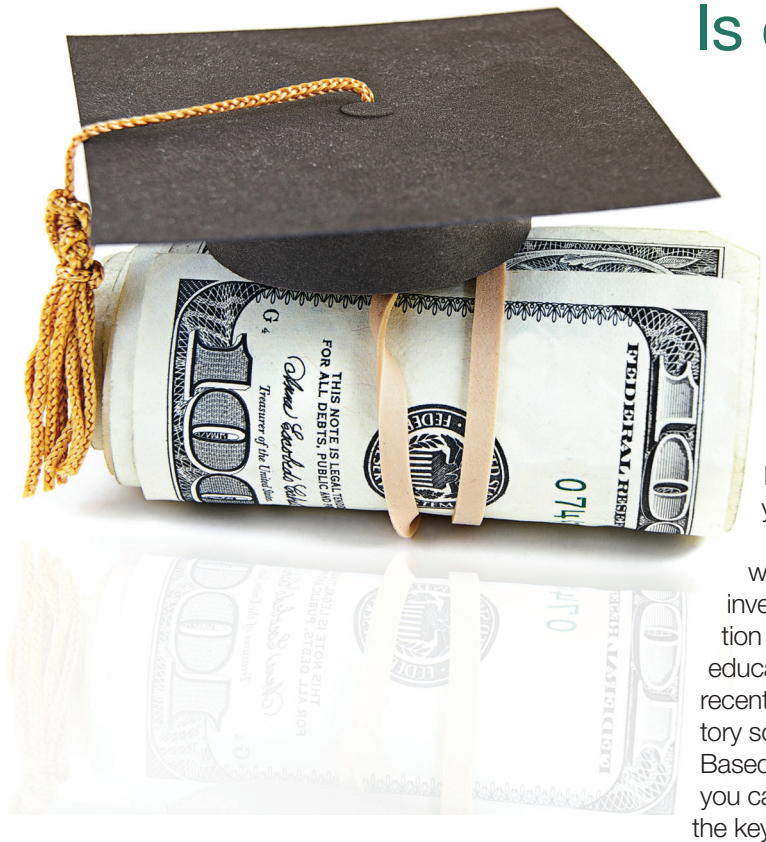
9. It is the night before your trip to Spain and you must decide how many hours to spend on expanding your vocabulary. The total benefits column shows how many more Spanish words you expect to learn. The cost column shows how many Spanish words you will mispronounce because of the increased fast learning. (The "marginal" columns show the effect of each additional hour spent studying. These marginal numbers are calculated by taking the difference within a column from one row to the next row.)

Hours Spent Learning	Total Benefit	Marginal Benefit	Total Cost	Marginal Cost
0	0	–	0	–
1	8	8	0	0
2	13	5	2	2
3	16	3	6	4
4	16	0	12	6

a. If you study in an optimal way, how many more Spanish words will you learn?

b. Explain how you can find the optimal number of hours by using the marginal benefits and marginal costs columns.

2 Economic Science: Using Data and Models to Understand the World



Is college worth it?

There is a good chance that you are either in college or thinking about taking the plunge. As you know, college is a big investment. During the 2019–2020 academic year, annual tuition (not counting room and board) averaged $3,730 for community colleges, $10,440 for in-state public colleges, $26,820 for out-of-state public colleges, and $36,880 for nonprofit private colleges.[1] And that's not the only cost. Your time, as we have seen, is worth $13 or more per hour—this time value adds at least $20,000 per year to the opportunity cost of a college education.

Why sit in class, then, if you could travel the world or earn money at a job? As with any other investment, you'd like to know how a college education is going to pay you back. What is the "return to education," and how would you measure it? We'll discuss recent research about the effect of college and mandatory schooling laws on wages in this chapter's Evidence-Based Economics feature. In this chapter, you'll see that you can answer such questions with data and models, the key tools that economists use to understand the world.

CHAPTER OUTLINE

KEY IDEAS

- A model is a simplified description of reality.
- Economists use data to evaluate the accuracy of models and understand how the world works.
- Correlation does not imply causality.
- Experiments help economists measure cause and effect.
- Economic research focuses on questions that are important to society and can be answered with models and data.

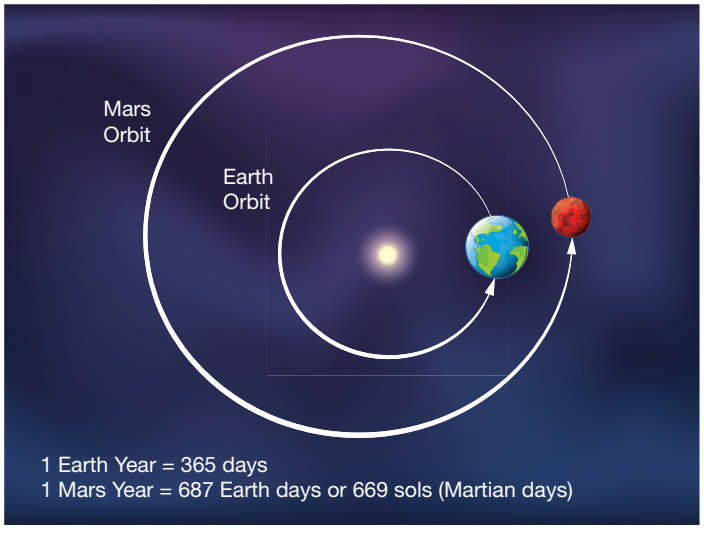
2.1 The Scientific Method

In Chapter 1, we explained the concepts of optimization and equilibrium, the first two principles of economics. Now we explain how economists put these two principles into practice and how you can, too.

Economics is a science. Like other scientists, economists explain data using scientific principles. For example, an astronomer might be interested in data about the changing location of Mars in the night sky as observed over many centuries. The scientific principle that is used to explain that data is the planet's gravitationally curved trajectory around another, much more massive astronomical body (our solar system's sun). Once you have an accurate model of Mars's orbit, you can both explain historical observations of the planet's location and accurately predict where it will be in the future. If you want to land autonomous vehicles—and one day a human settlement—on Mars, you'll need an accurate prediction of Mars's future location. Astronomers can tell us exactly where Mars will be millions of years in the future.

Economists are also trying to explain the past and predict the future. The *choices* that people make are the data we use. Economists explain this kind of data with our two core scientific principles: optimization and equilibrium. Gathering data and using it to understand the world is called empiricism, which is the third key principle of economics.

The **scientific method** is the name for the ongoing process that economists and other scientists use to (1) develop models of the world and (2) evaluate those models by testing them with data.



Astronomers use historical data on Mars's location in the sky to predict its future location, facilitating space travel and other forms of scientific inquiry. Economists use data on people's historical choices to predict their future choices, enabling households, businesses, and governments to foresee and plan for the future.

Empiricism—using data to analyze the world—is at the heart of all scientific analysis. The **scientific method** is the name for the ongoing process that economists, other social scientists, and natural scientists use to:

1. Develop models of the world
2. Evaluate those models by testing them with data

Testing models with data enables economists to separate the good models—those that make predictions that are mostly consistent with the data—from the bad models. When a model is overwhelmingly inconsistent with the data, economists try to fix the model or replace it altogether. By cycling through the two steps—developing models and then testing them—economists can move toward models that better explain the past and even predict the future.

For example, we'd like to know how going to college will improve a student's subsequent earnings in the labor market. To take another example, we'd like to know how raising the wages of Lyft drivers will affect the market share and profitability of that ride-sharing company. We would also like to know how an increase in the tax on

gasoline will affect gasoline purchases and, ultimately, emissions of greenhouse gases. As you'll see, empirical analysis enables us to answer these questions, along with myriad others that are relevant for households, businesses, governments, and society more generally.

Given the complexity of the world, we do not expect the scientific method to generate a perfect model of economic behavior—we'll never be able to precisely predict our economic future. However, economists do expect to identify models that are useful for understanding the data that we have already observed and to partially predict the future. In this section, we explain what a model is and how it can be tested with data.

Models and Data

Before the discoveries of the ancient Greek philosophers, everyone believed that the earth was flat. We now know that it is more like a beach ball than a Frisbee. Yet a flat-earth *model* is still actively used. Ask for directions from Google Maps, and you'll be using maps of a flattened planet.

A **model** is a simplified description of reality. Sometimes economists will refer to a model as a *theory*. These terms are usually used interchangeably.

Flat maps and spherical globes are both models of the surface of the earth. A **model** is a simplified description of reality. Sometimes economists will refer to a model as a *theory*. These terms are usually used interchangeably.

Because models are simplified, they are not perfect replicas of reality. Obviously, flat maps are not perfectly accurate models of the surface of the earth—they distort the curvature. If you are flying from New York to Tokyo, the curvature matters (see Exhibit 2.1). But if you are touring around New York City, you don't need to worry about the fact that the earth is shaped like a sphere (see Exhibit 2.2).

Scientific models are used to make predictions that can be checked with empirical evidence.

Scientists—and commuters—use the model that is best suited to analyzing the problem at hand. Even if a model/map is based on assumptions that are known to be false, like the flatness of the earth, the model may still help us to make good predictions and good plans for the future. It is more important for a model to be simple and useful than it is for the model to be a perfect replica of the world.

Exhibit 2.1 Flying from New York to Tokyo Requires More Than a Flat Map

This flat map is a model of part of the earth's surface. It treats the world as perfectly flat, which leads the map maker to exaggerate distances in the northern latitudes. It is useful for certain purposes—for instance, learning geography. But you wouldn't want to use it to find the best air route across the Pacific Ocean. The shortest flight path from New York to Tokyo is not a straight line through San Francisco. Instead, the shortest path goes through Northern Alaska. The flat-earth model is well suited for some tasks (geography lessons) and ill suited for others (intercontinental navigation).

Exhibit 2.2 New York City Subway Map

This is a model of the subway system in New York City. It is highly simplified—for example, it treats New York City as a perfectly flat surface, and it also distorts the shape of the city—but it is nevertheless very useful for commuters and tourists.

Empirical evidence consists of facts that are obtained through observation and measurement. Empirical evidence is also called **data**.

Scientific models are used to make predictions that can be checked with **empirical evidence**—in other words, facts that are obtained through observation and measurement. We also refer to empirical evidence as **data**. Recall from Chapter 1 that economists often describe themselves as empiricists, or say that we practice empiricism, because we use empirical evidence. Empiricists use data to answer questions about the world and to test models. For example, we could test the New York City subway map by actually riding the subway and checking the map's accuracy.

Hypotheses are predictions (typically generated by a model) that can be tested with data.

When conducting empirical analyses, economists refer to a model's predictions as **hypotheses**. Whenever such hypotheses are contradicted by the available data, economists return to the drawing board and try to come up with a better model that yields new hypotheses.

During the COVID-19 crisis that started in late 2019, scientists from Imperial College London developed an epidemiological model that had a large impact on public health policies. Using a few characteristics of the pandemic derived from empirical evidence—such as an estimated fatality rate of 0.9 percent among those infected—the scientists' developed a model of viral transmission that predicted 510,000 deaths in Great Britain and 2.2 million deaths in the United States *if* no action were taken to suppress the pandemic.[2] This model also projected that the number of deaths would be substantially lowered using public health policies such as social distancing. These policies were predicted to slow the spread of the virus and prevent medical systems from being overwhelmed with patients.

The model's key prediction, and the scientists' main hypothesis, was that social distancing would substantially reduce transmission of COVID-19. The Imperial College model was useful as a forecasting tool, and it spurred the adoption of stronger social distancing interventions, such as shelter-in-place policies, which did significantly slow the spread of the virus and also reduced the number of fatalities.[3]

An Economic Model

Let's consider an example of an economic model. We're going to study an extremely simple model to get the ball rolling. But even economic models that are far more complicated than this example are also simplified descriptions of reality.

All models begin with assumptions. Consider the following assumption about the return to education: *each additional year of education causes your future wages to rise by*

10 percent. Let's put the assumption to work to generate a model that relates a person's level of education to her wages.

Increasing a wage by 10 percent is the same as multiplying the wage by $(1 + 0.10) = 1.10$. Thus, the return-to-education assumption implies that someone with an extra year of education earns 1.10 times as much as she would have earned without the extra year of education. For example, if someone earns \$15 per hour with 13 years of education, then we predict that a 14th year of education will cause her hourly wage to rise to $1.10 \times \$15$, or \$16.50.

Economists use assumptions to derive other implications. For example, the return-to-education assumption implies that 2 additional years of education will increase earnings by 10 percent twice over—once for each extra year of education—producing a 21 percent total increase:

$$1.10 \times 1.10 = 1.21.$$

Likewise, four additional years of education will increase earnings by 10 percent four times over, implying a 46 percent total increase:

$$1.10 \times 1.10 \times 1.10 \times 1.10 = (1.10)^4 = 1.46.$$

This implies that going to college would increase a college graduate's income by 46 percent compared to what she would have been paid if she had ended her education after finishing high school. In other words, a prediction—or hypothesis—of the model is that college graduates will earn 46 percent more than high school graduates.

In principle, we can apply this analysis to any number of years of education. We therefore have a general model that relates people's educational attainment to their income. The model that we have derived is referred to as the return-to-education model. It describes the economic payoff of more education—in other words, the return on your educational investment. Most economic models are much, much more complex than this. In some economic models, it takes pages of mathematical analysis to derive the implications of the assumptions. Nevertheless, this simple model is a good starting point for our discussion. It illustrates two important properties of all models.

First, economists know that *a model is only an approximation* and accordingly understand that the model is not exactly correct. Taken literally, the model implies that each person would increase their future wages by exactly 10 percent if they obtained an extra year of education, but this precise prediction is false. For example, the final year of college does much more to increase your wages than the second-to-last year of college because that final year earns you the official degree, which is a key line on your resume. Likewise, your college major importantly impacts how much you will earn after college. Those who major in economics, for example, tend to earn more than graduates in most other majors. Our simple model overlooks such distinctions. Just as a flat subway map is only an approximation of the features of a city, the return-to-education model is only an approximation of the mapping from years of education to wages. The model's predicted relationship between education and wages is a simplification that overlooks lots of special considerations.

Second, *a model makes predictions that can be tested with data*—in this case, data on people's education and earnings. We are now ready to use some data to actually evaluate the predictions of the return-to-education model.

EVIDENCE-BASED ECONOMICS

Q: How much more does a worker with a 4-year college degree earn compared to a worker with a high school degree?

To put the model to the test we need data, which we obtain from the Current Population Survey, a U.S. government data source. This survey collects anonymized data on earnings, education, and many other characteristics of the general population and is available to anyone who wants to use it. When data are available to the general public, they are called "public-use data."

Exhibit 2.3 summarizes the average annual earnings for our test. The exhibit shows that full-time U.S. workers who are 25–34 years old and have a high school diploma (and no more education) had median annual earnings of $35,620 in 2018. The exhibit also shows that full-time U.S. workers who are 25–34 years old and have a 4-year college degree (and no more education) had median annual earnings of $55,660 in 2018.

If we divide these two medians—earnings for college-educated workers divided by earnings for high school educated workers—the ratio is 1.56, implying a 56 percent difference in earnings:

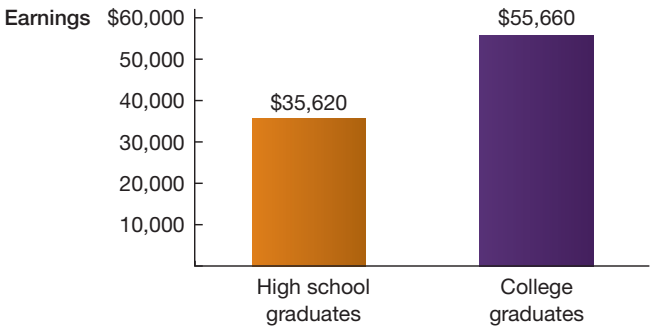
$$\frac{\text{Median annual earning of 25- to 34-year-old workers with 16 year of education}}{\text{Median annual earning of 25- to 34-year-old workers with 12 year of education}} = \frac{\$55{,}660}{\$35{,}620} = 1.56$$

Recall that the return-to-education model says that each additional year of education raises the wage by 10 percent, so 4 extra years of education should raise the wage by a factor of $(1.10)^4 = 1.46$. We can see that the model does not closely match the data but is in the right ballpark. Going from 12 years of education to 16 years is associated with a 56 percent difference in earnings, which is higher than the model's predicted increase of 46 percent.

Exhibit 2.3 Median Annual Earnings of Full-Time U.S. Workers by Education Level (2018 Earnings)

People who stop going to school after obtaining their high school diplomas have median annual earnings of $35,620, whereas those who stop going to school after obtaining a 4-year college degree earn $55,660.

Source: 2018 earnings are measured in the 2019 Current Population Survey.



Question

How much more does a worker with a 4-year college degree earn compared to a worker with a high school degree?

Answer

Median earnings for a college graduate are 56 percent higher than median earnings for a high school graduate.

Data

Wages in 2018 are measured in the 2019 Current Population Survey for full-time workers ages 25–34.[4] Exhibit 2.3 compares median annual earnings for each education group.

Caveat

These are medians for a large population of individuals. An individual's experience might differ.

Use the concepts presented in this feature by working through the Evidence-Based Economic Problem at the end of this chapter.

Means and Medians

The **median** value is calculated by ordering the numbers from least to greatest and then finding the value halfway through the list.

You may wonder how the data from the Current Population Survey were used to calculate the earnings reported above. We used the concept of the **median**, which is the "middle" value of a group of numbers. Specifically, the **median** value is calculated by ordering the numbers from least to greatest and then finding the value halfway through the list.

We can show how the median is calculated with a simple example. Say that there are five people: Mr. Kwon, Ms. Littleton, Mr. Locke, Ms. Reye, and Ms. Shephard, each with a different hourly wage:

$$\begin{aligned} \text{Kwon} &= \$26 \text{ per hour}, \\ \text{Littleton} &= \$24 \text{ per hour}, \\ \text{Locke} &= \$8 \text{ per hour}, \\ \text{Reye} &= \$35 \text{ per hour}, \\ \text{Shephard} &= \$57 \text{ per hour}. \end{aligned}$$

Recall that the **median** value is calculated by ordering the numbers from least to greatest and then finding the value halfway through the list. Ordering the data that we just described produces the list: \$8, \$24, \$26, \$35, \$57. The middle value—the median—is \$26. (When there are an even number of items in the list, the median is the midpoint between the two middle values. So the median of the numbers \$8, \$24, \$26, and \$35 is the midpoint between \$24 and \$26: \$25.)

The **mean** (or **average**) is the sum of all the different values divided by the number of values.

Scientists also sometimes study the *mean*, or *average*. The **mean (**or **average)** is the sum of all the different values divided by the number of values. Statisticians and other scientists use the terms *mean* and *average* interchangeably.

For the preceding example, if we add the five wages together and divide by 5, we calculate a mean wage of \$30 per hour:

$$\frac{\$26 + \$24 + \$8 + \$35 + \$57}{5} = \$30.$$

In review, the median is the value in the middle of an ordered group of numbers, and the mean is the average value of the group of numbers. When the group of numbers has one or more extreme values, the median and the mean pull apart. For example, suppose that Shephard is extremely highly paid—she might be a corporate lawyer—with an hourly wage of \$257 (instead of the original value of \$57 per hour). Then the group mean rises to \$70 per hour, but the median doesn't change at all: \$26 per hour is still the middle wage. Hence, the mean is affected by outliers, which are extreme numbers that are dissimilar to the rest of the numbers in the list, whereas the median is not affected by outliers.

This analysis of a small sample—only five people—illustrates the concepts of medians and means, but convincing data analysis in economics relies on using a large sample. For example, a typical economic research paper uses data gathered from thousands of people. When we showed in Exhibit 2.3 that higher levels of education are associated with higher levels of earnings, we didn't rely on a handful of *observations* (each piece of data is called an "observation"). Instead, we used data from 15,000 full-time workers randomly chosen from the U.S. population and surveyed by the Census Bureau. Using lots of observations strengthens the force of an empirical argument because a large sample of observations is likely to be representative of the underlying population from which the sample was drawn.

To show you how to make convincing empirical arguments, this book uses lots of real data from large groups of people. Credible empirical arguments, based on many observations, are a key component of the scientific method.

Argument by Anecdote

Education is not destiny. There are some people with lots of education who earn very little, and there are some people with little education who earn a lot. The second, fifth, and seventh richest people in the world didn't graduate from college: Bill Gates dropped out of Harvard to start Microsoft, Larry Ellison left two different universities before creating Oracle, and Mark Zuckerberg dropped out of Harvard to start Facebook.[5]

With these examples in mind, it might be tempting to conclude that dropping out of college is a great path to success. However, it is a mistake to use anecdotes, or any small sample of people, to try to judge a statistical relationship.

If you study two randomly chosen 30-year-olds, there is almost a one-third chance that the person with only a high school diploma has higher earnings than the one with a 4-year college degree. This fact highlights that there is much more than education that determines your earnings, although getting a college degree will usually help raise your earnings.

When you look at only a small amount of data, it is easy to jump to the wrong conclusion. Keep this warning in mind the next time a newspaper columnist tries to sway you with a few anecdotes. If the columnist backs up their story with data reflecting the experiences of thousands of people, then they have done their job and may deserve to win the argument. But if the columnist rests their case after sharing a handful of anecdotes, remain skeptical. Be doubly skeptical if you suspect that the anecdotes have been carefully selected to prove the columnist's point. Argument by anecdote should not be taken seriously.

There is one exception to this rule. Argument by example is appropriate when you are contradicting a *blanket* statement. For example, if someone asserts that every National Basketball Association (NBA) player has to be tall, just one counterexample is enough to prove this statement wrong. In this case, your proof would be Tyrone "Muggsy" Bogues, a 5-foot 3-inch (133-pound) dynamo who played point guard in the NBA for 15 seasons.

2.2 Causation and Correlation

Unfortunately, even analysis that relies on large data sets can be misleading. Consider our return-to-schooling example. Using our large data set on wages and years of education, we've seen that on average, wages rise roughly 10 percent for every year of additional education. Does that mean that staying in school one more year will cause *your* future wages to rise by 10 percent? Not necessarily. Let's use an example to think about why this is not always the case.

The Red Ad Blues

Imagine a department store has hired you as a consultant. You have developed a hypothesis about ad campaigns: you believe that campaigns using the color red are good at catching people's attention. To test your hypothesis, you assemble empirical evidence from historical ad campaigns, including the dominant color of the ad campaign and how revenue at the store changed during the campaign.

Your empirical research confirms your hypothesis! Sales go up 25 percent during campaigns with lots of red images and only 5 percent during campaigns with lots of blue images. You race to the chief executive officer (CEO) to report this remarkable result. You are a genius!

Unfortunately, the CEO instantly fires you. What did the CEO notice that you missed?

The red-themed campaigns were mostly concentrated during the Christmas season. The blue-themed campaigns were mostly spread out over the rest of the year. In the CEO's words, "The red colors in our advertising don't cause an increase in our revenue. Christmas causes an increase in our revenue. Christmas also causes an increase in the use of red in our ads. If we ran blue ads in December, our holiday season revenue would still rise by about 25 percent."

Unfortunately, this is actually a true story, though we've changed the details to protect our friends. We return, in the appendix, to a related story in which the CEO was not as sharp as the CEO in this story.

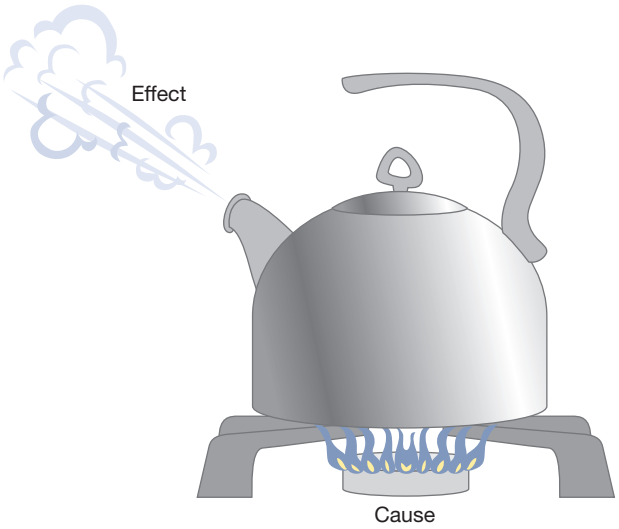
Causation Versus Correlation

Causation occurs when one thing directly affects another.

A **variable** is a changing factor or characteristic.

As in the misguided ad analysis, people often mistake *correlation* for *causation.* **Causation** occurs when one thing directly affects another. You can think of causation as the path from cause to effect: turning on the stovetop burner *causes* the water in the kettle to boil.

Scientists refer to a changing factor or characteristic as a **variable**—for example, the temperature of water in a teakettle. Scientists say that causation occurs when one variable (for instance, the flow of natural gas burning on a stovetop) causes another variable (the temperature of water in a teakettle) to change.



From cause to effect. The flame on the stove heats the water in the kettle, causing the water to boil and vaporize. The vaporizing water does *not* cause the flame to burn on the stovetop.

Does jogging cause people to be healthy? Does good health cause people to jog? In fact, both kinds of causation are simultaneously true.

You can think of causation as the path from cause to effect.

Correlation means that two variables tend to change at the same time—as one variable changes, the other changes as well. There is some kind of connection. It *might* be cause and effect, but correlation can also arise when causation is not present. For example, students who take music classes score better on their SATs than students who do not take music classes. Some music educators have happily jumped to the conclusion that this relationship is causal: more music causes higher SAT scores.

Correlation means that two variables tend to change at the same time.

But don't buy a clarinet for your younger sibling just yet. There is scant evidence of a causal relationship, and there are many alternative explanations for the correlation between music lessons and high SAT scores.

For example, the students who have music lessons tend to have wealthier parents who can pay for SAT tutors that raise their kids' SAT scores. In this scenario, the causal pathway is from wealth to SAT tutors to high SAT scores. Music lessons aren't causing high SAT scores. Parental wealth is causing music lessons, and parental wealth is also causing high SAT scores (through the tutor channel).

When two variables are correlated, it suggests that causation may be possible and that further investigation is warranted—but it's only the beginning of the analysis. Interestingly, when researchers have tried to document a *causal* link from music lessons to higher cognitive ability, they have almost always failed.[6] Accordingly, if a young trumpeter broke her finger and dropped out of music classes, this would not cause her future SAT scores to fall. To summarize, it does not appear that taking music lessons *causes* SAT scores to rise, even though music lessons and SAT scores are correlated.

Can you think of other situations in which correlation is confused with causality? Does being on a high school sports team cause you to be more successful in life (e.g., have a higher income at age 30)? Does smoking cigarettes at age 15 cause you to have a greater likelihood of later becoming addicted to illegal drugs? Are these causal relationships? Or are these only correlations?

Correlations are divided into three categories: *positive correlation, negative correlation*, and *zero correlation*. **Positive correlation** implies that two variables tend to move in the same direction—for example, surveys reveal that people who have a relatively high income are more likely to be married than people who have a relatively low income. In this situation, we say that the variables of income and marital status are positively correlated. **Negative correlation** implies that the two variables tend to move in opposite directions—for example, people with a high level of education are less likely to be unemployed. In this situation, we say that the variables of education and unemployment are negatively correlated. When two variables are not related, we say that they have a **zero correlation**. The number of friends you have has no relation to whether your address is on the odd or even side of the street.

Positive correlation implies that two variables tend to move in the same direction.

Negative correlation implies that two variables tend to move in opposite directions.

When the variables have movements that are not related, we say that the variables have **zero correlation**.

When Correlation Does Not Imply Causality There are two main reasons we should not jump to the conclusion that a correlation between two variables implies a particular causal relationship:

1. Omitted variables
2. Reverse causality

An **omitted variable** is something that has been left out of a study that, if included, would explain why two variables that are in the study are correlated.

An **omitted variable** is something that has been left out of a study that, if included, would explain why two variables are correlated. Recall that the amount of red content in the store's ads is positively correlated with the growth rate of their sales. However, the red color does not necessarily cause the store's sales to rise. The arrival of the Christmas season causes both the store's ads to be red and month-over-month sales revenue to rise. Thus, the Christmas season is an omitted variable that explains why red ads tend to occur at around the time that sales tend to rise. (See Exhibit 2.4.)

Is there also an omitted variable that explains why education and income are positively correlated? One possible factor might be an individual's tendency to work hard. What if workaholics tend to thrive in college classes more than other students? Perhaps pulling all-nighters to write term papers allows hard-working students to do well in their courses, encouraging them to stay in school. These same tendencies would also allow workaholics to earn more money than others—by staying late on the job, for example, or working on weekends. Does workaholism cause you to earn more and, incidentally, to graduate from college rather than drop out? Or does staying in college cause you to earn those higher wages? What is cause, and what is effect? We'll unravel this knot a bit later in this chapter.

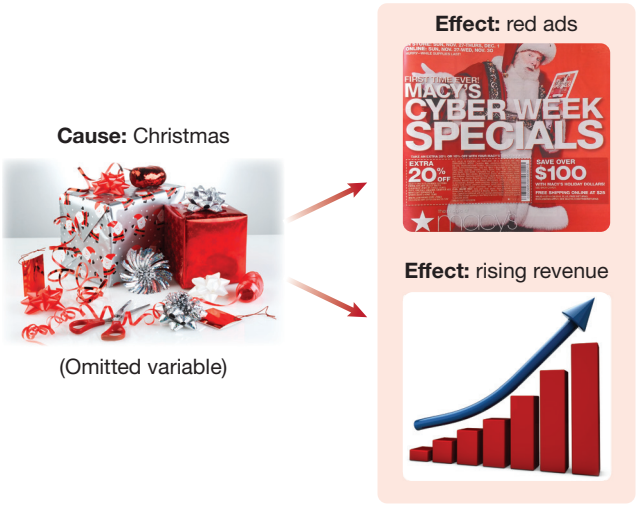
Reverse causality occurs when we mix up the direction of cause and effect.

Reverse causality is another problem that plagues our efforts to distinguish correlation and causation. Reverse causality occurs when we mix up the direction of cause and effect. For example, consider the fact that relatively wealthy people tend to be relatively healthy, too. This has led some social scientists to conclude that greater wealth causes better health—because, for instance, wealthy people can afford better healthcare. However, this could be a case of reverse causality: better health may cause greater wealth. For example, healthy people can work harder, can retire later in life, and have fewer healthcare expenditures than less healthy people. It turns out that both causal channels seem to exist: greater wealth causes better health, and better health causes greater wealth.

In our analysis of the return to education, could it be that reverse causality is at play? That is, could higher wages at age 30 cause you to get more education at age 20? We can logically rule this out. Assuming that you don't have a time machine, it is unlikely that your wage as a 30-year-old causes you to obtain more education in your 20s. So in the return-to-education example, reverse causality is probably not a problem. But in many other analyses—for example, the wealth-health relationship—reverse causality is a key consideration.

Exhibit 2.4 An Example of an Omitted Variable

The amount of red content in the store's ads is positively correlated with the growth of the store's revenue. In other words, when ads are red themed, the store's month-over-month sales revenue tends to grow the fastest. However, the redness does not cause the store's revenue to rise. The Christmas season causes the store's ads to be red, and the Christmas season also causes the store's sales revenue to rise. The Christmas season is the omitted variable that explains the positive correlation between red ads and month-over-month revenue growth.



CHOICE & CONSEQUENCE

Spend Now and Pay Later?

Two economists, Andrew Francis-Tan and Hugo Mialon, used U.S. survey data to calculate the empirical relationship between wedding spending and rates of divorce.[7] They found that more spending on a wedding ceremony or the engagement ring predicts a higher rate of divorce (holding other factors constant). For example, in their sample of recently married women whose weddings cost more than $20,000, the annual likelihood of divorce is 3.5 times higher compared to women whose weddings cost between $5,000 and $10,000.

That's an intriguing piece of empirical evidence. Does this correlation prove that the key to a long marriage is a small wedding or, even better yet, an elopement? Does spending more on a wedding actually cause the couple to divorce? Or are there omitted variables at work? What omitted variables might cause people to have fancy weddings and also cause them to end up divorced? Vanity? Pride? Materialism?

Or perhaps expensive weddings create financial strains for the newlyweds, and these strains might cause divorce. So there *might* be a causal path from wedding expenses to divorce rates.

In fact, the authors of this paper aren't claiming to prove that expensive weddings cause divorce. They understand that correlation need not imply causation. With complex examples like this in mind, can we ever determine what is correlation and what is actually causation? Economists have developed a rich set of tools for identifying cause and effect. We turn to some of these tools next.

Do expensive weddings cause divorce? Or is something else going on?

Experimental Economics and Natural Experiments

An **experiment** is a controlled method of investigating causal relationships among variables.

One method of determining cause and effect is to run an **experiment**—a controlled method of investigating causal relationships among variables. Though you may not read much about economic experiments in the newspaper, headlines for experiments in medicine are common. For example, the Food and Drug Administration requires pharmaceutical companies to run carefully designed experiments to provide evidence that new vaccines work before they are approved for use by the general public. As we write this text, dozens of vaccines for COVID-19 are going through this rigorous process of testing in the hope that at least one will emerge as a success.

To run an experiment, researchers usually take a target population and divide it into a treatment (test) group and a control group. The treatment group is exposed to some novel experience—for example, they are given a newly developed vaccine that is being evaluated for its effectiveness and safety. By contrast, the control group doesn't get any unusual treatment—for example, the control group might receive a placebo vaccine—for example, a saline injection with no known medical benefit. Participants are assigned randomly to participate either as a member of the treatment group or as a member of the control group.

Randomization is the assignment of subjects by chance, rather than by choice, to a treatment group or a control group.

Randomization is the assignment of subjects by chance, rather than by choice, to the treatment group or to the control group. The treatment group and the control group are treated identically, except along a single dimension that is intentionally varied across the two groups. Ultimately, the purpose of the experiment is to determine the impact of this variation.

If we want to know whether a promising new vaccine helps patients avoid COVID-19 infections, we could take 1,000 patients and randomly place 500 of them into a treatment group—those who receive the new vaccine. The other 500 patients would be in the control group and receive the placebo vaccine (the saline injection). Then we would follow all the patients and monitor their rate of infection with COVID-19. This experiment would test the causal hypothesis that the real vaccine is better than the saline injection at avoiding infections.

Now, consider an economics experiment. Suppose that we want to know what difference a college degree makes. We could take 1,000 high school students who cannot afford college but would like to attend college (if it were free) and randomly place 500 of them into a treatment group, where they had all their college expenses paid. The other 500 students would be placed in the control group. Then we would keep track of all the original 1,000 students—including the 500 control-group students who weren't able to go to college because they couldn't afford it. We would use periodic surveys during their adult lives to see how the wages in the group that got a college education compare with the wages of the group that did not attend college. This experiment would test the hypothesis that a college education causes wages to rise.

Experiments can sometimes be very costly to conduct. For instance, the college-attendance experiment that we just described would cost tens of millions of dollars because the researchers would need to pay the college fees for 500 students.

Another problem is that experiments do not provide immediate answers to some important questions. For example, learning how more education affects wages over the *entire working life* would take many decades.

And yet another problem is that experiments are sometimes run poorly. For example, if medical researchers do not truly randomize the assignment of patients to medical treatments, then the experiment may not teach us anything at all. For instance, if patients who go to cutting-edge research hospitals tend to be the ones who get prescribed the new vaccine, then we cannot identify causation; we don't know whether it was the vaccine or something else at the leading medical centers that caused those patients to fare better during the pandemic. In a well-designed experiment, randomization alone would determine who got the new vaccine and who didn't.

When research is badly designed, economists are skeptical of its conclusions. We say "garbage in, garbage out" to capture the idea that bad research methods invalidate a study's conclusions.

If we don't have the budget or time to run an experiment or don't have the ability to truly randomize treatment, how else can we identify cause and effect? One approach is to study historical data generated by a natural experiment. A **natural experiment** is an empirical study in which some process—out of the control of the experimenter—has assigned subjects to control and treatment groups in a random or nearly random way.

A **natural experiment** is an empirical study in which some process—out of the control of the experimenter—has assigned subjects to control and treatment groups in a random or nearly random way.

In many situations, natural experiments are literally the only kind of experiment that we have from which to draw a conclusion. For instance, generals don't randomly choose villages on which to drop bombs—if they did, they would be court-martialed. But sometimes random factors cause some villages to be bombed and other villages to be spared. Melissa Dell, an economist who just won the highly prestigious Bates Clark Prize, has explored such a natural experiment to determine the effect of different bombing policies during the Vietnam War.[8] Most natural experiments are far less ethically complex. In a moment, we'll discuss a natural experiment—in this case, a change in mandatory education laws—that led some kids to get an extra year of education.

Economists have found and exploited natural experiments to answer numerous major questions. This methodology can be useful for providing a more definitive answer to our question at hand: What are you getting from your education?

EVIDENCE-BASED ECONOMICS

Q: What is the return to education?

A century ago, compulsory schooling laws were much more permissive, allowing teenagers to drop out well before they graduated from high school. Philip Oreopoulos studied a natural experiment that was created by a change in these compulsory schooling laws.[9] Before 1947, the United Kingdom allowed kids to drop out of school once they reached age 14. In 1947, the United Kingdom raised the bar by 1 year, requiring 14-year-old kids to stay in school until they turned 15. Before 1947, most kids in the United Kingdom dropped out at age 14. After 1947, almost nobody did.

EVIDENCE-BASED ECONOMICS *(continued)*

In this natural experiment, those kids reaching age 14 in 1946 are a "control group" for those reaching age 14 in 1948 (who were compelled to stay in school an extra year). Oreopoulos compared the lifetime labor market earnings of students who turned 14 in 1946 to the lifetime earnings of the students who turned 14 in 1948. Using this natural experiment, Oreopoulos estimated that the return to schooling is about 10 percent. In other words, his analysis implies that the *causal* effect of staying in school an extra year is to earn 10 percent more *every* year of your working life.

Natural experiments are a useful source of data in empirical economics. In many problems, they help us separate correlation from causation. Applied to the return to education, they suggest that the correlation between years of education and higher income not only is due to some omitted variables but also reflects the causal influence of education. The return-to-education model thus obtains strong confirmation from the data. Does a 10 percent return to each additional year of education increase your appetite for more years of schooling?

Question	Answer	Data	Caveat
What is the return to education?	On average, wages rise by 10 percent when kids are compelled to stay in school an extra year.	United Kingdom General Household Survey. Compare kids in the United Kingdom who were allowed to drop out of school at age 14 with others who were compelled to stay in school an extra year due to changes in compulsory schooling laws.	Factors other than the change in the compulsory schooling laws might explain why the kids who were compelled to stay in school eventually earned more in the workforce. (This is an example of an omitted variable.)

Use the concepts presented in this feature by working through the Evidence-Based Economics Problems at the end of this chapter.

2.3 Economic Questions and Answers

Economists like to think about our research as a process in which we pose and answer questions. We've already seen a couple of these questions. For example, in the current chapter, we asked, "What is the return to education?" and in Chapter 1, we asked, "Is Facebook free?"

Good questions come in many different forms. But the most exciting economic questions share two properties.

1. ***Good economic questions address topics that are important to individual economic agents and/or to our society.*** Economists tend to think about economic research as something that contributes to society's welfare. We try to pursue research that has general implications for human behavior or economic activity. For example, understanding the return to education is extraordinarily important because individuals invest significant resources to obtain an education. The United States spends $1.5 trillion per year on education *plus* the opportunity cost of students' time. It is useful to understand the payoffs from all this investment. If the return to education

is very high, society may want to encourage more educational investment. If the return to education is low, we should share this important fact with students who are deciding whether to stay in school. Knowing the return to education will help individuals and governments decide how much of their scarce resources to allocate to educational investment.

2. ***Good economic questions can be answered.*** In some other disciplines, posing a good question is enough. For example, philosophers believe that some of the most important questions don't have answers. In contrast, economists are primarily interested in questions that can be answered with enough hard work, careful reasoning, and empirical evidence.

Here are some of the economic questions that we discuss in this book. As you look over the set, you will see that the answers to these questions have interesting (and occasionally comical) implications for you and for society as a whole. In this book we will explore those answers. We believe the journey will be illuminating and exhilarating.

Chapter	Questions
1	Is Facebook free?
2	How much more does a worker with a 4-year college degree earn compared to a worker with a high school degree? What is the return to education?
3	How does location affect the cost of housing?
4	How much gasoline would you buy if it were almost free?
5	Would a smoker quit the habit for $100 a month?
6	How would an ethanol subsidy affect ethanol producers?
7	Can markets composed of only self-interested people maximize the overall well-being of society? Do companies like Uber make use of the invisible hand?
8	Will free trade cause you to lose your job? What can the government do to lower the number of earthquakes in Oklahoma?
9	How can the Queen of England lower her commute time to Wembley Stadium?
10	What is the optimal size of government?
11	Is there discrimination in the labor market?
12	Can a monopoly ever be good for society?
13	Is there value in putting yourself into someone else's shoes?
14	How many firms are necessary to make a market competitive?
15	Do people exhibit a preference for immediate gratification?
16	Why do new cars lose considerable value the minute they are driven off the lot? Why is private health insurance so expensive?
17	How should you bid in an eBay auction? Who determines how the household spends its money?
18	Do people care about fairness?
19	In the United States, what is the total market value of annual economic production?
20	Why is the average American so much richer than the average Indian?
21	Why are you so much more prosperous than your great-great-grandparents were?
22	Are tropical and semitropical areas condemned to poverty by their geographies?
23	What happens to employment and unemployment if local employers go out of business?
24	How often do banks fail?
25	What caused the German hyperinflation of 1922–1923?

Chapter	Questions
26	What caused the recession of 2007–2009?
27	How much does government spending stimulate GDP?
28	Are companies like Nike harming workers in Vietnam?
29	How did George Soros make $1 billion?
Web Chapter 1	Do investors chase historical returns?
Web Chapter 2	What is the value of a human life?
Web Chapter 3	Do governments and politicians follow their citizens' and constituencies' wishes?

Summary

- The scientific method is the name for the ongoing process that economists and other scientists use to (1) develop models of the world and (2) evaluate those models by testing them with data.
- Empirical evidence is facts that are obtained through observation and measurement. Empirical evidence is also called data.
- Economists try to uncover causal relationships among variables.
- An experiment can be designed to measure a causal relationship. Economists now actively pursue experiments both in the laboratory and in the field. Economists also determine causality by studying historical data that have been generated by a natural experiment.

Key Terms

scientific method *p. 55*
model *p. 56*
empirical evidence (data) *p. 57*
hypotheses *p. 57*
median *p. 60*
mean (average) *p. 60*
causation *p. 61*
variable *p. 61*
correlation *p. 62*
positive correlation *p. 62*
negative correlation *p. 62*
zero correlation *p. 62*
omitted variable *p. 63*
reverse causality *p. 63*
experiment *p. 64*
randomization *p. 64*
natural experiment *p. 65*

Questions

1. Why do economists use the scientific method? Explain your answer by arguing for and against the use of this method.
2. Explain how economists study the economic behavior of a society empirically. By using hypotheses, confirmed by empirical evidence, how do the economists and the empirical evidence contribute to the welfare of the society?
3. Are economic models detailed or simplified versions of reality? Could economists build perfect economic models? Why?
4. How is the mean calculated from a series of observations? Suppose a supermarket near you sells four types of fruit juice (apple, orange, lemon, and grape). The price of the apple juice is €3, the price of the orange juice is €5, the lemon juice is €6, and the grape juice is €4. What is the average price of juice in the supermarket?
5. Why does the size of the sample matter in an empirical argument?
6. Explain why correlation does not equal causation. Give examples where the cause and effect relationship between events is not necessarily clear.
7. Consider the following examples and state whether there is positive correlation, negative correlation, or zero correlation between the variables.
   a. A person's gender and how well they drive a car.
   b. The number of sunglasses sold and the number of sunny days.
   c. The amount of gas (petrol) sold and its price.
8. What is data? Is it always numerical? How is data used in empirical analysis? Give an example.
9. Why is it necessary to conduct experiments before releasing new drugs in a market? Why is randomization needed for experiments?
10. Suppose you had to find the effect of smoking on cancer. Would you choose to run a randomized experiment or would it make sense to use natural experiments here? Explain.

Evidence-Based Economics Problems

1. Let's return to our examination of whether workers with 4-year college degrees earn more than workers with high school degrees. In the first Evidence-Based Economics module, we provided data about earnings for U.S. workers. We showed that the median earnings of full-time workers with a college degree was 56 percent higher than the median earnings of full-time workers with a high school degree, holding age fixed. From these data alone, can we infer that going to college causes higher wages? Choose one of the four answers below.

   i. Not necessarily. Higher earnings for college-educated workers might be due to preexisting characteristics that caused those workers to go to college and also cause those workers to earn more. This is called reverse causality.

   ii. Not necessarily. Higher earnings for college-educated workers might be due to preexisting characteristics that caused those workers to go to college and also cause those workers to earn more. This is called an omitted variable problem.

   iii. Yes. Being a college graduate is positively correlated with earnings.

   iv. Yes. Being a college graduate is positively correlated with earnings, and this is true even when we compare workers of the same age.

2. In the second Evidence-Based Economic module, we discussed how Philip Oreopoulos used a natural experiment involving compulsory schooling laws to infer that the return to one additional year of schooling is a 10 percent increase in earnings. For this question, let's assume that Oreopoulos's 10 percent finding is correct and applies to all people in all circumstances. (These are strong assumptions that are made for illustrative purposes.)

   a. Compare two workers, one of whom has 12 years of schooling and one of whom has 18 years of schooling. Assume these workers are otherwise identical. In percentage terms, how much higher will the earnings of the second worker be?

   b. Suppose the first worker earns $50,000 per year. How much would the second worker earn in a year?

Problems

1. Some studies have found that people who owned guns were more likely to be killed with a gun. Do you think this study is strong evidence in favor of stricter gun control laws? Explain.

2. The average score for a class of 30 students is 70. The score for the top 20 students in the class averaged at 75. What is the average score of the remaining 10 students in the class?

3. This chapter stressed the importance of using appropriate samples for empirical studies. Consider the following two problems in that light.

   a. Imagine you are a sociologist and your task is to find out the average wage in a small town in rural Europe. Since you are short on time you travel to the city and ask 10 random people waiting at the train station about their wages, then travel back and report on the data. Are you going to get an accurate number?

   b. Your friend was visiting a European capital city for two days and comes home saying that this city has the best restaurants in the world. Do you think his/her conclusion is justified?

4. A study in 1991 have found that hormone replacement therapy (HRT), used to treat symptoms of menopause, reduces coronary heart disease risk. Do you think this study is strong evidence in favor of HRT? Explain.

5. As the text explains, it can sometimes be very difficult to sort out the direction of causality.

   a. As opposed to the United States, which has serious speed limits, in Germany, many places have no speed limits on the motorway. This means that you can easily travel at 200 kilometers per hour. Does the lack of a speed limit on the motorway mean that there are likely to be more fatalities due to car accidents in Germany?

   b. In 2017, Europe experienced the hottest summer since 2003. The heatwave was aptly named Lucifer. Temperatures crossed 40°C. Do you think it is likely that more people would have bought an air-conditioning device for their home?

6. During the summer of 2015, the European Union (EU) experienced a record number of applications from asylum seekers. Some said they are economic migrants who just want to take advantage of the relatively good social protection system of the EU, whereas others pointed out that most asylum applications come from countries experiencing civil war. Why do you think asylum seekers were trying to get into the EU? List at least five possible explanations.

7. An independent variable is a variable whose value does not depend on another variable, whereas a dependent variable is a variable whose value depends on another variable. Assume that ACT scores obtained by the students is the dependent variable.

a. What kind of independent variables might we use in order to predict how a student might perform in secondary school?

b. Assuming that in order to pass their calculus module students on average have to spend 100 hours studying. If they study more, they will of course improve on their ACT score. If someone i) has a higher IQ ii) has better teachers iii) has more committed classmates iv) has to work part time, will they have to spend more or less hours on average to pass calculus?

8. In 2016, most British voters decided that the United Kingdom should exit the European Union (EU). This withdrawal is popularly known as Brexit. How can we use this to demonstrate the effects of EU membership? Is this a natural experiment? What economic impact will this have on the United Kingdom?

9. An economist believes that the consumption patterns of a household can be determined by using the equation $C = a + bI$, where I is the income, a denotes a positive number, and b a percentage.

a. Is the economist using a model?

b. How would you test this?

Appendix

Constructing and Interpreting Charts and Graphs

As you start to learn economics, it's important that you have a good grasp of how to make sense of data and how to present data clearly in visible form. Graphs are everywhere—on TV, on the Web, in newspapers and magazines, in economics textbooks. Why are graphs so popular?

A well-designed graph summarizes a large amount of information—as the saying goes, "a picture is worth a thousand words."

A well-designed graph summarizes a large amount of information—as the saying goes, "a picture is worth a thousand words." In this book, you will find many graphs, and you will see that they provide a way to supplement the verbal description of economic concepts.

Indeed, visualization can be extremely useful at every stage of economic analysis. As you'll see throughout this book, simple charts and graphs reveal the relationships between variables in a model. Charts and graphs make complicated databases more intuitive by giving the researchers a sense of important underlying properties in the data, like time trends. To demonstrate how data visualizations enhance economic analysis, we will walk you through a recent study that one of us—John List—co-authored, presenting data visualizations along the way.

A Study about Incentives

Would you study harder for this economics class if we paid you $50 for earning an A? What if we raised the stakes to $500? Your first impulse might be to think "Well, sure . . . why not? That money could buy a new iPhone or maybe a ticket to a Nicki Minaj concert."

As we learned in Chapter 1, though, there are opportunity costs of studying more, such as attending fewer music concerts or spending less time at your favorite coffee house talking with friends. Such opportunity costs must be weighed against the benefits of earning an A in this course. You might conclude that because this question is hypothetical anyway, there's no need to think harder about how you would behave.

But what if the question weren't imaginary?

Over the past few years, thousands of students have actually been confronted with such a financial offer. Sally Sadoff, Steven Levitt, and John List carried out an experiment at two high schools in the suburbs of Chicago over several years in which they used incentives to change students' behavior. Such an experiment allows us to think about the relationship between two *variables*—in this case, how an increase in a financial reward affects student test scores. And it naturally leads to a discussion of cause and effect, which we have just studied in this chapter: we'll examine simple correlations between variables and identify a causal relationship. Both correlation and causation are powerful concepts in gaining an understanding of the world around us—and, as we'll see, data visualizations are crucial tools for this analysis.

Experimental Design

There are two high schools in Chicago Heights, and both have a problem with student dropout rates. It is not uncommon for more than 50 percent of incoming ninth-graders to drop out before receiving a high school diploma. These problems are not unique to Chicago Heights; many urban school districts face a similar problem.

How can economists help? Some economists have devised incentive schemes to lower the dropout rates and increase academic achievement in schools. In this instance, students were *paid* for improved academic performance.[10]

Let's first consider the experiment to lower the dropout rate. Each student was randomly placed into one of the following three groups:

Treatment Group with Student Incentives: Students would receive $50 for each month they met special academic standards (explained below) established by the experimenters.

Treatment Group with Parent Incentives: Students' *parents* would receive $50 for each month the special academic standards were met by their child.

Control Group: Neither students nor parents received financial compensation linked to academic performance.

A student was deemed to have met the monthly standards if he or she:

1. did not have a D or an F in any classes during that month,
2. had no more than one unexcused absence during that month, and
3. had no suspensions during that month.

Describing Variables

Before we discover how much money these students actually made, let's consider more carefully the variables that we might be interested in analyzing. As its name suggests, a variable is a factor that is likely to vary or change; that is, it can take different values in different situations. In this section, we show you how to use three different techniques to help graphically describe variables:

1. Pie charts
2. Bar charts
3. Time series graphs

Pie Charts

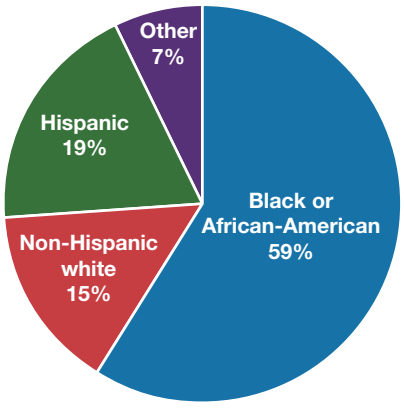
A **pie chart** is a circle split into slices of different sizes. The area of each slice represents the relative importance of non-overlapping parts that add up to the whole.

Understanding pie charts is a piece of cake. A **pie chart** is a circle split into slices of different sizes. The area of each slice represents the relative importance of non-overlapping parts that add up to the whole. Pie charts show how some economic variable can be divided into components that each represent a fraction of the total and that jointly add up to 100 percent.

For example, the students in our experiment were asked to choose one (and only one) category from this list: Black or African American, Non-Hispanic white, Hispanic, or other. In Exhibit 2A.1, we learn that 59 percent of ninth-graders in the study identify as Black or African American. We therefore differentiate 59 percent of our pie chart with the color blue to represent the proportion of Black or African-American participants in the study. We see that 15 percent of the students identify as non-Hispanic whites, represented by the red piece of the pie. We continue breaking down participation until we have filled in 100 percent of the circle. The circle then describes the self-identified racial and ethnic identities of the participants in the study.

Exhibit 2A.1 Chicago Heights Study Participants by Race and Ethnicity

The pie segments are a visual way to represent the fractions of all Chicago Heights high school students in the experiment that make up the four different categories. Just as the numbers add up to 100 percent, so do all of the segments add up to the complete "pie."



Bar Charts

A **bar chart** uses bars of different heights or lengths to indicate the properties of different groups.

Another type of graph that can be used to summarize and display a variable is a bar chart. A **bar chart** uses bars (no surprise there) of different heights or lengths to indicate the properties of different groups. Bar charts make it easy to compare a single variable across many groups. To make a bar chart, simply draw rectangles side by side, making each rectangle as high (or as long, in the case of horizontal bars) as the value of the variable it is describing.

An **independent variable** is a variable whose value does not depend on another variable; in an experiment it is manipulated by the experimenter.

A **dependent variable** is a variable whose value depends on another variable.

For example, Exhibit 2A.2 captures the overall success rates of students in the various experimental groups. In the exhibit we have the **independent variable**—the variable that the experimenter is choosing (the treatment group or control group in the study to which each student is randomly assigned)—on the horizontal or *x*-axis. On the vertical or *y*-axis is the **dependent variable**—the variable that is potentially affected by the experimental treatment. In the exhibit, the dependent variable is the proportion of students meeting the academic standards. Note that 100 percent is a proportion of 1, and 30 percent is a proportion of 0.30.

We find some interesting experimental results in Exhibit 2A.2. For instance, we can see from the bar chart that 25.1 percent of students in the Control group (students who received no incentives) met the academic standards. In comparison, 32.5 percent of students in the Parent Incentive group met the standards. This is a meaningful increase in the number of students meeting the standards—evidence that incentives can work.

Time Series Graphs

A **time series graph** displays data at different points in time.

With pie charts and bar charts, we can summarize how a variable is broken up into different groups, but what if we want to understand how a variable changes over time? For instance, how did the proportion of students meeting the standards change over the school year? A **time series graph** can do the trick. A time series graph displays data at different points in time.

As an example, consider Exhibit 2A.3, which displays the proportion of students meeting the standards in each month in the Control and Parent Incentive groups. Keep in mind that although there are multiple months and groups, we are still measuring only a single variable—in this case, the proportion meeting the standard. As Exhibit 2A.3 makes clear, the number of students meeting the standard is higher in the Parent Incentive treatment group than in the Control group. But notice that the difference within the Parent Incentive and Control groups changes from month to month. Without a time series, we would not be able to appreciate these month-to-month differences and would not be able to get a sense for how the effectiveness of the incentive varies over the school year. As you read this book, keep in mind that the variables we discuss can change over time—and that time series graphs are invaluable in tracking these changes.

Exhibit 2A.2 Proportion of Students Meeting Academic Standards by Experimental Group

The bar chart facilitates comparing numbers across groups in the experiment. In this case, we can compare how different groups perform in terms of meeting academic standards by comparing the height of each bar. For example, the Parent Incentive group's bar is higher than the Control group's bar, meaning that a higher proportion of students in the Parent Incentives group met the standards than in the Control group.

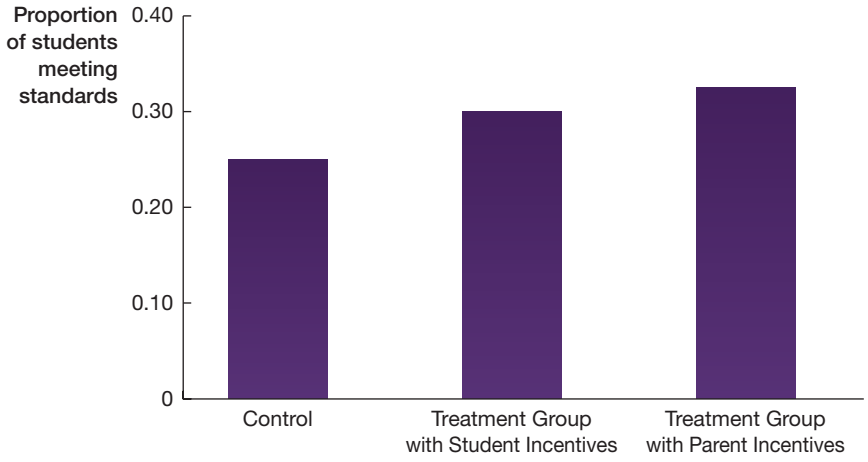
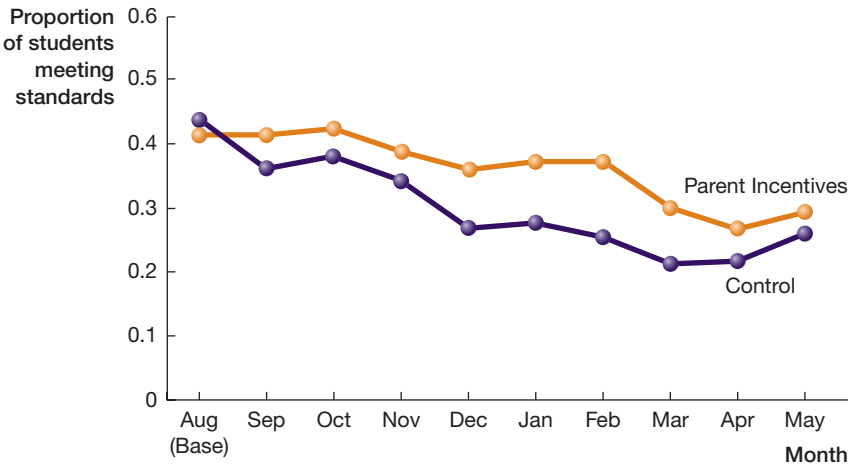


Exhibit 2A.3 Participants Meeting All Standards by Month

The time series graph takes some of the information that was in the bar chart and shows how it changes depending on the month of the school year during which the experiment was conducted. The points are connected to more clearly illustrate the month-to-month trend. In addition, by using a different color or line pattern, we can represent two groups (Control and Parent Incentives) on the same graph, giving the opportunity to compare the two groups, just as with the bar chart in the previous exhibit.



Cause and Effect

We've written about both causation and correlation in this chapter. Economists are much more interested in the former. Causation relates two variables in an active way—*a* causes *b* if, because of *a, b* has occurred.

For example, we can conclude in our experimental study that paying money for the students' performance *causes* them to improve their academic performance. This would not necessarily be the case if the experiment were not properly implemented—for example, if students were not randomly placed into control and treatment groups. For instance, imagine that the experimenters had placed all of the students who had achieved poorly in the past in the control group. Then the relatively poor performance of the control group might be due to the composition of students who were assigned to the control group, and not to the lack of financial incentives. Any relationship between academic achievement and payment stemming from such an experiment could be interpreted as a correlation because all other things were not equal at the start of the experiment—the control group would have a higher proportion of low achievers than the other groups.

Fortunately, the Chicago Heights experiment was implemented using the principle of randomization discussed earlier in this chapter. The experimenters split students into groups randomly, so each experimental group had an equal representation of students—that is, attributes like average student intelligence were similar across groups. Accordingly, any difference between the groups' academic performance during the experiment was due to the different experimental conditions, such as differences in financial incentives.

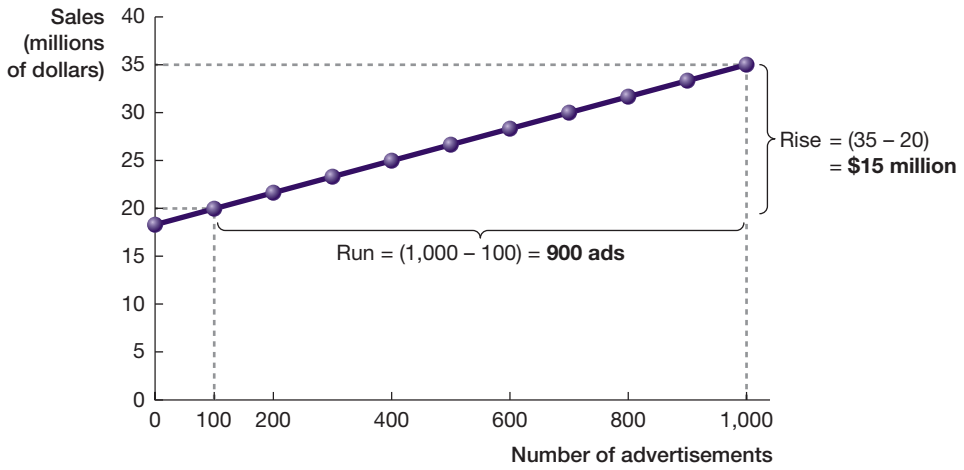
This means that we can claim that the cause of the difference between the performance of the Student Incentive group and that of the Control group is that students in the Student Incentive group were given an incentive of $50, whereas students in the Control group received no incentive for improvement.

Correlation Does Not Necessarily Imply Causality

Often, correlation is misinterpreted as causation. While correlation can certainly indicate potential causation—a reason to look more closely—it's only a first step. As an example, not long ago, a high-ranking marketing executive showed us Exhibit 2A.4 (the numbers are changed for confidentiality reasons). He was trying to demonstrate that his company's retail advertisements were effective in increasing sales: "It shows a clear positive relationship between ads and sales. When we placed 1,000 ads, sales were roughly $35 million. But see how sales dipped to roughly $20 million when we placed only 100 ads? This proves that more advertisements lead to more sales."

Exhibit 2A.4 Advertisements and Sales

Just looking at the line chart of sales versus number of advertisements, we would be tempted to say that more ads cause more sales. However, without randomization, we risk overlooking the role of a third variable that is omitted from the chart, which increases sales and is associated with advertising. Is such an omitted variable lurking here?



Before discussing whether this exhibit proves causality, let's step back and think about the basic characteristics of Exhibit 2A.4. In such an exhibit we have:

1. The *x*-variable plotted on the horizontal axis, or *x*-axis; in our figure the *x*-variable is the number of advertisements.
2. The *y*-variable plotted on the vertical axis, or *y*-axis; in our figure the *y*-variable is the sales in millions of dollars.
3. The origin, which is the point where the *x*-axis intersects the *y*-axis; both sales and the number of advertisements are equal to zero at the origin.

In the exhibit, the number of advertisements is the independent variable, and the amount of sales is the dependent variable. When the values of both variables increase together in the same direction, they have a positive relationship; when one increases and the other decreases, and they move in opposite directions, they have a negative relationship.

The **slope** is the change in the value of the variable plotted on the *y*-axis divided by the change in the value of the variable plotted on the *x*-axis.

So in Exhibit 2A.4, we find a positive relationship between the two variables. What is the strength of that positive relationship? This is called the slope. The **slope** is the change in the value of the variable plotted on the *y*-axis divided by the change in the value of the variable plotted on the *x*-axis:

$$\text{Slope} = \frac{\text{Change in } y}{\text{Change in } x} = \frac{\text{Rise}}{\text{Run}}.$$

In this example, the increase in the number of advertisements from 100 to 1,000 was associated with an increase in sales from $20 million to $35 million. Thus, the rise, or the change in sales (y), is $15 million and the run, or change in x, is 900 ads. Because both are rising (moving in the same direction), the slope is positive:

$$\text{Slope} = \frac{\$35{,}000{,}000 - \$20{,}000{,}000}{1000 \text{ ads} - 100 \text{ ads}} = \frac{\$15{,}000{,}000}{900 \text{ ads}} = \$16{,}667 \text{ per ad}.$$

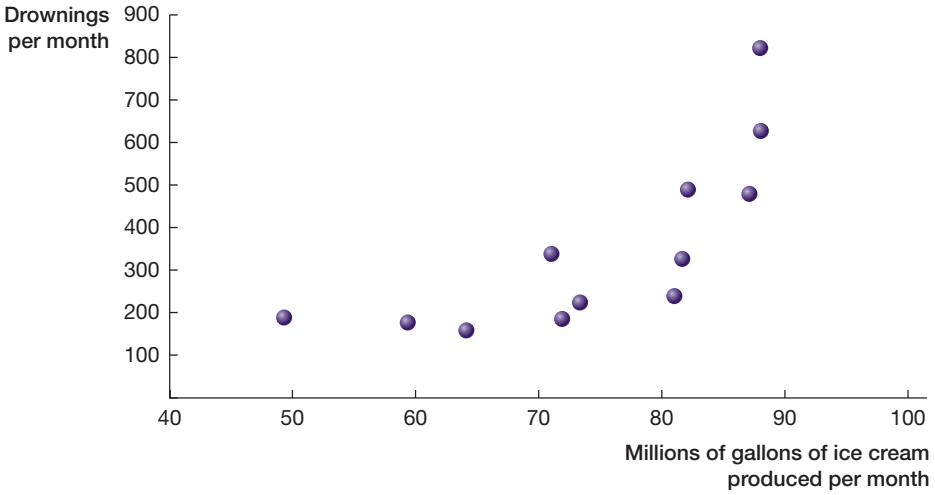
Thus, our exhibit implies that one more advertisement is associated with $16,667 more in sales. But, does this necessarily mean that if the retailer increases the number of advertisements by one, this will cause sales to increase by $16,667?

Unfortunately, no. While it is tempting to interpret the sales increasing with ads as a causal relationship between the two variables, we cannot be sure that this relationship is causal. In this case, the marketing executive forgot to think about *why* his company so drastically increased its advertisement volume to begin with—after all, the amount of advertising was not determined randomly in an experiment. As it turns out, the company did so because of the holiday season, a time when sales would presumably have been high anyway.

Exhibit 2A.5 Ice Cream Production and Drownings in the United States

We depict the relationship between monthly ice cream production and monthly drownings. Each of the 12 points represents a single month in 2011. Is this relationship causal or is there an omitted variable that is causing these two variables to move together? *Hint:* The point in the upper right corner of the exhibit is July and the point in the lower left corner of the exhibit is December!

Sources: Based on Centers for Disease Control and Prevention, and Brian W. Gould, University of Wisconsin Dairy Marketing and Risk Management Program (2011).



So, after some further digging (we'll spare you the details), what the data actually say is that the retailer placed more ads during times of busy shopping (around Thanksgiving and in December), but that is exactly when sales would normally be high—because of the holiday shopping season. Similar to what happened in the department store red/blue ad example in this chapter, taking into account seasonal variation in sales fully explains the correlation between ads and sales, eliminating the causal explanation.

This example shows that you should be careful when you connect a few points in a graph. Just because two variables move together (a correlation), they are not necessarily related in a causal way. They could merely be linked by another variable that is causing them both to increase—in this case, the shopping season.

To see the general idea of what is happening more clearly, let's instead graph the quantity of ice cream produced against the number of monthly drownings in the United States. Using data across months in a single year, we constructed Exhibit 2A.5. In Exhibit 2A.5, we see that in months when ice cream production is relatively high, there are a lot of drownings. Likewise, in months when there is relatively little ice cream production, there are far fewer drownings. Does this mean that you should not swim after you eat ice cream?

Indeed, parents persuaded by such a chart might believe that it's causal, and never let their kids eat ice cream near swimming pools or lakes! But luckily for us ice cream lovers, there is an omitted variable lurking in the background. In the summertime, when it is hot, people eat more ice cream *and* swim more. More swimming leads to more drowning. Even though people eat more ice cream cones in the summer, eating ice cream doesn't *cause* people to drown.

Just as a heightened shopping season was the omitted variable in the retailer advertisement example, here the omitted variable is heat—it causes us to swim more *and* to eat more ice cream cones. While the former causes more drownings (as we would all expect), the latter has nothing to do with drowning, even though there is a positive correlation between the two, as shown in Exhibit 2A.5.

Beyond an understanding of how to construct data figures, we hope that this appendix gave you an appreciation for how to interpret visual displays of data. An important lesson is that just because two variables are correlated—and move together in a figure—does not mean that they are causally related. Causality is the gold standard in the social sciences. Without understanding the causal relationship between two variables, we cannot reliably predict how the world will change when the government intervenes to change one of the variables. Experiments help reveal causal relationships; for example, we learned from the Chicago Heights experiment that incentives can affect student performance.

Appendix Key Terms

pie chart *p. 72*
bar chart *p. 73*
independent variable *p. 73*
dependent variable *p. 73*
time series graph *p. 73*
slope *p. 75*

Appendix Problems

A1. How would you represent the following graphically?

a. Income inequality in the United States has increased over the past 10 years.

b. All the workers in the manufacturing sector in a particular country fit into one (and only one) of the following three categories: 31.5 percent are high school dropouts, 63.5 percent have a regular high school diploma, and the rest have a vocational training certificate.

c. The median income of a household in Alabama was $43,464 in 2012, and the median income of a household in Connecticut was $64,247 in 2012.

A2. Consider the following data that show the quantity of coffee produced in Brazil from 2004 to 2012.

Year	Production (in tons)
2004	2,465,710
2005	2,140,169
2006	2,573,368
2007	2,249,011
2008	2,796,927
2009	2,440,056
2010	2,907,265
2011	2,700,440
2012	3,037,534

a. Plot the data in a time series graph.

b. What is the mean quantity of coffee that Brazil produced from 2009 to 2011?

c. In percentage terms, how much has the 2012 crop increased over the 2009–2011 mean?

A3. Suppose the following table shows the relationship between revenue that the Girl Scouts generate and the number of cookie boxes that they sell.

Number of Cookie Boxes	Revenue
50	$200
150	$600
250	$1,000
350	$1,400
450	$1,800
550	$2,200

a. Present the data in a scatter plot.

b. Do the two variables have a positive relationship or do they have a negative relationship? Explain.

c. What is the slope of the line that you get in the scatter plot? What does the slope imply about the price of a box of Girl Scout cookies?

3 Optimization: Trying to Do the Best You Can

How does location affect the rental cost of housing?

Suppose you just landed a job near the center of a city and you now need to decide where to live. If you live close to the city center, your round-trip commute will be 15 minutes. If you live in the suburbs, your round-trip commute will be 60 minutes. Holding square footage fixed, where will apartments be relatively less expensive? How will you choose where to live? How should you make the best decision given the trade-offs you face?

In this chapter, we'll dig into the concept of optimization—trying to choose the best feasible option. You will learn how to optimize by using cost-benefit analysis. And we will apply this knowledge to an example that we revisit throughout the chapter and examine empirically in the Evidence-Based Economics feature—choosing an apartment.

CHAPTER OUTLINE

KEY IDEAS

- When an economic agent tries to choose the best feasible option, they are optimizing.
- Optimization using total value calculates the total value of each feasible option and then picks the option with the highest total value.
- Optimization using marginal analysis calculates the change in total value when a person switches from one feasible option to another and then uses these marginal comparisons to choose the option with the highest total value.
- Optimization using total value and optimization using marginal analysis give identical answers.

3.1 Optimization: Trying to Choose the Best Feasible Option

In Chapter 1, we described economics as the study of choice. Economists usually assume that people make choices by trying to select the best feasible option, given the available information. In other words, people optimize. Recall that optimization is the first principle of economics.

Economists use optimization to predict most of the choices that people, households, businesses, and governments make.

Economists use optimization to predict most of the choices that people, households, businesses, and governments make. To an economist, seemingly unrelated decisions—for example, where a college student will travel on spring break, which apartment a worker will rent, or what price Apple charges for an iPhone—are all connected by the unifying principle of optimization. Whatever choices people face, economists believe that they will try to choose the best option. However, economists don't assume that people always *succeed*—an issue we will return to below.

Of course, optimization need not be easy, and optimization is often quite complex. To illustrate the complexity, consider the choice of an apartment. In a large city there could be millions of rental apartments, each with different characteristics to consider, such as the number of bedrooms, location, views, and neighborhood amenities.

Making an optimal decision, then, involves juggling multiple trade-offs. For example, how do you compare two apartments, one of which has the benefit of lower rent and one of which has the benefit of a shorter commute? How would you determine which apartment is a better choice for you? In this chapter, we are going to see how to optimally evaluate such trade-offs. We will introduce you to the most important optimization tools that economists use.

We have a lot to say about choosing a rental apartment, but remember that the choice of an apartment is just one illustration of the general concept of optimization. We can use the principal of optimization to analyze any decision that an economic agent faces, from the trivial—how many miles will you jog in a workout?—to the profound—how many years of education will you obtain?

Optimization can be implemented using many different techniques. In this chapter, we show you how to optimize using two different techniques, which yield *identical* answers. The first technique simply calculates the total value of each feasible option and then picks the option with the greatest total value. The second technique—*marginal analysis,* which we explain later in the chapter—focuses on differences among the feasible options and finds the best option by analyzing these differences. Because the two optimization techniques yield identical answers, you can decide to use whichever technique you find easier for each particular problem.

CHOICE & CONSEQUENCE

Do People Actually Choose the Best Feasible Option?

We have emphasized that people *try* to choose the best feasible option and have been noncommittal about how often and how well they succeed in those efforts. Do economic agents always *succeed* in picking the best feasible option? Of course not! So why do economists focus so much on the best feasible option, which economists refer to as the **optimal choice** or as the **optimum**?

Economists believe that optimal choice is a useful approximation of most economic behavior, even if real people *don't always* hit the bull's-eye. Economists are interested in identifying situations in which optimal choice is a good approximation of people's behavior. Likewise, economists are interested in identifying situations in which people systematically get things wrong.

There is even a branch of economics that specializes in studying how well people do in different situations. **Behavioral economics** explains why people pick (or nearly pick) the optimum in some situations and don't come close in others (even in situations where they are trying to choose well). Behavioral economists model this range of behavior by combining economic and psychological theories of human decision making.

Several special situations are associated with behavior that is not optimal. For example, when people have self-control problems—like procrastination or, far worse, addiction—optimal choice is not a good description of behavior. (We discuss self-control problems in Chapter 15.)

People also tend to fail to pick the optimum when they are new to a task. For instance, the first time individuals play poker, they tend to play poorly—they make rookie mistakes—even though they are trying to play well. We have never met someone who intentionally tried to lose money at the card table, but we have spent time with people who lost money because they weren't good at playing cards (or had too much to drink). Because inexperienced agents tend to make mistakes, the optimum is a much better description of behavior when people have lots of experience.

For example, as investors gain more years of experience, they tend to make fewer mistakes. John Campbell, Tarun Ramadorai, and Benjamin Ranish documented this pattern of improving performance in a 2014 research paper. They obtained anonymized data that summarized the activity of 11.6 million investors in India. The researchers found that experienced investors (those with brokerage accounts that have been open a relatively long time) have annual returns that are substantially higher than those of their inexperienced peers.[1] The authors named their paper after the Beatles song "Getting Better."

Because people aren't born knowing how to make the optimal choice in every situation, it is useful for all of us to learn how to make better choices. Economists show people how to choose optimally—such advice amounts to prescriptive economic analysis.

We hope that you use the concept of optimal choice in two ways: first, to describe the behavior of decision makers who are knowledgeable, experienced, and sober; and, second, to identify and improve suboptimal choices—especially your own!

3.2 Optimization Application: Renting the Optimal Apartment

Economists refer to the best feasible option as the **optimal choice** or as the **optimum**.

Behavioral economics jointly analyzes the economic and psychological factors that explain human behavior, helping to identify situations in which agents choose optimally (or nearly optimally) and situations in which people don't come close to choosing optimally.

Let's explore the theory of optimization in more depth. To illustrate these ideas, we return to our opening example in which you are an apartment hunter.

Imagine that you have narrowed your rental choice to four possible apartments—your "short list." Exhibit 3.1 summarizes this short list, including two key pieces of information for each apartment—the monthly rent and the amount of commuting time per month. Exhibit 3.1 assumes that rent decreases the farther you are from work; as rent falls, commuting time increases, generating a trade-off. Later in this chapter, we explain why economic forces predict this inverse relationship between rent and distance from work. We'll also show you empirical evidence that confirms this prediction.

You might wonder about everything that was left out of the summary of information in Exhibit 3.1. What about other differences among these apartments, like how long it takes to walk to the neighborhood laundromat or whether there is a park nearby? We also omitted commuting costs other than time, like the direct dollar cost of public transportation or, if you drive yourself, gasoline and tolls. Shouldn't all these considerations be part of the comparison?

Exhibit 3.1 Apartments on Your Short List, Which Differ with Regard to Commuting Time and Rent and Are Otherwise Identical

Many cities have a single central business district—which is often referred to as the city center—where lots of employers are concentrated. In most cities, apartments near the city center cost more to rent than otherwise identical apartments that are far away. Why is this so?

Apartment	Commuting Time (hours/month)	Rent ($/month)
Very Close	5 hours	$1,180
Close	10 hours	$1,090
Far	15 hours	$1,030
Very Far	20 hours	$1,000

The proximity of local amenities such as schools or parks should also go into a complete optimization analysis because these amenities change the net benefits of an apartment.

To keep things simple, we will omit these other factors for now, even though they *are* important in practice. We omit them to keep the calculations simple and so that the basic economic concepts are easier to understand. As you'll discover in the problems at the end of the chapter, once you understand the basic ideas, it is easy to add more details. For now, we will assume that the four apartments—Very Close, Close, Far, and Very Far—are identical except for the differences listed in Exhibit 3.1.

Note, too, that we are focusing only on costs in this example—the cost of commuting time and the cost of rent. We are assuming that the benefits of these apartments are the same—for instance, size or views. If the benefits are the same, then cost-benefit analysis becomes simpler. In normal cost-benefit analysis, the decision maker finds the alternative with the highest value of *net benefit*, which is benefit minus cost. When the benefits are the same across all the alternatives, cost-benefit analysis simplifies to finding the alternative with the lowest cost. That's what we are going to do next.

Exhibit 3.1 contains the information that we need, but on its own, it does not enable us to choose the best apartment. First, we need to sum the cost of rent and the cost of commuting time to calculate the *total* cost of each apartment. The total cost includes the *direct* cost of rent and the *indirect* cost of commute time.

To sum these two costs, we first need to decide on a common unit of account. Let's pick dollars per month for now. Because rent is already expressed in dollars per month, half of our work has been done for us. All that remains is to translate the indirect cost—commuting time—into the same unit of measurement.

Exhibit 3.2 Commuting Cost and Rental Cost Expressed in Common Units, Assuming an Opportunity Cost of Time of $10/Hour

To optimize, it is necessary to convert all of the costs and benefits into common units. In this example, the common unit is dollars per month. The optimum—in bold—is Far, which has the lowest total cost.

Apartment	Commuting Time (hours/month)	Commuting Cost ($/month)	Rent ($/month)	Total Cost: Rent + Commuting ($/month)
Very Close	5 hours	$50	$1,180	$1,230
Close	10 hours	$100	$1,090	$1,190
Far	**15 hours**	**$150**	**$1,030**	**$1,180**
Very Far	20 hours	$200	$1,000	$1,200

To do this, we use the concept of opportunity cost, which we introduced in Chapter 1. Let's begin by considering somebody with an opportunity cost of commuting time of $10/hour. This is the hourly value of the alternative activity that is crowded out when you spend more time commuting. The fact that it is a dollar value doesn't imply that this time would have been spent at work if it weren't spent commuting. An extra hour of time has value to you regardless of what you might choose to do with that time, including napping, socializing, watching videos, taking longer showers, or working.

If the round-trip commute takes 20 hours/month and the opportunity cost of time is $10/hour, then the dollar cost of that commute is

$$\left(\frac{20 \text{ hours}}{\text{month}}\right)\left(\frac{\$10}{\text{hour}}\right) = \left(\frac{\$200}{\text{month}}\right).$$

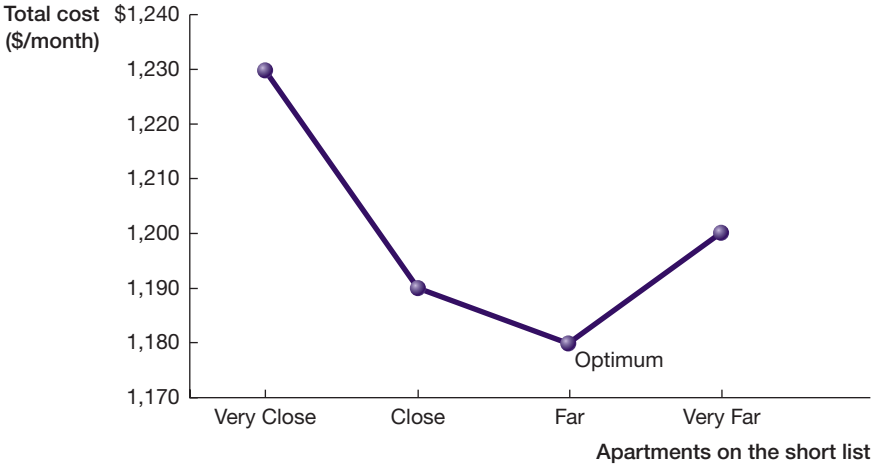
The first term on the left is commute time per month, which is expressed in hours per month, just as it is in Exhibit 3.1. The term just before the equal sign is the opportunity cost of time, which is expressed as dollars per hour. The "hours" units cancel, leaving a final cost expressed as dollars per month.

Now we are ready to rewrite Exhibit 3.1. Using the calculations that we just illustrated for 20 hours of monthly commuting time, we can calculate costs for a commute of any duration. Exhibit 3.2 reports this commuting cost in dollars per month for all four apartments.

Exhibit 3.2 gives us the answer to our optimization problem. "Far" is the best apartment for a consumer with an opportunity cost of time of $10/hour. This apartment has the lowest total cost—$1,180—taking into account both direct rental costs and indirect time costs of commuting.

Exhibit 3.3 Total Cost Including Both Rent and Commuting Cost, Assuming an Opportunity Cost of Time of $10/Hour

If the consumer chooses optimally, they will select Far. This apartment has the lowest total cost, which is the sum of the direct rental cost and the indirect commuting cost (see breakdown in Exhibit 3.2). The commuting cost is calculated by using the consumer's opportunity cost of time, which is $10/hour in this example.



We also easily see this result by plotting the total costs. Exhibit 3.3 plots the total cost of each of the four apartments—and, as the dip in the curve clearly shows, Far is the best choice. Economists call the best feasible choice the optimum, which you can see labeled on the total cost curve.

To sum up our discussion so far, *optimization using total value* has three steps:

1. Translate all costs and benefits into common units, like dollars per month.
2. Calculate the *total* net benefit of each alternative.
3. Pick the alternative with the highest net benefit.

Before and After Comparisons

If apartment hunters make optimal choices, then the choice of an apartment will be affected by a change in the opportunity cost of time. Until now we have assumed that the opportunity cost of time is $10/hour. Let's instead assume that the opportunity cost of time is $15/hour. Why might opportunity cost rise? For example, an hourly worker's opportunity cost of time would rise if their hourly wage rose.

How does this increase in the opportunity cost of time change the predicted behavior? Before we take you through it step by step, try to use your intuition. How would a change in the value of time affect the optimal decision of where to live? Should commuters with a higher value of time move closer to where they work or farther away?

To answer this question, we again need to translate the indirect cost—commuting time—into the same units as the direct cost of rent, which are dollars per month. Accordingly, we rewrite Exhibit 3.2, assuming instead a $15/hour opportunity cost of time. Exhibit 3.4 reports this commuting cost in dollars per month for all four apartments.

Exhibit 3.4 provides the answer to our new optimization problem. The best apartment for a consumer with an opportunity cost of time of $15/hour now shifts from Far to Close. Close has the lowest total cost—$1,240—taking into account both direct rental costs and indirect time costs of commuting.

Exhibit 3.5 plots the total cost of each of the four apartments assuming a $15/hour opportunity cost of time. Close is the best choice—the optimum.

When the opportunity cost of time increases from $10/hour to $15/hour, it becomes more valuable for the commuter to choose an apartment that reduces the amount of time spent commuting. So the optimal choice switches from a relatively inexpensive apartment with a longer commute—Far—to a relatively expensive apartment with a shorter commute—Close.

Exhibit 3.6 takes the two different cost curves from Exhibits 3.3 and 3.5 and plots them in a single figure. The purple line represents the total cost curve for the commuter with an opportunity cost of $10/hour. The orange line represents the total cost curve for the commuter with an opportunity cost of $15/hour. Two key properties are visible in Exhibit 3.6:

1. The $10/hour cost curve lies below the $15/hour cost curve. The $10/hour curve has lower commuting costs for each apartment, so the total cost, which takes into account both the direct cost of rent and the indirect cost of commuting, is lower for all apartments.

Exhibit 3.4 Commuting Cost and Rental Cost Expressed in Common Units, Assuming an Opportunity Cost of Time of $15/Hour

To optimize, it is necessary to convert all costs and benefits into common units. In this example, the common unit is dollars per month. The optimum—in bold—is Close, which has the lowest total cost.

Apartment	Commuting Time (hours/month)	Commuting Cost ($/month)	Rent ($/month)	Total Cost: Rent + Commuting ($/month)
Very Close	5 hours	$75	$1,180	$1,255
Close	**10 hours**	**$150**	**$1,090**	**$1,240**
Far	15 hours	$225	$1,030	$1,255
Very Far	20 hours	$300	$1,000	$1,300