PART I

INTRODUCTION

As you begin the study of economics, perhaps the most important thing to realize is that economics is not a collection of settled facts, to be copied down and memorized. Mark Twain said that nothing is older than yesterday's newspaper, and the same can be said of yesterday's economic statistics. Indeed, the only prediction about the economy that can be made with confidence is that there will continue to be large, and largely unpredictable, changes.

If economics is not a set of durable facts, then what is it? Fundamentally, it is a way of thinking about the world. Over many years, economists have developed some simple but widely applicable principles that are useful for understanding almost any economic situation, from the relatively simple economic decisions that individuals make every day, to the workings of highly complex markets such as international financial markets. The principal objective of this book, and of this course, is to help you learn these principles and how to apply them to a variety of economic questions and issues.

The two chapters in Part I lay out five of the seven core principles that will be used throughout the book. All core principles are listed on the previous page for easy reference.

Chapter 1 introduces and illustrates three core principles, the first of which is the *Scarcity Principle*—the unavoidable fact that, although our needs and wants are boundless, the resources available to satisfy them are limited. The chapter goes on to show that the *Cost–Benefit Principle*, deciding whether to take an action by comparing the cost and benefit of the action, is a useful approach for dealing with the inevitable trade-offs that scarcity creates. After discussing several important decision pitfalls, the chapter concludes by describing the *Incentive Principle* and introducing the concept of economic naturalism.

Chapter 2 goes beyond individual decision making to consider trade among both individuals and countries. An important reason for trade is the *Principle of Comparative Advantage*: by specializing in the production of particular goods and services, people and countries enhance their productivity and raise standards of living. Further, people and countries expand their production of the goods or services by applying the *Principle of Increasing Opportunity Cost*—first employing those resources with the lowest opportunity cost and only afterward turning to resources with higher opportunity costs.

Thinking Like an Economist

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LEARNING OBJECTIVES

In this chapter, we'll introduce three simple principles that will help you understand and explain patterns of behavior you observe in the world around you. These principles also will help you avoid three pitfalls that plague decision makers in everyday life. The principles and pitfalls you'll learn about are

1. The Scarcity Principle, which says that having more of any good thing necessarily requires having less of something else.
2. The Cost–Benefit Principle, which says that an action should be taken if, but only if, its benefit is at least as great as its cost.
3. The Incentive Principle, which says that if you want to predict people's behavior, a good place to start is by examining their incentives.
4. The pitfall of measuring costs and benefits as proportions rather than as absolute dollar amounts.
5. The pitfall of ignoring implicit costs.
6. The pitfall of failing to weigh costs and benefits at the margin.

How many students are in your introductory economics class? Some classes have just 20 or so; others average 35, 100, or 200 students. At some schools, introductory economics classes may have as many as 2,000 students. What size is best?

If cost were no object, the best size for an introductory economics course—or any other course, for that matter—might be a single student. Think about it: the whole course, all term long, with just you and your professor! Everything could be custom-tailored to your own background and ability, allowing you to cover the material at just the right pace. The tutorial format also would promote close communication and personal trust between you and your professor. And your grade would depend more heavily on what you actually learned than on your luck when taking multiple-choice exams. We may even suppose, for the sake of discussion, that studies by educational psychologists prove definitively that students learn best in the tutorial format.

Why, then, do so many universities continue to schedule introductory classes with hundreds of students? The simple reason is that costs *do* matter. They matter not just to the university administrators who must build classrooms and pay faculty salaries, but also to *you*. The direct cost of providing you with your own personal introductory economics course—most notably, the professor's salary and the expense of providing a classroom in which to meet—might easily top $50,000. *Someone* has to pay these costs. In private universities, a large share of the cost would be recovered directly from higher tuition payments; in public universities, the burden would be split between higher tuition payments and higher tax payments. But, in either case, the course would be unaffordable for many, if not most, students.

With a larger class size, of course, the cost per student goes down. For example, in a class of 300 students, the cost of an introductory economics course might come to as little as $200 per student. But a class that large would surely compromise the quality of the learning environment. Compared to the custom tutorial format, however, it would be dramatically more affordable.

In choosing what size introductory economics course to offer, then, university administrators confront a classic economic trade-off. In making the class larger, they lower the quality of instruction—a bad thing—but, at the same time, they reduce costs, and hence the tuition students must pay—a good thing.

1.1 ECONOMICS: STUDYING CHOICE IN A WORLD OF SCARCITY

economics the study of how people make choices under conditions of scarcity and of the results of those choices for society

Scarcity is a fundamental fact of life. There is never enough time, money, or energy to do everything we want to do or have everything we would like to have. **Economics** is the study of how people make choices under conditions of scarcity and of the results of those choices for society.

In the class-size example just discussed, a motivated economics student might definitely prefer to be in a class of 20 rather than a class of 100, everything else being equal. But other things, of course, are not equal. Students can enjoy the benefits of having smaller classes, but only at the price of having less money for other activities. The student's choice inevitably will come down to the relative importance of competing activities.

That such trade-offs are widespread and important is one of the core principles of economics. We call it the **Scarcity Principle** because the simple fact of scarcity makes trade-offs necessary. Another name for the Scarcity Principle is the **No-Free-Lunch Principle** (which comes from the observation that even lunches that are given to you are never really free—somebody, somehow, always has to pay for them).

Scarcity

The Scarcity Principle (also called "The No-Free-Lunch Principle"): Although we have boundless needs and wants, the resources available to us are limited. So having more of one good thing usually means having less of another.

Inherent in the idea of a trade-off is the fact that choice involves compromise between competing interests. Economists resolve such trade-offs by using *cost–benefit analysis*, which is based on the disarmingly simple principle that an action should be taken if, and only if, its benefits exceed its costs. We call this statement the **Cost–Benefit Principle**, and it, too, is one of the core principles of economics:

Cost–Benefit

The Cost–Benefit Principle: An individual (or a firm or a society) should take an action if, and only if, the extra benefits from taking the action are at least as great as the extra costs.

With the Cost–Benefit Principle in mind, let's think about our class-size question again. Imagine that classrooms come in only two sizes—100-seat lecture halls and 20-seat classrooms—and that your university currently offers introductory economics courses to classes of 100 students. Question: Should administrators reduce the class size to 20 students? Answer: Reduce if, and only if, the value of the improvement in instruction outweighs its additional cost.

This rule sounds simple, but to apply it we need some way to measure the relevant costs and benefits—a task that is often difficult in practice. If we make a few simplifying assumptions, however, we can see how the analysis might work. On the cost side, the primary expense of reducing class size from 100 to 20 is that we will now need five professors instead of just one. We'll also need five smaller classrooms rather than a single big one, and this too may add slightly to the expense of the move. For the sake of discussion, suppose that the cost with a class size of 20 turns out to be $1,000 per student more than the cost per student when the class size is 100. Should administrators switch to the smaller class size? If they apply the Cost–Benefit Principle, they will realize that *the reduction in class size makes sense only if the value of attending the smaller class is at least $1,000 per student greater than the value of attending the larger class*.

Cost–Benefit

Would you (or your family) be willing to pay an extra $1,000 for a smaller economics class? If not, and if other students feel the same way, then sticking with the larger class size makes sense. But if you and others would be willing to pay the extra tuition, then reducing the class size to 20 makes good economic sense.

Notice that the "best" class size, from an economic point of view, will generally not be the same as the "best" size from the point of view of an educational psychologist. The difference arises because the economic definition of "best" takes into account both the benefits *and* the costs of different class sizes. The psychologist ignores costs and looks only at the learning benefits of different class sizes.

In practice, of course, different people will feel differently about the value of smaller classes. People with high incomes, for example, tend to be willing to pay more for the advantage, which helps to explain why average class size is smaller, and tuition higher, at private schools whose students come predominantly from high-income families.

Scarcity and the trade-offs that result also apply to resources other than money. Bill Gates is one of the richest men on Earth. His wealth was once estimated at over $100 billion—more than the combined wealth of the poorest 40 percent of Americans. Gates has enough money to buy more houses, cars, vacations, and other consumer goods than he could possibly use. Yet Gates, like the rest of us, has only 24 hours each day and a limited amount of energy. So even he confronts trade-offs, in that any activity he pursues—whether it be building his business empire or redecorating his mansion—uses up time and energy that he could otherwise spend on other things. Indeed, someone once calculated that the value of Gates's time is so great that pausing to pick up a $100 bill from the sidewalk simply wouldn't be worth his while.

If Bill Gates saw a $100 bill lying on the sidewalk, would it be worth his time to pick it up?

1.2 APPLYING THE COST–BENEFIT PRINCIPLE

In studying choice under scarcity, we'll usually begin with the premise that people are **rational**, which means they have well-defined goals and try to fulfill them as best they can. The Cost–Benefit Principle illustrated in the class-size example is a fundamental tool for the study of how rational people make choices.

rational person someone with well-defined goals who tries to fulfill those goals as best he or she can

As in the class-size example, often the only real difficulty in applying the cost–benefit rule is to come up with reasonable measures of the relevant benefits and costs. Only in rare instances will exact dollar measures be conveniently available. But the cost–benefit framework can lend structure to your thinking even when no relevant market data are available.

To illustrate how we proceed in such cases, the following example asks you to decide whether to perform an action whose cost is described only in vague, qualitative terms.

Should you walk downtown to save $10 on a $25 computer game?

Imagine you are about to buy a $25 computer game at the nearby campus store when a friend tells you that the same game is on sale at a downtown store for only $15. If the downtown store is a 30-minute walk away, where should you buy the game?

Cost–Benefit

The Cost–Benefit Principle tells us that you should buy it downtown if the benefit of doing so exceeds the cost. The benefit of taking any action is the dollar value of everything you gain by taking it. Here, the benefit of buying downtown is exactly $10, since that is the amount you will save on the purchase price of the game. The cost of taking any action is the dollar value of everything you give up by taking it. Here, the cost of buying downtown is the dollar value you assign to the time and trouble it takes to make the trip. But how do we estimate that dollar value?

One way is to perform the following hypothetical auction. Imagine that a stranger has offered to pay you to do an errand that involves the same walk downtown (perhaps to drop off a letter for her at the post office). If she offered you a payment of, say, $1,000, would you accept? If so, we know that your cost of walking downtown and back must be less than $1,000. Now imagine her offer being reduced in small increments until you finally refuse the last offer. For example, if you would agree to walk downtown and back for $9.00 but not for $8.99, then your cost of making the trip is $9.00. In this case, you should buy the game downtown because the $10 you'll save (your benefit) is greater than your $9.00 cost of making the trip.

But suppose, alternatively, that your cost of making the trip had been greater than $10. In that case, your best bet would have been to buy the game from the nearby campus store. Confronted with this choice, different people may choose differently, depending on how costly they think it is to make the trip downtown. But although there is no uniquely correct choice, most people who are asked what they would do in this situation say they would buy the game downtown. ◆

1.2.1 ECONOMIC SURPLUS

economic surplus the economic surplus from taking any action is the benefit of taking that action minus its cost

Suppose again that in the preceding example your "cost" of making the trip downtown was $9. Compared to the alternative of buying the game at the campus store, buying it downtown resulted in an **economic surplus** of $1, the difference between the benefit of making the trip and its cost. In general, your goal as an economic decision maker is to choose those actions that generate the largest possible economic surplus. This means taking all actions that yield a positive total economic surplus, which is just another way of restating the Cost–Benefit Principle.

Cost–Benefit

Note that the fact that your best choice was to buy the game downtown doesn't imply that you *enjoy* making the trip, any more than choosing a large class means that you prefer large classes to small ones. It simply means that the trip is less unpleasant than the prospect of paying $10 extra for the game. Once again, you've faced a trade-off—in this case, the choice between a cheaper game and the free time gained by avoiding the trip.

1.2.2 OPPORTUNITY COST

Of course, your mental auction could have produced a different outcome. Suppose, for example, that the time required for the trip is the only time you have left to study for a difficult test the next day. Or suppose you are watching one of your favorite movies on cable, or that you are tired and would love a short nap. In such cases, we say that the **opportunity cost** of making the trip—that is, the value of what you must sacrifice to walk downtown and back—is high and you are more likely to decide against making the trip.

opportunity cost the opportunity cost of an activity is the value of what must be forgone in order to undertake the activity

Strictly speaking, your opportunity cost of engaging in an activity is the value of everything you must sacrifice to engage in it. For instance, if going for a medical checkup requires not only that you pay $50 for the doctor's visit but also that you give up two hours of work, valued at $10 per hour, then the opportunity cost of the medical checkup is $70.

Under this definition, *all* costs—both implicit and explicit—are opportunity costs. Unless otherwise stated, we will adhere to this strict definition.

We must warn you, however, that some economists use the term o*pportunity cost* to refer only to the implicit value of opportunities forgone. Thus, in the example just discussed, these economists would not include the $50 fee when calculating the opportunity cost of the medical checkup. But virtually all economists would agree that your opportunity cost of not working is $20.

In the previous example, if watching the last hour of the cable TV movie is the most valuable opportunity that conflicts with the trip downtown, the opportunity cost of making the trip is the dollar value you place on pursuing that opportunity—that is, the largest amount you'd be willing to pay to avoid missing the end of the movie. Note that the opportunity cost of making the trip is not the combined value of *all* possible activities you could have pursued, but only the value of your *best* alternative—the one you would have chosen had you not made the trip.

Throughout the text we will pose exercises like the one that follows. You'll find that pausing to answer them will help you to master key concepts in economics. Because doing these exercises isn't very costly (indeed, many students report that they are actually fun), the Cost–Benefit Principle indicates that it's well worth your while to do them.

Cost–Benefit

EXERCISE 1.1

You would again save $10 by buying the game downtown rather than at the campus store, but your cost of making the trip is now $12, not $9. How much economic surplus would you get from buying the game downtown? Where should you buy it?

1.2.3 THE ROLE OF ECONOMIC MODELS

Economists use the Cost–Benefit Principle as an abstract model of how an idealized rational individual would choose among competing alternatives. (By "abstract model" we mean a simplified description that captures the essential elements of a situation and allows us to analyze them in a logical way.) A computer model of a complex phenomenon like climate change, which must ignore many details and includes only the major forces at work, is an example of an abstract model.

Noneconomists are sometimes harshly critical of the economist's cost–benefit model on the grounds that people in the real world never conduct hypothetical mental auctions before deciding whether to make trips downtown. But this criticism betrays a fundamental misunderstanding of how abstract models can help to explain and predict human behavior. Economists know perfectly well that people don't conduct hypothetical mental auctions when they make simple decisions. All the Cost–Benefit Principle really says is that a rational decision is one that is explicitly or implicitly based on a weighing of costs and benefits.

Most of us make sensible decisions most of the time, without being consciously aware that we are weighing costs and benefits, just as most people ride a bike without being consciously aware of what keeps them from falling. Through trial and error, we gradually learn what kinds of choices tend to work best in different contexts, just as bicycle riders internalize the relevant laws of physics, usually without being conscious of them.

Even so, learning the explicit principles of cost–benefit analysis can help us make better decisions, just as knowing about physics can help in learning to ride a bicycle. For instance, when a young economist was teaching his oldest son to ride a bike, he followed the time-honored tradition of running alongside the bike and holding onto his son, then giving him a push and hoping for the best. After several hours and painfully skinned elbows and knees, his son finally got it. A year later, someone pointed out that the trick to riding a bike is to turn slightly in whichever direction the bike is leaning. Of course! The economist passed this information along to his second son, who learned to ride almost instantly. Just as knowing a little physics can help you learn to ride a bike, knowing a little economics can help you make better decisions.

RECAP **COST–BENEFIT ANALYSIS**

Scarcity is a basic fact of economic life. Because of it, having more of one good thing almost always means having less of another (the Scarcity Principle). The Cost–Benefit Principle holds that an individual (or a firm or a society) should take an action if, and only if, the extra benefit from taking the action is at least as great as the extra cost. The benefit of taking any action minus the cost of taking the action is called the *economic surplus* from that action. Hence, the Cost–Benefit Principle suggests that we take only those actions that create additional economic surplus.

1.3 THREE IMPORTANT DECISION PITFALLS[1]

Rational people will apply the Cost–Benefit Principle most of the time, although probably in an intuitive and approximate way, rather than through explicit and precise calculation. Knowing that rational people tend to compare costs and benefits enables economists to predict their likely behavior. As noted earlier, for example, we can predict that students from wealthy families are more likely than others to attend colleges that offer small classes. (Again, while the cost of small classes is the same for all families, the benefit of small classes, as measured by what people are willing to pay for them, tends to be higher for wealthier families.)

Yet researchers have identified situations in which people tend to apply the Cost–Benefit Principle inconsistently. In these situations, the Cost–Benefit Principle may not predict behavior accurately, but it proves helpful in another way: by identifying specific strategies for avoiding bad decisions.

1.3.1 PITFALL 1: MEASURING COSTS AND BENEFITS AS PROPORTIONS RATHER THAN ABSOLUTE MONEY AMOUNTS

As the next example makes clear, even people who seem to know they should weigh the pros and cons of the actions they are contemplating sometimes don't have a clear sense of how to measure the relevant costs and benefits.

[1] The examples in this section are inspired by the pioneering research of Daniel Kahneman and the late Amos Tversky. Kahneman was awarded the 2002 Nobel Prize in economics for his efforts to integrate insights from psychology into economics.

Should you walk downtown to save $10 on a $2,020 laptop computer?

You are about to buy a $2,020 laptop computer at the nearby campus store when a friend tells you that the same computer is on sale at a downtown store for only $2,010. If the downtown store is half an hour's walk away, where should you buy the computer?

Assuming that the laptop is light enough to carry without effort, the structure of this example is exactly the same as that of the earlier example about where to buy the computer game—the only difference being that the price of the laptop is dramatically higher than the price of the computer game. As before, the benefit of buying downtown is the dollar amount you'll save, namely, $10. And since it's exactly the same trip, its cost also must be the same as before. So if you are perfectly rational, you should make the same decision in both cases. Yet when real people are asked what they would do in these situations, the overwhelming majority say they would walk downtown to buy the game but would buy the laptop at the campus store. When asked to explain, most of them say something like, "The trip was worth it for the game because you save 40 percent, but not worth it for the laptop because you save only $10 out of $2,020."

This is faulty reasoning. The benefit of the trip downtown is not the *proportion* you save on the original price. Rather, it is the *absolute dollar amount* you save. Since the benefit of walking downtown to buy the laptop is $10—exactly the same as for the computer game—and since the cost of the trip must also be the same in both cases, the economic surplus from making both trips must be exactly the same. And that means that a rational decision maker would make the same decision in both cases. Yet, as noted, most people choose differently. ◆

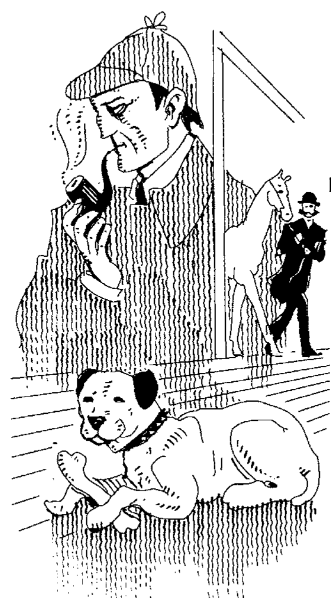
EXERCISE 1.2

Which is more valuable: saving $100 on a $2,000 plane ticket from Dubai to Toronto or saving $90 on a $200 plane ticket from Dubai to Doha?

The pattern of faulty reasoning in the decision just discussed is one of several decision pitfalls to which people are often prone. In the discussion that follows, we will identify two additional decision pitfalls. In some cases, people ignore costs or benefits that they ought to take into account, while on other occasions they are influenced by costs or benefits that are irrelevant.

1.3.2 PITFALL 2: IGNORING IMPLICIT COSTS

Sherlock Holmes, Arthur Conan Doyle's legendary detective, was successful because he saw details that most others overlooked. In *Silver Blaze*, Holmes is called on to investigate the theft of an expensive racehorse from its stable. A Scotland Yard inspector assigned to the case asks Holmes whether some particular aspect of the crime requires further study. "Yes," Holmes replies, and describes "the curious incident of the dog in the nighttime." "The dog did nothing in the nighttime," responds the puzzled inspector. But as Holmes realized, that was precisely the problem. The watchdog's failure to bark when Silver Blaze was stolen meant that the watchdog knew the thief. This clue ultimately proved the key to unraveling the mystery.



Implicit costs are like dogs that fail to bark in the night.

Just as we often don't notice when a dog fails to bark, many of us tend to overlook the implicit value of activities that fail to happen. As discussed earlier, however, intelligent decisions require taking the value of forgone opportunities properly into account.

The opportunity cost of an activity, once again, is the value of all that must be forgone in order to engage in that activity. If buying a computer game downtown means not watching the last hour of a movie, then the value to you of watching the end of that movie is an implicit cost of the trip. Many people make bad decisions because they tend to ignore the value of such forgone opportunities. To avoid overlooking implicit costs, economists often translate questions like "Should I walk downtown?" into ones like "Should I walk downtown or watch the end of the movie?"

Should you use your frequent-flyer miles to fly to Sharm El Sheikh for the holidays?

With the holidays only a week away, you are still undecided about whether to go to Sharm El Sheikh with a group of university classmates. The round-trip airfare is $500, but you have frequent-flyer miles you could use to pay for the trip. All other relevant costs for the vacation week at the beach total exactly $1,000. The most you would be willing to pay for the vacation is $1,350. That amount is your benefit of taking the vacation. Your only alternative use for your frequent-flyer miles is for your plane trip to Beirut the weekend after the holidays to attend your brother's wedding. (Your miles expire shortly thereafter.) If the Beirut round-trip airfare is $400, should you use your frequent-flyer miles to fly to Sharm El Sheikh for the holidays?

Cost–Benefit

The Cost–Benefit Principle tells us that you should go to Sharm El Sheikh if the benefits of the trip exceed its costs. If not for the complication of the frequent-flyer miles, solving this problem would be a straightforward matter of comparing your benefit from the week at the beach to the sum of all relevant costs. And since your airfare and other costs would add up to $1,500, or $150 more than your benefit from the trip, you would not go to Sharm El Sheikh.

But what about the possibility of using your frequent-flyer miles to make the trip? Using them for that purpose might make the flight to Sharm El Sheikh seem free, suggesting you would reap an economic surplus of $350 by making the trip. But doing so also would mean you would have to fork out over $400 for your airfare to Beirut. So the implicit cost of using your miles to go to Sharm El Sheikh is really $400. If you use them for that purpose, the trip still ends up being a loser because the cost of the vacation, $1,400, exceeds the benefit by $50. In cases like these, you are much more likely to decide sensibly if you ask yourself, "Should I use my frequent-flyer miles for this trip or save them for an upcoming trip?"

We cannot emphasize strongly enough that the key to using the Cost–Benefit Principle correctly lies in recognizing precisely what taking a given action prevents us from doing. The following exercise illustrates this point by modifying the details of the previous example slightly. ◆

EXERCISE 1.3

Same as the previous example, except that now your frequent-flyer miles expire in a week, so your only chance to use them will be for the Sharm El Sheikh trip. Should you use your miles?

1.3.3 PITFALL 3: FAILURE TO THINK AT THE MARGIN

When deciding whether to take an action, the only costs and benefits that are relevant are those that would occur as a result of taking the action. Sometimes people are influenced by costs they ought to ignore while other times they compare the wrong costs and benefits. *The only costs that should influence a decision about whether to take an action are those that we can avoid by not taking the action. Similarly, the only benefits we should consider are those that would not occur* *unless the action were taken.* As a practical matter, however, many decision makers appear to be influenced by costs or benefits that would have occurred independently of whether the action was taken. Thus, people are often influenced by **sunk costs—**costs that are beyond recovery at the moment a decision is made. For example, money spent on a nontransferable, nonrefundable airline ticket is a sunk cost.

sunk cost a cost that is beyond recovery at the moment a decision must be made

As the following example illustrates, sunk costs must be borne *whether or not an action is taken*, so they are irrelevant to the decision of whether to take the action.

How much should you eat at an all-you-can-eat restaurant?

Sangam, an Indian restaurant in Dubai, offers an all-you-can-eat lunch buffet for $5. Customers pay $5 at the door, and no matter how many times they refill their plates, there is no additional charge. One day, as a goodwill gesture, the owner of the restaurant tells 20 randomly selected guests that their lunch is on the house. The remaining guests pay the usual price. If all diners are rational, will there be any difference in the average quantity of food consumed by people in these two groups?

Having eaten their first helping, diners in each group confront the following question: "Should I go back for another helping?" For rational diners, if the benefit of doing so exceeds the cost, the answer is yes; otherwise it is no. Note that at the moment of decision about a second helping, the $5 charge for the lunch is a sunk cost. Those who paid it have no way to recover it. Thus, for both groups, the (extra) cost of another helping is exactly zero. And since the people who received the free lunch were chosen at random, there is no reason to suppose that their appetites or incomes are different from those of other diners. The benefit of another helping thus should be the same, on average, for people in both groups. And since their respective costs and benefits of an additional helping are the same, the two groups should eat the same number of helpings, on average.

Psychologists and economists have experimental evidence, however, that people in such groups do *not* eat similar amounts.[2] In particular, those for whom the luncheon charge is not waived tend to eat substantially more than those for whom the charge is waived. People in the former group seem somehow determined to "get their money's worth." Their implicit goal is apparently to minimize the average cost per bite of the food they eat. Yet minimizing average cost is not a particularly sensible objective. It brings to mind the man who drove his car on the highway at night, even though he had nowhere to go, because he wanted to boost his average fuel economy. The irony is that diners who are determined to get their money's worth usually end up eating too much, as evidenced later by their regrets about having gone back for their last helpings. ◆

The fact that the cost–benefit criterion failed the test of prediction in this example does nothing to invalidate its advice about what people *should* do. If you are letting sunk costs influence your decisions, you can do better by changing your behavior. In addition to paying attention to costs and benefits that should be ignored, people often use incorrect measures of the relevant costs and benefits. This error often occurs when we must choose the *extent* to which an activity should be pursued (as opposed to choosing whether to pursue it at all). We can apply the Cost–Benefit Principle in such situations by repeatedly asking the question "Should I increase the level at which I am currently pursuing the activity?"

In attempting to answer this question, the focus should always be on the benefit and cost of an *additional* unit of activity. To emphasize this focus, economists

[2] See, for example, Richard Thaler, "Toward a Positive Theory of Consumer Choice," *Journal of Economic Behavior and Organization*, **1**, no. 1 (1980).

marginal cost the increase in total cost that results from carrying out one additional unit of an activity

marginal benefit the increase in total benefit that results from carrying out one additional unit of an activity

refer to the cost of an additional unit of activity as the **marginal cost** of the activity. Similarly, the benefit of an additional unit of the activity is the **marginal benefit** of the activity.

When the problem is to discover the proper level at which to pursue an activity, the cost–benefit rule is to keep increasing the level as long as the marginal benefit of the activity exceeds its marginal cost. As the following example illustrates, however, people often fail to apply this rule correctly.

Should the United Arab Emirates expand its number of international tennis tournaments from two to three or more per year?

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The United Arab Emirates (UAE) currently hosts two international tennis tournaments yearly that attract the best tennis players in the world. The Capitala World Tennis Championship is held in the UAE's capital, Abu Dhabi, whereas the Barclays Dubai Tennis Championships is held in Dubai. Suppose that economists estimate the gains from the tournaments are currently $8 million per year (an average of $4 million per tournament) and that its costs are currently $7 million per year (an average of $3.5 million per tournament). On the basis of these estimates, the UAE government is advised to increase the number of tournaments from two to three or more per year. Should the UAE government agree?

average cost the total cost of undertaking *n* units of an activity divided by *n*

average benefit the total benefit of undertaking *n* units of an activity divided by *n*

To discover whether expanding the program makes economic sense, we must compare the marginal cost of a tournament to its marginal benefit. The professor's estimates, however, tell us only the **average cost** and **average benefit** of the program—which are, respectively, the total cost of the program divided by the number of tournaments and the total benefit divided by the number of tournaments. Knowing the average benefit and average cost per tournament for all hosted tournaments thus far is simply not useful for deciding whether to expand the program. Of course, the average cost of the tournaments undertaken so far *might* be the same as the cost of adding another tournament. But it also might be either higher or lower than the marginal cost of a tournament. The same statement holds true regarding average and marginal benefits.

Suppose, for the sake of discussion, that the benefit of an additional tournament is in fact the same as the average benefit per tournament thus far: $4 million. Should the UAE add another tournament? Not if the cost of adding the third tournament would be more than $4 million. And the fact that the average cost per tournament is only $3.5 million simply does not tell us anything about the marginal cost of the third tournament.

Suppose, for example, that the relationship between the number of tournaments and the total cost of the program is as described in Table 1.1. The average cost per tournament (third column) when there are two tournaments would then be $7 million/2 = $3.5 million per tournament. But note in the second column of the table that adding a third tournament would raise costs from $7 million to $12 million, making the marginal cost of the third tournament $5 million. So if the benefit of an additional tournament is $4 million, increasing the number of tournaments from two to three would make absolutely no economic sense. ◆

The following example illustrates how to apply the Cost–Benefit Principle correctly in this case.

How many international tennis tournaments should the UAE host?

The UAE must decide how many international tennis tournaments to host. The benefit of each tournament is estimated to be $6 million and the total cost again depends on the number of tournaments in the manner shown in Table 1.1.

TABLE 1.1
How Total Cost Varies with the Number of Tournaments

Number of tournaments	Total cost ($ million)	Average cost ($ million/tournament)
0	0	0
1	3	3
2	7	3.5
3	12	4
4	20	5
5	32	6.4

The UAE should continue to host tournaments as long as the marginal benefit exceeds the marginal cost. In this example, the marginal benefit is constant at $6 million per tournament, regardless of the number of hosted tournaments. The UAE should thus keep hosting tournaments as long as the marginal cost per tournament is less than or equal to $6 million.

Applying the definition of marginal cost to the total cost entries in the second column of Table 1.1 yields the marginal cost values in the third column of Table 1.2. (Because marginal cost is the change in total cost that results when we change the number of tournaments by one, we place each marginal cost entry midway between the rows showing the corresponding total cost entries.) Thus, for example, the marginal cost of increasing the number of tournaments from one to two is $4 million, the difference between the $7 million total cost of two tournaments and the $3 million total cost of one tournament.

As we see from a comparison of the $6 million marginal benefit per tournament with the marginal cost entries in the third column of Table 1.2, the first three tournaments satisfy the cost–benefit test, but the fourth and fifth tournaments do not. The UAE should thus host three international tennis tournaments.

EXERCISE 1.4

If the marginal benefit of each tournament had been not $6 million but $9 million, how many tournaments should the UAE have hosted?

TABLE 1.2
How Marginal Cost Varies with the Number of Tournaments

Number of tournaments	Total cost ($ million)	Marginal cost ($ million/tournament)
0	0	
		3
1	3	
		4
2	7	
		5
3	12	
		8
4	20	
		12
5	32	

The cost–benefit framework emphasizes that the only relevant costs and benefits in deciding whether to pursue an activity further are *marginal* costs and benefits—measures that correspond to the *increment* of activity under consideration. In many contexts, however, people seem more inclined to compare the *average* cost and benefit of the activity. As the first tennis tournament example made clear, increasing the level of an activity may not be justified, even though its average benefit at the current level is significantly greater than its average cost.

Here's an exercise that further illustrates the importance of thinking at the margin.

EXERCISE 1.5

Should a basketball team's best player take all the team's shots?

A professional basketball team has a new assistant coach. The assistant notices that one player scores on a higher percentage of his shots than other players. Based on this information, the assistant suggests to the head coach that the star player should take all the shots. That way, the assistant reasons, the team will score more points and win more games.

On hearing this suggestion, the head coach fires his assistant for incompetence. What was wrong with the assistant's idea?

RECAP | THREE IMPORTANT DECISION PITFALLS

1. **The pitfall of measuring costs or benefits proportionally.** Many decision makers treat a change in cost or benefit as insignificant if it constitutes only a small proportion of the original amount. Absolute dollar amounts, not proportions, should be employed to measure costs and benefits.
2. **The pitfall of ignoring implicit costs.** When performing a cost–benefit analysis of an action, it is important to account for all relevant costs, including the implicit value of alternatives that must be forgone in order to carry out the action. A resource (such as frequent-flyer miles) may have a high implicit cost, even if you originally got it "for free," if its best alternative use has high value. The identical resource may have a low implicit cost, however, if it has no good alternative uses.
3. **The pitfall of failing to think at the margin.** When deciding whether to perform an action, the only costs and benefits that are relevant are those that would result from taking the action. It is important to ignore sunk costs—those costs that cannot be avoided even if the action is not taken. Even though a ticket to a concert may have cost you $100, if you have already bought it and cannot sell it to anyone else, the $100 is a sunk cost and should not influence your decision about whether to go to the concert. It is also important not to confuse average costs and benefits with marginal costs and benefits. Decision makers often have ready information about the total cost and benefit of an activity, and from these it is simple to compute the activity's average cost and benefit. A common mistake is to conclude that an activity should be increased if its average benefit exceeds its average cost. The Cost–Benefit Principle tells us that the level of an activity should be increased if, and only if, its *marginal* benefit exceeds its *marginal* cost.

Some costs and benefits, especially marginal costs and benefits and implicit costs, are important for decision making, while others, like sunk costs and average costs and benefits, are essentially irrelevant. This conclusion is implicit in our original statement on the Cost–Benefit Principle (an action should be taken if, and only if, the extra benefits of taking it exceed the extra costs). When we encounter additional examples of decision pitfalls, we will flag them by inserting the icon for the Cost–Benefit Principle in the margin.

Cost–Benefit

1.4 NORMATIVE ECONOMICS VERSUS POSITIVE ECONOMICS

The examples discussed in the preceding section make the point that people *sometimes* choose irrationally. We must stress that our purpose in discussing these examples was not to suggest that people *generally* make irrational choices. On the contrary, most people appear to choose sensibly most of the time, especially when their decisions are important or familiar ones. The economist's focus on rational choice thus offers not only useful advice about making better decisions, but also a basis for predicting and explaining human behavior. We used the cost–benefit approach in this way when discussing how rising faculty salaries have led to larger class sizes. And as we will see, similar reasoning helps to explain human behavior in virtually every other domain.

The Cost–Benefit Principle is an example of a **normative economic principle**, one that provides guidance about how we *should* behave. For example, according to the Cost–Benefit Principle, we should ignore sunk costs when making decisions about the future. As our discussion of the various decision pitfalls makes clear, however, the Cost–Benefit Principle is not always a **positive**, or descriptive, **economic principle**, one that describes how we actually *will* behave. As we saw, the Cost–Benefit Principle can be tricky to implement, and people sometimes fail to heed its prescriptions.

normative economic principle one that says how people should behave

positive economic principle one that predicts how people will behave

That said, we stress that knowing the relevant costs and benefits surely does enable us to predict how people will behave much of the time. If the benefit of an action goes up, it is generally reasonable to predict that people will be more likely to take that action. And conversely, if the cost of an action goes up, the safest prediction will be that people will be less likely to take that action. This point is so important that we designate it as the **Incentive Principle**.

The Incentive Principle: A person (or a firm or a society) is more likely to take an action if its benefit rises, and less likely to take it if its cost rises. In short, incentives matter.

Incentive

The Incentive Principle is a positive economic principle. It stresses that the relevant costs and benefits usually help us predict behavior, but at the same time does not insist that people will behave rationally in each instance. For example, if the price of heating oil were to rise sharply, we would invoke the Cost–Benefit Principle to say that people *should* turn their thermostats down, and invoke the Incentive Principle to predict that average thermostat settings *will* in fact go down in most cases.

1.5 ECONOMICS: MICRO AND MACRO

By convention, we use the term **microeconomics** to describe the study of individual choices and of group behavior in individual markets. **Macroeconomics**, by contrast, is the study of the performance of national economies and of the policies that governments use to try to improve that performance. Macroeconomics tries to understand the determinants of such things as the national unemployment rate, the overall price level, and the total value of national output.

Our focus in this chapter is on issues that confront the individual decision maker, whether that individual confronts a personal decision, a family decision, a

microeconomics the study of individual choice under scarcity and its implications for the behavior of prices and quantities in individual markets

macroeconomics the study of the performance of national economies and the policies that governments use to try to improve that performance business decision, a government policy decision, or indeed any other type of decision. Further on, we'll consider economic models of groups of individuals, such as all buyers or all sellers in a specific market. Later still, we will turn to broader economic issues and measures.

No matter which of these levels is our focus, however, our thinking will be shaped by the fact that, although economic needs and wants are effectively unlimited, the material and human resources that can be used to satisfy them are finite. Clear thinking about economic problems must therefore always take into account the idea of trade-offs—the idea that having more of one good thing usually means having less of another. Our economy and our society are shaped to a substantial degree by the choices people have made when faced with trade-offs.

1.6 THE APPROACH OF THIS TEXT

Scarcity

Choosing the number of students to register in each class is just one of many important decisions in planning an introductory economics course. Another decision, to which the Scarcity Principle applies just as strongly, concerns which of many different topics to include on the course syllabus. There is a virtually inexhaustible set of topics and issues that might be covered in an introductory course, but only limited time in which to cover them. There is no free lunch. Covering some topics inevitably means omitting others.

All textbook authors are necessarily forced to pick and choose. A textbook that covered *all* the issues ever written about in economics would take up more than a whole floor of your campus library. It is our firm view that most introductory textbooks try to cover far too much. One reason that each of us was drawn to the study of economics was that a relatively short list of the discipline's core ideas can explain a great deal of the behavior and events we see in the world around us. So rather than cover a large number of ideas at a superficial level, our strategy is to focus on this short list of core ideas, returning to each entry again and again, in many different contexts. This strategy will enable you to internalize these ideas remarkably well in the brief span of a single course. And the benefit of learning a small number of important ideas well will far outweigh the cost of having to ignore a host of other, less important, ideas.

So far, we've already encountered three core ideas: the Scarcity Principle, the Cost–Benefit Principle, and the Incentive Principle. As these core ideas reemerge in the course of our discussions, we'll call your attention to them. And shortly after a *new* core idea appears, we'll highlight it by formally restating it.

A second important element in the philosophy of this text is our belief in the importance of active learning. In the same way that you can learn Spanish only by speaking and writing it, or tennis only by playing the game, you can learn economics only by *doing* economics. And because we want you to learn how to do economics, rather than just to read or listen passively as the authors or your instructor does economics, we will make every effort to encourage you to stay actively involved.

For example, instead of just telling you about an idea, we will usually first motivate the idea by showing you how it works in the context of a specific example. Often, these examples will be followed by exercises for you to try, as well as applications that show the relevance of the idea to real life. Try working the exercises *before* looking up the answers (which are at the back of the corresponding chapter).

Think critically about the applications: Do you see how they illustrate the point being made? Do they give you new insight into the issue? Work the problems at the end of the chapters and take extra care with those relating to points that you do not fully understand. Apply economic principles to the world around you. (We'll say more about this when we discuss economic naturalism below.) Finally, when you come across an idea or example that you find interesting, tell a friend about it. You'll be surprised to discover how much the mere act of explaining it helps you understand and remember the underlying principle. The more actively you can become engaged in the learning process, the more effective your learning will be.

1.7 ECONOMIC NATURALISM

With the rudiments of the cost–benefit framework under your belt, you are now in a position to become an "economic naturalist," someone who uses insights from economics to help make sense of observations from everyday life. People who have studied biology are able to observe and marvel at many details of nature that would otherwise have escaped their notice. For example, on a walk in the woods in early April, the novice may see only trees whereas the biology student notices many different species of trees and understands why some are already into leaf while others still lie dormant. Likewise, the novice may notice that in some animal species males are much larger than females, but the biology student knows that pattern occurs only in species in which males take several mates. Natural selection favors larger males in those species because their greater size helps them prevail in the often bloody contests among males for access to females. By contrast, males tend to be roughly the same size as females in monogamous species, in which there is much less fighting for mates.

In similar fashion, learning a few simple economic principles enables us to see the mundane details of ordinary human existence in a new light. Whereas the uninitiated often fail even to notice these details, the economic naturalist not only sees them, but becomes actively engaged in the attempt to understand them. Let's consider a few examples of questions economic naturalists might pose for themselves.

Example 1.1
THE ECONOMIC NATURALIST

Why do many hardware manufacturers include more than $1,000 worth of "free" software with a computer selling for only slightly more than that?

The software industry is different from many others in the sense that its customers care a great deal about product compatibility. When you and your classmates are working on a project together, for example, your task will be much simpler if you all use the same word-processing program. Likewise, an Internet user's browsing experience will be safer if her Internet security software is widely used by other Internet users.

The implication is that the benefit of owning and using any given software program increases with the number of other people who use that same product. This unusual relationship gives the producers of the most popular programs an enormous advantage and often makes it hard for new programs to break into the market.

Recognizing this pattern, Symantec Corporation offered computer makers free copies of *Norton Internet Security*, a software that protects against computer viruses, hackers, and privacy threats. Computer makers, for their part, were only too happy to include the program, since it made their new computers more attractive to buyers. *Norton* soon became the standard for Internet security programs. By giving away free copies of the program, Symantec "primed the pump," creating an enormous demand for upgrades of *Norton* and for more advanced versions of related software. ●

Inspired by this success story, other software developers have jumped onto the bandwagon. Most hardware now comes bundled with a host of free software programs. Some software developers are even rumored to *pay* computer makers to include their programs!

The free-software example illustrates a case in which the *benefit* of a product depends on the number of other people who own that product. As the next example

demonstrates, the *cost* of a product may also depend on the number of others who own it.

Example 1.2

THE ECONOMIC NATURALIST

Why don't auto manufacturers make cars without heaters?

Virtually every new car sold in the Middle East today has a heater. But not every car has a CD player. Why this difference?

One might be tempted to answer that, although everyone *needs* a heater, people can get along without CD players. Yet heaters are of little use in places like El Azizia, Lybia and Dallol, Ethiopia. What is more, cars produced as recently as the 1960s did *not* all have heaters.

Although heaters cost extra money to manufacture and are not useful in all countries, they do not cost *much* money and are useful on at least a few days each year in most countries. As time passed and people's incomes grew, manufacturers found that people were ordering fewer and fewer cars without heaters. At some point it actually became cheaper to put heaters in *all* cars, rather than bear the administrative expense of making some cars with heaters and others without. No doubt a few buyers would still order a car without a heater if they could save some money in the process, but catering to these customers is just no longer worth it.

Similar reasoning explains why certain cars today cannot be purchased without a CD player. Buyers of the 2009 BMW 750i, for example, got a CD player whether they wanted one or not. Most buyers of this car, which sells for more than $75,000, have high incomes, so the overwhelming majority of them would have chosen to order a CD player had it been sold as an option. Because of the savings made possible when all cars are produced with the same equipment, it would have actually cost BMW more to supply cars for the few who would want them without CD players.

Buyers of the least-expensive makes of car have much lower incomes on average than BMW 750i buyers. Accordingly, most of them have more pressing alternative uses for their money than to buy CD players for their cars, and this explains why some inexpensive makes continue to offer CD players only as options. But as incomes continue to grow, new cars without CD players will eventually disappear. ●

EXERCISE 1.6

In 500 words or less, use cost–benefit analysis to explain some pattern of events or behavior you have observed in your own environment.

There is probably no more useful step you can take in your study of economics than to perform several versions of the assignment in Exercise 1.6. Students who do so almost invariably become lifelong economic naturalists. Their mastery of economic concepts not only does not decay with the passage of time, it actually grows stronger. We urge you, in the strongest possible terms, to make this investment!

SUMMARY

- Economics is the study of how people make choices under conditions of scarcity and of the results of those choices for society. Economic analysis of human behavior begins with the assumption that people are rational—that they have well-defined goals and try to achieve them as best they can. In trying to achieve their goals, people normally face trade-offs: Because material and human resources are limited, having more of one good thing means making do with less of some other good thing. **LO1**

- Our focus in this chapter has been on how rational people make choices among alternative courses of action. Our basic tool for analyzing these decisions is cost–benefit analysis. The Cost–Benefit Principle says that a person should take an action if, and only if, the benefit of that action is at least as great as its cost. The benefit of an action is defined as the largest dollar amount the person would be willing to pay in order to take the action. The cost of an action is defined as the dollar value of everything the person must give up in order to take the action. **LO2**

- Often the question is not whether to pursue an activity but rather how many units of it to pursue. In these cases, the rational person pursues additional units as long as the marginal benefit of the activity (the benefit from pursuing an additional unit of it) exceeds its marginal cost (the cost of pursuing an additional unit of it). **LO2**

- In using the cost–benefit framework, we need not presume that people choose rationally all the time. Indeed, we identified three common pitfalls that plague decision makers in all walks of life: a tendency to treat small proportional changes as insignificant, a tendency to ignore implicit costs, and a tendency to fail to think at the margin—for example, by failing to ignore sunk costs or by failing to compare marginal costs and benefits. **LO4, LO5, LO6**

- Microeconomics is the study of individual choices and of group behavior in individual markets, while macroeconomics is the study of the performance of national economies and of the policies that governments use to try to improve economic performance.

CORE PRINCIPLES

The Scarcity Principle (also called "The No-Free-Lunch Principle")
Although we have boundless needs and wants, the resources available to us are limited. So having more of one good thing usually means having less of another.

Scarcity

The Cost–Benefit Principle
An individual (or a firm or a society) should take an action if, and only if, the extra benefits from taking the action are at least as great as the extra costs.

Cost–Benefit

The Incentive Principle
A person (or a firm or a society) is more likely to take an action if its benefit rises, and less likely to take it if its cost rises.

Incentive

KEY TERMS

average benefit (12)
average cost (12)
economic surplus (6)
economics (4)
macroeconomics (15)
marginal benefit (12)
marginal cost (12)
microeconomics (15)
normative economic principle (15)
opportunity cost (7)
positive economic principle (15)
rational person (6)
sunk cost (11)

■ REVIEW QUESTIONS ■

1. A friend of yours on the tennis team says, "Private tennis lessons are definitely better than group lessons." Explain what you think he means by this statement. Then use the Cost–Benefit Principle to explain why private lessons are not necessarily the best choice for everyone. **LO2**
2. True or false: Your willingness to drive downtown to save $30 on a new appliance should depend on what fraction of the total selling price $30 is. Explain. **LO4**
3. Why might someone who is trying to decide whether to see a movie be more likely to focus on the $10 ticket price than on the $20 she would fail to earn by not babysitting? **LO5**
4. Many people think of their air travel as being free when they use frequent-flyer miles. Explain why these people are likely to make wasteful travel decisions. **LO5**
5. Is the nonrefundable tuition payment you made to your university this semester a sunk cost? How would your answer differ if your university were to offer a full tuition refund to any student who dropped out of school during the first two months of the semester? **LO6**

■ PROBLEMS ■

connect™

1. The most you would be willing to pay for having a freshly washed car is $6. The smallest amount for which you would be willing to wash someone else's car is $3.50. You are going out this evening and your car is dirty. How much economic surplus would you receive from washing it? **LO2**
2. To earn extra money in the summer, you grow tomatoes and sell them at the farmers' market for 30 cents per kg. By adding compost to your garden, you can increase your yield as shown in the table below. If compost costs 50 cents per kg and your goal is to make as much money as possible, how many kilograms of compost should you add? **LO2**

Kg of compost	Kg of tomatoes
0	100
1	120
2	125
3	128
4	130
5	131
6	131.5

3. Residents of your city are charged a fixed weekly fee of $6 for garbage collection. They are allowed to put out as many cans as they wish. The average household disposes of three cans of garbage per week under this plan. Now suppose that your city changes to a "tag" system. Each can of refuse to be collected must have a tag affixed to it. The tags cost $2 each and are not reusable. What effect do you think the introduction of the tag system will have on the total quantity of garbage collected in your city? Explain briefly. **LO2**
4. Once a week, Abbas purchases a six-pack of cola and puts it in his refrigerator for his two children. He invariably discovers that all six cans are gone on the

first day. Mustafa also purchases a six-pack of cola once a week for his two children, but unlike Abbas, he tells them that each may drink no more than three cans. If the children use cost–benefit analysis each time they decide whether to drink a can of cola, explain why the cola lasts much longer at Mustafa's house than at Abbas's. **LO2**

5. Mukhtar is a potato farmer. He invests all his spare cash in additional potatoes, which grow on otherwise useless land behind his barn. The potatoes double in weight during their first year, after which time they are harvested and sold at a constant price per kg. Mukhtar's friend Ismail asks Mukhtar for a loan of $200, which he promises to repay after 1 year. How much interest will Ismail have to pay Mukhtar in order for Mukhtar to recover his opportunity cost of making the loan? Explain briefly. **LO2**

6. Suppose that in the last few seconds you devoted to question 1 on your physics exam you earned 4 extra points, while in the last few seconds you devoted to question 2 you earned 10 extra points. You earned a total of 48 and 12 points, respectively, on the two questions and the total time you spent on each was the same. If you could take the exam again, how—if at all—should you reallocate your time between these questions? **LO2**

7. Nadia and Sarah have the same preferences and incomes. Just as Nadia arrived at the theater to see a play, she discovered that she had lost the $10 ticket she had purchased earlier. Sarah also just arrived at the theater planning to buy a ticket to see the same play when she discovered that she had lost a $10 bill from her wallet. If both Nadia and Sarah are rational and both still have enough money to pay for a ticket, is one of them more likely than the other to go ahead and see the play anyway? **LO2**

8.* You and your friend Javed have identical tastes. At 2 p.m., you go to the local ticket outlet and buy a $30 ticket to a football game to be played that night 50 km away. Javed plans to attend the same game, but because he cannot get to the ticket outlet, he plans to buy his ticket at the game. Tickets sold at the game cost only $25 because they carry no surcharge. (Many people nonetheless pay the higher price at the outlet, to be sure of getting good seats.) At 4 p.m., an unexpected sandstorm begins, making the prospect of the 50-km drive much less attractive than before (but assuring the availability of good seats). If both you and Javed are rational, is one of you more likely to attend the game than the other? **LO2**

9.* For each long-distance call anywhere in Egypt, a new phone service will charge users 30 cents per minute for the first 2 minutes and 2 cents per minute for additional minutes in each call. Mukhtar's current phone service charges 10 cents per minute for all calls, and his calls are never shorter than 7 minutes. If Mukhtar's dorm switches to the new phone service, what will happen to the average length of his calls? **LO2**

10.* The meal plan at university A lets students eat as much as they like for a fixed fee of $500 per semester. The average student there eats 250 kg of food per semester. University B charges $500 for a book of meal tickets that entitles the student to eat 250 kg of food per semester. If the student eats more than 250 kg, he or she pays $2 for each additional kg; if the student eats less, he or she gets a $2 per kg refund. If students are rational, at which university will average food consumption be higher? Explain briefly. **LO3**

* Problems marked with an asterisk (*) are more difficult.

ANSWERS TO IN-CHAPTER EXERCISES

1.1 The benefit of buying the game downtown is again \$10 but the cost is now \$12, so your economic surplus from buying it downtown would be \$10 − \$12 = −\$2. Since your economic surplus from making the trip would be negative, you should buy at the campus store. **LO2**

1.2 Saving \$100 is \$10 more valuable than saving \$90, even though the percentage saved is much greater in the case of the Doha ticket. **LO4**

1.3 Since you now have no alternative use for your miles, the opportunity cost of using them to pay for the Sharm El Sheikh trip is zero. That means your economic surplus from the trip will be \$1,350 − \$1,000 = \$350 > 0, so you should use your miles and go to Sharm El Sheikh. **LO2**

1.4 The marginal benefit of the fourth tournament is \$9 million, which exceeds its marginal cost of \$8 million, so the fourth tournament should be added. But the fifth tournament should not, since its marginal cost (\$12 million) exceeds its marginal benefit (\$9 million). **LO2**

1.5 If the star player takes one more shot, some other player must take one less. The fact that the star player's *average* success rate is higher than the other players' does not mean that the probability of making his *next* shot (the marginal benefit of having him shoot once more) is higher than the probability of another player making his next shot. Indeed, if the best player took all his team's shots, the other team would focus its defensive effort entirely on him, in which case letting others shoot would definitely pay. **LO6**

Working with Equations, Graphs, and Tables

APPENDIX

Although many of the examples and most of the end-of-chapter problems in this book are quantitative, none requires mathematical skills beyond rudimentary high school algebra and geometry. In this brief appendix, we review some of the skills you'll need for dealing with these examples and problems.

One important skill is to be able to read simple verbal descriptions and translate the information they provide into the relevant equations or graphs. You'll also need to be able to translate information given in tabular form into an equation or graph, and sometimes you'll need to translate graphical information into a table or equation. Finally, you'll need to be able to solve simple systems with two equations and two unknowns. The following examples illustrate all the tools you'll need.

1A.1 USING A VERBAL DESCRIPTION TO CONSTRUCT AN EQUATION

We begin with an example that shows how to construct a long-distance telephone billing equation from a verbal description of the billing plan.

Your long-distance telephone plan charges you $5 per month plus 10 cents per minute for long-distance calls. Write an equation that describes your monthly telephone bill.

equation a mathematical expression that describes the relationship between two or more variables

variable a quantity that is free to take a range of different values

dependent variable a variable in an equation whose value is determined by the value taken by another variable in the equation

independent variable a variable in an equation whose value determines the value taken by another variable in the equation

constant (or parameter) a quantity that is fixed in value

An **equation** is a simple mathematical expression that describes the relationship between two or more **variables**, or quantities that are free to assume different values in some range. The most common type of equation we'll work with contains two types of variables: **dependent variables** and **independent variables**. In this example, the dependent variable is the dollar amount of your monthly telephone bill and the independent variable is the variable on which your bill depends, namely, the volume of long-distance calls you make during the month. Your bill also depends on the $5 monthly fee and the 10 cents per minute charge. But, in this example, those amounts are **constants**, not variables. A constant, also called a **parameter**, is a quantity in an equation that is fixed in value, not free to vary. As the terms suggest, the dependent variable describes an outcome that depends on the value taken by the independent variable.

Once you've identified the dependent variable and the independent variable, choose simple symbols to represent them. In algebra courses, X is typically used to represent the independent variable and Y the dependent variable. Many people find it easier to remember what the variables stand for, however, if they choose symbols that are linked in some straightforward way to the quantities that the variables represent. Thus, in this example, we might use B to represent your monthly *bill* in dollars and T to represent the total *time* in minutes you spent during the month on long-distance calls.

Having identified the relevant variables and chosen symbols to represent them, you are now in a position to write the equation that links them:

$$B = 5 + 0.10T, \qquad (1A.1)$$

where B is your monthly long-distance bill in dollars and T is your monthly total long-distance calling time in minutes. The fixed monthly fee (5) and the charge per minute (0.10) are parameters in this equation. Note the importance of being clear about the units of measure. Because B represents the monthly bill in dollars, we must also express the fixed monthly fee and the per-minute charge in dollars, which is why the latter number appears in Equation 1A.1 as 0.10 rather than 10. Equation 1A.1 follows the normal convention in which the dependent variable appears by itself on the left-hand side while the independent variable or variables and constants appear on the right-hand side.

Once we have the equation for the monthly bill, we can use it to calculate how much you'll owe as a function of your monthly volume of long-distance calls. For example, if you make 32 minutes of calls, you can calculate your monthly bill by simply substituting 32 minutes for T in Equation 1A.1:

$$B = 5 + 0.10\ (0.32) = 8.20. \qquad (1A.2)$$

Your monthly bill when you make 32 minutes of calls is thus equal to $8.20. ◆

EXERCISE 1A.1

Under the monthly billing plan described in the example above, how much would you owe for a month during which you made 45 minutes of long-distance calls?

1A.2 GRAPHING THE EQUATION OF A STRAIGHT LINE

The next example shows how to portray the billing plan described in the preceding example as a graph.

Construct a graph that portrays the monthly long-distance telephone billing plan described in the preceding example, putting your telephone charges, in dollars per month, on the vertical axis and your total volume of calls, in minutes per month, on the horizontal axis.

The first step in responding to this instruction is the one we just took, namely, to translate the verbal description of the billing plan into an equation. When graphing an equation, the normal convention is to use the vertical axis to represent the dependent variable and the horizontal axis to represent the independent variable. In Figure 1A.1, we therefore put B on the vertical axis and T on the horizontal axis. One way to construct the graph shown in the figure is to begin by plotting the monthly bill values that correspond to several different total amounts of long-distance calls. For example, someone who makes 10 minutes of calls during the month would have a bill of $B = 5 + 0.10(10) = \$6$. Thus, in Figure 1A.1 the value of 10 minutes per month on the horizontal axis corresponds to a bill of $6 per month on the vertical axis (point A). Someone who makes 30 minutes of long-distance calls during the month will have a monthly bill of $B = 5 + 0.10(30) = \$8$, so the value of 30 minutes per month on the horizontal axis corresponds to $8 per month on the vertical axis (point C). Similarly, someone who makes 70 minutes of long-distance calls during the month will have a monthly bill of $B = 5 + 0.10(70) = \$12$, so the value of 70 minutes on the horizontal axis corresponds to $12 on the vertical axis (point D). The line joining these points is the graph of the monthly billing Equation 1A.1.

As shown in Figure 1A.1, the graph of the equation $B = 5 + 0.10T$ is a straight line. The parameter 5 is the **vertical intercept** of the line—the value of B when $T = 0$, or the point at which the line intersects the vertical axis. The parameter 0.10 is the **slope** of the line, which is the ratio of the **rise** of the line to the corresponding **run**. The ratio rise/run is simply the vertical distance between any two points on the line divided by the horizontal distance between those points. For example, if we choose points A and C in Figure 1A.1, the rise is $8 - 6 = 2$ and the corresponding run is $30 - 10 = 20$, so rise/run $= 2/20 = 0.10$. More generally, for the graph of any equation $Y = a + bX$, the parameter a is the vertical intercept and the parameter b is the slope. ◆

vertical intercept in a straight line, the value taken by the dependent variable when the independent variable equals zero

slope in a straight line, the ratio of the vertical distance the straight line travels between any two points (*rise*) to the corresponding horizontal distance (*run*)

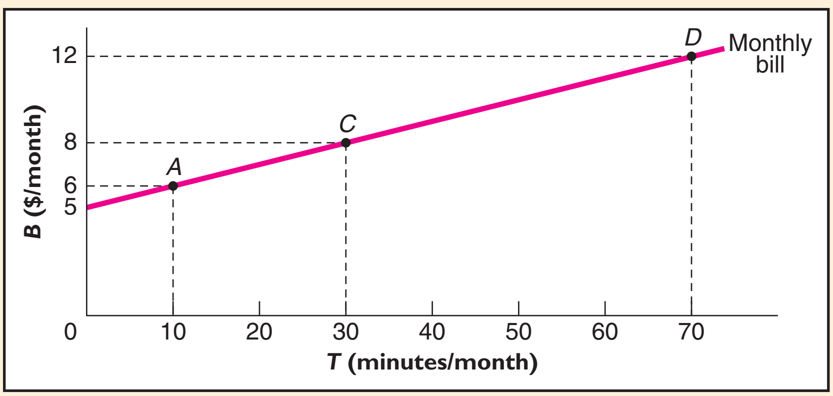


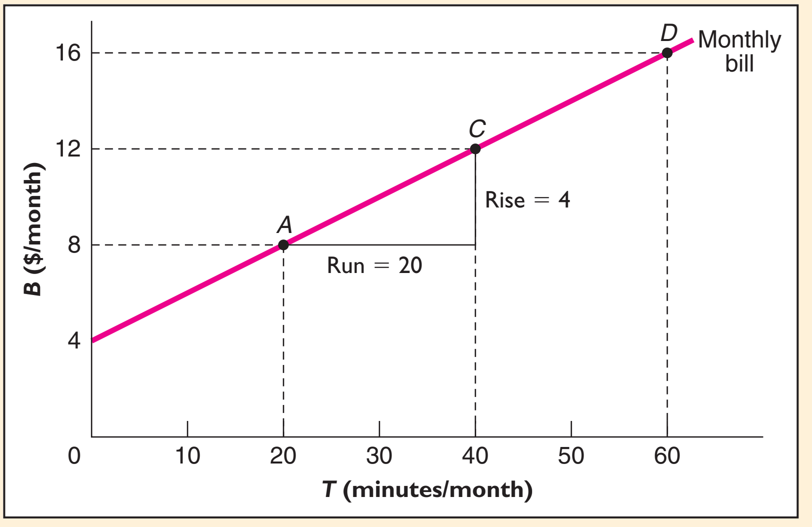
FIGURE 1A.1
The Monthly Telephone Bill in Example 1A.1.
The graph of the equation $B = 5 + 0.10T$ is the straight line shown. Its vertical intercept is 5 and its slope is 0.10.

1A.3 DERIVING THE EQUATION OF A STRAIGHT LINE FROM ITS GRAPH

The next example shows how to derive the equation for a straight line from a graph of the line.

Figure 1A.2 shows the graph of the monthly billing plan for a new long-distance plan. What is the equation for this graph? How much is the fixed monthly fee under this plan? How much is the charge per minute?

FIGURE 1A.2
Another Monthly Long-Distance Plan.
The vertical distance between points *A* and *C* is 12 − 8 = 4 units, and the horizontal distance between points *A* and *C* is 40 − 20 = 20, so the slope of the line is 4/20 = 1/5 = 0.20. The vertical intercept (the value of *B* when *T* = 0) is 4. So the equation for the billing plan shown is *B* = 4 + 0.20*T*.



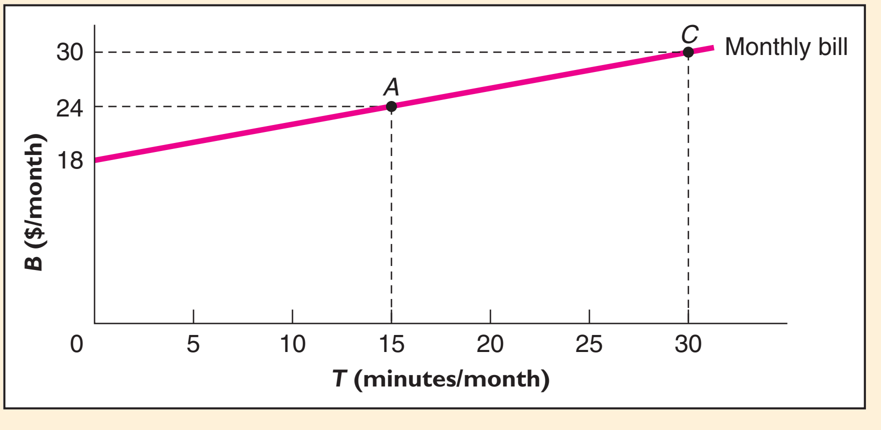
The slope of the line shown is the rise between any two points divided by the corresponding run. For points *A* and *C*, rise = 12 − 8 = 4 and run = 40 − 20 = 20, so the slope equals rise/run = 4/20 = 1/15 = 0.20. And since the horizontal intercept of the line is 4, its equation must be given by

$$B = 4 + 0.20T. \qquad (1A.3)$$

Under this plan, the fixed monthly fee is the value of the bill when $T = 0$, which is \$4. The charge per minute is the slope of the billing line, 0.20, or 20 cents per minute. ◆

EXERCISE 1A.2

Write the equation for the billing plan shown in the accompanying graph. How much is its fixed monthly fee? Its charge per minute?



1A.4 CHANGES IN THE VERTICAL INTERCEPT AND SLOPE

The next two examples and exercises provide practice in seeing how a line shifts with a change in its vertical intercept or slope.

Show how the billing plan whose graph is in Figure 1A.2 would change if the monthly fixed fee were increased from $4 to $8.

An increase in the monthly fixed fee from $4 to $8 would increase the vertical intercept of the billing plan by $4 but would leave its slope unchanged. An increase in the fixed fee thus leads to a parallel upward shift in the billing plan by $4, as shown in Figure 1A.3. For any given number of minutes of long-distance calls, the

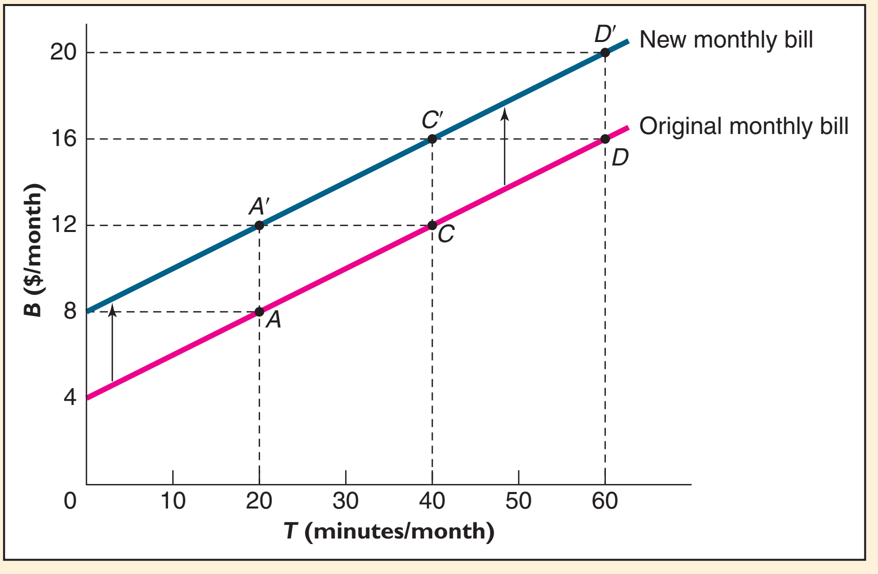


FIGURE 1A.3
The Effect of an Increase in the Vertical Intercept. An increase in the vertical intercept of a straight line produces an upward parallel shift in the line.

monthly charge on the new bill will be $4 higher than on the old bill. Thus 20 minutes of calls per month costs $8 under the original plan (point *A*) but $12 under the new plan (point *A′*). And 40 minutes costs $12 under the original plan (point C), $16 under the new plan (point *C′*); and 60 minutes costs $16 under the original plan (point *D*), $20 under the new plan (point *D′*). ◆

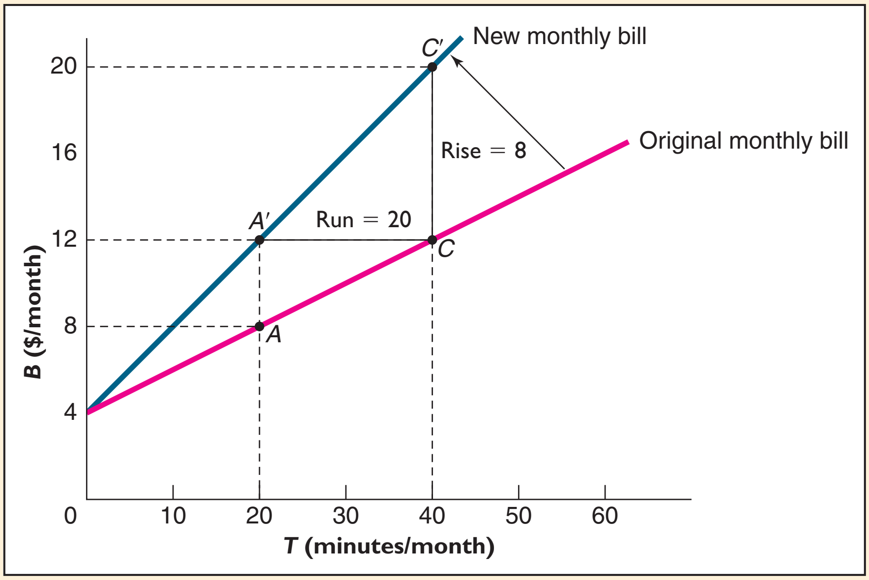
EXERCISE 1A.3

Show how the billing plan whose graph is in Figure 1A.2 would change if the monthly fixed fee were reduced from $4 to $2.

Show how the billing plan whose graph is in Figure 1A.2 would change if the charge per minute were increased from 20 cents to 40 cents.

Because the monthly fixed fee is unchanged, the vertical intercept of the new billing plan continues to be 4. But the slope of the new plan, shown in Figure 1A.4, is 0.40, or twice the slope of the original plan. More generally, in the equation $Y = a + bX$, an increase in b makes the slope of the graph of the equation steeper. ◆

FIGURE 1A.4
The Effect of an Increase in the Charge per Minute.
Because the fixed monthly fee continues to be $4, the vertical intercept of the new plan is the same as that of the original plan. With the new charge per minute of 40 cents, the slope of the billing plan rises from 0.20 to 0.40.



EXERCISE 1A.4

Show how the billing plan whose graph is in Figure 1A.2 would change if the charge per minute were reduced from 20 cents to 10 cents.

Exercise 1A.4 illustrates the general rule that in an equation $Y = a + bX$, a reduction in b makes the slope of the graph of the equation less steep.

1A.5 CONSTRUCTING EQUATIONS AND GRAPHS FROM TABLES

The next example and exercise show how to transform tabular information into an equation or graph.

Table 1A.1 shows four points from a monthly long-distance telephone billing equation. If all points on this billing equation lie on a straight line, find the vertical intercept of the equation and graph it. What is the monthly fixed fee? What is the charge per minute? Calculate the total bill for a month with 1 hour of long-distance calls.

TABLE 1A.1
Points on a Long-Distance Billing Plan

Long-distance bill ($/month)	Total long-distance calls (minutes/month)
10.50	10
11.00	20
11.50	30
12.00	40

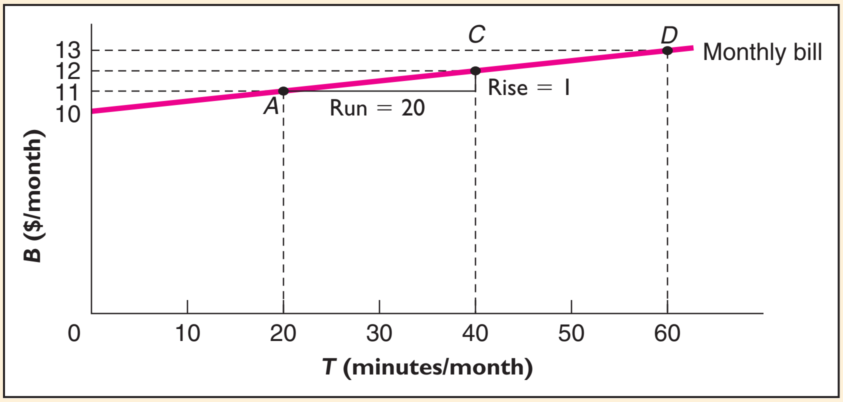


FIGURE 1A.5
Plotting the Monthly Billing Equation from a Sample of Points.
Point *A* is taken from row 2, Table 1A.1, and point *C* from row 4. The monthly billing plan is the straight line that passes through these points.

One approach to this problem is simply to plot any two points from the table on a graph. Since we are told that the billing equation is a straight line, that line must be the one that passes through any two of its points. Thus, in Figure 1A.5 we use *A* to denote the point from Table 1A.1 for which a monthly bill of $11 corresponds to 20 minutes per month of calls (second row) and *C* to denote the point for which a monthly bill of $12 corresponds to 40 minutes per month of calls (fourth row). The straight line passing through these points is the graph of the billing equation.

Unless you have a steady hand, however, or use extremely large graph paper, the method of extending a line between two points on the billing plan is unlikely to be very accurate. An alternative approach is to calculate the equation for the billing plan directly. Since the equation is a straight line, we know that it takes the general form $B = f + sT$, where f is the fixed monthly fee and s is the slope. Our goal is to calculate the vertical intercept f and the slope s. From the same two points we plotted earlier, *A* and *C*, we can calculate the slope of the billing plan as $s = \text{rise/run} = 1/20 = 0.05$.

So all that remains is to calculate f, the fixed monthly fee. At point *C* on the billing plan, the total monthly bill is $12 for 40 minutes, so we can substitute $B = 12$, $s = 0.05$, and $T = 40$ into the general equation $B = f + sT$ to obtain

$$12 = f + 0.05(40), \quad (1A.4)$$

or

$$12 = f + 2, \quad (1A.5)$$

which solves for $f = 10$. So the monthly billing equation must be

$$B = 10 + 0.05T. \quad (1A.6)$$

For this billing equation, the fixed fee is $10 per month, the calling charge is 5 cents per minute ($0.05/minute), and the total bill for a month with 1 hour of long-distance calls is $B = 10 + 0.05(60) = \$13$, just as shown in Figure 1A.5. ◆

EXERCISE 1A.5

The following table shows four points from a monthly long-distance telephone billing plan.

Long-distance bill ($/month)	Total long-distance calls (minutes/month)
20.00	10
30.00	20
40.00	30
50.00	40

If all points on this billing plan lie on a straight line, find the vertical intercept of the corresponding equation without graphing it. What is the monthly fixed fee? What is the charge per minute? How much would the charges be for 1 hour of long-distance calls per month?

1A.6 SOLVING SIMULTANEOUS EQUATIONS

The next example and exercise demonstrate how to proceed when you need to solve two equations with two unknowns.

Suppose you are trying to choose between two rate plans for your long-distance telephone service. If you choose Plan 1, your charges will be computed according to the equation

$$B = 10 + 0.04T, \qquad \text{(1A.7)}$$

where B is again your monthly bill in dollars and T is your monthly volume of long-distance calls in minutes. If you choose Plan 2, your monthly bill will be computed according to the equation

$$B = 20 + 0.02T. \qquad \text{(1A.8)}$$

How many minutes of long-distance calls would you have to make each month, on average, to make Plan 2 cheaper?

Plan 1 has the attractive feature of a relatively low monthly fixed fee, but also the unattractive feature of a relatively high rate per minute. In contrast, Plan 2 has a relatively high fixed fee but a relatively low rate per minute. Someone who made an extremely low volume of calls (for example, 10 minutes per month) would do better under Plan 1 (monthly bill = \$10.40) than under Plan 2 (monthly bill = \$20.20) because the low fixed fee of Plan 1 would more than compensate for its higher rate per minute. Conversely, someone who made an extremely high volume of calls (say, 10,000 minutes per month) would do better under Plan 2 (monthly bill = \$220) than under Plan 1 (monthly bill = \$410) because Plan 2's lower rate per minute would more than compensate for its higher fixed fee.

Our task here is to find the *break-even calling volume*, which is the monthly calling volume for which the monthly bill is the same under the two plans. One way to answer this question is to graph the two billing plans and see where they cross. At that crossing point, the two equations are satisfied simultaneously, which means that the monthly call volumes will be the same under both plans, as will the monthly bills.

In Figure 1A.6, we see that the graphs of the two plans cross at A, where both yield a monthly bill of \$30 for 500 minutes of calls per month. The break-even calling volume for these plans is thus 500 minutes per month. If your calling

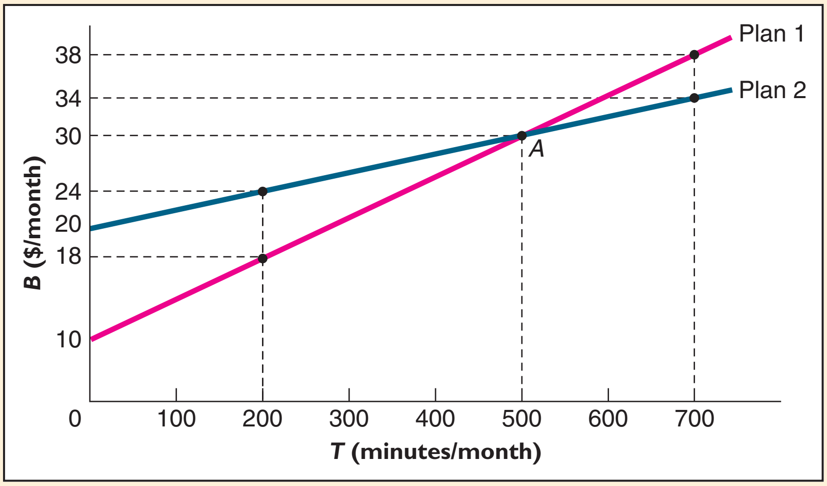


FIGURE 1A.6
The Break-Even Volume of Long-Distance Calls.
When your volume of long-distance calls is 500 minutes per month, your monthly bill will be the same under both plans. For higher calling volumes, Plan 2 is cheaper; Plan 1 is cheaper for lower volumes.

volume is higher than that, on average, you will save money by choosing Plan 2. For example, if you average 700 minutes, your monthly bill under Plan 2 ($34) will be $4 cheaper than under Plan 1 ($38). Conversely, if you average fewer than 500 minutes each month, you will do better under Plan 1. For example, if you average only 200 minutes, your monthly bill under Plan 1 ($18) will be $6 cheaper than under Plan 2 ($24). At 500 minutes per month, the two plans cost exactly the same ($30).

The question posed here also may be answered algebraically. As in the graphical approach just discussed, our goal is to find the point (T, B) that satisfies both billing equations simultaneously. As a first step, we rewrite the two billing equations, one on top of the other, as follows:

$$B = 10 + 0.04T. \qquad \text{(Plan 1)}$$

$$B = 20 + 0.02T. \qquad \text{(Plan 2)}$$

As you'll recall from high school algebra, if we subtract the terms from each side of one equation from the corresponding terms of the other equation, the resulting differences must be equal. So if we subtract the terms on each side of the Plan 2 equation from the corresponding terms in the Plan 1 equation, we get

$$\begin{array}{rl} B = 10 + 0.04T & \text{(Plan 1)} \\ -B = -20 - 0.02T & \text{(–Plan 2)} \\ \hline 0 = -10 + 0.02T & \text{(Plan 1 – Plan 2)} \end{array}$$

Finally, we solve the last equation (Plan 1 – Plan 2) to get $T = 500$.

Plugging $T = 500$ into either plan's equation, we then find $B = 30$. For example, Plan 1's equation yields $10 + 0.04(500) = 30$, as does Plan 2's: $20 + 0.2(500) = 30$.

Because, the point $(T, B) = (500, 30)$ lies on the equations for both plans simultaneously, the algebraic approach just described is often called *the method of simultaneous equations*. ◆

EXERCISE 1A.6

Suppose you are trying to choose between two rate plans for your long-distance telephone service. If you choose Plan 1, your monthly bill will be computed according to the equation

$$B = 10 + 0.01T \qquad \text{(Plan 1)},$$

where B is again your monthly bill in dollars and T is your monthly volume of long-distance calls in minutes. If you choose Plan 2, your monthly bill will be computed according to the equation

$$B = 100 + 0.01T \qquad \text{(Plan 2)}.$$

Use the algebraic approach described in the preceding example to find the break-even level of monthly call volume for these plans.

KEY TERMS

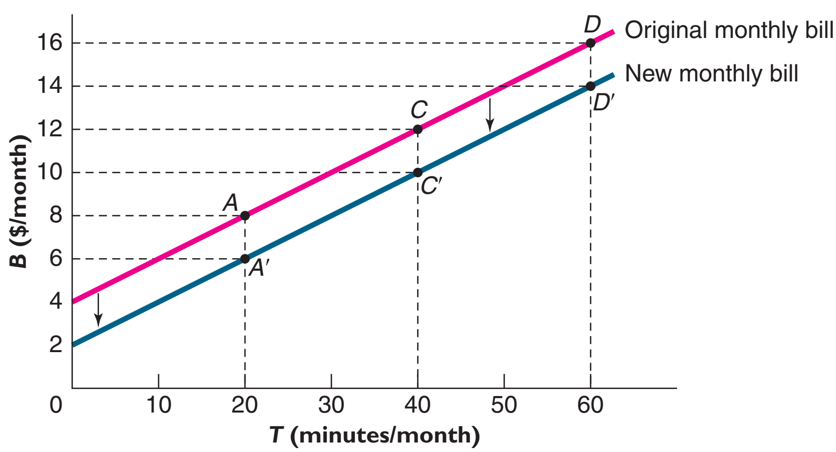
constant (24)
dependent variable (24)
equation (24)
independent variable (24)
parameter (24)
rise (25)
run (25)
slope (25)
variable (24)
vertical intercept (25)

ANSWERS TO IN-APPENDIX EXERCISES

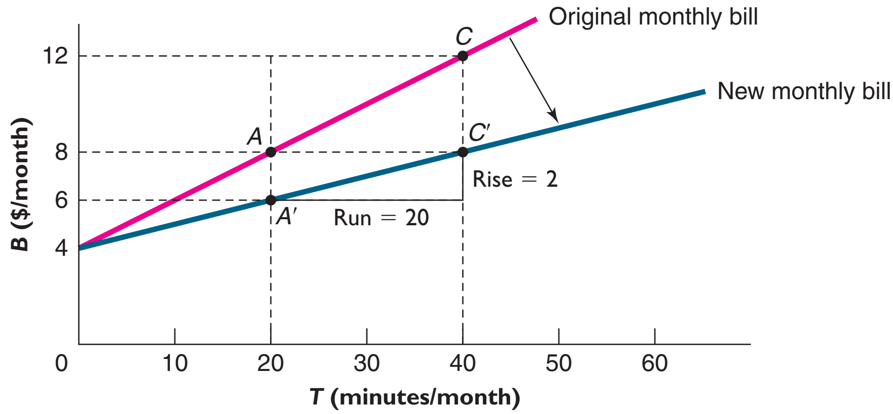
1A.1 To calculate your monthly bill for 45 minutes of calls, substitute 45 minutes for T in Equation 1A.1 to get $B = 5 + 0.10(45) = \$9.50$.

1A.2 Calculating the slope using points A and C, we have rise = 30 − 24 = 6 and run = 30 − 15 = 15, so rise/run = 6/15 = 2/5 = 0.40. And since the horizontal intercept of the line is 18, its equation is $B = 18 + 0.40T$. Under this plan, the fixed monthly fee is \$18 and the charge per minute is the slope of the billing line, 0.40, or 40 cents per minute.

1A.3 A \$2 reduction in the monthly fixed fee would produce a downward parallel shift in the billing plan by \$2.



1A.4 With an unchanged monthly fixed fee, the vertical intercept of the new billing plan continues to be 4. The slope of the new plan is 0.10, half the slope of the original plan.



1A.5 Let the billing equation be $B = f + sT$, where f is the fixed monthly fee and s is the slope. From the first two points in the table, calculate the slope s = rise/run = 10/10 = 1.0. To calculate f, we can use the information in row 1 of the table to write the billing equation as $20 = f + 1.0(10)$ and solve for $f = 10$. So the monthly billing equation must be $B = 10 + 1.0T$. For this billing equation, the fixed fee is \$10 per month, the calling charge is \$1 per minute, and the total bill for a month with 1 hour of long-distance calls is $B = 10 + 1.0(60) = \$70$.

1A.6 Subtracting the Plan 2 equation from the Plan 1 equation yields the equation

$$0 = -90 + 0.09T \qquad \text{(Plan 1 – Plan 2)},$$

which solves for $T = 1{,}000$. So if you average more than 1,000 minutes of long-distance calls each month, you'll do better on Plan 2.