CHAPTER 2

Specialization and Exchange

LEARNING OBJECTIVES

LO 2.1 Construct a production possibilities graph and describe what causes shifts in production possibilities curves.

LO 2.2 Define absolute and comparative advantage.

LO 2.3 Define specialization and explain why people specialize.

LO 2.4 Explain how the gains from trade follow from comparative advantage.

The Origins of a T-Shirt

How can we get the most out of available resources? It's one of the most basic economic questions. Factory managers ask it when looking for ways to increase production. National leaders ask it as they design economic policy. Activists ask it when they look for ways to reduce poverty or conserve the environment. And, in a different way, it's a question we all ask ourselves when thinking about what to do in life and how to make sure that we're taking full advantage of our talents.

To get a handle on this question, we start by thinking about resources at the highest level: the logic of international trade and the specialization of production between countries. By the end of the chapter, we hope that you'll see how the same ideas apply to decisions on any scale, right down to whether it makes more sense to fix your own computer or pay a specialist to do it for you.

We'll start with what seems to be a simple question: Where did your T-shirt come from? Look at the tag. We're betting it was made in a place you've never been to and maybe never thought of visiting. China? Malaysia? Honduras? Sri Lanka? Bangladesh?

That "made in" label only tells part of the story. Chances are that your shirt's history spans other parts of the globe. Consider a standard T-shirt. The cotton might have been grown in Mali and then shipped to Pakistan, where it was spun into yarn. The yarn might have been sent to China, where it was woven into cloth, cut into pieces, and assembled into a shirt. That shirt might then have travelled all the way to Canada, where it was shipped to a store near you. A couple of years from now, when you are cleaning out your closet, you may donate the shirt to a charity, which may ship it to a secondhand clothing vendor in Mali—right back where your shirt's travels began.

Of course, this is not only the story of shirts. It is remarkably similar to the story of shoes, computers, and cars, among many other manufactured goods. Today, the products and services most of us take for granted come to us through an incredibly complex global network of farms, mines, factories, traders, and stores. Why is the production of even a simple T-shirt spread across the world? Why is the cotton grown in Mali and the sewing done in China, rather than vice versa? Why isn't the whole shirt made in Canada, so that it doesn't have to travel so far to reach you?

This chapter addresses fundamental economic questions about who produces which goods and why. The fact that millions of people and firms around the globe coordinate their activities to provide consumers with the right combination of goods and services seems like magic. This feat of coordination doesn't happen by chance, and no superplanner tells everyone where to go and what to do. Instead, the global production chain is a natural outcome of people everywhere acting in their own self-interest to improve their own lives. Economists call this coordination mechanism the *invisible hand,* an idea that was first suggested by the eighteenth-century economic thinker Adam Smith.

To get some insight into the *who* and *why* of production, consider how the story of shirts has changed over the last few centuries. For most of the 1900s, North Americans wore shirts made in North America. Today, however, most shirts are made in China, Bangladesh, and other countries where factory wages are low. Have North American workers become worse at making shirts over the last two centuries? Definitely not. In fact, as we'll see in this chapter, it doesn't even mean that Chinese workers are better than North American workers at making shirts. Instead, each good tends to be produced by the country, company, or person with the lowest opportunity cost for producing that good.

Countries and firms *specialize* in making goods for which they have the lowest opportunity cost, and they trade with one another to get the combination of goods they want to consume. The resulting *gains from trade* can be split up so that everyone ends up better off. It's no surprise, then, that as transportation and communication between countries have improved, trade has taken off.

The concepts in this chapter apply not just to the wealth of nations and international trade. They also illuminate the daily choices most people face. Who should cook which dishes at Thanksgiving dinner? Should you hire a plumber or fix the pipes yourself? Should you become a rock star or an economist? The concepts these questions raise can be subtle and are sometimes misunderstood. We hope this chapter will provide insights that will help you become a better resource manager in all areas of your life.

David Malan/Getty Images

Production Possibilities

In Chapter 1 we talked about models. Good models help us understand complex situations through simplifying assumptions that allow us to zero in on the important aspects. The story of why China now produces shirts for Canadians that Canadians themselves were producing a hundred years ago is a complex one, as you'd expect. But by simplifying it into a model we can reach useful insights.

Let's assume Canada and China produce only two things—shirts and bushels of wheat. (In reality, of course, they produce many things, but we're trying not to get bogged down in details right now.) The model uses wheat to stand in for "stuff other than shirts," allowing us to focus on what we're really interested in—shirts.

Using this model we'll perform a thought experiment about production using a tool called the *production possibilities frontier.* This tool is used in other contexts, as well, many of which have no connection to international trade. Here we use it to show what has changed over the last couple of centuries to explain why Canadians now buy shirts from China.

Drawing the Production Possibilities Frontier

LO 2.1 Construct a production possibilities graph and describe what causes shifts in production possibilities curves.

Let's step back in time to Canada in 1900. In our simple model, there are two million Canadian workers, and they have two choices of where to work: shirt factories or wheat farms. In shirt factories, each worker produces one shirt per day. On wheat farms, each worker produces two bushels of wheat per day.

What would happen if everyone worked on a wheat farm? Canada would produce 4 million bushels of wheat per day (2 bushels of wheat per worker × 2 million workers). This is one "production possibility." We represent it by point A in panel A of Figure 2-1. Alternatively, what would happen if everyone went to work in a shirt factory? Canada would produce 2 million shirts per day (1 shirt per worker × 2 million workers). This production possibility is represented by point E in Figure 2-1.

Of course, Canada wouldn't want just shirts or just wheat—and there is no reason that all workers have to produce the same thing. There are many different combinations of shirts and wheat that Canadian workers could produce, as panel B of Figure 2-1 shows. For example, if one quarter of the workers go to the shirt factory, they can make 500,000 shirts (1 shirt per worker × 500,000 workers) and the remaining workers can produce 3 million bushels of wheat (2 bushels per worker × 1.5 million workers). This production possibility is represented by point B in panel B. Or maybe 1 million workers make shirts (1 million shirts) and 1 million grow wheat (2 million bushels). That's point C.

We can continue splitting the workforce between shirts and wheat in different ways, each of which can be plotted as a point on the graph in Figure 2-1. If we fill in enough points, we create the solid green line shown in Figure 2-2. This is the **production possibilities frontier (PPF)**. It is a line or curve that shows all the possible combinations of outputs that can be produced using all available

FIGURE 2-1

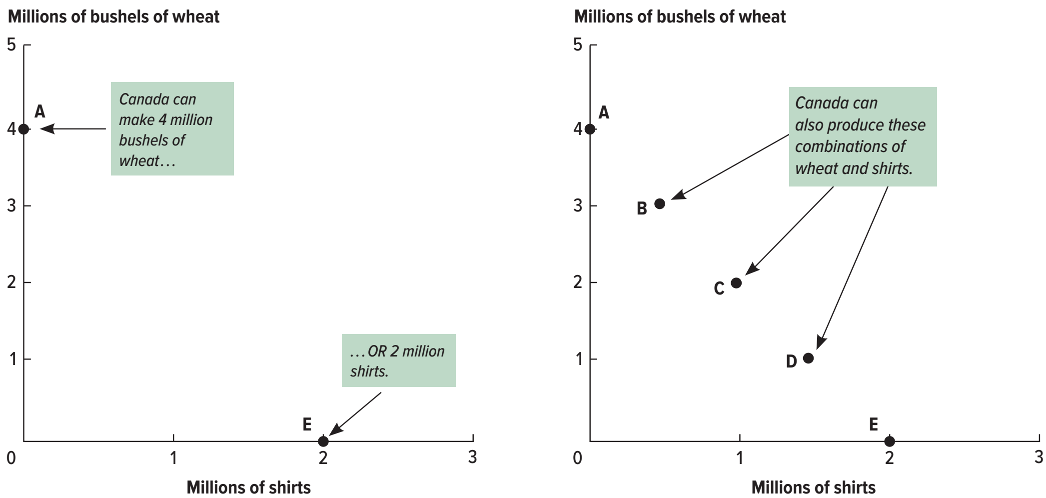
Possible Production Combinations

(A) Producing one good

Production possibilities	Bushels of wheat (millions)	Shirts (millions)
A	4	0
E	0	2

(B) Producing both goods

Production possibilities	Bushels of wheat (millions)	Shirts (millions)
B	3	0.5
C	2	1.0
D	1	1.5



Canada can produce the maximum number of shirts or the maximum amount of wheat by devoting all its resources to one good or the other.

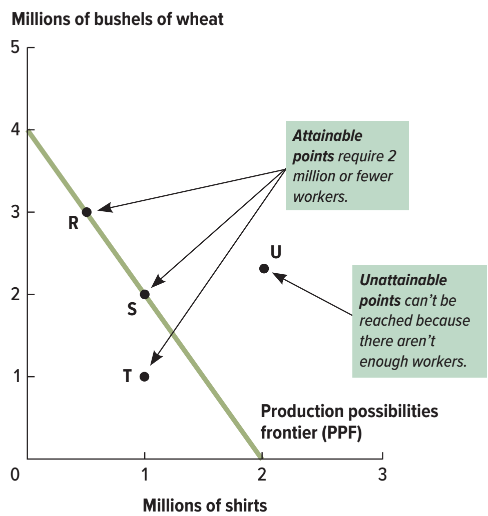
By allocating some resources to the production of each good, Canada can also produce many different combinations of wheat and shirts.

resources. In this case, the frontier plots all combinations of shirts and wheat that can be produced using all available workers in Canada. Points inside the frontier (such as point T) are achievable, but don't make full use of all available resources.

The production possibilities frontier helps us answer the first of the economists' questions that we discussed in Chapter 1: *What are the wants and constraints of those involved?* People in Canada want to consume shirts and wheat (and other things, of course; remember, we're simplifying). The production possibilities frontier gives us a way to represent the *constraints* on production. Canada cannot produce combinations of shirts and wheat that lie outside the frontier—such as point U in Figure 2-2. There just aren't enough workers or hours in the day to produce at point U, no matter how they are allocated between shirts and wheat.

The production possibilities frontier also addresses the second economists' question: *What are the trade-offs?* Each worker can make *either* one shirt *or* two bushels of wheat per day. In other words, there is a trade-off between the quantity of wheat produced and the quantity of shirts produced. If we want an

FIGURE 2-2
Production Possibilities Frontier



Points on or below the production possibilities frontier, such as R, S, and T, represent combinations of goods that the Canada can produce with available resources. Points outside the frontier, such as U, are unattainable because there aren't enough resources.

extra shirt, one worker has to stop growing wheat for a day. Therefore, the opportunity cost of one shirt is two bushels of wheat. Growing another bushel of wheat takes one worker half a day, so the opportunity cost of a bushel of wheat is half a shirt. This opportunity cost is represented graphically by the slope of the production possibilities frontier. Moving up the frontier means getting more wheat at the cost of fewer shirts. Moving down the frontier means less wheat and more shirts. Looking at Figure 2-2, you'll notice that the slope of the line is −2. This is the same as saying that the opportunity cost of one shirt is always two bushels of wheat.

Let's start off with all workers growing wheat and nobody making shirts. If we reallocate the workers who are best at making shirts, we can get a lot of shirts without giving up too much wheat. In other words, the opportunity cost of making the first few shirts is very low. Now imagine almost all the workers are making shirts, so that only the very best farmers are left growing wheat. If we reallocate most of the remaining workers to shirt making, we give up a lot of wheat to get only a few extra shirts. The opportunity cost of getting those last few shirts is very high.

> For a refresher on calculating and interpreting slopes, see Appendix A, Math Essentials: Understanding Graphs and Slope, which follows this chapter.

We can add a little more nuance to the model, to include land and machinery as resources also needed for production. We would find that the same pattern holds: the opportunity cost of producing an additional unit of a good typically increases as more of each resource is allocated to it. For instance, growing more wheat probably requires reallocating not only workers but farmland. Making more shirts means setting up new factories and buying more sewing machines.

Once again, let's start with everyone growing wheat. With wheat production pushed to the maximum, some farmers probably have to work on land that isn't well suited to growing wheat. It could be that the land is swampy or the soil has been over-farmed and depleted of nutrients. When farmers who had been working on this poor land switch over to making shirts, the economy will lose only a little wheat and gain many shirts in return. In contrast, if only a small amount of wheat is being grown using only the best, most fertile land, reallocating the last few farmers will cause a relatively large decrease in wheat production for each additional shirt.

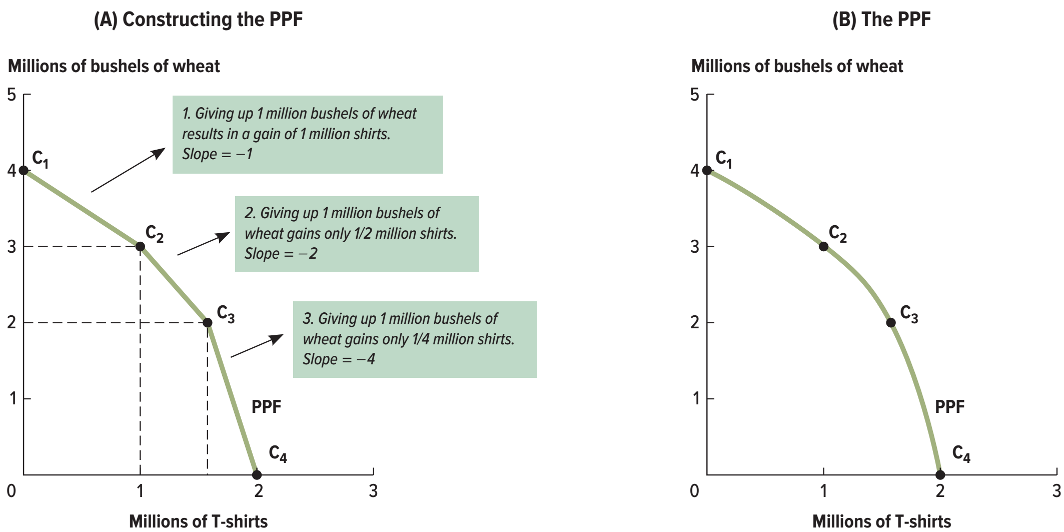
Returning to the simplest model, where workers are the only input to production, we can translate this increasing opportunity cost into the production possibilities frontier. Doing so, we get a curve that bows out (a convex curve) instead of a straight line, as shown in Figure 2-3. Panel A shows what happens if we have just three types of workers:

- For every bushel of wheat, some can make one shirt; they're the ones between points C_1 and C_2.
- For every bushel of wheat, some can make only $\frac{1}{2}$ of a shirt (between points C_2 and C_3).
- For every bushel of wheat, some can make only $\frac{1}{4}$ of a shirt (between points C_3 and C_4).

In other words, as we go down the curve, we move from those who are better at making shirts to those who are better at growing wheat. As we do so, the opportunity cost of making shirts versus growing

FIGURE 2-3

Bowed-Out (Concave) Production Possibilities Frontier



At point C_1, all workers produce wheat, and switching the best sewers to making shirts will result in a big gain in the quantity of shirts. As more and better farmers switch to making shirts, however, the gain in shirts produced decreases relative to the loss in the quantity of wheat. As a result the slope of the PPF is steeper from C_2 to C_3, and again from C_3 to C_4.

In reality, each worker has slightly different skills and therefore a slightly different opportunity cost of making shirts in terms of wheat. As a result, we get a smoothly curved production possibilities frontier.

wheat increases, and the slope of the curve gets steeper (−1 between C_1 and C_2, −2 between C_2 and C_3, and −4 between C_3 and C_4).

In reality there aren't just three types of workers—each worker will have slightly different skills. The many possibilities will result in a curve that looks smooth, as in panel B of Figure 2-3. At each point of the curved production possibilities frontier, the slope represents the opportunity cost of getting more wheat or more shirts, based on the skills of the next worker who could switch.

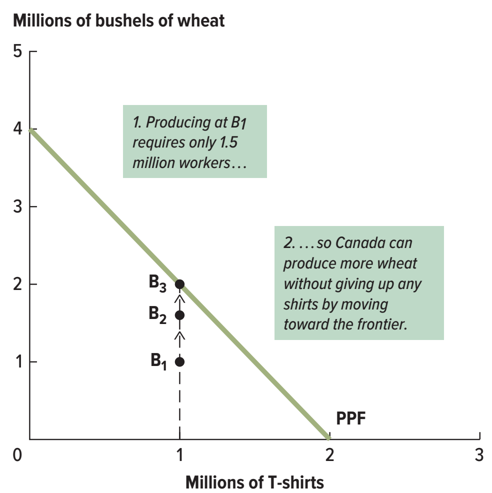
Choosing Among Production Possibilities

What can the production possibilities frontier tell us about what combination of goods an economy will choose to produce? Earlier, we noted that economies can produce at points inside the frontier as well as points on it. However, choosing a production point inside the frontier means a country could get more wheat, more shirts, or both, just by using all available workers. For instance, in Figure 2-4, Canada can get more wheat without giving up any shirts, by moving from point B_1 to point B_2. It can do the same by moving from point B_2 to B_3. But once at the frontier, it will have to give up some of one good to get more of the other. Points like B_3 that lie *on* the frontier are called **efficient points**, because they squeeze the most output possible from all available resources. Points *within* (inside) the frontier are *inefficient* because they do not use all available resources.

In the real world, economies aren't always efficient. A variety of problems can cause some workers to be unemployed or other resources to be left idle. We'll return to these issues in detail in future chapters.

FIGURE 2-4

Choosing an Efficient Production Combination



Canada needs only 1.5 million workers to reach point B_1. If the country employs more workers, it can reach point B_2 and get more wheat without giving up any shirts. The country can keep employing more workers until it reaches point B_3 (or any other point on the frontier) and there are no more workers left. Once the frontier is reached, getting more of one good requires giving up some of the other.

FIGURE 2-5

Choosing Between Efficient Combinations

At all points on the production possibilities frontier, Canada employs the entire workforce. Because the country uses all its resources fully at each point, choosing between points on the frontier is a matter of preference when there is no trade with other countries. Canada may choose to produce more wheat and fewer shirts (point F) or more shirts and less wheat (point F_2), depending on what its consumers want.

For now, we'll assume that production is always efficient. People and firms usually try to squeeze as much production as they can out of the resources available to them, so efficiency is a reasonable starting assumption.

Based on the assumption of efficiency, we can predict that an economy will choose to produce at a point on the frontier rather than inside it. What the production possibilities frontier cannot tell us is *which* point on the frontier that will be. Will it be F_1 in Figure 2-5, for example? Or will Canada choose to move down the curve to F_2, producing more shirts at the expense of less wheat? We can't say whether point F_1 or F_2 is better without knowing more about the situation. If the Canadian economy is completely self-sufficient, the decision depends on what combination of shirts and wheat people in Canada want to consume. If trade with other countries is possible, it also depends on consumers and production possibilities in those countries, as we'll see later in the chapter.

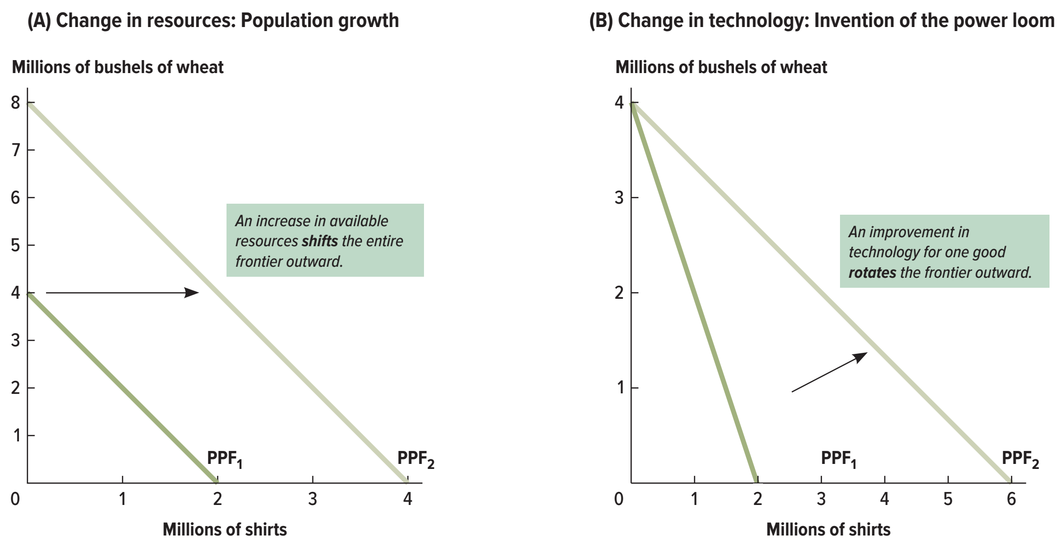
Shifting the Production Possibilities Frontier

Thus far, we've built a simple model that tells us what combinations of T-shirts and wheat Canada could produce in 1900. However, a lot of things have changed since 1900, including an incredible explosion in productive capacity. The production possibilities frontier is a useful tool for illustrating this change and understanding how it affects the constraints and trade-offs the country faces. Two main factors drive the change in Canadian production possibilities.

First, there are more workers. The Canadian population now is much larger than it was in 1900. Having more workers means more people available to produce shirts and wheat. Graphically, we can represent

FIGURE 2-6

Shifting the Production Possibilities Frontier



Production possibilities expand when resources increase. If the working population grows, the country can make more of everything by producing at the same rate as before. This causes the frontier to shift outward. If the population doubled, so would the maximum possible quantities of shirts and wheat.

Production possibilities expand when technology improves. If the textile industry adopts the power loom, workers can make more shirts in the same amount of time. This causes the frontier to rotate outward. The rate of wheat production remains constant while the rate of shirt production increases, so the slope of the frontier changes.

this change by shifting the entire frontier outward. Panel A of Figure 2-6 shows what happens to the frontier when the Canadian population doubles, with each worker still able to produce one shirt or two bushels of wheat per day.

However, the real magic of expanded productive capacity lies in the incredible technological advances that have taken place over the last couple of centuries. For example, in the early nineteenth century, the power loom enabled workers to weave much more cotton fabric every day than they could before.

We can model this change in technology through the production possibilities frontier by changing the rate of shirt production from one to three shirts per day, as shown in panel B of Figure 2-6. As the rate of shirt production increases while the rate of wheat production remains the same, the shape of the curve changes. In this case, it pivots outward along the *x*-axis, because for any given number of workers assigned to shirt-making, more shirts are produced than before. At every point except one (where all workers are growing wheat), the country can produce more with the same number of workers, thanks to improved technology.

> For a refresher about shifts and pivots in graphs, see Appendix B, Math Essentials: Working with Linear Equations, which follows Chapter 3.

✓ **CONCEPT CHECK**

- ☐ Could a person or country ever produce a combination of goods that lies outside the production possibilities frontier? Why or why not? [LO 2.1]
- ☐ Would an increase in productivity as a result of a new technology shift a production possibilities frontier inward or outward? [LO 2.1]

Absolute and Comparative Advantage

In the mid-nineteenth century, armed with power looms, pre-Confederation Canada started mass producing clothing. Since then, the Canadian population has grown larger and manufacturing technology has improved even more. So why is 30 percent of the world's clothing exports currently made in China while there are very few clothing factories in Canada?

Up to now, we have worked with a very simple model of production to highlight the key trade-offs faced by individual producers. If there is no trade between countries, Canada can consume only those goods that it produces on its own. In the real world, however, goods are made all over the world. If Canadians want to buy more shirts than are made in Canada, they can get them from somewhere else. Under these conditions, how can we predict which countries will produce which goods?

Understanding how resources are allocated among multiple producers is a step toward understanding why big firms work with specialized suppliers and why a wealthy, productive country like Canada trades with much poorer, less-productive countries. In this section we will see that trade actually increases total production, which can benefit everyone involved. To see why, let's turn to the question of why most T-shirts sold in Canada today are made in China.

Absolute Advantage

LO 2.2 Define absolute and comparative advantage.

Suppose that taking into account all the improvements in shirt-making and wheat-growing technology over the last two centuries, a Canadian worker can now make 50 shirts or grow 200 bushels of wheat per day. A Chinese worker, on the other hand, can produce only 25 shirts (perhaps because Canadian workers use faster cloth-cutting technology) or 50 bushels of wheat (maybe because Canadian farmers use fertilizers and pesticides that farmers in China don't). In other words, given the same number of workers, Canada can produce twice as many shirts or four times as much wheat as China.

If a producer can generate more output than others with a given amount of resources, that producer has an **absolute advantage**. In our simplified model, Canada has an absolute advantage over China at producing both shirts and wheat because it can make more of both products than China can per worker.

Comparative Advantage

Absolute advantage is not the end of the story, though. If it were, Canada would still be producing lots of shirts. The problem is that for every T-shirt Canada produces, it uses resources that could otherwise be spent growing wheat. Of course, the same could be said of China. But in our model of T-shirt and wheat production, the opportunity cost of making one shirt in Canada is four bushels of wheat (200 bushels ÷ 50 shirts = 4 bushels per shirt); the opportunity cost of making one shirt in China is only two bushels of wheat (50 bushels ÷ 25 shirts = 2 bushels per shirt). Canada has to give up more to make a shirt than China does.

When a producer can make a good at a lower opportunity cost than other producers, we say it has a **comparative advantage** at producing that good. In our model, China has a comparative advantage over Canada at shirt-making, because its opportunity cost of producing a shirt is only two bushels of wheat compared to four bushels of wheat for Canada.

Canada, on the other hand, has a comparative advantage over China at growing wheat. Each time Canada produces a bushel of wheat, it gives up the opportunity to produce one-quarter of a shirt (50 shirts ÷ 200 bushels = $\frac{1}{4}$ shirt per bushel). For China, however, the opportunity cost of growing a bushel of wheat is larger: it's one-half of a shirt (25 shirts ÷ 50 bushels = $\frac{1}{2}$ shirt per bushel). Canada has a lower opportunity cost for producing wheat than China ($\frac{1}{4}$ shirt is less than $\frac{1}{2}$ shirt), and therefore we say it has a comparative advantage at wheat production.

A country can have a comparative advantage without having an absolute advantage. In our scenario, Canada has an absolute advantage over China at producing both shirts and wheat. But it has a bigger advantage at producing wheat than at making shirts: it can make four times as much wheat per worker as China (200 versus 50 bushels) but only twice as many shirts per worker (50 versus 25). It's better at both—but it's "more better," so to speak, at producing wheat. (We know that "more better" is not good grammar, but it nicely expresses the idea.) China has a comparative advantage at the good it is "less worse" at producing, shirts, even without an absolute advantage.

You may have noticed that for each country, the opportunity cost of growing wheat is the *inverse* of the opportunity cost of producing shirts. (For Canada, $\frac{1}{4}$ is the inverse of 4; for China, $\frac{1}{2}$ is the inverse of 2.) Mathematically, this means that it is impossible for one country to have a comparative advantage at producing both goods. Each producer's opportunity cost depends on its *relative* ability to produce different goods. Logic tells us that you can't be better at A than at B and also better at B than at A. (And mathematically, if X is bigger than Y, then $\frac{1}{X}$ will be smaller than $\frac{1}{Y}$.) Canada can't be better at producing wheat than shirts relative to China and at the same time be better at producing shirts than wheat relative to China. As a result, no producer has a comparative advantage at everything, and each producer has a comparative advantage at something.

We can check this international trade scenario against an example closer to home. When your family makes Thanksgiving dinner, does the best cook make everything? If you have a small family, maybe one person can make the whole dinner. But if your family is anything like our families, you will need several cooks. Grandma is by far the most experienced cook, yet the potato peeling always gets outsourced to the kids. Is that because the grandchildren are better potato peelers than Grandma? We think that's probably not the case. Grandma has an absolute advantage at everything having to do with Thanksgiving dinner. Still, the kids may have a *comparative* advantage at potato peeling, which frees up Grandma to make those tricky pie crusts.

We can find applications of comparative advantage everywhere in life. Sports is no exception; look at the From Another Angle box, The Story of Multi-talented Athletes, for another example.

FROM ANOTHER ANGLE

The Story of Multi-talented Athletes

Two of the most famous multi-talented athletes in Canadian sports history are Harvey Pulford and Lionel Conacher. They both won national championships in Canadian football, hockey, boxing, and lacrosse, and Conacher's name appears in the halls of fame of four different sports. Each could easily have become one of the best football players or boxers or lacrosse players of his generation, but both ended up as hockey players. From a practical point of view, they could not play multiple sports professionally for a long time, so they had to make a choice. Although both had an *absolute* advantage at multiple sports, they had a *comparative* advantage as hockey players. So they took up hockey where they truly became stars. Pulford helped Ottawa to win four Stanley Cups and Conacher led more than one team to a Stanley Cup victory.

Two current examples would be Colorado Avalanche forward Jarome Ignila and Dallas Stars forward Jamie Benn. Both Benn and Ignila were also very talented baseball players. Ignila was a starting catcher on the Canadian National Junior Baseball Team and Benn was the MVP of the provincial AAA champion baseball team, the Victoria Capitals. But their comparative advantages as hockey players (and of course the income, too) made them to choose hockey over baseball.

✓ CONCEPT CHECK

- ☐ What does it mean to have an absolute advantage at producing a good? [LO 2.2]
- ☐ What does it mean to have a comparative advantage at producing a good? [LO 2.2]
- ☐ Can more than one producer have an absolute advantage at producing the same good? Why or why not? [LO 2.2]

Why Trade?

Canada is perfectly capable of producing its own shirts and its own wheat. In fact, in our simple model it has an absolute advantage at producing both goods. So, why buy shirts from China? We are about to see that both countries are actually able to consume more when they specialize in producing the good for which they have a comparative advantage and then trade with each other.

Specialization

LO 2.3 Define specialization and explain why people specialize.

If you lived 200 years ago, your everyday life would have been full of tasks that probably never even cross your mind today. You might have milked a cow, hauled water from a well, split wood, cured meat, mended a hole in a sock, and repaired a roof. Contrast that with life today. Almost everything we use comes from someone who specializes in providing a particular good or service. We bet you don't churn the butter you put on your toast and that you wouldn't even begin to know how to construct your computer. We are guessing you don't usually sew your own clothes or grow your own wheat. In today's world, all of us are dependent on one another for the things we need on a daily basis.

In our model, when Canada and China work in isolation, each produces some shirts and some wheat, each in the combinations that its consumers prefer. Suppose Canada has 30 million workers and China has 100 million. As before, each Canadian worker can make 50 shirts or 200 bushels of wheat, and each Chinese worker can make 25 shirts or 50 bushels of wheat. Suppose that, based on Canadian consumers' preferences, Canadian workers are split so that they produce 0.75 billion shirts and 3 billion bushels of wheat. In China workers are also split into groups producing the two goods—Chinese workers are producing 1.25 billion shirts and 2.5 billion bushels of wheat. Even though China's productivity per worker is lower, it has more workers and so is able to produce a larger total quantity of goods. (The quantities of shirts and wheat are unrealistically large, because we are assuming they are the only goods being produced. In reality, of course, countries produce many different goods, but this simplifying assumption helps us to zero in on a real-world truth.)

If each country focuses on producing the good for which it has a comparative advantage, total production increases. Focusing in this way is called **specialization**, the practice of spending all of your resources producing a particular good. When each country specializes in making a particular good according to its comparative advantage, total production possibilities are greater than if each produced the exact combination of goods its own consumers want.

We have seen that if Canada and China are self-sufficient (each producing what its people want to consume), then together the two countries can make 2 billion T-shirts and 5.5 billion bushels of wheat, as shown at the top of Table 2-1 (without specialization). What would happen if, instead, China put all its resources into making shirts and Canada put all its resources into growing wheat? The bottom section of Table 2-1 (with specialization) shows us:

Canada

$$200 \text{ bushels per worker} \times 30 \text{ million workers} = 6 \text{ billion bushels}$$

China

$$25 \text{ shirts per worker} \times 100 \text{ million workers} = 2.5 \text{ billion shirts}$$

TABLE 2-1 PRODUCTION WITH AND WITHOUT SPECIALIZATION

When China and Canada each specialize in the production of one good, the two countries can produce an extra 0.5 billion T-shirts using the same number of workers and the same technology.

	Country	Wheat (billions of bushels)	T-shirts (billions)
	Canada	3	0.75
Without specialization	China	2.5	1.25
	Total	**5.5**	**2**
	Canada	6	0
With specialization	China	0	2.5
	Total	**6**	**2.5**

By specializing, the two countries together can produce more wheat than before, *plus* 0.5 billion more shirts. Specialization increases total production, using the same number of workers and the same technology.

This rule applies to all sorts of goods and services. It explains why dentists hire roofers to fix a roof leak and why roofers hire dentists to fill a cavity. See the Real Life box, Specialization Sauce, for an example of the power of specialization in a setting you probably know well—McDonald's.

REAL LIFE

Specialization Sauce

Henry Ford pioneered the assembly-line method of automobile manufacturing, in which each worker does just one small task on each car before it moves down the line to the next worker, who does a different small task. Ford proved that he could build more cars in less time when each employee specialized in this way. Restaurants use the same principle: they can serve more customers faster if they split the work among managers, waitstaff, and chefs. Fast-food restaurants take specialization even further.

Fast food as we know it was born in 1948, when McDonald's founders Dick and Mac McDonald decided to implement a radically new method of preparing food. Inspired by factory assembly lines, they applied Ford's concept of specialization to the restaurant business. Instead of assigning several employees to general food preparation, they split each order into parts, parcelling out the steps required to prepare a meal. One employee became the grilling specialist, another added mustard and ketchup. A different employee operated the potato fryer, and yet another mixed the milkshakes.

Any single employee would almost certainly have been able to learn how to grill a hamburger, add condiments, make fries, *and* mix a milkshake. In each restaurant, one particularly skilled employee was probably faster than everyone else at all the steps in making a meal. Even so, specialization was more efficient. By assigning only one specific task to each employee, the McDonald's founders revolutionized the speed and quantity of food preparation. Harnessing the power of specialization allowed them to grill more burgers, fry more potatoes, and feed more hungry customers.

Gains from Trade

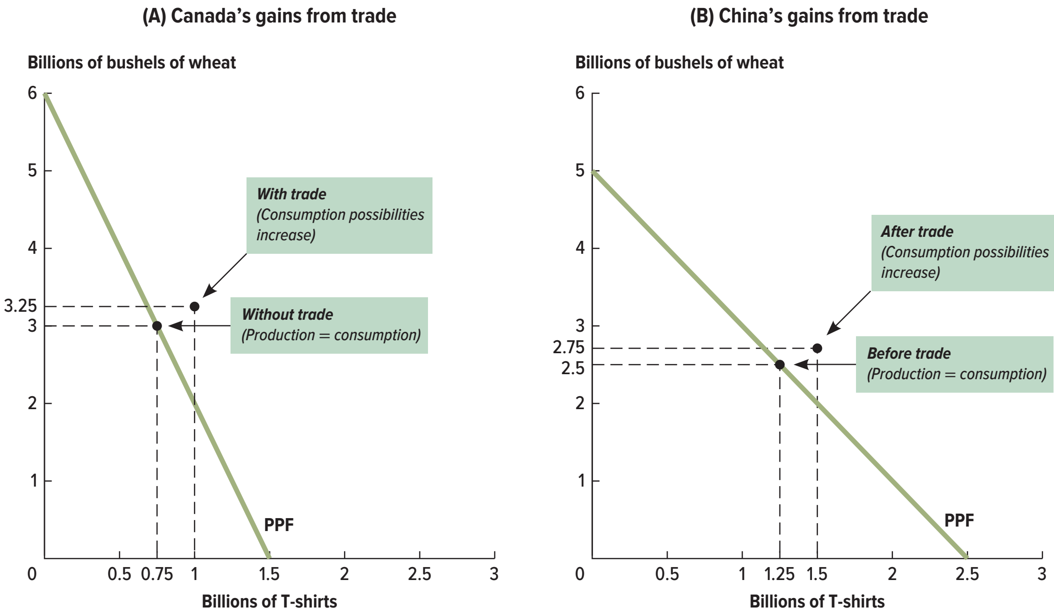
LO 2.4 Explain how the gains from trade follow from comparative advantage.

When countries specialize in producing the goods for which they have a comparative advantage, total production increases. The problem with specialization is that each producer ends up with only one good—in our model, wheat in Canada, shirts in China. If Canadians don't want to go naked and the Chinese don't want to starve, they must trade.

Suppose China completely specializes in T-shirts and Canada in wheat. Then China and Canada agree to trade 2.75 billion bushels of wheat for 1 billion T-shirts. As a result, each country ends up with 0.25 billion more bushels of wheat than before, plus 0.25 billion more shirts. This improvement in outcomes that occurs when specialized producers exchange goods and services is called the **gains from trade**.

FIGURE 2-7

Specialization and Gains from Trade



If a country does not specialize and trade, its production and consumption are both limited to points along its production possibilities frontier. By specializing and achieving gains from trading Canada gains 0.25 billion bushels of wheat and 0.25 billion T-shirts.

By specializing and achieving gains from trading China gains 0.25 billion bushels of wheat and 0.25 billion T-shirts.

Figure 2-7 shows the gains from trade through increased consumption. Before the trade, it was impossible for Canada and China to consume any combination of goods outside their production possibilities frontiers. After the trade between the two specialized producers, each country's consumption increases to a point that was previously unachievable.

In reality, the distribution can vary; there are other possible trading arrangements to benefit everyone.

Overall, there is room for trade as long as the two countries differ in their opportunity costs to produce a good and they set a trading price that falls between those opportunity costs. In our example, the price at which China and Canada are willing to trade T-shirts (2.75 bushels per shirt) must fall between China's opportunity cost of producing T-shirts (which is 2) and Canada's opportunity cost of producing T-shirts (which is 4). If China is the country that has specialized in T-shirts, it cannot charge a price greater than Canada's opportunity cost (4 bushels per shirt). If it does, Canada will simply make the T-shirts itself. Conversely, China must receive a price that covers its opportunity cost for making T-shirts (2 bushels per shirt) or it will not be willing to trade.

Consider the *wants* that drive people to engage in exchanges. When people specialize and trade, everyone gets more of the things they want than they would if they were self-sufficient. Thus, trade can be driven entirely by self-interest. Just as Canada benefits from trading with China, an experienced worker or large firm benefits from trading with a less experienced employee or a small, specialized company.

For example, when Bill Gates was the CEO of Microsoft, he probably got IT assistants to fix bugs on his computer, even though he could have done it faster himself. Let's say Bill could fix the bug in an hour, but for every hour he was distracted from running Microsoft, the company's profits went down by $1,000. The IT assistant earns only $50 an hour, so even if he takes two to three times as long to do the work, it was still worth it for Bill to hire him and spend his own time keeping Microsoft's productivity up. Bill had an absolute advantage at fixing computer bugs, but the opportunity cost in lost profits means the IT assistant had a comparative advantage. (Bill's comparative advantage was at running Microsoft.) Everyone ends up better off if they specialize.

In spite of the gains from specializing and trading, not everyone considers this an obvious choice in every circumstance—which brings us to our fourth question from Chapter 1: *Why isn't everyone already doing it?* Some people argue that it's worth giving up the gains from trade for various reasons. For some examples, see the What Do You Think? box, Is Self-Sufficiency a Virtue?

WHAT DO YOU THINK?

Is Self-Sufficiency a Virtue?

Why should Canada trade with other countries? If every other country in the world were to disappear tomorrow, Canada would probably manage to fend for itself. It has plenty of fertile land, natural resources, people, and manufacturing capacity.

Based on what you now know about specialization and the gains from trade, what do you think about the value of exchange versus the value of self-sufficiency? Economists tend to line up in favour of free international trade; they argue that trade makes both countries economically better off. Serious and worthwhile arguments have also been made on the other side. The following are some reasons that have been proposed for developing national self-sufficiency.

- **National heritage.** Many people feel that a line has been crossed when a country loses its family farms or outsources a historically important industry—for example, automaking in the United States. Does a country lose its culture when it loses these industries?
- **Security.** Some people worry that trade weakens a country if it goes to war with a country that it depends on for essential goods. Is it safe to rely on other countries for your food supply, or does that kind of dependency pose a security risk? What about relying on another country for steel or uranium or oil?
- **Quality control and ethics.** When goods are made in other countries, production standards are harder to control than if the goods are made at home. Some people argue that international trade undermines consumer safety and environmental regulations, or that it fosters labour conditions that would be considered unethical or illegal in Canada.

What do you think?

1. Do you agree with any of these objections to free trade? Why? When is self-sufficiency more valuable than the gains from trade?
2. Is the choice between trade and self-sufficiency an either/or question? Is there a middle-of-the-road approach that would address concerns on both sides of this issue?

Comparative Advantage Over Time

Our simplified model of production possibilities and trade helps us to understand why Canadians now buy shirts from China. But we noted at the beginning of the chapter that this wasn't always the case—a hundred years ago, Canada was producing its own shirts. To understand why this changed, we can apply our model to shifts in comparative advantage over time. These shifts have caused significant changes in different countries' economies and trade patterns.

When the Industrial Revolution began, Great Britain led the world in clothing manufacturing. In the nineteenth century, the United States snatched the comparative advantage through a combination of new technology (which led to higher productivity) and cheap labour (which led to lower production costs). Gradually, the comparative advantage in making clothing shifted away from the United States to other countries. By the 1930s, 40 percent of the world's cotton goods were made in Japan, where workers from the countryside were willing to work long hours for low wages. In the mid-1970s, clothing manufacturing moved to Hong Kong, Taiwan, and Korea, where wages were even lower than in Japan. The textile industry then moved to China in the early 1990s, when millions of young women left their farms to work for wages as much as 90 percent lower than those in Hong Kong. There's an upside to the progressive relocation of this industry and its jobs: eventually high-wage jobs replaced low-wage jobs, and these countries experienced considerable economic growth.

Losing a comparative advantage in clothing production sounds like a bad thing at first. But as we know from our model, you can't lose comparative advantage in one thing without gaining it in another. Changes in clothing manufacturing were driven by by the fact that workers in each country were becoming more skilled in industries that paid better than making clothes—such as making cars, or programming computers, or providing financial services. This meant the opportunity cost of making clothes increased, and the comparative advantage in clothing production shifted to countries where the workers lacked skills in better-paying industries and so were willing to work in textile factories for lower wages.

Most historians would agree that it wasn't a sign of failure when countries lost their comparative advantage in clothing production—it was a sign of success. The same was true for the Canadian economy when the great Canadian fur trade started to decline in the 1920s. It was a sign of progress. This was also the time when the number of automobiles exported from Canada started to increase. Like former textile producers Great Britain, the United States, Japan, Korea, and Hong Kong, Canada is much wealthier now than when it was at the centre of the fur trade.

However, these changes probably didn't look or feel like success at the time, especially for workers in textile factories who saw their jobs disappearing overseas. This same controversy is unfolding today in other industries as companies outsource tasks that can be done more cheaply in other countries. The Real Life box, Comparative Advantage: Call Centres, considers whether a country's loss of comparative advantage at producing a particular good is something to worry about.

REAL LIFE

Comparative Advantage: Call Centres

You may have noticed that when you call the customer service line for many large companies, you are likely to end up speaking with someone in India or the Philippines. Thirty years ago, that was not the case—call centres for Canadian customers were almost all located in Canada.

Canada has not become worse at running call centres. In fact, it may still have an absolute advantage at it. But there is a lower opportunity cost for India to provide the service. Canada can use its factors of production better by producing other products and services.

✓ **CONCEPT CHECK**

- ☐ Why do people or countries specialize? [LO 2.3]
- ☐ How do two countries benefit from trading with each other? [LO 2.4]
- ☐ Is it possible to not have a comparative advantage at anything? Why or why not? [LO 2.4]

Conclusion

Specialization and trade can make everyone better off. It is not surprising, then, that in an economy driven by individuals seeking to make a profit or to make the biggest difference in their communities, people specialize so as to exploit their comparative advantages. The principle is as true for countries such Canada and China as it is for individuals picking their careers.

No government intervention is required to coordinate production. The great economic thinker Adam Smith suggested the term *invisible hand* to describe this coordinating mechanism:

> It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their [self-interest]... he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. (A. Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations,* 1776.)

The functioning of the invisible hand depends on a lot of other assumptions, such as free competition, full information, and many others that do not always hold true in the real world. Later in the book we will discuss these assumptions, and when they work and when they do not.

Most people take for granted the prevalence of specialization and trade in their everyday lives. Few stop to think about the benefits and where they come from. In this chapter we tried to dig down to the bottom of the assumptions people make and expose the logic behind the gains from trade. As we proceed—especially when we return to topics like international trade and government intervention in the markets—try to remember the underlying incentive that drives people to interact with one another in economic exchanges.

Key Terms

production possibilities frontier (PPF)
efficient points
absolute advantage
comparative advantage
specialization
gains from trade

Summary

LO 2.1 Construct a production possibilities graph, and describe what causes shifts in production possibilities curves.

A production possibilities graph shows all the combinations of two goods that a person or an economy can produce with a given amount of time, resources, and technology. The production possibilities frontier is a line on that graph that shows all the maximum attainable combinations of goods. Producers of goods and services are not likely to choose a combination of goods inside the production possibilities frontier, because they could achieve a higher production level with the same amount of resources. And they cannot choose points outside the frontier, which would require more than the available resources. The choice between combinations on the production possibilities frontier is a matter of preference.

Shifts in the production possibilities frontier can be caused by changes in technology, as well as changes in population and other resources. Increases in technological capabilities and population will shift the PPF outward, while decreases in these factors will shift the PPF inward.

LO 2.2 Define absolute and comparative advantage.

Producers have an absolute advantage at making a good when they can produce more output than others with a given amount of resources. If you put two people or countries to work making the same good, the person or country that is more productive has an absolute advantage.

People or countries have a comparative advantage when they are better at producing one good than they are at producing other goods, relative to other producers. Everyone has a comparative advantage at something, whether or not they have an absolute advantage at anything.

LO 2.3 Define specialization and explain why people specialize.

Specialization means spending all or much of your time producing a particular good. Production is highest when people or countries specialize in producing the good for which they have a comparative advantage. Specialization increases total production but uses the same number of workers and the same technology.

LO 2.4 Explain how the gains from trade follow from comparative advantage.

The increase in total production that occurs from specialization and exchange is called the *gains from trade*. With specialization and trade, two parties can increase production and consumption, and each ends up better off. Shifts in comparative advantage over time have caused significant changes in different countries' economies and trade patterns. These changes generally signal economic success, although they can be painful for the individual workers and industries involved.

Review Questions

1. You've been put in charge of a bake sale for a local charity, at which you are planning to sell cookies and cupcakes. What would a production possibilities graph of this situation show? [LO 2.1]

2. You manage two employees at a pet salon. Your employees perform two tasks, giving flea baths and grooming animals. If you constructed a single production possibilities frontier for flea baths and grooming that combined both of your employees, would you expect the production possibilities frontier to be linear (a straight line)? Explain why or why not. [LO 2.1]
3. Back at the bake sale (see review question 1), suppose another volunteer is going to help you bake. What would it mean for one of you to have an absolute advantage at baking cookies or cupcakes? Could one of you have an absolute advantage at baking both items? [LO 2.2]
4. What would it mean for you or the other volunteer to have a comparative advantage at baking cookies or cupcakes? Could one of you have a comparative advantage at baking both items? [LO 2.2]
5. Suppose you have a comparative advantage at baking cookies, and the other volunteer has a comparative advantage at baking cupcakes. Make a proposal to the other volunteer about how to split up the baking. Explain how you can both gain from specializing, and why. [LO 2.3]
6. At the flower shop where you manage two employees, your employees perform two tasks, caring for the displays of cut flowers and making flower arrangements to fill customer orders. Explain how you would approach organizing your employees and assigning them tasks. [LO 2.3]
7. Suppose two countries produce the same two goods and have identical production possibilities frontiers. Do you expect these countries to trade? Explain why or why not. [LO 2.4]
8. Brazil is the largest coffee producer in the world, and coffee is one of Brazil's major export goods. Suppose that twenty years from now Brazil no longer produces much coffee and imports most of its coffee instead. Explain why Brazil might change its trade pattern over time. [LO 2.4]

Problems and Applications

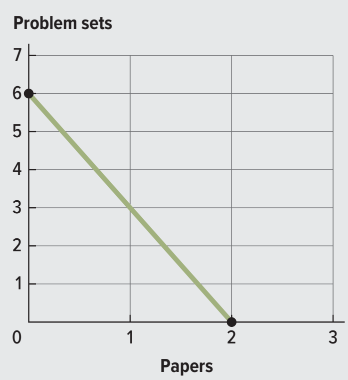
1. Your friend Sam has been asked to prepare appetizers for a university reception. She has an unlimited amount of ingredients but only six hours to prepare them. Sam can make 300 mini-sandwiches or 150 servings of melon slices topped with smoked salmon and a dab of sauce per hour. [LO 2.1]
   a. Draw Sam's production possibilities frontier.
   b. Now suppose that the university decides to postpone the reception until after the big game, and Sam has an extra four hours to prepare. Redraw her production possibilities frontier to show the impact of this increase in resources.
   c. In addition to the extra time to prepare, suppose Sam's friend Chris helps by preparing the melon slices. Sam can now make 300 mini-sandwiches or 300 melon appetizers per hour. Redraw Sam's production possibilities frontier to show the impact of increased productivity in making melon appetizers.
2. Your friend Sam has been asked to prepare appetizers for a university reception. She has an unlimited amount of ingredients and six hours in which to prepare them. Sam can make

300 mini-sandwiches or 150 servings of melon slices topped with smoked salmon and a dab of sauce per hour. [LO 2.1]

a. What is Sam's opportunity cost of making one mini-sandwich?
b. What is Sam's opportunity cost of making one melon appetizer?
c. Suppose the reception has been postponed, and Sam has an extra four hours to prepare. What is the opportunity cost of making one mini-sandwich now?
d. Suppose the reception has been postponed, and Sam has an extra four hours to prepare. What is the opportunity cost of making one melon appetizer now?
e. Suppose Sam's friend Chris helps by preparing the melon slices, increasing Sam's productivity to 300 mini-sandwiches or 300 melon appetizers per hour. What is the opportunity cost of making one mini-sandwich now?
f. Suppose Sam's friend Chris helps by preparing the melon slices, increasing Sam's productivity to 300 mini-sandwiches or 300 melon appetizers per hour. What is the opportunity cost of making one melon appetizer now?

3. Suppose that Canada produces two goods: lumber and fish. It has 18 million workers, each of whom can cut 10 metres of lumber or catch 20 fish each day. [LO 2.1]
   a. What is the maximum amount of lumber Canada could produce in a day?
   b. What is the maximum amount of fish it could produce in a day?
   c. Write an equation describing the production possibilities frontier, in the form described in section 2.1 (Figure 2-1 and Figure 2-2).
   d. Use your equation to determine how many fish can be caught if 60 million metres of lumber are cut.
4. The graph in Figure 2P-1 shows Tanya's weekly production possibilities frontier for doing homework (writing papers and doing problem sets). [LO 2.1]

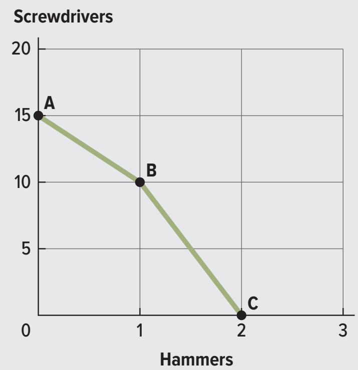
FIGURE 2P-1



   a. What is the slope of the production possibilities frontier?
   b. What is the opportunity cost of doing one problem set?
   c. What is the opportunity cost of writing one paper?

5. Use the production possibilities frontier in Figure 2P-2 to answer the following questions. [LO 2.1]
   a. What is the slope of the PPF between point A and point B?
   b. What is the slope of the PPF between point B and point C?
   c. Is the opportunity cost of producing hammers higher between points A and B or between points B and C?
   d. Is the opportunity cost of producing screwdrivers higher between points A and B or between points B and C?

FIGURE 2P-2



6. For each point on the PPF in Figure 2P-3, note whether the point is: [LO 2.1]
   - Attainable and efficient
   - Attainable and inefficient
   - Unattainable

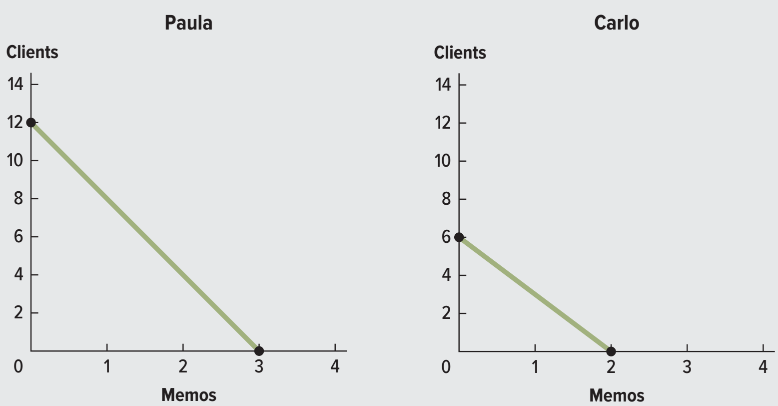
FIGURE 2P-3

7. For each point on the PPF in Figure 2P-4, note whether the point is: [LO 2.1]
   - Attainable and efficient
   - Attainable and inefficient
   - Unattainable

FIGURE 2P-4

8. Suppose that three volunteers are preparing cookies and cupcakes for a bake sale. Diana can make 27 cookies or 18 cupcakes per hour; Andy can make 25 cookies or 17 cupcakes; and Sam can make 10 cookies or 12 cupcakes. [LO 2.2]
   a. Who has the absolute advantage at making cookies?
   b. At making cupcakes?
9. Paula and Carlo are co-workers. Their production possibilities frontiers for counselling clients and writing memos are given in Figure 2P-5. [LO 2.2]

FIGURE 2P-5



   a. Which worker has an absolute advantage in counselling clients?
   b. Which worker has an absolute advantage in writing memos?
   c. Which worker has a comparative advantage in counselling clients?
   d. Which worker has a comparative advantage in writing memos?

10. Two students are assigned to work together on a project that requires both a written and an oral presentation. Steve can write 1 page or prepare 3 minutes of a presentation each day. Anna can write 2 pages or prepare 1 minute of a presentation each day. [LO 2.2]
    a. Who has a comparative advantage at writing?
    b. Suppose that Steve goes to a writing tutor and learns some tricks that enable him to write 3 pages each day. Now who has a comparative advantage at writing?
11. Suppose that the manager of a restaurant has two new employees, Rahul and Henriette, and is trying to decide which one to assign to which task. Rahul can chop 20 kilograms of vegetables or wash 100 dishes per hour. Henriette can chop 30 kilograms of vegetables or wash 120 dishes. [LO 2.3]
    a. Who should be assigned to chop vegetables?
    b. Who should be assigned to wash dishes?
12. The Dominican Republic and Nicaragua both produce coffee and rum. The Dominican Republic can produce 20 thousand tonnes of coffee per year or 10 thousand barrels of rum. Nicaragua can produce 30 thousand tonnes of coffee per year or 5 thousand barrels of rum. [LO 2.3]
    a. Suppose the Dominican Republic and Nicaragua sign a trade agreement in which each country would specialize in the production of either coffee or rum. Which country should specialize in coffee? Which country should specialize in producing rum?
    b. What are the minimum and maximum prices at which these countries will trade coffee?
13. Eleanor and her little sister Joanna are responsible for two chores on their family's farm, gathering eggs and collecting milk. Eleanor can gather 9 dozen eggs or collect 3 litres of milk per week. Joanna can gather 2 dozen eggs or collect 2 litres of milk per week. [LO 2.3]
    a. The family wants 2 litres of milk per week and as many eggs as the sisters can gather. Currently, Eleanor and Joanna collect one litre of milk each and as many eggs as they can. How many dozen eggs does the family have per week?
    b. If the sisters specialized, which sister should gather the milk?
    c. If the sisters specialized, how many dozen eggs would the family have per week?
14. Suppose Russia and Sweden each produce only paper and cars. Russia can produce 8 tonnes of paper or 4 million cars each year. Sweden can produce 25 tonnes of paper or 5 million cars each year. [LO 2.4]
    a. Draw the production possibilities frontier for each country.
    b. Both countries want 2 million cars each year and as much paper as they can produce along with 2 million cars. Find this point on each production possibilities frontier and label it A.
    c. Suppose the countries specialize. Which country will produce cars?
    d. Once they specialize, suppose they work out a trade of 2 million cars for 6 tonnes of paper. Find the new *consumption* point for each country and label it B.
15. Maya and Max are neighbours. Both grow lettuce and tomatoes in their gardens. Maya can grow 45 heads of lettuce or 9 kilograms of tomatoes this summer. Max can grow 42 heads of lettuce or 6 kilos of tomatoes this summer. If Maya and Max specialize and trade, the price of tomatoes (in terms of lettuce) would be as follows: 1 kilo of tomatoes would cost between _____ and _____ kilos of lettuce. [LO 2.4]

APPENDIX A

Math Essentials: Understanding Graphs and Slope

LEARNING OBJECTIVES

LO A.1 Create four quadrants using *x*- and *y*-axes and plot points on a graph.

LO A.2 Use data to calculate slope.

LO A.3 Interpret the steepness and direction of slope, and explain what that says about a line.

Creating a Graph

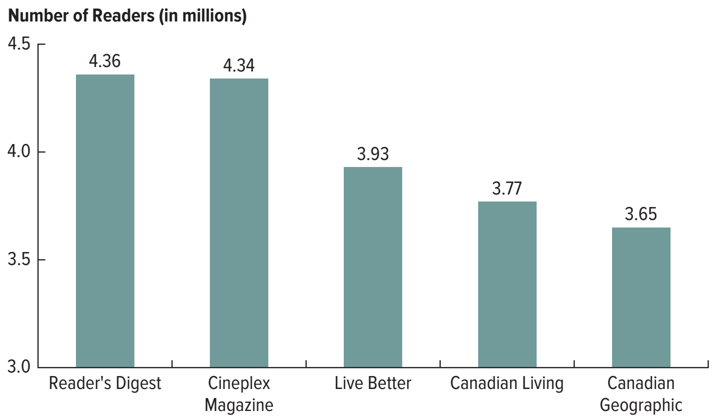
LO A.1 Create four quadrants using *x*- and *y*-axes and plot points on a graph.

A graph is one way to visually represent data. In this book, we use graphs to describe and interpret economic relationships. For example, we use a graph called a production possibilities frontier to explore opportunity costs and trade-offs in production. We graph average, variable, and marginal costs to explore production decisions facing a firm. And—the favourite of economists everywhere—we use graphs to show supply and demand, and the resulting relationship between price and quantity.

Graphs of One Variable

Graphs of a single variable come in three main forms: the bar chart, the pie chart, and the line graph. In school you've probably made all three and plastered them on science-fair posters and presentations or used them in reports. These graphs are versatile; they can be used to present all sorts of information. Throughout economics, and in this book, you'll come across these graphs frequently.

FIGURE A-1
Top Five Paid Magazines in 2014 by Circulation



As you can see, *Reader's Digest* had the highest circulation.

Probably the most common single-variable graph is the *bar graph,* an example of which is shown in Figure A-1. The bar graph shows the size or frequency of a variable using bars—hence the name. The size of the bar on the *y*-axis shows the value of the variable, while the *x*-axis contains the categories of the variables. In Figure A-1, for example, the bar graph shows the number of readers for English-language magazines in Canada in 2014. Since the bars stand next to each other, a bar graph makes it clear exactly where each magazine stands in comparison with the others. As you can see, the bar was largest for *Reader's Digest* and was much higher than the one for *Canadian Geographic*.

In general, bar graphs are versatile. You can show the distribution of letter grades in a class or the average monthly high and low temperatures in your city. Any time the size of a variable is important, you are generally going to want to use a bar graph.

Pie charts are often used to show how much of certain components make up a whole. Pie charts are usually a circle, cut into wedges that represent how much each makes up of the whole.

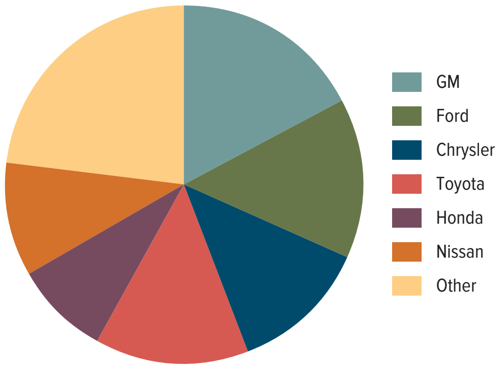
Figure A-2 shows the market share of the six of the largest car manufacturers (Toyota, GM, Ford, etc.) with all other manufacturers labelled as Other. The large wedges representing General Motors, Ford, and Toyota show that these are large automakers.

The most common use of pie charts is for budgeting. You'll often see government and business income and expenses broken down in a pie chart. Also, come election time, you'll see pie charts pop up all over the news media, representing the percentage of support in an election that each candidate receives.

The third main type of single-variable graph is called a *line* (or *time-series*) *graph.* This type of graph is helpful when you are trying to emphasize the trend of a single variable. In economics, the most common use for line graphs is to show the value of a variable over time. Inflation rates, GDP, and government debt over decades are all prime candidates for presentation on a line graph.

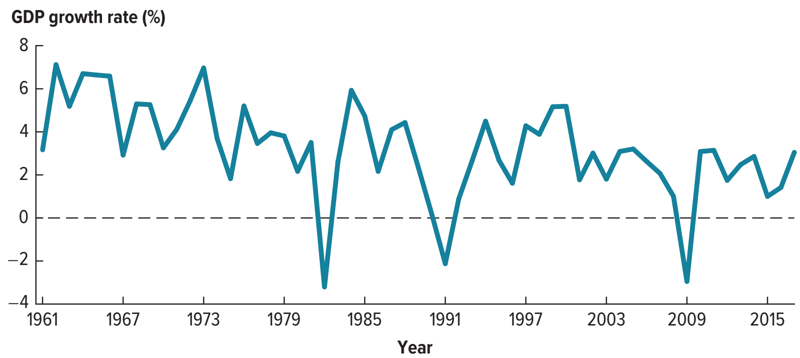
Figure A-3 shows the GDP growth rate in Mexico since 1961 on a time-series graph. Presenting the data this way makes it clear that Mexican GDP growth rate had strong GDP growth (anything above 4 percent growth is very good) during the 1960s and 70s, but GDP growth was lower after that.

FIGURE A-2
Automaker Market Share



This pie chart shows the relative market share of each automaker. The size of the wedge demonstrates the share of each automaker. General Motors has a large wedge, while Mercedes-Benz has a much smaller share of the market.

FIGURE A-3
GDP Growth in Mexico



A line graph commonly shows a variable over a range of time. This allows the trend in the variable to be clear. In this case, you can see that GDP growth in Mexico has been highly variable, but overall, GDP growth was higher on average before 1980.

Ultimately, single-variable graphs can take us only so far. In order to get at some of the most fundamental issues of economics, we need to be able to plot the values of two variables (such as price and quantity) simultaneously.

Graphs of Two Variables

In order to present two or more variables on a graph, we are going to need something called the *Cartesian coordinate system.* With only two dimensions, this graphing system consists of two axes: the *x* (horizontal) axis and the *y* (vertical) axis. We can give these axes other names, depending on what economic variables we want to represent, such as price and quantity or inputs and outputs.

In some cases it doesn't matter which variable we put on each axis. At other times, logic or convention will determine the axes. There are two common conventions in economics that it will be useful for you to remember:

1. **Price on the *y*-axis, quantity on the *x*-axis:** When we graph the relationship between price and quantity in economics, price is always on the *y*-axis and quantity is always on the *x*-axis.
2. **The *x*-axis "causes" the *y*-axis:** In general, when the values of one variable are dependent on the values of the other variable, we put the dependent variable on the *y*-axis and the independent variable on the *x*-axis. For example, if we were exploring the relationship between test scores and the number of hours a student spends studying, we would place hours on the *x*-axis and test scores on the *y*-axis, because hours spent studying generally affects scores rather than vice versa. Sometimes, though, the opposite is true. In economics, we often say that price (always the *y*-axis variable) causes the quantity demanded of a good (the *x*-axis variable).

The point where the two axes intersect is called the *origin.* Points to the right of the origin have *x*-coordinates with positive values, whereas points to the left of the origin have *x*-coordinates with negative values. Similarly, points above the origin have *y*-coordinates with positive values, and points below the origin have *y*-coordinates with negative values.

To specify a particular point, indicate the *x*- and *y*-coordinates in an ordered pair. Indicate the *x*-coordinate first and then the *y*-coordinate: (*x, y*). The intersection of the two axes creates four quadrants, as shown in Figure A-4.

Quadrant I: (*x,y*) The *x*- and *y*-coordinates are both positive.

Quadrant II: (−*x,y*) The *x*-coordinate is negative and the *y*-coordinate is positive.

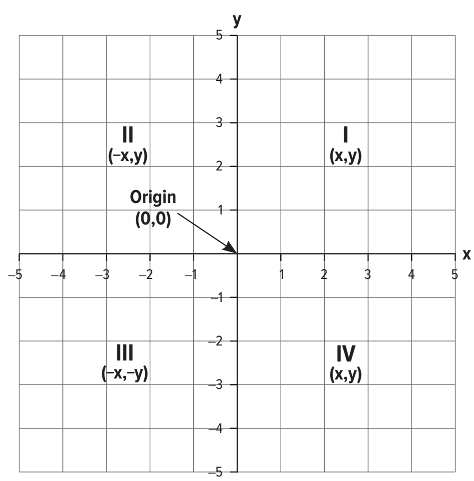
Quadrant III: (−*x,*−*y*) The *x*- and *y*-coordinates are both negative.

Quadrant IV: (*x,*−*y*) The *x*-coordinate is positive and the *y*-coordinate is negative.

Origin: **(0,0)** The *x*- and *y*-coordinates are both zero at the origin.

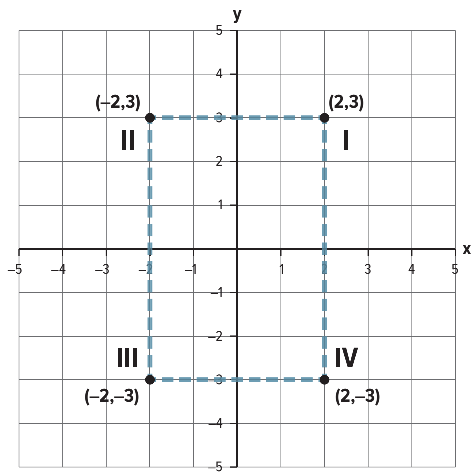
FIGURE A-4

The Four Quadrants



The Cartesian coordinate system is a way to plot values of two variables simultaneously. Different quadrants reflect whether the values of *x* and *y* are positive or negative.

FIGURE A-5
Plotting Points on a Graph



Each set of ordered pairs corresponds to a place on the Cartesian coordinate system.

Figure A-5 shows the following points plotted on a graph.

Quadrant I: (2,3)

Quadrant II: (−2,3)

Quadrant III: (−2,−3)

Quadrant IV: (2,−3)

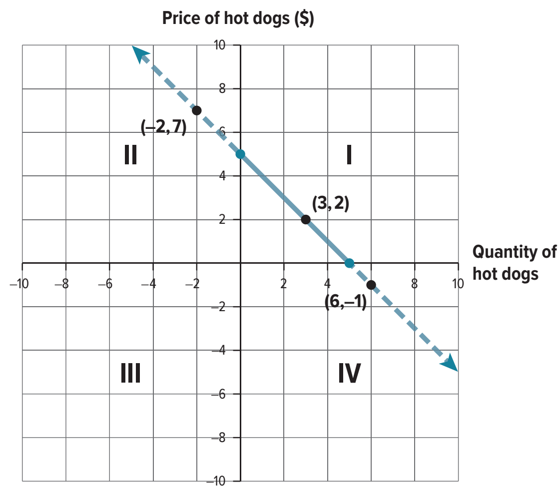
In economics, we often isolate quadrant I when graphing. This is because there are many economic variables for which negative values do not make sense. For example, one important graph we use in economics shows the relationship between the price of a good and the quantity of that good demanded or supplied. Since it doesn't make sense to consider negative prices and quantities, we show only quadrant I when graphing supply and demand.

Figure A-6 shows a line in quadrant I that represents the relationship between the price of hot dogs at the ballpark and the quantity of hot dogs a family wants to buy. Price is on the *y*-axis, and the quantity of hot dogs the family demands is on the *x*-axis. For instance, one coordinate pair on this line is (3,2), meaning that if the price of hot dogs is $2, the family will want to buy three of them.

We could extend this demand curve in ways that make sense graphically but that don't represent logical price–quantity combinations in the real world. For instance, if we extend the demand curve into quadrant II, we have points such as (−2,7). If we extend the demand curve into quadrant IV, we have points such as (6,−1). However, it doesn't make sense to talk about someone demanding negative two hot dogs, nor does it make sense to think about a price of negative $1.

Remember that we are not just graphing arbitrary points; we are illustrating a real relationship between variables that has meaning in the real world. Both (−2,7) and (6,−1) are points that are consistent with

FIGURE A-6
Thinking About the Logic Behind Graphs



Plotting points in the four quadrants on a graph gives a line.

the equation for this demand curve, but neither point makes sense to include in our analysis. To graph this price–quantity relationship, we would limit our graph to quadrant I.

However, some variables you will study (such as revenue) may have negative values that make sense. When this is the case, graphs will show multiple quadrants.

Slope

Both the table and the graph in Figure A-7 represent a particular relationship between two variables, x and y. For every x there is a corresponding y. When we plot the points in the table we see that there is a consistent relationship between the value of x and the value of y. In this case, we can see at a glance that whenever the x value increases by 1, the y value increases by 0.5. We can describe this relationship as the *slope* of the line.

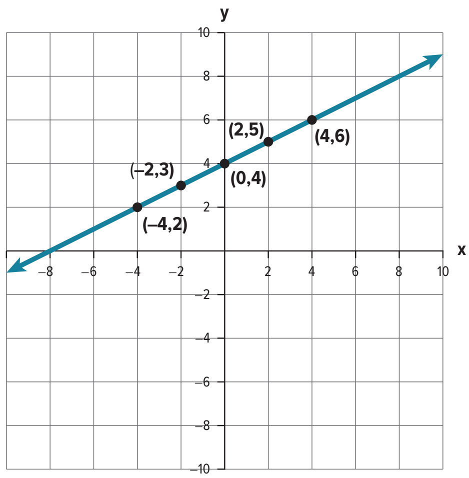
Slope is a ratio of vertical distance (change in y) to horizontal distance (change in x). We begin to calculate slope by labelling one point along the line point 1, which we denote (x_1,y_1), and another point along the line point 2, which we denote (x_2,y_2). We can then calculate the horizontal distance by subtracting x_1 from x_2. We calculate vertical distance by subtracting y_1 from y_2.

$$\text{Horizontal distance} = \Delta x = (x_2 - x_1)$$

$$\text{Vertical distance} = \Delta y = (y_2 - y_1)$$

FIGURE A-7
The Slope of a Line

X	Y
–4	2
–2	3
0	4
2	5
4	6



Slope refers to the shape of the line and is determined by the change in *y* and *x*.

The vertical distance is referred to as the **rise**, while the horizontal distance is known as the **run**. *Rise over run* is an easy way to remember how to calculate slope. (Note that the delta symbol, Δ, simply means *change in*.)

$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

When the relationship between *x* and *y* is linear (which means that it forms a straight line), the slope is constant. That is, for each one-unit change in the *x*-variable, the corresponding *y*-variable always changes by the same amount. Therefore, we can use any two points to calculate the slope of the line—it doesn't matter which ones we pick because the slope is the same everywhere on the line.

Slope gives us important information about the relationship between our two variables. As we are about to discuss, slope tells us something about both the direction of the relationship between two variables (whether they move in the same direction) and the magnitude of the relationship (how much *y* changes in response to a change in *x*).

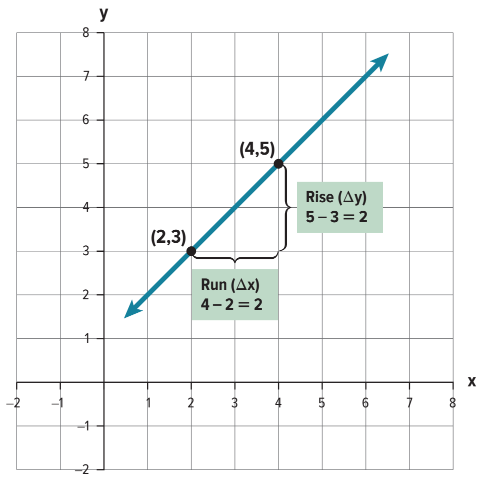
Calculating Slope

LO A.2 Use data to calculate slope.

In Figure A-8, the run or horizontal distance between point (2,3) and point (4,5) is 4 minus 2, which equals 2. The rise or vertical distance is 5 minus 3, which equals 2. Therefore, the slope of the line in Figure A-8 is calculated as

$$\text{Slope} = \frac{(y_2 - y_1)}{(x_2 - x_1)} = \frac{(5 - 3)}{(4 - 2)} = \frac{2}{2} = 1$$

FIGURE A-8
Calculating Slope



You can calculate the slope by dividing the change in the *y* value by the change in *x*—the rise over the run.

Let's return to Figure A-7 and apply this same calculation. Because the relationship between *x* and *y* is linear, we can use any two points to calculate the slope. Let's designate point (2,5) as point 1, which we call (x_1,y_1), and point (4,6) as point 2, which we call (x_2,y_2).

$$\frac{(y_2 - y_1)}{(x_2 - x_1)} = \frac{(6 - 5)}{(4 - 2)} = \frac{1}{2} = 0.5$$

Note that it doesn't matter which point we pick as point 1 and which as point 2. We could have chosen 5 as y_2 and 6 as y_1 rather than vice versa. All that matters is that y_1 is from the same ordered pair as x_1 and y_2 is from the same pair as x_2. To prove that this is true, let's calculate slope again using (2,5) as point 2. The slope is still 0.5:

$$\frac{(y_2 - y_1)}{(x_2 - x_1)} = \frac{(5 - 6)}{(2 - 4)} = \frac{(-1)}{(-2)} = \frac{1}{2} = 0.5$$

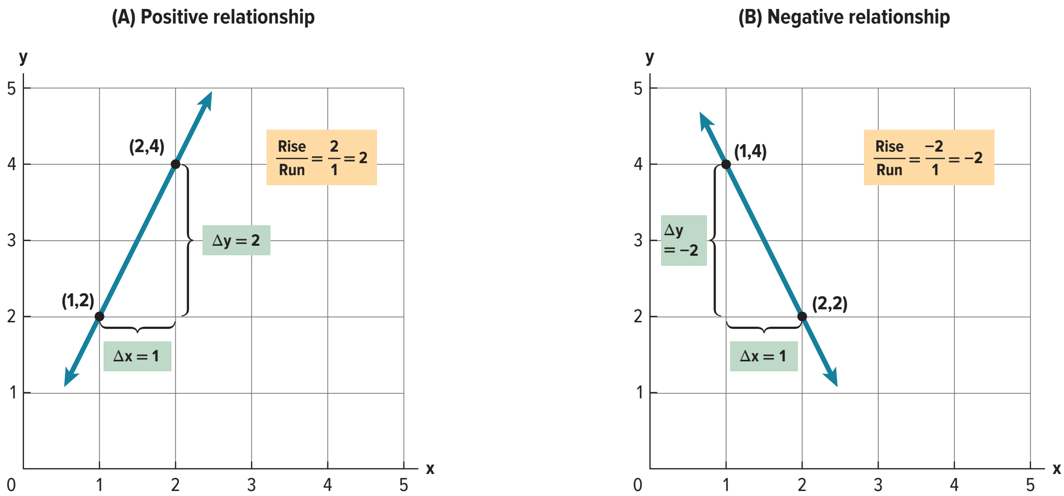
Use two different points from the table in Figure A-7 to calculate slope again. Try using the points (−4,2) and (0,4). Do you get 0.5 as your answer?

The Direction of a Slope

LO A.3 Interpret the steepness and direction of slope, and explain what that says about a line.

The direction of a slope tells us something meaningful about the relationship between the two variables we are representing. For instance, when children get older, they grow taller. If we represented this relationship in a graph, we would see an upward-sloping line, telling us that height increases as age increases,

FIGURE A-9
The Direction of a Slope



If a line slopes upward, its slope is positive; *y* increases as *x* increases, or *y* decreases as *x* decreases.

If a line slopes downward, its slope is negative: *y* decreases as *x* increases, or *y* increases as *x* decreases.

rather than decreasing. Of course, it is common knowledge that children get taller, not shorter, as they get older. But if we were looking at a graph of a relationship we did not already understand, the slope of the line would show us at a glance how the two variables relate to each other.

To see how we can learn from the direction of a slope and how to calculate it, look at the graphs in panels A and B of Figure A-9.

In panel A, we can see that when x increases from 1 to 2, y also increases, from 2 to 4. If we move the other direction down the line, we see that when x decreases from 2 to 1, y also decreases, from 4 to 2. In other words, x and y move in the same direction. Therefore, x and y are said to have a *positive relationship.* Not surprisingly, this means that the slope of the line is a positive number:

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{2}{1} = 2$$

When the slope of a line is positive, we know that y increases as x increases, and y decreases as x decreases. If a line slopes upward, then its slope is positive.

Now turn to the graph in panel B. In this case, when x increases from 1 to 2, y decreases from 4 to 2. Reading from the other direction, when x decreases from 2 to 1, y increases from 2 to 4. Therefore, x and y move in opposite directions and are said to have a *negative relationship.* The slope of the line is a negative number:

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{-2}{1} = -2$$

When the slope of a line is negative, we know that y decreases as x increases, and y increases as x decreases. If a line slopes downward, its slope is negative.

In Chapter 3, you will see applications of these positive and negative relationships between the variables price and quantity. Here's a preview:

- You will see a positive relationship between price and quantity when you encounter a *supply curve*. You will learn the meaning of that positive relationship: as the price of a good increases, suppliers are willing to supply a larger quantity to markets. Supply curves, therefore, are upward sloping.
- You will see a negative relationship between price and quantity when you encounter a *demand curve*. You will learn the meaning of that negative relationship: as the price of a good increases, consumers are willing to purchase a smaller quantity. Demand curves are downward sloping.

From these examples, you can see that two variables (such as price and quantity) may have more than one relationship with each other, depending on whose choices they represent and under what circumstances.

The Steepness of a Slope

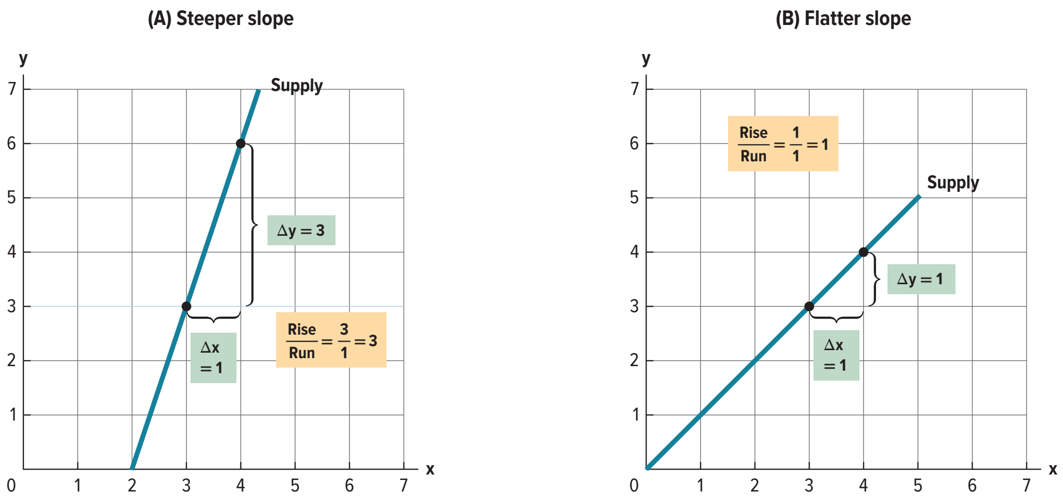
In addition to the *direction* of the relationship between variables, the *steepness* of the slope also gives us important information. It tells us how much y changes for a given change in x.

In both panels of Figure A-10 the relationship between x and y is positive (upward sloping), and the distance between the x values, Δx, is the same. However, the change in y that results from a one-unit change in x is greater in panel A than it is in panel B. In other words, the slope is *steeper* in panel A and *flatter* in panel B.

Numerically, the closer the number representing the slope is to zero, the flatter the curve will be. Remember that both positive and negative numbers can be close to zero. So a slope of -1 has the same steepness as a slope of 1, but one slopes downward and the other upward. Correspondingly, a line with a slope of -5 is steeper than a line with a slope of -1 or one with a slope of 1.

FIGURE A-10

The Steepness of a Slope



The larger the number representing slope is, the steeper the curve will be. The slope in panel A is steeper than the slope in panel B.

The closer the slope is to zero, the flatter the curve will be. The slope in panel B is flatter than the slope in panel A.

In general, slope is used to describe how much y changes in response to a one-unit change in x. In economics, we are sometimes interested in how much x changes in response to a one-unit change in y. In Chapter 4, for example, you will see how quantity (on the x-axis) responds to a change in price (on the y-axis).

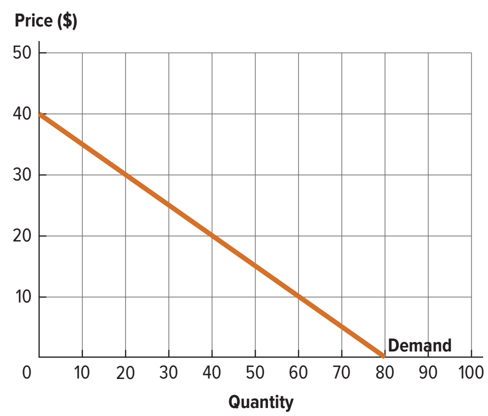
Key Terms

slope **rise** **run**

Problems and Applications

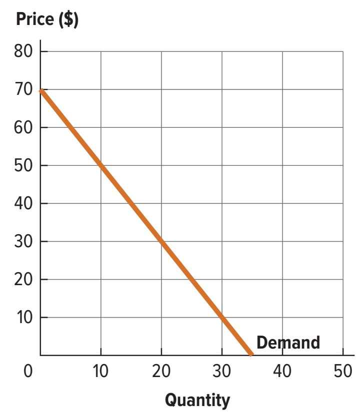
1. Create four quadrants using x- and y-axes. Use your graph to plot the following points. [LO A.1]
   a. (1,4)
   b. (−2,1)
   c. (−3,−3)
   d. (3,−2)
2. Create four quadrants using x- and y-axes. Use your graph to plot the following points. [LO A.1]
   a. (0,4)
   b. (0,−2)
   c. (1,0)
   d. (−3,0)
3. Use the curve labelled Demand in Figure AP-1 to create a table (schedule) that shows Price in one column and Quantity in another. What is the slope of the curve labelled Demand? [LO A.2]

FIGURE AP-1



4. Use the curve labelled Demand in Figure AP-2 to create a table (schedule) that shows Price in one column and Quantity in another. What is the slope of the curve labelled Demand? [LO A.2]

FIGURE AP-2



5. Use the information about price and quantity in Table AP-1 to create a graph, with Price on the *y*-axis and Quantity on the *x*-axis. Label the resulting curve Demand. What is the slope of that curve? [LO A.2]

TABLE AP-1

Price ($)	Quantity
0	120
2	100
4	80
6	60
8	40
10	20
12	0

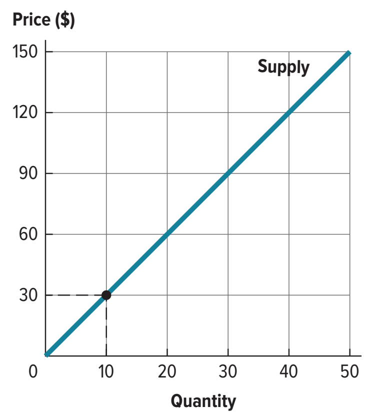
6. Use the information about price and quantity in Table AP-2 to create a graph, with Price on the *y*-axis and Quantity on the *x*-axis. Label the resulting curve Demand. What is the slope of that curve? [LO A.2]

TABLE AP-2

Price ($)	Quantity
0	5
5	4
10	3
15	2
20	1
25	0

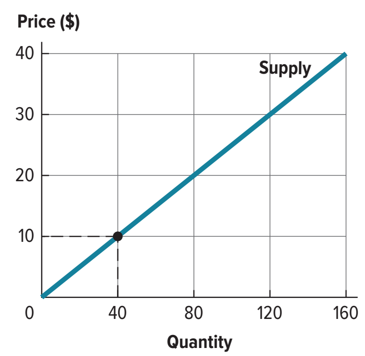
7. Use the curve labelled Supply in Figure AP-3 to create a table (schedule) that shows Price in one column and Quantity in another. What is the slope of the curve labelled Supply? [LO A.2]

FIGURE AP-3



8. Use the curve labelled Supply in Figure AP-4 to create a table (schedule) that shows Price in one column and Quantity in another. What is the slope of the curve labelled Supply? [LO A.2]

FIGURE AP-4



9. Use the information about price and quantity in Table AP-3 to create a graph, with Price on the y-axis and Quantity on the x-axis. Label the resulting curve Supply. What is the slope of that curve? [LO A.2]

TABLE AP-3

Price ($)	Quantity
0	0
25	5
50	10
75	15
100	20
125	25

10. Use the information about price and quantity in Table AP-4 to create a graph, with Price on the y-axis and Quantity on the x-axis. Label the resulting curve Supply. What is the slope of that curve? [LO A.2]

TABLE AP-4

Price ($)	Quantity
0	0
2	8
4	16
6	24
8	32
10	40
12	48

11. What is the direction of slope indicated by the following examples? [LO A.3]
    a. As the price of rice increases, consumers want less of it.
    b. As the temperature increases, the amount of people who use the town pool also increases.
    c. As farmers use more fertilizer, their output of tomatoes increases.

12. Rank the following equations by the steepness of their slope from lowest to highest. [LO A.3]
    a. $y = -3x + 9$
    b. $y = 4x + 2$
    c. $y = -0.5x + 4$