- The importance of trade-offs in economic analysis
- What the production possibilities curve model tells us about efficiency, opportunity cost, and economic growth
- The two sources of economic growth—increases in the availability of resources and improvements in technology

Module 3
The Production Possibilities Curve Model

A good economic model can be a tremendous aid to understanding. In this module, we look at the *production possibilities curve,* a model that helps economists think about the *trade-offs* every economy faces. The production possibilities curve helps us understand three important aspects of the real economy: efficiency, opportunity cost, and economic growth.

Trade-offs: The Production Possibilities Curve

The 2000 hit movie *Cast Away,* starring Tom Hanks, was an update of the classic story of Robinson Crusoe, the hero of Daniel Defoe's eighteenth-century novel. Hanks played the role of a sole survivor of a plane crash who was stranded on a remote island. As in the original story of Robinson Crusoe, the Hanks character had limited resources: the natural resources of the island, a few items he managed to salvage from the plane, and, of course, his own time and effort. With only these resources, he had to make a life. In effect, he became a one-man economy.

One of the important principles of economics we introduced in Module 1 was that resources are scarce. As a result, any economy—whether it contains one person or millions of people—faces trade-offs. You make a **trade-off** when you give up something in order to have something else. For example, if a castaway devotes more resources to catching fish, he benefits by catching more fish, but he cannot use those same resources to gather coconuts, so the trade-off is that he has fewer coconuts.

To think about the trade-offs necessary in any economy, economists often use the **production possibilities curve** model. The idea behind this model is to improve our understanding of trade-offs by considering a simplified economy that produces only two goods. This simplification enables us to show the trade-offs graphically.

Figure 3.1 shows a hypothetical production possibilities curve for Tom, a castaway alone on an island, who must make a trade-off between fish production and coconut

You make a **trade-off** when you give up something in order to have something else.

The **production possibilities curve** illustrates the trade-offs facing an economy that produces only two goods. It shows the maximum quantity of one good that can be produced for each possible quantity of the other good produced.

figure 3.1

The Production Possibilities Curve

The production possibilities curve illustrates the trade-offs facing an economy that produces two goods. It shows the maximum quantity of one good that can be produced, given the quantity of the other good produced. Here, the maximum quantity of coconuts that Tom can gather depends on the quantity of fish he catches, and vice versa. His feasible production is shown by the area *inside* or *on* the curve. Production at point *C* is feasible but not efficient. Points *A* and *B* are feasible and efficient in production, but point *D* is not feasible.

Quantity of coconuts

Feasible and efficient in production

Not feasible

Feasible but not efficient

Production possibilities curve (*PPC*)
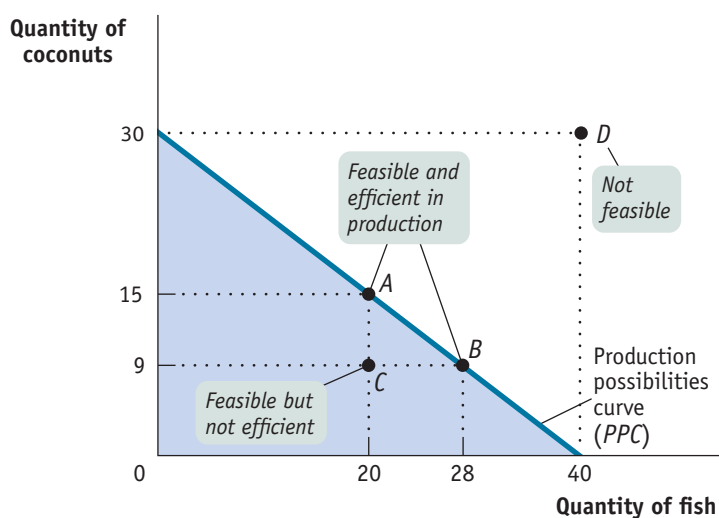
Quantity of fish

production. The curve shows the maximum quantity of fish Tom can catch during a week *given* the quantity of coconuts he gathers, and vice versa. That is, it answers questions of the form, "What is the maximum quantity of fish Tom can catch if he also gathers 9 (or 15, or 30) coconuts?"

There is a crucial distinction between points *inside* or *on* the production possibilities curve (the shaded area) and points *outside* the production possibilities curve. If a production point lies inside or on the curve—like point *C,* at which Tom catches 20 fish and gathers 9 coconuts—it is feasible. After all, the curve tells us that if Tom catches 20 fish, he could also gather a maximum of 15 coconuts, so he could certainly gather 9 coconuts. However, a production point that lies outside the curve—such as point *D,* which would have Tom catching 40 fish and gathering 30 coconuts—isn't feasible.

In Figure 3.1 the production possibilities curve intersects the horizontal axis at 40 fish. This means that if Tom devoted all his resources to catching fish, he would catch 40 fish per week but would have no resources left over to gather coconuts. The production possibilities curve intersects the vertical axis at 30 coconuts. This means that if Tom devoted all his resources to gathering coconuts, he could gather 30 coconuts per week but would have no resources left over to catch fish. Thus, if Tom wants 30 coconuts, the trade-off is that he can't have any fish.

The curve also shows less extreme trade-offs. For example, if Tom decides to catch 20 fish, he would be able to gather at most 15 coconuts; this production choice is illustrated by point *A*. If Tom decides to catch 28 fish, he could gather at most 9 coconuts, as shown by point *B*.

Thinking in terms of a production possibilities curve simplifies the complexities of reality. The real-world economy produces millions of different goods. Even a castaway on an island would produce more than two different items (for example, he would need clothing and housing as well as food). But in this model we imagine an economy that produces only two goods, because in a model with many goods, it would be much harder to study trade-offs, efficiency, and economic growth.

Efficiency

The production possibilities curve is useful for illustrating the general economic concept of efficiency. An economy is **efficient** if there are no missed opportunities—meaning that there is no way to make some people better off without making other people worse off. For example, suppose a course you are taking meets in a classroom that is

An economy is **efficient** if there is no way to make anyone better off without making at least one person worse off.

A crowded classroom reflects inefficiency if switching to a larger classroom would make some students better off without making anyone worse off.

too small for the number of students—some may be forced to sit on the floor or stand—despite the fact that a larger classroom nearby is empty during the same period. Economists would say that this is an *inefficient* use of resources because there is a way to make some people better off without making anyone worse off—after all, the larger classroom is empty. The school is not using its resources efficiently. When an economy is using all of its resources efficiently, the only way one person can be made better off is by rearranging the use of resources in such a way that the change makes someone else worse off. So in our classroom example, if all larger classrooms were already fully occupied, we could say that the school was run in an efficient way; your classmates could be made better off only by making people in the larger classroom worse off—by moving them to the room that is too small.

Returning to our castaway example, as long as Tom produces a combination of coconuts and fish that is on the production possibilities curve, his production is efficient. At point *A,* the 15 coconuts he gathers are the maximum quantity he can get *given* that he has chosen to catch 20 fish; at point *B,* the 9 coconuts he gathers are the maximum he can get *given* his choice to catch 28 fish; and so on. If an economy is producing at a point on its production possibilities curve, we say that the economy is *efficient in production*.

But suppose that for some reason Tom was at point *C,* producing 20 fish and 9 coconuts. Then this one-person economy would definitely not be efficient in production, and would therefore be *inefficient:* it is missing the opportunity to produce more of both goods.

Another example of inefficiency in production occurs when people in an economy are involuntarily unemployed: they want to work but are unable to find jobs. When that happens, the economy is not efficient in production because it could produce more output if those people were employed. The production possibilities curve shows the amount that can *possibly* be produced if all resources are fully employed. In other words, changes in unemployment move the economy closer to, or further away from, the production possibilities curve (PPC). But the curve itself is determined by what would be possible if there were full employment in the economy. Greater unemployment is represented by points farther below the PPC—the economy is not reaching its possibilities if it is not using all of its resources. Lower unemployment is represented by points closer to the PPC—as unemployment decreases, the economy moves closer to reaching its possibilities.

Although the production possibilities curve helps clarify what it means for an economy to be efficient in production, it's important to understand that efficiency in production is only *part* of what's required for the economy as a whole to be efficient. Efficiency also requires that the economy allocate its resources so that consumers are as well off as possible. If an economy does this, we say that it is *efficient in allocation*. To see why efficiency in allocation is as important as efficiency in production, notice that points *A* and *B* in Figure 3.1 both represent situations in which the economy is efficient in production, because in each case it can't produce more of one good without producing less of the other. But these two situations may not be equally desirable. Suppose that Tom prefers point *B* to point *A*—that is, he would rather consume 28 fish and 9 coconuts than 20 fish and 15 coconuts. Then point *A* is inefficient from the point of view of the economy as a whole: it's possible to make Tom better off without making anyone else worse off. (Of course, in this castaway economy there isn't anyone else; Tom is all alone.)

This example shows that efficiency for the economy as a whole requires *both* efficiency in production and efficiency in allocation. To be efficient, an economy must produce as much of each good as it can, given the production of other goods, and it must also produce the mix of goods that people want to consume.

Opportunity Cost

The production possibilities curve is also useful as a reminder that the true cost of any good is not only its price, but also everything else in addition to money that must be given up in order to get that good—the *opportunity cost*. If, for example, Tom decides to go from point *A* to point *B,* he will produce 8 more fish but 6 fewer coconuts. So the opportunity cost of those 8 fish is the 6 coconuts not gathered. Since 8 extra fish have an opportunity cost of 6 coconuts, 1 fish has an opportunity cost of $^6\!/_8 = {}^3\!/_4$ of a coconut.

Is the opportunity cost of an extra fish in terms of coconuts always the same, no matter how many fish Tom catches? In the example illustrated by Figure 3.1, the answer is yes. If Tom increases his catch from 28 to 40 fish, an increase of 12, the number of coconuts he gathers falls from 9 to zero. So his opportunity cost per additional fish is $^9\!/_{12} = {}^3\!/_4$ of a coconut, the same as it was when his catch went from 20 fish to 28. However, the fact that in this example the opportunity cost of an additional fish in terms of coconuts is always the same is a result of an assumption we've made, an assumption that's reflected in the way Figure 3.1 is drawn. Specifically, whenever we assume that the opportunity cost of an additional unit of a good doesn't change regardless of the output mix, the production possibilities curve is a straight line.

Moreover, as you might have already guessed, the slope of a straight-line production possibilities curve is equal to the opportunity cost—specifically, the opportunity cost for the good measured on the horizontal axis in terms of the good measured on the vertical axis. In Figure 3.1, the production possibilities curve has a *constant slope* of $-^3\!/_4$, implying that Tom faces a *constant opportunity cost* per fish equal to $^3\!/_4$ of a coconut. (A review of how to calculate the slope of a straight line is found in the Section I Appendix.) This is the simplest case, but the production possibilities curve model can also be used to examine situations in which opportunity costs change as the mix of output changes.

Figure 3.2 illustrates a different assumption, a case in which Tom faces *increasing opportunity cost*. Here, the more fish he catches, the more coconuts he has to give up to catch an additional fish, and vice versa. For example, to go from producing zero fish to producing 20 fish, he has to give up 5 coconuts. That is, the opportunity cost of those 20 fish is 5 coconuts. But to increase his fish production from 20 to 40—that is, to produce an additional 20 fish—he must give up 25 more coconuts, a much higher opportunity cost. As you can see in Figure 3.2, when opportunity costs are increasing rather

figure 3.2

Increasing Opportunity Cost

The bowed-out shape of the production possibilities curve reflects increasing opportunity cost. In this example, to produce the first 20 fish, Tom must give up 5 coconuts. But to produce an additional 20 fish, he must give up 25 more coconuts.
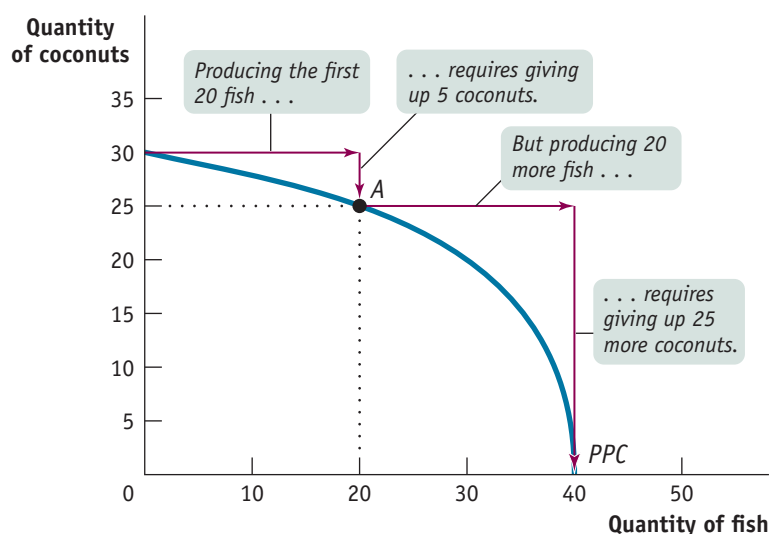
than constant, the production possibilities curve is a bowed-out curve rather than a straight line.

Although it's often useful to work with the simple assumption that the production possibilities curve is a straight line, economists believe that in reality, opportunity costs are typically increasing. When only a small amount of a good is produced, the opportunity cost of producing that good is relatively low because the economy needs to use only those resources that are especially well suited for its production. For example, if an economy grows only a small amount of corn, that corn can be grown in places where the soil and climate are perfect for growing corn but less suitable for growing anything else, such as wheat. So growing that corn involves giving up only a small amount of potential wheat output. Once the economy grows a lot of corn, however, land that is well suited for wheat but isn't so great for corn must be used to produce corn anyway. As a result, the additional corn production involves sacrificing considerably more wheat production. In other words, as more of a good is produced, its opportunity cost typically rises because well-suited inputs are used up and less adaptable inputs must be used instead.
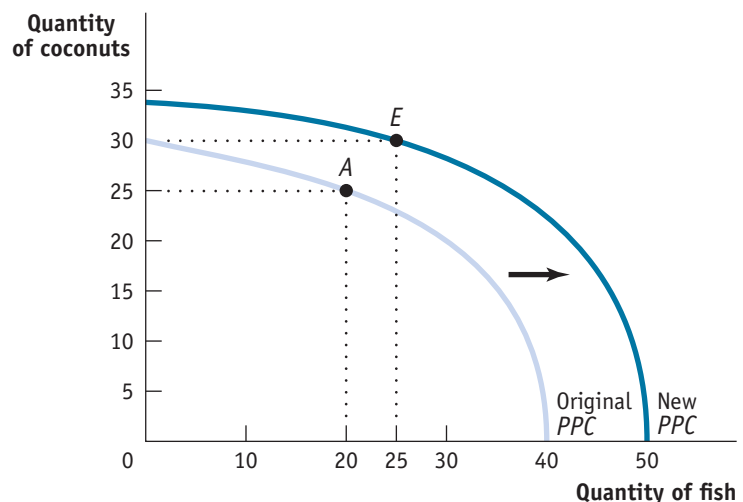
Economic Growth

Finally, the production possibilities curve helps us understand what it means to talk about *economic growth*. We introduced the concept of economic growth in Module 2, saying that it allows *a sustained rise in aggregate output*. We learned that economic growth is one of the fundamental features of the economy. But are we really justified in saying that the economy has grown over time? After all, although the U.S. economy produces more of many things than it did a century ago, it produces less of other things—for example, horse-drawn carriages. In other words, production of many goods is actually down. So how can we say for sure that the economy as a whole has grown?

The answer, illustrated in Figure 3.3, is that economic growth means an *expansion of the economy's production possibilities:* the economy *can* produce more of everything. For example, if Tom's production is initially at point *A* (20 fish and 25 coconuts), economic growth means that he could move to point *E* (25 fish and 30 coconuts). Point *E* lies outside the original curve, so in the production possibilities curve model, growth is shown as an outward shift of the curve. Unless the PPC shifts outward, the points beyond the PPC are unattainable. Those points beyond a given PPC are beyond the economy's possibilities.

figure 3.3

Economic Growth

Economic growth results in an *outward shift* of the production possibilities curve because production possibilities are expanded. The economy can now produce more of everything. For example, if production is initially at point *A* (20 fish and 25 coconuts), it could move to point *E* (25 fish and 30 coconuts).

What can cause the production possibilities curve to shift outward? There are two general sources of economic growth. One is an increase in the resources used to produce goods and services: labor, land, capital, and entrepreneurship. To see how adding to an economy's resources leads to economic growth, suppose that Tom finds a fishing net washed ashore on the beach. The fishing net is a resource he can use to produce more fish in the course of a day spent fishing. We can't say how many more fish Tom will catch; that depends on how much time he decides to spend fishing now that he has the net. But because the net makes his fishing more productive, he can catch more fish without reducing the number of coconuts he gathers, or he can gather more coconuts without reducing his fish catch. So his production possibilities curve shifts outward.

The other source of economic growth is progress in **technology,** the technical means for the production of goods and services. Suppose Tom figures out a better way either to catch fish or to gather coconuts—say, by inventing a fishing hook or a wagon for transporting coconuts. Either invention would shift his production possibilities curve outward. However, the shift would not be a simple outward expansion of every point along the PPC. Technology specific to the production of only one good has no effect if all resources are devoted to the other good: a fishing hook will be of no use if Tom produces nothing but coconuts. So the point on the PPC that represents the number of coconuts that can be produced if there is no fishing will not change. In real-world economies, innovations in the techniques we use to produce goods and services have been a crucial force behind economic growth.

Again, economic growth means an increase in what the economy *can* produce. What the economy actually produces depends on the choices people make. After his production possibilities expand, Tom might not choose to produce both more fish and more coconuts; he might choose to increase production of only one good, or he might even choose to produce less of one good. For example, if he gets better at catching fish, he might decide to go on an all-fish diet and skip the coconuts, just as the introduction of motor vehicles led most people to give up horse-drawn carriages. But even if, for some reason, he chooses to produce either fewer coconuts or fewer fish than before, we would still say that his economy has grown, because he *could* have produced more of everything. If an economy's PPC shifts inward, the economy has become smaller. This could happen if the economy loses resources or technology (for example, if it experiences war or a natural disaster).

The production possibilities curve is a very simplified model of an economy, yet it teaches us important lessons about real-life economies. It gives us our first clear sense of what constitutes economic efficiency, it illustrates the concept of opportunity cost, and it makes clear what economic growth is all about.

Technology is the technical means for producing goods and services.

Judith Pilossof/FoodPix/Getty Images

M o d u l e ③ A P R e v i e w

Solutions appear at the back of the book.

Check Your Understanding

1. True or false? Explain your answer.
   a. An increase in the amount of resources available to Tom for use in producing coconuts and fish does not change his production possibilities curve.
   b. A technological change that allows Tom to catch more fish relative to any amount of coconuts gathered results in a change in his production possibilities curve.
   c. Points inside a production possibilities curve are efficient and points outside a production possibilities curve are inefficient.

Tackle the Test: Multiple-Choice Questions

Quantity of capital goods

Quantity of consumer goods
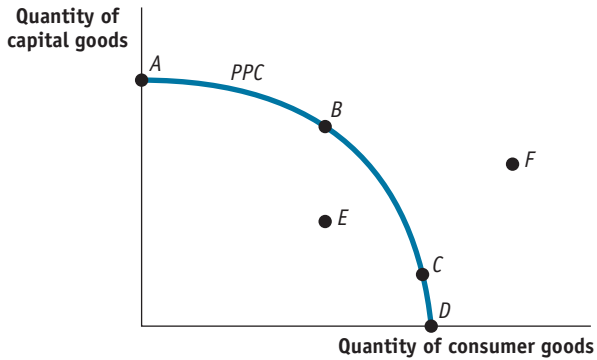
Refer to the graph above to answer the following questions.

1. Which point(s) on the graph represent efficiency in production?
   a. *B* and *C*
   b. *A* and *D*
   c. *A, B, C,* and *D*
   d. *A, B, C, D,* and *E*
   e. *A, B, C, D, E,* and *F*

2. For this economy, an increase in the quantity of capital goods produced without a corresponding decrease in the quantity of consumer goods produced
   a. cannot happen because there is always an opportunity cost.
   b. is represented by a movement from point *E* to point *A*.
   c. is represented by a movement from point *C* to point *B*.
   d. is represented by a movement from point *E* to point *B*.
   e. is only possible with an increase in resources or technology.

3. An increase in unemployment could be represented by a movement from point
   a. *D* to point *C*.
   b. *B* to point *A*.
   c. *C* to point *F*.
   d. *B* to point *E*.
   e. *E* to point *B*.

4. Which of the following might allow this economy to move from point *B* to point *F*?
   a. more workers
   b. discovery of new resources
   c. building new factories
   d. technological advances
   e. all of the above

5. This production possibilities curve shows the trade-off between consumer goods and capital goods. Since capital goods are a resource, an increase in the production of capital goods today will increase the economy's production possibilities in the future. Therefore, all other things equal (*ceteris paribus*), producing at which point today will result in the largest outward shift of the PPC in the future?
   a. *A*
   b. *B*
   c. *C*
   d. *D*
   e. *E*

Tackle the Test: Free-Response Questions

1. Refer to the graph below. Assume that the country is producing at point *C*.

Quantity of military goods ("guns")

Quantity of social goods ("butter")
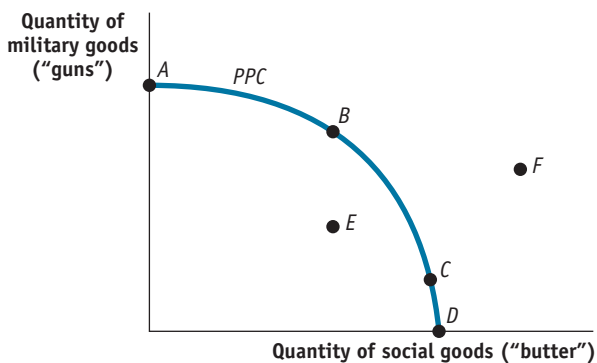
   a. Does this country's production possibilities curve exhibit increasing opportunity costs? Explain.
   b. If this country were to go to war, the most likely move would be from point *C* to which point? Explain.
   c. If the economy entered into a recession, the country would move from point *C* to which point? Explain.

> **Answer (6 points)**
>
> **1 point:** Yes
>
> **1 point:** The PPC is concave (bowed outward), so with each additional unit of butter produced, the opportunity cost in terms of gun production (indicated by the slope of the line) increases. Likewise, as more guns are produced, the opportunity cost in terms of butter increases.
>
> **1 point:** *B*
>
> **1 point:** The country would choose an efficient point with more (but not all) military goods with which to fight the war. Point A would be an unlikely choice because at that point there is no production of any social goods, some of which are needed to maintain a minimal standard of living.
>
> **1 point:** *E*
>
> **1 point:** A recession, which causes unemployment, is represented by a point below the PPC.

2. Assume that an economy can choose between producing food and producing shelter at a constant opportunity cost. Draw a correctly labeled production possibilities curve for the economy. On your graph:
   a. Use the letter *E* to label one of the points that is efficient in production.
   b. Use the letter *U* to label one of the points at which there might be unemployment.
   c. Use the letter *I* to label one of the points that is not feasible.