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CHAPTER 2
Production Possibilities Frontier Framework

Chapter 2 introduces the basics of the PPF, comparative advantage, and trade. This is not exactly a "tools of economics" chapter; instead it explores basic premises that underlie the economic analysis presented throughout the text.

■ KEY IDEAS

1. The PPF is a framework used to examine production.
2. The PPF can be used to demonstrate several economic concepts.
3. Individuals can make themselves better off by specializing in production according to their comparative advantages, and then trading for other goods.

■ CHAPTER OUTLINE

I. THE PRODUCTION POSSIBILITIES FRONTIER

The production possibilities frontier is a framework in which to examine production; it represents the combination of two goods that can be produced in a certain period of time, under the conditions of a given state of technology and fully employed resources.

A. The Straight-Line PPF: Constant Opportunity Costs

A straight-line PPF indicates that the opportunity cost of producing additional units of output is fixed.

B. The Bowed-Outward (Concave-Downward) PPF: Increasing Opportunity Costs

A bowed-outward PPF indicates that the law of increasing opportunity costs holds, that is, for most goods, opportunity costs increase as more of the good is produced. ~~The law of increasing opportunity costs holds because people have varying abilities, so that they aren't equally adept at producing all goods.~~

C. Law of Increasing Opportunity Costs

The law of increasing opportunity costs holds because people have varying abilities, so they aren't equally adept at producing all goods. The law of increasing opportunity costs suggests that f~~F~~or most goods, the opportunity costs increase as more of the good is produced.

D. Economic Concepts in a *Production Possibilities Frontier* Framework

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The PPF can be used to illustrate seven economic concepts: choice, opportunity costs, productive inefficiency, and the four discussed in this section:

1. Scarcity

The PPF separates two regions: an attainable region, which consists of the points on the PPF and all points below it, and an unattainable region, which consists of all points above and beyond the PPF. Within the attainable region, individuals must choose which combination of goods they want to produce. There is an opportunity cost associated with each choice whenever there is a movement along a PPF.

2. Productive Efficiency

An economy is productive efficient if it is producing the maximum output with the given resources and technology (that is, if it is producing at a point on the frontier), and is productive inefficient if it is not.

3. Unemployed Resources

One reason that an economy may exhibit productive inefficiency is that it is not using all its resources.

4. Economic Growth

Economic growth refers to the increased productive capabilities of an economy, and is illustrated by a shift outward in the PPF. An increase in the quantity of resources or an advance in technology will lead to economic growth.

II. SPECIALIZATION AND TRADE CAN MOVE US BEYOND OUR PPF

A country that specializes in the production of certain goods, and then trades those goods to countries for other goods, can make itself better off.

A. A Simple Two-Person PPF Model

This section uses a two-person model to show the advantages of specialization and trade. An economist would advise each person in this model to produce the good that he or she can produce at a lower cost. In economics, a person who can produce a good at a lower cost than another person is said to have a comparative advantage in the production of the good. Individuals and countries can make themselves better off by specializing in the production of goods that they have a comparative advantage in, and then trading for other goods.

B. On or Beyond the PPF?

What holds for individuals holds for countries too. For example, if both Americans and Brazilians specialize in producing those goods for which they have a comparative advantage, and then trade some of those goods for the others' goods, both Americans and Brazilians can consume more of both goods than if

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they don't specialize and don't trade.

~~**C. Why Do People Specialize and Trade?**~~

~~People specialize and trade because of comparative advantage: some people can produce certain goods and services at a lower opportunity cost than others. There would be less specialization and trade in a world where there are no comparative advantages than in a world where there are comparative advantages.~~

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■ TEACHING ADVICE

1. One of the most important things that students can learn from studying the production possibilities frontier is that choices have consequences. Emphasize that when we choose to produce at one point rather than at some other point on the PPF, we obtain more of one good than we would have had at the other point, but we don't get to have as much of the other good as we would have had at the other point. Use the Production Possibilities Frontier Exercise (presented below as a sheet that can easily be reproduced for students) to reinforce this point and the point that the law of increasing opportunity cost holds.

2. Go to www.bls.gov and, on the right side of the screen, click on the historical data link for unemployment rates. Use this data to show how recent changes in unemployment rates have affected our position relative to the PPF (ceteris paribus, increases in the unemployment rate do not affect the position of our nation's PPF, but, rather how close to the PPF we can operate).

3. http://www.economy.com/dismal/ provides daily examples of economic life in government-controlled versus less-controlled environments, and examples that can be used to discuss tradeoffs, efficiency, and the production possibilities frontier. The same is true for http://cnn.com and http://cnnfn.com.

■ ASSIGNMENTS FOR MASTERING KEY IDEAS

Assignment 2.1

Key Idea: The PPF is a framework used to examine production.

1. Explain what a production possibilities frontier represents.
2. Analyze what it means for the PPF to be bowed out from the origin (curved), and what it means for the PPF to be a straight line.
3. State the law of increasing opportunity costs and explain why it holds.

Assignment 2.2

Key Idea: The PPF can be used to demonstrate several economic concepts.

1. Explain how the PPF is used to demonstrate scarcity.
2. Use the PPF to demonstrate choice and opportunity cost.
3. Define productive efficiency and use the PPF to demonstrate it.
4. Use the PPF to show unemployment.
5. Use PPF curves to show economic growth and list the sources of economic growth.

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Assignment 2.3
Key Idea: Individuals can make themselves better off by specializing in production according to their comparative advantages, and then trading for other goods.

1. Use the concept of comparative advantage to describe who should produce a particular good.
2. Explain why people should specialize and trade.
3. Explain how acting in one's self interest benefits society.

■ ANSWERS TO ASSIGNMENTS FOR MASTERING KEY IDEAS

Assignment 2.1 Answers

1. A production possibilities frontier represents the combination of two goods that can be produced in a certain period of time, under the conditions of a given state of technology and fully employed resources.
2. A straight line PPF indicates that the opportunity cost of producing additional units of output is fixed, while a bowed-outward PPF indicates that the opportunity cost rises with production.
3. The law of increasing opportunity costs says that as more of a good is produced, the opportunity costs of producing that good increase. It holds because people have varying abilities, and aren't equally adept at producing all goods.

Assignment 2.2 Answers

1. The PPF separates an attainable region (all points on or under the PPF) from an unattainable region (all points above the PPF). Scarcity makes the points above the PPF unattainable.
2. Only one point on a PPF can be chosen. When choosing one point over another point, the value of what could have been chosen but wasn't chosen is the opportunity cost of our choice.
3. An economy is productive efficient if it is producing the maximum output with given resources and technology. All of the points on the frontier are points of productive efficiency.
4. If there is unemployment, then the economy will be at a point below the PPF.
5. Economic growth is illustrated by an outward shift ~~shift outward in the~~of the PPF, and would be caused by more resources or an advance in technology.

Assignment 2.3 Answers

1. A person who can produce a good at a lower cost than another person has a comparative advantage in the production of that good, and is the person who should produce it.
2. Specialization and trade increase production and make people better off. When someone specializes and trades his surplus, he earns a profit. The person who buys the surplus lowers her cost of living.
3. When people act in their own self-interest and produce goods with a lower opportunity cost, the overall output of society increases.

■ ANSWERS TO VIDEO QUESTIONS AND PROBLEMS

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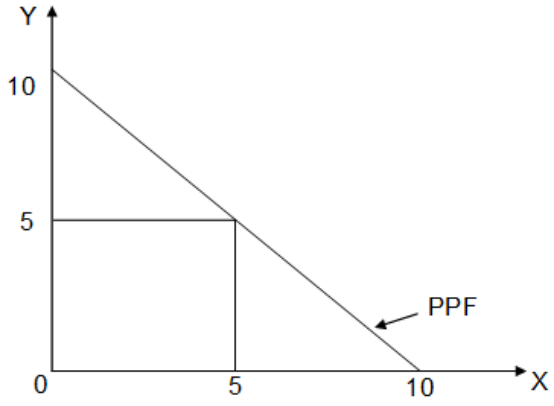
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1. Explain how to derive a production possibilities frontier (PPF).

Assume that a country can produce two goods, X and Y. The country can use the resources available at its disposal to produce any combination of X and Y. For example, it may choose to produce:

a. 10 units of X and 0 units of Y; or
b. 5 units of X and 5 units of Y; or
c. 0 units of X and 10 units of Y.

In the following figure, the good Y is shown on the vertical axis and good X is shown on the horizontal axis. The three combinations of output have been plotted on the graph to form the PPF.



2. What does a PPF that is bowed outward imply about the opportunity cost of production?

Assume a PPF showing the different combinations of X and Y that can be produced in an economy. If the PPF is bowed outward, it means the opportunity cost of producing good X is increasing. That is, as we produce more quantities of good X, more and more quantities of good Y have to be given up for producing every additional unit of good X.

3. Based on the data below, identify which good each person has a comparative advantage in producing.

a. Person A can produce the following three combinations of goods: (1) 10X and 0Y, (2) 5X and 5Y, (3) 0X and 10Y.

b. Person B can produce the following three combinations of goods: (1) 10X and 0Y, (2) 5X and 15Y, (3) 0X and 30Y

Person A has to give up 5 units of X to produce 5 units of Y. Thus, his opportunity cost of producing 5X is 5Y; that is, 1X = 1Y or 1Y = 1X.
Person B has to give up 5 units of X to produce 15 units of Y. Thus, his opportunity cost of producing 5X is 15Y; that is, 1X = 3Y or 1Y = 1/3 X.
a. To produce 1 unit of X, person A has to give up only 1 unit of Y, while person B has to

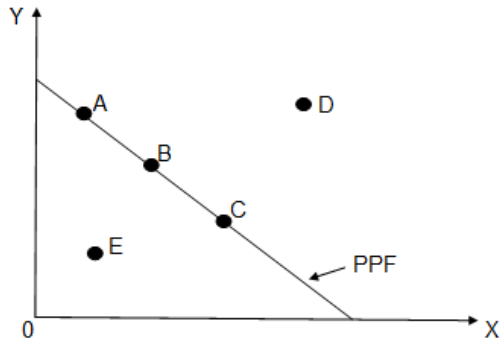
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give up 3 units of Y. Thus, person A has a comparative advantage in producing good X.
b. To produce 1 unit of Y, person A has to give up 1 unit of X, while person B has to give up only 1/3 X. Thus, person B has a comparative advantage in producing good Y.

4. Illustrate scarcity, opportunity cost, and economic growth within a PPF framework of analysis.

a. Scarcity is represented by the boundary of the PPF. That is, given a country's resources, there is a limit to the amount of output that can be produced. While a country can produce any combination of goods on, or inside the PPF, any output beyond the PPF is not possible due to the scarcity of resources.
b. Opportunity cost refers to the sacrifice that is to be made in terms of one good in order to increase the production of another good by one more unit. In terms of PPF, a downward movement along the curve shows the quantity of the good, on the vertical axis, that has to be given up for every additional unit produced of the good on the horizontal axis.
c. Economic growth is represented by an outward shift in the PPF. The economy moves to a point on the new PPF as there are now more resources that can be used to produce goods.

5. A country is currently experiencing a high unemployment rate. Diagrammatically represent the country within a PPF framework of analysis.



In the above graph, points A, B, and C represent full employment of resources since they lie on the PPF. Point D which lies beyond the PPF indicates that level of output which cannot be attained by the economy due to finite resources. Point E that lies below the PPF indicates that the resources of the economy are not fully employed. Thus, a high unemployment rate is shown by point E within a PPF framework of analysis.

■ ANSWERS TO CHAPTER QUESTIONS AND PROBLEMS

1. Describe how each of the following would affect the U.S. production possibilities frontierPPF: (a) an increase in the number of illegal immigrants entering the country, (b) a war that takes place on U.S. soil, (c) the discovery of a new oil field,

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(d) a decrease in the unemployment rate, and (e) a law that requires individuals to enter lines of work for which they are not suited.

(a) *Ceteris paribus*, an increase in the number of illegal immigrants entering the country will increase the available productive human resources of the economy; therefore, the PPF should shift outward, as shown in Exhibit 6(a).
(b) A war would remove individuals, capital, and potentially other resources from the productive process; therefore, *ceteris paribus*, the PPF would shift inward.
(c) The discovery of a new oil field would represent an addition to the country's resources; therefore, the PPF would shift outward.
(d) A decrease in the unemployment rate would be represented by movement from a point below the PPF to another point closer to or on the frontier, such as from point F to point D, in Exhibit 5.
(e) Such a law would decrease the productive efficiency of labor, thereby moving the economy from a point on or inside the frontier to another point further inside the frontier.

2. Explain how the following can be represented in a PPF framework: (a) the finiteness of resources implicit in the scarcity condition; (b) choice; (c) opportunity cost; (d) productive efficiency; and (e) unemployed resources.

Scarcity is illustrated by the existence of the frontier: if there were unlimited resource availability, there would be no limit on output. Choice is illustrated by the variety of possible combinations along the frontier: there is not a single optimum or efficient combination of the two goods. Opportunity cost is represented by the slope of the frontier or can be viewed as how much we give up of one good to get one more unit of another good. Productive efficiency is represented by points on the frontier. Unemployed resources are represented by points below the frontier.

3. What condition must hold for the production possibilities frontier to be bowed outward (concave downward)? To be a straight line?

In order for a nation's PPF to be bowed outward, resources must be somewhat specialized, so that the law of increasing opportunity costs holds. With specialized resources, additional units of a good can only be produced at increasing opportunity costs. In order for a nation's PPF to be a straight line, there must be complete interchangeability of resources, with no specialization, so that the law of increasing opportunity costs does not apply.

4. Give an example to illustrate each of the following: (a) constant opportunity costs and (b) increasing opportunity costs.

Answers will vary. Constant opportunity costs occur when increasing output of a good does not cause society to give up more and more resources in order to produce that good. Although, at some point increasing opportunity costs will occur, over some level of output constant opportunity costs could prevail. For example, if a college has a $20 million budget and each class costs $25,000 to offer, then the school can offer 800 classes during the year. If the college received a $500,000 grant, it could offer another 20 classes if its costs did not increase, perhaps because there were unemployed professors ready and willing to work at the going wage rate. Increasing opportunity costs occur when society has to give up more and more of one resource in order to obtain another resource. If the college received a second $500,000 grant, it might not be able to offer another 20 classes, if there were no unemployed professors ready and willing to

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work at the going wage rate. In order to hire more teachers, the college would have to hire individuals who had a higher opportunity cost.

5. Why are most production possibilities frontiers for goods bowed outward (concave downward)?

Most production possibilities frontiers are concave downward because the law of increasing opportunity costs holds. This law says that as society devotes more resources to the production of a given good, the opportunity cost of producing that good will increase. The reason for this is that the most efficient resources will be used to initially produce that good. Only as those resources are used up will society employ less productive resources. Farmers will plant wheat in Kansas before they plant wheat in Alaska or Nevada.

6. Within ~~the~~ a PPF framework, explain each of the following: (a) a disagreement between a person who favors more domestic welfare spending and one who favors more national defense spending; (b) an increase in the population; and (c) a technological change that makes resources less specialized.

(a) The first question deals with choices among possible output combinations along a frontier representing total government spending. For illustrative purposes, substitute ~~"domestic welfare spending"~~ for "Good X" with ~~"~~"domestic welfare spending" and "Houses" with "national defense spending"~~ for "Houses"~~ in Exhibit 3. The person favoring more welfare spending would prefer point C, while the person favoring more defense spending would prefer point D.

(b) An increase in population, *ceteris paribus*, will shift the PPF outward, as in Exhibit 6(a).

(c) A technological change that makes resources less specialized will lessen the opportunity cost of switching production from one good to another. The production possibility frontier will become less bowed outward (straighter relative to the origin).

7. Explain how to derive a production possibilities frontier. ~~-~~For instance, how is the extreme point on the vertical axis identified? ~~-~~How is the extreme point on the horizontal axis identified?

The extreme point on the vertical axis is identified by figuring out how much of the good on that axis can be produced using all of the economy's available resources. The extreme point on the horizontal axis is identified by figuring out how much of the good on the horizontal axis can be produced using all of the economy's available resources. Once the extreme point on the vertical axis (for example) has been identified, other points can be identified by asking how much of that good must be given up in order increase production of the good on the horizontal axis by some discrete amount. The production possibilities frontier can be derived by identifying all the points that show the combinations of both goods that can be produced in the economy.

8 If the slope of the ~~production possibilities frontier~~PPF is the same between any two points, what does this imply about costs? ~~-~~Explain your answer.

A PPF slope that is the same between any two points implies that the opportunity cost of producing the two goods represented on the axes is constant.

9 Suppose a nation's PPF shifts inward as its population grows. What happens, on average, to the material standard of living of the people? Explain your answer.

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The material standard of living would tend to decrease. The economy, as a whole, would have fewer goods and services to go around and would be distributing them to more people. Consequently, each person would get less and less.

10. Can a technological advancement in sector X of the economy affect the number of people who work in sector Y of the economy? Explain your answer.

Yes. A technological advancement in sector X makes it possible to produce X with fewer people, freeing those people to produce other things (Y, for example).

11. Use the PPF framework to explain something in your everyday life that was not mentioned in the chapter.

Answers will vary, but should illustrate some of the following: choice, opportunity costs, productive inefficiency, scarcity, productive efficiency, unemployed resources, and growth.

12. What exactly allows individuals to consume more if they specialize and trade than if they don't?

The fact that each person specializes in producing what he or she can produce at lower cost is what "releases" resources to produce more goods, which then leads to greater consumption.

■ ANSWERS TO PROBLEMS IN THE WORKING WITH NUMBERS AND GRAPHS SECTION

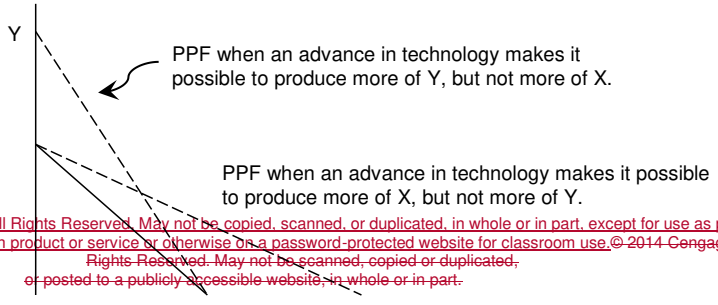
1. Illustrate constant opportunity costs in a table similar to the one in Exhibit 1(a). Next, draw a PPF based on the data in the table.

Answers will vary, but the PPF will be a straight line similar to the one in Exhibit 1(b).

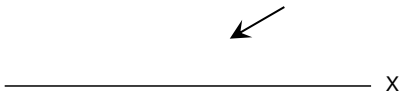
2. Illustrate increasing opportunity costs (for one good) in a table similar to the one in Exhibit 2(a). Next, draw a PPF based on the data in the table.

Answers will vary, but the PPF will be bowed outward similar to the one in Exhibit 2(b).

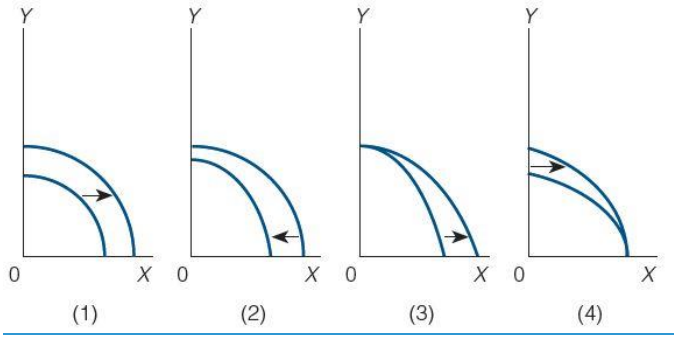
3. Draw a PPF that represents the production possibilities for goods X and Y if there are constant opportunity costs. Next, represent an advance in technology that makes it possible to produce more of X, but not more of Y. Finally, represent an advance in technology that makes it possible to produce more of Y, but not more of X.



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4. In the following figure, which graph depicts a technological breakthrough in the production of good X only?



Graph (3). The technological breakthrough allows more of good X to be produced, so the extreme point of the PPF on the horizontal axis shifts outward.

5. In the preceding figure, which graph depicts a change in the PPF that is likely as a consequence of war?

Graph (2). A likely consequence of war is decreased production of all goods leading to an inward shift of the PPF.

6. If PPF_2 in the following graph is the relevant production possibilities frontier, then which points are unattainable? Explain your answer.

J, I and H are unattainable. They are farther from the origin than PPF_2, which represents maximum possible output.

7. If PPF_1 in the preceding figure is the relevant production possibilities frontier, then which point(s) represent efficiency? Explain your answer.

Points A, B, and C represent efficiency because they are located on the frontier itself. By definition, a point on the frontier requires us to use all our existing resources and technology to their most efficient level.

8. Tina can produce any of the following combinations of goods X and Y: (a) 100X and 0Y, (b) 50X and 25Y, and (c) 0X and 50Y. David can produce any of the following combinations of goods X and Y: (a) 50X and 0Y, (b) 25X and 40Y, and (c) 0X and 80Y. Who has a comparative advantage in the production of good X? Oef good Y? Explain your answer.

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Tina gives up 50X to produce 25Y (100 – 50 and 0 – 25). David gives up 25X to produce 40Y (50 – 25 and 0 – 40). Tina's opportunity cost is 2X = 1Y (1X = 1/2Y) and David's is 5/8X = 1Y (1X = 8/5Y). David can give up 50X and get 80Y, while Tina gets only 25Y for 50X. So, David has the lower opportunity cost for good Y and Tina for good X.

9. Using the data in Problem 8, prove that both Tina and David can be made better off through specialization and trade.

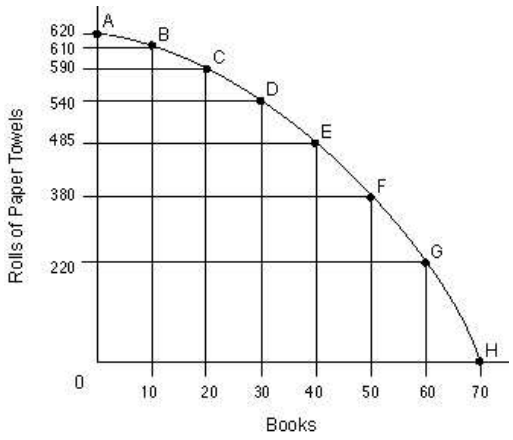
~~Start with~~Suppose Tina produces~~ing~~ 50X and 25Y and David produces~~ing~~ 25X and 40Y. Together, they produce 75X and 65Y. Now, ~~have~~ suppose Tina produces 100X and 0Y and David produces 0X and 80Y. Together, they ~~now~~ produce 100X and 80Y. Tina could now consume (for example) 60X and 35Y and David could consume 40X and 45Y, making both better off.

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■ PRODUCTION POSSIBILITIES FRONTIER EXERCISE

Pinnacle Paper Products Inc. can produce books or rolls of paper towels. Here is its PPF for the resources and technology it has available:



1. What is gained by choosing to produce at point B, instead of at point A?

2. What is the opportunity cost of choosing to produce at point B, instead of at point A?

3. What is gained by choosing to produce at point C, instead of at point B?

4. What is the opportunity cost of choosing to produce at point C, instead of at point B?

5. Continue moving point by point down the PPF. What is the pattern of gains as one chooses to move down this PPF from point A to B to C to D and so forth?

6. What is the pattern of opportunity costs as one chooses to move down this PPF from point A to B to C to D and so forth?

7. Does the law of increasing opportunity costs hold for book production at Pinnacle Paper Products? How do you know?

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8. Explain how to determine whether the law of increasing opportunity cost holds for paper towel production at Pinnacle Paper Products.

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■ PRODUCTION POSSIBILITIES FRONTIER EXERCISE ANSWERS

1. 10 books are gained by producing at point B, instead of at point A.
2. 10 rolls of paper towels is the opportunity cost of producing at point B, instead of at point A.
3. 10 books are gained by producing at point C, instead of at point B.
4. 20 rolls of paper towels is the opportunity cost of producing at point C, instead of at point B.
5. The gains are constant. 10 books are gained with each move.
6. Opportunity cost increases with each move. Increasingly larger numbers of rolls of paper towels are given up (10, then 20, 50, 55, 160, and finally, 220).
7. The law of increasing opportunity costs holds for book production at Pinnacle Paper Products, because each additional 10 books are more expensive than the previous 10 books in terms of the rolls of paper towels that must be given up in order to produce them.
8. Answers will vary, but should discuss finding the opportunity cost of obtaining constant gains in paper towels (for instance, from 0 to 155 rolls, to 310 rolls, to 465 rolls, to 620 rolls). Students can graphically show that the opportunity cost of obtaining these gains will rise. More and more books have to be given up to maintain this constant rate of gains. Therefore, the law of increasing opportunity costs does hold for paper towel production at Pinnacle Paper Products.

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