CHAPTER 2
SPECIALIZATION AND EXCHANGE

Chapter Overview

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 improve their communities, people specialize so as to exploit their comparative advantages. That principle is as true for countries, like the United States and Bangladesh, 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.

The functioning of the invisible hand depends on a lot of other assumptions, such as free competition and full information. 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.

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: Explain why people specialize.
LO 2.4: Explain how the gains from trade follow from comparative advantage.

Chapter Outline

OPENING STORY: THE ORIGINS OF A T-SHIRT
Production Possibilities **(LO 2.1)**

Drawing the Production Possibilities Frontier
Choosing Among Production Possibilities
Shifting the Production Possibilities Frontier
Absolute and Comparative Advantage
Absolute Advantage **(LO 2.2)**
Comparative Advantage
BOX FEATURE: FROM ANOTHER ANGLE – BABE RUTH, STAR PITCHER
Why Trade?
Specialization **(LO 2.3)**
BOX FEATURE: REAL LIFE – SPECIALIZATION SAUCE
Gains from Trade **(LO 2.4)**
BOX FEATURE: WHAT DO YOU THINK? – IS SELF-SUFFICIENCY A VIRTUE?
Comparative Advantage over Time
BOX FEATURE: REAL LIFE – COMPARATIVE ADVANTAGE: THE GOOD, THE BAD, AND THE UGLY

Beyond the Lecture

Class Discussion: Production Possibilities (LO 2.1)
In order to highlight the concept of the production possibilities curve, have students consider the production possibilities curve for a student deciding how to study for two exams given a fixed timeframe. This helps to highlight the concept of tradeoffs for students, as you can ask them to consider the tradeoff between grades on the two exams. Assume that the students have a fixed number of hours in one evening to study for two large exams the following day.

1. What tradeoffs does a student face when deciding how to spend his or her time?
2. What factors should the student consider when making the decision regarding how to study?
3. Why might different students make different decisions regarding how to spend the hours studying?

Class Discussion: Absolute and Comparative Advantage (LO 2.2)
You can show the following clip during class from the TV show Suits. (Please note that there is a small bit of language in the clip that some may find objectionable). The page itself has some commentary on absolute and comparative advantage. In short, the boss does all the work overnight (showing his absolute advantage).

1. If the boss has the absolute advantage, why doesn't he just do all the work?

Writing Assignment: Specialization (LO 2.3)
Have students read (or listen to the audio book for) *I, Pencil* by Leonard E. Read. Ask students to write a brief essay on why no single individual can personally produce even a seemingly simple product like a pencil.

Class Activity: Gains from Trade (LO 2.4)

A simple trading exercise can highlight the concept of gains from trade for students. Bring a few bags of chips or other snacks to class and distribute them to students (you may choose only a few students for this activity in a large lecture).

1. Ask each student to rate their satisfaction with the snack you've given them on a scale from 1-10, with 1 being highly dissatisfied and ten being highly satisfied. Record their answers somewhere where all students can see.
2. Ask the students if they want to trade, and give them a few minutes to interact and exchange snacks. (Remind them that it must be voluntary—they do not have to trade if they do not wish to.)
3. Ask the students about their satisfaction again, this time with their new snack. Have the students explain any changes in their answer from before.

After trading, students should be at the very least equally as well off in terms of satisfaction as the first time they answered. This exercise can be used to highlight the gains from trade. You can also discuss the fact that the original distribution matters as well. This can tie into a number of discussions, including income distribution and comparative advantage.

Clicker Questions

There are three main purposes to clicker questions. First, they are a great way to do a quick and instant "on demand" test of student understanding of the material. You can cover material, and instantly get feedback on student comprehension. You can see whether you need to explain certain topics again, or move on to the next subject. Second, they are a great method to break up the class and take a moment away from lecture. It gets the students actively involved. Finally, certain clicker questions can be framed in a "discussion" manner, in which you can invite students to talk about the possible right answer with their peers. You can instruct students to convince their classmate of a right or wrong answer.

1. A movement along the production possibilities frontier would imply that **[LO 2.1]**
A. firms have more labor to produce goods
B. new technology has improved production processes
C. society chose a new combination of output to produce
D. workers are taking more vacation days

2. Which of the following could cause an outward shift of the production possibilities curve? **[LO 2.1]**
A. a decrease in productivity
B. an increase in the amount of labor inputs available to firms
C. a different choice of outputs produced by society
D. an increase in the price of final goods that society can produce

Feedback: Price increases won't shift the PPF. Remember that the PPF simply shows what we CAN produce, not necessarily what we would WANT to produce. If a good has a higher price, that doesn't automatically give us more capabilities to produce it!

3. The production possibilities frontier model illustrates which economic concept(s)? **[LO 2.1]**
A. scarcity
B. tradeoffs and choices
C. opportunity cost
D. all of the above

4. Gains from trade depend on **[LO 2.4]**
A. absolute advantage
B. comparative advantage
C. finite vs. infinite production possibilities
D. the willingness of individuals to specialize

Feedback: Trade can occur even if one person (or country) has the absolute advantage in all goods. The gains come from comparative advantage, where we take advantage of the lowest opportunity costs.

5. The United States has a lot of land. Japan has very little land area compared to the United States. Compared to Japan, what output do you think the United States would most likely have an absolute and comparative advantage in producing? **[LO 2.4]**
A. agricultural commodities
B. smart phones
C. automobiles
D. clothing

Solutions to End-of-Chapter Questions and Problems

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]**

Answer: On one axis, the production possibilities graph would show the total number of cookies you could bake if you spent all of your time and resources baking cookies. The other

axis would show the total amount of cupcakes you could bake if you spent all of your time and resources baking cupcakes. The two endpoints would be connected by a downward-sloping line. The slope of this line would represent the tradeoff (opportunity cost) you face between baking cookies and baking cupcakes. If you bake more cupcakes, you must bake fewer cookies. The production possibilities graph would show all of the combinations of cookies and cupcakes you could produce with your time and resources.

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' work efforts, would you expect the production possibilities frontier to be linear (a straight line)? Explain why or why not. **[LO 2.1]**

Answer: You would not expect a production possibilities frontier that combined both of your employees' work efforts to be linear. Each worker would likely differ in her relative skills at grooming and giving flea baths and would therefore differ in the opportunity cost for performing each task.

3. You and another volunteer are in charge of a bake sale for a local charity, at which you are planning to sell cookies and cupcakes. 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]**

Answer: If you have an absolute advantage in the production of cupcakes (or cookies), it means that you can produce more cupcakes (or cookies) in total with the same amount of resources than the other volunteer. Absolute advantage is about having greater productivity. You could have an absolute advantage in baking both cupcakes and cookies if you are more productive in both goods than the other volunteer.

4. You and another volunteer are in charge of a bake sale for a local charity, at which you are planning to sell cookies and cupcakes. 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]**

Answer: If you had a comparative advantage in baking cookies, it would mean that you have a lower opportunity cost (you give up fewer cupcakes for each cookie you bake) than the other volunteer. It is not possible for you to have a comparative advantage in baking both goods. If you have a comparative advantage in baking cookies, the other volunteer will have a comparative advantage in baking cupcakes.

5. You and another volunteer are in charge of a bake sale for a local charity, at which you are planning to sell cookies and cupcakes. 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 volunteer about how to split up the baking. Explain how you can both gain from specializing, and why. **[LO 2.3]**

Answer: If you have a comparative advantage in baking cookies and the other volunteer has a comparative advantage in baking cupcakes, then you should specialize in baking cookies and the other volunteer should specialize in baking cupcakes. If you spend all of your time baking cookies and the other volunteer spends all of his time baking cupcakes, you will wind up with more cookies and cupcakes between you than you would have if you each spent half of your time baking each good.

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]**

Answer: You would have your employees specialize in the task for which they have the lowest opportunity cost. The worker who has the lower opportunity cost of caring for the displays should switch to filling customer orders only if there are orders left to complete after all the cut flowers have been cared for (water changed, old blooms removed, etc.). You would assign making floral arrangements to fill customer orders to the worker who has the comparative advantage in that task. This worker should fill customer orders and switch to caring for the cut flower displays only if there is such work left to complete after customer orders have been filled.

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]**

Answer: We would not expect countries with the same production possibilities frontiers to trade. Identical production possibilities frontiers would indicate that the two countries faced the same opportunity costs. The basis for gains from trade is specializing according to differing opportunity costs.

8. Brazil is the largest coffee producer in the world, and coffee is one of Brazil's major export goods. Suppose that in 20 years, 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]**

Answer: Brazil would change from exporting to importing coffee if its comparative advantage changes. Over time, Brazil could lose its comparative advantage in coffee if its opportunity costs for growing coffee increase. If this were the case, we would expect Brazil to gain a comparative advantage elsewhere.

Problems and Applications

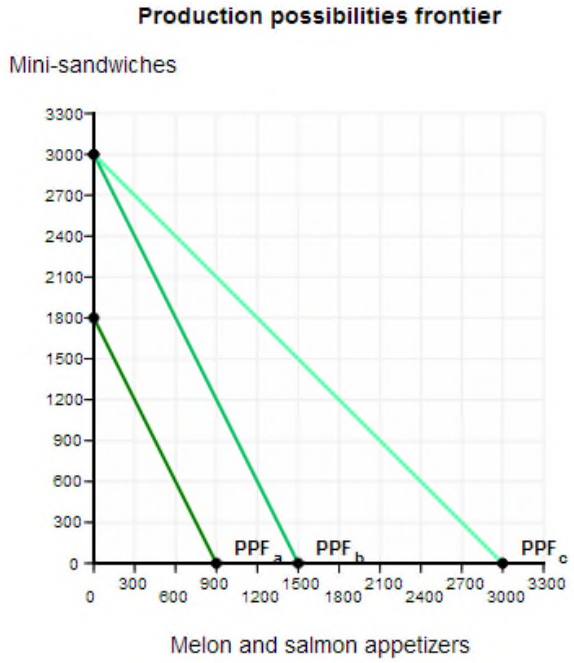
1. Your friend Sam has been asked to prepare appetizers for a university reception during homecoming weekend. She has an unlimited amount of ingredients but only six hours to prepare them. Sam can make 300 mini-sandwiches or 150 servings of melon slices topped with smoked salmon and a dab of sauce per 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, so Sam has an extra four hours to prepare. Redraw her production possibilities frontier to show the impact of this increase in resources.

c. Now, 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.

Answer:



a. 300 mini-sandwiches/hr = 1,800 mini-sandwiches in 6 hours. This is the endpoint on the Y-axis. 150 melon appetizers/hr = 900 melon appetizers in 6 hours. This is the endpoint on the X-axis.

b. 300 mini-sandwiches/hr = 3,000 mini-sandwiches in 10 hours. This is the endpoint on the Y-axis. 150 melon appetizers/hr = 1,500 melon appetizers in 10 hours. This is the endpoint on the X-axis.

c. 300 mini-sandwiches/hr = 3,000 mini-sandwiches in 10 hours. This is the endpoint on the Y-axis. 300 melon appetizers/hour = 3,000 melon appetizers in 10 hours. This is the endpoint on the X-axis.

2. Your friend Sam has been asked to prepare appetizers for the 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, so 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, so 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 pre-paring 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?

Answer: The opportunity cost is the value of what you have to give up in order to get something. It is the value of your next-best alternative.

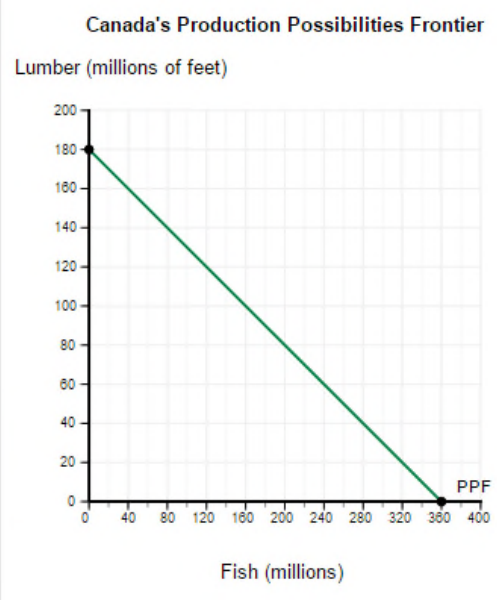
a. To make 1 more mini-sandwich you have to give up 1/2 melon appetizer.
b. To make 1 more melon appetizer you have to give up 2 mini-sandwiches.
c. To make 1 more mini-sandwich you still have to give up 1/2 melon appetizer. The opportunity cost has not changed.
d. To make 1 more melon appetizer you still have to give up 2 mini-sandwiches.
e. To make 1 more mini-sandwich you have to give up 1 melon appetizer. The opportunity cost has changed.
f. To make 1 more melon appetizer you have to give up 1 mini-sandwich.

3. Suppose that Canada produces two goods: lumber and fish. It has 18 million workers, each of whom can cut 10 feet 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. Draw Canada's production possibilities frontier.
d. Use your graph to determine how many fish can be caught if 60 million feet of lumber are cut.

Answer:

a. The maximum amount of lumber Canada could produce in a day is 10 feet x 18 million workers = *180 million* feet.
b. The maximum amount of fish Canada could produce in a day is 20 fish x 18 million workers = *360 million* fish.
c. The two endpoints of the PPF are (0,180) and (360,0).



d. The opportunity cost of producing 1 foot of lumber is 2 fish. Therefore, the opportunity cost of producing 60 million feet of lumber is 120 million fish. If Canada produces 60 million feet of lumber, then it can only produce 360 - 120, or 240 million fish.

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]**

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?

Answer:

a. The slope of the production possibilities frontier is -(6/2) = -3.
b. The opportunity cost of doing one problem set is (2 papers/6 problems sets) = 1/3 paper.
c. The opportunity cost of writing one paper is (6 problems sets/2 papers) = 3 problems sets.

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?

Answer:

a. The slope of the production possibilities frontier between Point A and Point B is -(5/1) = -5.
b. The slope of the production possibilities frontier between Point B and Point C is -(10/1) = -10.
c. The opportunity cost of producing hammers is lower between points A and B (5 hammers) than between points B and C (10 hammers).
d. The opportunity cost of producing screwdrivers is higher between points A and B (1/5 screwdriver) than between points B and C (1/10 screwdriver).

6. For each point on the PPF in Figure 2P-3, note whether the point is attainable and efficient, attainable and inefficient, or unattainable. **[LO 2.1]**

Answer: Points that lie on the frontier are called efficient, 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. Points outside the frontier are unattainable with current resources.

a. Attainable and efficient.
b. Unattainable.
c. Attainable and inefficient.
d. Attainable and efficient.

7. For each point on the PPF in Figure 2P-4, note whether the point is attainable and efficient, attainable and inefficient, or unattainable. **[LO 2.1]**

Answer: Points that lie on the frontier are called efficient, 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. Points outside the frontier are unattainable with current resources.

a. Attainable and efficient.
b. Attainable and efficient.
c. Attainable and efficient.
d. Attainable and inefficient.
e. Unattainable.

8. The Red Cross and WIC (Women, Infants, and Children program) both provide emergency food packages and first-aid kits to New York City home-less shelters. Table 2P-1 shows their weekly production possibilities in providing emergency goods to NYC homeless shelters. NYC homeless shelters need a total of 20 first-aid kits per week. Currently, they get 10 kits from the Red Cross and 10 kits from WIC. With their remaining resources, how many food packages can each organization provide to NYC homeless shelters? **[LO 2.1]**

Answer: From the table, we find that the Red Cross can produce 300 food packages OR 50 first-aid kits OR some combination in-between (for example, 150 food packages and 25 first-aid kits.) The opportunity cost of providing one first-aid kit is 6 food packages. The requirement of 10 kits from the Red Cross comes at a cost of 60 food packages (6 food packages per first-aid kit times 10). Out of the 300 food packages possible from the Red Cross 60 must be given up, leaving *240* (300 - 60) food packages available.

Likewise, the WIC can produce 200 food packages OR 20 first-aid kits OR some combination in-between. The opportunity cost for this organization of providing one first-aid kit is 10 food packages. The requirement of 10 first-aid kits from the WIC means giving up 100 food packages. Out of the 200 food packages possible, *100* (200 - 100) are still available.

9. 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?

Answer: If a producer can generate more output than others with a given amount of resources, that producer has an absolute advantage. 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.

a. Of the three workers, Diana has the absolute advantage at making cookies. She can make the most cookies (27) in an hour compared with Andy (25) and Sam (10).
b. Diana also has the absolute advantage at baking cupcakes. She can bake 18 cupcakes in an hour, whereas Andy can only bake 17 and Sam can only bake 12.

10. Paula and Carlo are coworkers. Their production possibilities frontiers for counseling clients and writing memos are given in Figure 2P-5. **[LO 2.2]**

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

Answer: Absolute advantage is the ability to produce more of a good or service than others can with a given amount of resources. Comparative advantage is the ability to produce a good or service at a lower opportunity cost than others.

a. Paula has the absolute advantage in counseling clients because she can produce more of this service than Carlo can with a given amount of resources.
b. Paula has the absolute advantage in writing memos because she can write more of them than Carlo can with a given amount of resources.
c. Paula has the comparative advantage in counseling clients because her opportunity cost of counseling a client is 0.25 memos compared to Carlo's opportunity cost of 0.33 memos.
d. Carlo has the comparative advantage in writing memos because his opportunity cost of writing a memo is 3 counseled clients compared to Paula's opportunity cost of 4 counseled clients.

11. Two students are assigned to work together on a project that requires both writing 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?

Answer: Absolute advantage is the ability to produce more of a good or service than others can with a given amount of resources. Comparative advantage is the ability to produce a good or service at a lower opportunity cost than others.
a. Anna has a comparative advantage at writing because she has the lower opportunity cost. She gives up 0.5 minutes of presentation for each page she writes, whereas Steve gives up 3 minutes of presentation for each page he writes.
b. If Steve goes to a writing tutor and increases his productivity in writing, his opportunity costs change. If Steve is now able to write 3 pages a day, it means his opportunity cost for each page he writes is now 1 minute of presentation. However, Anna still has a comparative advantage at writing because she still only gives up 0.5 minutes of presentation for each page he writes.

12. 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 pounds of vegetables or wash 100 dishes per hour. Henriette can chop 30 pounds 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?

Answer: Comparative advantage is the ability to produce a good or service at a lower opportunity cost than others.
a. Henriette should chop vegetables, as she has the lower opportunity cost for chopping vegetables. Henriette's opportunity cost for chopping 1 vegetable is a loss of 4 dishes washed, whereas Rahul's opportunity cost for chopping 1 vegetable is a loss of 5 dishes washed.
b. Rahul should be assigned to wash dishes, as she has the lowest opportunity cost for washing dishes. Rahul's opportunity cost for washing 1 dish is a loss of 0.2 vegetables

chopped, whereas Henriette's opportunity cost for washing 1 dish is a loss 0.25 vegetables chopped.

13. The Dominican Republic and Nicaragua both produce coffee and rum. The Dominican Republic can produce 20 thousand tons of coffee per year or 10 thousand barrels of rum. Nicaragua can produce 30 thousand tons 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 producing coffee? Which country should specialize in producing rum?

b. What are the minimum and maximum prices at which these countries will trade coffee?

Answer:

a. If the Dominican Republic and Nicaragua sign a trade agreement in which each country would specialize in production, coffee and rum will be produced according to which country has a comparative advantage in the production of each good. Comparing their opportunity costs for producing coffee, we see that Nicaragua has a lower opportunity cost for producing coffee (1/6 of a barrel of rum, versus the Dominican Republic's opportunity cost of 1/2 barrel of rum). Nicaragua, therefore, should specialize in coffee. Comparing their opportunity costs for producing rum, we see that the Dominican Republic has a lower opportunity cost for producing rum (2 tons of coffee, versus 6 tons for Nicaragua). The Dominican Republic, therefore, should specialize in rum.

b. The minimum price at which these countries will trade coffee is 1/6 (0.167) of a barrel of rum per ton of coffee and the maximum price is 1/2 (0.500) of a barrel of rum per ton of coffee. The price of coffee will end up between the opportunity costs for the two countries. Nicaragua specializes in coffee because it has the lower opportunity cost (1/6 as compared to 1/2). It will not sell coffee for less than its opportunity cost. The Dominican Republic will not pay more than its opportunity cost (1/2) because if the price of coffee was higher than 1/2 of a barrel of rum, then it would be better off producing the coffee itself.

14. 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 gallons of milk per week. Joanna can gather 2 dozen eggs or collect 2 gallons of milk per week. **[LO 2.3]**

a. The family wants 2 gallons of milk per week and as many eggs as the sisters can gather. Currently, Eleanor and Joanna collect one gallon of milk each and as many eggs as they can. How many dozens of eggs does the family have per week?

b. If the sisters specialized, which sister should collect the milk?

c. If the sisters specialized, how many dozens of eggs would the family have per week?

Answer: Comparative advantage is the ability to produce a good or service at a lower opportunity cost than others.

a. Eleanor's opportunity cost for collecting a gallon of milk is 3 dozen eggs. Therefore Eleanor will gather 9-3 = 6 dozen eggs. Joanna's opportunity cost for collecting a gallon of milk is 1 dozen eggs. Therefore, Joanna will gather 2-1 = 1 dozen eggs. *Together the sisters*

will gather 7 bushels of apples.

b. Joanna should specialize in collecting milk because she has the lower opportunity cost.

c. If they specialize, Joanna will collect both gallons of milk and no eggs. Eleanor will collect 9 dozen eggs and no milk. The family will now have 9 dozen eggs with their 2 gallons of milk, more than they were able to have before the sisters specialized.

15. Suppose Russia and Sweden each produces only paper and cars. Russia can produce 8 tons of paper or 4 million cars each year. Sweden can produce 25 tons 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."

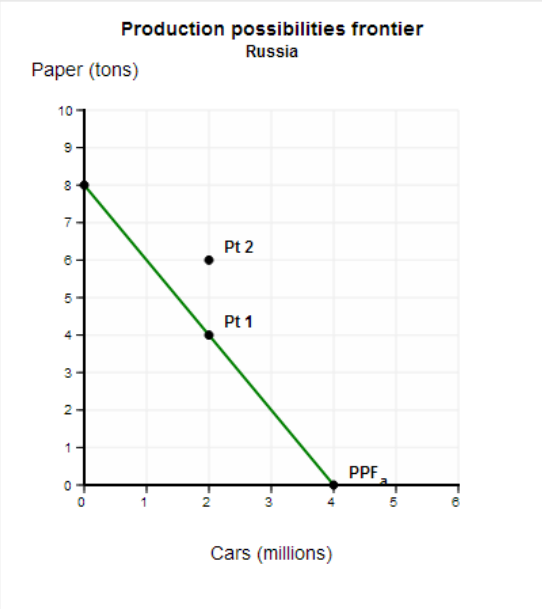
c. Suppose the countries specialize. Which country will produce cars?

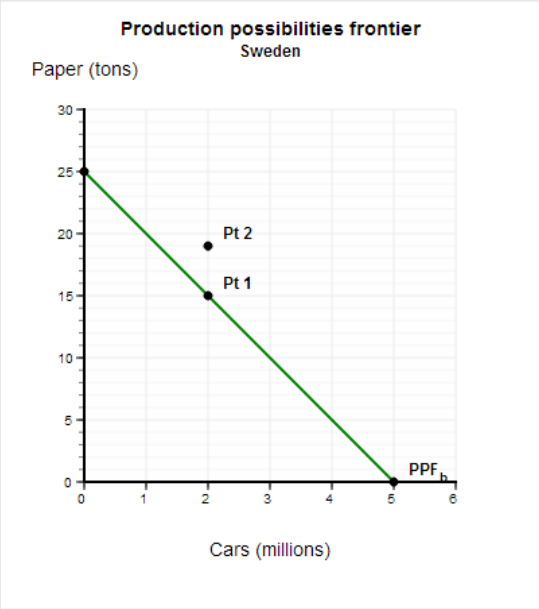
d. Once they specialize, suppose they work out a trade of 2 million cars for 6 tons of paper. Find the new consumption point for each country and label it "B."

Answer:

a. The production possibilities frontier identifies the different combinations of the two goods (cars and paper) that can be produced by each country. Russia can produce 8 tons of paper and 0 cars or 0 tons of paper and 4 million cars. These are the two endpoints of Russia's PPF. Sweden can produce 25 tons of paper and 0 cars or 0 tons of paper and 5 million cars. These are the two endpoints of Sweden's PPF.

b. If Russia wants to produce 2 million cars then they are only able to produce 4 tons of paper. If Sweden wants to produce 2 million cars then they are only able to produce 15 tons of paper. Notice Russia's opportunity cost of producing 1 million cars is 2 tons of paper, and Sweden's opportunity cost of producing 1 million cars is 5 tons of paper





c. Russia will produce cars because Russia has a lower opportunity cost for producing cars than Sweden.
d. Russia will produce 4 million cars (complete specialization is assumed) and trade 2 million cars to Sweden in exchange for 6 tons of paper. Therefore, Russia ends up consuming 2 million cars and 6 tons of paper. Sweden will produce 25 tons of paper and trade 6 tons of paper to Russia in exchange for 2 million cars. Therefore, Sweden ends up consuming 2 million cars and 19 tons of paper. Both counties are better of with trade because they still have 2 million cars each, but both end up with more paper than they had before trade. Notice the post-trade consumption point is outside the production possibilities frontier meaning each country was unable to achieve this point without trade.

16. Maya and Max are neighbors. They both grow lettuce and tomatoes in their gardens. Maya can grow 45 heads of lettuce or 9 pounds of tomatoes this summer. Max can grow 42 heads of lettuce or 6 pounds of tomatoes this summer. If Maya and Max specialize and trade, the price of tomatoes (in terms of lettuce) would be as follows: 1 pound of tomatoes would cost between __ and __ heads of lettuce.

Answer: If Maya and Max specialize and trade, the price of tomatoes (in terms of lettuce) would be: 1 pound of tomatoes would cost between 5 and 7 heads of lettuce. Maya will grow tomatoes because she has the lower opportunity cost. (Maya's opportunity cost is 5 heads of lettuce for 1 pound of tomatoes, whereas Max's is 7 heads of lettuce for 1 pound of tomatoes.) She must receive at least 5 heads of lettuce from Max for a pound of tomatoes or she is better off growing the lettuce herself. Max will buy tomatoes from Maya but only if she charges him no more than 7 heads of lettuce. Otherwise, Max is better off growing the tomatoes himself. If, for example, Maya charges Max 6 heads of lettuce for a pound of tomatoes both neighbors would be better off than what they can do on their own.

APPENDIX B
MATH ESSENTIALS: WORKING WITH LINEAR EQUATIONS

Learning Objectives

LO B.1: Use linear equations to interpret the equation of a line.
LO B.2: Use linear equations to explain shifts and pivots.
LO B.3: Use linear equations to solve for equilibrium.

Appendix Outline

Interpreting the Equation of a Line **(LO B.1)**
- Turning the graph into an equation
- Turning the equation into a graph
- Equations with *x* and *y* reversed

Shifts and Pivots **(LO B.2)**
Solving for Equilibrium **(LO B.3)**

Problems and Applications

1. Use the demand curve in Figure BP-1 to derive a demand equation. **[LO B.1]**

   Answer: First, use the endpoints to calculate the slope. The slope is the rise over the run, or the change in the Y, or price, direction (120 - 0), divided by the change in the X, or quantity, direction (0 - 40). The slope is 120/-40 or -3.

   To find the Y-intercept, look at the graph and determine where the line intersects the Y-axis. This occurs at $120, so the Y-intercept is 120.

   The equation is then: P = 120 - 3Q.

2. Use the demand schedule in Table BP-1 to derive a demand equation. **[LO B.1]**

   Answer: The y-intercept occurs where quantity demanded = 0, or 80. The slope is the change in price (10) divided by the change in quantity demanded (-40), which is (-10/40) or -0.25. The equation is P = 80 - 0.25Q.

3. Use the supply curve in Figure BP-2 to derive a supply equation. **[LO B.1]**

Answer: The y-intercept occurs where the line crosses the *y*-axis, which in this case is 0. The slope is the rise over the run, or the change in price (2) divided by the change in quantity (40), which is (2/40) or 0.05. The equation is P = 0.05Q.

4. Use the supply schedule in Table BP-2 to derive a supply equation. **[[LO B.1]**

Answer: The y-intercept occurs where quantity supplied = 0, or 100. The slope is the change in price (100) divided by the change in quantity supplied (25), which is (100/25) or 4. The equation is P = 100 + 4Q.

5. Graph the equation P = 2Q + 3. Is this the supply curve or demand curve? **[LO B.1]**

Answer: This line slopes upward, so it is a supply curve. The slope is the rise over the run or the change in price (13 - 3) divided by the change in quantity (5 - 0). This curve has a slope of (10/5) or 2.

6. Graph the equation P = -8Q + 10. Is this the supply curve or demand curve? **[LO B.1]**

Answer: This line slopes downward, so it is a demand curve. The slope is the rise over the run or the change in price (10 - 0) divided by the change in quantity (0 - 1.25), which is (10/-1.25) or -8.

7. Rearrange the equation Q = 5 – 0.25P and sketch the graph. Is this a supply curve or a demand curve? **[LO B.1]**

Answer: Start with Q = 5 - 0.25P. Subtract 5 from both sides: Q – 5 = - 0.25P. Divide both sides by - 0.25: -4Q + 20 = P. Re-arrange: P = 20 - 4Q. This is a downward-sloping demand curve.

8. Rearrange the equation Q = 0.2P and sketch the graph. Is this a supply curve or a demand curve? **[LO B.1]**

Answer: Start with Q = 0.2P. Divide both sides by 0.2: 5Q = P. Re-arrange: P = 5Q. This is an upward-sloping line, so it is a supply curve.

9. The entrance fee at your local amusement park is $20 for the day. The entrance fee includes all rides except roller coasters. Roller coasters cost an extra $2 per ride. **[LO B.2]**

a. Write an equation that represents how much money you will spend on rides as a function of the number of rides you on: S = total spending on rides; Q = the quantity of roller coasters rides.

b. What is your total spend on rides if you ride 4 roller coasters?

c. Draw a graph of the relationship between total spending on rides and the number of roller coaster rides.
d. Redraw the graph from part (c) to show what changes if the entrance fee increases to $25.
e. Rewrite the equation from part (a) to incorporate the increased entrance fee of $25.
f. After the entrance fee increases to $25, what is your total spending on rides if you ride 4 roller coasters?

Answer: a. The y-intercept is 20, which is the cost of the entrance fee when no roller coasters are ridden. Every additional roller coaster ride costs $2. So, the equation of the line is S = 20 + 2Q.

b. If you ride 4 roller coasters, you will pay $20 for entry plus $2 × 4 for the four rides. The total is $28.

c. See the correct graph below. The line should start at a price of $20 and a quantity of 0 roller coaster rides and end at a price of $40 and a quantity of 10 roller coaster rides.

d. If the entrance fee increases to $25, the line will shift up by $5, but will be parallel to the original line. It will start at $25 and 0 roller coaster rides and end at $45 and 10 roller coaster rides.

e. Since the entrance fee is all that has changed, only the y-intercept changes in the equation. The new equation is S = 25 + 2Q.

f. If you ride 4 roller coasters, you will pay $25 for entry plus $2 × 4 for the four rides. The total is $33.

10. Use the following two equations: **[LO B.3]**

(1) P = 12 – 2Q

(2) P = 3 +Q

a. Find the equilibrium price and quantity.

b. Graph the demand and supply equations. Illustrate the equilibrium point.

Answer:

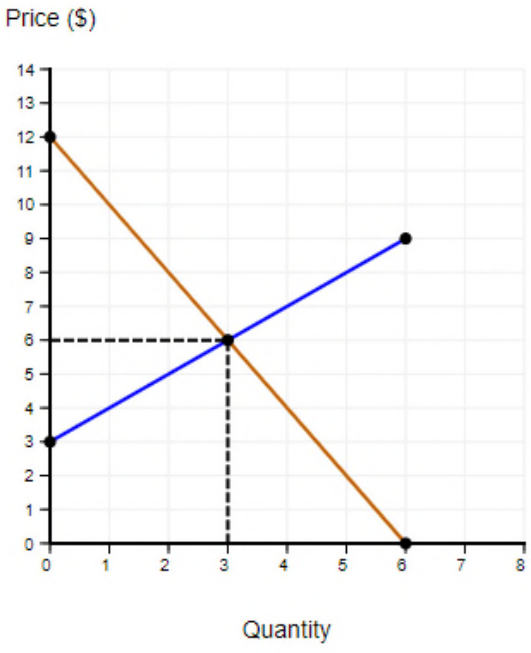
a. Setting the equations equal to each other: 12 – 2Q = 3+ Q. Solving for Q: 9 = 3Q or Q = 3. Substituting into either equation: P = 12 – 2(3) = $6.

The x-intercept for the demand line occurs where P = 0. So 0 = 12 - 2Q. Solving, -12 = -2Q, so the x-intercept is Q = 6.

The y-intercept for the demand line occurs where Q = 0. So the y-intercept is P = 120.

The y-intercept for the supply line occurs where Q = 0. So the y-intercept is P = 3.

The endpoint for the supply line is determined where Q = 6. So when Q = 6, P = 3 + 6 or $9.



11. With reference to Table BP-3: **[LO B.3]**
a. Use the information from the table to create the demand and supply equations.
b. Use your demand and supply equations to solve for equilibrium.
c. Graph supply and demand curves. Illustrate the equilibrium point.

Answer: a. The y-intercept of the demand equation occurs where the quantity demanded is 0 at 120. The slope of the demand equation is the change in P (20) divided by the change in quantity demand (-2) or -10. The demand equation is P = 120 – 10Q.

The y-intercept of the supply equation occurs where the quantity supplied is 0 at 0. The slope of the supply equation is the change in P (20) divided by the change in quantity supplied (4) or 5. The supply equation is P = 5Q.

b. Setting the equations equal to each other: 120 – 10Q = 5Q. Solving for Q: 120 = 15Q Q = 8. Substituting into either equation: P = 120 – 10(8) = $40.

The x-intercept for the demand line occurs where P = 0. So 0 = 120 - 10Q. Solving: -120 = -10Q, so the x-intercept is Q = 12.

The y-intercept for the demand line occurs where Q = 0. So the y-intercept is P = 120.

The y-intercept for the supply line occurs where Q = 0. So the y-intercept is P = 0.

The endpoint for the supply line is determined where Q = 24. So when Q = 24, P = 5 (24) or $120. This is also shown in the table.

c.