chapter

3

The Standard Theory of International Trade

LEARNING GOALS:

After reading this chapter, you should be able to:

- Understand how relative commodity prices and the comparative advantage of nations are determined under increasing costs
- Show the basis and the gains from trade with increasing costs
- Explain the relationship between international trade and deindustrialization in the United States and other advanced nations

3.1 Introduction

This chapter extends our simple trade model to the more realistic case of increasing opportunity costs. Tastes or demand preferences are introduced with community indifference curves. We then see how these forces of supply and demand determine the equilibrium-relative commodity price in each nation in the absence of trade under increasing costs. This will also indicate the commodity of comparative advantage for each nation.

Subsequently, we examine how, with trade, each nation gains by specializing in the production of the commodity of its comparative advantage and exporting some of its output in exchange for the commodity of its comparative disadvantage. The last section of the chapter shows how mutually beneficial trade is possible even when two nations are exactly alike except for tastes under increasing cost conditions.

In this and in the following chapters, it will be convenient to generalize the presentation and deal with Nation 1 and Nation 2 (instead of the United States and United Kingdom) and commodity X and commodity Y (instead of wheat and cloth).

The appendix to this chapter is a review of those aspects of production theory that are essential for understanding the material presented in the appendices of the chapters that follow. This and the subsequent appendices can be omitted without loss of continuity in the text.

3.2 The Production Frontier with Increasing Costs

It is more realistic for a nation to face increasing rather than constant opportunity costs. Increasing opportunity costs mean that the nation must give up more and more of one commodity to release just enough resources to produce each additional unit of another commodity. Increasing opportunity costs result in a production frontier that is concave from the origin (rather than a straight line).

3.2A Illustration of Increasing Costs

Figure 3.1 shows the hypothetical production frontier of commodities X and Y for Nation 1 and Nation 2. Both production frontiers are concave from the origin, reflecting the fact that each nation incurs increasing opportunity costs in the production of *both* commodities.

Suppose that Nation 1 wants to produce more of commodity X, starting from point *A* on its production frontier. Since at point *A* the nation is already utilizing all of its resources with the best technology available, the nation can only produce more of X by reducing the output of commodity Y. (In Chapter 2, we saw that this is the reason production frontiers are negatively sloped.)

Figure 3.1 shows that for each additional batch of 20X that Nation 1 produces, it must give up more and more Y. The increasing opportunity costs in terms of Y that Nation 1 faces are reflected in the longer and longer downward arrows in the figure, and result in a production frontier that is concave from the origin.

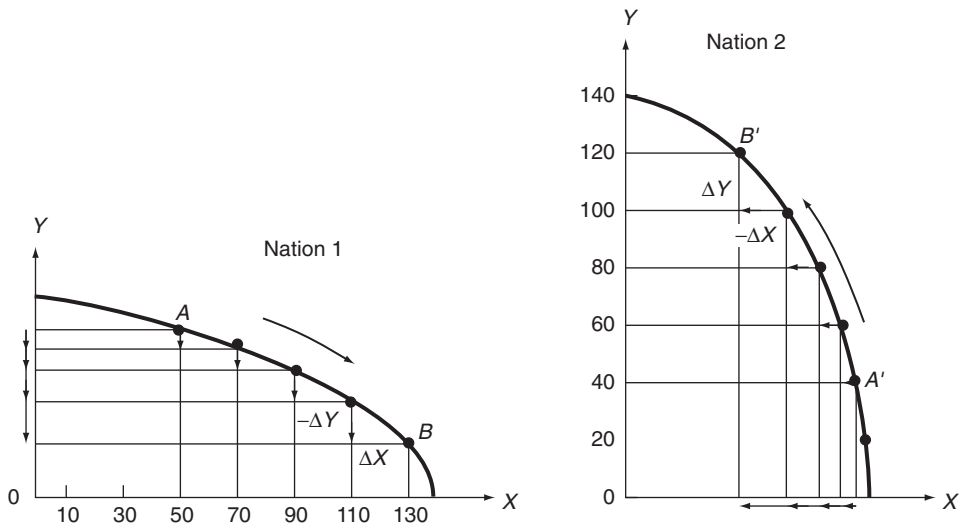

FIGURE 3.1. Production Frontiers of Nation 1 and Nation 2 with Increasing Costs.
Concave production frontiers reflect increasing opportunity costs in each nation in the production of *both* commodities. Thus, Nation 1 must give up more and more of Y for each additional batch of 20X that it produces. This is illustrated by downward arrows of increasing length. Similarly, Nation 2 incurs increasing opportunity costs in terms of forgone X (illustrated by the increasing length of the leftward arrows) for each additional batch of 20Y it produces.

Nation 1 also faces increasing opportunity costs in the production of Y. This could be demonstrated graphically by showing that Nation 1 has to give up increasing amounts of X for each additional batch of 20Y that it produces. However, instead of showing this for Nation 1, we demonstrate increasing opportunity costs in the production of Y with the production frontier of Nation 2 in Figure 3.1.

Moving upward from point A' along the production frontier of Nation 2, we observe leftward arrows of increasing length, reflecting the increasing amounts of X that Nation 2 must give up to produce each additional batch of 20Y. Thus, concave production frontiers for Nation 1 and Nation 2 reflect increasing opportunity costs in each nation in the production of *both* commodities.

3.2B The Marginal Rate of Transformation

The marginal rate of transformation (MRT) of X for Y refers to the amount of Y that a nation must give up to produce each additional unit of X. Thus, MRT is another name for the opportunity cost of X (the commodity measured along the horizontal axis) and is given by the (absolute) *slope* of the production frontier at the point of production.

If in Figure 3.1 the slope of the production frontier (MRT) of Nation 1 at point A is ¼, this means that Nation 1 must give up ¼ of a unit of Y to release just enough resources to produce one additional unit of X at this point. Similarly, if the slope, or MRT, equals 1 at point B, this means that Nation 1 must give up one unit of Y to produce one additional unit of X at this point.

Thus, a movement from point A down to point B along the production frontier of Nation 1 involves an increase in the slope (MRT) from ¼ (at point A) to 1 (at point B) and reflects the increasing opportunity costs in producing more X. This is in contrast to the case of a straight-line production frontier (as in Chapter 2), where the opportunity cost of X is constant regardless of the level of output and is given by the constant value of the slope (MRT) of the production frontier.

3.2C Reasons for Increasing Opportunity Costs and Different Production Frontiers

We have examined the meaning of increasing opportunity costs as reflected in concave production frontiers. But how do increasing opportunity costs arise? And why are they more realistic than constant opportunity costs?

Increasing opportunity costs arise because resources or factors of production (1) are not homogeneous (i.e., all units of the same factor are not identical or of the same quality) and (2) are not used in the *same* fixed proportion or intensity in the production of all commodities. This means that as the nation produces more of a commodity, it must utilize resources that become progressively less efficient or less suited for the production of that commodity. As a result, the nation must give up more and more of the second commodity to release just enough resources to produce each additional unit of the first commodity.

For example, suppose some of a nation's land is flat and suited for growing wheat, and some is hilly and better suited for grazing and milk production. The nation originally specialized in wheat but now wants to concentrate on producing milk. By transferring its

hilly areas from wheat growing to grazing, the nation gives up very little wheat and obtains a great deal of milk. Thus, the opportunity cost of milk in terms of the amount of wheat given up is initially small. But if this transfer process continues, eventually flat land, which is better suited for wheat growing, will have to be used for grazing. As a result, the opportunity cost of milk will rise, and the production frontier will be concave from the origin.

The difference in the production frontiers of Nation 1 and Nation 2 in Figure 3.1 is due to the fact that the two nations have different factor endowments or resources at their disposal and/or use different technologies in production. In the real world, the production frontiers of different nations will usually differ, since practically no two nations have identical factor endowments (even if they could have access to the same technology).

As the supply or availability of factors and/or technology changes over time, a nation's production frontier shifts. The type and extent of these shifts depend on the type and extent of the changes that take place. These changes are examined in detail in Chapter 7, which deals with economic growth and its effect on international trade.

3.3 Community Indifference Curves

So far, we have discussed production, or supply, considerations in a nation, as reflected in its production frontier. We now introduce the tastes, or demand preferences, in a nation. These are given by community (or social) indifference curves.

A community indifference curve shows the various combinations of two commodities that yield equal satisfaction to the community or nation. Higher curves refer to greater satisfaction, lower curves to less satisfaction. Community indifference curves are negatively sloped and convex from the origin. To be useful, they must not cross. (Readers familiar with an individual's indifference curves will note that community indifference curves are almost completely analogous.)

3.3A Illustration of Community Indifference Curves

Figure 3.2 shows three hypothetical indifference curves for Nation 1 and Nation 2. They differ on the assumption that tastes, or demand preferences, are different in the two nations.

Points N and A give equal satisfaction to Nation 1, since they are both on indifference curve I. Points T and H refer to a higher level of satisfaction, since they are on a higher indifference curve (II). Even though T involves more of Y but less of X than A, satisfaction is greater at T because it is on indifference curve II. Point E refers to still greater satisfaction, since it is on indifference curve III. For Nation 2, $A' = R' < H' < E'$.

Note that the community indifference curves in Figure 3.2 are negatively sloped. This is always the case because as a nation consumes more of X, it must consume less of Y if the nation is to have the same level of satisfaction (i.e., remain on the same level of satisfaction). Thus, as Nation 1 moves from N to A on indifference curve I, it consumes more of X but less of Y. Similarly, as Nation 2 moves from A' to R' on indifference curve I′, it consumes more of X but less of Y. If a nation continued to consume the same amount of Y as it increased its consumption of X, the nation would necessarily move to a higher indifference curve.

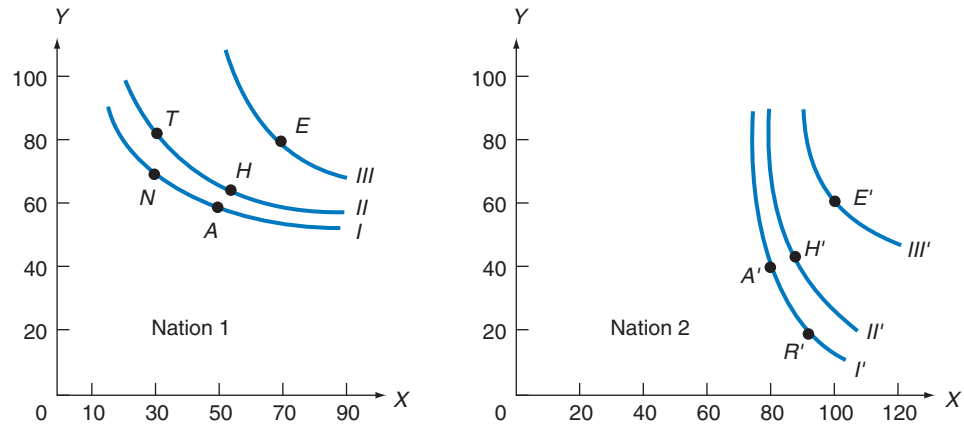

FIGURE 3.2. Community Indifference Curves for Nation 1 and Nation 2.
A community indifference curve shows the various combinations of X and Y that yield equal satisfaction to the community or nation. A higher curve refers to a higher level of satisfaction. Community indifference curves are downward, or negatively, sloped and convex from the origin; to be useful, they must not cross. The declining slope of the curve reflects the diminishing marginal rate of substitution (MRS) of X for Y in consumption.

3.3B The Marginal Rate of Substitution

The marginal rate of substitution (MRS) of X for Y in consumption refers to the amount of Y that a nation could give up for one extra unit of X and *still remain on the same indifference curve*. This is given by the (absolute) slope of the community indifference curve at the point of consumption and declines as the nation moves down the curve. For example, the slope, or MRS, of indifference curve I is greater at point N than at point A (see Figure 3.2). Similarly, the slope, or MRS, of indifference curve I′ is greater at point A' than at R'.

The decline in MRS or absolute slope of an indifference curve is a reflection of the fact that the more of X and the less of Y a nation consumes, the more valuable to the nation is a unit of Y at the margin compared with a unit of X. Therefore, the nation can give up less and less of Y for each additional unit of X it wants.

Declining MRS means that community indifference curves are convex from the origin. Thus, while *increasing* opportunity cost in production is reflected in *concave* production frontiers, a *declining* marginal rate of substitution in consumption is reflected in *convex* community indifference curves. In Section 3.4, we will see that this convexity property of indifference curves is necessary to reach a unique (i.e., a single), well-behaved equilibrium consumption point for the nation.

3.3C Some Difficulties with Community Indifference Curves

As we said earlier, to be useful, community indifference curves must not intersect (cross). A point of intersection would refer to equal satisfaction on two different community indifference curves, which is inconsistent with their definition. Thus, the indifference curves of Nation 1 and Nation 2 in Figure 3.2 are drawn as nonintersecting.

However, a particular set, or map, of community indifference curves refers to a particular *income distribution* within the nation. A different income distribution would result in a completely new set of indifference curves, which might intersect previous indifference curves.

This is precisely what may happen as a nation opens trade or expands its level of trade. Exporters will benefit, while domestic producers competing with imports will suffer. There is also a differential impact on consumers, depending on whether an individual's consumption pattern is oriented more toward the X or the Y good. Thus, trade will change the distribution of real income in the nation and *may* cause indifference curves to intersect. In that case, we could not use community indifference curves to determine whether the opening or the expansion of trade increased the nation's welfare.

One way out of this impasse is through the so-called *compensation principle*. According to this principle, the nation benefits from trade if the gainers would be better off (i.e., retain some of their gain) even after fully compensating the losers for their losses. This is true whether or not compensation actually occurs. (One way that compensation would occur is for the government to tax enough of the gain to fully compensate the losers with subsidies or tax relief.) Alternatively, we could make a number of restrictive assumptions about tastes, incomes, and patterns of consumption that would preclude intersecting community indifference curves.

Although the compensation principle or restrictive assumptions do not completely eliminate all the conceptual difficulties inherent in using community indifference curves, they do allow us to draw them as nonintersecting (so that we can continue to make use of them, even if a bit cautiously).

3.4 Equilibrium in Isolation

In Section 3.2, we discussed production frontiers, which illustrate the production, or supply, conditions in a nation. In Section 3.3, we examined community indifference curves, which reflect the tastes, or demand preferences, in a nation. We will now see how the interaction of these forces of demand and supply determines the equilibrium point, or point of maximum social welfare, in a nation in isolation (i.e., in the absence of trade).

In the absence of trade, a nation is in equilibrium when it reaches the highest indifference curve possible given its production frontier. This occurs at the point where a community indifference curve is tangent to the nation's production frontier. The common slope of the two curves at the tangency point gives the internal equilibrium-relative commodity price in the nation and reflects the nation's comparative advantage. Let us see what all this means.

3.4A Illustration of Equilibrium in Isolation

Figure 3.3 brings together the production frontiers of Figure 3.1 and the community indifference curves of Figure 3.2. We see in Figure 3.3 that indifference curve I is the highest indifference curve that Nation 1 can reach with its production frontier. Thus, Nation 1 is in equilibrium, or maximizes its welfare, when it produces and consumes at point A in the absence of trade, or autarky. Similarly, Nation 2 is in equilibrium at point A', where its production frontier is tangent to indifference curve I′.

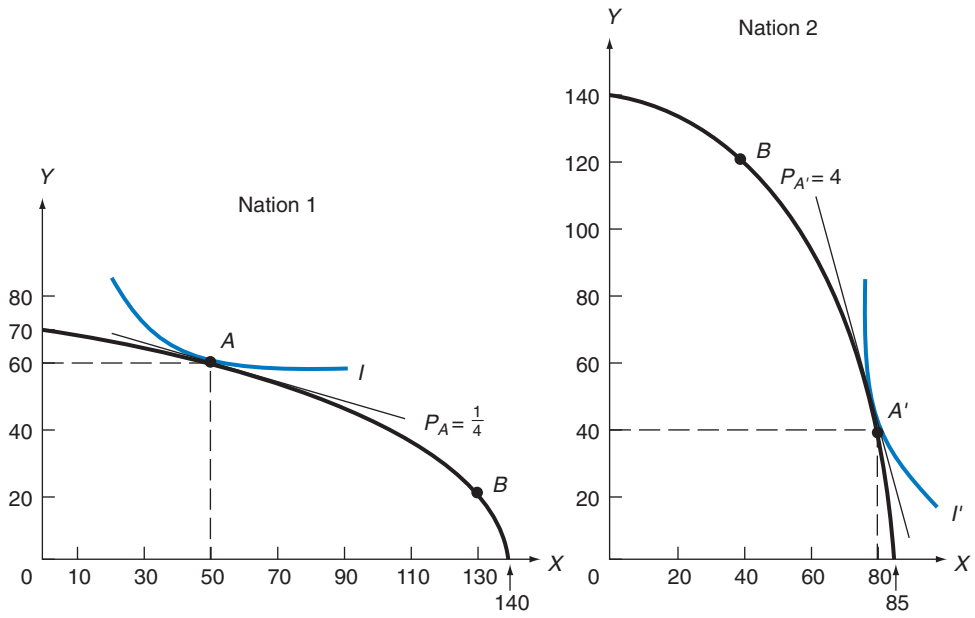

FIGURE 3.3. Equilibrium in Isolation.
Nation 1 is in equilibrium, or maximizes its welfare, in isolation by producing and consuming at point *A*, where its production frontier reaches (is tangent to) indifference curve I (the highest possible). Similarly, Nation 2 is in equilibrium at point *A*′, where its production frontier is tangent to indifference curve I′. The equilibrium-relative price of X in Nation 1 is given by the slope of the tangent common to its production frontier and indifference curve I at point *A*. This is $P_A = 1/4$. For Nation 2, $P_{A'} = 4$. Since the relative price of X is lower in Nation 1 than in Nation 2, Nation 1 has a comparative advantage in commodity X and Nation 2 in commodity Y.

Note that since community indifference curves are convex from the origin and drawn as nonintersecting, there is only one such point of tangency, or equilibrium. Furthermore, we can be certain that one such equilibrium point exists because there are an infinite number of indifference curves (i.e., the indifference map is dense). Points on lower indifference curves are possible but would not maximize the nation's welfare. On the other hand, the nation cannot reach higher indifference curves with the resources and technology presently available.

3.4B Equilibrium-Relative Commodity Prices and Comparative Advantage

The equilibrium-relative commodity price in isolation is given by the slope of the tangent common to the nation's production frontier and indifference curve at the autarky point of production and consumption. Thus, the equilibrium-relative price of X in isolation is $P_A = P_X/P_Y = 1/4$ in Nation 1 and $P_{A'} = P_X/P_Y = 4$ in Nation 2 (see Figure 3.3). Relative prices are different in the two nations because their production frontiers and indifference curves differ in shape and location.

CASE STUDY 3-1 Comparative Advantage of the Largest Advanced and Emerging Economies

Table 3.1 gives some of the manufactured products in which the United States, the European Union, Japan, China, and Brazil have a comparative advantage (i.e., in which they had a trade surplus) in 2010.

TABLE 3.1. The Comparative Advantage of the United States, European Union, Japan, China, Brazil, and Korea in 2010

United States:	Chemicals other than pharmaceuticals, aircraft, integrated circuits, nonelectrical machinery, and scientific and controlling instruments
European Union:	Iron and steel, chemicals (including pharmaceuticals), transport equipment (automobiles and aircraft), all types of machinery, and scientific and controlling instruments
Japan:	Iron and steel, chemicals other than pharmaceuticals, office and telecom equipment and most other types of machinery, automobiles and other transport equipment, and scientific and controlling instruments
China:	Iron and steel, pharmaceuticals, office and telecom equipment and most other types of machinery other than integrated circuits, transport equipment other than automobiles, power generating and electrical machinery, textiles and clothing, and personal household goods
Brazil:	Iron and steel, and transport equipment other than automobiles, and personal and household goods

Source: World Trade Organization, *International Trade Statistics* (Geneva: WTO, 2011).

Since in isolation $P_A < P_A'$ Nation 1 has a comparative advantage in commodity X and Nation 2 in commodity Y. It follows that both nations can gain if Nation 1 specializes in the production and export of X in exchange for Y from Nation 2. How this takes place will be seen in the next section.

Figure 3.3 illustrates that the forces of supply (as given by the nation's production frontier) and the forces of demand (as summarized by the nation's indifference map) *together* determine the equilibrium-relative commodity prices in each nation in autarky. For example, if indifference curve I had been of a different shape, it would have been tangent to the production frontier at a different point and would have determined a different relative price of X in Nation 1. The same would be true for Nation 2. This is in contrast to the constant costs case, where the equilibrium P_X/P_Y is constant in each nation regardless of the level of output and conditions of demand, and is given by the constant slope of the nation's production frontier.

Case Study 3-1 gives the comparative advantage of the largest advanced and emerging market economies in manufactured products.

3.5 The Basis for and the Gains from Trade with Increasing Costs

A difference in relative commodity prices between two nations is a reflection of their comparative advantage and forms the basis for mutually beneficial trade. The nation with the lower relative price for a commodity has a comparative advantage in that commodity

and a comparative disadvantage in the other commodity, with respect to the second nation. Each nation should then specialize in the production of the commodity of its comparative advantage (i.e., produce more of the commodity than it wants to consume domestically) and exchange part of its output with the other nation for the commodity of its comparative disadvantage.

However, as each nation specializes in producing the commodity of its comparative advantage, it incurs increasing opportunity costs. Specialization will continue until relative commodity prices in the two nations become equal at the level at which trade is in equilibrium. By then trading with each other, both nations end up consuming more than in the absence of trade.

3.5A Illustrations of the Basis for and the Gains from Trade with Increasing Costs

We have seen (Figure 3.3) that in the absence of trade the equilibrium-relative price of X is $P_A = 1/4$ in Nation 1 and $P_{A'} = 4$ in Nation 2. Thus, Nation 1 has a comparative advantage in commodity X and Nation 2 in commodity Y.

Suppose that trade between the two nations becomes possible (e.g., through the elimination of government obstacles to trade or a drastic reduction in transportation costs). Nation 1 should now specialize in the production and export of commodity X in exchange for commodity Y from Nation 2. How this takes place is illustrated by Figure 3.4.

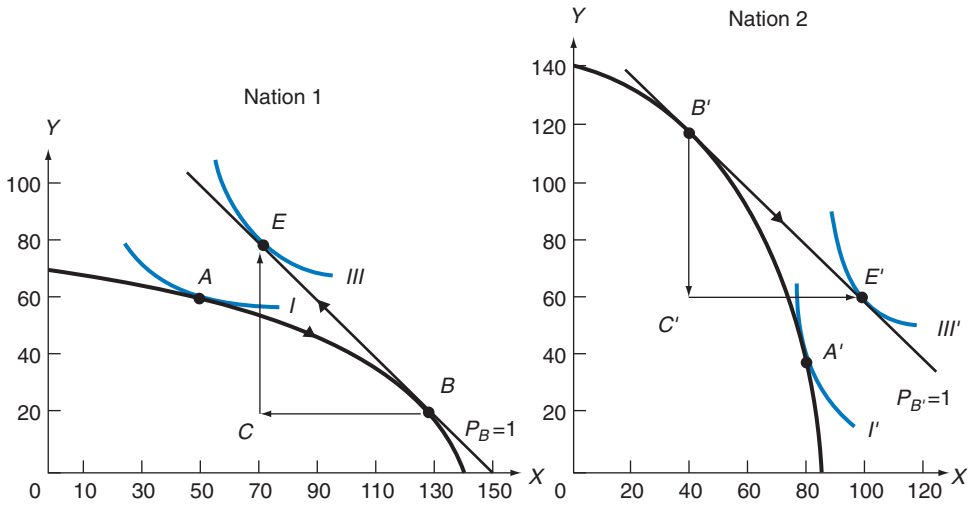

FIGURE 3.4. The Gains from Trade with Increasing Costs.
With trade, Nation 1 moves from point *A* to point *B* in production. By then exchanging 60X for 60Y with Nation 2 (see trade triangle *BCE*), Nation 1 ends up consuming at point *E* (on indifference curve III). Thus, Nation 1 gains 20X and 20Y from trade (compare autarky point *A* with point *E*). Similarly, Nation 2 moves from *A′* to *B′* in production. By then exchanging 60Y for 60X with Nation 1 (see trade triangle *B′C′E′*), Nation 2 ends up consuming at point *E′* and also gains 20X and 20Y. $P_B = P_{B'} = 1$ is the equilibrium-relative price—the price at which trade is balanced.

Starting from point A (the equilibrium point in isolation), as Nation 1 specializes in the production of X and moves *down* its production frontier, it incurs increasing opportunity costs in the production of X. This is reflected in the increasing *slope* of its production frontier. Starting from point A', as Nation 2 specializes in the production of Y and moves *upward* along its production frontier, it experiences increasing opportunity costs in the production of Y. This is reflected in the *decline in the slope* of its production frontier (a reduction in the opportunity cost of X, which means a rise in the opportunity cost of Y).

This process of specialization in production continues until relative commodity prices (the slope of the production frontiers) become equal in the two nations. The common relative price (slope) with trade will be somewhere between the pretrade relative prices of ¼ and 4, at the level at which trade is balanced. In Figure 3.4, this is $P_B = P_{B'} = 1$.

With trade, Nation 1 moves from point A down to point B in production. By then exchanging 60X for 60Y with Nation 2 (see trade triangle BCE), Nation 1 ends up consuming at point E (70X and 80Y) on its indifference curve III. This is the highest level of satisfaction that Nation 1 can reach with trade at $P_X/P_Y = 1$. Thus, Nation 1 gains 20X and 20Y from its no-trade equilibrium point. (Compare point E on indifference curve III with point A on indifference curve I.) Line BE is called the *trade possibilities line* or, simply, *trade line* because trade takes place along this line.

Similarly, Nation 2 moves from point A' up to point B' in production, and, by exchanging 60Y for 60X with Nation 1 (see trade triangle $B'C'E'$), it ends up consuming at point E' (100X and 60Y) on its indifference curve III′. Thus, Nation 2 also gains 20X and 20Y from specialization in production and trade.

Note that with specialization in production and trade, each nation can consume outside its production frontier (which also represents its no-trade consumption frontier).

3.5B Equilibrium-Relative Commodity Prices with Trade

The equilibrium-relative commodity price with trade is the common relative price in both nations at which trade is balanced. In Figure 3.4, this is $P_B = P_{B'} = 1$. At this relative price, the amount of X that Nation 1 wants to export (60X) equals the amount of X that Nation 2 wants to import (60X). Similarly, the amount of Y that Nation 2 wants to export (60Y) exactly matches the amount of Y that Nation 1 wants to import at this price (60Y).

Any other relative price could not persist because trade would be unbalanced. For example, at $P_X/P_Y = 2$, Nation 1 would want to export more of X than Nation 2 would be willing to import at this high price. As a result, the relative price of X would fall toward the equilibrium level of 1. Similarly, at a relative price of X lower than 1, Nation 2 would want to import more of X than Nation 1 would be willing to export at this low price, and the relative price of X would rise. Thus, the relative price of X would gravitate toward the equilibrium price of 1. (The same conclusion would be reached in terms of Y.)

The equilibrium-relative price in Figure 3.4 was determined by trial and error; that is, various relative prices were tried until the one that balanced trade was found. There is a more rigorous theoretical way to determine the equilibrium-relative price with trade. This makes use of either the total demand and supply curve of each commodity in each nation or the so-called offer curves, and is discussed in the next chapter.

All we need to say at this point is that the greater Nation 1's desire is for Y (the commodity exported by Nation 2) and the weaker Nation 2's desire is for X (the commodity

exported by Nation 1), the closer the equilibrium price with trade will be to ¼ (the pretrade equilibrium price in Nation 1) and the smaller will be Nation 1's share of the gain. Once the equilibrium-relative price with trade is determined, we will know exactly how the gains from trade are divided between the two nations, and our trade model will be complete. In Figure 3.4, the equilibrium-relative price of X with trade ($P_B = P_{B'} = 1$) results in equal gains (20X and 20Y) for Nation 1 and Nation 2, but this need not be the case.

Of course, if the *pretrade-relative* price had been the same in both nations (an unlikely occurrence), there would be no comparative advantage or disadvantage to speak of in either nation, and no specialization in production or mutually beneficial trade would take place.

3.5c Incomplete Specialization

There is one basic difference between our trade model under increasing costs and the constant opportunity costs case. Under constant costs, both nations specialize completely in production of the commodity of their comparative advantage (i.e., produce only that commodity). For example, in Figures 2.2 and 2.3, the United States specialized completely in wheat production, and the United Kingdom specialized completely in cloth production. Since it paid for the United States to exchange some wheat for British cloth, it paid for the United States to obtain *all* of its cloth from the United Kingdom in exchange for wheat because the opportunity cost of wheat remained constant in the United States. The same was true for the United Kingdom in terms of cloth production.

In contrast, under increasing opportunity costs, there is incomplete specialization in production in both nations. For example, while Nation 1 produces more of X (the commodity of its comparative advantage) with trade, it continues to produce some Y (see point B in Figure 3.4). Similarly, Nation 2 continues to produce some X with trade (see point B' in Figure 3.4).

The reason for this is that as Nation 1 specializes in the production of X, it incurs increasing opportunity costs in producing X. Similarly, as Nation 2 produces more Y, it incurs increasing opportunity costs in Y (which means declining opportunity costs of X). Thus, as each nation specializes in producing the commodity of its comparative advantage, relative commodity prices move toward each other (i.e., become less unequal) until they are identical in both nations.

At that point, it does not pay for either nation to continue to expand production of the commodity of its comparative advantage (see Case Study 3-2). This occurs before either nation has completely specialized in production. In Figure 3.5, $P_B = P_B{}' = 1$ before Nation 1 or Nation 2 has completely specialized in production.

CASE STUDY 3-2 Specialization and Export Concentration in Selected Countries

Because of increasing costs, no nation specializes completely in the production of only one product in the real world. The closest to complete specialization in production and trade that any nation comes is Kuwait, where petroleum exports represented 92.1 percent of the total value of its exports in 2010. For Argentina, another developing nation with highly specialized natural

(continued)

CASE STUDY 3-2 Continued

resources, food exports represent 49.5 percent of its total exports. Table 3.2 shows that the largest export product of the United States, and the 27-member European Union (EU-27), represents less than 16 percent of their total exports. The figure is between 19 and 21 percent in Japan and Korea, and 28 and 30 percent in China and Brazil.

TABLE 3.2. Leading Export as a Percentage of Total Exports of Selected Countries in 2010

United States	Chemicals	14.8
European Union	Chemicals	15.8
Japan	Automotive products	19.4
Korea	Office and telecommunications equipment	25.7
China	Office and telecommunications equipment	28.5
Brazil	Food	30.1
Argentina	Food	49.5
Kuwait	Fuels	92.1

Source: World Trade Organization, *International Trade Statistics* (Geneva: WTO, 2011).

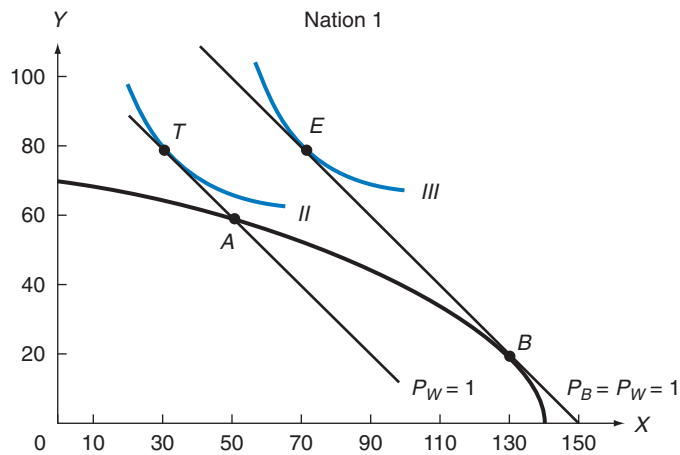

FIGURE 3.5. The Gains from Exchange and from Specialization.
If Nation 1 could not specialize in the production of X with the opening of trade but continued to produce at point *A*, Nation 1 could export 20X in exchange for 20Y at the prevailing world price of $P_W = 1$ and end up consuming at point *T* on indifference curve II. The increase in consumption from point *A* (in autarky) to point *T* represents the gains from exchange alone. If Nation 1 subsequently did specialize in the production of X and produced at point *B*, it would then consume at point *E* on indifference curve III. The increase in consumption from *T* to *E* would represent the gains from specialization in production.

3.5D Small-Country Case with Increasing Costs

Recall that under constant costs, the only exception to complete specialization in production occurred in the small-country case. There, only the small nation specialized completely in production of the commodity of its comparative advantage. The large nation continued to produce both commodities even with trade (see Figure 2.3) because the small nation could not satisfy all of the demand for imports of the large nation. In the increasing costs case, however, we find incomplete specialization even in the small nation.

We can use Figure 3.4 to illustrate the small-country case with increasing costs. Let us assume that Nation 1 is now a very small country, which is in equilibrium at point A (the same as before) in the absence of trade, and that Nation 2 is a very large country or even the rest of the world. (The diagram for Nation 2 in Figure 3.4 is to be completely disregarded in this case.)

Suppose that the equilibrium-relative price of X on the world market is 1($P_W = 1$), and it is not affected by trade with small Nation 1. Since in the absence of trade, the relative price of X in Nation 1 ($P_A = 1/4$) is lower than the world market price, Nation 1 has a comparative advantage in X. With the opening of trade, Nation 1 specializes in the production of X until it reaches point B on its production frontier, where $P_B = 1 = P_W$. Even though Nation 1 is now considered to be a small country, it still does not specialize completely in the production of X (as would be the case under constant costs).

By exchanging 60X for 60Y, Nation 1 reaches point E on indifference curve III and gains 20X and 20Y (compared with its autarky point A on indifference curve I). Note that this is exactly what occurred when Nation 1 was *not* considered to be small. The only difference is that now Nation 1 does not affect relative prices in Nation 2 (or the rest of the world), and Nation 1 captures all the benefits from trade (which now amount to only 20X and 20Y).

3.5E The Gains from Exchange and from Specialization

A nation's gains from trade can be broken down into two components: the gains from exchange and the gains from specialization. Figure 3.5 illustrates this breakdown for *small* Nation 1. (For simplicity, the autarky price line, $P_A = 1/4$, and indifference curve I are omitted from the figure.)

Suppose that, for whatever reason, Nation 1 could *not* specialize in the production of X with the opening of trade but continued to produce at point A, where MRT = 1/4. Starting from point A, Nation 1 could export 20X in exchange for 20Y at the prevailing world relative price of $P_W = 1$ and end up consuming at point T on indifference curve II. Even though Nation 1 consumes less of X and more of Y at point T in relation to point A, it is better off than it was in autarky because T is on higher indifference curve II. The movement from point A to point T in consumption measures the gains from exchange.

If subsequently Nation 1 also specialized in the production of X and produced at point B, it could then exchange 60X for 60Y with the rest of the world and consume at point E on indifference curve III (thereby gaining even more). The movement from T to E in consumption measures the gains from specialization in production.

In sum, the movement from A (on indifference curve I) to T (on indifference curve II) is made possible by exchange alone. This takes place even if Nation 1 remains at point A (the autarky point) in production. The movement from point T to E (on indifference curve III) represents the gains resulting from specialization in production.

Note that Nation 1 is not in equilibrium in production at point A with trade because MRT $< P_W$. To be in equilibrium in production, Nation 1 should expand its production of X until it reaches point B, where $P_B = P_W = 1$. Nation 2's gains from trade can similarly be broken down into gains from exchange and gains from specialization.

Case Study 3-3 illustrates the reallocation of labor in the United States as a real-world example of comparative advantage at work, while Case Study 3-4 shows that deindustrialization in the industrial countries as a group, in the United States, in the European Union, and in Japan was due mainly to increases in labor productivity or internal causes rather than foreign trade. During the past decade, however, huge trade deficits as well as the electronic revolution have led to many more job losses than gains in the United States.

CASE STUDY 3-3 Job Losses in High U.S. Import-Competing Industries

Table 3.3 shows the number of workers who lost their jobs (i.e., were displaced) in various high import-competing industries in the United States between 1979 and 1999. High import-competing industries were broadly defined as those in the top 25 percent in import shares. From the table, we see that almost 6.5 million workers lost their jobs in these industries over the 1979–1999 period, with the electrical machinery and apparel industries leading the list, with 1,181,000 and 1,136,000 jobs lost, respectively.

More recently, the AFL-CIO estimated that the nation has lost more than 2.5 million manufacturing jobs and more than 850,000 professional service and information sector jobs from 2001 to 2004. Forrester Research Inc. estimated that 588,000 U.S. jobs have been going overseas annually from 2005 to 2009 and predicts that U.S. employers will move another 3.4 million white-collar jobs overseas by 2015. As Case Study 3-4 shows, however, only a small fraction of these job losses were due to imports, as such. Most were lost to technological change and outsourcing.

TABLE 3.3. Job Losses in High Import-Competing Industries

Industry	Jobs Lost (thousands)	Industry	Jobs Lost (thousands)
Electrical machinery	1,181	Textiles	159
Apparel	1,136	Toys and sporting goods	156
Motor vehicles	918	Primary metals other than steel	133
Electronic computing equipment	513	Photographic equipment	68
Radio and television	395	Leather products	57
Steel	361	Office and accounting machines	41
Construction machinery	351	Pottery and related products	24
Tires and other rubber products	193	Watches and clocks	9
Footwear	184	Leather, tanning and finishing	5
Scientific instruments	164	Other industries	406
		Total	6,454

Sources: L. G. Kletzer, *Job Loss from Imports: Measuring the Costs* (Washington, D.C.: Institute for International Economics, 2001), pp. 18–19; AFL-CIO, ''Exporting America'' 2010, http://www.aflcio.org/issues/exportingamerica/outsourcing_problems.cfm; Forrester Research Inc., *Biz India Magazine*, December 26, 2009; and ''The Factory Floor Has a Ceiling on Job Creation,'' *The Wall Street Journal*, January 12, 2012, p. A6.

CASE STUDY 3-4 International Trade and Deindustrialization in the United States, the European Union, and Japan

Since the 1970s, most advanced economies have been concerned with the problem of *deindustrialization*, as reflected in their declining share of manufacturing employment. Table 3.4 shows the relative importance of the different factors accounting for deindustrialization in all advanced countries as a group, in the United States, in the European Union, and in Japan, from 1970 to 1994.

Table 3.4 shows that the overall share of manufacturing employment declined by about 10 percentage points in all industrial countries, as a group, and in the United States and in the European Union, and by about 4 percentage points in Japan. The table also shows, however, that most of this decline resulted from the growth of labor productivity (which made possible higher levels of output with less labor) and less as a result of the decline in the rate of investments and other domestic forces. International trade actually resulted in an increase in industrial employment (the negative signs indicate the opposite of deindustrialization), except in the United States (where it led to a 9.6 percentage point decline in manufacturing employment). During the past decade, however, huge trade deficits as well as the electronic revolution and outsourcing have led to many more job losses than gains in the United States. In fact, the percentage of the labor force in U.S. manufacturing declined from 30 percent in the 1970s to about 12 percent in 2012. This topic is explored further in Chapters 5, 8, and 9 of the text.

TABLE 3.4. Factors Responsible for Deindustrialization

	Industrial Countries	United States	European Union	Japan
Share of manufacturing Employment (in percent)				
1970	27.6	26.4	30.4	27.0
1994	18.0	16.0	20.2	23.2
Change	−9.6	−10.4	−10.2	−3.8
Percentage change due to:				
Productivity growth	65.6	65.4	59.8	157.9
Investment	18.8	3.8	20.6	71.1
Trade	(−)2.1	9.6	(−)2.9	(−)30.0
Other	17.7	21.2	22.5	(−)51.7
Total	100.0	100.0	100.0	100.0

Sources: International Monetary Fund, *Staff Studies for the World Economic Outlook*, Washington, D.C., December 1997, p. 68; R. E. Scott, "Costly Trade with China," *Briefing Paper #188*, Economic Policy Institute, October 9, 2007; "Pain from Free Trade Spurs Second Thoughts," *The Wall Street Journal*, March 28, 2008, p. A1; "Is U.S. Manufacturing Falling off the Radar Screen," *The New York Times*, September 10, 2010, p. 1; and "The Factory Floor Has a Ceiling on Job Creation," *The Wall Street Journal*, January 12, 2012, p. A6.

3.6 Trade Based on Differences in Tastes

The difference in *pretrade-relative* commodity prices between Nation 1 and Nation 2 in Figures 3.3 and 3.4 was based on the difference in the production frontiers and indifference curves in the two nations. This determined the comparative advantage of each nation and set the stage for specialization in production and mutually beneficial trade.

With increasing costs, even if two nations have identical production possibility frontiers (which is unlikely), there will still be a basis for mutually beneficial trade if tastes, or demand preferences, in the two nations differ. The nation with the relatively smaller demand or preference for a commodity will have a lower autarky-relative price for, and a comparative advantage in, that commodity. The process of specialization in production and trade would then follow, exactly as described in the previous section.

3.6A Illustration of Trade Based on Differences in Tastes

Trade based solely on differences in tastes is illustrated in Figure 3.6. Since the production frontiers of the two nations are now assumed to be identical, they are represented by a single

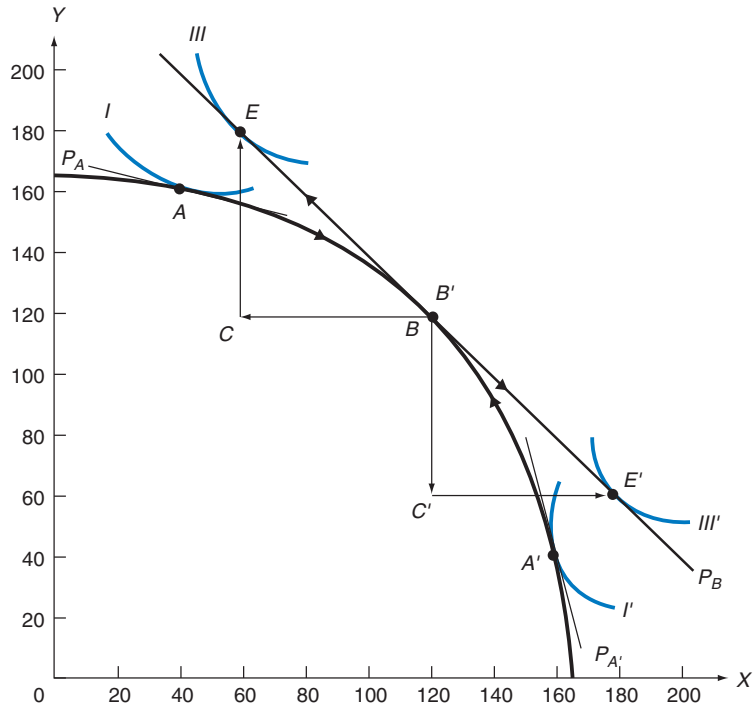

FIGURE 3.6. Trade Based on Differences in Tastes.
Nations 1 and 2 have identical production frontiers (shown by a single curve) but different tastes (indifference curves). In isolation, Nation 1 produces and consumes at point *A* and Nation 2 at point *A'*. Since $P_A < P_{A'}$, Nation 1 has a comparative advantage in X and Nation 2 in Y. With trade, Nation 1 specializes in the production of X and produces at *B*, while Nation 2 specializes in Y and produces at *B'* (which coincides with *B*). By exchanging 60X for 60Y with each other (see trade triangles *BCE* and *B'C'E'*), Nation 1 ends up consuming at *E* (thereby gaining 20X and 20Y), while Nation 2 consumes at *E'* (and also gains 20X and 20Y).

curve. With indifference curve I tangent to the production frontier at point *A* for Nation 1 and indifference curve I′ tangent at point *A′* for Nation 2, the pretrade-relative price of X is lower in Nation 1. Thus, Nation 1 has a comparative advantage in commodity X and Nation 2 in commodity Y.

With the opening of trade, Nation 1 specializes in the production of X (and moves down its production frontier), while Nation 2 specializes in Y (and moves up its own production frontier). Specialization continues until P_X/P_Y is the same in both nations and trade is balanced. This occurs at point B (which coincides with point B′), where $P_B = P_{B'} = 1$. Nation 1 then exchanges 60X for 60Y with Nation 2 (see trade triangle BCE) and ends up consuming at point E on its indifference curve III. Nation 1 thus gains 20X and 20Y as compared with point A. Similarly, Nation 2 exchanges 60Y for 60X with Nation 1 (see trade triangle B′C′E′) and ends up consuming at point E′ on its indifference curve III′ (also gaining 20X and 20Y from point A′). Note that when trade is based solely on taste differences, the patterns of production become more similar as both nations depart from autarky.

Thus, mutually beneficial trade can be based exclusively on a difference in tastes between two nations. In Chapter 5, we will examine the opposite case, where trade between the two nations is based exclusively on a difference in factor endowments and production frontiers. (This will be referred to as the Heckscher–Ohlin model.) Only if the production frontier and the indifference curves are identical in both nations (or the difference in production frontiers is exactly neutralized, or offset, by the difference in the indifference curves) will the pretrade-relative commodity prices be equal in both nations, ruling out the possibility of mutually beneficial trade.

SUMMARY

1. This chapter extended our simple trade model to the more realistic case of increasing opportunity costs. It also introduced demand preferences in the form of community indifference curves. We then went on to examine how the interaction of these forces of demand and supply determines each nation's comparative advantage and sets the stage for specialization in production and mutually beneficial trade.

2. Increasing opportunity costs mean that the nation must give up more and more of one commodity to release just enough resources to produce each additional unit of another commodity. This is reflected in a production frontier that is concave from the origin. The slope of the production frontier gives the marginal rate of transformation (MRT). Increasing opportunity costs arise because resources are not homogeneous and are not used in the same fixed proportion in the production of all commodities. Production frontiers differ because of different factor endowments and/or technology in different nations.

3. A community indifference curve shows the various combinations of two commodities that yield equal satisfaction to the community or nation. Higher curves refer to a greater level of satisfaction. Community indifference curves are negatively sloped and convex from the origin. And to be useful, they must not cross. The slope of an indifference curve gives the marginal rate of substitution (MRS) in consumption, or the amount of commodity Y that a nation could give up for each extra unit of commodity X and still remain on the same indifference curve. Trade affects the income distribution within a nation and can result in intersecting indifference curves. This difficulty can be overcome by the compensation principle, which states that the nation gains from trade if the gainers would retain some of their gain even after fully compensating losers for their losses. Alternatively, some restrictive assumptions could be made.

4. In the absence of trade, a nation is in equilibrium when it reaches the highest indifference curve

possible with its production frontier. This occurs at the point where a community indifference curve is tangent to the nation's production frontier. The common slope of the two curves at the tangency point gives the internal equilibrium-relative commodity price in the nation and reflects the nation's comparative advantage.

5. With trade, each nation specializes in producing the commodity of its comparative advantage and faces increasing opportunity costs. Specialization in production proceeds until relative commodity prices in the two nations are equalized at the level at which trade is in equilibrium. By then trading, each nation ends up consuming on a higher indifference curve than in the absence of trade. With increasing costs, specialization in production is incomplete, even in a small nation. The gains from trade can be broken down into gains from exchange and gains from specialization in production.

6. With increasing costs, even if two nations have identical production frontiers, there is still a basis for mutually beneficial trade if tastes, or demand or preferences, differ in the two nations. The nation with the relatively smaller demand or preference for a commodity will have a lower autarky-relative price for, and a comparative advantage in, that commodity. This will set the stage for specialization in production and mutually beneficial trade, as described earlier.

A LOOK AHEAD

In Chapter 4, we introduce the demand curve for imports and the supply curve of exports, as well as the offer curve of each nation, in order to examine precisely how the equilibrium-relative commodity price and terms of trade of each nation are determined with trade. We can then determine how the gains from trade are shared by each nation. With this addition, our simple trade model will be complete. In Chapter 5, we will see how this simple trade model was extended by Heckscher and Ohlin.

KEY TERMS

Autarky, p. 62
Community indifference curve, p. 60
Deindustrialization, p. 70
Equilibrium-relative commodity price in isolation, p. 63
Equilibrium-relative commodity price with trade, p. 66
Gains from exchange, p. 69
Gains from specialization, p. 69
Incomplete specialization, p. 67
Increasing opportunity costs, p. 58
Marginal rate of substitution (MRS), p. 61
Marginal rate of transformation (MRT), p. 59

QUESTIONS FOR REVIEW

1. In what way is the material in this chapter more realistic than that of Chapter 2?
2. How are the tastes, or demand preferences, of a nation introduced in this chapter? Why are they needed?
3. Why does a production frontier that is concave from the origin indicate increasing opportunity costs in both commodities? What does the slope of the production frontier measure? How does the slope change as the nation produces more of the commodity measured along the horizontal axis? more of the commodity measured along the vertical axis?
4. What is the reason for increasing opportunity costs? Why do the production frontiers of different nations have different shapes?
5. What does a community indifference curve measure? What are its characteristics? What does the slope of an indifference curve measure? Why does

it decline as the nation consumes more of the commodity measured along the horizontal axis?

6. What difficulties arise in the use of community indifference curves in trade theory? How can these difficulties be overcome?

7. What is meant by the equilibrium-relative commodity price in isolation? How is this price determined in each nation? How does it define the nation's comparative advantage?

8. Why does specialization in production with trade proceed only up to the point where relative commodity prices in the two nations are equalized? How is the equilibrium-relative commodity price with trade determined?

9. Why is there incomplete specialization in production (even in a smaller nation) with increasing opportunity costs? How are the results under increasing costs different from the fixed-costs case?

10. What is meant by gains from exchange? by gains from specialization?

11. Can specialization in production and mutually beneficial trade be based solely on a difference in tastes between two nations? How is this different from the more general case?

12. Can specialization in production and mutually beneficial trade be based exclusively on a difference in factor endowments and/or technology between two nations?

PROBLEMS

1. On one set of axes, sketch a fairly large production frontier concave from the origin.

   (a) Starting near the midpoint on the production frontier, use arrows to show that the nation incurs increasing opportunity costs in producing more of X (the commodity measured along the horizontal axis) and more of Y.

   (b) How does the slope of the production frontier change as the nation produces more of X? more of Y? What do these changes reflect?

2. On another set of axes, sketch three community indifference curves, making the top two curves cross each other.

   (a) Why have you drawn community indifference curves downward, or negatively, sloped?

   (b) What does the slope of the curves measure? Why is the slope of each curve smaller for lower points?

   (c) Which of the two intersecting indifference curves shows a greater level of satisfaction to the right of the point of intersection? to the left? Why is this inconsistent with the definition of indifference curves? What conclusion can you reach?

*3. On one set of axes, sketch a community indifference curve tangent to the fairly flat section of a concave production frontier. On a second set of axes, sketch another (different) community indifference curve tangent to the fairly steep portion of another (different) concave production frontier.

   (a) Draw in the line showing the equilibrium-relative commodity price in isolation in each nation.

   (b) Which is the commodity of comparative advantage for each nation?

   (c) Under what (unusual) condition would there be no such thing as comparative advantage or disadvantage between the two nations?

*4. **(a)** On the graphs of Problem 3, show, for each nation with trade, the direction (by an arrow on the production frontier) of specialization in production and the equilibrium point of production and consumption.

   (b) How much does each nation gain in consumption compared with its autarky point? Which of the two nations gains more from trade? Why?

5. On one set of axes, sketch Nation 1's supply of exports of commodity X so that the quantity supplied *(QS)* of X is $QS_x = 0$ at $P_X/P_Y = \frac{1}{4}$, $QS_x = 40$ at $P_X/P_Y = \frac{1}{2}$, $QS_x = 60$ at $P_X/P_Y = 1$, and $QS_x = 70$ at $P_X/P_Y = 1\frac{1}{2}$. On the same set of axes,

* = Answer provided at www.wiley.com/college/salvatore.

sketch Nation 2's demand for Nation 1's exports of commodity X so that the quantity demanded *(QD)* of X is $QD_x = 40$ at $P_X/P_Y = 1\frac{1}{2}$, $QD_x = 60$ at $P_X/P_Y = 1$, and $QD_x = 120$ at $P_X/P_Y = \frac{1}{2}$.

(a) Determine the equilibrium-relative commodity price of the exports of commodity X with trade.

(b) What would happen if P_X/P_Y were $1\frac{1}{2}$

(c) What would happen if $P_X/P_Y = \frac{1}{2}$

6. What is the relationship between the figure you sketched for Problem 5 and the results you obtained in Problem 5 and Figure 3.4 in the text? Explain.

***7.** On one set of axes, sketch a community indifference curve tangent to the fairly flat section of a concave production frontier and show the nation's autarky equilibrium-relative commodity price, labeling it P_A. Assume that this graph refers to a very small nation whose trade does not affect relative prices on the world market, given by P_W. Show on the graph the process of specialization in the production, the amount traded, and the gains from trade.

8. **(a)** Explain why the small nation of Problem 7 does not specialize completely in the production of the commodity of its comparative advantage.

(b) How does your answer to part (a) differ from the constant-cost case?

9. On two sets of axes, draw identical concave production frontiers with different community indifference curves tangent to them.

(a) Indicate the autarky equilibrium-relative commodity price in each nation.

(b) Show the process of specialization in production and mutually beneficial trade.

10. What would have happened if the two community indifference curves had also been identical in Problem 9? Sketch a graph of this situation.

11. What would happen if the production frontiers are identical and the community indifference curves are different, but we have constant opportunity costs? Draw a graph of this.

12. Draw a figure showing the separation of the gains from exchange from the gains from specialization for Nation 2 in the right panel of Figure 3.4 if Nation 2 were now a small nation.

13. During the negotiations for NAFTA (North American Free Trade Agreement among the United States, Canada, and Mexico) in the early 1990s, opponents argued that the United States would lose many jobs to Mexico because of the much lower wages in Mexico. What was wrong with this line of reasoning?

APPENDIX

In this appendix, we review those aspects of production theory that are essential for understanding the material presented in subsequent appendices. We begin with a review of production functions, isoquants, isocosts, and equilibrium. We then illustrate these concepts for two nations, two commodities, and two factors. Next, we derive the Edgeworth box diagram and, from it, the production frontier of each nation. Finally, we use the Edgeworth box diagram to show the change in the ratio of resource use as each nation specializes in production with trade.

A3.1 Production Functions, Isoquants, Isocosts, and Equilibrium

A production function gives the *maximum* quantities of a commodity that a firm can produce with various amounts of factor inputs. This purely technological relationship is supplied by engineers and is represented by isoquants.

An isoquant is a curve that shows the various combinations of two factors, say, capital (K) and labor (L), that a firm can use to produce a specific level of output. Higher isoquants refer to larger outputs and lower ones to smaller outputs. Isoquants have the same general characteristics as indifference curves. They are negatively sloped, convex from the origin, and do not cross. (However, isoquants give a cardinal measure of output, while indifference curves give only an ordinal measure of utility.)

Isoquants are negatively sloped because a firm using less K must use more L to remain on the same isoquant. The (absolute) slope of the isoquant is called the marginal rate of technical substitution of labor for capital in production (MRTS) and measures how much K the firm can give up by increasing L by one unit and still remain on the same isoquant. As a firm moves down an isoquant and uses more L and less K, it finds it more and more difficult to replace K with L. That is, the marginal rate of technical substitution of L for K (or slope of the isoquant) diminishes. This makes the isoquant convex from the origin. Finally, isoquants do not cross because an intersection would imply the same level of output on two isoquants, which is inconsistent with their definition.

In Figure 3.7, the curve labeled $1X$ is the isoquant for one arbitrarily defined unit of commodity X, and curve $2X$ is the isoquant for two units of X. Note that the isoquants are negatively sloped and convex from the origin and that they do not cross.

An isocost is a line that shows the various combinations of K and L that a firm can hire for a given expenditure, or total outlay *(TO)*, at given factor prices. For example, suppose that the total outlay of the firm in Figure 3.7 is $TO = \$30$, that the price of a unit of capital is $P_K = \$10$, and that the wage rate is $P_L = \$5$. Under these conditions, the firm can hire either $3K$ (the vertical intercept) or $6L$ (the horizontal intercept) or any combination of L and K shown on the straight line (isocost). The (absolute) slope of the isocost of $\frac{3}{6} = \frac{1}{2}$ gives the relative price of L (the factor plotted along the horizontal axis). That is, $P_L/P_K = \$5/\$10 = \frac{1}{2}$. A $TO = \$60$ and unchanged factor prices give a new isocost parallel to the first one and twice as far from the origin (see Figure 3.7).

A producer is in equilibrium when it maximizes output for a given cost outlay (i.e., when it reaches the highest isoquant possible with a given isocost). This occurs where an

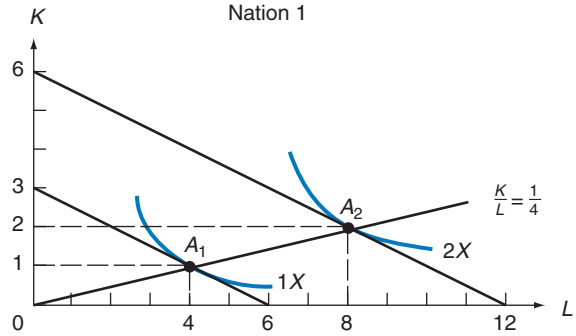

FIGURE 3.7. Isoquants, Isocosts, and Equilibrium.
Isoquants 1X and 2X give the various combinations of K and L that the firm can use to produce one and two units of X, respectively. Isoquants are negatively sloped, convex, and do not cross. An *isocost* shows the various amounts of K and L that a firm can hire with a given total outlay (TO). The lines from $3K$ to $6L$ and from $6K$ to $12L$ are isocosts. The (absolute) slope of the isocost measures P_L/P_K. Equilibrium is at points A_1 and A_2, where the firm reaches the highest isoquant possible for a given TO. At A_2 the firm produces twice as much output and uses twice as much K and L as at A_1. The straight line through the origin joining A_1 and A_2 is the *expansion path* and gives the constant $K/L = \frac{1}{4}$ ratio in producing 1X and 2X.

isoquant is tangent to an isocost (i.e., MRTS $= P_L/P_K$). In Figure 3.7, the producer is in equilibrium at point A_1, producing $1X$ with the lower isocost, and at point A_2, producing $2X$ with the higher isocost. Note that isoquant $2X$ involves twice as much output as isoquant $1X$, is twice as far from the origin, and requires twice as much outlay of K and L to be reached. The straight line from the origin connecting equilibrium points A_1 and A_2 is called the expansion path and shows the constant $K/L = \frac{1}{4}$ in producing $1X$ and $2X$.

A production function, such as the one above, that has a straight-line expansion path and that shows that increasing inputs in a given proportion results in output increasing in the same proportion is a Cobb–Douglas production function that is homogeneous of degree 1 and exhibits constant returns to scale. We will make much use of this production function in international economics because of its useful properties. Since the K/L ratio remains the same with this production function (as long as factor prices do not change), the productivity of K and L also remains the same, regardless of the level of output. Furthermore, with this type of production function, all the isoquants that refer to the production of various quantities of a particular commodity look exactly alike or have identical shape (see Figure 3.7). As a result, the elasticity of substitution of labor for capital (which measures the degree by which labor can be substituted for capital in production as the price of labor or the wage rate falls) is equal to 1. (This is examined in detail in Appendix A5.6.)

A3.2 Production Theory with Two Nations, Two Commodities, and Two Factors

Figure 3.8 extends Figure 3.7 to deal with the case of two nations, two commodities, and two factors. Figure 3.8 shows isoquants for commodity X and commodity Y for Nation 1 and Nation 2. Note that commodity Y is produced with a higher K/L ratio in both nations.

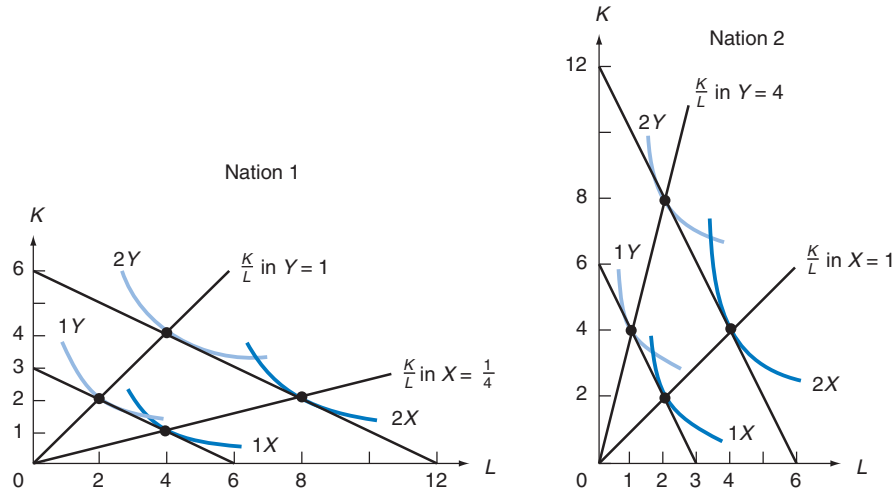

FIGURE 3.8. Production with Two Nations, Two Commodities, and Two Factors.
Y is the K-intensive commodity in both nations. The K/L ratio is lower in Nation 1 than in Nation 2 in both X and Y because P_L/P_K is lower in Nation 1. Since Y is always the K-intensive commodity and X is always the L-intensive commodity in both nations, the X and Y isoquants intersect only once in each nation.

Thus, we say that Y is K-intensive and X is the L-intensive commodity. Note also that the K/L ratio is lower in Nation 1 than in Nation 2 for both X and Y. The reason for this is that the relative price of labor (i.e., P_L/P_K, or slope of the isocosts) is lower in Nation 1 than in Nation 2.

If, for whatever reason, the relative price of labor (i.e., P_L/P_K) rose in both nations, each nation would substitute K for L in the production of both commodities to minimize costs. As a result, the K/L ratio would rise in both nations in the production of both commodities.

Even though both X and Y are more K intensive in Nation 2 than in Nation 1, X is always the L-intensive commodity in both nations. This important fact is reflected in the isoquants of X and Y intersecting only once (see Figure 3.8), and it will be of great use in the appendix to Chapter 5, which deals with factor-intensity reversal.

A3.3 Derivation of the Edgeworth Box Diagram and Production Frontiers

We will now use the knowledge gained from Figure 3.8 to derive the Edgeworth box diagram and, from it, the production frontier of each nation. This is illustrated in Figure 3.9 for Nation 1 and in Figure 3.10 for Nation 2.

Our discussion will first concentrate on the top panel of Figure 3.9. The dimensions of the box in the top panel reflect the total amount of L (measured by the length of the box) and K (the height of the box) available in Nation 1 at a given time.

The lower left-hand corner of the box (O_X) represents the zero origin for commodity X, and X-isoquants farther from O_X refer to greater outputs of X. On the other hand, the top right-hand corner (O_Y) represents the zero origin for commodity Y, and Y-isoquants farther from O_Y refer to greater outputs of Y.

Any point within the box indicates how much of the *total* amount of labor available (L) and how much of the total amount of capital available (K) are used in the production of X and Y. For example, at point A, L_A and K_A are used to produce 50X, and the remaining quantities, or $L - L_A$ and $K - K_A$, are used in the production of 60Y (see Figure 3.9).

By joining all points in the box where an X-isoquant is tangent to a Y-isoquant, we get the nation's production contract curve. Thus, the contract curve of Nation 1 is given by the line joining O_X to O_Y through points A, F, and B. At any point not on the contract curve, production is not efficient because the nation could increase its output of one commodity without reducing its output of the other.

For example, from point Z in the figure, Nation 1 could move to point F and produce more of X (i.e., 95X instead of 50X) and the same amount of Y (both Z and F are on the isoquant for 45Y). Or Nation 1 could move from point Z to point A and produce more of Y (i.e., 60Y instead of 45Y) and the same amount of X (both Z and A are on the isoquant for 50X). Or Nation 1 could produce a little more of both X and Y and end up on the contract curve somewhere between A and F. (The isoquants for this are not shown in the figure.) Once on its contract curve, Nation 1 could only expand the output of one commodity by reducing the output of the other. The fact that the contract curve bulges toward the lower right-hand corner indicates that commodity X is the L-intensive commodity in Nation 1.

By transposing the contract curve from the input space in the top panel to the output space in the bottom panel, we derive Nation 1's production frontier, shown in the bottom panel. For example, from point Z, where the isoquant for 50X crosses the straight-line

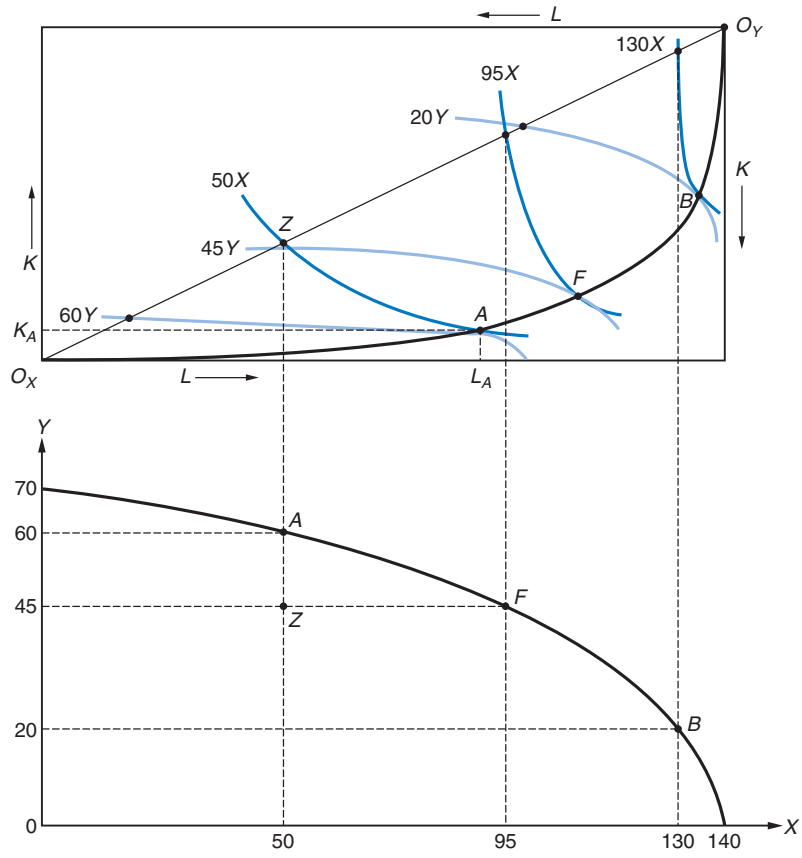

FIGURE 3.9. Derivation of the Edgeworth Box Diagram and Production Frontier for Nation 1.
The size of the box in the top panel gives the total amount of *L* and *K* available to Nation 1. The bottom left-hand corner is the origin for X, so that higher X outputs are given by X-isoquants farther away from this origin. The top right-hand corner is the origin for Y, and higher Y outputs are given by Y-isoquants farther from this origin. Any point in the box gives how much *K* and *L* are used in the production of X and Y, respectively. The line joining points of tangency of X- and Y-isoquants is called the *contract curve*. Any point not on the contract curve is not efficient because the nation could produce more of one commodity without reducing the output of the other. The contract curve is not a straight line because factor prices change to keep *K* and *L* fully employed. By mapping the contract curve from input to output space, we derive the production frontier of Nation 1 in the bottom panel.

diagonal $O_X O_Y$ in the top panel, we get point A (i.e., 50X) in the bottom panel. Note that point A in the bottom panel is directly below point Z in the top panel, rather than directly below point A in the top panel, because output is *measured* at constant K/L (i.e., along the straight-line diagonal). The measurement along the diagonal reflects the fact that inputs are being used to measure outputs (with constant returns to scale).

Even though outputs are measured along the diagonal, efficiency considerations (discussed earlier) require that Nation 1 produce 50X at point A in the top panel, where the X-isoquant for 50X is *tangent* to the Y-isoquant for 60Y. This gives point A in the bottom panel, referring to the output of 50X and 60Y. If Nation 1 produced at point Z instead of

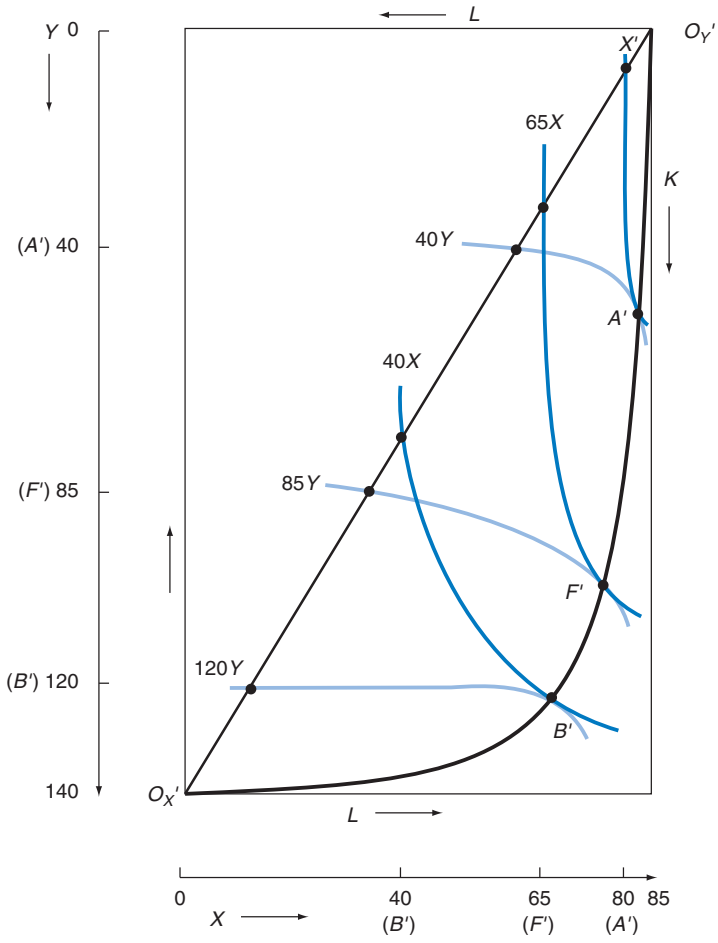

FIGURE 3.10. Derivation of the Edgeworth Box Diagram and Production Frontier for Nation 2.
The dimensions of its Edgeworth box indicate that Nation 2 has a relative abundance of *K* compared with Nation 1. Efficiency considerations require that Nation 2 produce on its contract curve shown by the line joining O_X' to O_Y' through points *A′*, *F′*, and *B′*. The amount of commodity X produced at points *A′*, *F′*, and *B′* is given by the points where the X-isoquant through each crosses the diagonal. This output is then projected down to the X-axis at the bottom of the figure. Similarly, the amount of commodity Y produced at points *A′*, *F′*, and *B′* is given by the points where the Y-isoquant through each (and tangent to an X-isoquant) crosses the diagonal. This output is then projected to the Y-axis at the left of the figure.

point *A* in the top panel, Nation 1 would produce 50X but only 45Y, giving point *Z* *inside* the production frontier in the bottom panel.

Similarly, directly below the point in the top panel where the X-isoquant showing 95X crosses the diagonal, we get point *F*, referring to 95X and 45Y, on the production frontier in the bottom panel. Finally, point *B* on the isoquants for 130X and 20Y in the top panel is projected down to point *B*, referring to 130X and 20Y, on the production frontier in the bottom panel. Thus, there is a one-to-one correspondence between the contract curve and the production frontier, with each point on the contract curve uniquely defining one point on the production frontier.

Note that the output of commodity X is proportional to the distance from origin O_X along the diagonal because of our assumption of constant returns to scale. Similarly, the output of commodity Y is proportional to the distance from origin O_Y along the diagonal. (This is the reason for measuring outputs along the diagonal.) Also note that the X-intercept and the Y-intercept of the production frontier correspond to the length and height of the Edgeworth box.

Figure 3.10 shows the Edgeworth box for Nation 2. The dimensions of the box indicate that Nation 2 has a relative abundance of K compared with Nation 1. As with Nation 1, the amount of commodity X produced at points A', F', and B' is given by the points where the X-isoquant through each point crosses the diagonal. This output is then projected down to the X-axis at the bottom of the figure. Similarly, the amount of commodity Y produced at points A', F', and B' is given by the points where the Y-isoquant through each point (and tangent to an X-isoquant) crosses the diagonal. This output is then projected to the Y-axis at the left of the figure. For example, the X-isoquant through B' crosses the diagonal at an output of 40X (see the X-axis at the bottom of the figure). Similarly, the Y-isoquant through point B' crosses the diagonal at the output of 120Y (see the Y-axis at the left of the figure). These give the coordinates of point B' as 40X and 120Y on Nation 2's production frontier (not shown). The other points on Nation 2's production frontier are similarly derived. Note that the production frontiers for Nation 1 and Nation 2 that we have just derived are the ones that we used earlier in this chapter. However, we have now derived rather than assumed them.

Problem Derive from Figure 3.10 Nation 2's production frontier. Which commodity is L intensive in Nation 2? Why?

A3.4 Some Important Conclusions

The movement from point A to point B on Nation 1's *contract curve* (see Figure 3.9) refers to an increase in the production of X (the commodity of its comparative advantage) and results in a rise in the K/L ratio. This rise in the K/L ratio is measured by the increase in the slope of a straight line (not drawn) from origin O_X to point B as opposed to point A. The same movement from point A to point B also raises the K/L ratio in the production of Y. This is measured by the increase in the slope of a line from origin O_Y to point B as opposed to point A.

The rise in the K/L ratio in the production of both commodities in Nation 1 can be explained as follows. Since Y is K intensive, as Nation 1 reduces its output of Y, capital and labor are released in a ratio that exceeds the K/L ratio used in expanding the production of X. There would then be a tendency for some of the nation's capital to be unemployed, causing the relative price of K to fall (i.e., P_L/P_K to rise).

As a result, Nation 1 will substitute K for L in the production of both commodities until all available K is once again fully utilized. Thus, the K/L ratio in Nation 1 rises in the production of both commodities. This also explains why the production contract curve is not a straight line but becomes steeper as Nation 1 produces more X (i.e., it moves farther from origin O_X). The *contract curve would be a straight line only if relative factor prices remained unchanged, and here factor prices change*. The rise in P_L/P_K in Nation 1 can be visualized in the top panel of Figure 3.9 by the greater slope of the common tangent to the isoquants at point B as opposed to point A (to keep the figure simple, such tangents are

not actually drawn). We will review and expand these results in the appendix to Chapter 5, where we prove the factor-price equalization theorem of the Heckscher–Ohlin trade model.

Problem Explain why, as Nation 2 moves from point A' to point B' on its contract curve (i.e., specializes in the production of Y, the commodity of its comparative advantage), its K/L ratio *falls* in the production of both X and Y. (If you cannot, reread Section A3.4.)

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http://www.wto.org

http://unstats.un.org/unsd

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For deindustrialization, see the work of G. Hacche and F. Ramaswamy at:

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For U.S. trade statistics by region or country see the International Trade Administration, Office of Trade and Economic Analysis of the U.S. Department of Commerce at:

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