General Equilibrium Analysis and Economic Efficiency

How is equilibrium determined in all markets simultaneously and to what extent do markets promote the well-being of the members of a society as a whole?

Chapter Outline

Learning Objectives

- Delineate the difference between partial and general equilibrium analysis.
- Explain the concept of economic efficiency.
- Outline the three conditions necessary for the attainment of economic efficiency.
- Examine efficiency in production and what this implies about input usage across different industries.
- Show how efficiency in output is related to the production possibility frontier.
- Demonstrate how perfect competition satisfies all three conditions for economic efficiency.
- Spell out the reasons why economic efficiency may not be achieved.

T he analysis developed in previous chapters focused on individual markets in isolation. Price and quantity in each market, whether it was a product or an input market, were determined by supply and demand conditions in that specific market. The analysis largely ignored events in other markets.

We know, of course, that markets are interrelated. Changes in the market for gasoline, for example, affect the automobile market, and changes in the automobile market in turn affect the gasoline market. Consequently, an analysis that focuses on one market in isolation

GENERAL EQUILIBRIUM ANALYSIS

the study of how equilibrium is determined in all markets simultaneously

is incomplete. To see how the interdependence of individual markets can be taken into account, this chapter provides a brief introduction to **general equilibrium analysis**, the study of how equilibrium is determined in all markets simultaneously.

In addition to exploring their interdependence, this chapter also evaluates the extent to which markets promote the well-being of the members of a society as a whole. We revisit the concept of economic efficiency first introduced in Chapter 6, and discuss the conditions that must be met for an economy to ensure efficiency in allocation of inputs across firms, distribution of products among consumers, and output mix. We show how perfect competition satisfies these conditions as well as consider the reasons why markets may fail to promote efficiency.

19.1

PARTIAL AND GENERAL EQUILIBRIUM ANALYSIS COMPARED

PARTIAL EQUILIBRIUM ANALYSIS

the study of the determination of an equilibrium price and quantity in a given product or input market viewed as self-contained and independent of other markets

In previous chapters we have employed partial equilibrium analysis almost exclusively. **Partial equilibrium analysis** focuses on the determination of an equilibrium price and quantity in a given product or input market, where the market is viewed as largely self-contained and independent of other markets. An analysis of the gasoline market using supply and demand curves, for instance, is a partial equilibrium analysis. The supply and demand curves for gasoline are drawn on the assumption of given and unchanging prices in other product and input markets. In effect, these assumptions allow us to focus on the gasoline market and ignore others.

Characteristic of a partial equilibrium approach is the assumption that *some things—like other prices—that conceivably could change do not.* In many situations this assumption may be reasonable. For example, a tax on gasoline that raises its price is unlikely to have a measurable effect on the price of wristwatches. A change in the price of gasoline could conceivably cause a change in the price of wristwatches by raising or lowering their demand, but in a partial equilibrium analysis of the gasoline market, we assume it does not. In contrast, a higher gasoline price would probably have a significant effect on the market for automobiles. In that case the partial equilibrium assumption that the price of automobiles does not change could be seriously flawed.

Partial equilibrium analysis therefore tends to ignore some of the interrelationships among prices and markets. Formally, this is accomplished through the "other things equal" assumption. By contrast, in a general equilibrium analysis all prices are considered variable, and the analysis focuses on the simultaneous determination of equilibrium in all markets.

The Mutual Interdependence of Markets Illustrated

Before turning to the discussion of a model of general equilibrium, let's examine what is meant by the interrelationships, or *mutual interdependence*, among markets. Consider two markets where the interdependence on the demand side is likely to be fairly pronounced—the markets for margarine and butter. Margarine and butter are close substitutes, so a higher price for margarine shifts the demand curve for butter upward; similarly, a higher price for butter causes the demand for margarine to increase.

Figure 19.1a shows the margarine market, and Figure 19.1b shows the butter market. Initially, assume both markets are in equilibrium, with the price of margarine at $2.00 per pound and the price of butter at $3.00 per pound. From our earlier analysis of demand curve relationships, recall that the prices of other goods are assumed to be fixed at all points along a given demand curve, as are consumers' incomes and tastes. Our emphasis here will be on prices in other markets. Thus, at all points along D_M the price of butter is $3.00 per pound, and at all points along D_B the price of margarine is $2.00 per pound.

To illustrate the significance of mutual interdependence, let's examine the effects of an excise tax of $0.75 per pound on margarine. Using the familiar partial equilibrium approach,

FIGURE 19.1

**Interdependence Between Markets: Butter and Margarine**
By raising the price of margarine, a tax on margarine increases the demand for butter. The higher butter price causes the margarine demand curve to shift to D'_M. This result illustrates economic interdependence between markets.


(a)

(b)
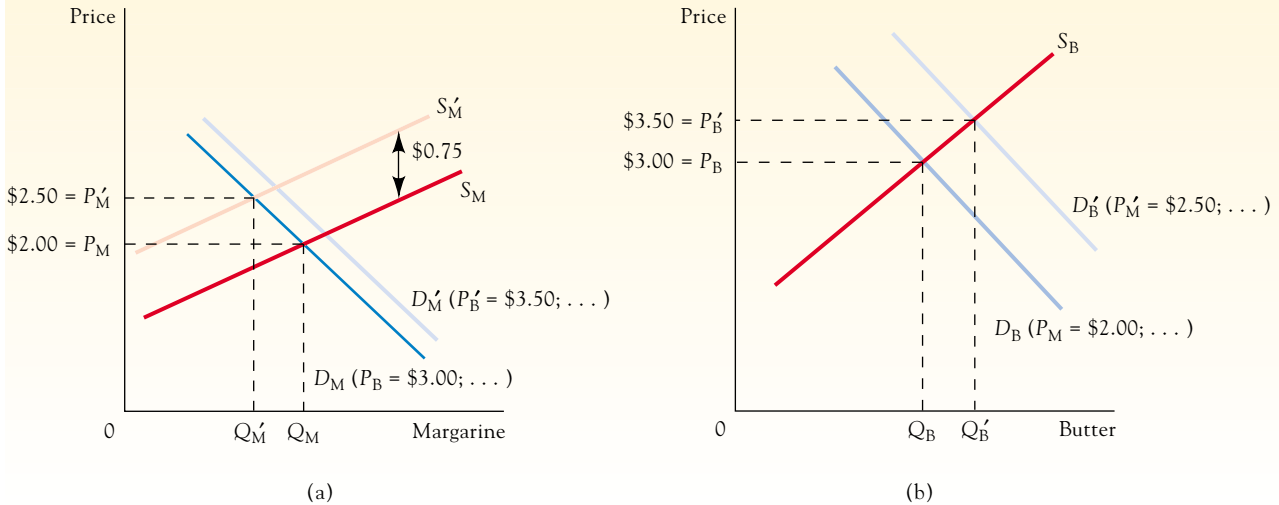
we could analyze an excise tax by shifting the supply curve in Figure 19.1a upward to S'_M, which causes the price to rise to \$2.50 and the quantity to fall to Q'_M. Now, however, let's see how the partial equilibrium approach ignores the mutual interdependence between the margarine and butter markets and what implications this procedure has for the analysis.

The foregoing partial equilibrium analysis neglects two types of consequences. *First, the change in the margarine market has a* **spillover effect** *on other markets, which disrupts the equilibria there.* In our example, the higher margarine price causes the demand for butter to rise because butter and margarine are substitutes. Don't forget that in drawing D_B we held the price of margarine fixed at \$2.00 per pound; when the tax raises the price of margarine to \$2.50 per pound, we must redraw the demand curve for butter on the basis of the higher margarine price. Thus, D'_B is the demand for butter when the margarine price is \$2.50. In short, the tax on margarine leads to an increase in the demand for butter, which in turn increases the price of butter to \$3.50 per pound.

If this type of spillover effect from the margarine market to the butter market were the only effect neglected by partial equilibrium analysis, there would be little cause for concern. The analysis of the margarine market would remain exactly correct. But there is a *second effect neglected: the induced change in the butter market has a* **feedback effect** *on the margarine market.* So far, the tax on margarine has led to a higher price for butter. Now consider the demand curve for margarine once again. We constructed the original demand curve, D_M, on the assumption that the price of butter was \$3.00. Since the price of butter has risen, the demand curve for margarine will shift upward. When the price of butter is \$3.50, for example, the demand curve for margarine is D'_M. So the partial equilibrium analysis of the margarine market, which identified P'_M and Q'_M as the equilibrium price and quantity, does not correctly identify the final result. Partial equilibrium analysis, by assuming that prices in other markets remain unchanged, rules out the possibility of such a feedback effect.
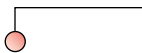
SPILLOVER EFFECT
a change in equilibrium in one market that affects other markets
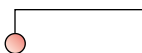
FEEDBACK EFFECT
a change in equilibrium in a market that is caused by events in other markets that, in turn, are the result of an initial change in equilibrium in the market under consideration

This example illustrates what economists mean by mutual interdependence among markets: what happens in one market affects others (spillover effects) and is affected by other markets (feedback effects). The margarine–butter example is a simple case of mutual interdependence since just two markets, related only on the demand side, are involved. In the real world a change in one market may affect the operation of hundreds of other markets and, in turn, be affected by conditions in those markets. In addition, the interdependence need not be restricted to the demand side of the markets. The employment and pricing of inputs in one market will affect the supply curves in others that employ the same or closely related inputs. For example, the increase in defense spending promoted by the Reagan administration in the 1980s led to an expansion in the demand for inputs such as land in Boston and southern California, where a large number of defense contractors are based. This increase in demand for land made it more expensive for other industries such as banking, entertainment, and education to do business in the same cities and shifted their respective output supply curves leftward.

When Should General Equilibrium Analysis Be Used?

The first 18 chapters of this book concentrated on partial equilibrium analysis, and it would not have received such emphasis if economists believed that it was an unreliable framework for analysis. Yet we have seen that partial equilibrium analysis neglects some market interdependencies that can affect the way a given market functions. General equilibrium analysis, in contrast, accounts for the interrelationships among markets. On these grounds, the general equilibrium approach would appear superior, so it is worthwhile to explain why economists continue to rely on partial equilibrium analysis to study many issues.

Partial equilibrium analysis explicitly ignores some factors that could have a bearing on the analysis, but in many cases these neglected factors may be *quantitatively* unimportant in the sense that if they were taken into account, the conclusions would be affected only to a trivial degree. For instance, in our butter–margarine example, the excise tax on margarine may affect the price of butter only slightly, and this in turn will have an even smaller effect on the demand curve for margarine. In that case, ignoring the market interdependencies and assuming that the margarine demand curve "stays put" yields a result that is a sufficiently close approximation to the true outcome.

This does not imply that partial equilibrium analysis can always be used. There are cases where the implications of a partial and general equilibrium analysis differ significantly. A reasonable guideline is that partial analysis is usually accurate in cases involving a change in conditions primarily affecting one market among many, with repercussions on other markets dissipated throughout the economy. When a change in conditions affects many, or all, markets at the same time and to the same degree, however, general equilibrium analysis tends to be more appropriate.

An example will clarify this distinction. Suppose that a price control is applied to one product—say, rental housing. Rent control is sure to have a major impact on the rental housing market, but the impact on other markets is likely to be slight and uncertain. Most economists would agree that a partial equilibrium analysis focusing on the rental housing market is adequate to investigate this issue.

By contrast, imagine that the government applies price controls to all goods simultaneously. With all markets affected at the same time, and to a large degree, a general equilibrium analysis is required. In fact, a partial equilibrium analysis may give misleading results. Suppose, for example, that the government mandates a 50 percent reduction in the prices of all goods except rental housing and a 5 percent reduction for that. If we looked at the rental housing market using partial equilibrium analysis, we would be tempted to say the output of rental housing would fall and a shortage would result. The opposite is more likely to be the case because this set of price controls *increases the relative price* of rental housing compared with all other goods. Resources would shift from industries where prices are most depressed

Pareto optimal
the condition in which it is not possible, through any feasible change in resource allocation, to benefit one person without making some other person or persons worse off

to those where they are least depressed, increasing output in the latter. Only a general equilibrium analysis is capable of accurately evaluating this situation.

Thus, both general and partial equilibrium approaches are quite valuable, with their relative usefulness depending on the issue under investigation. Earlier chapters give numerous examples of topics that can be fruitfully studied by using the partial equilibrium approach. This section has shown how the separate markets form an interconnected system and attain a general equilibrium. In the remainder of this chapter we will see how we can use the general equilibrium model to evaluate the efficiency with which an economy allocates resources. Chapter 6 first introduced the concept of economic efficiency in the context of the distribution of fixed quantities of goods among consumers. Now we are concerned with *efficiency* in a more general sense. In our discussion the terms *efficient* and **Pareto optimal** are used interchangeably; the latter term is named after the Italian economist Vilfredo Pareto, who first gave careful attention to the concept.[1]

19.2 ECONOMIC EFFICIENCY

EFFICIENT
carries the same meaning as Pareto optimal

INEFFICIENT
the condition in which it is possible, through some feasible reallocation of resources, to benefit at least one person without making any other person worse off

Let's begin with a formal definition of economic efficiency and its corollary, economic inefficiency. *An allocation of resources is* **efficient** *when it is not possible, through any feasible change in resource allocation, to benefit one person without making any other person, worse off*. In other words, when the economy is operating efficiently, there is no scope for further improvement in anyone's well-being unless they are benefited at the expense of other people.

An allocation of resources is **inefficient** *when it is possible, through some feasible change in the allocation of resources, to benefit at least one person without making any other person worse off*. Inefficiency implies waste, in the sense that the economy is not satisfying the wants of people as well as it could.

These abstract definitions become clearer when we employ a diagram. To simplify matters, let's assume that society consists of only two people, Scrooge and Tiny Tim, although we can easily extend the analysis to larger numbers. In Figure 19.2, Scrooge's welfare is measured horizontally and Tiny Tim's welfare vertically. Since no objective way exists to attach units of measurement to a person's utility or welfare, the welfare measure is entirely ordinal. In other words, a rightward movement in the diagram implies that the resource allocation has changed in a way beneficial to Scrooge, but it does not tell us how much better off Scrooge is. All we know from the diagram is that the farther to the right we are, the higher is the indifference curve Scrooge attains. Upward movements similarly imply a change beneficial to Tiny Tim.

The levels of well-being attained by Scrooge and Tiny Tim depend on their consumption of goods. There are limits, though, to how much they can consume, because limited quantities of resources are available to produce those goods. Scarcity places upper limits on the well-being of Scrooge and Tiny Tim, and these limits are shown in Figure 19.2 by the welfare frontier *WW′*. The **welfare frontier** separates welfare levels that are attainable from those that cannot be reached, given the available resources. Any point on or inside the frontier is attainable. For example, different allocations of resources would place Scrooge and Tiny Tim at points *A*, *B*, *C*, *D*, *E*, or *F*. Any point beyond the frontier, like *L*, is unattainable. The economy cannot produce enough goods and services to make Scrooge and Tiny Tim as well off as the point indicated by *L*.

WELFARE FRONTIER
a curve that separates welfare levels that are attainable from those that cannot be reached given the available resources

A welfare frontier illustrates how the allocation of resources affects the well-being of members of society. To use it correctly, we must understand how it is derived from the underlying characteristics of an allocation of resources, and we will do this in the remainder of

[1]Vilfredo Pareto, *Manuel d'Economie* (Paris: V. Giard and E. Briere, 1903).

FIGURE 19.2

The Welfare Frontier
The welfare frontier shows how any resource allocation affects the well-being of both consumers. Any point on the frontier is an efficient point. Points inside the frontier, like point *D*, are inefficient since both parties can be made better off.
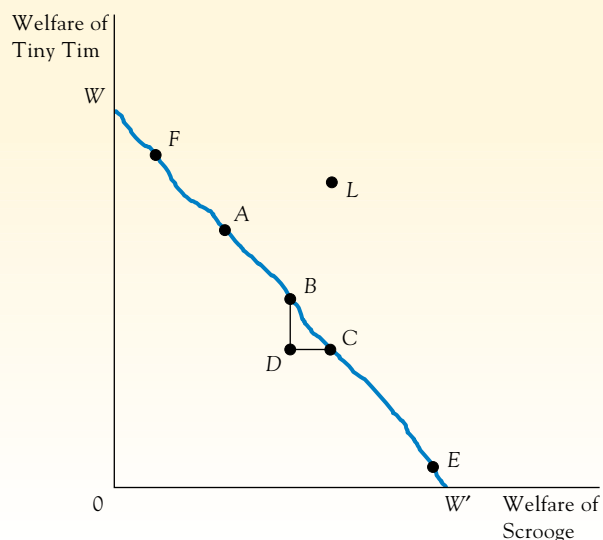
the chapter. For now, let's take the existence of the frontier for granted and use it to illustrate several points about the nature of economic efficiency.

Any resource allocation resulting in a point on the *WW'* frontier is efficient, or optimal; that is, it satisfies the definition of efficiency given earlier. Consider point A, for example. Since it is impossible to move beyond the frontier, there is no move from point A that can benefit one person without making the other worse off. The same is also true of point B; any move from point B harms at least one of the two persons. Thus, point B also represents an efficient allocation of resources. Indeed, *every point lying on the welfare frontier satisfies the definition of economic efficiency*. In fact, all points on the frontier are equally efficient, and no point on the frontier is more efficient than any other.

Any point inside the welfare frontier represents an inefficient resource allocation. Point D, for instance, is inefficient because resources can be reallocated so as to benefit one person without harming the other. A vertical move from D to B makes Tiny Tim better off and leaves Scrooge's welfare unchanged. Alternatively, a horizontal move from D to C benefits Scrooge without harming Tiny Tim. *Every point lying inside the welfare frontier represents an inefficient allocation of resources*. Note, also, that an inefficient point means it is possible to reallocate resources in a way that makes *all* parties better off, such as a move from point D to a point between B and C on the welfare frontier.

Efficiency as a Goal for Economic Performance

The notions of efficient and inefficient resource allocations, as summarized by the points on and inside the welfare frontier, naturally lead to an emphasis on the factors that affect the level and distribution of well-being. But this focus does not allow us to identify one resource allocation as being better than any other. To see why, consider a choice among the points on the welfare frontier, all of which are efficient. Is one better than another? Note that the points differ in terms of the distribution of well-being; a movement from one point to another—for example, from E to B—benefits one person and harms another. Since there is no objective way to compare one person's gain with another person's loss—interpersonal utility comparisons cannot be made objectively—economics must remain silent on this issue. As individuals we might believe for normative reasons that B is superior to E, but we can't rest our judgment on positive, efficiency-based considerations.

To see that economic efficiency is a reasonable goal, notice what an inefficient allocation of resources, like point D, implies. Inefficiency indicates that it is possible to reallocate resources in a way that benefits some, perhaps all, people without harming anyone, a noble goal. Since a move from inside the frontier at D to a point on the frontier between B and C benefits both parties, would anyone oppose such a change? In this context we must realize that when we talk about people being better off, we mean better off according to their own preferences: Tiny Tim views himself as better off at B than at D. Accepting efficiency as a goal means accepting the premise that each person is the best judge of their own welfare. One could quarrel with this view, but it appears a reasonable assumption in most situations. If granted, we could conclude that changes benefiting some and harming no one—that is, movements from inefficient to efficient points—are desirable, which is why we use efficiency as a goal.

We cannot conclude, however, that *any* efficient position is better than *any* inefficient position. For example, although a move between points D and E is a change from an inefficient to an efficient allocation, the change in this case greatly benefits Scrooge while impoverishing Tiny Tim. In comparing these points, we cannot simply note that one is efficient and the other inefficient; we must also take into account the change in the distribution of well-being. Taking equity considerations into account, we might judge point D to be superior to point E. By making such a judgment, however, we recognize that efficiency is not the only goal: the distribution of well-being counts, too. Even so, efficiency goals are not irrelevant since there are still efficient points between B and C making both Scrooge and Tiny Tim better off than point D.

Almost all real-world resource allocation changes involve both a move to a more (or less) efficient position and a change in the distribution of well-being, like the move from D to E in the diagram. In these cases, demonstrating that there is a gain in efficiency does not prove that the change is desirable, since distributional effects are important as well. Consequently, economists are generally reluctant to claim that one resource allocation is superior to any other. Economics can sometimes prove that one situation is more efficient than another, but there are other goals besides efficiency.

19.3 CONDITIONS FOR ECONOMIC EFFICIENCY

Notwithstanding the importance of other goals, such as distributional equity, let us turn now to deriving the conditions necessary for achieving economic efficiency. In general, any economy must solve three fundamental economic problems:

1. How much of each good to produce.
2. How much of each input to use in the production of each good.
3. How to distribute goods among consumers.

Each of these problems can be solved in different ways, but not all solutions are equally efficient. For example, consider the distribution of goods among consumers, an issue we discussed in Chapter 6. Recall that in a simple two-person, two-good setting, an Edgeworth exchange box shows all possible distributions of goods between consumers. Only some of these distributions, however, are efficient. The contract curve identifies which distributions of goods across consumers are efficient; distributions located off the contract curve are inefficient. At all points along the contract curve, the marginal rate of substitution (MRS) between any two goods is the same across consumers. Thus, we can concisely express the condition for efficiency in the distribution of goods as:

$$MRS^1 = MRS^2 = \ldots = MRS^i; \tag{1}$$

where the superscripts 1, 2, . . . i represent the i consumers in an economy. If this condition does not hold, at least some consumers can be made better of without harming other consumers by a change in the distribution of goods.

We now turn to developing similar conditions for efficiency in both production and output. We do so by employing the now-familiar constructs of an Edgeworth box and a production possibility frontier (*PPF*).

EFFICIENCY IN PRODUCTION

To address the issue of efficiency in production, think about a simplified world in which there are only two inputs (labor and land) and two possible consumer goods produced with the inputs (food and clothing). Assume that consumers' incomes are earned through the sale of the services of their labor and land and are spent on food and clothing. All inputs are homogeneous; each worker, for instance, is interchangeable with any other. Most importantly, the overall quantities of land and labor are taken to be in fixed supply. In other words, the aggregate labor and land supply curves are vertical. Finally, although the total supply of each input is fixed, the amount employed in each industry is not. The food industry can employ more labor, for instance, but only by bidding workers away from the clothing industry, since the total employment by the two industries together is fixed.

Although these assumptions describe about the simplest economy imaginable, understanding how the pieces fit together is still complex. Note that there are six identifiable markets: labor employed in producing food, labor employed in producing clothing, land employed in producing food, land employed in producing clothing, and the two product markets for food and clothing. Moreover, these markets are interrelated. For the food industry to expand, for example, it will have to bid away inputs from the clothing industry. Consequently, we must determine a pattern of prices and quantities in which the quantities demanded and supplied in each of the six markets are brought into equality simultaneously—that is, a general equilibrium.

The Edgeworth Production Box

EDGEWORTH PRODUCTION BOX
a diagram that identifies all the ways two inputs such as labor and land can be allocated between industries in a simplified economy

An **Edgeworth production box** (analogous to the Edgeworth exchange box introduced in Chapter 6) identifies all the ways labor and land can be allocated between the food and clothing industries in our simplified economy. As shown in Figure 19.3, the length of the box indicates the amount of labor employed by the two industries, in this case 80 units; the height of the box shows the amount of land employed by the two industries, 50 units.
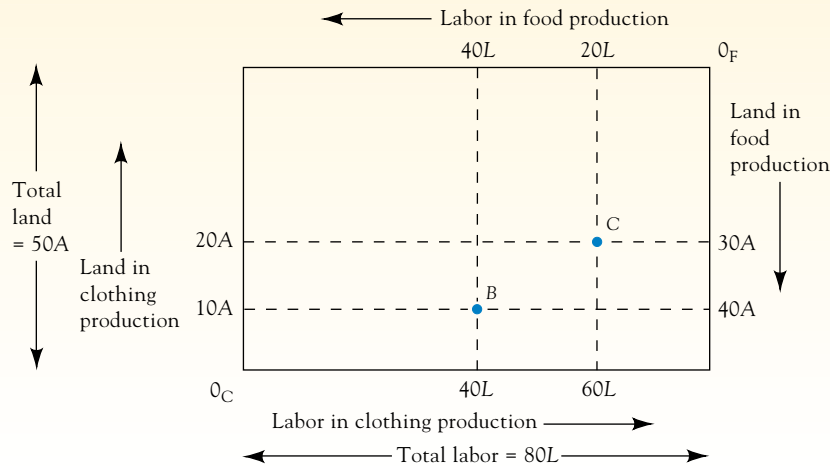
Through the Edgeworth production box we can determine the quantities of labor and land employed by both industries. Let's measure the employment of labor in clothing production horizontally from the southwest corner, point 0_C, and the employment of land in clothing production vertically from the same point. Point B, for example, indicates that 40 units of labor (L) and 10 units of land (A) are used in clothing production; point C implies 60 units of labor and 20 units of land. Because the total available input quantities are shown by the dimensions of the box, a given point also identifies employment levels in the food industry. Since total employment of labor in both industries together is 80 units, if the clothing industry employs 40 units, the food industry must be employing the remaining 40 units. In the diagram we measure the employment of labor and land in the food industry to the left and down, respectively, from the northeast corner, point 0_F. Thus, at point B the clothing industry employs 10A and 40L, and the food industry employs the remaining 40A and 40L. A move from B to C would indicate an expansion in employment of both inputs in clothing production to 20A and 60L, coupled with a decline in employment of both inputs in food production to 30A and 20L. Put differently, a move from B to C shows that the clothing industry has bid 20 labor units and 10 land units away from the food industry, although the total employment in both industries together remains unchanged.

Edgeworth Production Box

With fixed total input supplies, we can show all the possible ways of allocating inputs between food and clothing production with an Edgeworth production box. Point *B*, for example, indicates employment of 10 units of land (*A*) and 40 units of labor (*L*) in clothing production; the remaining inputs, 40 units of land and 40 units of labor, are employed in food production.


Having shown how the allocation of inputs is indicated by a point in the Edgeworth production box, we next want to identify the levels of food and clothing output corresponding to each possible input allocation. This is accomplished by incorporating clothing and food isoquants into the diagram, since these curves identify the output level associated with each combination of inputs. In Chapter 7 we explained how a *firm's* production function could be graphed as a set of isoquants. Here, though, isoquants are used to represent the production function of an entire *industry* composed of all the separate firms producing each good. The industry isoquants have the same characteristics as those of individual firms.

Figure 19.4 incorporates the clothing and food isoquants into the Edgeworth production box. For clothing, several isoquants are drawn with their origin at point 0_C—100C, 150C, 160C, and so on—each labeled to indicate the amount of clothing produced with each combination of land and labor. Note that the isoquants have the familiar shapes discussed in Chapter 7. The food isoquants—100F, 220F, 260F, and so on—are drawn relative to the origin at point 0_F, with the employment of labor measured to the left and the employment of land measured down from 0_F. In effect, the food isoquants are turned upside down, which accounts for their unconventional appearance. Nonetheless, the food isoquants embody the familiar properties, with isoquants lying closer to the origin at point 0_F representing lower food output.

With the isoquants drawn in, each point in the Edgeworth production box indicates the employment of labor and land in both industries as well as the output of food and clothing. For example, point B implies employment of 40L and 10A by the clothing industry, with an output of 100 clothing units; point *B* also indicates employment of 40A and 40L by the food industry (see point B in Figure 19.3 to understand this explicitly; to avoid cluttering the diagram, we have not shown these input use levels on the Figure 19.4 axes), with an output of 300 food units. In the same way, point *D* shows employment of 20A and 10L producing 100 food units, with the remaining 30A and 70L used to produce 200 clothing units.

General Equilibrium in Input Markets
A competitive equilibrium involves an input allocation lying somewhere on the contract curve connecting points of tangency between food and clothing isoquants. Input prices depend on exactly where on the contract curve the equilibrium lies.
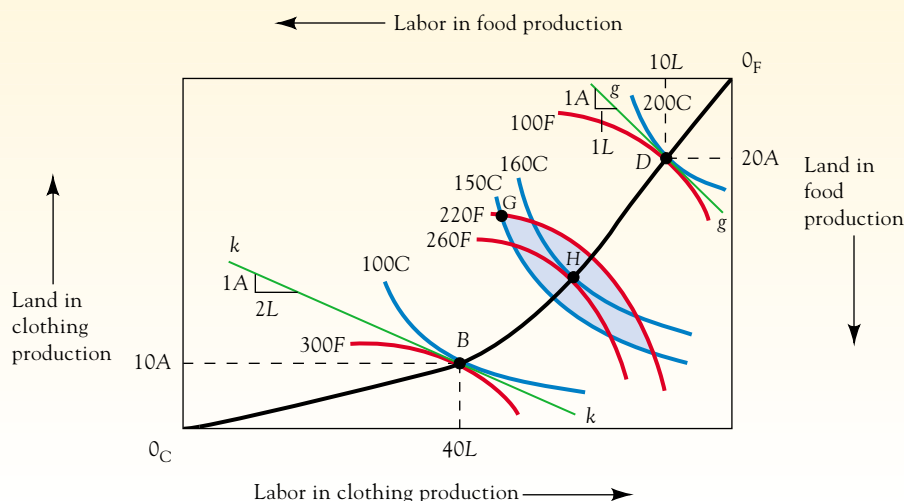
The Production Contract Curve and Efficiency in Production

The Figure 19.4 box shows every conceivable way of allocating labor and land between the two industries. Still, only some of these resource allocations are *efficient* in the sense that the output of one good cannot be increased without decreasing the output of the other. Indeed, *only input allocations where the isoquants are tangent to one another represent efficient resource allocations.* The *production contract curve* running from one origin to the other and passing through points B, H, and D connects all the points where food and clothing isoquants are tangent.

To see why only points on the production contract curve represent efficient input allocations, consider point G, where a food (220F) and a clothing (150C) isoquant intersect. At point G, a lens-shaped area lies between the intersecting food and clothing isoquants. The significance of the lens-shaped area is that every allocation of inputs identified by a point inside the area involves larger outputs of both goods than at point G. For instance, point H implies greater production of both clothing (160) and food (260) than point G (150 clothing units and 220 food units). Thus, a move from point G to H, which involves shifting some labor from the food to the clothing industry and some land from the clothing to the food industry, will increase the output of both goods at no additional cost. This result is true at every point in the box where isoquants intersect. Thus, any point where food and clothing isoquants intersect, which includes all points not on the production contract curve, cannot represent efficiency in production.

General Equilibrium in Competitive Input Markets

If perfect competition prevails in input markets, a point on the production contract curve (that is, efficiency in production) will be attained. To see why, recall from Chapter 16 that in competitive markets, the price of an input tends to be equalized across firms and industries. Here, this tendency means that the wage rate earned by laborers will be the same in the clothing and food industries, and similarly for the rental price of land. Furthermore, every firm will minimize cost by employing inputs in quantities so that the ratio of marginal

products (MP) equals the ratio of input prices (Chapter 8). For a wage rate of w and a rental price of land of v, the condition for cost minimization is:

$$w/v = MP_L/MP_A = MRTS_{LA}. \tag{2}$$

Geometrically, this equality is shown by the tangency between an isocost line, with a slope of w/v, and an isoquant where the isoquant's slope, the marginal rate of technical substitution ($MRTS_{LA}$), is equal to the ratio of marginal products (MP_L/MP_A).

In a competitive equilibrium, each food producer operates at a point where the slope of its food isoquant equals the ratio of input prices, w/v. In addition, each clothing producer operates at a point where the slope of its clothing isoquant also equals the *same* input price ratio. *Therefore, the slopes of the clothing and food isoquants must equal one another since both are equal to the same input price ratio*. Consequently, the equilibrium must lie on the contract curve, which identifies resource allocations where the slopes of clothing and food isoquants are equal. For example, if the wage rate is half the rental price of land, isocost lines have a slope of 1/2, as illustrated by line kk in Figure 19.4. To minimize the cost of producing 100 clothing units, clothing producers would operate at point B where the 100C isoquant is tangent to kk. Similarly, food producers also minimize the cost of producing 300 food units when they use the remaining inputs, since the 300F isoquant is also tangent to kk at point B. Only when the isoquants are tangent can both industries be minimizing cost when confronted with the same input prices.

For these reasons the competitive equilibrium can exist only at a point on the production contract curve in Figure 19.4. Exactly where on the contract curve the equilibrium will lie depends on the consumers' demands for clothing and food. If the demand for clothing is relatively high, for example, equilibrium will occur at a point like D, where a large quantity of clothing and very little food is produced. On the other hand, if the demand for clothing is relatively small (which is equivalent to saying that the demand for food is relatively great), not much clothing and a large quantity of food will be produced, as at point B.

19.5

THE PRODUCTION POSSIBILITY FRONTIER AND EFFICIENCY IN OUTPUT

To bring the output markets for food and clothing clearly into focus, we use a concept introduced in Chapter 1, the *production possibility frontier* (*PPF*). The *PPF* shows the alternative combinations of food and clothing that can be produced with fixed supplies of labor and land. The same information is already contained in the Edgeworth production box, but the *PPF* presents it more clearly. Glance once again at the contract curve in Figure 19.4. Each point identifies a certain combination of food and clothing output that can be produced with available inputs. A movement between points on the contract curve, as from B to H, shows that as more clothing is produced, food output must fall.

The PPF *is derived from the contract curve in Figure 19.4 by plotting the various possible output combinations directly*. In Figure 19.5, the frontier is the bowed-out curve ZZ'. Points B, H, D, and G in Figure 19.5 correspond to these same points in Figure 19.4. For example, point B indicates an output combination of 100C and 300F in both diagrams. The frontier slopes downward, indicating that more clothing can be produced only by giving up food output, since land and labor must be transferred from the food to the clothing industry to produce more clothing.

With the available quantities of labor and land, firms can produce any combination of output lying on or inside the *PPF*. Points lying inside the frontier represent allocations that are production inefficient. That is, in Figure 19.5 a point like G inside the frontier corresponds to a point where isoquants intersect in the box of Figure 19.4; more of both goods can be obtained from the available resources, such as at point H.

As discussed in Chapter 1, the *PPF* is typically bowed out, or concave to the origin. The *PPF* slope thus becomes more steep in absolute value as we move down the curve from point Z to point Z'. Like many slopes in economics, the *PPF* slope has a special name, the **marginal rate of**

MARGINAL RATE OF TRANSFORMATION
the rate at which one product can be "transformed" into another

The Production Possibility Frontier Revisited
The *PPF* plots the output combinations from the contract curve in Figure 19.4. It is normally bowed out from the origin. The slope of the frontier, called the *marginal rate of transformation*, shows how much of one good must be given up to produce more of the other.
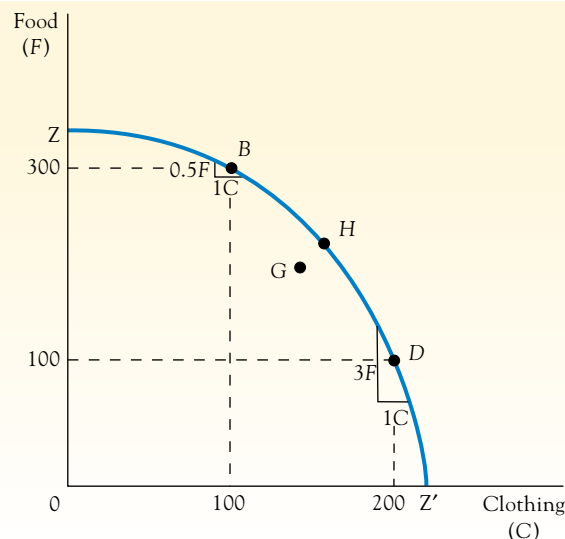
transformation, or *MRT*. At any point on the frontier, the *MRT* indicates the rate at which one product can be "transformed" into the other. Of course, once food is produced, it cannot usually be changed into clothing, but clothing output can be increased by transferring land and labor from food to clothing production, thereby gaining more clothing at a cost of reduced food output. At point *B* the marginal rate of transformation is 0.5F/1.0 C, indicating that production of one more clothing unit requires removing resources from food production by an amount that will reduce food output by 1/2 unit. Further down the frontier, at point *D*, the *MRT* is 3F/1C, implying that increasing clothing output by one unit necessitates a sacrifice of three food units.

   As Chapter 1 shows, the marginal rate of transformation, or the *PPF* slope, reflects the opportunity cost of one good in terms of the other. The marginal rate of transformation also equals the ratio of the monetary marginal cost (MC) of clothing production to the monetary marginal cost of food production. *At any point on the frontier, the slope, or* MRT, *equals* MC_C/MC_F. To see why, suppose that at current output levels the marginal costs of clothing and food are $100 and $200, respectively. How much food would we have to give up to produce one more clothing unit? (That is, what is the *MRT* between clothing and food?) Producing one more clothing unit utilizes $100 worth of resources (labor and land), so $MC_C = \$100$. If we remove $100 worth of resources from food production, food output falls by half a unit since the marginal cost of a food unit is $200. Thus, we must give up half a food unit to produce one more clothing unit—that is, $MRT = 0.5F/1.0 \, C = 1F/2C$. This ratio is also equal to the marginal cost ratio: $MC_C/MC_F = \$100/\$200 = 1F/2C$.

   When the marginal cost of food is twice that of clothing, we know that one more clothing unit requires a sacrifice of half a unit of food. Point *B* illustrates this situation. As we move down the frontier, the marginal cost of clothing increases as more is produced, and the marginal cost of food declines as less is produced. (This means that the ratio MC_C/MC_F rises since the numerator increases and the denominator decreases.) At point *D*, for example, $MC_C/MC_F = 3F/1C$, showing that the marginal cost of clothing is three times the marginal cost of food, so three food units must be given up to produce one more clothing unit.[2]

[2]As mentioned in Chapter 1, it is possible for the *PPF* to be a straight line with a constant slope. This situation occurs when both industries are constant-cost so that each good's marginal cost is constant over all output levels. The ratio MC_C/MC_F is constant at all output combinations, implying a linear production frontier.

Efficiency in Output

Now we come to the question of where on the *PPF* we should operate—that is, what combination of food and clothing should be produced? Producing an efficient output mix requires balancing the subjective wants, or preferences, of consumers with the objective conditions of production. More specifically, efficiency in output is attained when the rate at which consumers are willing to exchange one good for another (the marginal rate of substitution, or *MRS*, of those consumers) equals the rate at which, on the production side, one good can be transformed into another (the marginal rate of transformation, or *MRT*):

$$MRS^1 = MRS^2 = \ldots = MRS^i = MRT; \tag{3}$$

where the superscripts refer to an economy's *i* consumers.

To see why the foregoing equality needs to be satisfied to ensure efficiency in output, recall from Chapter 4 that, in the context of our example, MRS_{CF} reflects a consumer's willingness to pay for an additional unit of clothing by consuming less food. As we saw in the preceding section, MRT_{CF} represents the ratio of the marginal cost of clothing relative to the marginal cost of food.

Now, suppose that the MRS_{CF} is equal across all consumers (that is, we have achieved efficiency in distribution) and equal to three units of food per clothing unit, while the MRT_{CF} equals one food unit per clothing unit. Such an outcome would not represent an efficient output mix. When consumers' MRS_{CF} is 3F/1C, then the marginal benefit to a consumer of one more clothing unit is equal to three food units—this is the maximum amount of food that a consumer is willing to give up for one more clothing unit. In contrast, when MRT_{CF} is 1F/1C, the marginal cost of one more clothing unit is only one food unit. Thus, when MRS_{CF} is greater than MRT_{CF}, the marginal benefit to consumers of more clothing output exceeds the marginal cost of producing it—both expressed in food units. Additional clothing is worth more to consumers than it costs to produce, and consumers can be made better off by moving along the *PPF* to a point where more clothing and less food is produced.

As more clothing and less food is produced, MRT_{CF} rises, and as consumers consume more clothing and less food, their marginal rates of substitution tend to decline. The process of producing more clothing and less food tends to bring MRT_{CF} and MRS_{CF} closer together. This movement along the production frontier can continue to benefit consumers until the two terms are exactly equal. In sum, *it is always possible to change the output mix and leave consumers better off whenever their common marginal rates of substitution are not equal to the marginal rate of transformation.*

We can illustrate the preceding analysis with a diagram. In Figure 19.6, the points on the production possibility frontier *ZZ'* all represent efficient input allocations in our two-good economy. Of these points, an efficient output mix is represented by a point such as *P* on the frontier. At point *P*, the marginal rate of transformation between food and clothing (MRT_{CF}) equals the slope of a representative consumer's indifference curve, the marginal rate of substitution between food and clothing (MRS_{CF}), at the optimal consumption point, *E*, chosen by the consumer. The slope of the production frontier at *P* is reflected by the slope of line *gg* and is equal to two units of food per one clothing unit. The slope of the representative consumer's indifference curve U_i at consumption point *E* is represented by the slope of the line *hh* and also equals two units of food per clothing unit.[3]

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[3]Figure 19.6 does not rule out the possibility that consumers differ in their incomes and, from that, in how far removed their budget lines may be from the origin. For efficiency in output mix to result, all that is necessary is that, at the consumption points selected by individual consumers, the slopes of various consumers' indifference curves be identical and equal to the slope of the *PPF*.

FIGURE 19.6

Efficiency in Output
The output mix at point *P*, together with the consumption point *E* selected by a representative consumer, satisfy the condition for efficiency in output. For efficiency in output to be realized, the slope of the *PPF* (the marginal rate of transformation) must equal the slope of all consumers' indifference curves (the marginal rates of substitution) at their selected consumption points.
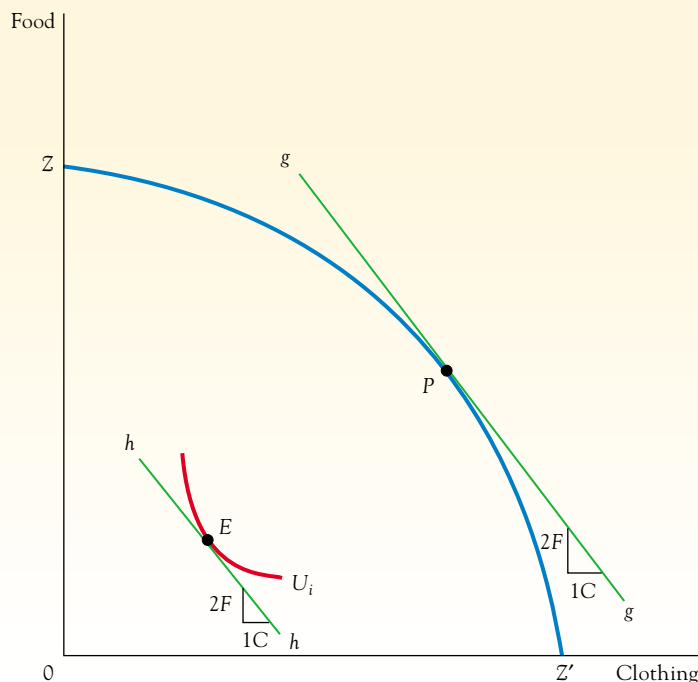
By calling for the marginal rates of substitution and transformation to be equal, the condition for efficiency in output is simply restating what we discussed earlier in Chapter 10: namely, efficiency in output requires the output of any good to be expanded to the point where marginal benefit (*MRS*) equals marginal cost (*MRT*). The only difference of note is that in Chapter 10 we employed a partial equilibrium perspective and showed how, at any given output level, the marginal benefit to consumers from a good is represented by the height of the demand curve, while the height of the supply curve represents the marginal cost. Relying on a partial equilibrium approach, we saw how efficiency in output thus is realized where the demand and supply curves intersect.

In this chapter we have adopted a general equilibrium approach and avoided the assumption that we can treat the market for any good in isolation. The heights of demand and supply curves for a good at any given output level can be influenced by the operation of markets for other goods.

An Economy's *PPF* and the Gains from International Trade

Our general equilibrium analysis has been developed for a society that does not trade with other countries. It can, however, be easily extended to show the consequences of international trade. In fact, a general equilibrium approach provides a particularly vivid demonstration of the sense in which a country can be said to gain from participation in international trade.

In Figure 19.7, suppose that we are a nation initially isolated from world trade and in equilibrium at point *B* on our production possibility frontier, *ZZ′*. The assumed pretrade price ratio between the two goods is shown by the slope of *gg*, or 2F/1C. Now assume that we begin engaging in international trade. The terms on which other countries are willing to trade are measured by the world price ratio. If that ratio is, for instance, 1F/1C, then other countries are willing to supply us with one food unit for each clothing unit we supply to

The *PPF* and the Gains from International Trade
Without trade, equilibrium is at point *B*. When trade becomes possible at terms of 1*F*/1*C*, production takes place at point *J*, and exports of F_1 minus F_2 food units are exchanged for imports of C_2 minus C_1 clothing units. The country can attain more of both goods through trade (at point *K*) than it did without trade (at point *B*).
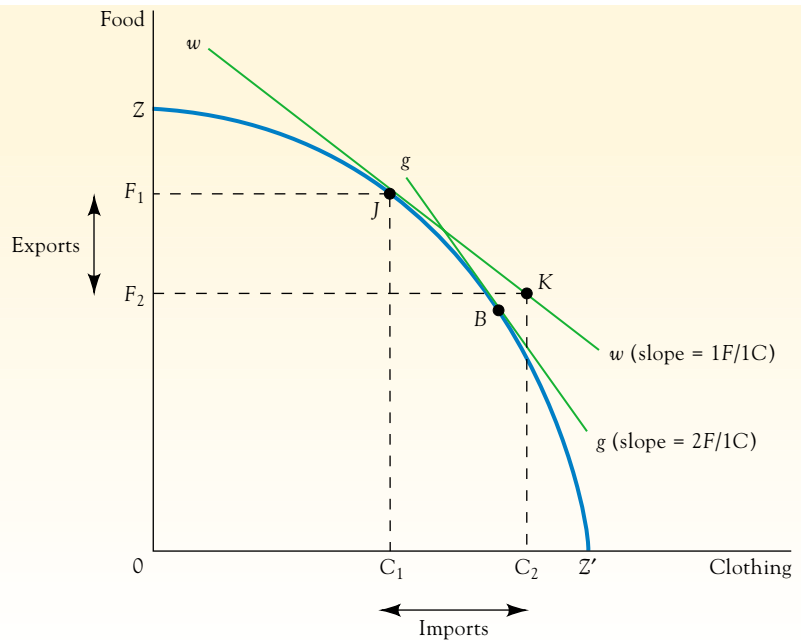
them, or to sell us one clothing unit for one food unit. In this model we view our exports of one product as paying for our imports, with the world price ratio indicating how much of one product can be exchanged for the other. (In reality, money is used to pay for imports, but since the money received by international sellers is used to purchase our exports, exports are really being exchanged for imports.)

If the opportunity for international trade at a price ratio of 1*F*/1*C* exists and the domestic price ratio is initially 2*F*/1*C*, then the domestic economy will undergo a number of changes to adjust to a new equilibrium position. With the world price of clothing lower than the domestic price, clothing consumers will switch from domestic to imported apparel and expand total clothing purchases. As a consequence, the domestic clothing industry will lose customers and have to contract its output. (In partial equilibrium terms, the domestic industry moves down its supply curve until it operates where the domestic price equals the world price.)

At the same time that the clothing industry contracts in the face of foreign competition, the food industry expands. Since the world price of food (one *C* for one *F*) is higher than the initial domestic price (one-half *C* for one *F*), food producers can make higher profits by exporting food. Food production will expand until the domestic food price rises to equal the world price of food.

So, domestic clothing production falls and domestic food production rises until the domestic price ratio equals the world price ratio. These adjustments are illustrated in Figure 19.7. The world price ratio is equal to the slope of line *ww*. Since domestic production adjusts until the domestic price ratio equals the world price ratio, the output mix produced by the economy shifts to point *J* on the production frontier; at point *J*, the slope of *ZZ′* equals the slope of *ww*, the world price ratio. Point *J* thus identifies the output mix produced by the economy. It does not, however, identify the domestic consumption of food and clothing since the country can, by engaging in trade, consume a different bundle of products than it produces. In fact, through trade the country may consume any output combination along line *ww*.

Exactly where on ww consumption will take place depends on domestic demands for the two products, which are not shown in the diagram. Suppose, however, that consumers choose to consume at point K. To arrive at K, an amount of food equal to F_1 minus F_2 is exported and used to pay for clothing imports of C_2 minus C_1. *Note that consumption of both products is greater at point* K *than at the no-trade equilibrium of point* B. This difference shows clearly the nature of the gain made possible when a nation engages in international trade: it is possible to consume more of all goods. In effect, trade makes possible the consumption of goods beyond the domestic production possibility frontier.

Does this analysis demonstrate that trade is beneficial for the country as a whole? As discussed in Chapter 10, the answer to this question depends on what is meant by "country as a whole." Not everyone is likely to benefit. Since the adjustment to trade implies that the domestic clothing industry will contract, the owners of resources specialized in clothing production are likely to find their real incomes reduced. Alternatively, in our general equilibrium model, as the output of food expands at the expense of clothing (see Figure 19.4), the wage rate falls relative to the rental price of land, so workers may lose. Our analysis shows that trade makes it possible for everyone to consume more of all goods, not that everyone actually will. This idea has significant policy implications. The analysis indicates, for example, that the trade liberalization brought about by the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT) may not result in all Americans consuming more of all goods, though it does make it possible for them to do so. Trade liberalization raises the average standard of living, but not everyone is average.

APPLICATION 19.1

THE EFFECTS OF TRADE RESTRICTIONS ON AN ECONOMY'S CONSUMPTION AND PRODUCTION POSSIBILITIES

In terms of Figure 19.7, trade restrictions prevent a country from moving between points B and J on the production side—a movement that permits access to greater consumption possibilities such as at point K along the free-trade price-ratio line of ww. The effects on a country's consumption possibilities and welfare from such trade restrictions can be substantial. For example, the Smoot-Hawley Tariff Act enacted by the United States in 1930, and similar "beggar-thy-neighbor" protectionist policies adopted at the same time by other countries, arguably exacerbated the severity and length of the worldwide Great Depression.[4]

In addition to the effect of protectionism on a country's overall consumption possibilities, the tradeoffs implied on the production side can be quite sizable.[5] For

example, consider the case of voluntary export restraints (VERs) on sales of Japanese cars in the United States. Since 1981, Japanese car manufacturers have "voluntarily" restricted their exports of cars to the United States to 1.7 million cars per year. Robert W. Crandall of the Brookings Institution estimates that under this program 26,000 automotive manufacturing jobs have been saved in the United States at an annual cost of $4.3 billion in diminished U.S. car consumer surplus. The annual cost per domestic auto job preserved by VERs is thus $160,000 ($4.3 billion/26,000) in terms of reduced consumer spending on other, non-automotive goods.

The same type of calculations reveal similarly substantial production-side tradeoffs in the case of other domestic industries protected from international competition. For example, tariffs on imports have been estimated to save 116,000 jobs in the domestic clothing industry at an annual consumer surplus cost of $45,000 per job saved. The cost of preserving a job in the domestic steel industry through government protection from international competition has been estimated at $750,000 per year.

[4]Jagdish Bhagwati, *Protectionism* (Cambridge, MA: The MIT Press, 1988).

[5]"The $750,000 Job," in *The Economics of Public Issues*, 9th ed., by Roger L. Miller, Daniel K. Benjamin, and Douglass C. North (New York: HarperCollins Publishers, 1993), pp. 228–233.

19.6 **COMPETITIVE MARKETS AND ECONOMIC EFFICIENCY**

Economists tend to be advocates of perfect competition because it satisfies all three conditions for economic efficiency. Let's consider each of the three conditions in turn and show why this is the case.

1. As shown in Chapter 6, a perfectly competitive economy results in an efficient distribution of products among consumers. To see why this is the case, recall that, in maximizing utility, each consumer will select a basket of goods where the consumer's *MRS* between any two goods (say, food and clothing) equals the ratio of the prices of the two goods, or:

$$P_C/P_F = MRS_{CF}. \tag{4}$$

Since competitive markets establish a uniform price for each good, the ratio P_C/P_F confronting all consumers is the same. Because all consumers equate their individual marginal rates of substitution to the same price ratio, the marginal rates of substitution between goods will end up being the same across consumers:

$$MRS^1_{CF} = MRS^2_{CF} = \ldots = MRS^i_{CF}; \tag{5}$$

where the superscripts signify the *i* consumers in an economy. This is the condition for an efficient distribution of goods across consumers. A competitive equilibrium therefore implies an efficient distribution of goods.

2. A perfectly competitive economy results in efficiency in production. This point was covered in Section 19.4. Recall that each firm producing a good minimizes cost by employing inputs in quantities such that the marginal rate of technical substitution between the inputs equals the input price ratio. In the context of a two-input economy (labor and land), each firm thus equates:

$$w/v = MRTS_{LA}. \tag{6}$$

Since competitive markets equalize input prices across firms and industries, the ratio w/v is the same for all firms. Therefore, the marginal rates of technical substitution end up being the same across all firms and industries:

$$MRTS^1_{LA} = MRTS^2_{LA} = \ldots = MRTS^j_{LA}; \tag{7}$$

where the superscripts indicate the *j* producers in an economy. This is the condition for efficiency in production. The condition requires that we end up on the contract curve of the economy's Edgeworth production box and that the slopes of all producers' isoquants are identical.

3. A perfectly competitive economy results in efficiency in output. This can be shown by considering the equilibrium conditions of firms in output markets and the equilibrium conditions of consumers. When clothing producers produce the profit-maximizing outputs, they operate where marginal cost equals price, or:

$$P_C = MC_C. \tag{8}$$

For food producers, the profit-maximizing condition is:

$$P_F = MC_F. \tag{9}$$

Dividing equation (8) by (9) yields:

$$P_C/P_F = MC_C/MC_F. \tag{10}$$

We know that MC_C/MC_F equals the marginal rate of transformation between food and clothing (MRT_{CF}) and that utility-maximizing consumers will equate their marginal rates of

substitution between food and clothing to the ratio of prices of these two goods (that is, $MRS_{CF} = P_C/P_F$). By substitution, therefore, we obtain:

$$MRS^1_{CF} = MRS^2_{CF} = \ldots = MRS^i_{CF} = MRT_{CF}; \tag{11}$$

where the superscripts refer to an economy's i consumers. This is the condition for efficiency in output.

The preceding formal manipulations show that *if perfect competition prevails, then all three conditions for economic efficiency are satisfied.* Perhaps the most intuitive way of understanding why perfect competition efficiently solves the three basic economic problems of distribution, production, and output is to note that a competitive economy relies on voluntary exchanges. Whenever any possible change in the allocation of either inputs or goods promises mutual benefits to market participants, people have an incentive to work out exchanges to realize these gains. If all mutually beneficial exchanges are consummated, as they are in competitive markets, then no further change will benefit some without harming others. The outcome is efficient.

This discussion is proof, at an abstract level, of Adam Smith's famous "invisible hand" theorem: namely, that people pursuing their own ends in competitive markets promote an important social goal—economic efficiency—that is not actually their intention and that they may not even understand. In terms of our welfare frontier construct, it means that competitive markets attain a point on the frontier. Although the one point on the welfare frontier that represents a competitive equilibrium is not the only efficient resource allocation, we should recognize that competitive markets get us to a point on the welfare frontier, no easy task.

The Role of Information

Before closing our discussion of economic efficiency and why perfect competition attains it, we should emphasize the important role of information in the process. When showing what an efficient resource allocation looks like, we assumed that all the relevant information was known: consumer preferences, production functions, and the quantities and productive capabilities of inputs. Clearly, in the real world, with millions of consumers, firms, and products, no one person knows or could possibly ever know all the relevant information needed to attain economic efficiency. Take the case of even a simple lead pencil. Producers of pencils purchase wood, graphite, steel, paint, and rubber from other people. Pencil producers cannot produce these inputs themselves. Despite the fact that no one individual knows how to make a pencil, much less an automobile or a personal computer, these items are produced. How?

The answer lies in the nature of a market system: partial bits of information possessed by many different people are coordinated to produce a result that no one fully comprehends. The only information individual consumers or producers need to know about the rest of the economy to adjust their behavior is conveyed through prices. For example, if the supply of cotton expands while the supply of wool declines, the price of cotton clothing will fall relative to the price of wool clothing. Buyers will substitute cotton for wool in their apparel, using more of the plentiful fabric and economizing on the scarce. This efficient response can, and probably will, occur without anyone knowing why prices changed the way they did.

A market system can function efficiently without any single individual understanding how. In this sense markets economize on the information people individually require to coordinate their economic activities. An immense amount of information must be utilized to achieve an efficient resource allocation. Perhaps the most significant implication of our analysis is that, in principle, an efficient outcome can be accomplished by decentralized, voluntary transactions among people, each of whom has only a tiny portion of the requisite information.

APPLICATION 19.2 — CAN CENTRALIZED PLANNING PROMOTE EFFICIENCY?

During the early part of the twentieth century, economists Oscar Lange and Abba Lerner argued that it would be possible to attain Pareto optimality through central planning. All that was necessary, according to them, was individual consumers and producers reporting to a central planning board information about underlying consumer preferences, production technology, input availability, and so on. The central planning board could then specify the amount of each commodity to be produced, the input usage levels to be used in production, and the distribution of goods among consumers. The Lange and Lerner scheme gave credence to the fascist and communist governments coming into power at that time and raised the possibility that such forms of government might be more effective in promoting efficiency than governments relying on decentralized, market-based economies.

Among the earliest critics of the hypothesis advanced by Lange and Lerner was Austrian economist Friedrich Hayek.[6] Hayek argued that central planning inevitably must fail because it can never fully accommodate the particular and changing information about costs and/or demand possessed by individual consumers and producers. Moreover, central planning also undermines the incentive consumers and producers have to acquire information and to act on the information they have acquired. As Hayek stated:

> [Knowledge of this kind] cannot be conveyed to any central authority in statistical form. The statistics . . . would have to be arrived at precisely by abstracting from minor differences between the things, by lumping together, as resources of one kind, items which differ in regards to location, quality, and other particulars, in a way which may be very significant for the specific decision. It follows from this that central planning based on statistical information by its nature cannot take direct account of these circumstances of time and place and that the central planner will have to find some way or other in which the decisions depending on them can be left to the "man on the spot." . . .

[T]he ultimate decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them. We cannot expect that this problem will be solved by first communicating all this knowledge to a central board which, after integrating all knowledge, issues its orders. We must solve it by some form of decentralization.

[Where] knowledge of the relevant facts is dispersed among many people, prices can act to coordinate the actions of separate people. . . . The marvel is that in a case like the scarcity of one raw material, without an order being issued, without more than perhaps a handful of people knowing the cause, tens of thousands of people whose identity could not be ascertained by months of investigation, are made to use the material or its products more sparingly. . . . I have deliberately used the word "marvel" to shock the reader out of the complacency with which we often take the working of this [price] mechanism for granted. I am convinced that if it were the result of deliberate human design, and if the people guided by the price changes understood that their decisions have significance far beyond their immediate aim, this mechanism would have been acclaimed as one of the greatest triumphs of the human mind. Its misfortune is the double one that it is not the product of human design and that the people guided by it usually do not know why they are made to do what they do. But those who clamor for "conscious direction" [i.e., central planning]—and who cannot believe that anything which has evolved without design (and even without our understanding it) should solve problems which we should not be able to solve consciously—should remember this: The problem is precisely how to expand the span of our utilization of resources beyond the span of control of any one mind; and, therefore, how to dispense with the needs of conscious control and how to provide inducements which will make the individuals do the desirable things without having to tell them what to do.

[6]Friedrich A. Hayek, "The Use of Knowledge in Society," *American Economic Review*, 35 No. 4 (September 1945), pp. 519–530.

19.7

THE CAUSES OF ECONOMIC INEFFICIENCY

A market may fail to satisfy the conditions for Pareto optimality for several reasons, including market power, imperfect information, and externalities/public goods. We briefly discuss each of these reasons in sequence.

Market Power

The preceding section showed that competitive markets, without government intervention, will result in the attainment of Pareto optimality. This will not be the outcome, however, if producers or consumers have some market power and perfect competition does not prevail. To see why monopoly or monopsony power results in economic inefficiency, consider the case of a monopoly in an output market. Suppose, for example, that in our simplified two-good economy, the food industry is competitive while the clothing industry is controlled by a monopoly seller.

The clothing monopoly maximizes its profit by reducing output below the competitive level and setting the per-unit clothing price above the marginal cost. Since the price of food equals its marginal cost (we assumed that the food market is competitive), the relative price of clothing exceeds its relative marginal cost:

$$P_C/P_F > MC_C/MC_F. \tag{12}$$

The preceding inequality indicates that an output market monopoly violates the output efficiency condition. With a monopoly seller in the clothing market, the rate at which consumers are willing to trade food for clothing (MRS_{CF}, which equals P_C/P_F provided consumers are utility maximizers) exceeds the marginal rate of transformation between food and clothing on the production side (MRT_{CF}, or MC_C/MC_F).[7]

More clothing and less food should be produced since the marginal benefit of more clothing, in terms of food, exceeds its marginal cost at the monopoly equilibrium. Such a change in output mix, however, will not occur, because it would be contrary to the profit-maximizing interest of the monopoly clothing supplier.

A similar inefficiency results in the case of monopoly in input markets. For example, suppose that the market for labor in the clothing industry is monopolized by a union. This implies that in our simple, two-good economy, the ratio of the labor wage rate (w) to the rental price of land (v) will be higher in the clothing industry than in the food industry (provided that competition characterizes all other input markets):

$$w_C/v > w_F/v. \tag{13}$$

Since profit-maximizing firms equate their *MRTS* between labor and land to the relative input costs (that is, $MRTS_{LA} = w/v$), the rate at which producers are willing to exchange land for labor units ($MRTS_{LA}$) will be greater in the clothing than in the food industry. In equilibrium, that is, labor is relatively more productive if employed in clothing manufacturing than in food production. The input-pricing actions of the union, however, prevent the movement of labor from the food to the clothing industry.

In the context of a *PPF* such as that in Figure 19.5, the union's action results in an outcome such as point G inside the frontier. Note that this outcome occurs not because resources are unemployed (since we assume that all inputs are employed), but because of an inefficient allocation of inputs between the food and the clothing industries—inefficiency in production. Total output is lower than it could be, as is total consumption. At least in terms of total economic surplus, society is not as well off at point G as it could be if it were operating on the production frontier.

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[7]In the context of Figure 19.6, the clothing monopoly results in a point on the *PPF* being realized somewhere between Z and P (less than the optimal amount of clothing produced). The slope at the *PPF* at the realized point is less than the slope of all consumers' indifference curves (as indicated by line *hh* in Figure 19.6). That is, the rate at which consumers are willing to trade food for clothing (given by the slope at line *hh*) is greater than the marginal rate of transformation between food and clothing (as indicated by the slope of the *PPF* at the realized point between Z and P with a clothing monopoly).

Imperfect Information

If consumers or producers are not accurately informed, they may take actions that run counter to the dictates of Pareto optimality. For example, consumers may mistakenly think that a certain "miracle" gel can help reverse hair loss. Upon applying the gel to their scalps, the consumers may be disappointed to find that their hair continues to thin. Worse yet, some consumers may end up bald. Likewise, if a computer manufacturer is unaware that a particular chip has a computational glitch, it may use the chip extensively in the production of computers.

Of course, the existence of imperfect information does not in and of itself imply that government intervention can best remedy the problem. After all, information may be considered to be just another good for which private markets provide better production and consumption incentives than do government edicts.

APPLICATION 19.3 — DETERRING CIGARETTE SMOKING

Since the early 1950s, increasingly strong scientific evidence has shown that smoking cigarettes is harmful to one's health. As the evidence has mounted, the presumption that government is best able to inform consumers about these effects has prevailed. Since 1965, for example, all cigarette packages have been required by the Federal Trade Commission to carry a warning from the Surgeon General. Carriage of the same warnings on all cigarette advertisements has been mandated since 1972.

Economist John Calfee, formerly of the Federal Trade Commission, has examined the historical role played by the government in improving information about the health risks associated with cigarettes.[8] Calfee's examination suggests that, at least in this case, the presumption that government is best able to diminish informational imperfections may not be warranted. For example, from the 1920s through the 1950s, while smoking was considered glamorous by many, it was also widely described in such unglamorous terms as "coffin nails," "smoker's cough," "gasper," and "lung duster"—despite a lack of scientific evidence about smoking's mortal long-term effects.

Rather than suppressing smokers' fears or arguing that they were unfounded, cigarette manufacturers relied on these fears as an advertising tool. Among the slogans employed by particular brands were "Not a cough in a carload" (Chesterfield), "Not a single case of throat irritation due to smoking Camels," and "Why risk sore throats?" (Old Gold).

In the early 1950s, two well-designed scientific studies sponsored by the American Cancer Society linked smoking with lung cancer. Newspapers and magazines such as *Reader's Digest* provided extensive coverage of the academic studies and *Consumer Reports* began publishing tar and nicotine ratings for all cigarette brands. Cigarette producers, notably the smaller firms, began introducing brands with filters that greatly reduced tar and nicotine. Filtered brands grew from 1 to 10 percent of the total cigarette market between 1950 and 1954. The companies selling them sought to spur their sales by scaring smokers about rival brands: "Filtered smoke is better for your health" (Viceroy), "just what the doctor ordered" (L&M), and "[Kent] takes out more nicotine and tars than any other leading cigarette—*the difference in protection is priceless.*" Television advertisements showed the dark smoke left by competing unfiltered brands on Kent's filter.

Producers' actions thus had the unintended consequence of better informing smokers about the health risks associated with cigarettes in general. According to Calfee, these actions, coupled with the reports in the popular press, did more to deter smoking through the early 1960s than the actions of the government. If anything, Calfee argues, government actions actually hindered the dissemination of information about smoking's risks after a 1955 Federal Trade Commission regulation forbidding producers from making any tar and nicotine claims until "it has been established by competent scientific proof that the claim is true, and if true, that such difference or differences are significant." Although the guidelines explicitly permitted the advertising of taste and pleasure, any references to the presence or absence of physical effects of smoking were banned.

Predictably, cigarette advertisements changed to stressing taste and pleasure rather than the fear associated

[8]John E. Calfee, "The Ghost of Cigarette Advertising Past," *Regulation*, 10 No. 2 (November/December 1986), pp. 35–45.

with smoking. Kent advertisements changed from "significantly less tars and nicotine" to "satisfies your appetite for a real good smoke." Duke, one of the new low-tar brands, switched from "lowest in tars" to "designed with your taste in mind." Cigarette sales ended their several-year decline in 1955 and rose significantly in the ensuing decade. In 1966, acceding to appeals from the American Cancer Society, the Federal Trade Commission reversed its policy and authorized tar and nicotine advertising.

Externalities/Public Goods

Sometimes, in the process of producing or consuming certain goods, harmful or beneficial side effects called *externalities* are borne by people not directly involved in the market activities. Take the case of a motorist choosing to travel an urban freeway during rush hour. The motorist may impose congestion costs on other drivers, costs for which the motorist is not directly accountable. Other goods, known as *public goods*, simultaneously provide benefits to multiple consumers. For example, the same parade, park, or B-1 bomber may enhance the well-being of more than one consumer.

Because the benefits or costs of a good may not be fully accounted for by market actors, externalities and public goods can result in inefficiency—even if competitive markets prevail. In the following chapter, we extensively discuss the reasons why as well as the best mechanisms for promoting efficiency in the case of externalities and public goods.

SUMMARY

• Partial equilibrium analysis concentrates on one market at a time, viewing that market as independent from other markets.

• In contrast, general equilibrium analysis views the economy as a network of interconnected markets, with events in one market affecting others and, in turn, being affected by others. Mutual interdependence among markets is emphasized.

• The concept of economic efficiency, or Pareto optimality, defines a situation in which no person's well-being can be further improved unless someone else is harmed.

• Three conditions determine whether an economy is operating efficiently. First, the goods produced must be efficiently distributed among consumers. Efficient distributions occur at points on the contract curve in an Edgeworth exchange box.

• Second, inputs must be allocated efficiently in the production of goods. Efficiency in production is shown by points on the contract curve in an Edgeworth production box or, equivalently, by the economy's operation on, rather than inside, its production possibility frontier.

• Third, the output mix produced must be efficient. Efficiency in output is identified by a point on the production frontier where, when the outputs are distributed among consumers, each consumer's marginal rate of substitution between any two goods equals the marginal rate of transformation between those two goods.

• If perfect competition prevails, all three efficiency conditions are satisfied and an economy will end up at a point on its welfare frontier. The reasons why economic efficiency may not be realized include market power, imperfect information, externalities, and public goods.

REVIEW QUESTIONS AND PROBLEMS

Questions and problems marked with an asterisk have solutions given in Answers to Selected Problems at the back of the book (page 584).

19.1. What do economists mean when they say markets are *mutually interdependent*? Give an example to support your explanation.

*19.2. In the Figure 19.1 butter–margarine example, would there be any spillover effect on the butter market from the margarine market if the supply curve of margarine were horizontal?

19.3. What does the contract curve in an Edgeworth production box signify? Why do competitive markets generate equilibriums that lie on the contract curve?

19.4. What is the relationship between the *PPF* and the contract curve in an Edgeworth production box?

*19.5. If all industries are in competitive equilibrium, and the price of personal computers is 10 times the price of cellular telephones, what is the *MRT* between the two goods?

19.6. The domestic computer chip manufacturing industry argues that permitting free trade will cost the jobs of thousands of computer chip workers. How does general equilibrium analysis help in responding to this argument?

19.7. What factors determine whether a particular economic issue can be adequately analyzed by using a partial rather than a general equilibrium approach?

19.8. Is every efficient allocation of resources preferred to every inefficient allocation of resources?

19.9. Explain why, when all markets are competitive and in equilibrium, all three conditions for efficiency are satisfied. Does this result indicate that society's welfare is maximized?

*19.10. According to Albert Einstein, "The economic anarchy of capitalist society as it exists today is, in my view, the main cause of our evils. Production is carried on for profit, not for use." Is there a conflict between "production for profit" and "production for use"?

19.11. If Cisco has a monopoly in the server market, what efficiency condition is violated? Would the regulation of Cisco and the elimination of Cisco's profit lead to a more efficient allocation of resources? Will all members of society benefit?

*19.12. Ignoring rationing problems and black markets, under rent control (or any price ceiling that produces a shortage) the price paid by consumers equals the marginal cost of producing the good. Does this mean the output level is efficient? Explain.

19.13. "Using efficiency as a criterion biases the analysis in favor of the status quo, since any change is certain to harm someone." Discuss.

19.14. In each of the cases below, state whether one of the conditions for economic efficiency is violated. "Uncertain" is an acceptable response. If one of the efficiency conditions is violated, indicate which one and whether the resources in question are overused or underused.

a. The Rapid Transit District charges reduced bus fares to its senior citizens.

b. There is a limit to the number of people who can legally immigrate to the United States from India per year.

c. Some neighborhood families do not regularly mow their lawns.

d. The market for hot dogs is perfectly competitive. Michael Jordan's consumption of a hot dog leaves fewer hot dogs available for the rest of the world.

e. The Federal Trade Commission provides free pamphlets helping potential used car buyers identify whether a car's odometer has been rolled back.

f. A per-unit tax is applied to clothing in the context of a two-good (food-and-clothing), two-input (labor-and-capital) economy.

g. A selective minimum wage is imposed by the government on labor employed in clothing production in the context of a two-good (food-and-clothing), two-input (labor-and-capital) economy.

19.15. Why might a resource allocation that achieves efficiency in production not satisfy the condition for efficiency in output? Provide a real-world example.

19.16. Suppose that in the production of computer software, the marginal rate of technical substitution between engineers and marketers is 5 for IBM and 3 for Microsoft. Explain why this outcome violates the condition for efficiency in production and how a voluntary exchange could make both companies better off.

19.17. Most former communist governments of Eastern Europe subsidized food production (both in absolute terms and relative to any subsidies provided other goods). Explain the effect of this policy on the relationship between the typical Eastern European consumer's marginal rate of substitution between food and all other goods (treated as a composite good) and the marginal rate of transformation beween food and all other goods.

*19.18. In the international trade example, we implicitly assumed that the world price ratio was unaffected when the domestic country engaged in trade. Under what conditions is this assumption reasonable? If the world price ratio is affected, how will it change? How will this change affect the analysis?

19.19. Under marketing orders instituted during the 1930s and administered by the U.S. Department of Agriculture, orange growers in California and Arizona have been successful in behaving as a cartel in the fresh orange market. Despite the ability of California and Arizona growers to rely on marketing orders to cartelize the fresh fruit market, explain why, from a general equilibrium perspective, marketing orders have had only a limited effect on grower profits because of the fact that fruit can be diverted to secondary, processed food markets such as orange juice concentrate.

19.20. All points on the welfare frontier depicted in Figure 19.2 are efficient. There is no reason, therefore, why one point on the frontier should be preferred to another. True, false, or uncertain? Explain.

19.21. Suppose that the United States limits the amount of steel that can be imported from other countries. Using a *PPF* that puts units of steel on the horizontal axis and units of another good, such as food, on the vertical axis, explain how such a steel import quota will affect production of food and steel in the United States and alter our consumption possibilities. Will the quota make the United States better off as a whole? If not, will it make anyone in the United States better off? Explain.